APP - W7 - 2 – APPENDICES TO PROOF OF EVIDENCE

The Network Rail (Cambridge Re-Signalling) Order

Appendices to Proof of Evidence

CONTENTS

NC1

Department for Transport

TAG UNIT M3.1

Highway Assignment Modelling

May 2020

Department for Transport

Transport Analysis Guidance (TAG)

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This TAG unit is guidance for the **MODELLING PRACTITIONER**

This TAG unit is part of the family **M3 – SUPPLY-SIDE MODELLING**

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Contents

1 Introduction

1.1 Scope of the Unit

1.1.1 This unit provides guidance on developing, calibrating and validating a highway assignment model. It provides advice on aggregate highway assignment models, for both general and specific purposes, which represent average conditions over the modelled period, often one hour. The focus of this guidance is hence on steady-state equilibrium models. The features and methods used in dynamic assignment and microsimulation are not covered explicitly. However, it should be recognised that many of the principles of this guidance are equally applicable, irrespective of model type.

1.1.2 The unit provides advice on the topics shown in Figure 1. The numbers in brackets relate to the sections in this unit, with the aim of providing a means by which topics can be located relatively easily.

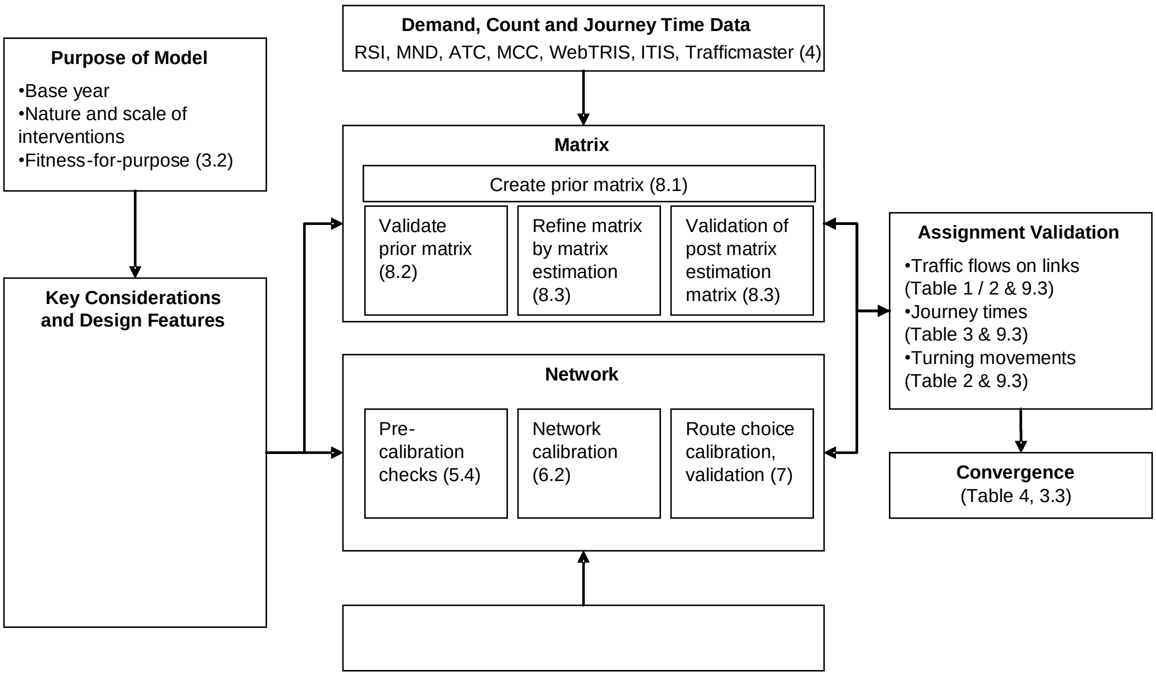

Figure 1 Structure of this Unit

1.2 Relationship of this Unit to Other Advice

1.2.1 This unit **excludes** advice on the following topics which are related to highway assignment modelling:

- travel demand data collection, including roadside interview surveys, traffic counts and journey time surveys
- the development of base or prior trip matrices for highway assignment models
- preparing forecasts using highway assignment models

1.2.2 This unit is a companion to the following TAG units:

- M1.2 – Data Sources and Surveys
- M2.1 – Variable Demand Modelling
- M2.2 – Base Year Demand Matrix Development

- M3.2 – Public Transport Assignment Modelling

1.2.3 A glossary of the terms used in this unit can be found in Appendix A.

2 Designing a Highway Assignment Model

2.1 Introduction

2.1.1 This section provides advice on the following topics:

- overall consideration of fitness for purpose of a highway assignment model
- the specification of the Fully Modelled and External Areas of the model
- the design of the zoning system
- the structure of the network representation, including centroid connector design
- the time periods which should be modelled
- the specification of the classes of user which should be assigned separately
- the assignment method
- the specification of generalised cost and the sources of the operating costs and values of time which should be used
- capacity restraint mechanisms, including the use of junction modelling and speed/flow relationships
- the relationships of the highway assignment model with variable demand models and public transport assignment models

2.2 Modelled Area

Fully Modelled and External Areas

2.2.1 The geographic coverage of highway assignment models generally needs to:

- allow for the strategic re-routeing impacts of interventions
- ensure that areas outside the main area of interest, which are potential alternative destinations, are properly represented
- ensure that the full lengths of trips are represented for the purpose of deriving costs

2.2.2 It is important to establish at the outset the nature, scale and location of the interventions which are to be tested using the model.

2.2.3 The second and third requirements are particularly important where a highway assignment model will be linked to a demand modelling system. See section 2.10 for further details.

2.2.4 The modelled area should ideally be no larger than is necessary to meet these requirements. A larger than necessary modelled area will add to model run times and make acceptable convergence harder to achieve. This means that, where a model is developed from an existing model, consideration should be given to removing or simplifying redundant areas of network and zoning so that the model is no larger or more detailed than is necessary to meet the requirements set out above.

2.2.5 Within the overall modelled area (in many models encompassing the whole country), the level of modelling detail will vary. It is useful to consider this variation in terms of a classification of modelled area type as set out below.

- **Fully Modelled Area**: the area over which proposed interventions have influence. This is further subdivided as set out below:
  - **Area of Detailed Modelling.** This is the area over which significant impacts of interventions are certain. Modelling detail in this area would be characterised by: representation of all trip movements; small zones; very detailed networks; and junction modelling (including flow metering and blocking back)
  - **Rest of the Fully Modelled Area.** This is the area over which the impacts of interventions are considered to be quite likely but relatively weak in magnitude. It would be characterised by: representation of all trip movements; somewhat larger zones and less network detail than for the Area of Detailed Modelling; and speed/flow modelling (primarily link-based but possibly also including a representation of strategically important junctions)
- **External Area**: In this area impacts of interventions would be so small as to be reasonably assumed to be negligible. It would be characterised by: a network representing a large proportion of the rest of Great Britain, a partial representation of demand (trips to, from and across the Fully Modelled Area); large zones; skeletal networks and simple speed/flow relationships or fixed speed modelling.

2.2.6 In traffic routeing terms, a primary objective for the External Area is to ensure that traffic enters the Fully Modelled Area at the right locations and that opportunities to avoid travelling through the Fully Modelled Area are properly represented. The same principle applies to the relationship between the Rest of the Fully Modelled Area and the Area of Detailed Modelling. This will usually involve an appreciation of the catchment areas of the main roads crossing the boundaries of the Fully Modelled Area and Area of Detailed Modelling.

2.2.7 The key to determining the boundaries of these areas is to understand the nature and scale of the interventions to be tested using the model. In some cases, models will be built for the appraisal of a specific scheme. In other cases, though, the model may be conceived with only some provisionally specified interventions in mind or as a general purpose tool. There is a need for clarity about the uses to be made of the model, that is, **the purposes for which the model can be used**.

2.2.8 Once an understanding about the uses to be made of the model has been gained, there are a number of ways to define the boundaries of the various model areas. One method is to make use of an existing model with geographic coverage as wide as or wider than that for the proposed new model. Testing of a range of potential interventions using such a model will, through analysis of link flow changes from a base position, allow an indication of where impacts are strong, weak or negligible. These categories broadly correspond to the three model areas as set out above. Where interventions could have a particularly strong impact on travel demands and where only highway assignment modelling is available rather than a fully specified variable demand model, the use of elastic assignment techniques could be made in this analysis.

2.2.9 Without an appropriate existing model, other less directly informative methods will need to be employed. Commercially available digital networks (with fixed speeds by road type) could be incorporated in a provisional highway assignment network and interrogated as above. Local knowledge and professional judgement should also be applied in the definition of the areas, although in this case the need to err on the side of wider geographic coverage may arise.

Cordon Models

2.2.10 Cordon models are assignment model variants where the modelled area is curtailed at a specified boundary. Trips with one or both end points outside of this area are not represented for their full length, being curtailed to one of the zones that represent the cordon boundary.

principles have followed compatible rules). This advice also applies in respect of the zoning system of any other data sources to be used in constructing the model.

2.3.5 Within the above constraints, further factors that should be taken account of and exploited in the definition of zones include:

- natural barriers (rivers, railways, motorways or other major roads)
- areas of similar land use that have clearly identifiable and unambiguous points of access onto the road network to be included in the model

2.3.6 Zone boundaries should take account of the need for internal screenlines (interviews and counts) for trip matrix building, calibration and validation. It is desirable that all counts should be located on zone boundaries or sufficiently close to these, such that the positioning of zone connectors makes the modelled traffic on the relevant links consistent with the observed flows.

2.3.7 Once zone boundaries and survey locations are defined, it is generally quite straightforward to fit a study-specific programme of counts, for calibration and validation, to the zone boundaries. However, where development of the model is dependent upon use of existing counts for such purposes, the process will be more problematic, and the location of these counts would also need to be taken account of in the zone definition process.

2.3.8 In some models, especially those covering urban centres in considerable detail, it will be necessary to represent explicitly the location of the main car parks or groups of car parks as unique zones. Trip matrices for highway assignment models should represent vehicle rather than person trip ends, and in urban centres these can be significantly different[1].

2.3.9 There will always be a degree of interdependence between the definitions of the zoning system and the network, such that one should not be defined without reference to the other. If zones are significantly larger than implied by the detail of the network, it will often be impossible to locate zone connectors realistically. This may lead to distorted traffic flows on nearby links and turning movements at nearby junctions, which may themselves distort traffic patterns elsewhere in the network. In urban area models in particular, zones should be small enough to avoid this type of problem.

2.3.10 Generally, zones should be designed so that the number of zone connectors for each zone is minimised. Use of multiple connectors leads to loadings at the periphery of zones, underestimating travel and therefore traffic within the zone itself and should, if at all possible, be avoided[2].

2.3.11 An important feature of the zoning system for the Area of Detailed Modelling in a highway assignment model is that the resultant numbers of trips to and from individual zones should be approximately the same for most zones and that the numbers of trips to and from each zone should be some relatively small number, such as 200 or 300 per hour, to avoid unrealistically high loads appearing at some points in the network. Some will need to be smaller than this, in order to model their loading points sufficiently accurately. Beyond that, any major increase in the number of zones, with fewer trips per zone, is likely to increase the complexity of the model without adding significantly to real model accuracy. Small zones should be concentrated in the key parts of the modelled area. In the Rest of the Fully Modelled Area, where zones will be significantly larger than for the Area of Detailed Modelling, it will be often necessary to relax the constraint on numbers of trips to and from each zone.

1 By contrast demand models require person trip ends, so the zone system must also be designed to represent these in an adequate manner.

2 Some software has the ability to allocate traffic to zone connectors in a way that reflects the user assumed distribution of trip ends within a zone, and this would allow for the appropriate use of multiple connectors and somewhat larger zones. The practice is not common in highway assignment modelling, although it is widely used for public transport modelling.

2.3.12 The level of zonal detail adopted will be a matter of judgement. However, analysts should bear in mind that, although a finer zoning system and network will give a better loading of traffic onto the local road system, this better definition is achieved at the expense of less data certainty, model building costs and computer run times.

2.4 Network Structure

Network Structure: Area of Detailed Modelling

2.4.1 Within the Area of Detailed Modelling, a relatively high level of detail will generally be appropriate. Guidelines for Developing Urban Transport Strategies (Institution of Highways and Transportation 1996) suggests that “all roads that carry significant volumes of traffic” should be included and more generally that networks “should be of sufficient extent to include all realistic choices of route available to drivers”.

2.4.2 For a model created for a specific scheme, the network should include all main roads, as well as those secondary routes, and roads in residential areas (especially 'rat-runs'), that are likely to carry traffic movements which could use the scheme being assessed, either in the base year or in future years, and that are significant in relation to the capacity of the scheme. Modelling this ‘rat run’ traffic may present some technical difficulties, but it is desirable that the effectiveness of the scheme in attracting this traffic back to the main road network, is accurately assessed. Local highway authorities will normally be aware of the common 'rat-runs', but some independent assessment may also be required. In the absence of count data, accident plots may also give an indication of alternative routes that vehicles are using to avoid local congestion points.

Network Structure: Rest of the Fully Modelled Area

2.4.3 Impacts of interventions could occur over the Rest of the Fully Modelled Area, albeit at a relatively weak magnitude, as ensured by well-considered model design. This part of the model would be characterised by somewhat larger zones and less network detail than in the Area of Detailed Modelling and capacity restraint modelling by means of speed/flow relationships (primarily link-based but possibly also including a representation of strategically important junctions).

2.4.4 The appropriate balance between demand and supply for this area should be carefully considered. An appropriate balance is ensured in the Area of Detailed Modelling through use of quite small zones and detailed networks. In the External Area, travel costs should not be responsive to levels of demand and therefore the need to ensure an appropriate balance between demand and supply does not arise.

2.4.5 In the Rest of the Fully Modelled Area, while demand would be fully represented, zones would be relatively large and networks would not be comprehensive. The possibility exists that the demand loaded to the network links could be either excessive, where the network is too sparse in relation to the level of zoning, or too low, where zones are large and many trips are intra-zonal and therefore not loaded onto the network. Either possibility would distort the representation of journey times and could introduce undesirable levels of sensitivity of journey times to demand changes. An appropriate balance therefore needs to be found. The ideal would be a situation where the loaded demand is appropriate for the capacity of the roads that are included in the network.

2.4.6 Some key points to bear in mind when defining networks and zones for the rest of the Fully Modelled Area are as follows:

- intra-zonal trips are not loaded onto the network
- it would be appropriate to consider including in the network all significantly trafficked links that cross zone boundaries
- some increase in the capacity of the modelled roads to reflect that of roads that have not been included could be considered

traffic appropriately onto the network; in these instances, whether traffic loads onto one or other of the roads will depend on the analyst's judgment about the location of the centre of gravity of the zone in relation to the road network.

2.4.14 In general, centroid connectors should not be connected directly into modelled junctions unless a specific arm exists to accommodate that movement. In practice, certain packages allow a range of different types of connection. It is important that the analyst understands how flows are output by the package being used and ensures that this information is used and reported in a consistent manner.

2.4.15 It is generally preferable to minimise the number of centroid connectors from a single zone to a network. Multiple connections can lead to instability during assignment and model convergence problems. There are also associated difficulties introduced where multiple centroid connectors can straddle traffic count locations and this should be avoided. Centroid connectors from adjacent zones should not be loaded onto the same point as this will lead, at worst, to movements between the zones not appearing on the network. Indeed, this can be a common source of errors and warnings from TUBA.

2.4.16 The times, distances and money costs coded onto centroid connectors should represent the average costs of accessing the network from the development in the zone as realistically as possible.

2.5 Time Periods

2.5.1 Traffic patterns, trip purpose and vehicle type proportions, traffic flows and congestion vary by time of day. Highway assignment models should therefore normally represent the morning and evening peaks and the inter-peak period separately as a minimum. There may also be a need to model further time periods, such as off-peak times and weekends, if this materially affects the analysis of the scheme impacts, including economic and environmental, and cannot be accommodated adequately by the appraisal 'annualisation factors' (see TAG unit A1.3 – User and Provider Impacts).

2.5.2 The peak periods should be identified by analysis of Automatic Traffic Counts (ATCs) at as many points as are available throughout the Fully Modelled Area. The aim should be to designate those periods where traffic flows are markedly higher as the peak periods[3] with the inter-peak period being a period between the two peaks during which flows are approximately constant. It is conventional to define peak periods, and inter-peak periods, as multiples of hours rather than as hours plus fractions of hours.

2.5.3 In the inter-peak period, it is usually appropriate to model an average hour. In the peaks, however, models could represent one of the following:

- each individual hour within each peak period
- the actual peak hour within each peak period
- the average hour within the peak periods

2.5.4 In theory, a separate model run should be prepared for periods where demand differs significantly from others. During the peaks, it may therefore be necessary to model each hour separately where the profile of demand across the peak is substantially different, rendering the use of an average hour an unrealistic representation. In practice, constraints on resource to collect the adequate data and calibrate and validate the model for each time slice can be prohibitive. Where this is the case, some compromise will be necessary and where possible a peak hour model should be preferred to an average hour where such a distinct peak exists.

[3] It should be noted that flows are often tidal, so the flows in the peak period in one direction may actually be lower.

2.5.5 Actual peak hour models are therefore to be preferred in most circumstances. However, highway assignment models are commonly used to provide generalised costs for demand models and demand models normally represent peak periods (as well as inter-peak and off-peak periods). The use of actual peak hour assignment models, and possibly models of the peak shoulder hours, to drive peak period demand changes is considered further in section 2.10.

2.5.6 Peak hour models have the following advantages:

- traffic flows and congestion at peak times will be more accurately modelled, which will not be the case if average conditions are lesser congested
- a peak hour is more representative of a situation in reality. While traffic counts and journey times can, in principle, be averaged over the peak hours, it is hard to judge the plausibility of the routes modelled for a period which does not exist in reality

2.5.7 Average peak hour models may be suitable to use in the following circumstances, noting that it will be rare for these conditions to be met for models of regions and for urban areas outside Inner and Central London:

- capacity on the network is more than adequate to cater for the forecast demand in the base year and forecast years and/or
- traffic levels are approximately constant throughout the period and/or
- a substantial proportion of the trips in the Fully Modelled Area are longer than one hour (although this may be more appropriately handled through modelling using longer time periods or through dynamic methods)

2.6 User Classes

2.6.1 Operating costs vary by vehicle type and values of time vary by the purpose of the trip being made. Values of time may also vary by income group. This means that different combinations of vehicle and user may have different distance coefficients (defined as the vehicle operating cost / value of time) and therefore be modelled as choosing different routes through the network.

2.6.2 The total trip matrix should therefore be split into a number of **user classes**, each of which should have distinctly different distance coefficients in their generalised cost formulation. Unless there are special circumstances, cars on business, other cars, LGVs and HGVs should be treated as individual user classes and assigned separately in a multi-user class assignment. Non-work car demand should also be split by income band where tolling and charging schemes are to be assessed.

2.6.3 It is also possible that separate user classes may need to be distinguished for other reasons. Examples of such reasons include the following.

- In some models, some vehicle types may be exempt from or prone to certain restrictions. For example, goods vehicles are sometimes permitted to use bus priorities, or restricted from using certain roads. They should therefore be treated as a separate user class, assuming the network coding can accommodate these exemptions or restrictions.
- Certain vehicle types are important for particular appraisals. For example, HGV noise and air pollutant emission levels are much higher than those for cars and therefore should be treated as a separate user class. Also, employers' business trips have relatively high values of time and the impacts of these trips will play a significant role in the Transport Economic Efficiency appraisal. Being able to identify the demands and costs for these trips separately and realistically is important.

2.7.7 As described in section 2.5, it may be deemed necessary to model more than one hour to represent a period within which the demand profile varies significantly. This is particularly important where there is significant queuing delay necessitating explicit junction modelling.

2.7.8 The use of **time slices** to model the effects of varying traffic levels within peak periods may be considered to address the above issues. However, the use of time slices can introduce additional complexity into the assignment process. This needs to be balanced against the improved modelling of the growth and decay of queues and delays. The method chosen for a particular scheme appraisal will depend on the circumstances surrounding the scheme. If assignments are undertaken for time-slices of less than one hour, the traffic measures should be presented in terms of hourly flow rates.

2.7.9 One specialised use of a time slice approach that may be considered is the use of a pre-peak assignment to represent queued traffic present at the start of the main modelled time period. Some assignment suites allow for existing queues (and the volumes of traffic represented) to be used as initial conditions in the network. In such cases, it is often convenient to introduce a ‘feedback’ loop, whereby estimates of demand in the main time period are factored appropriately and used as demand for the pre-peak period.

2.7.10 Some congested assignment models also incorporate procedures for estimating the effects of capacity restrictions on downstream traffic flows (sometimes referred to as **flow metering**). This is an important feature of many congested road networks, and failure to take it into account can lead to serious over-estimation of queues and delays at downstream junctions and poor estimation of overall network delays. It also leads to the distinction between 'demand' flow (ie the flow that would exist if there was no upstream capacity restriction) and 'actual' flow (after taking such restrictions into account). If this modelling feature is in operation, care must be taken to use the correct flow definition in the subsequent traffic, environmental and economic appraisal calculations (including the validation of traffic flows). Where aggregate flows over a complete model time period (or a series of time periods) are being used, the difference will often be negligible but, if flows for shorter periods are being considered, as for example in certain environmental and design calculations, it is the 'actual' flow values that are most appropriate.

2.7.11 The operation of junctions in urban areas is sometimes influenced by queues **blocking back** from an adjacent junction and limiting flow through upstream junctions. Some modelling packages have procedures for dealing with this situation. The use of blocking back procedures can generally be justified in terms of producing more realistic assignments in congested networks, although users should be aware of potential problems where very short links are coded.

2.8 Generalised Cost

2.8.1 In principle, the basis for route choice in a highway assignment model should be generalised cost, defined as follows:

Generalised cost = (time) +

(vehicle operating cost per km x distance / value of time) +

(road user charges / value of time)

It should be noted that where user classes are defined by income group (for example where road user charges are important), the values of time used in the generalised cost formulation should vary by income group.

2.8.2 **Generalised cost is expressed in units of time.** This removes the difficulty of changes in costs over time, due to inflation and other changes, which may produce inconsistencies from year to year. In this regard, time is the more stable measure to use and does not require further adjustment, beyond the change in values of time over time.

2.8.3 The vehicle operating cost per km should be calculated using the formulae in TAG unit A1.3 – User and Provider Impacts. The values of time used to convert the vehicle operating costs to time units should also be taken from TAG unit A1.4. In a highway assignment model, the vehicle operating costs and road user charges should relate to vehicles (as distinct from persons as required for a demand model). Average vehicle occupancies should be derived from local data, such as roadside interview surveys, in order to convert the values of time per person given in unit A1.4 to the values of time per vehicle.

2.8.4 The operating cost formulae given in TAG unit A1.3 relate vehicle operating costs to speed of travel, by vehicle type. It is not considered necessary to use the speeds of traffic on each link individually, not least because modelled speeds will vary as the assignment iterations proceed, and varying vehicle operating costs (and therefore the basis for route choice) within the assignment process is likely to make convergence harder to achieve efficiently. Some kind of average speed should therefore be used.

2.8.5 Where separate speed/flow relationships are used for light and heavy vehicles, the average speeds used in these vehicle operating cost calculations should vary accordingly. See the next section for further advice on this aspect.

2.8.6 Values of vehicle operating cost and value of time should be derived from TAG unit A1.3 for the base year and for forecasting assignments without amendment. This will maximise consistency between the assignment and the demand model in line with the advice in TAG unit M4 – Forecasting and Uncertainty.

2.8.7 It is a requirement for the assessment of road tolling and charging that demand in the highway assignment model is segmented to reflect the variation in values of time. When introducing segmentation by income (that is, values of time which vary by income group), that variation in the value of time should usually only be allowed to affect the tolls and charges and not the vehicle operating costs; the same distance coefficient should be applied to all income groups in each car purposes[5]. In cases where there are no significant tolls and charges in the base year, this approach means that the assignment model can be calibrated without income segmentation, with merely a final check made that segmenting the matrices by income in the base year does not materially affect the validation.

2.8.8 The value of time given in TAG unit A1.3 for HGVs relates to the driver's time and does not take account of the influence of owners on the routeing of these vehicles. On these grounds, it may be considered to be more appropriate to use a value of time around twice the TAG unit A1.3 values[6]. If the higher value of time is used, a sensitivity test should be run to show the impacts of using the values of time from TAG unit A1.3.

2.9 Capacity Restraint Mechanisms

Introduction

2.9.1 Capacity restraint is the process by which speeds, and therefore travel times and generalised costs, are adjusted so that they are consistent with the assigned traffic flows. As the assigned traffic flows are dependent on the generalised costs of each route, and as the generalised costs are dependent on the assigned flows, an iterative procedure is required to find the equilibrium when the assigned flows are consistent with the generalised costs. The methods by which this equilibrium can be determined are outlined in section 2.7 and Appendix B.

2.9.2 In models of congested areas, capacity restraint should be applied throughout the Fully Modelled Area. Capacity restraint may be applied by the use of either:

5 Usually, only the consumer purposes.

6 For further information on values of time, see Hague Consulting Group (1994 (revised 1996)).

- link-based speed/flow or flow/delay relationships or
- flow/delay modelling of junctions or
- a combination of both

2.9.3 Junction modelling will be required where junction capacities have a significant impact on drivers' route choice, and where delays are not adequately represented by speed/flow relationships applied to network links. Care must be taken to specify realistic capacities throughout the Fully Modelled Area and in the choice of turning movements for which it is necessary to specify individual turn capacities.

Junction Modelling and Speeds Between Junctions

2.9.4 The Fully Modelled Area will contain the highest level of detail within the model and hence this is the area within which all significant junctions should be modelled in detail (often referred to as 'simulated').

2.9.5 It is usually assumed that, in **urban** areas, flow does not greatly influence link speeds between junctions (cruise speeds), although there are some exceptions, such as motorway links and long dual carriageway links. Speeds between junction queues are more related to the type of road and activity levels alongside links and pedestrian flows crossing links than flow levels.

2.9.6 There may be instances where link capacities are lower than junction arm capacities. In these cases, speed/flow relationships should be used to represent the effects of the link capacities.

2.9.7 Appendix D specifies the speed/flow relationships used in COBA[7] (the DfT's link-based COst Benefit Analysis software) and which may also be used in highway assignment models. However, the **urban** speed/flow relationships apply to networks rather than individual links and also include an allowance for junction delays. These **urban** relationships are therefore only suitable for the approximate modelling of capacity restraint effects in areas peripheral to the area over which the main impacts of the interventions being tested would be felt; they should **not** be used in conjunction with junction modelling. The **suburban** and **small town** speed/flow relationships apply to whole routes rather than individual links but exclude delays at major junctions which need to be modelled explicitly.

2.9.8 Generally, in **urban** areas within the Fully Modelled Area, the use of fixed cruise speeds is advised in conjunction with junction modelling, rather than using link-based speed/flow relationships. Cruise speeds should **not** be based on speed limits but should reflect mean speeds on a link. This is particularly relevant for traffic-calmed links, for links carrying heavy bus flows that impede other traffic, and for links with high parking and/or pedestrian activity.

2.9.9 Experience suggests that, in an **urban** network, the times taken to travel along links between queues can, for the network as a whole, be as much as twice the total delay at junctions; that is, as much as two-thirds of total travel times will come from the cruise speeds rather than junction delays. Thus, cruise speeds need to be established accurately. See section 5.2 for further advice.

2.9.10 There may be a need to represent mid-link delays, such as pedestrian crossings, where pedestrian crossing flows are significant, principally near to public transport interchanges, rail stations and shopping streets. Time penalties based on signal timings for pedestrian crossings (see Local Transport Note 2/95 (Department for Transport 1995)) can be allocated to affected links to represent such mid-link delays. Alternatively, pedestrian `crossing signals can be explicitly modelled where outputs from signal control systems are available. In some circumstances, it may be appropriate to

7 The COBA manual has now been withdrawn but is still available from the National Archives: https://webarchive.nationalarchives.gov.uk/20090902134923/http://www.dft.gov.uk/pgr/economics/software/coba11usermanual/

use the suburban and small town speed/flow relationships to represent the effects of minor junctions which are not modelled explicitly.

2.9.11 Junction modelling may also be appropriate in **inter-urban** networks where significant delays at major junctions on trunk roads and intersections on motorways occur. In these instances, it will generally be appropriate to use speed/flow relationships on the links between the modelled junctions rather than fixed cruise speeds. The **rural** speed/flow relationships given in Appendix D exclude delays at major junctions so the use of these relationships in conjunction with junction delay modelling would not lead to delays being included twice.

2.9.12 Advice on the modelling of delays at motorway merges is provided in Appendix D.

Speed/Flow Relationships

2.9.13 The speed/flow relationships recommended for use in highway assignment models are specified in Appendix D. These relationships are specified in terms of vehicles and the Appendix includes advice on their conversion to Passenger Car Units (PCUs). It also specifies the forms of speed/flow relationship which should be used in highway assignment models to cater for circumstances when assigned demand exceeds capacity, leading to standing queues.

2.9.14 The use of separate speed/flow relationships for light and heavy vehicles is expected in most circumstances. This is because this approach provides more accurate estimates of changes in vehicle operating costs. Having separate speed/flow relationships for goods vehicles may assist modellers in the challenging area of HGV route assignment. This is of crucial importance in environmental assessments, for example of noise and air quality, where accurate flows of goods vehicles will be required at a relatively detailed level.

2.9.15 There are a number of points to note, as follows:

- The **urban** and **small town** speed/flow relationships in COBA apply to all vehicles and do not provide separate estimates for light and heavy vehicle speeds. If the use of these relationships is confined to areas away from the area of influence of the interventions to be tested, the assumption that light and heavy vehicle speeds are the same should be acceptable.

- The **rural** and **suburban** speed/flow relationships provide separate estimates for light and heavy vehicles. Where possible, the modelled journey times for the two vehicle types should be validated separately, which would require journey times to be surveyed in such a way that reliable data for the two separate vehicle types is obtained.

2.9.16 Where a single relationship is used for all vehicle types, it will be necessary to assume a percentage of heavy vehicles so that a flow-weighted average of the relationships for light and heavy vehicles can be derived. The proportion of heavy vehicles will vary by link in the network and will also vary as the assignment calibration proceeds. The obvious source for these proportions is traffic counts by vehicle type. However, the 95% confidence interval for volumes of heavy vehicles from a single day Manual Classified Count (MCC) is ±28%. Moreover, counts will be available for only a sample of the modelled roads. It is therefore recommended that **average** heavy vehicle proportions should be calculated from counts by, at least, road type (motorway, all-purpose dual carriageway, single carriageway) and by type of area (rural, urban central, urban non-central, small towns and suburban). Other categories, such as roads leading to freight generators, should be considered depending on the availability of sufficient count data to support further categorisation.

2.9.17 As the calibration of the assignment model proceeds, the proportions derived from counts should be compared with the proportions derived from the assigned flows. Where discrepancies are significant, the conversions of the capacities and breakpoints in the speed/flow curves should be revised. While it may be impractical to make this comparison at each stage in the calibration of the assignment model, periodic checks should be made and adjustments made as necessary, especially near the end of the calibration process.

2.9.18 The relationships given in Appendix D allow for the effects of road geometry and other attributes to be taken into account. The analyst should consider whether the hilliness and bendiness of the links being modelled are sufficient to have a material effect on the speed/flow relationship. In practice, in most cases only a very small proportion of links within the highway network are likely to require bespoke speed-flow curves to capture their hilliness and bendiness. Highway assignment models often cover a significant study area and measurements of specific geometric attributes should therefore typically only be reserved as a possible calibration technique if modelled journey times provide a poor match against observations.

2.10 Relationships with Variable Demand and Public Transport Assignment Models

Introduction

2.10.1 This section provides advice on a number of aspects of highway assignment models which have a bearing on aspects of variable demand models and public transport assignment models. The implications of these matters for demand models and public transport assignment models should be borne in mind when designing a highway assignment model.

2.10.2 It is possible for highway interventions to be modelled using a highway assignment model and demand model on the basis that public transport times are assumed to be constant, both over time and as a result of the highway intervention. In these instances, the implications for public transport models will not be relevant. In multi-modal transport models, however, which are intended for the assessment of both highway and public transport interventions, the implications for public transport assignment models will be important to bear in mind.

Convergence

2.10.3 A high level of convergence for the highway assignment is particularly necessary where the assignment model is linked to a variable demand model because inadequate convergence is likely to result in unstable and unreliable forecasts. TAG unit M2.1 discusses the process of supply/demand convergence.

Compatibility of Highway Assignment, Public Transport Assignment and Demand Model Zones

2.10.4 An identical zoning system for highway and public transport assignment model components of a comprehensive transport modelling system is **not** required or necessarily appropriate. It is often the case that zones for a public transport assignment model need to be sufficiently small around stations and stops for access by walking to be realistically represented by the centroid connector times[8]. It is therefore quite conceivable that the ideal zoning system for a public transport assignment model will be different from the ideal zoning system for a highway assignment model. Forcing one to match the other, or a compromise between zoning systems could lead to unsatisfactory results. A fine zoning system that was a combination of both systems could lead to unacceptably long model run times.

2.10.5 However, within a demand model system there is a need for consistency of highway and public transport zoning to allow the travel choices other than that of route (eg mode or destination) to be appropriately dealt with. To this end, it is desirable that the two zone systems can be nested together, eg where public transport zones are smaller than highway zones, the former should be able to be aggregated to the latter. On this basis, and given that public transport zones need never be larger than highway zones, use of the highway model zones as the basis for demand modelling has become standard practice. A further argument supporting these principles is the need for both highway and public transport zone systems to respect the administrative boundaries defined in section 2.3.

8 This is not always the case as some public transport assignment model software has the capability to spread loading along centroid connectors in a manner that reflects a distribution of trip ends within a large zone.

use of cost changes derived from actual peak **hour** assignment models in the demand model may well lead to peak **period** demand changes being over-estimated.

2.10.14 Sensitivity tests should be carried out using damped cost changes from the actual peak hour assignment model in order to gauge the extent to which the demand changes might be over-estimated. This will assist in determining an appropriate conversion from costs in the peak hour to the peak period.

User Classes

2.10.15 The demand segments usually employed in demand models will be based on trip purpose and car availability (although the car user classes employed in highway assignment models will, by definition, all be in the car available category). The number of trip purposes treated separately in the highway model will normally be fewer than those treated separately in the demand model, so some aggregation will normally be required.

Generalised Costs

2.10.16 In the case of a highway assignment model which operates with a demand model, it is better if the values of vehicle operating cost and value of time derived from TAG unit A1.3 can be retained in the base year assignment without amendment and that they are changed in forecasting in line with the advice in that unit. This approach will maximize consistency between the assignment and the demand model.

2.10.17 In a highway assignment model, the car vehicle operating costs and road tolls and charges should relate to vehicles whereas, in a demand model, they should relate to persons.

Capacity Restraint Modelling in Tiered Model Systems

2.10.18 In some cases, the size and nature of the Fully Modelled Area, and the nature of the preferred assignment method, may mean that convergence between demand changes and cost changes cannot be achieved within practical model run times. Such areas will be characterised by large numbers of small zones and detailed and congested networks. Normally, for areas of this kind, the preferred assignment method would be user equilibrium assignment, with capacity restraint modelled by detailed junction modelling, including flow metering.

2.10.19 One way of reducing run times to more practical levels, while retaining the desired level of detail in the highway assignment model, is to create a **tiered model system**. In such a system, a simplified version of the detailed highway assignment model is created from the detailed version and cost changes from this simplified version are used to derive the demand changes. Because the simplified highway assignment model is able to run to convergence in much shorter times than the detailed model, convergence between demand changes and cost changes can be achieved in shorter times. See Appendix E for further details on tiered model systems.

3 Validation and Convergence Standards

3.1 Introduction

3.1.1 This section provides advice on the following topics:

- validation criteria and guidelines
- convergence measures and acceptable values
- the importance of fitness for purpose of the highway assignment model

3.1.2 In general, the advice in this section applies to models created for both general and specific purposes. However, in the case of models created for the assessment of specific interventions, it will be natural to pay greater attention to validation quality in the vicinity of the interventions.

3.1.3 It is important to bear in mind that the role of calibration is to develop a model that is fit for purpose and does not produce unduly misleading or biased results that are material in the context of the schemes or policies being tested. This is discussed further in section 3.2. The issues of calibration and validation should be addressed up front in model development and be part of the Appraisal Specification Report (see Guidance for the Technical Project Manager), agreeing the scope of the model and the purpose for which it will be used.

3.2 Fitness for Purpose

3.2.1 **The test of fitness for purpose of a model is: can robust conclusions be drawn from the model outputs?**

3.2.2 The achievement of the validation guidelines specified in Table 1, Table 2 and Table 3 does not guarantee that a model is 'fit for purpose' and likewise a failure to meet the specified validation standards does not mean that a model is not 'fit for purpose'. A model that meets the specified validation standards may not be fit for particular purposes and, conversely, a model that fails to meet to some degree the validation standards may be usable for certain applications. Local Model Validation Reports should therefore **not** include statements to the effect that, **because** the validation standards have been (largely) achieved, the model is **necessarily** fit for purpose.

3.2.3 For a model developed to assess a specific intervention, tests of the sensitivity of the appraisal of that intervention to variations in aspects of the model thought to be weaker and of relevance will show the robustness of the appraisal to uncertainties in the model. Standard output from the model such as assignment flows and journey times are important to check. In addition, it may be useful to conduct Transport Economic Efficiency appraisals, since these are relatively sensitive to uncertainties in the modelling, to ascertain the sensitivity of the appraisal results. This may also be important for assessments of air quality, for example, which are also very sensitive to modelling uncertainties.

3.2.4 For further discussion of this point, particularly in the context of matrix estimation, please also refer to paragraph 3.3.3.

3.2.5 For a general purpose model, it may be useful to carry out a series of demonstration tests so that potential users of the model can gauge the usefulness of the model for particular applications. The range of tests should cover the range of interventions for which the model is intended to be used.

3.3 Validation Criteria and Guidelines

3.3.1 Any adjustments to the model intended to reduce the differences between the modelled and observed data should be regarded as **calibration**. **Validation** simply involves comparing modelled and observed data that is independent from that used in calibration. The extent of data available for model development is often limited and it may be appropriate to use data first for validation through independent testing of other data and model relationships, and then to undertake additional calibration to refine the model. In this case the extent of change from introducing complementary data should be explained.

3.3.2 The differences between modelled and observed data should be quantified and then assessed using some criteria. The recommended proportion of instances where the criteria are met should be assessed. The purpose of this assessment is to explain the confidence that can be placed on the model outputs; it should not be interpreted as a target that the model should be constrained to achieve. Paragraph 3.2.2 gives more detail about the fitness for purpose of models.

3.3.3 In some models, particularly models of large congested areas, it may be difficult to achieve the link flow and journey time validation guidelines as set out later in this section in Table 2 and Table 3 without matrix estimation bringing about changes greater than the limits shown in Table 5. In these cases, the limits set out in Table 5 should be respected, the impacts of matrix estimation should be reduced so that they do not become significant, and a lower standard of validation reported.

In other words, matrix estimation should not be allowed to make significant changes to the prior matrices in order that the validation standards are met.

3.3.4 Outliers should also be examined, even when the criteria in Table 5 are met. Explanations about the relevance of the outliers to the intended uses of the model should be included in the Local Model Validation Report.

3.3.5 The validation of a highway assignment model should include comparisons of the following:

- assigned flows and counts totalled for each screenline or cordon, as a check on the quality of the trip matrices;
- assigned flows and counts on individual links and turning movements at junctions as a check on the quality of the assignment; and
- modelled and observed journey times along routes, as a check on the quality of the network and the assignment.

3.3.6 These are the **main** comparisons that are recommended. Other checks are discussed in sections 6, 7, 8 and 9. The validation **measures**, **criteria** and **guidelines** for each of these comparisons are as follows.

Trip Matrix Validation

3.3.7 For trip matrix validation within traffic assignments, the measure which should be used is the percentage differences between modelled flows and counts. Comparisons at screenline level provide information on the quality of the trip matrices. The validation **criterion** and **guideline** for screenline flows are defined in Table 1. In the first instance the prior matrix should be assigned and tested against this criterion before any impact of matrix estimation takes effect. If matrix estimation is required to improve the model validation, then its impact on screenline flows should be also be monitored.

Criteria	Guideline
Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines (ie 95%)

3.3.8 With regard to screenline validation, the following should be noted:

- screenlines should normally be made up of 5 links or more
- the comparisons for screenlines containing high flow routes such as motorways should be presented both including and excluding such routes
- the comparisons should be presented separately (a) where data were used to inform matrix development, (b) for screenlines used as constraints in matrix estimation; and (c) screenlines used for independent validation (as noted in para 3.3.1 there may also be a need to report both validation tests and then the extent of change when data are used to refine the model)
- the comparisons should be presented by vehicle type (preferably cars, light goods vehicles and other goods vehicles)
- the comparisons should be presented separately for each modelled period

Advice on the specification of the screenlines for matrix estimation and validation is provided later in section 4. Further advice on trip matrix verification is provided in TAG unit M2.2.

3.3.9 As explained in TAG unit M2.2, the integrity of the demand matrices with the source data and consistency with the forecasting methods is of particular importance. Where models do not achieve the guidelines the analyst should review the assumptions and quality of data used to develop the trip matrices, but should not impose constraints just to improve the base year flow validation. In reporting the analyst should explain why the model does not reproduce traffic volumes to these tolerances and should indicate the scale and nature of potential forecasting uncertainty and suitability of the model for its intended purpose.

Link Flow and Turning Movement Validation

3.3.10 For link flow validation, the measures which should be used are:

- the absolute and percentage differences between modelled flows and counts
- the GEH statistic, which is a form of the Chi-squared statistic that incorporates both relative and absolute errors, and is defined as follows:

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

where: GEH is the GEH statistic

M is the modelled flow

C is the observed flow

These two measures are broadly consistent and link flows that meet either criterion should be regarded as satisfactory.

3.3.11 The validation **criteria** and **guidelines** for link flows and turning movements are defined in Table 2.

Table 2 Link Flow and Turning Movement Validation Criteria and Guidelines

Criteria	Description of Criteria	Guideline
1	Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases
	Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	
	Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	
2	GEH < 5 for individual flows	> 85% of cases

3.3.12 With regard to flow validation, the following should be noted:

- the above criteria should be applied to both link flows and turning movements
- the guideline may be difficult to achieve for turning movements
- the comparisons should be presented for cars and all vehicles but not for light and other goods vehicles unless sufficiently accurate counts have been obtained
- the comparisons should be presented separately for each modelled period
- it is recommended that comparisons using both measures are reported in the model validation report

Consideration of count accuracy in calibration and validation is provided later in section 4. Further advice on assignment validation is provided in section 9. Where models do not achieve the guidelines the analyst should review the network coding quality and the local quality of the trip matrices, but should not impose constraints just to improve the base year accuracy of the model. The focus here should be to ensure that the model is suitable for its intended purpose within the critical area for the interventions that are to be tested. In reporting the analyst should explain why the model does not reproduce traffic volumes to these tolerances and should indicate the scale and nature of potential forecasting uncertainty and suitability of the model for its intended purpose. Paragraph 3.2.2 gives more detail about the fitness for purpose of models.

3.3.13 Experience has shown that the level of model validation outlined in this section results in a robust standard of traffic model used for major scheme appraisal. The greater the difference in modelled flows from observed flows, noting that there will also be uncertainty and variation in observed flow data, the wider the uncertainty around the performance of the model and hence the resulting appraisal results. Practitioners should examine the extent to which this affects the robustness of their models on a case-by-case basis. This will depend on factors such as the proximity of poorly validating links to the scheme (or schemes) to be tested and the degree to which modelled flows differ from observed.

3.3.14 An important consideration is to add wider context and interpretation to the model performance by including narrative about its fitness for purpose in addition to presenting validation statistics for links or cordons in tabular form. For example, a way to present outputs geographically would be through the inclusion of network diagrams that illustrate how the model performs in the area around the scheme and in the wider modelled area. If there are particular areas where the model validation performs poorly, practitioners should highlight these to ensure that potential weaknesses in the model are understood.

Journey Time Validation

3.3.15 For journey time validation, the measure which should be used is: the percentage difference between modelled and observed journey times, subject to an absolute maximum difference. The validation **criterion** and **guideline** for journey times are defined in Table 3.

Table 3 Journey Time Validation Criterion and Guideline

Criteria	Guideline
Modelled times along routes should be within 15% of surveyed times (or 1 minute, if higher than 15%)	> 85% of routes

3.3.16 With regard to the journey time validation, the following should be noted:

- it is expected that separate speed/flow relationships and/or link speeds are used for light and other vehicles; hence comparisons should be presented for light and other vehicles separately; otherwise, the comparisons should be presented for all vehicle types together;
- for validation of journey times by vehicle type, it will be necessary to obtain journey times by vehicle type to a level of accuracy which will allow a meaningful validation; if journey times by vehicle type are not available but separate speed/flow relationships for light and heavy vehicles have been used, a weighted average of the modelled light and heavy vehicle speeds should be compared with the surveyed all-vehicle speed; and
- the comparisons should be presented separately for each modelled period.

3.3.17 Advice on the specification of the journey time routes and sources of observed journey times is provided later in section 4.3. Further advice on assignment validation is provided in section 9.

not sufficient indicators of convergence. It is recommended that, in addition to satisfying the true convergence measures described below, assignment model iterations should continue until at least four successive values of 'P' or ‘P2’ in excess of 98% have been obtained. If this cannot be achieved, especially in a future year assignment, this may be an indication of instability caused by the level of traffic demand being higher than can be absorbed by the network capacity.

3.4.7 The Delta statistic or %GAP (see Appendix D for definitions) is a truer measure of convergence but may not be provided by all packages. Delta values generally decrease towards a minimum value as the number of iterations increases but will not do so monotonically. Delta has traditionally been preferred over Epsilon and should be used as the first choice measure of assignment convergence.

3.4.8 In all cases, supporting information on stability, including acceptable values when measured against the other criteria, should be provided. The attainment of high degrees of convergence is particularly necessary where the assignment modelling is linked to a variable demand model because inadequate convergence is likely to result in unstable and unreliable forecasts. See TAG unit M2.1.

3.4.9 **Origin-Based Assignment** (OBA) is a more recently developed algorithm for computing a Wardrop equilibrium which, in principle, guarantees convergence to an ‘exact’ solution by eliminating non-optimum paths commonly found in solutions generated by more conventional equilibrium algorithms. Convergence may be monitored by both Delta and %GAP, as for conventional approaches. For further details see Appendix B.

Stochastic User Equilibrium Assignment

3.4.10 Stochastic User Equilibrium (SUE) assignment algorithms typically converge more slowly than Wardrop User Equilibrium algorithms, although the speed of convergence depends on the algorithm used. It is also far more difficult to monitor convergence with SUE assignment. The process has to converge with respect to both the effects of congestion (as with Wardrop) plus the effects of random perceptions and, unlike Wardrop equilibrium, there are no parameters which definitely reduce to zero at perfect convergence - even if two successive iterations give identical results this could simply be the result of a singular set of random numbers.

3.4.11 It is recommended that the percentage change in total user costs between successive iterations ('V') should be used to monitor convergence. At convergence, the total costs could be expected to fluctuate randomly about the ‘true’ value; therefore a consistent increasing or decreasing trend in total costs is indicative of a lack of convergence. In this case, iterations should continue until four successive absolute values of 'V' less than 0.05% have been obtained, recognising that the measure should approach zero at convergence but, for the reasons noted above, will never exactly equal zero.

Acceptable Levels of Convergence

3.4.12 During the development of the base year model, to ensure that reasonable levels of convergence are achieved, sufficient iterations should be carried out to achieve an acceptably low value for %GAP. A guideline target for this is 0.1% or less. In previous guidance this guideline was more relaxed. Improving computing power and software design has enabled many more iterations to make an improved target achievable.

3.4.13 A level of convergence which is sufficient to ensure that scheme benefits can be estimated robustly above model ‘noise’ is essential and a lower value of %GAP than the 0.1% guideline may need to be achieved. More iterations may be required in the forecast year, when congestion levels are forecast to be higher, simply to achieve the base year value of 0.1%, and even more iterations will be required to achieve the lower %GAP values required for robust economic appraisal.

3.4.14 However, it is clearly difficult to be precise about the appropriate level of convergence at the outset of model development. As soon as is practically possible, the analyst should, assess the model ‘noise’ within each model run as well as between model runs, that is, between a without-scheme model run and a with-scheme model run. This should assess the overall change in vehicle (or PCU) hours between assignment loops (the model 'noise') and the difference in vehicle (or PCU) hours between corresponding loops in the without-scheme and with-scheme model runs.

3.4.15 As noted in TAG unit M2.1, it is also good practice to check the size of the %GAP in relation to the scale of the user benefits of the tested intervention to the total network costs. Ideally, the user benefits as a percentage of network costs should be at least ten times the % GAP achieved in the without-scheme and with-scheme scenarios, although smaller values are not necessarily indicative of a problem.

3.4.16 Experience has shown that %GAP values of less than 0.05% have often been achieved in order to provide a more robust basis for economic appraisal of highway schemes. The larger the model, the more difficult it will be to attain the requirements set out in TAG unit M2.1. In fact, this target will often be impossible to achieve in a large model and hence a balance needs to be attained between practical model run times and convergence levels. Whilst computers are becoming faster, benefits in processing speed could be countered by the development of larger and/or more sophisticated models. For smaller networks, smaller values of %GAP may be achievable without an excessive number of iterations. The potential need for more stringent convergence standards for scheme appraisal applies to the other measures of convergence as well as to %GAP.

3.4.17 Table 4 summarises the most appropriate convergence measures (of proximity and stability) and the values generally considered acceptable for use in establishing a base model. **Tighter levels of convergence may be required for scheme appraisal**.

Table 4 Summary of Convergence Measures and Base Model Acceptable Values

Measure of Convergence	Base Model Acceptable Values
Delta and %GAP	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P)<1%	Four consecutive iterations greater than 98%
Percentage of links with cost change (P2)<1%	Four consecutive iterations greater than 98%
Percentage change in total user costs (V)	Four consecutive iterations less than 0.1% (SUE only)

4 Calibration and Validation Data

4.1 Introduction

4.1.1 This section contains guidance regarding the use of specific highway survey data for the calibration and validation of models.

4.1.2 For guidance on the availability of highway survey data and the conduct of surveys, see TAG unit M1.2 – Data Sources and Surveys**.** This unit also contains guidance on the assumed confidence intervals for surveys, the accuracy of survey data and guidance on the factoring of data.

4.1.3 Calibration and validation data are generally of two kinds: traffic counts, and journey times.

4.1.4 Traffic counts may be obtained by automatic means (Automatic Traffic Counts, ATCs) or manually (Manual Classified Counts, MCCs). Journey times may be obtained from commercial sources such as tracked vehicle data or camera observations from Automatic Number-Plate Recognition systems (ANPR).

4.2 Traffic Counts for Matrix Estimation and Model Validation

4.2.1 The main purpose of matrix estimation is to refine estimates of those movements that do not provide an accurate match against observed volumes, often due to the high-level nature of either the data source or expansion method used to derive them. TAG unit 2.2 provides advice on interpreting the relative confidence of synthesised demand and different data sources. For some data sources, such as RSI, counts are directly used for data expansion. A hierarchy may be considered distinguishing screenlines:

- directly used in expanding source data (and not therefore independent) where relevant to the data used to develop prior trip matrices
- for calibration, ie used in matrix estimation or to help inform prior matrix development
- for validation

As noted in paragraph 3.3.1 it may be judged that there are insufficient data to retain screenlines purely for independent validation. Nevertheless, the hierarchy should be considered for staged or sequential use of the data, with the hierarchy designed to give progressively finer spatial granularity (ie 'validation' screenlines would generally intercept movements within sectors defined by calibration screenlines).

4.2.2 The density of screenlines should be designed so that the majority of intra-sector movements of relevance to the model purpose are subject to comparison with counts. In designing the screenlines, account should therefore be taken of the trip length distribution. The best estimate of the mean length of these trips is likely to be the synthetic matrices.

4.2.3 Matrix estimation should be applied to individual vehicle type matrices because the routes used in the matrix estimation will vary by user class. This means that MCCs are required at the sites where constraints are to be applied. The use of average vehicle proportions to obtain vehicle splits by type in the absence of MCCs should be avoided where possible.

4.2.4 To enable matrix estimation to adjust the prior matrices to approximately the correct overall levels, ATCs are also required at the constraint sites. Thus, the ATCs should be used to give the total vehicles, and the MCCs to provide the split by vehicle type.

4.2.5 Turning movement counts should only be used as constraints in matrix estimation if they have been derived from both MCCs **and** ATCs. In the absence of ATCs, turning movement counts should be used mainly as a diagnostic during model calibration. Alternatively, ANPR and video counts should provide sufficient accuracy.

4.2.6 Neither ATCs nor MCCs will yield counts of light and heavy goods vehicles which are sufficiently accurate for the validation of the assigned flows of these vehicle types on individual links. Validation of these vehicle types will therefore generally need to be reported for short screenlines using grouped counts which have sufficiently small confidence intervals.

4.2.7 Validation of assigned flows on individual links will generally have to be restricted to cars and all vehicles. The counts of all vehicles used for this purpose should be ATCs with MCCs being used to determine the proportion of cars.

4.3 Journey Times for Calibration and Validation

4.3.1 The importance of setting accurate cruise speeds has been explained in section 2.9. Cruise speeds must distinguish delays from junctions. Comparisons will show how well total link times are modelled and therefore, given that the cruise speeds may have been largely derived from observations, how well junction delays are represented.

4.3.2 For general purpose models, the routes for the validation of journey times should cover as wide a range of route types as possible and cover the Fully Modelled Area as evenly as possible. For models developed for the appraisal of specific interventions, routes should include those from which it is expected traffic will be affected by the scheme, as well as covering the scheme itself as appropriate.

4.3.3 The validation routes should be neither excessively long (greater than 15 km) nor excessively short (less than 3 km). Routes should not take longer to travel than the modelled time periods (although, a few minutes longer is unlikely to be problematic). Where Moving Car Observer (MCO) surveys are undertaken start times should be staggered, particularly if runs are undertaken on the same day. For models of actual peak hours, journey time routes ought to be no longer than about 40 minutes to allow some staggering of start times.

4.3.4 As described, it is standard practice to use journey time validation at the route level. However, increasingly there is a need to take a more detailed approach and check journey time validation at the link level or for segments of the route as well. This can be very important to assess noise and air quality impacts in the detail that they are required. Where these impacts may be material, the analyst should produce some assessment of the accuracy of speeds at a finer level.

5 Network Data, Coding and Checking

5.1 Introduction

5.1.1 Advice is provided in section 2.4 on the design of the structure of the networks in the Fully Modelled and External Areas. The data required to describe the networks were also identified there. In this section, sources of network data are discussed and advice is provided on the coding and checking of network data.

5.1.2 For additional guidance on the availability of network data sources see TAG unit M1.2 – Data Sources and Surveys.

5.2 Network Data and Coding

5.2.1 Network descriptions in the Area of Detailed Modelling will generally need to include both link and junction details.

Link Representation

5.2.2 **Links** are usually described in terms of:

- the reference numbers at the ends of the link (ie 'nodes')
- the link length
- the cruise speed in the base year, defined as the mid-link speed, separate from any junction delay, during the time period modelled
- the speed/flow relationship (if any) appropriate for the link (but see section 2.9 for further advice)
- whether the link operates in both directions or in one direction only
- any restrictions to particular vehicle types using the link

5.2.3 Highway assignment models should represent **mean** traffic speeds[10]. Therefore, cruise speeds should represent the mean speed of traffic between junction queues, given the activity alongside

[10] In this context, the mean speed referred to here is the mean of the speeds of all vehicles, or all vehicles in each vehicle type for which separate speed/flow relationships have been defined.

and crossing the link in the time period concerned. Cruise speeds are therefore **not** free-flow speeds and should **not** necessarily be set at the speed limits either.

5.2.4 In urban areas, it may sometimes be necessary to consider the impact of traffic management measures such as bus lanes, traffic calming, parking controls and cycleways, on the capacity and cruise speed of individual network links. The network coding should vary between time periods to reflect variations in the application of bus lanes and parking controls by time of day. The way in which the above information is input to a model may vary slightly according to the software package that is being used.

Junction Representation

5.2.5 The way in which **junctions** are described varies between different modelling packages. The usual requirements are:

- the junction type (traffic signals, roundabouts, priority)
- the number of approach arms and their order (in terms of entry link references)
- the number and width of traffic lanes on each junction approach, the flare length, and the lane discipline adopted (including prohibited turns)
- any additional data required to describe the operational characteristics of the junction (eg saturation flows, signal timings and phasing, turning radii and gap acceptance characteristics)

5.2.6 In practice, the way that junctions are used may not accord with the layout painted on the road surface. For instance, where no lane is reserved for right-turning vehicles, there may be sufficient room to accommodate one or two right-turning vehicles without impeding straight-ahead traffic and, in these instances, the coding should reflect actual use rather than the painted layout.

5.2.7 Modern data sources provide the analyst with a large array of information to assist in network coding. The following framework and data sources are suggested for coding a network:

- determine the number of approach arms, and establish their order (in terms of entry link references). A site visit will add value over using desk-based sources alone and can obtain greater clarification
- derive a sensible structure for numbering of nodes (and zones) – preparing a structured numbering system will save time and effort when making modifications later in the process
- identify 'complex' junctions, ie gyratories and signalised roundabouts, at the outset as these will need to be 'expanded' rather than treated as single nodes
- confirm the network structure and a-node/b-node connectivity – time spent in preparing the structure of the network before coding commences will avoid problems of mis-specification of connections later in the process
- derive geographical co-ordinates for all nodes
- ensure one way links/banned turns are incorporated
- for large models, on-site network inventories may not be affordable, in which case, obtain aerial photographs and maps of the area to be coded; a number of products are available, such Google Maps/Earth/Streetview, and Bing Maps, which can be extremely helpful in verifying junction layouts, types and geometry[11]

[11] It should be noted that the age of such sources are often indeterminate, so care is required where more recent changes may have occurred to the network.

measurements of saturation flow rates be undertaken and that these surveys should include a cross-section of junction types and layouts.

5.3 Network Checking

5.3.1 Most network modelling packages contain procedures for checking the integrity of the network description. However, with large models, the multiple levels of warnings and errors and the quantity of diagnostic output that many such packages generate often means that such diagnostics can be over-looked. Resources should be set aside to examine all the warnings and other diagnostics.

5.3.2 The following is a basic checklist of items designed to minimise problems once the network has been coded:

- check for appropriate junction types
- check that the appropriate number of entry lanes have been coded and that flaring of approaches, where appropriate, are accounted for
- check that turn restrictions have been correctly identified (these may vary by time period)
- check that one-way roads and no entries, if applicable, have been correctly specified
- check that saturation flows are appropriate (particularly if turn rates appear excessively high or low compared to straight ahead)
- check that link lengths, link types and cruise speeds for each direction of a link are consistent, and that the second and third do not vary unjustifiably along series of links
- compare crow-fly link lengths against actual lengths, check that the coded link length is between 1.1 and 1.3 times the crow-fly distance and inspect links which fall outside this range. It is often the case that analysts may re-locate nodes to enhance the representation of a junction on-screen. Whilst this does not affect the coded link length it will obviously affect the crow-fly distance. Given the eventual need to interface with other models for environmental assessment of noise and air quality, experience shows that it is preferable to ensure that traffic model nodes are positioned according to their actual geographical location.

5.3.3 In addressing errors, the network structure and connectivity should be checked first, followed by the link attributes and then, if necessary, the more detailed (junction-related) data such as junction type, lane usage, saturation flows, signal timings and so on, should be checked.

5.3.4 The use of standardised templates and error checking procedures is recommended. Coding assumptions and default values should be set out as early as possible and before any coding is attempted. The development of a standardised approach to coding is important as this task is often carried out by a number of people and consistency of approach is necessary.

5.3.5 The Ordnance Survey OpenData datasets[13] can be useful in verifying network structure and, in conjunction with GIS software packages, can be used as a backdrop to modelled network and zoning systems. The OS ITN dataset is also a useful source for this.

5.4 Pre-Calibration Checks

5.4.1 Calibration should not start unless the network has passed a series of basic checks as described here. The network calibration should not be viewed as a means of debugging a network containing errors, although in practice some errors not captured in the initial network coding checks may manifest themselves during that process. The intention should be to identify and eradicate, as far as possible, common sources of error such that the calibration (and validation) process is largely

[13] Available at www.ordnancesurvey.co.uk/opendata

confined to monitoring network performance and fine-tuning it to match observed conditions. This latter process is described in section 6.2.

Network Documentation and Completeness

5.4.2 It is useful to document headline statistics, such as the number of links, nodes and the version of the software used to develop the network. It is possible that new versions of software may be introduced during the course of the development of a model which may update or upgrade certain aspects of network coding.

5.4.3 Data sources should be documented and a map or plan showing which parts of the network have been coded using newly surveyed or derived data and those parts which have been coded or derived from existing models should be prepared. The location of any junction inventory surveys, signal timing and saturation flow measurement surveys should also be documented and mapped. The intention is to provide an overview of the extent of the coded network and data sources.

Network Compilation

5.4.4 Invariably, each transport modelling software package has its own error trapping procedures so it is not possible to be prescriptive on what checks should be applied. Nevertheless, certain errors will cause the network build process to fail and these, clearly, need to be addressed. If the software package provides graded error messages, the analyst should seek to ensure that a satisfactory explanation for each type of warning (not necessarily each warning) is documented if steps to remove the warning(s) are judged to be unnecessary.

Consistency of Coding

5.4.5 It is commonplace, particularly in the development of large models, for network coding to be undertaken by a team of analysts. Consistency of approach is essential to ensure that the network is coded in a uniform fashion using a consistent set of rules. Documentation of network coding assumptions is essential in this respect. Whilst it is recognised that assumptions can be changed (during calibration and validation), the need to record a consistent and sensible starting set of assumptions is important. This should minimise the potential for excessive adjustments later in the model development process.

5.4.6 The selection of appropriate link types and cruise speeds within the Fully Modelled Area is important. Where a link type and/or cruise speed changes on a specific link, checks should be undertaken and mapped to demonstrate that this accords with the source data. A check should also be undertaken comparing the coded link lengths against suitable source data (eg the OS ITN data). Justification for using coded links of length significantly greater than the crow-fly distance should be documented.

Check of Key Junctions

5.4.7 It is important to demonstrate that key junctions and intersections which have the greatest influence in model calibration and validation, are coded appropriately. All key junctions and intersections should be formally reviewed. The review should seek to ensure that junction types are correctly defined and that the representation of key characteristics is appropriate and accords with available data sources.

5.4.8 Again, different software packages represent junctions in different ways but the following should be viewed as a reasonably common source of information for review. F**or all junction types**: number of lanes at the stop line; number of lanes on the main (mid-link) approach; link type classification/cruise speed attributed; representation of flaring; lane usage/definition of turns; representation of bus lanes; and representation of banned turns. **For traffic signals**: representation of filters; definition of stages; cycle times and offsets; green times; and inter-green times.

6.2.6 Further checks should be carried out by inspecting the routes through the network taken by selected traffic movements. This is complicated by the fact that capacity restraint procedures calculate several sets of routes. Plotting of routes used between key origins and destinations should be undertaken to verify that the routes appear plausible.

6.2.7 When inspecting routes, the likely differences between the routes taken by HGVs and other vehicles should be recognised. Actual HGV routes may differ from the routes taken by other traffic for a variety of reasons, including different acceleration and speeds, associated fuel costs, possibly different geometric delays at junctions, and general propensity for HGVs to use the main, higher capacity, roads and to avoid use of local, narrower, roads, especially roads with vehicle height and width restrictions. Separate speed/flow curves can partially deal with these issues.

6.2.8 It is not envisaged that large changes to saturation flow rates, signal timings or cruise speeds would be necessary at the calibration stage. Adjustments should be made for valid traffic reasons. For example, closer inspection may reveal that short-term peak hour parking close to a junction may have a detrimental effect on the saturation flow rates assumed which may not have been taken into account, or the poor visibility from a side road onto a main road has been under-estimated or not taken into account and, as a result, the saturation flow rates are over-estimated. While changes in the order of ±20% may be justifiable, larger adjustments would benefit from further explanation and documentation. In some cases, site visits may be necessary to gain more insight into how the network and junctions are used.

6.2.9 In addressing problems, it is recommended that structure and connectivity should be checked first, followed by link attributes and then, if necessary, more detailed (junction-related) data such as junction type, lane usage, saturation flows and signal timings.

6.3 Network Validation

6.3.1 It is not possible to validate a network in isolation, since the output traffic flows and travel times will reflect not only errors in the network, but also those inherited from the input trip matrix. This is a particularly important consideration in congested urban areas, where relatively small discrepancies in a trip matrix can have a disproportionate impact on junction delays and hence on the routes taken by vehicles through the network.

6.3.2 It would not be possible to undertake a meaningful comparison, or validation, of journey times based on an assignment of a unit matrix as junction delays will not be modelled correctly. Once an initial estimate of a prior matrix is available, more meaningful comparisons of observed and modelled journey times can be made.

6.3.3 Areas of the network which show differences at a route level of greater than 25% should be investigated. This may, nonetheless, hide problems along the route so time/distance graphs are an essential means of highlighting problems en-route.

6.3.4 Once the trip matrix has been finalised, model validation will include the validation of modelled journey times against observed data (see section 9).

7 Route Choice Calibration and Validation

7.1 Introduction

7.1.1 The calibration of an assignment model should be, as far as possible, a sequential process. Thus, effort should be made to ensure that each element in the sequence – zones, network structure, centroid connectors, network coding, capacity restraint procedures and trip matrices – is developed as accurately as reasonably possible before moving on to the next. Nevertheless, some iteration will be inevitable, with adjustments potentially being made to each of the constituent elements as part of the process of refining the accuracy of the assignment.

7.1.2 The accuracy of the assignment will be dependent not only on the accuracy of the constituent elements listed above but also on the realism of the modelled routes. It is very rare for surveys of actual routes to be undertaken and the best that can usually be done is that the analyst assesses the plausibility of the modelled routes.

7.1.3 The modelled routes will depend on:

- the appropriateness of the zone sizes and modelled network structure and the realism of the connections to the modelled network (centroid connectors)
- the accuracy of the network coding and the appropriateness of the simplifications adopted
- the accuracy with which delays at junctions and times along links are modelled, which are dependent not only on data and/or coding accuracy and appropriateness but also on the appropriateness of the approximations inherent in the junction flow/delay and link speed/flow relationships
- the accuracy of the trip matrices which, when assigned, will lead to the times used in the route choice process (via the flow/delay and speed/flow relationships)

7.1.4 At various stages in the model development process, modelled routes should be examined and their plausibility checked. For example, as suggested in paragraph 6.2.6, early plotting of minimum path routes is a useful way of identifying network coding errors. Modelled routes may also be usefully considered in the later stages of calibrating the model.

7.1.5 Whether or not route choice is 'calibrated', it is essential that the plausibility of the modelled routes is displayed and assessed. This may be viewed as 'validating' the modelled routes and the way that this should be done is described in the final part of this section.

7.2 Route Choice Calibration for HGVs

7.2.1 The generalised cost formulation for highway assignment modelling and the source for the coefficients are set out in section 2.8. As explained there and in section 2.6, the distance coefficient (given by vehicle operating cost / value of time) will vary by user class, that is, by vehicle type and trip purpose combination. However, as also explained in section 2.8, changes to the distance coefficients should no longer be used as a means of calibrating route choice.

7.2.2 It is often the case that the routes based on generalised costs given in TAG for heavy goods vehicles do not appear to take full account of the attractiveness of motorways and trunk roads and the unattractiveness of local roads for these vehicles. While the route choice calibration process described above applies, in principle, equally to all user classes, heavy goods vehicle routes may require further special attention.

7.2.3 Distance coefficients given in TAG for HGVs can have the effect of deterring these vehicles from being assigned to longer, faster routes, such as motorways and trunk roads in favour of shorter and slower routes. If HGV routeing is considered implausible, special modifications to the distance coefficients should be considered. One approach is to introduce a link-based calculation of generalised costs so that, for HGVs, longer, faster routes such as motorways and trunk roads appear more attractive. This would enable an alternative distance coefficient to be used on such routes and ensure that HGVs were not deterred from using such routes in the assignment. This would need experimentation to determine appropriate values to ensure plausible routeing but a good starting point would be to adopt the car distance coefficients.

7.2.4 Further adjustments that may also be considered are to use separate HGV speed/flow curves (in rural areas) and/or to set HGV-specific link cruise speeds and/or to include HGV-specific penalties to represent geometric delay at junctions.

7.2.5 Whichever approach is adopted, details should be provided in the Local Model Validation Report.

7.3 Route Choice Validation for Private Travel

7.3.1 As the calibration of the assignment proceeds, checks should be carried out by inspecting the routes through the network taken by **selected** traffic movements. Plotting of trees, that is routes from an origin to all destinations, is easy to do but not particularly informative. A better approach is to examine the modelled routes between selected origins and destinations. These selected origins and destinations should focus on important centres of population and employment or key intersections. These should be chosen so that the routes:

- relate to significant numbers of trips
- are of significant length or cost (eg 20+ minutes)
- pass through areas of interest (eg scheme impacted areas)
- include both directions of travel (to sense check differences)
- link different compass areas (eg north to south, east to west, etc.)
- coincide with journey time routes as appropriate

The routes modelled for each user class should be examined separately.

7.3.2 The number of pairs of zones which should be examined and displayed will be dependent on the size of the model. The following rule of thumb should be used:

Number of OD pairs = $(\text{number of zones})_{0.25}$ x the number of user classes.

7.3.3 Observations of routes are not usually available, so these checks must be based on local knowledge and judgement and hence cannot be regarded as true validation. Nonetheless, the results from the zone-to-zone route plots should be documented in the Local Model Validation Report and any remedial action taken explained.

8 Trip Matrix Calibration and Validation

8.1 Introduction

8.1.1 Trip matrices should be created following the advice referred to in TAG unit M2.2. The process of producing trip matrices involves the following steps as outlined in Figure 1 of TAG unit M2.2:

- planning
- data assembly
- matrix development
- matrix refinements

8.1.2 It is common for the trip matrices produced by the methods referred to in TAG unit M2.2 to be termed ‘prior’ trip matrices. The adjective ‘prior’ usually refers to matrices which have not (yet) been subjected to matrix estimation. That convention is adopted here.

8.1.3 Having designed the zoning system, network structure and centroid connectors, and calibrated and validated the network and routes, it will be essential to validate the trip matrices by comparing assigned flows with traffic counts. Depending on the proximity of the modelled flows and counts, three courses of action are possible:

- reconsider the development of the prior trip matrices with a view to producing new versions which, when assigned, yield modelled flows which accord more closely with the counts

- refine the trip matrices using **matrix estimation**, as discussed below in this section
- explain the model performance and potential limitations for its use

8.2 Validation of the Prior Trip Matrices

8.2.1 It is important that the need for either matrix estimation or other adjustments to the prior trip matrices is clearly established before any such processes are carried out. The prior trip matrices should therefore be validated by comparing total screenline and cordon modelled flows and counts by vehicle type and time period.

8.2.2 As explained in TAG unit M2.2 screenline count evidence should be considered in developing prior matrices. Documentation reporting the matrix development should explain consistency of the data sources and derived matrices with count evidence. This should explain how evidence from the count data has informed the matrix development. For some data sources, such as the use of RSI data, screenlines used to expand the source survey data should be distinguished, from other screenlines.

8.2.3 The flow difference measures specified in section 3.3 should be used. If the criteria given in Table 1 are not met for all or nearly all screenlines and cordons, remedial action should be considered.

8.2.4 All screenlines and cordons used for this and similar purposes should be ‘watertight’. They should include all the roads in the actual network that intersect them.

8.2.5 While it is possible to validate trip matrices using cordons, care needs to be exercised to ensure that discrepancies between modelled flows and counts are not the result of traffic erroneously routeing to avoid crossing the cordons. Long screenlines, on the other hand, will show the quality of the matrix more clearly and should be used in preference to cordons where possible.

8.3 Refinement of Prior Trip Matrices By Matrix Estimation

The Purpose of Matrix Estimation

8.3.1 The primary purpose of matrix estimation is to **refine** prior matrices and the refinements should be sufficiently small that they are not regarded as significant. Matrix estimation can be a useful tool to initially establish any inconsistency in the pattern of demand between the matrices and the count data that should be investigated.

8.3.2 Matrix estimation only either increases or decreases non-zero cell values in the prior trip matrix. The technique cannot be used, therefore, to provide estimates of trips not observed in surveys or not contained in the synthesised trips.

8.3.3 Matrix estimation should not be used to factor matrices from one year to another or to factor period or average hour matrices to actual hour matrices or vice versa. While matrix estimation could be used mechanically for this purpose, experience has shown that the resulting changes are often significant – indeed, the longer the period over which matrices are being grown, the larger the changes are likely to be.

8.3.4 Matrix estimation should not be used to only achieve the flow validation criteria to the expense of significantly changing the demand matrix patterns (refer to paragraph 8.3.17).

Applying Matrix Estimation

8.3.5 It is important that the effects of matrix estimation are minimised. If the prior trip matrices have been developed from matrices in existing models, and the existing model matrices were not developed in accord with best practice, do not meet acceptable validation standards or were not adequately documented, the matrices taken from the existing models should exclude the effects of any matrix estimation carried out during the development of the existing models. Applying matrix estimation to a matrix which has been subjected previously to matrix estimation may not achieve the aim of minimising the effects of matrix estimation. Thus, the trip matrices taken from existing models should be ‘prior’ trip matrices.

8.3.6 Count constraints should generally be grouped and applied at the short screenline level. The use of counts at individual sites as constraints should be avoided. The reason for this advice is that the mismatch between modelled flows and counts at any one location may be due to a number of reasons and not solely due to deficiencies in the trip matrices. In adjusting the prior matrices, matrix estimation may well compensate (undesirably) for other errors arising from the design of the zoning system, network structure, centroid connectors, network coding and route choice coefficients, which is why all these aspects should be checked before applying matrix estimation. Applying constraints at individual sites is likely to exacerbate the tendency of the matrix estimation procedure to compensate for deficiencies in other aspects of the model.

8.3.7 As explained in section 4.2, the counts used as constraints in matrix estimation should be derived from two-week ATCs at a minimum, with the vehicle type proportions being obtained from MCCs. Turning movement counts should only be used as constraints in matrix estimation if they have been derived from MCCs **and** ATCs.

8.3.8 As also explained in section 4.2, unless unusually accurate counts of LGVs and HGVs have been obtained, it will not be appropriate to apply constraints on the matrices of these vehicle types on individual links, even when there is a case, albeit rare, for applying constraints on the car trip matrices at individual sites.

8.3.9 Constraints should not be applied to individual user classes unless counts of these user classes have been made individually. Thus, in cases where MCCs are not available, constraints can only be applied to total trips, that is, all user classes combined, which is not advisable because routes vary between user classes. In practice, therefore, total counts across all purposes will have to be used.

8.3.10 It will be desirable that the highway assignment matrices are as consistent as possible with the trip matrices used in a related demand model. In addition to applying count constraints, therefore, trip end constraints should also be applied whenever acceptable trip end estimates can be obtained. The trip end constraints should be applied in the same way as the count constraints are applied, in preference to controlling the estimated matrices to exogenously derived trip ends in a Furness procedure at the end of the matrix estimation process.

8.3.11 Some software packages allow weights to be attached to the inputs to matrix estimation which reflect their relative accuracy. In principle, this approach should be adopted. Thus, weights should be attached to prior matrix cells, trip ends, and counts to reflect their relative accuracy. Any weighting calculations and associated assumptions should be reported.

8.3.12 Ultimately, the assignment convergence standards used during matrix estimation should be consistent with those used in the assignment model. However, there is merit in considering a staged approach as initial matrix estimation runs may be based on initial demand estimates and the network may still require further calibration. Hence, adopting tight convergence criteria may be inefficient and a more relaxed value may be used, although not exceeding the guideline %GAP of 0.1%.

8.3.13 The convergence of the iteration between assignment and matrix estimation should be continued until the changes in the matrices, at zone to zone level, between iterations becomes negligible.

Monitoring the Changes Brought About By Matrix Estimation

8.3.14 The changes brought about by matrix estimation should be carefully monitored by the following means:

- scatter plots of matrix zonal cell values, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R_2 values)

8.3.21 Where the source data provides high confidence in the pattern of movements (eg at inter-sector level), comparisons of the **post** matrix estimation matrices with source data used to develop the trip matrices may be useful. Where the comparisons of the changes brought about by matrix estimation listed in paragraph 8.3.14 show material changes arising in matrix estimation, or similar verification of the prior matrices indicates differences, post estimation matrices should be compared with source data and the process undertaken in developing the prior trip matrices, as outlined in TAG unit M2.2, should be reviewed and updated if necessary. The confidence that can be placed in the source data should be appropriately reflected in the process.

9 Assignment Calibration and Validation

9.1 Introduction

9.1.1 Advice has been provided on calibration of:

- networks in section 6
- routes in section 7
- trip matrices in section 8

9.1.2 Section 9.2 provides advice on some possible further means of calibrating an assignment.

9.1.3 The final step in setting up a model is a formal validation of the assignment. The requirements are specified in section 9.3.

9.2 Assignment Calibration

9.2.1 If the steps set out in sections 6, 7 and 8 to calibrate the network, routes and trip matrices do not yield an acceptable validation of link flows, turning movements and journey times, the following further steps to calibrate the assignment model may be considered:

- the number of zone centroid connectors, their coded times and the points at which they connect to the network should be reconsidered and adjusted if necessary
- ‘forests’ should be analysed to understand routeing and adjustments may be made to competing routes
- modelled and surveyed journey times should be compared and analysed in order to:
  - identify queue locations
  - check outturn capacities on congested (queued approaches) and hence adjust signal timings, saturation flows, lane use, etc., accordingly

9.2.2 It may also be useful to ‘stress test’ the model by increasing the numbers of trips in the matrices by 10% or 20% and reassigning. This may reveal faults in the network which previous checks have not detected. For instance, against expectations, some junctions may become over-loaded while others show no queues despite the increased demands.

9.3 Assignment Validation

9.3.1 In addition to evidence of network, route and trip matrix validation, the Local Model Validation Report should include evidence of the validation of the assignment, in the following primary terms.

- **Traffic flows on links.** Modelled flows and counts should be compared by vehicle type and time period for screenlines. For cars, flows on individual links should be compared. For goods vehicles, flows on short screenlines should be compared unless very accurate counts have been obtained. The measures, criteria and guidelines given in Table 2 should be used.

- **Journey times.** Modelled and surveyed journey times should be compared along routes, by vehicle type if separate speed/flow relationships have been used for light and heavy vehicles, and by time period. End to end route times should be analysed, with the means and 95% confidence intervals of observed times being presented alongside the modelled times. In addition, time/distance graphs should be produced for individual section on each route. The measures, criteria and guidelines given in Table 3 should be used.

9.3.2 **Turning movements** at key junctions should also be validated by time period. However, it is rare that turning movements will have been counted using automatic methods over a number of days; most likely, the available or affordable counts will be single day MCCs. For this reason alone, turning movements may not validate to the standards achieved for link flows. Given the 95% confidence intervals usually associated with LGV and HGV counts, it is unlikely that it will be sensible to validate turning movements by vehicle type. Nevertheless, modelled turning flows and counts should be compared by time period and assessed using the link flow criteria and guidelines given in Table 2.

9.3.3 In addition to the primary tests above, the following further checks may also be valuable:

- If available, comparisons of the trip patterns assigned to key links with the patterns derived from source data for those links – note that this analysis should be conducted at a sector rather than zonal level, as a close match at the latter level is highly unlikely due to source data statistical accuracy

- comparison of average modelled network speeds with average speeds derived from the more comprehensive journey time data sources, such as tracked vehicle data, by area

9.3.4 All significant discrepancies between modelled and observed data should be noted and a commentary provided in each instance. These commentaries should state whether or not the discrepancies might affect the model's usefulness for certain applications.

9.3.5 All text summarising validation results should be carefully considered to ensure that the correct impression about the quality of the model is conveyed.

10 Reporting

10.1.1 The following two reports are required which relate to the advice in this unit:

- Highway Assignment Model Specification Report (or as part of the Appraisal Specification Report); and

- Local Model Validation Report.

10.1.2 The recommended structures of these reports are set out in Appendix F.

10.1.3 The **Appraisal Specification Report** should be prepared as the first task in the process developing a model. The report should include: proposed uses of the model and key model design considerations; model standards; key features of the model; **specification** of the required calibration and validation data; and the **methodologies** for network development, trip matrix development, and for calibrating and validating the network, route choices, trip matrices, and assignment.

10.1.4 The **Local Model Validation Report** will be the last task in the model development process. The report should include: updated sections on proposed uses of the model and key model design considerations, model standards (including convergence), and key features of the model; a description of the calibration and validation data used; descriptions of the network and trip matrix development; and descriptions of the calibration and validation of the network, route choices, trip matrices, and assignment.

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12 Document Provenance

This unit consists of restructured and edited material from **WebTAG unit 3.19 Highway Assignment Modelling** that existed in the previous WebTAG structure at August 2012

Appendix A Glossary of Terms

All-or-nothing assignment:	An assignment in which all the trips between each origin and destination are loaded onto a single path, usually the minimum generalised cost path.
Area of Detailed Modelling:	The area over which significant impacts of interventions are certain. Modelling detail in this area would be characterised by: representation of all trip movements; small zones; very detailed networks; and junction modelling (including flow metering and blocking back).
Calibration:	Adjustments to the model intended to reduce the differences between the modelled and observed data.
Capacity restraint:	The restraining effects on demand of capacity limitations or the process by which speeds, and therefore travel times are adjusted so that they are consistent with the assigned traffic flows. Capacity restraint mechanisms include junction **flow/delay** and link **speed/flow** relationships.
Centroid connectors:	The means by which the demand from or to zones is loaded onto or leaves the network.
Convergence:	An equilibrium or balanced position between two inter-related model outputs. A converged assignment is one where the assigned flows and the resulting travel costs are consistent. A converged demand/supply loop is one where the demands are consistent with the travel costs in the supply model.
Convergence criteria:	The values of measures of convergence by which it is accepted that an acceptable level of convergence or equilibrium has been reached.
Cordon model:	Assignment model variants where the modelled area is curtailed at a specified boundary. Trips with one or both end points outside of this area are not represented for their full length, being curtailed to one of the zones that represent the cordon boundary.
Cruise speed:	The speed of traffic on links between queues at modelled junctions. The cruise speed is dependent on the attributes of the link and activity levels alongside and crossing the link. It is not related to flow to any significant degree and is not necessarily equal to the speed limit.
Demand model:	A model which forecasts changes in trip frequency, mode of travel, time of travel, and trip destination.
Deterministic User Equilibrium Assignment:	Assignment procedures designed to achieve **Wardrop's First Principle of Traffic Equilibrium**. Deterministic algorithms take no account of drivers' differing perceptions of costs. See also **User Equilibrium Assignment** and **Stochastic User Equilibrium Assignment**.

Distance coefficient:	The coefficient of distance-related money costs which are combined with time and other money costs to form **generalised costs**.
Dynamic assignment model:	Highway assignment models which permit the trip matrix to vary in terms of both level and pattern of flow during the modelled period.
Elastic assignment:	An extension of a normal assignment procedure which uses an elasticity function to approximate some demand responses in addition to the change of route response modelled by an assignment.
External Area:	The area outside the **Fully Modelled Area**.
Flow/delay relationship:	The relationship between traffic flow and travel time along a link sometimes including delays at junctions and also the relationship between traffic flow and delay for turning movements at junctions.
Frank-Wolfe Algorithm:	A method of deriving a **User Equilibrium Assignment** by means of combining successive All-or-Nothing assignments such that an objective function is maximised, with the result that the contributions of the All-or-Nothing assignments to the final assigned flows are optimised (and not determined by the number of All-or-Nothing assignments as in the case of the **Method of Successive Averages**).
Free-flow speed:	The speed at zero flow, as defined by a **speed/flow relationship**.
Fully Modelled Area:	The area where trip matrices are complete (as opposed to partial in the **External Area**) and the network and zoning are at their most detailed (as opposed to coarser as in the External Area).
Generalised cost:	A linear combination of time and money costs, expressed in time or monetary units. See also **distance coefficient**.
Heavy goods vehicles:	Heavy goods vehicles (HGVs) are defined as other goods vehicles (OGV1 and OGV2).
Heavy vehicles:	Heavy vehicles are defined as HGVs, buses and coaches (PSV).
Highway assignment model:	A model which allocates car and goods vehicle trips to routes through a highway network. It includes path building and loading of trips to routes between zones. It excludes all demand responses other than route choice.
Light vehicles:	Light vehicles are defined as cars and light goods vehicles (LGV).
Matrix estimation:	The adjustment of **prior trip matrices** so that, when assigned, the resulting flows accord more closely with counts used as constraints in the process.
Method of Successive Averages:	A method of deriving a **User Equilibrium Assignment** by means of combining successive All-or-Nothing assignments

Trip matrix synthesis: The creation of a matrix of trips by use of non-trip data, usually via a gravity model.

User class: Combinations of vehicle types and trip purposes which are assigned separately in a multi-user class assignment.

User Equilibrium Assignment: An assignment procedure in which a number of assignments are combined such that the resulting network flows satisfy **Wardrop's First Principle of Traffic Equilibrium**. See **Frank-Wolfe Algorithm** and **Method of Successive Averages**.

Validation: The comparison of modelled and observed data. Any adjustments to the model intended to reduce the differences between the modelled and observed data should be regarded as **calibration**.

Validation guidelines: The recommended proportion of instances where the **validation criteria** are met.

Validation criteria: The differences between modelled and observed data should be quantified (using some **measures**) and then assessed using some **criteria**.

Wardrop's First Principle of Traffic Equilibrium:

Traffic arranges itself on networks such that the cost of travel on all routes used between each OD pair is equal to the minimum cost of travel and all unused routes have equal or greater cost.

WebTRIS: Highways England's Traffic Information System.

Appendix B Assignment Methods

B.1 Introduction

B.1.1 This appendix provides some details on **Steady State Assignment** models. Models of this nature fall into the following categories:

- **Deterministic User Equilibrium Assignment** models, of which the following types exist:
  - **Link-Based Assignment**
  - **Path-Based Assignment**
  - **Origin-Based Assignment** and
- **Stochastic User Equilibrium Assignment** models

These four assignment methods are described below. There then follows a note on an aspect of capacity restraint which has a bearing on the assignment method.

B.1.2 Some brief notes are then provided on **Dynamic Assignment** models and **Micro-Simulation** models.

B.2 Steady State Assignment Models

Link-Based Assignment

B.2.1 The most common forms of Link-Based Assignment are the so-called Frank-Wolfe Algorithm and the alternative Method of Successive Averages (MSA).

B.2.2 Equilibrium assignment conventionally employs the relatively efficient Frank-Wolfe Algorithm for combining simple All-or-Nothing (AON) assignments (where all trips from a particular origin-destination pair are assigned to a single 'best' route based on current costs) such that the resulting linear combination of network flows satisfies Wardrop's First Principle of Traffic Equilibrium. It works by recognising that the set of flows V_a satisfying Wardrop's First Principle could also be obtained by finding the set of flows which minimised a certain 'objective function', Z, given by:

$$Z = \sum_a \int_O^{V_a} C\ a(v)dv$$

where: the summation is over all network links, a

$C_a(v)$ is the cost of travel on link a with volume v

the upper integration limit is the volume of trips on each link V_a

B.2.3 This equivalence enables algorithms to be constructed which, by minimising Z, guarantee finding an equilibrium solution. In practice, the Frank-Wolfe algorithm is most commonly used to derive a solution which meets Wardrop's Principle. The algorithm works by iterating over a large number of simple AON assignments and combining these in an 'optimum' way, by seeking on each iteration a 'descent direction' in which the current solution is improved and moving an optimum distance, λ, in that direction which minimises Z.

B.2.4 In terms of link flows the optimum solution may be written:

$$V_a^{(n+1)} = (1-\lambda)V_a^{(n)} + \lambda F_a^{(n)}$$

where:

$\sum_p T_{pij} = T_{ij}$

for $T_{pij} \geq 0$

$$T_{pij}^{(n+1)} \begin{cases} = (1-\lambda)T_{pij}^{n} & pij \neq pij* \\ = (1-\lambda)T_{pij}^{n} \quad +\lambda T_{ij} & pij = pij* \end{cases}$$

T_{pijn} is the number of trips from i to j using path p on iteration n.

B.2.10 Some suites provide solution algorithms that are variants of the Frank-Wolfe algorithm, but which make more explicit use of path flows.

Origin-Based Assignment

B.2.11 **Origin-Based Assignment** (OBA) (Bar Gera 2002) is a relatively recent development that is now offered by a number of mainstream assignment suites. It is effectively intermediate between Link-Based and Path-based Assignment in that it stores the link flows as generated by each individual origin:

$$V_a^i = \sum_i T_{ij} P_{ija}$$

where:

P_{ija} is the proportion of the trips T_{ij} from origin i to destination j which use link a.

B.2.12 The main theoretical advantage of OBA is that it provides virtually exact solutions to the Wardrop Equilibrium without requiring either excessive memory or excessive processing time, eliminating 'non-optimal' paths (and associated 'noise') which are routine by-products of Frank-Wolfe based solutions. In practice, exact solutions may still be difficult to obtain, particularly for complex assignments where an iterative process with a junction simulation model is involved.

Stochastic Equilibrium Assignment Methods

B.2.13 An element of user-perception modelling can be introduced within the equilibrium frameworks described above through the use of **Stochastic User Equilibrium (SUE) Assignments**. SUE Assignment methods try to account for variability in travel costs (or drivers' perception of those costs) by assuming that the perceived cost of travel on each network link varies randomly, within predefined limits. These methods are generally only required where the network is not congested.

B.2.14 The most common method, a variant of 'Burrell multi-routeing', is a form of Monte Carlo simulation. Prior to each AON assignment within the equilibrium (effectively MSA) process, a new set of costs is generated for each link, or each origin to destination pair. Costs are chosen 'randomly' from a distribution whose mean is the current link (or OD) cost before the n_{th} iteration AON paths and flows are generated. A normal distribution of 'perceived' costs with a user defined 'spread' is conventionally assumed. No optimum combination of flows can be calculated for stochastic methods, so the combination of AON iterations reverts to the MSA approach. As a consequence large numbers of iterations are required to achieve convergence.

B.2.15 With this type of (SUE) assignment, the spread in route choice due to the stochastic effects tends to reduce as congestion increases, so the potential advantages of increased realism may be small. In general, where congestion levels are significant, conventional equilibrium assignment should be sufficient. If stochastic assignment methods are used, the randomness factor used in the calculation of link costs should be clearly stated in the model reporting.

B.3 Capacity Restraint Mechanisms

B.3.1 Some form of capacity restraint mechanism is a prerequisite for any form of congested equilibrium assignment. A characteristic of this mechanism will be a relationship between the volume of trips and the cost of travel (on a network link or for a turning movement). In general, a monotonic relationship is required, so that the greater the flow volume, the greater the cost. This provides the mechanism for the transfer of trips from more costly to less costly routes.

B.3.2 At its simplest, this mechanism takes the form of link-based speed/flow curves, whereby speed reduces with increasing flow. Speed/flow curves specific to link categories can be pre-defined to form the basis for an 'equilibrium' solution. Where costs on a link are dependent upon flows on that link only, costs are said to be '**separable**' – a pre-condition for algorithms such as Frank-Wolfe to guarantee convergence.

B.3.3 The quantification and achievement of convergence is an important subject in this context and is dealt with in section 3.4 and Appendix C.

B.4 Dynamic Assignment Methods

B.4.1 The assignment methods described above usually assume steady state conditions, in which the demand (trip matrix) is assumed to remain constant (in terms of level and pattern) throughout the modelled period. A few assignment model packages - sometimes referred to as **Dynamic Assignment Models** - permit the trip matrix to vary in terms of both level and pattern of flow during the modelled period. These packages usually require the trip matrix to be specified in 'time slices'. Each time slice is assigned to the network separately, ensuring that network travel costs during each time slice are consistent with the level of demand being assigned. This ensures that routeing fully reflects the level of demand and the corresponding journey time for each time slice.

B.4.2 The potential advantages of dynamic models in reflecting time-varying conditions, including the build up and decay of congestion, are often unrealised because of the extra complexity involved relative to steady state models and the more detailed (demand) data required. Model convergence to an acceptable level has also proved challenging, as has model calibration and validation.

B.5 Micro-Simulation Models

B.5.1 A **Micro-Simulation** model is a dynamic model in which individual user-decisions are represented at a disaggregate level, and the combined effects of these decisions contribute to the overall system state. In the context of traffic assignment, decisions - including randomly generated 'micro' gap acceptance and car following behaviour - dictate traffic flows and delays whose effects may be translated into route choice.

B.5.2 Micro-simulation will not always involve route choice, however, some micro-simulation packages allow the use of routes extracted from 'equilibrium' type assignment models, eg for more detailed operational assessments.

B.5.3 If route choice (assignment) is required, the user will typically choose how often 'new' routes are calculated based on 'current' costs. At a more detailed level, routes may be decided for individual 'vehicles' and updated as progress is made through the network. The concepts of equilibrium and convergence are difficult under such conditions and stability becomes a more crucial concern for micro-simulation based assignments, particularly for models of large areas.

C.2.2 **Stability at global level** (eg total travel time, costs or distance) **is necessary but not sufficient for ensuring model convergence.** Such measures may hide substantial uncertainty at a lower level, such as in individual link flows or OD-costs.

C.2.3 Of a large number of **disaggregate stability indicators**, the following three have been identified as being straightforward to compute, easy to interpret and explain, and robust in their explanation of assignment stability.

- Average Absolute Difference (AAD) in link flows between successive iterations:

$AAD = \frac{1}{N}\sum_{a=1}^{N} |V_a^n - V_a^{n-1}|$ where:

N is the number of links

V_{an} is the flow on link a in iteration n

- Relative Average Absolute Difference (RAAD) in link flows between

$AAD = \frac{1}{N}\sum_{a=1}^{N} |V_a^n - V_a^{n-1}|$ successive iterations:

- %FLOW, the proportion of links in the overall network with flows changing less than 1% from the previous iteration,

C.2.4 **Proximity measures** can only be calculated when an assignment objective has been formulated. This is usually the case with equilibrium assignment, and deterministic extensions (multiple user classes, dynamics, elastic assignment).

The most appropriate proximity indicator is the duality gap delta (δ). The duality gap expresses the flow-weighted difference between current total cost estimates on the network, as determined by the present flow pattern and the speed/flow curves, and the costs if all traffic would use minimum cost routes (as calculated by the next all-or-nothing assignment). The duality gap is a natural convergence indicator for equilibrium process, measuring how far the current flow pattern is removed from the desired equilibrium, and should approach 0 at that equilibrium. In link form, this is given by:

$$\delta = \frac{\sum_a C_a(V_a^n)(V_a^n - F_a^{n+1})}{\sum_a F_a^{n+1} C_a(V_a^n)}$$ where:

$C_a(V_{an})$ is the cost for link a based on current flow estimate V_{an}

F_{an+1} is the all or nothing flow based on $C_a(V_{an})$

The summation is made over all network links and implicitly all i and j pairs.

Note that an equivalent formulation can be made on a path basis:

$$\delta = \frac{\sum T_{pij}(c_{pij} - c_{ij}^*)}{\sum T_{ij} c_{ij}^*}$$ where:

T_{pij} is the flow on route p from origin i to destination j

T_{ij} is the total travel from i to j

c_{pij} is the (congested) cost of travel from i to j on p

c_{ij}* is the minimum cost of travel from i to j

C.2.5 Of a large number of **disaggregate stability indicators**, the following three have been identified as being straightforward to compute, easy to interpret and explain, and robust in their explanation of assignment stability.

C.2.6 **'Gap' is the single most valuable indicator of overall model convergence.** It has a definite theoretical interpretation, does differentially weight 'good' and 'bad' fits and is easy to compare between networks of very different sizes, complexity and degrees of congestion. Regardless of which actual stopping criterion is chosen, Gap should always be monitored, its final values reported and convergence judged against the values obtained.

C.2.7 In complex assignment models, two separate 'Gaps' are sometimes reported, delta as above, and the '%GAP', which is a generalisation of the delta function to include the interaction effects within the simulation. It is, firstly, the difference between the current total vehicle costs on the assigned routes and the total vehicle costs if all drivers were to use minimum cost routes with the costs FIXED. This measure is then normalised by dividing by the total vehicle costs and expressing it as a %. It is therefore the same as delta except that the costs are calculated after the simulation rather than after the assignment.

C.2.8 Although proximity and stability usually accompany each other, they both should be assessed separately, as each relates to different aspects of the iterative process. The following criteria have been found to lead to stable and robust assignment results, whilst in practice being achievable in most cases and with most assignment packages and for very large models. The following should be satisfied at convergence:

- **Proximity** measures:
  - Delta (δ) < 0.1%
  - %GAP (if relevant) < 0.1%

AND the following:

Stability measures:

- RAAD in flows < 0.1%
- %Links with Flows changing by less than 1% > 98% ("P1")
- %Links with Costs changing by less than 1% > 98% ("P2")

The RAAD is considered to be a more robust indicator of stability than AAD, hence its inclusion above.

C.2.9 Both stability and proximity criteria should be satisfied for four consecutive iterations before convergence can be judged to be acceptable. At least one of the stability criteria should be satisfied, the values of the other two measures should also be reported. If examination of the statistics in more detail shows that (rather than oscillating about a constant value) all these indicators still move in the same direction, it is necessary to continue the iterative process further, or to investigate further the reasons behind the unsatisfactory convergence.

C.3 Convergence Monitoring for Different Assignment Methods

C.3.1 Not all of the above criteria are applicable to all assignment options:

- in **user equilibrium assignment** both proximity and stability should be satisfied
- in **multiple user class assignment** stability should be monitored for each class separately and proximity should be assessed for total flow

C.4.3 If convergence proves difficult, a spatially segregated assessment of convergence in different parts of the network should be carried out, by calculating the convergence statistics over subsets of the network. If this indicates that the problem is remote from the scheme, it may be possible to take results from the converged part only. If not, it is important to examine the coding of the part of the network where convergence problems arise.

C.5 Assessing the Accuracy of the Final Results

C.5.1 A key element of successful and robust scheme evaluation is the relationship between:

- the size of the model (in terms of total network times/costs)
- the time/cost savings of the scheme under consideration
- the uncertainty due to possible lack of convergence

C.5.2 If a large model is used to evaluate a scheme with relatively small network impacts, then convergence requirements need to be very tight. Otherwise the noise in poorly converged models can swamp the difference in total costs between without-scheme and with-scheme cases.

C.5.3 When using assignment models in scheme appraisal, the remaining uncertainty in model results may still be substantial, even after the model has achieved the desired level of convergence. This may arise where very large assignment models are used for relatively minor highways schemes, so that a small relative convergence error in the overall model may be quite large in comparison with the estimated scheme benefits. This can also happen when very high demand forecasts in future years lead to instabilities in the iterative sequence, particularly in the without-scheme scenario.

C.5.4 In some cases the remaining uncertainty in the model cannot be eradicated, as the model oscillates around the optimum flow pattern. It is necessary to assess this uncertainty in comparison with the scheme benefit estimates, to ensure that results are robust.

C.5.5 If the level of uncertainty is considered acceptable (in the context of scheme costs, etc) then the assignment may be taken to be robust. Out of the converged iterations for the without-scheme and with-scheme assignments those should be selected which have minimum total network travel time in each case.

C.6 Presentation of Convergence Results

C.6.1 Final results should always be accompanied by supporting documentation on convergence quality. Convergence monitoring of the assignment models used should form an explicit element of both the Local Model Validation Report and the presentation of forecasts. One suggested form of presentation is a ‘convergence monitor’ showing iteration number and the values of both proximity and stability indicators over the final four model iterations.

Appendix D Speed/Flow Relationships

D.1 Introduction

D.1.1 The speed/flow relationships previously used in COBA were derived from national research and are considered to be the most appropriate for use in traffic models. These relationships predict the traffic speeds associated with a given traffic flow. They should be fitted locally by use of local parameters, and then validated by journey time runs.

D.1.2 Speed/flow relationships may be used in various kinds of highway assignment models, as follows.

- In models of urban areas, junction delays should normally be modelled explicitly. In these models, the use of speed/flow relationships should generally be restricted to motorways and dual carriageway links.
- In models of inter-urban areas, junction modelling may be limited to the key junctions and greater use may be made of speed/flow relationships, for single carriageway roads as well as motorways and dual carriageways.
- In some models, in urban, suburban and small town networks away from the main area of interest, junction modelling may be regarded as being unnecessarily detailed. In these cases, network speed/flow relationships for urban and route speed/flow relationships suburban areas and small towns may be used as an approximation.

This Appendix gives details of the speed/flow relationships for all categories of road.

D.1.3 The basic form of the speed/flow relationships varies between road classes. For rural, suburban and small town roads, the speed of vehicles reduces as flow increases until a critical flow level 'break point' is reached, at which the rate of speed reduction becomes greater until capacity is reached. The relationships for urban roads are simpler and they have a uniform speed/flow slope for all flow levels above their nominal capacity.

D.1.4 The standard road classes are as follows.

Table D.1 Road Classes

Road Class	Description	Section in Appendix E
1	Rural single carriageway	2
2	Rural all-purpose dual 2-lane carriageway	3
3	Rural all-purpose dual 3 or more lane carriageway	3
4	Motorway, dual 2-lanes	3
5	Motorway, dual 3-lanes	3
6	Motorway, dual 4 or more lanes	3
7	Urban, non-central	4
8	Urban, central	4
9	Small town	5
10	Suburban single carriageway	6
11	Suburban dual carriageway	6

D.1.5 Class 1 to 6 roads are all-purpose roads and motorways that are generally not subject to a local speed limit. Class 7 and 8 roads are roads in large towns or conurbations subject to 30 mile/h (48 km/h) speed limits only. Class 9 roads are roads in small towns or villages for routes subject to a 30 mile/h (48 km/h) or 40 mile/h (64 km/h) speed limit. Class 10 and 11 roads are major suburban routes in towns and cities that are generally subject to a 40 mile/h (64 km/h) speed limit.

use of a single road type for roads with markedly different characteristics (particularly free flow speeds) should be avoided.

D.2.3 The actual width of surfaced road is defined by two parameters. The first (CWID) being the width of carriageway between any continuous white lines which may or may not be delineating a hard strip. The second (SWID) is the total width of any continuous edge line and hard strip, which increases the effective carriageway width (as set out below) by at least 0.8 metres and thus increases free-flow speeds as well.

D.2.4 Figure D.1 explains how measurements of bendiness, hilliness and visibility should be taken. Hilliness is (H_R + H_F) and net gradient NG is (H_R - H_F). On two-way links net gradient is always zero because the two directions of flow are not disaggregated. On one-way links, rises and falls are defined with respect to the direction of traffic flow and, in general, they will not cancel out.

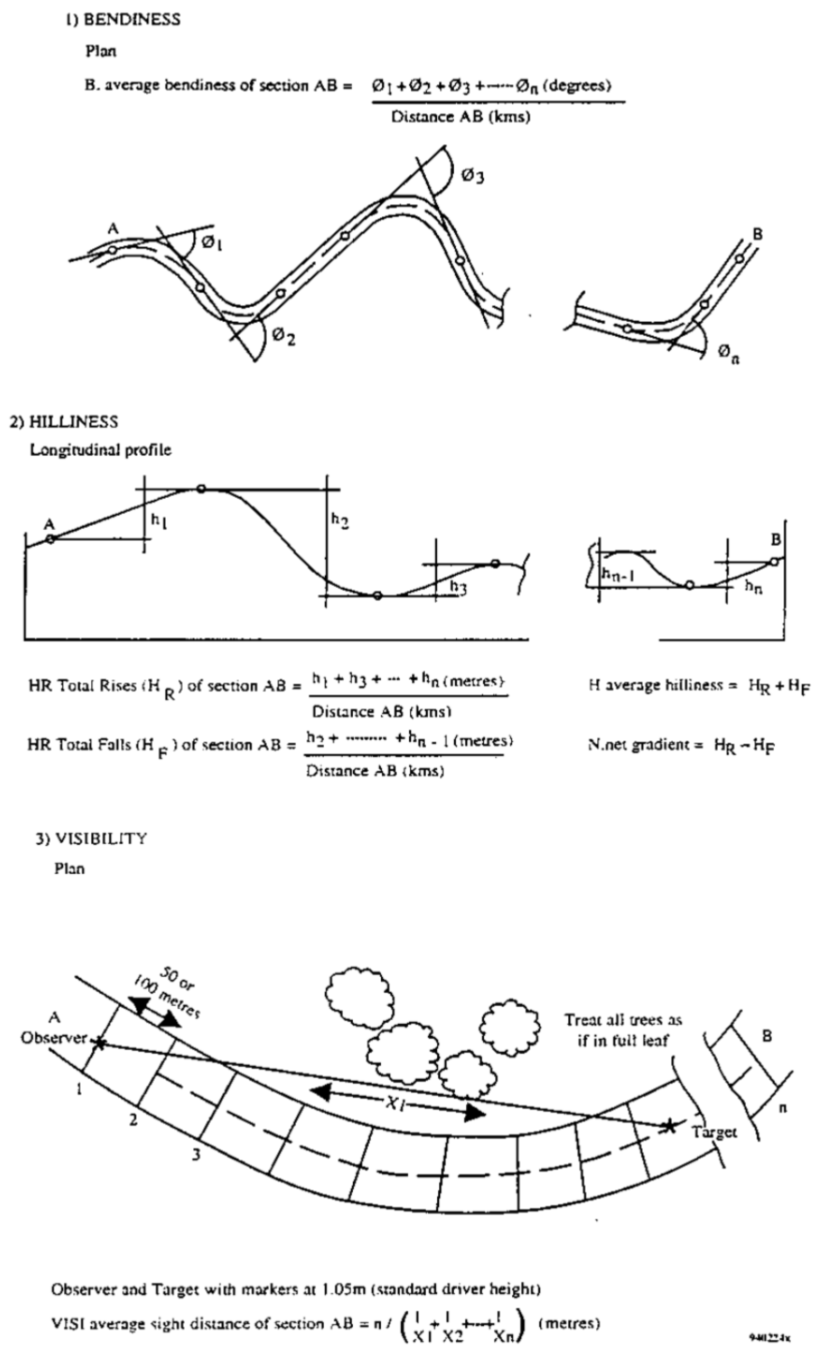

Figure D.1 Measurement of Road Geometry on Rural Roads

D.2.5 The average sight distance, VISI, is the harmonic mean of individual observations. For proposed new roads, VISI should be calculated from engineering drawings. For existing roads, an empirical relationship has been derived which provides estimates of VISI given bendiness and edge details:

Log VISI = 2.46 + (VWID + SWID)/25 - BEND/400

This relationship should normally be used for all existing roads for which bendiness and verge width have been measured. On long straight roads or where sight distance is available outside the highway boundary, VISI should be set to 700 metres for roads with high visibility; otherwise estimates should be made from plans or site measurements.

Table D.3 Definition of Variables Used in Speed/Flow Relationships for Rural Single Carriageways

Symbol	Variable Description	Typical Values	Max
DES	Is road designed to TD9/93 standards?	Yes	No
BEND	Bendiness; total change of direction (deg/km)	0	150
HILLS	Hilliness; total rise (H_R) and fall (H_F) (m/km)	0	45
NG	Net gradient one-way links only (m/km)	-45	45
JUNC	Side roads intersection, both direction (no/km)	0	5
CWID	Average carriageway width between white line edge markings, excluding any painted out portion (m)	6	11
SWID	Average width of hard strip on both sides, including width of white line (m)	0	1
VWID	Average verge width, both sides (m)	0	7
VISI	Average sight distance (m)	100	550
PHV	Percentage of heavy vehicles (OGV1 + OGV2 + PSV)	2	30
V_L, V_H	Speed of light and heavy vehicles (km/h)	n/a	n/a
S_L, S_H	Speed/flow slope of light and heavy vehicles (km/h reduction per 1000 increase in Q)	5	50
Q	Flow all vehicles (veh/hour/direction)	n/a	n/a
Q_B	Breakpoint: the value of Q at which the speed/flow slope of light vehicles changes (veh/hour/direction)	0.8 Qc	
Q_C	Capacity: defined as the maximum realistic value of Q (veh/hour/direction)	900	1600

D.2.6 The capacity of a single carriageway **per direction** is:

Q_C = 2400(CWID - 3.65)/CWID x (92 - PHV)/80 veh/hour

D.2.7 This value of Q_C identifies links which are likely to be overloaded. When flows reach this level the user must decide whether the flows are realistic and what course of action to take. The point of change of slope (Q_B) is given by the relationship:

Q_B = 0.8 Q_C

D.2.8 For flow levels less than the breakpoint Q_B the speed prediction formulae for light vehicles in km/h is:

V_L = 72.1 - 0.09 x BEND or -0.015 x BEND for roads designed to TD9/93

- 0.0007 x BEND x HILLS

- 0.11 x NG (one-way links only)

- 1.9 x JUNC

Q	Flow, all vehicles, two-way or one-way (veh/hour/lane)	0		2300
Q_B	Breakpoint: the value of Q at which the speed/flow slope of light vehicles changes (veh/hour/lane)	1080	or	1200
V_B	Speed of vehicles at flow Q_B (km/h)	80		105
Q_C	Capacity: defined as the maximum realistic value of Q (veh/hour/lane)	1400		2250

D.3.2 Vehicle speeds for a given flow level are dependent on the geometric variables (BEND, HILL and H_R). The value of those variables should be calculated, and the relationships set out below applied, for **at least** each individual road link longer than two kilometres, **on which flows change as a result of the scheme being appraised**. For other links, similar roads may be allocated to one of a number of typical link types (eg D3L uphill) each representing averaged characteristics. The use of a single road type for roads with markedly different characteristics (particularly free-flow speeds) should be avoided.

D.3.3 Q_C, the maximum realistic value of Q, per lane is:

2330 / (1 + 0.015 x PHV) for motorways, and

2100 / (1 + 0.015 x PHV) for all-purpose dual carriageways.

D.3.4 Q_B, the value of Q at which the speed/flow slope changes, is 1200 and 1080 veh/hour/lane for motorways and all-purpose dual carriageways, respectively.

D.3.5 For flow levels **less** than the breakpoint (Q_B), the speed prediction formula for light vehicles, in km/h is:

$V_L = K_L$ - 0.1 x BEND

- 0.14 x HILL (two-way links only)

- 0.28 x H_R (one-way links only)

- S_L x Q

where K_L is 108 for dual 2-lane all-purpose (Class 2),

115 for dual 3-lane all-purpose (Class 3),

111 for dual 2-lane motorways (Class 4),

118 for dual 3-lane motorways (Class 5),

118 for dual 4-lane motorways (Class 6),

and S_L, the speed/flow slope for light vehicles, is 6 km/h per 1000 vehicles.

D.3.6 At flow levels **greater** than the breakpoint (Q_B) the speed prediction formula for light vehicles, in km/h is:

$V_L = V_B - 33(Q - Q_B)/1000$

D.3.7 There is no allowance for merge delays at grade-separated junctions in the above formulae. Any such delays should be separately modelled as set out in detail in section D.9.

D.3.8 The speed prediction formula for heavy vehicles, which applies at all flow levels, in km/h is:

$V_H = K_H$ - 0.1 x BEND

- 0.25 x HILLS (two-way links only)

- 0.5 x H_R (one-way links only)

where K_H is 86 for allpurpose (Road- Classes 2 and 3) and

93 for motorways (Road Classes 4, 5 and 6)

subject to the constraint (which is unlikely to apply before the breakpoint) that, if the calculated value of V_H is greater than V_L, then V_H is set equal to V_L

D.3.9 The dual carriageway speed/flow relationships are expressed in flow per lane and not flow per direction as is the case with single carriageways. The research to develop the speed/flow relationships was undertaken on links with close to the standard 3.65 metre width lanes and was not able to detect a significant width parameter for use in the speed prediction formulae. Also it found that, unlike single carriageway links, the average speed of light vehicles on all-purpose dual carriageways is not influenced by the presence of a hard strip. However, if the average lane width of the proposed scheme is significantly less than the standard 3.65 metres, it may be necessary to survey free-flow speeds and use a local speed/flow relationship.

D.4 Urban Roads (Road Classes 7 and 8)

D.4.1 In built-up areas, generally subject to a local speed limit, the road network becomes more dense and intersections play a more significant role in determining speeds. The speed/flow relationships that have been developed for urban areas apply to the main road network in towns (population greater than 70,000) and cities where there is a 30 mile/h (48 km/h) speed limit. The relationships are designed to represent average speeds in towns on the roads that function as traffic links. A distinction is made between central and non-central areas, and they include an allowance for an average number of junctions. They are linear relationships of fixed negative slope.

D.4.2 Central areas are defined as those including the main shops, offices and central railway stations, with a high density of land use and frequent multi-storey developments, as in the widely used classification ‘central business district’ or CBD. Conurbations will have several CBDs whilst most freestanding towns will normally have only one. Streets which have commercial or industrial development but are not of a high-density CBD nature should not be included in the central area category. Non-central areas comprise the remainder of the urban area. With this classification, the central areas constituted between 4 per cent and 22 per cent (average 11 per cent) of the total street length in the networks of the 13 towns where the data used to develop the relationships were collected.

Table D.5 Definition of Variables Used in Speed/Flow Relationships for Urban Roads

Symbol	Variable Description	Typical Values	
		Min	Max
INT	Frequency of major intersections averaged over the main road network (no/km)	2	9
DEVEL	Percentage of road network with frontage development (%)	50	90
V	Average vehicle speed (km/h)	n/a	n/a
Vo	Speed at zero flow (km/h)	28	48
Q	Total flow, all vehicles, per standard lane (veh/h/3.65m lane)	0	1200
Qc	Capacity: defined as the maximum realistic value of Q (veh/h/3.65m lane)	800	

D.4.3 Away from the area of immediate interest (ie **where flows are not expected to change markedly as a result of the scheme**), the use of network class 7 or 8 speed/flow relationships which include an allowance for junction delays may be satisfactory. In such cases, all links in a particular area should have the same value for INT or DEVEL, and therefore the same speed/flow relationship per

Table D.6 Definition of Variables Used in Speed/Flow Relationships for Small Towns

Symbol	Variable Description	Typical Values	
		Min	Max
DEVEL	Percentage of route with frontage (%)	35	90
P30	Percentage of route subject to a 30 mile/h speed limit	0	100
V	Average vehicle speed (km/h)	n/a	n/a
V_B	Average vehicle speed at Q_B	38	57
Q	Total flow, all vehicles, per standard lane (veh/h/3.65m lane)	0	1200
Q_B	Breakpoint: the value of Q at which the speed/flow slope changes (veh/h/3.65m lane)	70	

D.5.2 Like the suburban speed/flow relationships (Classes 10 and 11), they do **not** apply to individual links but model traffic speeds **over the whole of a route that is subject to a speed limit of 30 or 40 mile/h**. Unlike the suburban relationships, however, they do **not** distinguish between light and heavy vehicles, and they **specifically exclude junction delays**; hence junctions where the route loses priority must be modelled separately.

D.5.3 The breakpoint flow Q_B is taken as 700 veh/h/3.65 metre lane. The maximum realistic flow (Q_C) should be taken as 1200 veh/h/3.65 metre lane.

D.5.4 The average speed in km/h of all vehicles for flows below the breakpoint (Q_B) is given by:

$$V = 70 - DEVEL/8 - P30/8 - 12Q/1000$$

where DEVEL is the percentage of the length of route that has frontage development, counting business and residential development as 100% and open space as 0%: the value will normally lie in the range 35% - 90%.

D.5.5 For flows greater than Q_B, the average speed in km/h of vehicles is given by:

$$V - V_B - 45 (Q - Q_B)/1000$$

D.5.6 These relationships should not be used for routes with P30 < 10% (that is for routes with an almost continuous 40 mile/h limit), DEVEL < 65 (that is with less than 65% development), and access friction < 3. Access friction is defined as the total number, both sides, of laybys, side roads and accesses per km (excluding house and field entrances) divided by the carriageway width in metres. In such cases, the route should be split into links, as appropriate, and the standard rural relationships should be used instead.

D.6 Suburban Roads (Road Class 10 and 11)

D.6.1 The suburban speed relationships apply to the major suburban routes in towns and cities where the speed limit is generally 40 mile/h (64 km/h).

D.6.2 The suburban relationships provide estimates of the average journey speed of light and heavy vehicles separately, including delays at junctions. Table D.7 below defines the variables used in the relationships and gives the ranges of values over which the relationships apply. The relationships cannot necessarily be taken to apply outside the given ranges of the variables. The geometric variables INT and AXS should be averaged over a reasonable length of link, generally not less than two kilometres. **Congested junctions should be modelled separately** and not included in the calculation of the value of INT.

Table D.7 Definition of Variables Used in Speed/Flow Relationships for Suburban Roads

Symbol	Variable Description	Typical Values	
		Min	Max
INT	Frequency of major intersections (no/km)	0	2
AXS	Number of minor intersections and private drives (no/km)	5	75
PHV	Percentage of heavy vehicles (%)	2	20
V_L,V_H	Speed of light and heavy Vehicles (km/h)	n/a	n/a
S_L,S_H	Speed/flow slope of light and heavy vehicles (km/h) reduction per 100 increase in Q	0	45
V_0	Speed at zero flow (km/h)	48	64
Q	Total flow, all vehicles, per standard lane (veh/h/3.65m lane)	0	1500
Q_B	Breakpoint: the value of Q at which the speed/flow slope changes (veh/h/3.65m lane)	1050	
Q_C	Capacity: defined as the maximum realistic value of Q (veh/h/3.65m lane)	1350	1700

D.6.3 Generally, the use of **area-wide** class 10 or 11 speed/flow relationships which include an allowance for junction delays will be satisfactory **only** away from the area of immediate interest.

D.6.4 There are important differences between the definition of the variable INT for suburban roads and urban roads. For suburban roads, INT is specific to each section of route and major intersections are either roundabouts or traffic signals. Junctions between consecutive links should not be double counted, and classified junctions, whose delays are separately modelled, should be excluded from INT. The number of minor intersections and private drives, AXS, should be the total for both sides of the road.

D.6.5 The maximum realistic flow (Q_C) is the same for both single and dual carriageways and is calculated by the relationship:

Q_C = 1500 (92 - PHV)/80 veh/h/3.65m lane

D.6.6 A standard value of 12% heavy vehicles (a typical value for main roads) is used to calculate the point of change of slope (Q_B) of light vehicles by the relationship:

Q_B = 0.7 x Q_C = 1050 veh/h/3.65m lane

D.6.7 The speed for vehicles (V_0) at zero flow (Q = 0) in km/h is given by:

V_0 = C - 5 x INT - 3 x AXS/20

where, for single carriageways (Road Class 10),

C = 70 for light vehicles, and

C = 64 for heavy vehicles,

and, for dual carriageways (Road Class 11)

C = 80 for light vehicles, and

C = 74 for heavy vehicles.

D.8.2 The Department has identified two relationships which may be used in conjunction with the 'COBA' relationships described in this appendix: (a) the so-called 'Advice Note 1A' (AN1A) relationship, and (b) the Akçelik relationship. These relationships are based on theory rather than empirical data[14].

The Advice Note 1A Relationship

D.8.3 The over-capacity speed/flow relationship specified in DoE Advice Note 1A[15] takes the form:

$$V = \frac{V_c}{1 + \frac{V_c}{8L}(E-1)}$$

$$E = \frac{Q}{Q_c}$$

where

V = speed (in km/h) at the assigned volume, Q (in PCU/h/lane), which is greater than the capacity, Q_c (in PCU/h/lane)

V_c = speed at capacity, Q_c

L = link length (in km)

D.8.4 In terms of time, this function is rather more simply represented as:

$$t = t_c + B(E-1)$$

where

t = link travel time at demand flow

t_c = link travel time at capacity

B = a constant equal to half the model period

D.8.5 This function is based on deterministic queuing theory and assumes that an increase in delay as E exceeds 1 is equal to the time it would take half of the queued flow to dissipate. Advice Note 1A assumed a 15-minute model period, which gives rise to the factor of 8 in the formula above; this should be changed to 2 for models of one-hour periods.

D.8.6 The delay calculated by this function is constant irrespective of the link length. This means that the delay time on a longer link is a much smaller proportion of the total time than on a shorter link and so, at a given over-capacity assigned flow, the shorter link will have a lower average speed than the longer link.

Choice of Relationship

D.8.7 The Akçelik function is more unwieldy than the AN1A relationship. It needs the delay parameter, k_d, to be defined for different link types. Also, it would only be usable in software that allows custom functions to be defined for link delays.

D.8.8 Both relationships essentially assume that there is one queue that exists at the end (or start) of the link. This means that, when a link is arbitrarily split by a 'dummy' node (for connection to a zone centroid, for example), twice as much over-capacity delay would be modelled despite there being no real change to the network.

D.8.9 The achievement of convergence can be affected by the shape of the over-capacity relationship. If the slope of the relationship is too steep, there is a risk of an oscillating assignment; if the slope is

14 Speed/Flow Relationships: Comparisons of Alternatives to Advice Note 1A, Technical Note A3.11, Parsons Brinckerhoff and The Denvil Coombe Practice, June 2009.
15 Advice Note 1A, Department of the Environment, 1971.

too gentle, links may appear too attractive with the result that convergence is achieved with assigned flows in excess of capacity despite under-capacity alternatives being available. If convergence problems are experienced, analyses should be undertaken to assess the extent to which assigned flows are in excess of capacity. If only a few or a small proportion of the modelled links have assigned flows above capacity, the shape of the over-capacity speed/flow relationship may not be a significant cause and other aspects of the model should be considered. If, however, a significant number or proportion of the modelled links have assigned flows above capacity, the shape of the over-capacity speed/flow relationship should be reviewed.

D.8.10 The effect of the Advice Note 1A relationship may be adjusted by altering the length of the affected links, either by removing or adding dummy nodes. Using two links instead of one will effectively double the over-capacity delay and using one link instead of two will effectively halve the delay. The result may be thought of as effectively doubling or halving the overall slope of the relationship.

D.8.11 The shape of the Akçelik relationship may be adjusted by changing the value of k_d. At $k_d = 0$, the Akçelik relationship is equivalent to the AN1A relationship. Increasing k_d increases the amount below the AN1A relationship which the Akçelik relationship tends towards, although the slope of the Akçelik relationship remains essentially the same. However, changing k_d will impact on the slope of the relationship for volume to capacity ratios in the region of 1.0 to 1.2.

D.9 Merge Modelling on High Speed Roads

D.9.1 Research by TRL into traffic behaviour on high speed roads (published in CR 279) has allowed the speed/flow relationships to be updated. Further research then developed a modified speed/flow relationship on the links between junctions and a relationship for the delay caused by merges on high speed roads. The resultant advice on merge delays applies to all merge types (including lane gains) which involve weaving and merging manoeuvres.

D.9.2 The merge delay formula is:

Delay (seconds per vehicle) = 227 x (downstream flow/average capacity - 0.75)

D.9.3 This is applicable when flows exceed 0.75 times average capacity and increase linearly with flow. When flows reach average capacity delay per vehicle is 57 seconds. It applies equally to all traffic when acceleration lanes are provided to Departmental design standards for high speed merges (80 km/h or higher), as then traffic can merge with minimal delay at that point. The extra traffic joining at such merges reduces gap lengths in the downstream traffic flow until the traffic is able to spread out. However, when flows are heavy, average capacity may be exceeded and "flow breakdown" may follow starting 0.5 to 2 kilometres downstream from the merge point, rather than from the merge point itself. After flow breakdown, capacity is reduced by 5-10% and speeds are significantly reduced. Average capacity reflects situations both with and without flow breakdown.

D.9.4 Behaviour at such merges is therefore different from the ‘Give Way’ mechanism, usually based on a gap acceptance, which forms the underlying basis of most congested assignment packages. The mechanism of demand exceeding capacity can be represented in most congested assignment packages by means of their "blocking back" procedures. These use a mechanistic process which at some point usually reduces effective capacity on upstream links and can thus propagate blocked backed queues on either a) the upstream link designated as giving way, or b) where priorities are designated as equal, predominantly on the more congested upstream link (which can be either the mainline or joining feeder).

D.9.5 There is no evidence to support either a priori rule at High Speed Merges. Hence, unless evidence has been collected over 10 or more days which shows that a more appropriate factor can be calibrated locally, blocking back in traffic models of high speed merges should be controlled by the analyst to delay joining and mainline traffic to an equal extent. This can be achieved by keeping the modelled blocking back delay downstream of the merge. This may require careful choice of the model parameter for the average length of a vehicle in a queue, or other measures of stacking

Appendix E Tiered Model Systems

E.1.1 If a tiered modelling approach is being considered, it is a requirement that the demand estimated by the higher tier model and supply estimated by the detailed model meets the guidelines for acceptable demand-supply convergence in TAG unit M2.1. There must always be a check that the demand response to a particular price predicted by the upper level is consistent with that predicted at the lower level, and especially that the aggregate speed-flow relationship of the higher level is fully compatible with that governing the network model.

E.1.2 The ultimate proof that the upper tier demand changes are consistent with the lower tier cost changes is to run the demand model and detailed highway assignment model to convergence. However, this will rarely be practical for more than one or two tests (which is why a tiered system would be considered necessary). One way in which consistency can be achieved is to design the upper tier or simplified highway assignment model so that it replicates as closely as possible the costs and cost changes produced by the lower tier highway assignment model.

E.1.3 The recommended procedure for creating a simplified model is one that is fully automated, using inputs from the detailed version. Ideally, there should be no manual coding, or manual adjustments to the coding, of the simplified model. This applies to both base year and forecast versions of the model. The simplified and detailed models should have the same network link and node structure and the same zone system[17] as the detailed model (ie there is no spatial simplification within the recommended process).

E.1.4 For the rest of the Fully Modelled area and the External Area, no simplification is required and the network coding from the detailed model can be used directly. For the Area of Detailed Modelling, where junction delays are modelled explicitly, there are two alternative approaches to simplification:

- summarising of junction turn flow/delay effects to form link flow/delay curves
- direct use of turn flow/delay curves

The former is a simplified version of the latter. Direct use of turn flow/delay curves has proved to be greatly superior in the replication of detailed model flows and journey times. The remainder of this discussion focuses on this method.

E.1.5 Turn flow/delay curves derived for a simplified highway assignment model need to be applicable for the whole of the duration of the modelled period (generally one hour). However, the flow/delay curve for a particular turn is not a static property. It is, to a degree, dependent upon the level of flow for any opposing movements and upon other factors such as traffic signal timings. Within each iteration of the detailed assignment process, these factors are varied to some degree. As a result, turn flow/delay curves have to be developed from the results of a converged assignment and not just from the network coding for the detailed model.

E.1.6 In the development of the base year model, the turn flow/delay curves that are the outturn of the validated detailed model should be used for the simplified model. The process of extracting turn flow/delay curves will vary depending upon the software used for the detailed model. Some software explicitly develops and stores such curves as part of its internal processes, eg because a junction simulation process is employed. For other software, points on a curve may have to be developed through a process of assigning varying levels of demand to the base year network.

E.1.7 Following completion of the base year simplified model, the following comparisons with the detailed model should be undertaken (as a minimum):

- assigned flows using base year demand

[17] Examples of where the simplified model uses an aggregated version of the zone system do exist, but results have not generally been satisfactory.

- inter-zonal times using base year demand
- inter-zonal times and time changes using demand factored by 0.9, 1.1, and 1.3

E.1.8 A formal link flow validation (that is, a comparison of modelled flows and counts) should be carried out as specified in section 9. It would be surprising if the assigned flows in the simplified model validated as well as those in the detailed model. However, whether the assigned flows in the simplified model are sufficiently accurate may be judged from the accuracy with which inter-zonal time changes are replicated. It is these inter-zonal time changes which are the most important output from the simplified model as it is these time changes which will drive the demand changes.

E.1.9 Regression analyses of detailed and simplified times and time changes should be carried out. It is to be expected that the intercepts will be zero or very near to zero. If the slopes lie outside the range 0.95 to 1.05 and/or if the R_2 value is less than 0.90, ways of improving the performance of the simplified model should be investigated.

E.1.10 Preparation of a simplified model for future years is more complicated than for the base year, as the future demand is not known (and indeed is an output of the supply/demand process). The recommended procedure is as follows:

- prepare and check the future year detailed model networks
- assign the future matrices that have been prepared assuming no cost change from the base year (ie the reference case demand)
- from the above prepare the simplified network as per the base year

E.1.11 In iterating the demand and simplified supply models to convergence, it is desirable to re-build the simplified network at least once, ie inserting a run of the detailed highway assignment model.

Journey Time Surveys for Calibration and Validation

6 Network Development Methodology

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Junctions: Flow/Delay Relationships

Signal Timings

Saturation Flows

Links: Speed/Flow Relationships

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8 Network Calibration and Validation Methodology

Network Calibration

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Route Choice Calibration

Route Choice Validation

10 Trip Matrix Calibration and Validation Methodology

Trip Matrix Estimation

Trip Matrix Validation

11 Assignment Calibration and Validation Methodology

Assignment Calibration

Assignment Validation

12 Summary of Model Development, Standards Proposed, and Fitness for Purpose

Summary of Model Development

Summary of Standards Proposed

Proposed Assessment of Fitness for Purpose

F.3 Highway Assignment Local Model Validation Report

F.3.1 The following structure should be used.

The recommended content of this chapter is detailed in Appendix F of TAG unit 2.2.

8 Network Calibration and Validation

Network Calibration

Network Validation

9 Route Choice Calibration and Validation

Route Choice Calibration

Route Choice Validation

10 Trip Matrix Calibration and Validation

Trip Matrix Estimation

Trip Matrix Validation

11 Assignment Calibration and Validation

Assignment Calibration

Assignment Validation

12 Summary of Model Development, Standards Achieved, and Fitness for Purpose

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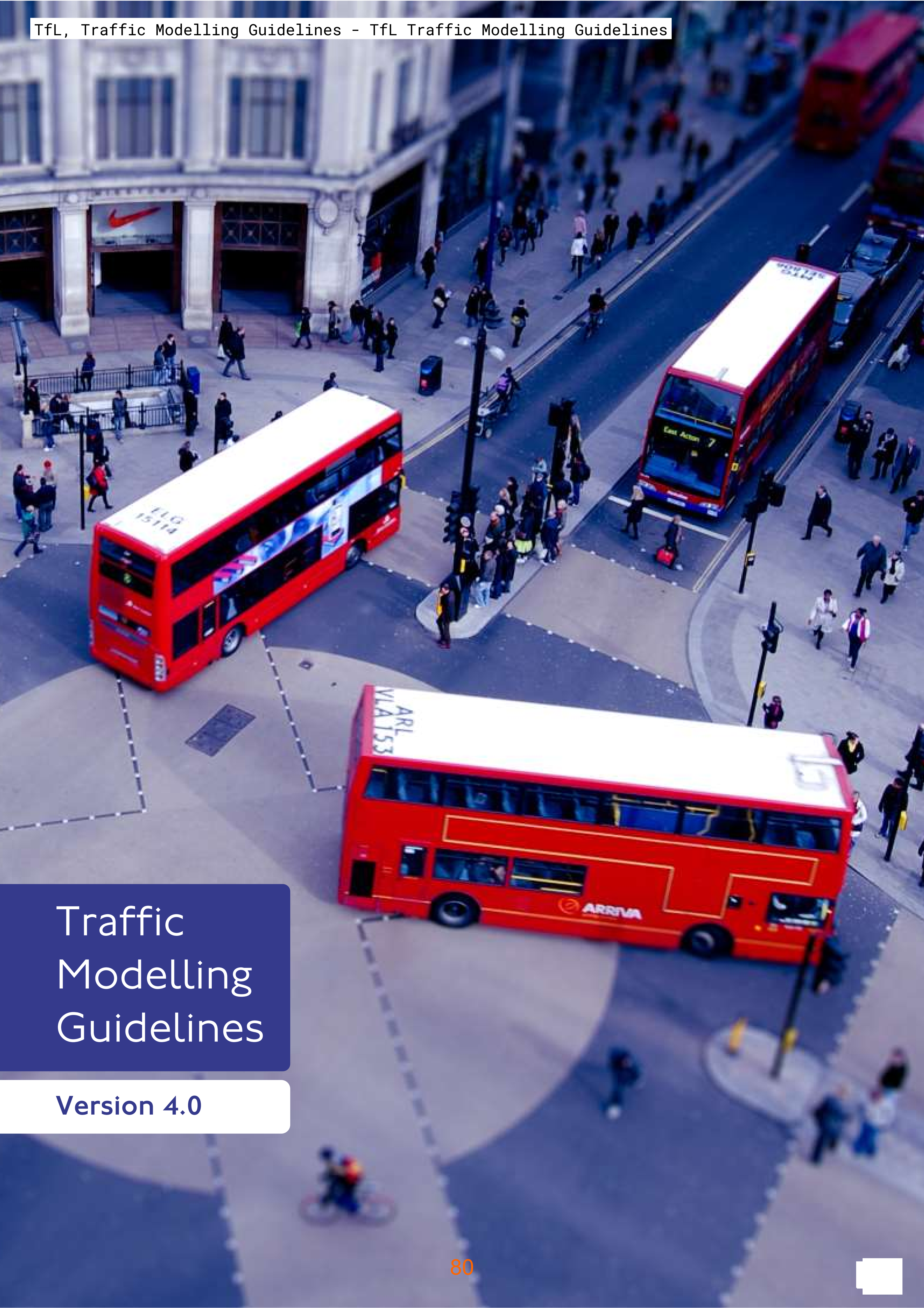

Traffic Modelling Guidelines

Version 4.0

Edited by

Lucy Beeston, Robert Blewitt, Sally Bulmer and James Wilson

Disclaimer

This publication is intended to provide accurate information. However, TfL and the authors accept no liability or responsibility for any errors or omissions or for any damage or loss arising from use of the information provided.

Foreword

London's roads have a vital role in realising the Mayor's vision for a fairer, greener, healthier and sustainable city. The road network is changing to enable our customers, goods and services to move about the Capital more efficiently and safely – especially for bus passengers, cyclists and pedestrians as part of the Mayor's vision.

A primary goal of Transport for London's Traffic Manager is to maintain network availability to ensure reliable operations on the Transport for London Road Network (TLRN) and Strategic Road Network (SRN). It is essential that all schemes proposing changes to the way our roads operate are developed to a high quality, that the impacts on the wider network are well understood and mitigated, and the contribution to achieving Mayoral policy is considered.

Operational modelling plays a central role in all scheme development and design, both through the high-quality technical assessments which are important for developing scheme designs and supporting business decisions, but also in the modelling information which stakeholders and customers have come to expect when they engage with scheme consultations.

These Guidelines provide valuable support to all transport professionals; they draw upon expertise from across the industry and form a comprehensive source of good practice.

I hope you find them useful in your daily work and I welcome any feedback or ideas you have. This will ensure that together we can continuously improve the Guidelines for the benefit of everyone.

Glynn Barton

Director of Network Management

Traffic Manager for TfL

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Introduction

The Traffic Modelling Guidelines have been produced by Transport for London's (TfL) Network Management Directorate (NM) that sits within Surface Transport. The following document represents the views and needs of a broad spectrum of traffic modelling practitioners with contributions from departments across TfL and external industry experts

The Director of NM is the TfL Road Network Traffic Manager and therefore has a duty to secure the expeditious movement of people and goods (collectively termed 'Traffic' in this document) as detailed in the 2004 Traffic Management Act[1]). NM is dependent on comprehensive modelling and supporting information from clients (including London boroughs and TfL departments) and consultants in order to design, assess, implement and operate traffic schemes effectively.

Appropriate, comprehensive and accurate modelling is necessary to ensure permanent traffic schemes can be:

- Fully assessed for impacts and benefits;
- Effectively designed to satisfy original objectives and mitigate any adverse impacts;
- Clarified to avoid confusion or misinterpretation of the design;
- Effectively and efficiently implemented and operated; and
- Implemented with an accurate prediction of operation within a high level of confidence.

NM has developed these Guidelines to help inform modellers, network operations practitioners and scheme Promoters. They encourage consistency, promote best practice and are intended to deliver improvements in modelling quality. The aim is that this will in turn promote high quality scheme design that delivers and maintains appropriate balanced network performance across all transport modes, in line with relevant policies in place at the time.

Since the previous version of the Traffic Modelling Guidelines[2] was published in September 2010, this new version has been produced to bring the document up to date and to ensure that guidance is compliant with current best practice.

1 Great Britain, Traffic Management Act 2004: Elizabeth II, Chapter 18, The Stationery Office, London, 2004

2 RSM Modelling Guidelines v3.0: Traffic Schemes in London Urban Networks, Directorate of Road Space Management, Transport for London, 2010

The Traffic Modelling Guidelines are now separated into three parts to simplify access and use:

Part A

Part A has been written to give a high-level understanding of traffic modelling as it applies in a TfL context. It is designed to be read by a wide audience, both internally and externally, including non-technical decision makers, project managers and scheme Promoters. It does not assume any prior knowledge of traffic modelling.

Part B

Part B contains technical guidance relating to the use of traditional traffic modelling software. The first chapter covers topics which are common to all types of traffic model, while subsequent sections provide more detailed guidance on modelling best practice for specific types of traffic model.

Part C

Part C contains evolving modelling guidance that continues to be developed to support active travel modes as advocated through the Mayor's Transport Policy, which focuses on promoting health and reducing reliance on private vehicle use.

About the Authors

These Guidelines have been compiled and edited by staff from TfL's Network Performance (NP) department, within NM. Staff within NP possess a high level of technical modelling expertise, which has been developed internally in TfL and under predecessor organisations such as the Traffic Control Systems Unit. Modelling specialists within NP are responsible for developing TfL's modelling assets and undertaking advanced model assessments to support highway development.

A wide range of TfL staff, many of whom are respected as subject matter experts in the traffic modelling field, have contributed significantly to the development and review of these Guidelines.

PART A – MODELLING CONSIDERATIONS

1 Introduction to Part A

The Network Management Directorate (NM) within TfL Surface Transport is responsible for the management and operation of London's 6,000+ traffic signals and their accompanying systems, technologies and equipment.

NM is a centre of traffic engineering expertise and applies traffic modelling in two core areas:

- The Network Performance Delivery (NPD) section, where traffic models are used for signal design optimisation, operational timing reviews and traffic scheme impact assessments; and
- The Network Performance Modelling & Visualisation team (M&V), which provides modelling assurance through expert modelling support of traffic scheme impact assessments and is responsible for development of the Model Auditing Process (MAP), Traffic Modelling Guidelines and the Operational Network Evaluator (ONE) assignment model.

Part A of these Traffic Modelling Guidelines has been written to give a high-level understanding of traffic modelling as it applies within a TfL context. It is designed to be read by a wide internal and external audience, including non-technical project managers and scheme Promoters. It does not assume any prior knowledge of traffic modelling.

Part A introduces the background to traffic modelling in London with an outline of TfL's legislative responsibilities, including its Traffic Manager duties, policy considerations and requirements to deliver against relevant road network performance metrics. It covers the reasons why modelling is appropriate, how it should be carried out and who is involved.

At the core of **Part A** is the modelling hierarchy, which shows how different levels of modelling interact and relate both to each other and the process of modelling as a whole.

The key requirements to produce traffic modelling to a suitable standard are outlined along with a brief description of the model submission process and the presentation of modelling results.

Developing models to a correct standard, and using these models to inform the design process, requires expertise and experience on behalf of the model developer and the design team. A scheme Promoter (section **A3.6.1**) should ensure that any consultant they appoint possesses the requisite experience and expertise. This chapter provides guidance to the scheme Promoter on necessary expertise and outlines some of the basic fundamentals which must be met by the model developer and the design team using the model.

The final chapter introduces a range of traffic modelling software and describes the applications and outputs of each. It provides a context for the remainder of the Guidelines.

2 Background to Highway Scheme Modelling in London

TfL is responsible for operating 5% of the roads and all the traffic signals in London. Before talking about modelling, it is useful to give an outline of the legislative framework which regulates that operation, define the terminology used to change it, and describe how the traffic signals are controlled. All traffic modelling is based around the ways the road network currently operates, so some knowledge of this background is important when undertaking any kind of modelling project.

2.1 Legislative Responsibilities

The Traffic Management Act (TMA) 2004, with text updated by virtue of the Infrastructure Act (2015) requirements, places a Network Management Duty (NMD) on all Local Traffic Authorities (LTAs) in England, including TfL and the London boroughs. As London's strategic traffic authority, TfL has both a local and strategic NMD. The NMD requires the LTA to:

- Ensure the expeditious movement of traffic on its own road network; and
- Facilitate the expeditious movement of traffic on the networks of others.

Guidance was produced by the Secretary for State in 2005, but essentially the NMD requires an authority to manage all their activities in such a way as to maximise the efficiency of movement on their road network and minimise unnecessary delay. Each LTA must appoint a Traffic Manager, whose role includes ensuring that the NMD is fully considered and applied throughout all the authority's functions.

TfL's responsibility covers:

- Transport for London Road Network (TLRN), a network of nearly 580km of London's roads (shown in red in **Figure 1**). This makes up 5% of the roads but carries 30% of London's traffic and is the responsibility of TfL under the TMA;
- All of the traffic signals in London, whether they are on the TLRN or not; and
- Strategic Road Network (SRN), comprised of a further 500km of routes which are considered to have a strategic importance in terms of network operation, including major bus routes (shown in pink in **Figure 1**). Boroughs have overall responsibility for these routes, however TfL has operational oversight and has to be notified of activities which will affect, or are likely to affect, them. TfL also has powers to intervene in relation to activities which will affect, or are likely to affect the SRN, where it is necessary to do so.

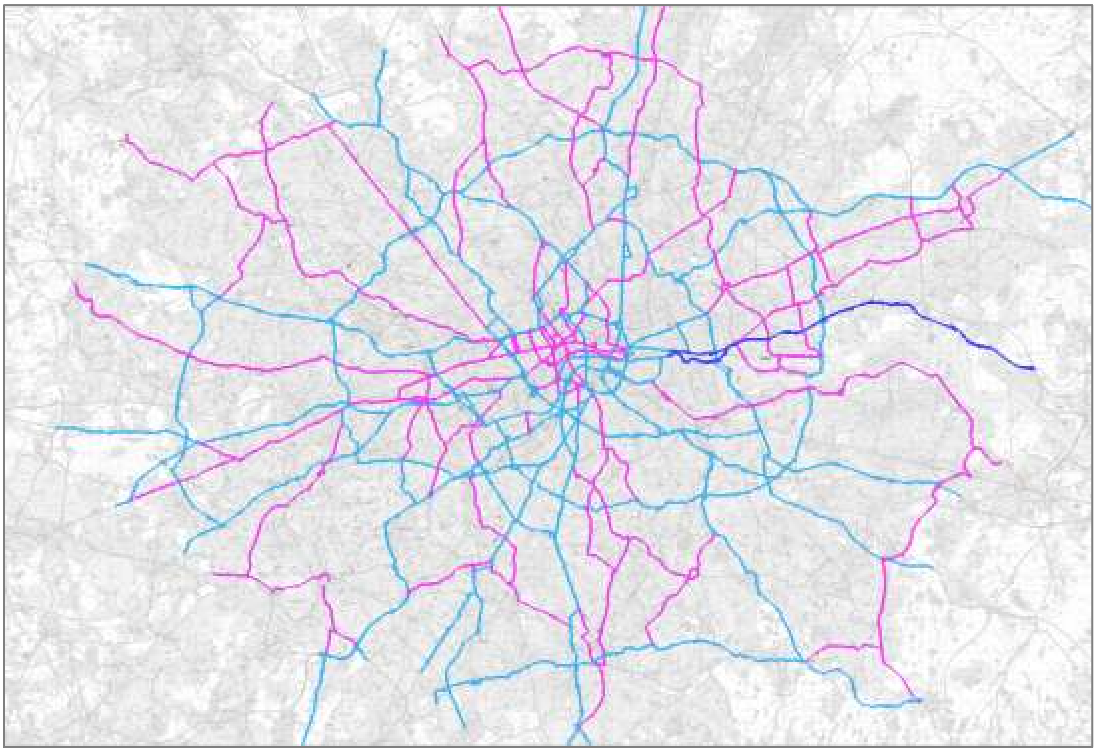

Figure 1: The TLRN (shown in blue) and the SRN in (shown in pink)

Given the proximity of neighbouring road networks in London, and the fact that the TLRN runs through 32 of the 33 London boroughs, the importance of evaluating changes to the highway environment in the context of a broader network is paramount, and modelling is a critical tool by which to do this effectively.

Highway Authorities are also required to make decisions about highway changes in the context of current policies. TfL is responsible for supporting the Mayor of London to deliver their Transport Strategy. The current Mayor's Transport Strategy (MTS)[3] was published in March 2018 and is available at **https://tfl.gov.uk/corporate/about-tfl/the-mayors-transport-strategy**. These Guidelines provide specific guidance on modelling for 'sustainable modes', taking into account the expectations of the current MTS in London and wider central Government policies to encourage more walking, cycling and use of public transport to address public health and environmental policies.

2.1.1 Scheme Definition

Before detailing how this NMD relates to TfL and traffic modelling in particular, it is useful to have a working definition of how the word 'scheme' is used in the context of these Guidelines:

A scheme is a planned change to the road network or signal operation at one or more junctions that is intended to improve safety, junction performance or road user experience. The scope may vary from a minor adjustment of signal timings at a single site to a complete redesign of road and junction layouts, and methods of control across a wide area. Schemes may be introduced by a Highway Authority as result of strategic objectives, policy considerations or in response to a private initiative, such as a new supermarket or housing development. Before implementing a scheme the Highway Authority will typically engage with residents and other interested parties, and there may be a requirement for a statutory consultation period (section **A4.6.2**).

2.1.2 Applying the Network Management Duty in TfL

Within NM, the Network Impact Specialist Team (NIST) works on behalf of the Traffic Manager to ensure that the NMD has been fully complied with in the development, design and implementation of highway scheme proposals impacting on London's major roads - the TLRN and SRN.

Part of the NMD is to ensure the best possible movement of all modes of transport at signal-controlled junctions in the network. The modes of

3 Mayor's Transport Strategy, Greater London Authority, March 2018

transport that need to be considered are specified by the Department for Transport (DfT) in the order of priority shown in **Figure 2**[4]: In these Guidelines, all these modes of transport are collectively referred to as 'traffic'.

Consider first	Pedestrians
↓	Cyclists
↓	Public transport users
↓	Specialist service vehicles (e.g. emergency services, waste, etc.)
Consider last	Other motor vehicles

Figure 2: DfT's hierarchy of user provision

When a scheme Promoter proposes temporary or permanent changes that may impact on the operational performance of the TLRN or SRN, that Promoter is required to notify TfL and gain approval through NIST. Additionally, TfL has made it mandatory within its organisation that any proposals developed internally that impact on these same road networks must also be notified and approved through NIST. One of the key benefits of modelling is to support notifications to NIST by quantifying the impact on network performance.

NM provides independent technical support to scheme Promoters, in the form of a Scheme Impact Report (SIR, section **A4.6.1**) to enable NIST to make informed decisions when assessing and reviewing schemes. TfL requires an understanding of the impact of any scheme on bus and cycle journey times, and pedestrian delay at signalised crossings, as well as the impact on journey times for general traffic. This information, which should be derived from models, will be assessed alongside the broader scheme benefits.

4 Traffic Signs Manual – Chapter 6 "Traffic Control", Department for Transport, 2019

2.2 Traffic Signals

In general terms, the control of traffic signals in London (including junctions and pedestrian crossing facilities[5]) can be split into two types: Urban Traffic Control (UTC) and non-UTC. All signalised sites contain basic timings and settings in a controller on-street, however, UTC coordinates the operation of junctions over an area through use of timing plans implemented by a central computer. Non-UTC signals operate under local control, where all timings are stored locally on each controller and activated according to a pre-defined timetable.

The primary function of the UTC system is to transmit stage change events via timing plans to on-street controllers which then adjust the amount of available red and green time for each traffic movement. The majority of UTC-controlled sites are coordinated using Split Cycle Offset Optimisation Technique (SCOOT). Operational systems such as the one used in UTC SCOOT optimise traffic signals using a live data model, and the optimisation method and fundamental principles are similar to those employed by junction design and deterministic models (section **A3.4.1**). These operational models are coded and validated manually to ensure that accurate capacity estimates are generated. They commonly use live data inputs from carriageway detectors to make decisions in real time regarding the optimisation of network signal timings. UTC and SCOOT are in the process of being updated and replaced over the next few years.

Non-UTC signal sites are operated by the local controller rather than a centralised system. These facilities are controlled using Cableless Linking Facility (CLF), Microprocessor Optimised Vehicle Actuation (MOVA) or Vehicle Actuation (VA). CLF-controlled sites operate using timing plans stored locally within the controller and, once implemented, timings can only be changed by an engineer on site. MOVA and VA allocate green times to different traffic movements based on vehicle detection between defined minimum and maximum limits. These junctions are usually found in outer London.

Use of the live signal control systems is carried out by NPD and is not covered in these Guidelines, except as a source of data for other forms of modelling and as the ultimate destination for any signal timings that the modelling produces. Whichever method is used to control the signals, all timings will have been through some form of modelling before they are implemented on street.

5 Signalised pedestrian crossings in London include: Puffin crossings, Toucan crossings, Pelican crossings (legacy), signal-controlled pedestrian facilities (PEDEX) and equestrian crossings (sometimes known as Pegasus crossings).

3 Modelling Overview

This chapter contains a basic introduction to modelling, including the reasons for carrying out traffic modelling and an overview of the modelling types and processes that are carried out at TfL.

3.1 What is a Model?

Since these Guidelines are concerned with building traffic models, it is appropriate to define what is meant by the term 'model' in its most general form:

> "A model can be defined as a simplified representation of a part of the real world ... which concentrates on certain elements considered important for its analysis from a particular point of view." [6]

It is important to be aware of the simplifications that are made in creating a model and to understand whether they have any significance for the intended analyses.

6 Ortúzar J de D & Willumsen L G, Modelling Transport, 4th Ed., Ch1, Wiley, London, 2011, p2

Simplifications can be made, either deliberately or inadvertently, during model development or calibration, or can be inherent to the particular choice of modelling software used for a project. Model simplifications can be wide ranging and are detailed further in **B2.1.2**. Any model simplification should not diminish the value or quality of the model.

3.2 Why Do Modelling?

Models are designed as simplifications of the real world and used to evaluate the impacts, both negative and positive, of future network and policy interventions. It would be impractical and costly to undertake scheme selection and evaluation in real world environments, so traffic models present a simulated environment in which numerous design solutions can be tested and appraised with the aim of achieving the optimum balance of benefits and value for money.

Modelling can be a powerful tool in understanding the potential traffic impacts of proposals if used in an appropriate way. It can also enable strategies to be developed to mitigate adverse impacts.

To expand on these points, reasons that modelling is both necessary and useful fall into the following areas:

- **Design** – When considering introducing a scheme on the road network, modelling allows for the testing of a variety of options to arrive at a preferred design. Once this has been achieved, the chosen model can also be used for iteration between the design and modelling functions in order to further refine the design to give the optimal operational performance;
- **Balance** – The needs of all road users can be considered and competing demands balanced. The simulated environment can also consider the needs of predicted new users of a facility which does not yet exist, for example customers of a new supermarket or cyclists encouraged by a new cycle lane. This can help to maximise the benefits of a scheme;
- **Prediction** – Models can help to quantify the impacts of a scheme using standard outputs such as flow, journey time and speed changes. They can also highlight stoplines which may have capacity issues in the proposed design so that mitigation measures can be investigated;
- **Communication** – The results of modelling can be used to communicate the predicted effects of a scheme and give stakeholders some idea of how it will look after implementation. Most forms of

modelling have some form of visual output which can be used to clearly convey technical data to a non-technical audience; and

- **Demand** – Models can be used to explore implications of alternative demand resulting from in travel behaviour or the introduction of new mobility technologies.

In addition to these general points, as indicated in section **A2.1.2**, TfL has a duty to assess the impact of any proposed scheme on the network. Modelling is a significant part of any assessment and provides information to the SIR. This enables NIST to understand the proposed operation of the scheme and make an informed decision on whether to grant approval.

3.3 Basic Modelling Process

The generalised process for creating traffic models for scheme assessments is described in this section. For most TfL modelling projects this is formalised and expanded in the Three Stage Modelling Process, which is described in section **A3.5**, however the steps described here will form part of any modelling exercise where there is a defined outcome.

3.3.1 Replicating the Current Situation

The starting point to any modelling project is to build a model that replicates the current traffic conditions at a given point in time, usually when the data used to build it was collected. This model represents a baseline which can be used for comparison with any other scenarios and is called a 'Base' model. A Base model is created for any time period that requires assessment. At a minimum this would usually include AM and PM peaks, but more time periods may be modelled if they are deemed necessary.

Base models are developed and calibrated using data collected on street, and are validated to demonstrate that they have adequately represented the current conditions and are suitable to be used for comparison when assessing other scenarios. Validation is an exercise that involves comparing model outputs with real-world data and showing that they match to within a prescribed level of accuracy. The levels used by TfL for each parameter can be found in MAP, which is described more fully in section **A3.6**. The data used for validation is also collected on street and should be independent of the build data. The particular parameters that are validated depend on the type of modelling software which is being used. Examples include the degree of saturation (the percentage of capacity that is used) at a stopline and journey times between two points.

3.3.2 Assessing Future Scenarios

Almost all traffic modelling exercises are carried out with the purpose of predicting the operational performance of a proposed future intervention. During the development of future scenario models it is necessary to make assumptions regarding road user behaviour under new proposals, since these cannot be observed or measured in reality. All assumptions made at this stage should be determined following a logical approach and recorded. The approach should draw upon available survey data and observations where possible. Often assumptions will depend on the nature of the scheme proposals, in which case an understanding of the wider project is essential.

These scenario models will be built using the Base model as a starting point and change only those aspects which are a direct result of the proposed design. If the Three Stage Modelling Process applies (section A3.5) then an intermediate step may be added, to build a future year model where the scheme is not included and accounting for any future demand changes. This is in order to provide a future year basis for comparison when assessing the results.

3.3.3 Interpretation and Presentation of Modelling Results

The model developer is responsible for presenting modelling results. In the case of the Base model the results are used to:

- Demonstrate the model adequately represents the existing situation; and
- Provide the reader with a detailed assessment of the existing situation.

In the case of the proposal, model results should demonstrate the effect and operation of the scheme on the road network. The model developer must ensure that any impact on the road network is presented and the cause for this impact discussed. Results from the modelling should be presented as a comparison with the Base model or, if more appropriate, with a future year Base model to demonstrate the impact of the scheme against a future without the scheme.

In order to inform accurate decision making, the presentation of model results should detail any assumptions made during model development and any influence they have on the reported results.

3.4 Transport Modelling Hierarchy

Transport modelling operates at various levels of detail and scale, from large regions that may cover an entire city or country down to single junctions. The hierarchy in scale of these modelling levels is illustrated below in **Figure 3**:

- Deterministic modelling covers the smallest area, from a single junction to a group of linked junctions;
- Microsimulation modelling covers areas from a few junctions to a whole corridor or town centre; and
- Tactical and Strategic modelling may cover similar spatial areas (for example the whole of Greater London) however tactical models look at shorter timescales and are often cordoned to focus on specific regions, whereas strategic models consider traffic patterns across the city and commuter catchment area up to 30 years ahead.

Data exchange usually operates between different levels of modelling to promote analytical consistency, and is described further in section **A3.4.5**.

3.4.1 Deterministic Modelling

Deterministic modelling, also known as local modelling or junction modelling, can cover areas ranging from a single junction to a group or ‘region’ of junctions with linked signal timings. This level of modelling focuses in detail on the capacity of individual stoplines and junctions, and the interaction between them. The use of the word deterministic to describe these models relates to the fact that given identical starting conditions the outputs will be the same every time the model is run, meaning the results are pre-determined.

The key feature of deterministic modelling when compared to other types is that it can be used to optimise signal timings. Settings are entered as in on-street junction controllers, so these models can be used for designing and optimising methods of control at junctions and the results can be applied directly. The focus on individual junctions allows quick option testing of modifications to geometric layout and signal staging design, and the interactions between junctions with linked signal timings can also be tested.

3.4.2 Microsimulation Modelling

Microsimulation models can cover an area from a few junctions to an entire corridor or town centre. The size of a model is normally restricted by data requirements and the model run times allowed by current levels of computing capabilities.

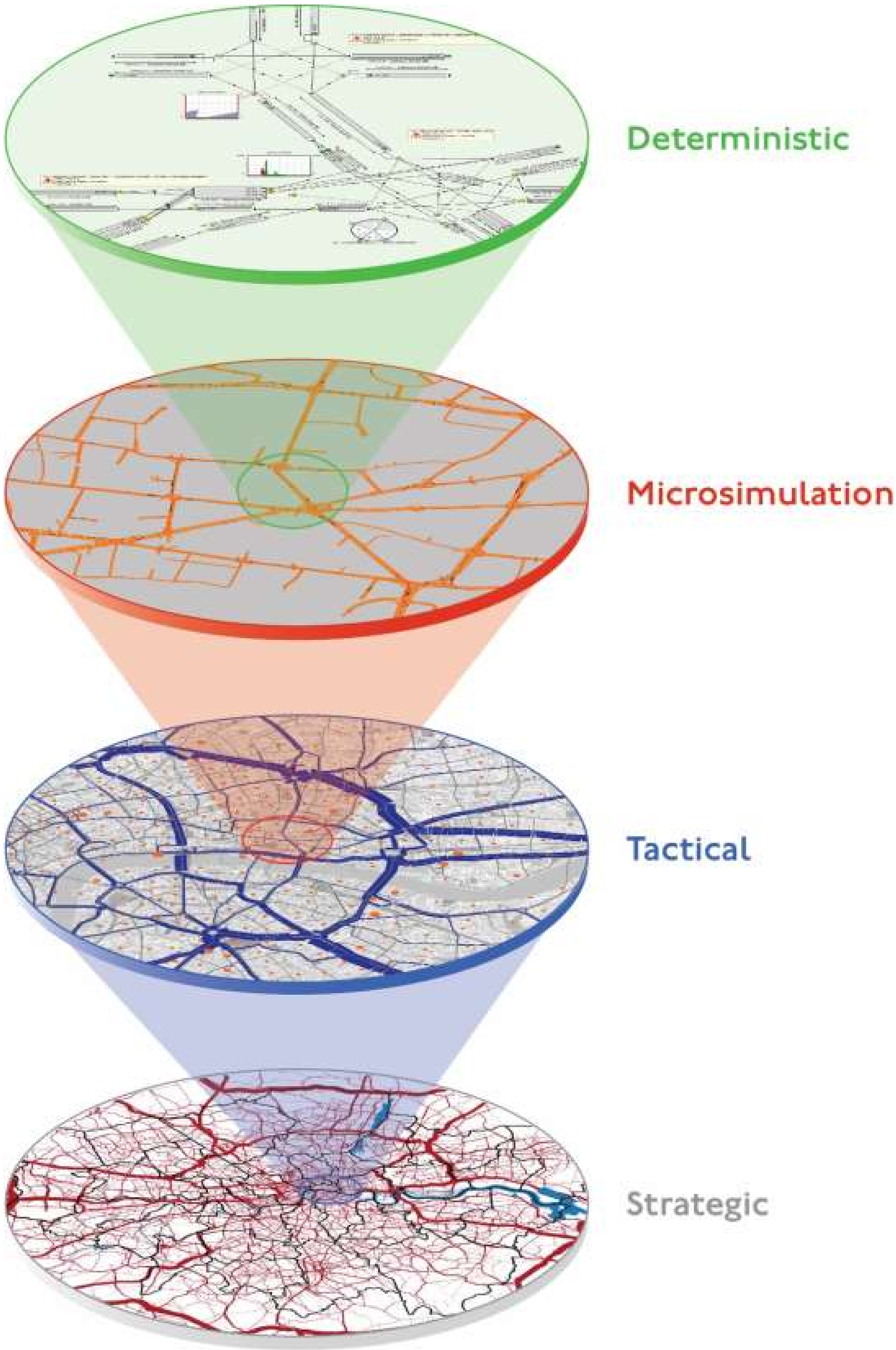

Figure 3: Transport modelling hierarchy

Microsimulation modelling simulates the movements and reactions of individual vehicles, cyclists and pedestrians using behaviour models. It uses randomisation of elements such as vehicle inputs to produce variable model runs which replicate the variability of the real world. The outputs from microsimulation consist of the average of results from a number of model runs.

Due to this modelling of individual vehicles, microsimulation is able to reproduce dynamic phenomena such as queuing behaviour and blocking back through junctions, and the impact of parking or incidents upon the network. It can also represent signal control features such as demand dependency and bus priority using detectors and vehicles / pedestrians in the model.

At TfL, microsimulation models can typically be connected to a simulated version of the same traffic control system which is used to operate the signalised junctions in London. This means that any signal control strategy which can be applied to the street can be accurately modelled, which gives the highest level of realism.

3.4.3 Tactical Modelling

Tactical models consider how vehicles will use the available road network in a relatively short time horizon, predicting up to 5 years ahead[7]. They cover large areas and use aggregated flow values and road / stopline capacities to understand how changes to the road network will affect route choice, speeds and congestion. These models can be used at an early stage in scheme assessment for optioneering and are also used to inform final flow patterns in a chosen design. Mode choice behaviour is not explicitly modelled, however the effect of mode choice can be reflected at tactical level using outputs from strategic travel demand models.

Along with strategic modelling (section **A3.4.4**), tactical models are usually built in macroscopic modelling software, which is based on aggregate flows and capacities, as described above. More recently, it has been possible to use a more detailed model than macroscopic, where individual vehicles are simulated but without the complex behaviours and interactions of microsimulation. This type of modelling is called mesoscopic. It is not widely used at TfL at the time of publishing, although its uses are being investigated.

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7 Shortest term of demand input provided by City Planning is 5 years, which is why M&V tactical models work in 5 year intervals. With any term longer than this confidence levels decrease and is less useful for operational purposes.

The Operational Network Evaluator (ONE) model is a tactical model that is developed and maintained by M&V. It is used to conduct operational assessments to indicate the impact of short-term changes on the network and is usually commissioned to support major development schemes. The model covers Greater London and is used to predict global traffic reassignment and congestion impacts due to local network changes. Assessing the implications of local network changes, such as improvements to junction layout or signal timings, requires detailed transport network representation and assignment methods capable of replicating congestion effects. At the time of publishing, the ONE model represents AM and PM peak periods.

3.4.4 Strategic Travel Demand Modelling

Strategic travel demand models are trip demand models which consider multiple future years, often predicting demand on the road network up to 30 years ahead. They cover a large area, typically a whole city or more, and are informed by models which predict population growth, land use and employment change. In TfL, they are used to support planning and help make key investment decisions.

TfL's strategic demand model, Model of Travel in London (MoTiON), uses economic and travel behaviour assumptions and planned transport investment to forecast the total number of trips made, what mode they will use, their travel times and to determine crowding and congestion. It covers all of Greater London and also has zones across the country to account for trips into and through London. This model is built and used by TfL's City Planning Strategic Analysis team[8], and so is not covered in detail in these Guidelines. Integrated into MoTiON are the following assignment models:

- London Highway Assignment Model (LoHAM), a traffic assignment model covering the whole of London which models the routes drivers choose and the associated congestion and delay impacts;
- Railplan, a public transport model for predicting the modes and routes customers choose; and
- Cynemon, which predicts cyclist routes and journey times.

Strategic travel demand is modelled at an aggregate level of detail. Traveller demand is usually defined in person trips and is derived from demographic census data, observed trip making behaviour from surveys and, more recently, anonymised mobile phone and vehicle satellite navigation data. The outputs of these models, traffic demand matrices, are passed to tactical models.

8 http://content.tfl.gov.uk/londons-strategic-transport-models.pdf

3.4.5 Model Integration

Although each level of modelling can be carried out independently, in practice this is rarely the case when producing models for schemes in London. Information is usually shared between modelling levels in order to inform model development, share data and improve the reliability of the results. This is often an iterative process to ensure consistency in model data across different software platforms. As shown in Figure 4, there are a number of interactions involved in most modelling projects. The coloured components represent areas covered in these Guidelines.

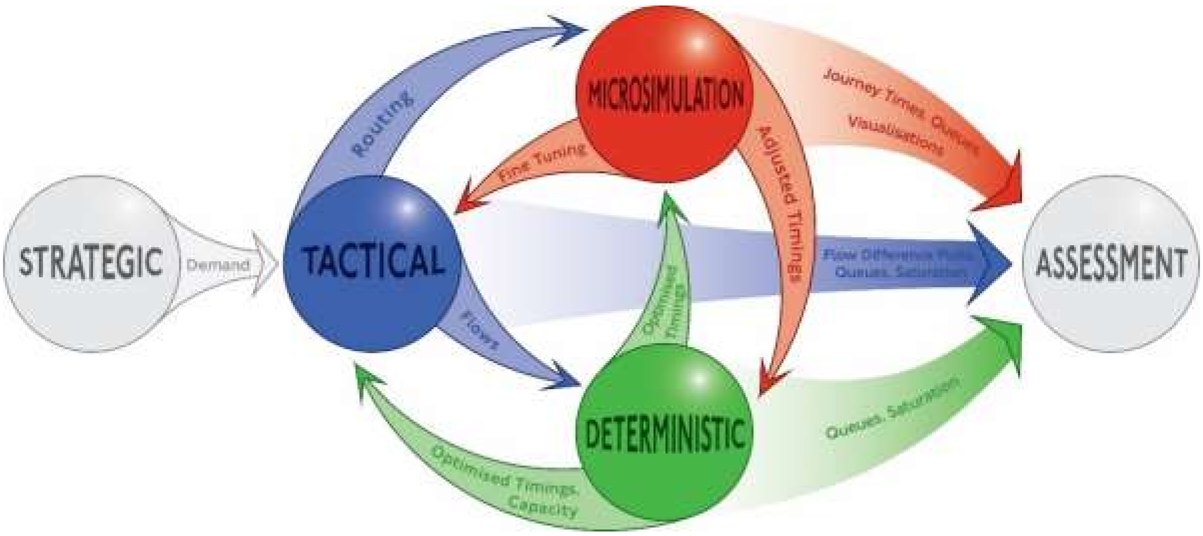
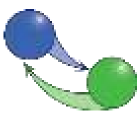
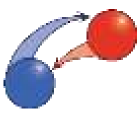


Figure 4: Interactions between different types of modelling

Strategic to Tactical – Strategic travel demand modelling supplies demand, in the form of traffic demand matrices, to tactical models. Usually these matrices do not change during a project, however, the recent emphasis on active travel modes such as cycling has led to increased use of modelling involving shifts between modes. Future scheme modelling may involve an adaptive demand approach where there are significant changes to the network.

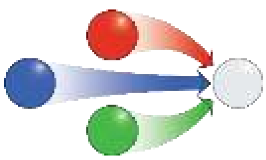


Tactical to Deterministic – Tactical models produce flow data for the Future / Proposed scenario. Deterministic junction models are optimised using these flows as inputs. Optimised signal timings and stopline capacities from deterministic models are then fed back to update the tactical model. This iterative process stops when neither flows nor timings change significantly.



Tactical to Microsimulation – Tactical models provide routing information to microsimulation models, usually in both Base and future scenarios, as they produce end-to-end routes which cannot be observed on street. End-to-end routing is preferred in microsimulation as it allows vehicles to anticipate their route choice at the same point as they would on street which leads to more realistic behaviour on the approaches to junctions. Since microsimulation models involve individual vehicles and data is collected over sections of road, it is easier to see if the routing is causing any obvious problems such as excessive queuing, missing banned turns or anomalous behaviour at gyratories. Any tweaks or refinements can be passed back to improve the tactical model. These are one-time transfers of data and do not usually iterate unless the issues are significant. The aim is to get the best from each model, bearing in mind the differences in software. Significant changes in signal timings can also be fed back from microsimulation to tactical, although these usually come from deterministic models as described above.

Deterministic to Microsimulation – Deterministic and microsimulation models share signal timings. Optimised signal timings are transferred from deterministic models and used as a starting point in microsimulation models. Any adjustments made in the microsimulation models, as well as timings from any traffic management strategies, can be transferred back to deterministic models to derive capacity and saturation results.



Assessment –Results from the Proposed deterministic, microsimulation and tactical models are comapared against the validated Base or Future Base model results to assess the benefits and impacts of a scheme and influence a decision-making process. The modelling results are fully analysed, as appropriate to the level of modelling used, to inform any decision making and design revisions. Where appropriate, this assessment forms part of the SIR (section **A4.6.1**).

3.5 Three Stage Modelling

The Three Stage Modelling Process has been developed in order to capture the interaction between modal types and understand impacts such as traffic reassignment due to neighbouring schemes. The process ensures that both the isolated impacts of the schemes and the overall future state of the network are assessed and enables a more complex analysis of the network, focusing on the impact on every journey. The three stages of this process are outlined in **Figure 5**, and they expand and formalise the basic modelling process described in section **A3.3**.

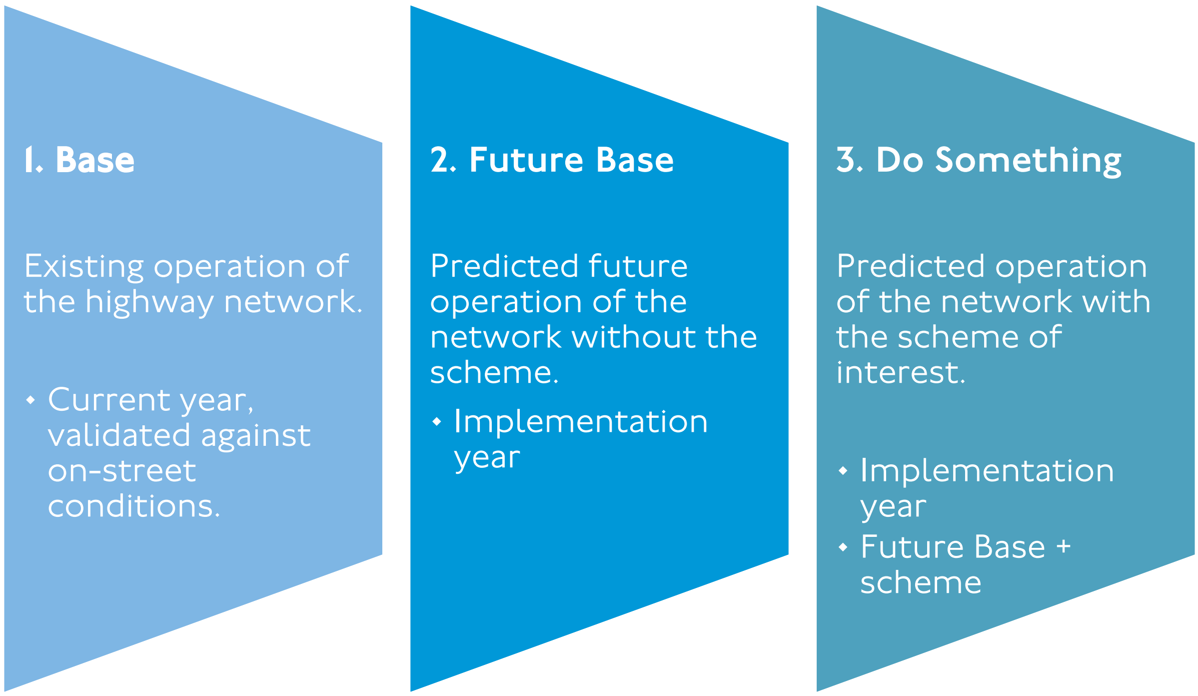


Figure 5: The TfL Three Stage Modelling Process

The Base model is a model that has been demonstrated to represent traffic conditions as observed and measured on street to an acceptable level of accuracy. It should be suitable for use in analysing current network performance and as a benchmark against which other modelling scenarios can be tested.

The Future Base model is developed by altering the Base model to take into account adjacent planned schemes and likely network changes, patterns of traffic growth, a change in road user composition or a number of other interrelated factors that influence the scheme impact footprint. The aim is for this model to represent the future year of scheme implementation without including the scheme under consideration. This is in order to provide a basis for comparison when assessing the results which is hopefully more meaningful than comparing against the Base model alone.

The final, Do Something, stage is to build the scheme into the Future Base model, changing only those aspects which are a direct result of the proposed design. The isolated impact of the scheme in question can be determined by comparing the Do Something and Future Base scenarios. However, in some instances, it is useful to determine the predicted change from the current situation, and so a comparison between the Do Something and Base results can also be made.

It is recommended that the Three Stage Modelling Process should be used in operational scheme assessments when:

- Traffic reassignment is anticipated as a result of the scheme;
- Traffic reassignment is anticipated as a result of adjacent scheme(s); or
- Network changes occur within the model boundary as a result of other nearby schemes.

This will cover the majority of schemes in London, so it will only rarely be the case that the Three Stage Modelling Process does not apply. The decision as to whether a scheme is to be subject to the Three Stage Modelling Process would occur during the Base model scoping meeting (section **A4.4**).

3.6 Modelling Standards

The scheme Promoter is advised to ensure that the person(s) engaged to develop the modelling related to any scheme has appropriate levels of experience. A common cause of poor modelling and analysis is a lack of understanding and experience on behalf of the person producing the model. Any modelling work should be overseen by an experienced modeller who possesses a thorough understanding of modelling concepts and data collection methods, as well as experience of analysing modelling results. Key competencies that are likely to be required include:

- Proven modelling experience with the relevant software and modelling projects, including the different levels of modelling which will be used and the interaction between them;
- Proven experience in on-site data collection of traffic control parameters including saturation flows, degrees of saturation, lane utilisation identification and wasted green measurement;
- A good understanding of the capabilities of signal controllers, particularly with respect to interstage design and phase delays; and
- Experience of modelling signal controllers using modelling software such as LinSig and TRANSYT.

In the particular case where use of the ONE model is required, there is a further constraint. The ONE model is available for use both within TfL, or by a third party. Due to the complex nature of the model it is important that all users are proficient in tactical modelling. As such, each year, interested parties are able to submit their applications to be accredited to use the ONE model. Each of these applications is assessed by M&V and permission to use the model is granted on a case-by-case basis. Applications to use the ONE model come from a range of consultancies and a list of our accredited consultancies can be provided on request from **ONE@tfl.gov.uk**. Accreditation is an annual process, which occurs at the beginning of each financial year.

Effective traffic modelling requires knowledge and skill on the part of the modeller, and many techniques are acquired through experience or passed on from colleagues. Some of the finer techniques used in traffic modelling are not documented in software manuals, and this is especially true for complex situations where good judgement of available options is required. It is therefore useful to provide modelling guidance, aimed at experienced practitioners, to document tried and tested practical modelling techniques. Traffic modelling for TfL should be conducted according to existing standards of best practice set out in internal and external documents:

- Traffic Modelling Guidelines (this document);

- Model Auditing Process (MAP), also published by TfL and discussed further in the next section; and
- Transport Analysis Guidance (TAG)[9], published by the DfT.

3.6.1 TfL Standards and Guidance

The TfL Traffic Modelling Guidelines and MAP are complementary documents, as shown in **Figure 6**. They provide a framework to deliver the modelling quality required by TfL, for both Base and Proposed models, from scheme consideration through to a detailed design.

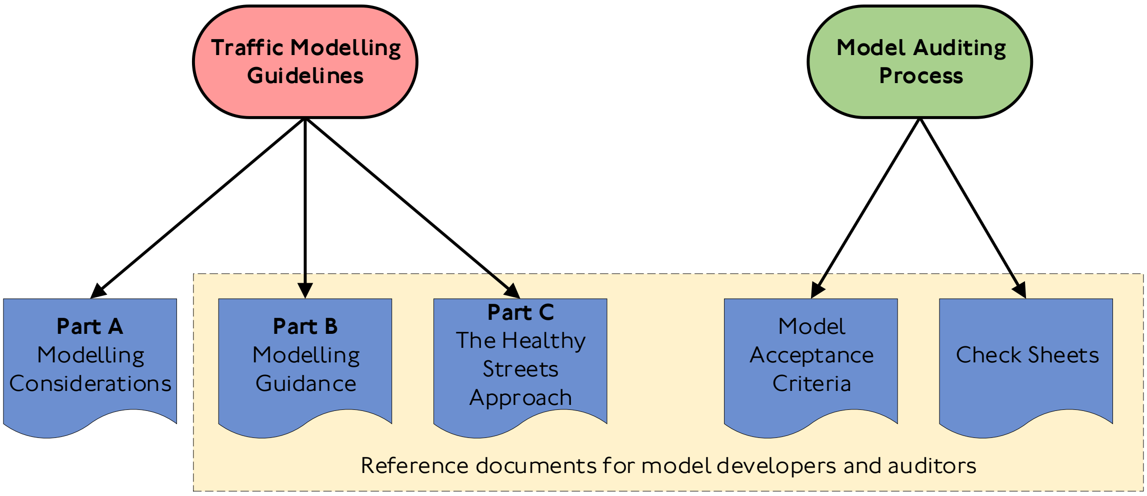


Figure 6: The relationship between the Traffic Modelling Guidelines and MAP

MAP defines the standards expected for all modelling submitted as part of TfL-sponsored schemes. The TfL Traffic Modelling Guidelines indicate recommended 'best practice' relating to the approach and methodology of model development in order to reach those standards. In this context MAP provides a structural procedure for auditing models against software-specific modelling standards prior to further phases of development. The TfL Traffic Modelling Guidelines provide overarching guidance on approaches which may be adopted to efficiently meet the standards defined by MAP.

The level of detail and accuracy of a model must reflect the purpose for which the model is intended. The objectives of a scheme will directly influence the type and purpose of any prerequisite modelling.

For a specific scheme, a model may pass through a number of development phases and at each subsequent stage the required level of detail and

9 https://www.gov.uk/guidance/transport-analysis-guidance-tag

modelling accuracy increases. Common stages of development can be expressed as:

- Outcome definition;
- Feasibility (business case support);
- Concept stage (developing design preference); and
- Detailed design ahead of scheme approval.

It should be noted that not all schemes will be developed to the point where approval is sought, and different schemes will require different levels of detail to support business case development or assessment.

Traffic modelling to support a permanent scheme through NM approval represents the highest level of detail and accuracy required of a model. In general, the modelling guidance presented in **Part B** applies to this highest level of accuracy.

MAP has been developed by TfL in order to ensure consistency in both the production and auditing of traffic modelling. From April 2008 MAP has applied to all TfL-sponsored schemes audited by NP. Full guidance relating to MAP, most recently updated in March 2017, can be obtained from the TfL website[10]. MAP sets out the stages which should be followed when submitting traffic models for auditing. The six stages established by MAP are:

- **Stage 1** – Base Scoping Meeting (section **A4.4**);
- **Stage 2** – Calibrated Base Model Submission;
- **Stage 3** – Validated Base Model Submission;
- **Stage 4** – Proposal Scoping Meeting (section **A4.5**);
- **Stage 5** – Proposed Model Submission; and
- **Stage 6** – Submission of SIR to Promoter (section **A4.6.1**).

It also defines a protocol for communication relating to model submission and auditing. Generally, MAP is designed to improve communication and ensure that models are developed to a consistent and high standard so that they progress efficiently through TfL audit with limited, if any, amendments required.

One of the ways MAP facilitates this communication is by the definition of specific roles within the modelling project. These are defined in **Table 1** below:

10 http://content.tfl.gov.uk/map-v3-5-overview.pdf

Table 1: Task description for the different parties involved in MAP

Role	Title	Description
Promoter	P	The person responsible for delivering and project managing the proposal.
Design Engineer	DE	The engineer responsible for creating the modelling for the Promoter.
Checking Engineer	CE	The engineer responsible for checking and signing off the Design Engineer's work as fit-for-purpose for the Promoter.
TfL Signals Auditing Engineer	SAE	The TfL engineer responsible for checking and safety approving the proposal.
TfL Model Auditing Engineer	MAE	The TfL engineer responsible for auditing the modelling and assessing the network impact of the scheme.
TfL Network Assurance Engineer	NAE	The TfL operations engineer responsible for assessment, then approval / rejection of the Promoter's proposal (under the TMA).

In summary, the P engages a DE to develop traffic modelling for their proposed scheme. The traffic modelling is internally assessed by a CE, before being submitted to the MAE for auditing.

Standardised check sheets are used for communication between the DE, MAE and SAE during MAP Stages 1 to 5. The SIR provides a summary of the scheme impacts resulting from the modelling assessment.

While NM are accountable for auditing the final scheme models and preparing the SIR (section **A4.6.1**), scheme Promoters and their agents (DE and CE) are accountable for ensuring that all scheme models meet the requirements set out within the current version of MAP. Lack of experience on behalf of the DE is a common reason for scheme modelling to not successfully pass through a MAP audit so it is important that the CE role is performed thoroughly.

Failure by the CE to audit a model before submission to TfL may result in unnecessary delay to the scheme programme, due to iterations between the DE and the MAE.

If there is a requirement for a scheme to be audited, that scheme must be registered on the NM Workbook in order that TfL resources for auditing can be assigned. Unfortunately, work cannot be undertaken on any project which is not registered on the NM workbook. For any queries on the process or how to register requirements, contact **PPD3rdPartyRequests@tfl.gov.uk**.

3.6.2 External Standards and Guidance

DfT's web-based TAG provides information on the role of transport modelling and appraisal. It consists of software tools and guidance on transport modelling and appraisal methods that are applicable to a full range of highway and public transport measures. These enable evidence to be prepared supporting business case development, which inform investment funding decisions. TAG modelling guidance covers subjects such as forecasting future levels of demand and modelling the impacts that a proposal will have on travel choices such as route choice, choice of destination and choice of mode. TAG is focused on options generation, development and evaluation of the subsequent impacts and is distinct from the decision making process. Although TAG may not always be directly applicable to schemes in London, it provides best practice guidance and many of the same standards are carried across into MAP (discussed further in **A3.6.1**).

4 Stakeholder Engagement

As outlined in the previous chapter, the aim of these Guidelines, together with MAP, is to provide consistency to a modelling project and to ensure all stakeholders are aware of what is involved. This chapter explains this stakeholder engagement in more detail and outlines what is required at each stage.

4.1 Model Purpose

The one key point that must be considered at the start of any modelling project is:

Why is this model being built?

There may be a number of answers to this, based around the aims of the scheme and any anticipated impacts, but coming up with a comprehensive list of objectives is vital to the success of the modelling. All future conversations and decisions should be built upon this question; and it directly relates to significant choices which must be made early in the project:

- What types of modelling are required?
- What modes of transport need to be modelled?
- To what level of detail?
- What types of data need to be collected?

The answers to these questions will contribute significantly to the timescales that can be applied when putting together the programme for carrying out the work.

4.2 Key Stakeholders

There should be coordination and cooperation between all interested parties in the design of scheme proposals.

All stakeholders should be consulted before undertaking the design of a new highway scheme. It is common that a scheme Promoter will have a particular focus for the outcome and a clearly defined set of benefits, however it is the responsibility of the scheme designer to ensure that all road users are considered.

In addition, the scheme designer should contact all relevant authorities who have jurisdiction over the area being impacted by the scheme to ensure that any concurrent scheme proposals are taken into consideration. The existence of other proposed schemes could impact on traffic flows, junction layout and signal control, so it is important this information is included in the modelling assessment of the area influenced by the scheme.

The interested parties are likely to be: NP and NIST, TfL Engineering Directorate, TfL Buses Directorate, Investment Delivery Planning (IDP, formerly called Sponsorship), the relevant London borough, City Planning Directorate, and Project & Programme Delivery (PPD). Among these, the key stakeholders as far as MAP is concerned are listed in **Table 1** in section **A3.6.1**. All of these should be involved at the start to give awareness of the scheme and ensure that they are all clear on the purpose of the modelling.

4.3 Early Design Stages

There are stages of a project design lifecycle that occur prior to creating modelling for MAP approval. The type of project will influence the modelling assessment and project delivery approach, so a broad indication of the stages that may be necessary is included here.

Once the project is addressed and understood, the business outcome is decided and the benefits of undertaking the project are established. Key stakeholders are introduced to the project before any detailed modelling commences, which provides an opportunity for discussions to be held over anticipated difficulties in designing and delivering the scheme.

The feasibility stage is where the proposed outcomes are established, and a decision is made on the achievability of the project's benefits. A variety of options are designed and modelled in this stage, so a single feasible option can be selected. This modelling is usually carried out in deterministic modelling software, as these models are the simplest to build.

Full modelling would be very time consuming and, in some cases, unnecessary for every option, and so deterministic modelling, incorporating the Base traffic flow data, is initially used. Optioneering gives the parties a good understanding of any impacts each option will have on the network, as it demonstrates the changes in capacity at each approach of the impacted junctions. By testing the scheme designs, the model results are interpreted and the designs continually improved through a collaborative effort from the project team.

The options are summarised by assessing the benefits and disadvantages to each transport mode and examining criteria including indicative cost, traffic impact, time to deliver, physical constraints and whether approval is required under the regulatory framework. The modes considered are cyclists, pedestrians, other road users and, particularly, buses.

The optioneering will also aid in fixing the scope of the project, and once the preferred option(s) is decided on, work can move forward to a full Three Stage Modelling assessment and MAP submission.

4.4 Base Scoping Meeting

On initiation of the full modelling works for a scheme, the Promoter or their representative sets up a Base scoping meeting with all parties listed in **Table 1**. This meeting is for discussion of the scheme and modelling work that is required for both Base and Proposed modelling stages.

It is recommended that these meetings occur prior to the scheme detailed design being developed. This is to ensure that all TfL information and requirements are known to the Promoter and those they engage to do modelling work prior to development of the scheme. It provides an opportunity for the Promoter's team to record details for future submission and to ensure all parties understand their roles and responsibilities within MAP.

> MAP Stage 1 serves as the Base scoping meeting for modelling projects which are following MAP.

4.4.1 Modelling Scope

A scheme may have an influence beyond the boundaries of the physically modified area. The scheme designer, alongside other contributors to the scoping meeting, is thus responsible for determining the extent of the area of influence. The area to be modelled is determined by the area which is considered to be affected by the scheme proposal. In order to properly assess scheme proposals and deliver a model which is fit for purpose, the modelling must cover this area.

The scheme designer is responsible for ensuring that these wider impacts are considered, discussed and, where appropriate, mitigated and that any mitigation forms part of the scheme proposals.

It is the scheme Promoter's responsibility to assure NIST that the proposed scheme can be appropriately accommodated in the network.

Deciding on the boundary of the modelling work to be undertaken necessarily includes identifying all the signal-controlled junctions which must be modelled. Once these have been finalised it is necessary to determine how they are controlled (section **A2.2**) so that the appropriate data can be collected on their method of operation.

It is also necessary to decide on the time periods which need to be modelled. At a minimum this would include the AM and PM peaks, however, depending on the location, other time periods may be required. For example, shopping areas may be busy during the middle of the day or at weekends, and models including the end of the school day may need to start earlier than the traditional PM peak. Decisions should be based on knowledge of the area and should also consider any changes which may be introduced as part of the scheme.

4.4.2 Site Visit and Data Collection

It is not possible to develop a model to the standards required by MAP without conducting appropriate observations for each period being modelled. Site visits are expected to be undertaken.

Models commonly fail a MAP audit due to a lack of familiarity with the site on the part of the model developer. It is therefore essential that the model developer conducts site visits to:

- Familiarise themselves with conditions for all road users at the site and the surrounding environment;
- Confirm that supplied drawings are current and accurate;
- Understand how the junction / network operates in terms of road user behaviour, capacity and safety; and

- Collect accurate data for developing the calibrated model and validating the Base model.

Some of the data required to develop a model can be collected by third-party survey companies, however, certain data such as degrees of saturation should only be collected by an experienced model developer as their accurate representation in a model is essential.

4.4.3 Modelling Expectations Document

To ensure that there is no ambiguity relating to the modelling requirements for a scheme, a Modelling Expectations Document (MED) should be produced following the Base scoping meeting at MAP Stage 1 (section **A3.6.1**). The MED summarises the agreed scheme-specific modelling requirements and is agreed by all parties before a scheme can progress through MAP.

The content of the MED will vary in accordance to the scale and purpose of a scheme. Common topics that are included with a MED are:

- Model purpose;
- Model area;
- Peak periods;
- Software requirements;
- Calibration / Validation criteria;
- Data collection;
- Signal data;
- Programme; and
- Contact details.

Scheme proposals may evolve throughout the modelling process. The MED should be reviewed during the Proposal Scoping Meeting, MAP Stage 4 (section **A3.6.1**) and updated if any of the modelling requirements have changed.

4.5 Proposal Scoping Meeting

TfL is committed to supporting all scheme Promoters in delivering a successful highway scheme which meets the stated outcomes and benefits. The Proposal Scoping Meeting, which will usually take place once the Base modelling is complete and approved, should involve all previously mentioned stakeholders. The aim is to discuss the scheme proposals and the requirements for Proposed models in order to ensure a high quality and consistent approach to model development. The modelling must clearly demonstrate how outcomes and benefits are achieved and illustrate the impacts. Any changes and developments will be recorded in the MED.

MAP Stage 4 serves as the Proposal Scoping Meeting for modelling projects which are following MAP.

4.5.1 Strategy Considerations for Highway Scheme Development

As indicated in section **A2.1**, all design decisions must be made taking account of the requirements and objectives set out by the following:

- Mayoral Policy and the current Mayor's Transport Strategy;
- The Network Management Duty as defined in the Traffic Management Act (2004), including any amendments; and
- The strategic and policy requirements of the local highway authority.

TfL's expectation is that proposed scheme impacts on each group of affected road users will be balanced and manageable. NPD will support scheme Promoters to develop designs and mitigate any unacceptable impacts wherever possible. The precise level of impacts deemed acceptable will depend on current policies and network conditions, and will be balanced against the benefits of the scheme to those same road users.

4.5.2 Scheme Design

This section outlines some considerations when designing and modelling junctions and is intended to help less technical audiences understand what might be required to support the design and assessment of any scheme. Relevant standards and documents are also introduced to give an awareness of how and when they are used.

4.5.2.1 Scheme Safety

The safety of all road users is the top priority for TfL and we advocate that all highway schemes should look to improve safety in the scheme outcomes. Changes to the operation of junctions can have significant influence on the safety of all road users.

Safety underpins the whole scheme design and modelling process and is specifically covered as part of MAP and the SIR. The role of the SAE within MAP is to ensure that the proposed junction and crossing designs meet the safety requirements in SQA-0640[11], and there is a check sheet to verify that this has been carried out. The SIR contains a section on safety checks which must be carried out by the Engineering Services team. It includes boxes for design approval and reviews on timings, buildability and maintainability, which must all be examined for safety implications before they can be signed off.

SQA-0640 refers to the following series of documents, which are produced by TfL's Engineering directorate:

- SQA-0640 - Policy, Standards and Guidance to Procedures for the Design of Traffic Signals;
- SQA-0641 - High Level Process for the Design of Traffic Signals;
- SQA-0642 - Client Requirements;
- SQA-0643 - Design for Signalised Junctions;
- SQA-0644 - Design for Stand Alone Crossings;
- SQA-0645 - Traffic Signal Timings;
- SQA-0646 - Safety and Design Checking of Signal Schemes;
- SQA-0647 - Justification for Traffic Signals; and
- SQA-0648 - Documentation for the Design File.

These are governed by the Traffic Signs Regulations and General Directions (TSRGD[12]) which is published by the DfT, and the Design Manual for Roads and Bridges (DMRB[13]), Volume 8 – Section TA 84/06 – "Code of Practice for Traffic Control and Information Systems for All Purpose Roads" which is published by National Highways (formerly known as Highways England).

The TSRGD is a UK Statutory Instrument which prescribes the designs and conditions of use for traffic signs, including road markings, traffic signals and pedestrian, cycle and equestrian crossings used on or near roads.

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11 *Policy, Standards and Guidance to Procedures for the Design of Traffic Signals*, Specification SQA-0640, Issue 1, Asset Management Directorate, Transport for London, 2016.

12 *Traffic Signs Regulations and General Directions*, Department for Transport, 2016. **https://www.legislation.gov.uk/uksi/2016/362/contents/made**

13 Design Manual for Roads and Bridges, Highways England, March 2020. **https://www.standardsforhighways.co.uk/dmrb/**

Further advice from the DfT on the implementation of the TSRGD can be found in the Traffic Signs Manual (TSM[14]), Chapter 6 – "Traffic Control". This chapter of the TSM contains advice recommended for those designing traffic signal junctions and crossings on roads with a speed limit of 40mph and under, particularly in urban areas.

The DMRB contains information about current standards relating to the design, assessment and operation of motorway and all-purpose trunk roads in the United Kingdom, these are roads with speed limits above 40mph.

4.5.2.2 Junction Layout

The layout of proposed junctions is determined by a wide range of factors. The final design must comply with the appropriate design standards and safety requirements, as described in section **A4.5.2.1** above, whilst also delivering a balanced level of service for all road users within the physical limitations of the site and considering the DfT's transport priorities (section **A2.1.2**).

Often there will be a number of different junction layouts that comply with design standards and safety requirements. In this situation it is necessary to assess the impact of the different options on network operation, in order to determine which layout delivers the best performance for all road users, in line with the agreed scheme outcomes.

The related SQA document which may be referenced during scheme design is SQA-8448[15] (or its accompanying guidance SQA-0448). This records the safety-critical timings which will be implemented in the controller on street when the junction is installed. Values in this document are dependent on specific features such as precise stopline locations and so will usually need to be updated on any modification of the proposed layout.

4.5.2.3 Network Operation

It is the responsibility of scheme designers to reduce adverse impacts on network operation. Any impacts that cannot be mitigated through design may require implementation of wider network management strategies. TfL should be consulted where it is anticipated that this will be necessary and will work in conjunction with scheme designers to achieve minimal disruption.

14 Traffic Signs Manual, Chapter 6 – Traffic Control, Department for Transport, Department for Infrastructure (Northern Ireland), Scottish Government, Welsh Government, 2019. **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/851465/dft-traffic-signs-manual-Chapter-6.pdf**

15 Junction Traffic Signal Design Sheet, Specification SQA-8448, Issue 4, Transport for London, 2020

It is necessary to ensure that any scheme design can operate effectively at all times of day. Any issues that may arise outside of the traditionally modelled peak periods should have been highlighted early on in the project (section **A4.4.1**). Consideration should be given to weekend operation, where traffic levels may be similar to a weekday but where capacity may be constrained through the relaxation of parking, waiting and loading restrictions, or where increased levels of pedestrians may require a higher level of service to reduce delays at signalised crossings. Operation of the network overnight is also important, as demand from night-time freight movements is increasing and roadworks are often permitted during the night to reduce disruption at busier times.

4.5.2.4 Design Refinement

The bulk of option testing should have been carried out before the project reaches the full modelling stage that is the focus of these Guidelines (section **A4.3**), however, small tweaks to the design may be necessary once operation in a microsimulation model has been observed. Any of this sort of optioneering will be carried out by the DE and usually only the final design will be submitted for audit.

4.5.3 Public Transport Considerations

It is important that public transport is represented in models, especially where a scheme includes existing or proposed public transport services such as bus or tram routes. It is necessary to consider the impact of public transport on traffic behaviour and network capacity and also for scheme modelling to present the impact of a proposal on public transport performance.

Correct representation of fixed bus routing within a network is important when building an accurate traffic model. Bus timetables[16] and routing maps[17] indicate the frequency of buses and bus type by time of day, additionally bus performance data from systems such as iBus may also be available. This data can be requested from TfL, but any requests must go through a TfL sponsor to ensure the request is valid and formatted correctly.

Depending upon the focus of the scheme, it may be necessary to use observed data to verify that modelled bus journey times are accurately represented. If this is the case, it places constraints on the type of modelling that can be used, as explained in Chapter **A5** on **Which Traffic Modelling Software? Why?**.

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16 **https://tfl.gov.uk/travel-information/timetables/**
17 **https://tfl.gov.uk/maps/bus**

4.5.4 Pedestrian Considerations

Pedestrian facilities are provided to assist pedestrians in safely crossing the carriageway whilst exercising due care and attention. There are a number of signalised methods for achieving this and which of these methods can be best applied should be considered on a site-by-site basis. In order to assess which method is most applicable it is useful to have knowledge relating to pedestrian flow patterns, vehicular degree of saturation, the topographical layout of the network or junction and the local services and destinations which may play a role in driving pedestrian demand levels at certain times of the day (such as schools, shopping centres or places of worship).

It is necessary to have an understanding of the volume, location and timing of demand from pedestrian movements around the study area and particularly at junctions. This information is useful for accurate modelling and can be provided by surveys of pedestrian movement.

Pedestrian desire lines represent the major pedestrian movements within a network. An understanding of desire lines is useful for the design of junction layouts and signal timing plans and to ensure that any proposed facilities will be used effectively by pedestrians.

Signal timings and crossing points can be designed to allow a smooth progression of pedestrians in the direction of heaviest flow. The direction of pedestrian demand can vary according to the time of day and the day of the week. Pedestrian waiting times should be minimised to prevent overcrowding during peak periods, particularly on central islands within the carriageway.

Pedestrians may be explicitly modelled using specialist modelling software or spreadsheets, or they may be included as part of vehicular traffic models. See Chapter **A5** on **Which Traffic Modelling Software? Why?** and Chapter **C3** on **Pedestrian Modelling**, for further information on the different options available for modelling pedestrians. Specific pedestrian models are particularly useful where proposed changes to land use or public transport provision may result in changes to pedestrian flows. Pedestrian behaviour may be affected by changes in total volume of people or their desired routes. The results from pedestrian modelling can therefore be used to mitigate these issues and assist in designing appropriate signal schemes.

4.5.5 Cyclist Considerations

The number of cyclists in London is growing, especially during peak periods, and in the Congestion Charging Zone it has reached 16% of total vehicle flow[18]. A growth in cycling, and sustainable travel modes in general, has been integral to a succession of Mayor's Transport Strategies. Given the numbers of cyclists on the network in London it is important to consider them in any network assessment.

Any effects of a proposed scheme on cycling (and any growth in cycle demand) need to be carefully considered before selecting the most appropriate software for a modelling project based on the detail required. Particularly in inner London, cyclists should typically be considered in any modelling work unless there is reasonable justification to exclude them.

Schemes are advantageous to cycling if they reduce journey times or delay and help cyclists to maintain a steady speed and a direct course, without interruption or obstruction, from a position where they can be seen by drivers and pedestrians. For this reason, the cyclist user experience can benefit from specialist provisions within a scheme, particularly those incorporating safety considerations. Cyclist safety may be improved through the use of various different infrastructure and signalling techniques, including:

- **Advanced Stop Lines (ASLs)** – these allow cyclists to position themselves in front of queuing traffic so they can remove themselves from conflicts with turning vehicles. If the road layout allows, they can be combined with feeder lanes which allow easy access and safer cyclist progression within the carriageway;
- **Cyclist early start** – these are signals which turn green for cyclists a few seconds before those for general traffic which, again, allows cyclists to avoid conflicts with turning vehicles. They can be smaller, low-level signals or full-size signal heads, depending on the junction layout;
- **Widened carriageways** – which will give vehicles more space to overtake cyclists, reducing conflicts. These can be marked with a cycle lane to encourage vehicles to consider cyclists; and
- **Segregated cycle lanes** – where cyclists are physically separated from traffic by some form of barrier and have their own signals at junctions.

There is an increasingly large network of cycle routes across London, including Cycle Superhighways, Cycleways and Quietways, which should be taken into account when a scheme is planned as it is important that these are not negatively impacted. In schemes where specialist provisions are proposed it is necessary to model the impact that these will have on all road users including public transport.

18 Harryman, M., Traffic Note 3 – TfL Cordon & Screenline Surveys 1971-2018, Transport for London, 2019

Further guidance on cycle design can be found in Chapter 4 of the London Cycling Design Standards (LCDS)[19]. LCDS sets out requirements and advice for cycle network planning and for the design of dedicated cycle infrastructure, cycle-friendly streets and cycle parking. This guidance applies to all streets in London and must be adhered to for relevant funding programmes.

Cyclist behaviour and routing is considerably less predictable than for other vehicles and cyclists vary widely in their speed and ability. It is often the case that factors other than cyclists determine which type of modelling will be used in a particular scheme, however, cyclists should always be included in the decision-making process, particularly if the scheme has a cycling focus. See Chapter **A5** on **Which Traffic Modelling Software? Why?** and Chapter **C2** on **Cyclist Modelling**, for further information on the different options available for modelling cyclists.

4.5.6 Emissions Considerations

Motorised traffic produce emissions with include greenhouse gases and airpollutants. Greenhouse gases like CO_2 have little impact on local health but are considered to contribute to global warming. The Climate Change Act details the UK's commitment to be carbon neutral by 2050[20]. Air pollutants are substances in the air that can harm human health and affect quality of life. The Mayor's London Environment Strategy[21] details the specific challenges surrounding air quality and the measures which are planned to overcome them. Air pollution causes thousands of Londoners to die sooner than they should (estimated over 9000 Londoners died prematurely from long-term exposure to air pollution in 2010[21]). Children, the elderly and people already suffering from pulmonary or cardiovascular disease are particularly vulnerable. In order to tackle these issues, the London Environment Strategy aims to reduce car use and switch to cleaner fuels to ensure that London's transport system is zero emission by 2050. It also prioritises reduced air pollution at locations such as schools, nurseries, care homes and hospitals.

Road transport contributes significantly to the emission of air pollutants in London[22]. Pollutants which have an impact on local air quality and human health can broadly be divided into two categories:

19 London Cycling Design Standards – A guide to the design of a better cycling environment, London Cycling Centre of Excellence, Transport for London, 2016
20 **https://lordslibrary.parliament.uk/climate-change-targets-the-road-to-net-zero/**
21 London Environment Strategy, Greater London Authority, May 2018. Can be accessed at **https://www.london.gov.uk/what-we-do/environment/london-environment-strategy**
22 Air Quality Team, *London Atmospheric Emissions Inventory 2016*, Greater London Authority, 2019.

- **Nitrogen dioxide (NO_2)** – NO_2 is mainly formed in the atmosphere from nitric oxide (NO) emitted by road vehicles, but it is also emitted directly. By convention, the sum total of NO and NO_2 is termed 'nitrogen oxides' (NO_x);
- **Airborne particulate matter** – Different classifications are used to describe particulate matter according to their physical characteristics[23], the most common being PM_{10} and $PM_{2.5}$; and
- **Carbon Dioxide (CO_2) –** a main greenhouse gas contributing to global warming and climate change.

The two major road-based initiatives that have been introduced are the Low Emission Zone[24], which dates from 2008 and covers most of Greater London, and the Ultra Low Emission Zone[25] (ULEZ). ULEZ launched in April 2019 covering the area inside the Inner Ring Road and is due to be expanded in October 2021. These zones charge the most polluting vehicles for entering with the aim of removing them from areas with the worst air quality and the London Environment Strategy presents data which shows that air quality is improving overall across London.

Schemes which cover smaller areas can also be investigated for their environmental impact in addition to the typical modelling expectations. Appropriate environmental conditions are central to the effective delivery of any Healthy Streets focused scheme. Walking and Cycling schemes must be delivered in an environment that is conducive to undertaking these activities.

As indicated in Chapter **C4** on **Emissions Modelling**, although air quality cannot be directly modelled due to the large number of factors which affect it, the emissions for vehicles can be estimated. Following a scheme assessment, outputs can be taken from tactical models to be used in an air quality assessment undertaken by specialist environmental consultants. The area considered to be influenced by the scheme may be larger for the environmental assessment than for other traffic models due to wider reassignment of vehicles outside the area of interest, so the area for outputs should be agreed between all parties. The outputs from tactical models for air quality assessments can include number of lanes, link length, link speed, volume of vehicles (broken down by vehicle type) for all sections of road within the agreed area. The specialist environmental consultants are required to factor the peak hour tactical or microsimulation model outputs into 12 hour weekday, and 18 and 24 hour Annual Average Daily Traffic for use in the air quality assessment. If further, more detailed, emissions

23 PM_{10} and $PM_{2.5}$ relate to particulate matter with a diameter of less than 10µm and 2.5µm respectively.
24 **https://tfl.gov.uk/modes/driving/low-emission-zone**
25 **https://tfl.gov.uk/modes/driving/ultra-low-emission-zone**

modelling is considered necessary then outputs from microsimulation models can be used, as described in Chapter **C4** on **Emissions Modelling**. The common outputs provided are vehicle record files, which include the vehicle type, speed and acceleration for each vehicle every second.

The outputs from the air quality assessments are then used by a Promoter as part of an Environmental Impact Assessment (EIA). An EIA for a relevant highway scheme should consider estimated emissions, traffic, noise and vibration, visual impact and impact on local ecology. Following the submission of an EIA, the local authority or the Secretary of State then determine if consent is given for the scheme to proceed.

4.6 Final Design Stages

NM provides independent technical support to scheme Promoters, in the SIR, to enable NIST to make informed decisions when assessing and reviewing schemes. TfL requires an understanding of the impact of any scheme on bus and cycle journey times, and pedestrian delay at signalised crossings, as well as the impact on journey times for general traffic. Modelling is a significant part of deriving this information and the results will be assessed alongside the broader scheme benefits.

On completion of MAP and the SIR, the modelling results are presented to a formal review panel, where key stakeholders evaluate the delays in the network for each mode as well as assess the impact on the wider network. If successful at the review panel, the project may be presented at public consultation, where possible amendments to the design may be agreed. The results of modelling can be used in the public consultation to communicate the predicted effects of a scheme and give stakeholders some idea of how it will look after implementation.

After a successful public consultation and review panel approval, PPD will begin organising scheme construction. NIST will also be involved during the delivery in accordance with the TMA, as well as NPD, who will manage the traffic signal strategy during construction.

4.6.1 Scheme Impact Report

The Scheme Impact Report (SIR) is used to identify the impact of implementing a scheme on the network. It allows the Promoter to provide all the required information to NIST which enables them to make an informed decision on the project under the TMA. The SIR is completed in the following stages:

- The scheme Promoter initiates the SIR;
- TfL's Engineering Services team will complete the safety checks, including a review of the buildability and maintainability of the design (section **A4.5.2.1**);
- The SIR is then handed to NPD to inform on the integrity of the modelling and network impact; and
- Once complete, the SIR is handed back to the Promoter who will then submit the scheme to NIST for approval.

The SIR contains a section on model integrity, which details all the modelling work that has been carried out along with any assumptions or exceptions that could affect the conclusions. It also has sections on Walking, Cycling, Bus Network, Freight / Servicing, General Traffic and Taxis, as all of these modes must be included when considering the impact of a scheme.

An SIR must be completed for all schemes planned for implementation on the TLRN, SRN, and on borough roads if bus operation is also impacted.

4.6.2 Public Consultation

TfL consults the public on a variety of changes to London's transport infrastructure. Some of these consultations are legally required statutory consultations and some are carried out to help the decision-making process by understanding the impact of the scheme on the people affected. Public consultation is mandated wherever proposals significantly affect the road network.

One of the consultation principles, followed by TfL, regarding the provision of information to a public consultation, is stated as:

> There is enough information to allow 'intelligent consideration' - the information we provide will be readily accessible, easily interpretable and relevant to the consultation and will be enough to enable consultees to offer an informed response.[26]

Modelling outputs are often a key part of this information and are usually presented in the form of journey times, separated by mode, from microsimulation modelling. These journey times are the key routes within the model boundary which, if possible, have been validated in the Base model. Tactical and deterministic modelling can provide supporting information, as required. For tactical modelling this would include any predicted rerouting that might impact surrounding areas, and deterministic modelling can provide stopline saturation and any significant signal timings. It is also important to establish any caveats or limitations to the modelling results.

For particularly high-profile schemes, it may also be advisable to include 3D visualisations of the scheme in operation. This is particularly useful to help the public understand the interaction between general traffic, buses, cyclists and pedestrians and to demonstrate any benefits to vulnerable road users.

26 https://tfl.gov.uk/info-for/boroughs-and-communities/consulting-with-you

5 Which Traffic Modelling Software? Why?

The most important considerations when deciding on which type of modelling to use and what modelling software would be most suitable are the purpose of the modelling project and the outputs that are required to achieve it. It is also necessary to consider the amount of time and effort that is required for each modelling type to ensure that it is achievable within the scope of the project.

There are a wide variety of software packages available, which vary in their approaches to modelling different traffic situations and behaviours. This chapter aims to provide an estimation of the capabilities of those software packages which are used by TfL and included in the rest of these Guidelines, together with an indication of when it would be appropriate to use them and the timescales that would be required to do so.

The different levels of modelling are outlined in section **A3.4**, together with an indication of how they might interact if more than one is used. The types of modelling covered are:

- **Deterministic** – including traffic modelling software and spreadsheets;
- **Microsimulation** – including software that models traffic, pedestrians and both together; and
- **Tactical** – including the use of TfL's ONE model.

Table 2 summarises the key points in relation to each type of modelling, and this is expanded on through the rest of the chapter.

In general terms, deterministic modelling is most commonly used for designing and optimising signal-controlled junctions, microsimulation has the best capability to examine complex and busy road networks with variable signal timing strategies, and tactical modelling concentrates on routing and rerouting of vehicles. Most modelling projects will involve some form of deterministic modelling as it will be used to generate the timings which will be implemented on street. The use of microsimulation and/or tactical modelling will be dictated by the needs of the particular scheme that is being modelled and it is often necessary to use a combination of two or more different packages to complete a full scheme design and assessment.

In addition to the types of modelling covered above, a pedestrian-focused scheme, or a scheme in an area with high pedestrian numbers, may require the use of specific pedestrian modelling software or software that has the capability to model the interaction between pedestrians and general traffic at crossing facilities. Using this software, it is possible to estimate the impact of pedestrians on road network performance or the impact of a new traffic scheme on pedestrians. Since this involves simulation of individual pedestrians, it is covered in the microsimulation section below, as well as in Chapter C3 on Pedestrian Modelling.

Also considered in the microsimulation section is emissions modelling. This is because the type of emissions modelling covered in these Guidelines (Chapter C4 on Emissions Modelling) makes use of the second-by-second outputs for individual vehicles which can only be generated by microsimulation models.

The software packages that are detailed in this chapter are those that have been approved for use at TfL after an open competitive procurement process to ensure our modelling software requirements are met.

Table 2: Key features of the different levels of modelling

Modelling	Software	Pros	Cons	Outputs	Timescale / Cost
Deterministic	• LinSig • TRANSYT • ARCADY PICADY Junctions • Spreadsheets	• Optimisation of signal timings • Similarity to Controller Specifications • First point of call • Quick and easy – good for optioneering • Immediate results	• Limited ability to model different modes • Cannot model wider traffic reassignment • Aggregate flows • Limited ability to model blocking back • Based on average signal timings (demand dependency not directly modelled)	• Degree of saturation • Queue length • Stops and Delay • Signal timings for other types of modelling	• Quick to build (~days) • Quick to run (~seconds) • Low cost
Microsimulation	• Aimsun Next • Vissim • LEGION • Viswalk • EnViVer • PHEM	• Models and outputs different modes • Realistic modelling of behaviour • Graphic outputs • Variability included in terms of flows / signals (randomness) • More accurate representation of signal timing (demand dependency, SCOOT, bus priority)	• Time consuming to build and validate • Large data requirements • More expertise needed • Limited treatment of route choice, typically requires use of tactical models	• Journey times • Graphical outputs • 3D simulation • Heat maps (both pedestrians and vehicles) • Vehicle record files • Detailed outputs suitable for local area emissions calculations (EIA)	• Slow to build (~months) • Run overnight (~hours) • High cost

		• Models congestion and blocking back impacts	• Auditing process more detailed (additional MAP stage)	• Detailed vehicle movements for use by emissions modelling software • Emission maps	
Tactical	• Aimsun Next • SATURN • Visum	• Models traffic reassignment • Quick tests on road closures • Highlights potential rat runs • Includes impact of multiple schemes which aren't yet on street • Can use the same model for multiple schemes (subject to Base review)	• Model runs typically 48hrs plus • Aggregate flow • Use only average signal timings • Time consuming to build and validate • Do not model pedestrians • Cycling is typically poorly modelled	• Flow difference plots • Network statistics • Outputs suitable for wider area emissions calculations (EIA) • Bus impacts (high level) • Routing information for microsimulation models	• Initial build slow (~many months) • Updates for scheme (~weeks) • Slow to run (~days) • Higher cost

5.1 Deterministic Models

Deterministic models utilise empirical algorithms to calculate the performance of junction designs and the optimal signal settings based on fixed traffic and layout inputs. Deterministic traffic models calculate optimum signal timings based on fixed flows and capacities. This level of modelling focuses in detail on the capacity of individual stoplines and junctions, and the interaction between them. The use of the word deterministic to describe these models relates to the fact that given identical starting conditions the outputs will be the same every time the model is run. Model inputs vary by software but serve to represent the traffic network and its underlying operation, for example by defining geometric details and traffic flow.

A deterministic model is most suited for optimising the coordination of traffic signals to minimise vehicle delay. Deterministic models can estimate the potential performance of a junction or network and allow for option testing of different signal timing strategies. Outputs from these models can provide a general indication on whether a proposal will operate comfortably within the capacity of a road network.

In congested urban areas it is necessary to coordinate the movement of traffic in order to ensure reliable, repeatable performance. The efficient control of vehicles in a network is usually promoted through the use of coordinated traffic signals. The most efficient traffic control strategy for an area will be defined by the most effective way to achieve the outcomes and benefits of the scheme, whilst avoiding significant detriment to any type of road user (section **B2.5.3**). The optimum settings for coordinated control will typically vary according to time of day and day of week and they are usually derived from deterministic models.

Deterministic models are generally unable to provide detailed representation of more complex situations such as vehicle merging, junction exit-blocking, traffic reassignment, or the dynamic operation of demand-dependent stages. Although some complex situations can be emulated within deterministic models via the adjustments of vehicle inputs other modelling software may be more appropriate for example microsimulation modelling (section **A5.2**) or tactical modelling (section **A5.3**).

The approved design and modelling tools for individual and networks of signalised junctions are LinSig and TRANSYT, which can be used to quickly assess the method by which traffic is controlled. Basic models can be built with only minimal input data, making these tools particularly suitable for preliminary design.

The second category of models that falls within the scope of deterministic modelling is that of unsignalised or priority junctions and roundabouts. Unsignalised control takes place where traffic on a minor movement gives way to traffic on a major movement through the use of signs or markings on the carriageway. The visibility and geometry of a junction both influence the ability of traffic on the minor movement to progress while giving way to the major movement. Schemes which include unsignalised junctions and roundabouts can be modelled with software such asTRL's Junctions, PICADY and ARCADY.

The final type of modelling that should be mentioned is the modelling carried out in spreadsheets. Many forms of data analysis can be performed in spreadsheets, however the ones that are relevant to these Guidelines are used for assessing pedestrian impacts when detailed pedestrian modelling is not required.

5.1.1 Signalised Networks

Deterministic modelling of signalised networks is the most common type of modelling carried out in Network Performance, and the two main software packages used are LinSig and TRANSYT.

5.1.1.1 LinSig

LinSig, developed by JCT Consultancy Ltd (JCT) [27], can be used for detailed junction design, assessment of scheme proposals and the creation of 'skeleton' models for checking against junction Controller Specifications. It combines geometric layout, traffic and controller modelling to ensure that it accurately reflects the way existing junctions work, and how any design proposals would operate if implemented.

LinSig provides the functionality to maximise the efficiency of interstage design and is capable of optimising signal timings to either minimise delay or maximise the spare capacity (known as Practical Reserve Capacity, or PRC) of junctions. Signal timings can be manually adjusted to refine the timings or to match site specific safety requirements. Additionally, there is a cycle time optimiser which allows selection of an optimum cycle time by showing how delay and capacity vary against cycle time increments.

As well as individual junction design, LinSig can model and optimise networks of multiple junctions with separate controllers. The optimisation

27 http://www.jctconsultancy.co.uk

criteria of delay and PRC can be applied to the network as a whole or to individual junctions. LinSig may also be used to model give-way junctions, albeit with constrained functionality and as part of a wider network.

The most common performance outputs from LinSig models are degree of saturation (DoS) and queue length, which can be used to evaluate if a junction, and therefore the immediate surrounding road network, can operate effectively with the new scheme. Other graphic outputs are available within this software, such as the Cyclic Flow Profile graph shown in **Figure 7**, which can be used to analyse where in the cycle most vehicles arrive at a stopline.

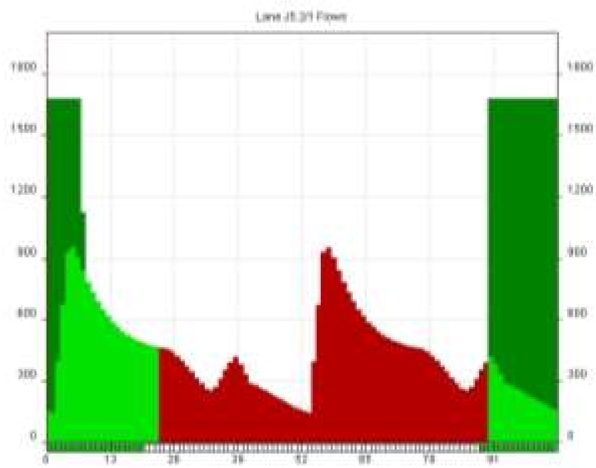

Figure 7: Cyclic Flow Profile graph, showing previously delayed vehicles (dark green), vehicles arriving on green (light green) and vehicles arriving on a red signal (red)

An advantage to using LinSig is the similarity of its interface to junction Controller Specifications, which makes it easy to input data and to transfer timings onto street. LinSig has the ability to optimise junctions and networks for different traffic scenarios, so it is useful for optioneering. Models are quick to build, and the results are available immediately. Conversely, it has minimal capability to model different modes and blocking back and it cannot simulate phenomena such as wider traffic rerouting. It uses aggregated flows and signal timings so the randomness of real life, in particular demand dependency, is not directly replicated.

5.1.1.2 TRANSYT

TRANSYT, developed by TRL[28], is used for the optimisation of signal timings, predominantly across coordinated networks of primarily signalised neighbouring junctions. It is capable of estimating optimum signal timings for representative traffic conditions within a network. TRANSYT optimisation is conducted using algorithms which attempt to find optimal signal settings that minimise stops and delay in the network. TRANSYT can be used to model a wide variety of networks, from unsignalised junctions to signalised roundabouts. It is used for impact assessment of proposed schemes and for the initial preparation of signal timing plans prior to implementation.

The most common performance outputs from TRANSYT models are degree of saturation (DoS) and queue length, which can be used to evaluate if a junction, and therefore the immediate surrounding road network, can operate effectively with the new scheme. Other graphic outputs are available within this software, such as the Cyclic Flow Profile graph shown in **Figure 8**, which can be used to analyse where in the cycle most vehicles arrive at a stopline. It can also display performance metrics for assessment using indicators such as capacity utilisation and queue prediction.

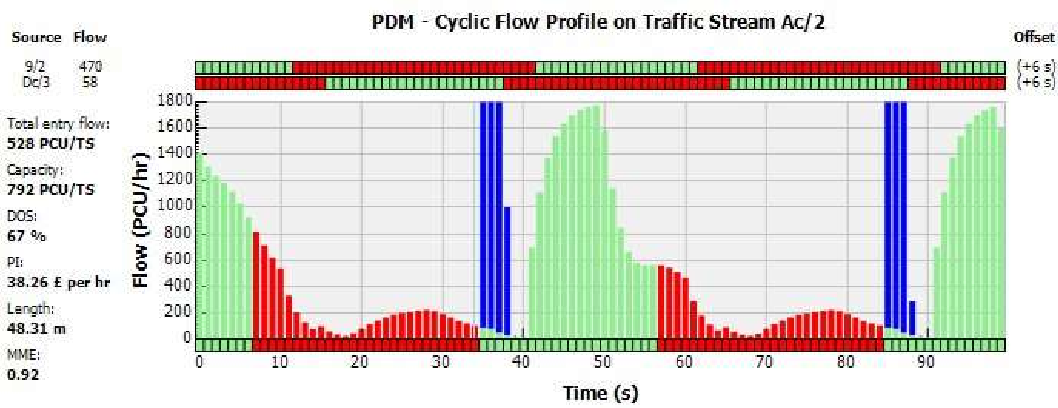

Figure 8: Cyclic Flow Profile graph, showing previously delayed vehicles (blue), vehicles arriving on green (green) and vehicles arriving on a red signal (red)

TRANSYT has the ability to optimise junctions and networks for different traffic scenarios, so it is useful during optioneering. Models are quick to build, and the results are available immediately. Conversely, more recent versions of the software have limited capability to model different modes and blocking back and has capability to model priority junctions beyond standard give-way coefficients. It cannot simulate phenomena such as

28 https://www.trl.co.uk/

wider traffic rerouting. It uses aggregated flows and signal timings so the randomness of real life, in particular demand dependency, is not directly replicated.

5.1.2 Priority Junctions

PICADY can be used to estimate the performance of a unsignalised isolated junction in terms of potential queue lengths and vehicle delays. The software incorporates TRL research to encapsulate the influence of junction design upon driver behaviour and visibility at priority intersections with specific geometric characteristics. It can also model zebra crossings on the approaches to priority junctions.

ARCADY is a tool used to assess unsignalised roundabouts and can model most types of roundabout to predict accident rates, performance and delay to traffic. Like PICADY, it can also model zebra crossings on the roundabout approaches.

As well as being separate pieces of software, PICADY and ARCADY are packaged together in the Junctions application. Unlike the individual software packages, Junctions can be used to model a network of priority junctions and/or roundabouts. In addition, the latest TRANSYT modelling suite allows for limited-functionality PICADY and ARCADY objects to be included within a TRANSYT model, this excludes the modelling of zebra crossings. ARCADY, PICADY, Junctions and TRANSYT are all developed by TRL[29].

The most common outputs from these applications are the ratio of flow to capacity for any movement (the unsignalised equivalent of degree of saturation), queue lengths and delay statistics.

The advantages of these software packages are that they are quick and easy to use, and the results are available immediately. Also, they are specifically designed to model priority junctions and so consider more features of the road's geometry than other deterministic software. Conversely, they cannot model different modes or phenomena such as traffic rerouting and blocking back. In addition, they need multiple days of queue data to validate against.

5.1.3 Pedestrian Modelling

The main uses of deterministic pedestrian modelling are for walking and wait times as well as the level of comfort attained in the area. Spreadsheets that have been developed and are in use at TfL for looking at

29 **https://www.trl.co.uk/**

different aspects of the pedestrian experience. These are applied at schemes where it has been decided that full pedestrian modelling is not necessary or possible. The spreadsheets are explained in more detail in Chapter **C3** on **Pedestrian Modelling**.

The main measure for the pedestrian experience of a scheme is the Pedestrian Comfort Level (PCL) which classifies the level of comfort based on the level of crowding a pedestrian experiences on the street. In the spreadsheet, geometric features of a pavement or crossing are used to derive a value in pedestrians per metre per minute. This is converted into a level, based on a scale from PCL A, which means pedestrians have a lot of space, to PCLs D and E, where pedestrians have little space and their movement is restricted. Whether these levels are considered acceptable or not depends on the type of area being assessed, for example, a retail area such as a high street would become uncomfortable at a lower PCL than a transport hub.

Another spreadsheet for measuring pedestrian performance is used to calculate the delay experienced when travelling across a series of crossings, for example, where there are separate crossings across the entry and exit movements of one arm of a junction. This spreadsheet uses the signal timings and crossing widths to calculate how long a pedestrian arriving at each second of the signal cycle would have to wait at each crossing and uses this to derive an average wait time.

The advantage of using spreadsheets over more complex pedestrian modelling software is that they are much quicker to use. The data requirement is usually only based around the geometric attributes of the area which are readily available in scheme design drawings and so do not involve complex and time-consuming surveys. Conversely, pedestrian behaviour may involve some complex interactions which cannot be conveyed by the spreadsheets.

5.2 Microsimulation Models

Microsimulation modelling simulates the movements and reactions of individual vehicles, cyclists and pedestrians using behaviour models. As a result, microsimulation modelling is able to reproduce dynamic phenomena such as queuing behaviour and blocking back through junctions, and the impact of parking or incidents upon the network.

Microsimulation models are useful when modelling heavily congested conditions where a network suffers poor performance due to excess queuing from neighbouring junctions. In order to represent the different characteristics of drivers, vehicles and pedestrians, microsimulation models perform multiple model runs based on random seeds. This approach seeks to replicate the variability of the real world and helps to highlight any possible performance issues that may be caused by short-lived spikes or disruptions in traffic flow.

The outputs from microsimulation consist of the average of results from a number of model runs, however, individual runs can also be studied since runs with the same seed are repeatable. In networks where significant congestion is expected, microsimulation models are needed to model detailed vehicle behaviour and compliment deterministic model outputs.

Microsimulation can represent signal control features such as demand dependency and bus priority using detectors and vehicles / pedestrians in the model. Depending on the software, microsimulation models can also replicate the detailed behaviour of London's UTC and SCOOT traffic control systems (section **A2.2**), so that simulated vehicles and pedestrians can alter the modelled signal timings in the same way as they would on street.

In addition, microsimulation packages are capable of generating animations of the individual vehicles moving within a network and they can produce output files which are used in 3D modelling software to generate high-quality visualisations. As a result, microsimulation modelling can provide a useful visual aid when presenting the performance of complex scheme designs to a non-technical audience.

The disadvantages of microsimulation are that their development and validation is very time consuming, require extensive data collection and considerable modelling experience. Microsimulation models normally rely on tactical modelling for routing information and they typically cannot optimise signal timings. In terms of model run times, depending on the size and complexity of the model, it could take anywhere between 5 and 30 minutes to complete an hour of simulated time. This means that conducting a full set of 20 seed runs, required to produce average results, would usually be done overnight.

Other, less obvious, issues are that the models tend to be taken as precise predictions of the future, since the viewer can see the 'vehicles' moving. It should be recognised that the best model in the world is still 'just' a model and not the same as real life. It is intended to provide an indication of future performance rather than an exact prediction.

The two vehicle-based microsimulation software packages covered here are Aimsun Next and Vissim.

Modelling the interactions between individual pedestrians is also undertaken using microsimulation and these interactions are generally more complex than modelling traffic. This is because pedestrians have degrees of freedom not enjoyed by traffic: they are not restricted to travel in lanes and can, within reason, move where they like. The two pedestrian microsimulation software packages covered in these Guidelines are LEGION and Viswalk.

Finally, emissions modelling is included in the microsimulation section as it relies on the outputs from microsimulation modelling. The two software packages covered in these Guidelines are EnViVer and PHEM.

5.2.1 Traffic

Microsimulation packages generally do not have the ability to optimise traffic signal settings without external tools, therefore deterministic modelling is commonly used in conjunction with microsimulation modelling. The boundary of a microsimulation model should encompass the extent of the impact of the scheme. If this is not possible a larger tactical model maybe required.

Journey times are the main outputs that are used from microsimulation modelling. These will have been identified as significant routes that are long enough for the results to be meaningful and short enough that a reasonable number of vehicles complete them. The results are usually split by mode and used to compare different scenarios. Heatmaps can be used to display results such as delays, speeds, flows and queue lengths. Most of the data can be exported as a database or text file for use in other software. One of the main benefits of microsimulation models is the ability to visualise detailed vehicle behaviour, overall network performance and the effects of congestion.

5.2.1.1 Aimsun Next

Aimsun Next is transport modelling software produced by Aimsun SLU[30] (Aimsun), which is a subsidiary of Siemens Mobility. It is a fully integrated application which includes microsimulation, mesoscopic, macroscopic and travel demand modelling. It also has the capability to combine these in two hybrid simulators: micro-meso and macro-meso. Only the microsimulation aspect of Aimsun Next is considered in detail in these Guidelines.

Aimsun Next microsimulation uses a Lane-Based network layout and a car-following model to reflect the way vehicles move through junctions and roads and interact with each other. The latest version includes integrated pedestrians and has started to include a lateral behaviour model for cyclists. At a basic level Aimsun Next is capable of modelling fixed signal timings and simple responses to vehicle and pedestrian demands. More complex signal behaviour can be manually coded through use of custom written scripts. At the time of publishing there is no simulated version of UTC that works with Aimsun Next, however it is planned that future versions of UTC will have Aimsun Next integration.

Aimsun Next can be used to model complex and congested traffic networks, where deterministic modelling cannot provide a realistic representation. In common with other microsimulation software, it is unable to optimise signal timings, and so is usually used in conjunction with deterministic modelling when looking at proposed schemes.

5.2.1.2 Vissim

Vissim is microsimulation software produced by Planung Transport Verkehr AG[31] (PTV) for modelling traffic in urban areas. Vissim uses a Lane-Based network layout and a car-following model to accurately reflect the way vehicles move through junctions and roads and interact with each other. It also has the capacity for lateral behaviour within lanes, which makes modelling features such as cyclists and overtaking possible.

At a basic level Vissim is capable of modelling fixed signal timings and simple responses to vehicle and pedestrian demands. More complex signal behaviour can be manually coded through use of custom written scripts. The UTC-Vissim Interface has also been developed, which allows signals to be controlled using a simulated version of TfL's UTC system within Vissim.

30 https://www.aimsun.com/aimsun-next/
31 https://www.ptvgroup.com/en/solutions/products/ptv-vissim/

This allows modelling of real time signal optimisation and advanced signal control strategies such as bus priority.

A further benefit is that the pedestrian modelling package Viswalk (section A5.2.2.2) is integrated with Vissim, so pedestrian and vehicle interactions can be investigated.

Vissim is typically used to model complex and congested traffic networks, where deterministic modelling cannot provide a sufficiently realistic representation. In common with other microsimulation software, it is unable to optimise signal timings, and so is usually used in conjunction with deterministic modelling when looking at proposed schemes. When the UTC-Vissim Interface is used, signal timings are optimised dynamically by the SCOOT model, however deterministic modelling is still used to provide overall optimal timings.

5.2.2 Pedestrians

Microsimulation pedestrian modelling is useful for schemes with a pedestrian focus, such as a new pedestrianised area; where there is a high volume of pedestrians, such as a high street or outside a station; or where a traffic scheme is predicted to have a significant impact on pedestrian movements. It can provide more insights into how pedestrians will experience the scheme than the spreadsheets covered in section A5.1.3, since it involves simulating individual pedestrians and how they interact with each other. Different types of pedestrians can be modelled, for example men, women, tourists and commuters. These can be given different speeds and routing based on research and data collected on site. For example, tourists with suitcases take up more space and are likely to move more slowly than commuters who travel to the area every day.

The outputs from pedestrian modelling include pedestrian level of service (LoS, similar to pedestrian comfort levels mentioned in section A5.1.3) and journey times, only based on the 3D densities and movements of pedestrian entities rather than a spreadsheet calculation. LoS can be displayed in the form of heat maps, as can data such as walking speed and space utilisation. Pedestrian journey times can also be assigned a monetary value, or social cost, which is weighted based on the pedestrian activity and allows comparisons between different layouts and options. Pedestrian modelling software also has the capability to export animations or output files which can be turned into 3D visualisations.

As with all microsimulation models, pedestrian modelling provides more detailed analysis at the cost of greater data requirements and longer development and run times.

5.2.2.1 LEGION

LEGION is pedestrian modelling software produced by Bentley[32] which represents pedestrians as adaptive agents and treats pedestrian movement as a multi-agent complex system. The interactions between individual pedestrians lead to crowd behaviour emerging naturally rather than being explicitly modelled. LEGION uses inputs, along with other types of object such as drift zones and direction modifiers, in order to best represent pedestrian movement and interaction in the modelled area. LEGION has been used for many years by London Underground to model passenger behaviour in stations and is also often used to model high-profile surface schemes.

LEGION cannot explicitly model adaptive signalised junctions or crossings. Signal control is simulated using waiting zones, where pedestrians are stationary for a defined and fixed period of time, so adaptive timings are not possible. In addition, LEGION does not include vehicles and so cannot predict situations where vehicles may affect pedestrian movements or vice versa.

5.2.2.2 Viswalk

Viswalk, developed by PTV[33], particularly models pedestrians in urban areas. Pedestrian movement in Viswalk is built on a 'social force' model, so movement is based on forces assumed to be exerted by pedestrians and obstacles. Viswalk uses inputs in order to best represent pedestrian movement and interaction in the modelled area. The key benefit of Viswalk over other pedestrian modelling software is that it is integrated seamlessly within Vissim, so it can take advantage of all Vissim's signal control capabilities and investigate the impact of interactions between vehicles and pedestrians. TfL's use of Viswalk is relatively new.

5.2.3 Emissions

The most widely used approach to estimate road traffic emissions is based on the type of vehicle and its average speed on a section of road (section **A4.5.6**), this approach can be used with outputs from deterministic or tactical models. However, emissions are very dependent on a number of context and environmental factors and are significantly higher during acceleration compared to cruising. This means that a more granular approach to vehicle and movement is needed, namely second-by-second data for each individual vehicle and location. The use of average flows will

32 https://www.bentley.com/en/products/brands/legion
33 https://www.ptvgroup.com/en/solutions/products/ptv-viswalk/

not enable an accurate estimation of emissions in an urban environment, where a lot of stop-start actions take place. In such areas, emissions modelling based on the instantaneous properties of vehicles (type, speed, acceleration and gradient, for example) should be captured.

Microsimulation traffic models are needed to provide the detailed individual vehicle outputs used by the instantaneous emissions model. These outputs can be processed by various emissions software packages which are based around vehicle performance and engine standards. The two software packages covered in these Guidelines are EnViVer and PHEM.

5.2.3.1 EnViVer

EnViVer (Environmental Vissim-VERSIT+ simulations) is an emissions modelling software package specifically designed to calculate emissions based on the simulated traffic data from Vissim (although other software can be used if the output files are adjusted appropriately). It is developed by TNO (the Organisation for Applied Scientific Research) in the Netherlands[34]. The vehicle emissions calculation in EnViVer works on individual vehicle data with a one-second frequency, such as that from microsimulation models.

EnViVer allows users to define their own vehicle fleet models by configuring fuel type, vehicle age distribution and Euro engine classification standard proportions so that the emissions calculations can be estimated based on local data. EnViVer also has batch processing and post-processing functionality which can be used to calculate, analyse and compare results for multiple different traffic scenarios.

5.2.3.2 PHEM

PHEM (Passenger car and Heavy duty Emission Model) is an emissions modelling software package developed by Technical University of Graz (TUG)[35] for calculating vehicle emissions. PHEM calculates the emissions of vehicles on the basis of their speed and acceleration / deceleration rates using individual vehicle data with a one-second frequency, such as that from microsimulation models.

The model calculates the engine power output and engine speed from vehicle positions, speeds and accelerations, so any driving condition can be modelled as long as the vehicle record files are available. The simulation of different vehicle payloads in combination with road gradients, variable

34 https://www.tno.nl
35 https://www.tugraz.at/en/home/

speeds and accelerations can be modelled replicating the different gear-shifting behaviour of drivers.

PHEM includes an extensive database of previously measured vehicles and engines for the calculation of road traffic emissions, however emissions levels can also be modelled for other types if the vehicle specifications are provided.

5.3 Tactical Models

Tactical models are used to explore how vehicles will use the available road network in a relatively short time horizon, predicting up to 5 years ahead. They typically cover large areas and use aggregated flow values and road / stopline capacities to understand how changes to the road network will affect route choice, speeds and congestion. These models can be used at an early stage in scheme assessments as part of an optioneering process and are also used to inform final flow patterns in a chosen design. Mode choice behaviour is not explicitly modelled, however, the effect of mode choice can be reflected at tactical level using outputs from travel demand models.

The tactical models used for modelling schemes in London will be based on pre-existing models, such as the ONE model, that cover the whole of London. This is because building a validated tactical model has extremely large time and data requirements. Use of existing models will usually involve a ‘Base review’ to ensure that the area of interest in the model is up-to-date and has any relevant proposed schemes coded in.

Tactical models can output flow difference plots, network statistics, outputs suitable for wider area emission calculations used in EIAs, and high-level bus impacts. They are also used to provide routing information for microsimulation or deterministic models.

The use of tactical models is advantageous where there is likely to be traffic rerouting as a result of the scheme. Since the models already exist, they can be used for quick tests on road closures or potential rat runs and also to investigate the impact of multiple schemes which are not yet on street. Conversely, building them in the first place is extremely labour intensive and they have relatively long run times of as much as 48 hours. They use aggregate flows rather than modelling individual vehicle behaviour and they use average signal timings, so they cannot be used to examine the detailed operation of a scheme.

For schemes with considerable or wide-reaching network impacts, a tactical model can be used in conjunction with deterministic and microsimulation modelling. It is normal for successive iterations to be required with these models in order to assess the impact of a scheme on traffic volumes and driver route choice (section **A3.4.5**).

Aimsun Next[36], SATURN[37] and Visum[38] are the three packages which can be used by TfL for tactical modelling in London.

5.3.1 Aimsun Next

Aimsun Next is transport modelling software produced by Aimsun, a subsidiary of Siemens Mobility. It is a fully integrated application which includes microsimulation, mesoscopic simulation, macroscopic and travel demand modelling. It also has the capability to combine these in two hybrid simulators: micro-meso and macro-meso. These Guidelines only consider the microsimulation aspect of Aimsun Next as, at the time of publishing, TfL is still investigating the additional capabilities.

5.3.2 SATURN

SATURN is a suite of programs developed by the Institute for Transport Studies at the University of Leeds in partnership with the transport consultant Atkins (SNC Lavalin). It is a combination of network analysis programs that combine traffic simulation and traffic assignment to analyse the impact of traffic management on a regional, sub-regional and local scale. The main use of SATURN at TfL is at a strategic level, as the LoHAM traffic assignment model (section **A3.4.4**) is built in SATURN. For further information, contact **StrategicModelling@tfl.gov.uk**. For this reason, use of SATURN is not covered in detail in these Guidelines.

5.3.3 Visum

Visum is developed by PTV as a system for travel demand modelling, transport planning and network data management. It is designed for multi-modal analysis which integrates different modes of transportation into a single network model. It is used to conduct operational assessments to indicate the impact of short-term changes on the network and is usually commissioned to support major development schemes. Modelling traffic reassignment and congestion impacts due to local network changes requires detailed transport network representation and assignment methods capable of replicating congestion effects.

36 **https://www.aimsun.com/aimsun-next/**
37 **http://www.saturnsoftware.co.uk**
38 **https://www.ptvgroup.com/en/solutions/products/ptv-visum/**

NM's tactical model, the Operational Network Evaluator (ONE) Model, is developed in Visum. It covers Greater London, out to and including the M25. The model covers a large area so not all roads are represented. Motorways, A Roads, the TLRN, the SRN, and most other roads carrying in excess of 100 vehicles an hour are included. The ONE Model is used to assess schemes and investigate the implications of local network changes, such as improvements to junction layout or signal timings, on the wider network. Outputs from the ONE Model include flow difference plots, link speeds and junctions approaching saturation. At the time of publishing, the ONE Model represents AM and PM peak periods.

6 Summary

This section has attempted to provide assistance to the scheme Promoter and has evolved from the previous version to provide additional considerations for a range of influencing factors to enhance this support. The aim of this part of the document is to guide the reader towards making decisions from the outset with regards to scheme modelling assessment on London's road network that influence the best outcomes for all road users. The intention is to promote best practice and transparency across the industry. We hope that you find these Guidelines useful and informative in order to elevate standards, promote knowledge sharing and further collaborative efforts.

We are very appreciative of the support from all internal and external contributors to the creation of these Guidelines. We look to take on board feedback from all stakeholders and are always open to recommendations. Please direct any feedback to **TfLModellingGuidelines@tfl.gov.uk**.

PART B – MODELLING GUIDANCE

I Introduction to Part B

Within the TfL Network Management Directorate (NM), Network Performance Delivery (NPD) is dependent on comprehensive modelling and supporting information from clients (including London boroughs and TfL departments) and consultants in order to effectively design, assess, implement and operate traffic schemes.

Appropriate, comprehensive and accurate modelling is necessary to ensure traffic schemes are:

- Assessed for impacts and benefits;
- Effectively designed to satisfy any objectives;
- Clarified to avoid confusion or misinterpretation of the design;
- Communicated to the public and other stakeholders in terms of the design and impacts; and
- Effectively and efficiently implemented and operated.

Part B of the Traffic Modelling Guidelines contains technical advice relating to modelling best practice. The first chapter initially covers general topics that are common to all types of traffic model undertaken by or for TfL Network Performance (NP), with subsequent chapters containing more detailed advice for specific traffic modelling software methods. It is recommended that all model developers producing a traffic model within the London area familiarise themselves with Chapter **B2** on **Modelling Principles**, prior to commencing model development, and irrespective of the particular software they intend to use.

Within **Part B** of the Traffic Modelling Guidelines, an assumption has been made that the reader has an awareness of basic traffic engineering principles, covering traffic signal control, traffic flows and traffic surveys. Specific concepts and signal terminology that should be already understood include phases, phase minimums, intergreens, phase delays, stages, stage minimums, interstages, cycle times, offsets, saturation flow and degree of saturation (DoS) [39].

This level of awareness would typically come from introductory courses to traffic signals and industry-standard software packages, combined with experience in the traffic engineering / transport planning field.

The remainder of **Part B** is organised into chapters appropriate to different types of traffic model and modelling software. Individual chapters can be referred to for relevant guidance on the traffic model type and modelling software being used for a particular project. If any specialist competencies relate to specific modelling software, these will be stated in the chapter for that package.

39 DfT Traffic Signs Manual Chapter 6 Section 6 describing these terms **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/851465/dft-traffic-signs-manual-Chapter-6.pdf**

2 Modelling Principles

This chapter contains key information which should be read and understood by anyone undertaking traffic modelling. The key areas that will be covered include:

- Levels of Modelling;
- Three Stage Modelling Process;
- Model Auditing Process;
- Planning a modelling project;
- Data Collection;
- Base and Proposed Model Development;
- Proposed Model Optimisation; and
- Model Reporting.

All model developers are also encouraged to familiarise themselves with **Part A** of the Traffic Modelling Guidelines to ensure that the considerations outlined there will be met by any Proposed model.

2.1 Modelling Overview

This section provides an overview of the different levels of modelling covered by these Guidelines, modelling undertaken early in the design process, the Three Stage Modelling Process and the Model Auditing Process.

2.1.1 Levels of Modelling

Different levels of models may be required for a modelling project depending on the purpose of the scheme and the outputs that are required. It is common for multiple modelling levels to be required to fully assess the impacts of a proposal. The main levels of modelling used by NM for scheme assessments are summarised in the following subsections. The decisions on the level(s) of modelling required as part of a scheme assessment should be agreed during the relevant model scoping meeting, which is discussed further in **B2.1.5.1**.

2.1.1.1 Deterministic Modelling

Deterministic traffic models are used to assess junction performance and calculate optimised signal timings, including the coordination of signal timings between junctions. They are based on the capacity of individual stoplines based on geometric inputs and fixed traffic flows. Deterministic models are based on aggregate traffic flows and average signal timings, therefore complex signal strategies, demand dependency and blocking back of queues cannot be explicitly modelled.

The main outputs from these models include degree of saturation (DoS) and mean maximum queue (MMQ) lengths. The models can also provide a general indication of whether a proposal will operate comfortably within the capacity of a road network.

For further information on deterministic modelling, refer to Chapters **B4** and **B6** covering **LinSig Modelling** and **TRANSYT Modelling** respectively.

A second category of deterministic models are used to assess the performance of unsignalised or priority-controlled junctions and roundabouts. Priority control occurs when traffic on a side road or minor road gives way to traffic on a major movement or circulating carriageway. The key inputs for this type of modelling include geometric and visibility details for the junction. Outputs for this type of modelling include delays, queues and capacity. Schemes which include unsignalised junctions and roundabouts can be modelled with PICADY and ARCADY, which are included within the Junctions software package and as optional modules within TRANSYT 16 (covered in **B6.4.6.5**).

2.1.1.2 Microsimulation Modelling

Microsimulation models can represent individual vehicles, cyclists and pedestrians within a modelled network using behaviour models. Therefore, microsimulation can be used to assess congested networks more accurately than other modelling levels as they can explicitly represent queuing behaviour, blocking back through junctions, merging and random events such as breakdowns or lane closures.

Complex signal control features, such as demand dependency and bus priority, can be replicated in microsimulation models using detectors and vehicles / pedestrians in the model. Depending on the software, microsimulation models can also replicate the behaviour of on-street signal operation, where modelled vehicles and pedestrians can alter the modelled signal timings. However, microsimulation models are unable to optimise signal timings and are therefore often used together with deterministic models.

Microsimulation models allow for the effects of randomness, where different random seeds are used to give a variety of results with differing traffic and pedestrian arrival profiles. By averaging the outputs from many random seeds, the natural variability of real-life traffic conditions can be captured in the results.

The most common outputs of microsimulation modelling are journey times, which are recorded over predetermined distances over which a reasonable number of vehicles or pedestrians travel. This journey time information can be broken down by mode, so that the impact of a scheme on individual user classes can be assessed. Numerous other outputs, such as flows, queue lengths, delays and speeds, can be exported from models in either data or heatmap formats. Microsimulation model outputs can also be used by other software, such as for production of 3D visualisations or calculating emissions outputs from modelled vehicles.

For further information on microsimulation modelling, refer to Chapters **B3** and **B7** on **Aimsun Next Modelling** and **Vissim Modelling**.

2.1.1.3 Tactical Modelling

Tactical modelling can be used to understand how changes to the road network will affect route choice, vehicle speeds and congestion. Tactical models are used in modelling assessments where vehicle rerouting is a likely result from the scheme proposals. They use aggregate flows rather than modelling individual vehicle behaviour, and use average signal timings, so they cannot be used to examine the detailed operation of a scheme.

Tactical models are used to predict how vehicles will use the future road network, typically within a 5-year time horizon. They can also assess the cumulative impact of traffic reassignment resulting from multiple proposals. This is discussed in more detail within **B2.1.4**, where the Three Stage Modelling Process is outlined. The main outputs produced by tactical models are flow difference plots, network statistics and queue plots.

Mode choice behaviour is not explicitly modelled in tactical models, however, the effect of mode choice can be reflected at a tactical level using outputs from strategic travel demand models.

For further information on tactical modelling refer to Chapter **B5** on **Highway Traffic Assignment**.

2.1.1.4 Pedestrian Modelling

Specific pedestrian modelling is carried out for schemes with a pedestrian focus, and microsimulation modelling is most commonly used. Pedestrian microsimulation modelling represents individual pedestrians and how they interact with each other and other items or obstacles in their environment. In similarity with traffic microsimulation modelling, different pedestrian types can be modelled to represent different walking speeds or other factors such as pavement space used.

Outputs from pedestrian modelling include pedestrian levels of service, heat maps, journey times and videos. Data from pedestrian modelling can also be used in 3D visualisations.

For further information on pedestrian modelling refer to Chapter **C3** on **Pedestrian Modelling**.

2.1.1.5 Emissions Modelling

Estimates of road traffic emissions can be based on the type of vehicle and its average speed on a section of road. This is a widely used approach, which uses outputs extracted from deterministic or tactical modelling. However, as these models are based on aggregate information, this approach is unable to assess the emissions produced by a vehicle as a result of acceleration. Where there is significant stop-start behaviour, such as in an urban environment, detailed emissions modelling therefore uses microsimulation modelling outputs to provide a more accurate estimate. The detailed outputs for each vehicle in a microsimulation model can be exported for use in various emissions software packages.

Guidance on using instantaneous emissions modelling with individual vehicle data can be found in Chapter **C4** on **Emissions Modelling**.

2.1.2 Common Model Simplifications

Simplifications are inherent in models, as discussed in **A3.1**, and may vary between different levels of modelling. They are necessary to achieve a balance between model quality, model complexity and timely delivery. Some of the common model simplifications that are made include:

- **Response to changing traffic conditions** – Deterministic and microsimulation models typically do not account for alterations to traffic routing, time of travel, or react to changing congestion within the modelled environment during the simulation. Tactical models which can handle dynamic route choice have the capability to alter trip route choice within the modelled period, however the added complexity of this capability must be carefully justified. Typically tactical models output a single set of trips and routes per assignment;

- **Variations in traffic demand** – Models are built to represent a single, or set of, 'neutral' days across the year. This is usually a midweek day during term time, on a day in which light conditions or adverse weather do not affect the demand or flow of vehicles;

- **Simplification of traffic flows** – Vehicle / pedestrian types and their behaviours are simplified in all models. Models either standardise vehicles into Passenger Car Units (section **B2.3.4.1.1**), or group them into sets of users with similar characteristics. These could be performance characteristics, physical space requirements, filtering behaviours, accessibility limitations or many others;

- **Trip origins and destinations** – Models do not represent individual trip start and end points, they are either aggregated into demand zones or loaded onto the edges of a model and then exit the model elsewhere at another edge. The number and distribution of trips between origins and destinations are typically fixed in models. The potential modal shift, demand suppression or peak spreading incurred by a scheme is not usually modelled;
- **Modelled networks** – Traffic models used in London are typically either Lane or Link-Based and may limit the representation of weaving or filtering through traffic. Pedestrian models do not capture all informal crossings which occur in reality;
- **Treatment of congestion** – Unless scheme assessment is undertaken in a microsimulation model, the effects of congestion blocking junctions and interfering with the flow of traffic elsewhere on the network may not be adequately represented. Manual adjustments are often required to reflect congested conditions in other levels of modelling;
- **Operation of traffic signals** – Many models cannot capture the detailed effects of adaptive or optimisable traffic signal operation, such as SCOOT, bus priority or automated strategy application. As a consequence, these models typically simulate a fixed cycle time and green times. Microsimulation models built with an interface to the UTC system (such as UTC-Vissim, discussed in **B7.4.5.3**) can accurately represent more intelligent signalling strategies; and
- **Modelling complex route choice** – Models simulate trips that have a single fixed origin and destination. Where tactical models are used, route choice is calculated based on vehicles finding the least cost path through the network to reach their destination. Other modelling software typically does not have the ability to predict or affect route choice. Modelling certain vehicle behaviours, such as taxis looking for a fare or delivery vehicles making multiple drop offs, often cannot be adequately represented in models. Where models include multiple vehicle classes, routing behaviours can however be applied to represent differences in the way each class uses the available network. This could account for behaviours such as use of bus lanes, compliance width / height / turn restrictions or differing levels of network knowledge.

2.1.3 Early Design Stages

Prior to detailed scheme assessment with the Three Stage Modelling Process (**B2.1.4)**, and formal submission to TfL under the Model Auditing Process (**B2.1.5**), earlier stages of scheme design take place. This section provides an insight to these early stages of the design lifecycle and the involvement of modelling assessments in the project delivery approach.

Once the business outcome of a project is decided and the benefits of undertaking the project are established, key stakeholders are introduced to the project to discuss any anticipated difficulties in designing and delivering the scheme.

The feasibility stage is where a variety of options are considered and designed in order to achieve the proposed outcomes of the project. Modelling undertaken at this stage will narrow down the proposed options so that a single feasible option can be progressed to a full scheme assessment. This modelling is typically carried out using deterministic modelling software, as these models are the simplest to build. The optioneering process gives the key project stakeholders a good understanding of each option's impact on the network. The feasibility model results allow the designs to be continually improved, usually involving collaboration between designers, modellers and other key parties.

Optioneering will also aid in fixing the scope of the project, and once a decision is taken on the preferred option(s), work can move forward to a full Three Stage Modelling assessment and formal submission under the Model Auditing Process. Although the focus of the Traffic Modelling Guidelines is on detailed scheme assessments, the same modelling concepts can be applied to all kinds of assessment including optioneering.

2.1.4 Three Stage Modelling Process

Over recent years the Mayor's Transport Strategy[40] has reduced focus on improving car trips and shifted towards developing a more sustainable transport network, providing benefits for buses, cyclists and pedestrians. The move towards sustainable travel, together with changes in infrastructure and public spaces as a result of population growth, has resulted in many transport schemes being implemented within the same time frame. Therefore, the Three Stage Modelling Process was developed in order to capture the interaction between model types and to better understand impacts such as traffic reassignment due to neighbouring schemes. The process ensures that both the isolated impacts of a scheme and the overall future state of the network are considered, enabling a more holistic analysis of the network, focusing on the impact on every journey. The three stages of this process are detailed in the following sections and in **Figure 9**.

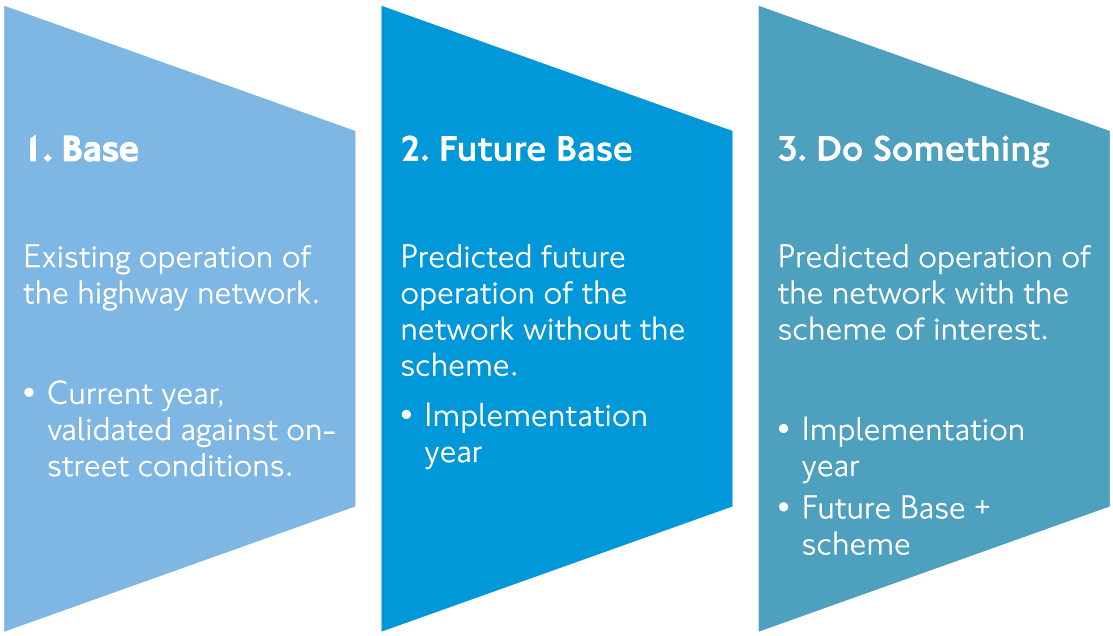

Figure 9: The TfL Three Stage Modelling Process

40 Mayor of London, Mayor's Transport Strategy, March 2018

2.1.4.1 Stage 1: Base Model

A Base model is a model that has been demonstrated to accurately represent traffic conditions as observed and measured on street. It should be suitable for use in analysing current network performance and as a benchmark against which other modelling scenarios can be tested.

The initial tactical Base model is first reviewed in terms of signal timings, network coding, junction capacities and turning count validation for the study area to create a scheme-specific tactical Base model. Base deterministic and microsimulation models are also developed to represent the existing operation of the network and are validated against on-street conditions to the standards defined in the Model Auditing Process, as detailed in **B2.1.5**.

2.1.4.2 Stage 2: Future Base Model

The Future Base model represents the future year in which the scheme under consideration is planned to be implemented, but it does not include the scheme itself. The model should include all future network changes planned for implementation up to the future year being assessed. This includes schemes which may not be finalised and uses the most recent proposals at the time of Future Base model development, which may be subject to change at a later date.

Through an iterative process the tactical and deterministic models are used to refine optimised signal timings for the expected future year flows. Once optimisation has been carried out, routes and signal timings can be fed into the microsimulation Future Base model.

2.1.4.3 Stage 3: Do Something

The Do Something model represents the future year in which the scheme under consideration is planned to be implemented, and also includes the scheme itself. The scheme proposals are coded into the Future Base model to create the Do Something model.

As with Future Base modelling, the refinement of the signal timings takes place during an iterative process between deterministic and tactical models, and the final optimised signal timings and routes are fed into the microsimulation Do Something model.

The isolated impact of the scheme in question can be determined by comparing the Do Something and Future Base scenarios. In some instances, it can additionally be useful to determine the predicted change from the current situation, and so a comparison between the Do Something and Base results can also be made.

2.1.4.4 When to use the Three Stage Modelling Process

It is recommended that the Three Stage Modelling Process should be used in operational scheme assessments when:

- Traffic reassignment is anticipated as a result of the scheme;
- Traffic reassignment is anticipated as a result of adjacent scheme(s); or
- Network changes occur within the model boundary as a result of adjacent schemes.

This will cover the majority of significant schemes in London, so it will only rarely be the case that the Three Stage Modelling Process does not apply. The decision as to whether a scheme is to be subject to the Three Stage Modelling Process would occur during the Base scoping meeting, discussed in **B2.1.5.1**.

2.1.4.5 Scheme Assessments

The diagram in **Figure 10** below shows the iterative process used in order to produce the Base, Future Base and Do Something models for a scheme assessment following the Three Stage Modelling Process.

Firstly, the tactical model needs to be reviewed and validated to a Base year, with the assistance of signal timings and capacities from validated Base deterministic models. The routes from the tactical model are then used during calibration of the microsimulation Base model.

An extra stage is applied for building future year models, as an iterative process needs to be undertaken between the tactical model and deterministic models in order to optimise the signal timings with the predicted future year flows. The iterative process involves transferring the tactical model flows into the deterministic model, optimising the signal timings, and applying the new signal timings in the tactical models. Once the flows are settled, the routings are fed into the microsimulation model to start the build of the future year models.

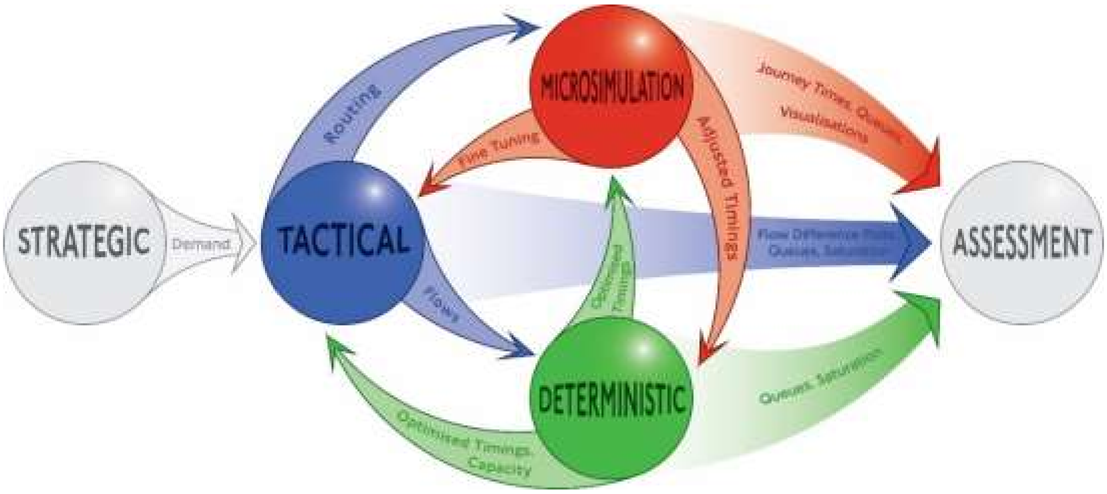

Figure 10: Interactions between different levels of modelling within the Three Stage Modelling Process

2.1.5 Model Auditing Process

Traffic model development is a complex task that can be completed in a variety of ways, and the process of auditing a model can therefore be challenging. The Model Auditing Process (MAP) has been created by the Network Performance (NP) Modelling & Visualisation team (M&V) to simplify this process by providing a structured framework which leads all interested parties through model development, submission and auditing. MAP was implemented in April 2008 and the most recent version at the time of publishing, MAP v3.5, was released in March 2017. The latest MAP documentation is available, without charge, from the TfL website[41].

MAP contains six stages, which outline traffic model development and auditing from initial scoping of the Base model through to submission of the Scheme Impact Report (SIR) to the NP Network Impact Specialist Team (NIST). It defines each model auditing step, assigns key roles, encourages communication and provides standardised auditing check sheets.

The primary objective of MAP is to ensure that traffic models submitted to NPD are developed, calibrated and validated to an appropriate standard. This ensures that NPD is able to provide advice to NIST based on accurate and robust modelling. Further information on NIST can be found in **A2.1.2**.

MAP applies in all circumstances where NIST requires traffic modelling to assess impacts on the Transport for London Road Network (TLRN) or the Strategic Road Network (SRN). However, where a borough is the Promoter of a scheme that does not impact on the TLRN or the SRN the use of MAP

41 **https://www.tfl.gov.uk/trafficmodelling**

is only advisory. All traffic models commissioned by TfL and submitted to NPD are audited in accordance with MAP.

MAP is designed to give a common structure for all model submissions. However, for each modelling package the details, and consequently the checks, are different. At the time of publishing there are four software-specific MAPs, for Aimsun Next (AMAP), LinSig (LMAP), TRANSYT (TMAP) and Vissim (VMAP). However, a similarly structured six-stage approach can be beneficial when applied to any type of modelling software.

The six stages established by MAP are:

- **Stage 1** – Base Scoping Meeting;
- **Stage 2** – Calibrated Base Model Submission;
- **Stage 3** – Validated Base Model Submission;
- **Stage 4** – Proposal Scoping Meeting;
- **Stage 5** – Proposed Model Submission; and
- **Stage 6** – Submission of SIR to Promoter.

Each stage has unique requirements, as outlined in the MAP documents, however the administrative process for dealing with model submissions and the communication associated with each stage remains the same.

MAP also defines six key roles:

- **Promoter (P)** – The person responsible for delivering and project managing the proposal. Considered the client for a scheme;
- **Design Engineer (DE)** – The engineer responsible for creating the modelling for the Promoter. Normally a consultant traffic engineer engaged by the scheme Promoter;
- **Checking Engineer (CE)** – The engineer responsible for checking and signing off the Design Engineer's work as 'fit for purpose' for the Promoter. This is typically a senior consultant traffic engineer engaged by the scheme Promoter;
- **Signals Auditing Engineer (SAE)** – The TfL engineer responsible for checking and safety approving the signal infrastructure elements of the proposal;
- **Model Auditing Engineer (MAE)** – The TfL engineer responsible for auditing the modelling and assessing the network impact of the scheme; and
- **Network Assurance Engineer (NAE)** – The TfL engineer responsible for assessment, then approval / rejection of the Promoter's proposal (under the Traffic Management Act).

For all MAP Stages there are check sheets to be signed off by the DE, the CE and the MAE.

The following key points should be noted:

- All model submissions should be version controlled;
- All model submissions should be internally audited by the CE prior to submission; and
- All model submissions to NP should be sent to the **NMSchemeAssessments@tfl.gov.uk** email address.

2.1.5.1 Scoping Meetings

On initiation of detailed modelling work a Base scoping meeting should be arranged with all parties involved in MAP, as described in **A4.4**. The scheme will be discussed at this meeting, along with the required outputs and modelling work that will be required at the Base and Proposed modelling stages. This constitutes the first stage of the MAP process, MAP Stage 1, and provides an opportunity for the details of the modelling work and future submissions to be recorded within the Modelling Expectations Document (MED), which is discussed further in **B2.1.5.2** and used as a reference as the modelling work progresses.

A Proposal Scoping Meeting should take place at MAP Stage 4 once the Base modelling is approved, as described in **A4.5**. This meeting should involve all the previously mentioned MAP parties. The aim of the meeting is to discuss the scheme proposals and modelling requirements in order to ensure a high quality and consistent approach to model development. Any changes and developments should be recorded and the MED updated.

2.1.5.2 Modelling Expectations Document

To ensure that there is no ambiguity relating to the modelling requirements for a scheme, a Modelling Expectations Document (MED) is produced following the Base scoping meeting at MAP Stage 1. The MED summarises the agreed scheme-specific modelling requirements and is agreed by all parties before a scheme can progress to MAP Stage 2.

The content and size of the MED will vary in accordance to the scale and purpose of a scheme. Common topics that are included within the MED are:

- **Scheme Summary** – this should include a summary of the scheme, details of the Promoter, the scheme objectives and a summary of the proposed changes;
- **Model Area** – detailing the area to be covered by each level of modelling required by the project;

- **Peak Periods** – outlining the peak periods to be modelled for each modelling level, noting there may be differences between the different levels;
- **Software Requirements** – detailing the specific versions of each software to be used in the scheme assessment;
- **Calibration / Validation Criteria** – detailing any processes to be followed to ensure accurate representation of the Base situation within the models, and the targets to be met to achieve a calibrated / validated model;
- **Data Collection** – detailing the data required to build a Base model, including information on what data already exists and whether surveys need to be commissioned or site visits arranged;
- **Signal Data** – this will specify any signal timings that can be collected by TfL or the methodology for collecting signal timings on site at locally controlled junctions or crossings;
- **Interaction Between Modelling Levels** – detailing which modelling levels are to be used and how the different levels will interact;
- **Proposed Modelling** – this should detail if there are any specific requirements for building the Proposed models;
- **Documentation / Outputs** – defining which outputs are to be produced as part of the modelling process, including the scenarios to be compared. The supporting documentation that is to be produced alongside model submissions should also be specified;
- **Programme** – detailing any key milestones / deadlines for the modelling project; and
- **Contact Details** – listing the contact details of all involved parties.

Scheme proposals may evolve throughout the modelling process. The MED should be reviewed during the MAP Stage 4 Proposal Scoping Meeting and updated if any of the modelling requirements have changed.

Care should be taken to make sure that all elements of the modelling process are carefully thought through, discussed at the scoping meetings and then documented.

2.2 Planning a Modelling Project

Adequate time should be given to build fit-for-purpose models, including time allocated for thorough analysis. This can be achieved by planning the project, allowing enough time for each task and avoiding unnecessary delays early in the project.

The following sections detail the key aspects of a modelling project that should be considered when planning a scheme assessment and the associated programme.

A degree of flexibility needs to be incorporated into any modelling project, to encompass any required changes to the initial modelling requirements. Any changes to the modelling requirements should be agreed with the project stakeholders.

2.2.1 Network Familiarisation

Before commencing any modelling work or measurements on site, it is important to become familiar with the study area by identifying the following:

- Junctions and pedestrian crossings covered, which each have a unique TfL site number. All requests for site information should be directed to **AssetOperationsDataLegalRequest@tfl.gov.uk**;
- The TfL signal area the site numbers fall within, which is defined by the UTC group / region number (if applicable, obtained from TfL NPD);
- Time period(s) under consideration; and
- Date(s) when traffic flow data was collected, if available.

Section **B2.3** details some of the initial steps that should be taken in order to become familiar with the area to be modelled.

2.2.2 Modelling Purpose

The development of a clear brief can prevent ambiguity and increase the likelihood of producing fit for purpose traffic models. It is important to define the intended purpose and include any specific objectives and required modelling outputs. This will help when deciding on the scope of the model and when analysing modelling results. The model developer should be made fully aware of this purpose in order to ensure that the final modelling meets the required criteria.

The scheme objectives will determine which modelling outputs are required, with the model scope determining what outputs are possible. The scope of the traffic model as defined in MAP Stage 1 (**B2.1.5**) should be clearly stated in accompanying reports and in any discussion or reference to results obtained from the model. The model developer should also relate decisions made in the model's development process to the requirements of the model, as defined by its purpose.

2.2.3 Spatial Scope

When developing Base models, all road users should be considered and more than one model may be required to capture the impact over a large area. The model boundary should encompass the area for which traffic flows, journey times or delays will be significantly affected by the scheme. This includes the impact of a scheme on the surrounding network, not just the individual junction(s) or area of works proposed.

It is important to consider the proposed scheme objectives and potential impacts when discussing the scope of the Base model to ensure that appropriate model outputs are produced. The model boundary should be agreed with TfL during MAP Stage 1, as described in **B2.1.5**. For guidance, junctions should be included in the model boundary if the proposal:

- Significantly changes the traffic flow at the junction;
- Physically changes the road network;
- Changes the operation of the traffic control; or
- Is expected to cause exit-blocking at certain junctions, either as a result of the proposal or changes in the local traffic control strategy.

The model boundary should include the maximum extent of expected queuing on modelled entry links and should be scoped so there is sufficient capacity for all vehicles to load into the network for the modelled time period, for all scenarios. This is to ensure:

- Any upstream blocking back effects can be easily identified and mitigated; and
- That the model does not produce a biased result, by underestimating the capacity.

If the model area is part of a Cableless Linking Facility (CLF) or UTC group with a proposed change in cycle time, then the whole operational group must be included in any modelling. If there is no proposed change to cycle time, then the whole group does not have to be included provided none of the above criteria are met by junctions adjacent to the proposal.

> It is recommended that Base scoping meetings (**B2.1.5.1**) occur prior to the scheme being registered on the NM workbook (**A3.6.1**). This will

ensure that all NM NPD requirements are captured by the Promoter and Design Engineer prior to development of the scheme design.

2.2.4 Required Outputs

When planning a modelling project, it is important to determine what modelling outputs are required to achieve the purpose of the modelling project. The modelling outputs must clearly demonstrate how the outcomes and benefits of a scheme are achieved and illustrate the impacts. For example, if the purpose of a scheme is to improve bus journey times then outputs would be required that separate bus journey times from those of other modes. Once this has been determined it will be possible to determine the level or levels of modelling required and the specific modelling software to be used.

For further information on the different levels of models and their outputs, refer to **Table 2** in **A5 (Which Traffic Modelling Software? Why?)**.

2.2.5 Modelling Software

Once the required outputs of a scheme are known the type of modelling software to be used in an assessment can be determined. The software typically used for operational modelling assessment has been listed below:

- **Deterministic** – Used to calculate the optimal signal timings based on network conditions. The deterministic model's signal timing output will feed into all other models produced. Software packages used include LinSig (Chapter **B4**) and TRANSYT (Chapter **B6**);
- **Microsimulation** – Microsimulation modelling, where models typically cover larger areas compared to deterministic modelling. Microsimulation models capture a high level of detail that is lacking in tactical modelling. Within the Three Stage Modelling Process (section **B2.1.4**), it is used to assess detailed impacts of the scheme. Software packages used include Aimsun Next (Chapter **B3**), LEGION (section **C3.3.2.1**) and Vissim (Chapter **B7**);
- **Tactical** –Tactical modelling (Chapter **B5**) is the level of macroscopic model used within TfL for operational purposes. Tactical models cover large areas and are primarily used in the Three Stage Modelling Process (**B2.1.4**), to understand route choice and the impact the scheme has on the wider network. Software packages used include Aimsun Next (Chapter **B3**) and Visum; and

- **Mesoscopic** – A compromise between tactical and microsimulation, where there is less detail than microsimulation modelling and more detail than tactical modelling. The development of NM's mesoscopic capability is ongoing at the time of publishing and so the main body of this chapter focuses on deterministic, tactical and microsimulation modelling. However, its usage should be discussed at Stage 1 of the Model Auditing Process (MAP) in section **B2.1.5**. Software packages include Aimsun Next (Chapter **B3**), Vissim (Chapter **B7**) and Visum.

For further guidance on the different levels of modelling, refer to sections **A3.4** and **B2.1.1**.

2.2.5.1 Versions of Modelling Software

Software companies frequently release new versions of their software, either to introduce new features or to address specific software issues. Consideration should be given to the software available and which version is the most appropriate to use for the model(s) being developed. Although it may seem probable, it is not always the case that the most recently released version of the software is the most appropriate one to use, even for development of entirely new models.

It is the collective responsibility of all MAP parties to determine and agree the most appropriate software versions to be used before any modelling work commences.

Under no circumstances should software versions change between the calibration of a Base model and the production of a Future Base and Do Something model (section **B2.1.4**). Even with identical inputs, it is common for different software versions to produce different results. It will therefore likely invalidate a previously validated model if it is used in a software version different from the one in which it was developed.

2.2.6 Planning Traffic Surveys and Data Collection

Traffic surveys and data collection should be considered at an early stage of planning a modelling project. Surveys and data collection need to be planned in advance to ensure they are representative of typical traffic conditions and so that enumerators, where required, can be commissioned to undertake the work. The degree of data collection necessary depends on the modelling purpose and outputs required. Further information on the types of data that need to be collected as part of a modelling project is provided in section **B2.3**.

2.3 Data Collection

Once familiar with the modelled network it is necessary to collect the relevant information required to generate a fit-for-purpose traffic model. Without accurate data a model cannot be correctly developed, calibrated or validated. Data collection in this context refers to both making use of existing data sources and arranging for new data to be collected on site. Both of these areas are detailed in the following sections.

A common cause of inaccurate data is a lack of understanding and experience on behalf of those conducting a survey. On-site measurements should be conducted by an experienced practitioner who possesses a thorough understanding of modelling concepts and accepted survey methods, as well as experience of developing traffic models.

Where third parties have been contracted to undertake on-site observations, it is necessary to ensure the competence of the enumerator and that they have been accurately instructed on how to collect the required observations.

2.3.1 Existing Data Sources

When building Base models it is recommended to make use of available data where suitable, including the large amount of data that is routinely collected and maintained by TfL.

For signalised facilities, the following TfL paperwork should be consulted for all sites within the model boundary, and is available on request from **AssetOperationsDataLegalRequest@tfl.gov.uk**:

- Current TfL Controller Specifications and Timing Sheets, which detail phasing, methods of control, intergreens, phase minimums and phase delays along with other pertinent information relating to the site. Basic controller terminology is covered in more detail in **B2.3.8.1**;
- Site Layout Drawings (SLDs), detailing junction layout, lane markings and site equipment; and where appropriate; and
- SCOOT Link Diagrams, showing link and node structure for SCOOT regions. See section **B2.3.8.2** for further detail on SCOOT terminology.

Other information collected by TfL that can be useful in Base model development includes:

- **Traffic survey data** – including counts performed by the TfL Traffic Surveys Team and other stakeholders, such as Manual Classified Counts (MCC). Available from **ModellingData@tfl.gov.uk**,;
- **Automated Traffic Counters (ATC) and Automated Cycle Counters (ACC) data** – This data provides traffic volume and speed data broken down by categories, collected over several days. Available from **ModellingData@tfl.gov.uk**;
- **TfL's Cordon and Screenline data** – part of an ongoing programme of surveys on the central, inner and boundary cordons and the Thames, northern, peripheral and radial screenlines. Available from **ModellingData@tfl.gov.uk**;
- **iBus data** – providing information on bus journey times, frequencies and bus stop dwell times, as detailed in **B2.3.5**. Available via a project's TfL sponsor; and
- **Cynemon** – a strategic cycling model built by TfL City Planning on the Cube platform, which estimates cyclist routes, flows and journey times at a strategic level across London. Data available from **Cynemon@tfl.gov.uk**, with further information in Chapter **C2** on **Cyclist Modelling**.

Detailed drawings, maps and aerial photographs can be used to help inform site layout, however a site visit must be carried out to confirm the accuracy of any material used.

The internet provides a valuable resource for mapping and aerial photography, which can be useful for reference during initial stages of network familiarisation. Websites and associated tools commonly used for this purpose include:

- Google Maps[42];
- Google Streetview[42];
- Google Earth[43];
- Bing Maps[44];
- Bing Streetside[44];
- OpenStreetMap[45]; and
- TomTom[46].

42 http://maps.google.co.uk
43 https://www.google.co.uk/intl/en_uk/earth/
44 http://www.bing.com/maps/
45 https://www.openstreetmap.org
46 https://www.tomtom.com/en_gb/traffic-index/london-traffic/

Of the aerial photography options available, Google Maps currently provides the highest resolution imagery of central London. In cases where aerial photographs are either obstructed or unclear, the '3D' option provided by Google Maps and 'Bird's Eye' view provided by Bing Maps show oblique images that provide an alternative view. Historical aerial photography can also be accessed via Google Earth.

One of the most useful online tools comes in the form of street-level panorama photography, showing a driver's eye view of the road network using imagery taken with 360° cameras. Examples include Google Streetview and Bing Streetside, with Streetview also providing historical imagery. Whichever tool is used it is important to make note of the year the imagery was taken to ensure it is suitable for the intended purpose.

A number of online tools can indicate typical traffic conditions for a certain day or time, including Google Maps' traffic conditions function. The TomTom My Drive site provides similar functionality but displays live traffic conditions only.

During model development vast amounts of data can be quickly checked using online data sources, from lane markings and parking restrictions to the specific details of road geometry or signage. However, online data sources should not be viewed as an alternative to site visits as material may be out of date and not representative of current on-street conditions. Instead, they offer useful supplemental information which can be confirmed later during site observations.

2.3.2 Site Visits

All models are developed using calibration data, which needs to be collected in the form of site observations and on-street parameter measurement. The quality of the final model, and any analysis derived from it, depends on the data used during model development. The consistent collection of data is paramount in ensuring the accuracy of any traffic model.

Data on its own does not provide enough information to develop an accurate model. The correct interpretation of the data requires a thorough understanding of on-site conditions. This understanding can only be acquired through visiting the site during each period for which a model is being developed. These site visits should include the collection of some of the more complex information which can only be undertaken by someone with appropriate knowledge and experience.

As described in B2.3.1, it is important to verify the accuracy of any drawings or aerial photography used during model development, to ensure their content accurately represents current site layout and appearance.

Site-specific parameters should also be recorded for all periods of the day for which the models are being prepared. Common examples of observations that can be noted or measured during site visits in order to replicate the network conditions are listed below:

- Junction / network layout;
- Link lengths, lane widths and pedestrian crossing distances;
- Lane / road markings and usage;
- Merging and lane changing areas;
- Cycle infrastructure, including cycle lanes (both segregated or mixed traffic conditions), cycle feeder lanes, Advanced Stop Lines (ASLs) and cyclist signals;
- Interaction of cyclists and general traffic / buses;
- Lane changing areas;
- Cruise times;
- Saturation flows at stoplines;
- Give-way behaviour;
- Visibility issues;
- Vehicle, cyclist or pedestrian spot counts;
- Right-turner storage and blocking effects;
- Flare lengths and usage;
- Vehicle usage of the flashing amber period at Pelican crossings;
- Fanning and funnelling;
- Exit-blocking;
- Bus lanes, hours of operation;
- Bus stop location and, type (layby / within traffic lane / floating) and bus stop dwell times;
- Car parks, street parking and interference during parking manoeuvres;
- Restrictions on the network (including parking, stopping and loading);
- Taxi ranks;
- Speed limits;
- Roadworks and other incidents, and their impact;
- Degree of saturation (DoS) and Underutilised Green Time (UGT) measurements, including noting the cause;
- Journey times (for both private and public transport); and
- Locations and lengths of queues.

Whilst many of these parameters can be measured in quantifiable terms, it is also important to record general site observations that capture more subtle behaviour exhibited within the study area. It can be useful to note where traffic behaviour does not reflect street markings or the intended geometric design of a junction, for example where ahead-moving vehicles use a dedicated left-turn lane.

2.3.2.1 Sample Size

When measuring data, it is necessary to obtain a sufficient number of measurements to give confidence that average values collected are representative. For most data types it is recommended that a minimum of ten measurements are collected in order to obtain a suitable sample. Where the data being collected shows a large variation on street, a higher number of readings may be required in order to capture a representative average. Where a large variation in values is recorded, the sample size can be determined by achieving an accuracy level of ±10% (at 95% confidence level). In some cases fewer measurements may be appropriate, such as when recording link lengths and crossing distances.

Many parameters are time-dependent and should therefore be recorded for each period being modelled. For example, effective flare usage can vary at a site as a result of differing traffic patterns through the day. In order to achieve an overall measurement that is representative and to avoid difficulty during model validation, data sampling should be distributed across the whole of each period during which the measurement is being collected. It can be useful to check surveyed measurements compared to other available data sources to ensure they are representative of the peak hour. For example, when collecting on-street measurements it is useful to compare the proportion of results collected during cycles where demand-dependent stages were called compared to the demand dependency data supplied from the UTC system (see section **B2.3.8.5**). In the case of exit-blocking, it is important that the proportion of measurements collected whilst a junction is exit-blocked is representative of typical exit-blocking during the surveyed time period and that this is not the result of a network issue elsewhere in the network, as discussed in the next section.

2.3.3 Typical Traffic Conditions

Where data needs to be collected on site, it is necessary to ensure that network conditions are typical, that traffic signals are operating normally and that there are no unusual activities or travel patterns taking place. Possible disruptions include, but are not limited to:

- **Day of week behaviour** – a neutral day should normally be chosen, typically a Tuesday, Wednesday or Thursday;
- **Planned events** – such as roadworks, demonstrations, ceremonial events, festivals, temporary road closures, public holidays and school holidays; or
- **Unplanned events** – such as traffic incidents, temporary loss of UTC control (local control), and temporary use of atypical (UTC or non-UTC contingency) timing plans or traffic management strategies.

Data should be collected for all critical time periods being studied, which may include a pre-peak warm-up period. The following time periods should usually be considered:

- AM peak;
- PM peak; and
- Inter-peak, late evening or weekend peaks, where there are significant levels of traffic.

The above list is not however exhaustive, and additional or multiple time periods may be required depending on site-specific traffic patterns, flow profiles or project-related interests. The start time and duration of each peak period will also vary. Variation in peak periods may occur between sites within the model boundary, therefore sufficient time periods should be surveyed to capture the overall peak period for all sites to be modelled.

NPD should be consulted when determining a programme for on-site data collection. It is necessary to check that normal traffic control conditions are expected during the planned survey times and this should also be confirmed once on site. Contingency dates should be set aside in case a scheduled survey has to be cancelled. NPD should also be informed in advance of any surveys so that they can monitor network conditions and capture average SCOOT timings if necessary (see **B2.3.8.3.1**).

2.3.4 Private Transport

Vehicle surveys are needed to capture specific data for calibration and validation purposes, to aid in Base model development. This section details some of the information that may be required for private transport.

2.3.4.1 Traffic Count Surveys

It is advisable that NPD is contacted before commencing road traffic counts to establish current best practice for data collection, and to ensure data formatting complies with TfL requirements. This is particularly important when surveys are not being carried out by those building the model, to ensure requirements are properly documented.

> The time and duration of the peak periods to be modelled will typically be determined by the survey count data. The peak usually represents the period showing the largest volume of observed general traffic, although other factors may be taken into consideration, including cyclist volumes, queuing and where congestion charging zones are included. The modelled peak period is commonly assumed as one hour, however longer peaks should be used where appropriate, such as in the case of larger traffic models where the peak on street is at different times in different locations.

Traffic counts should be classified by vehicle type and aggregated in 15-minute intervals. Classified turning counts should be obtained at each junction or, in the case of a network with complex route choice, an OD survey may be more appropriate. The chosen approach will depend on the road network being modelled and type of software being used for the project. Traffic surveys can be performed on site by manual counters, using fixed location video cameras or via Automatic Number Plate Recognition (ANPR) systems.

Wherever possible, traffic counts should be recorded on the same day at all modelled junctions and for all modelled periods. In some cases, it may be acceptable to use flow-factoring techniques, based on flows recorded during another representative peak, but authorisation should be sought from the MAE before applying this technique.

Site visits should be carried out during traffic count surveys to collect pertinent calibration and validation data. and to ensure that site conditions remain typical. These visits are important as journey time, degree of saturation and queue length surveys should ideally be conducted while traffic counts are taking place. Multiple factors may have a bearing on survey results, such as traffic management, and it is important that these are identified in addition to the usual weather and incident reports provided by survey companies. It is advisable to contact NPD to check the UTC system logs to determine whether any faults or non-timetabled operation occurred at the time of the traffic surveys.

Classified turning count surveys have inherent limitations. Before they are used in a model, a check must be made to see whether traffic leaving one junction arrives at neighbouring junctions. If there is a discrepancy of more than five percent between junctions, short site surveys should be undertaken to determine if there are other major sinks and sources of traffic (such as side roads or car parks) that were not captured in the original survey. If sinks or sources are found, 15-minute spot counts should be conducted to estimate hourly flow rates. Where a discrepancy exists, and no sinks or sources are discovered, a 15-minute spot count can be conducted to compare with surveyed flows to see if the original counts are reasonable. To get an accurate spot count, it is recommended that the flow is recorded over a whole number of completed cycles.

> Analysis of traffic flows across the whole network may highlight a particular count site as being in error, for example if flows at neighbouring survey sites are out by a similar value. Where a manual counting error appears to have been made, a general rule is to take the larger flow count from adjacent survey sites as being accurate, as it is more common for errors to result in under-counting than over-counting. This also represents the worst case as far as the network is concerned, as the largest observed flow will be modelled.

2.3.4.1.1 Passenger Car Unit

Traffic is composed of various types of vehicles, the range and relative composition of which can vary from location to location. Traffic modelling software packages frequently use a common unit, known as the Passenger Car Unit (PCU), to represent general traffic. Common vehicle types are assigned a conversion factor so that an equivalent PCU value can be generated from classified vehicle data. Typical PCU values used for different vehicle types are shown in **Table 3**.

Where cyclists are present, their volume can have an impact on the calibration and validation of traffic models. As the volume of cyclists changes, their impact on traffic behaviour varies in a non-linear manner. The considerations to be taken into account when modelling cyclists are discussed in Chapter **C2** on **Cyclist Modelling**.

Table 3: Passenger Car Unit (PCU) values for various vehicle types

Vehicle Type	PCU Value
Pedal Cycle	0.2 [47]
Motorcycle	0.4
Passenger Car	1.0
Light Goods Vehicle (LGV)	1.0
Medium Goods Vehicle (MGV)	1.5
Buses and Coaches	2.0
Heavy Goods Vehicle (HGV)	2.3

2.3.4.2 Cruise Times / Speeds

Cruise times reflect the typical non-delayed time taken for a vehicle in the middle of a platoon to travel from stopline to stopline, as would be the case if there were no traffic signals to cause a reduction in speed. Cruise times should be used as an input into traffic models whenever possible as they tend to be more accurate than cruise speeds, which could lead to incorrect offsets being calculated during signal timing optimisation. In some cases however, depending on the model type, purpose or project-specific considerations it may be appropriate to carry out a dedicated speed survey.

It may prove difficult to obtain accurate free-flow cruise times in congested conditions. If congestion prevents data collection it is therefore advisable to measure free-flow cruise times outside of peak hours. An alternative approach is to measure the cruise time for a free-flowing section on each approach, and extrapolate a value for the whole distance, based on the relative lengths of the free-flowing and congested sections. If persistent congestion always prevents cruise time measurement in a particular location, it may also be acceptable to measure cruise times for vehicles travelling in the opposite direction, but this should be noted in accompanying technical reports.

Full cruise time measurements may not possible when the downstream stopline is not visible (this may be due to a bend or significant distance). In this case the measurement can be divided into segments using an arbitrary

47 Research undertaken for TfL by TRL has indicated that a constant value of 0.2 PCU for cyclists may be an oversimplification, and could in fact vary based on cycle infrastructure[114]. See Chapter **C2** on **Cyclist Modelling** for further information. It is accepted that a value of 0.2 PCU should generally be assumed unless agreed otherwise with NP.

reference point, with segment journey times summed to obtain a total journey time for the full cruise time, or two surveyors can collaborate to choose a particular vehicle and communicate progress along the link between stoplines. A good sample is needed to develop confidence in the model results so it is recommended that a minimum of ten readings is taken on site to obtain a mean average, however more readings may be required if significant variation is observed. Refer to section **B2.3.2.1** for further information on sample sizes.

2.3.4.3 Journey Times

Journey times are usually measured between arbitrary reference points for the purpose of model validation, and may cover longer distances and multiple stoplines. All journey times should be collected under normal network conditions, free from incidents and events. Surveying should ideally take place at the same time as the traffic surveys, however, where this is not possible, the traffic conditions should be similar. It may be necessary to conduct journey time surveys over several days depending on the size of the network. If collecting journey time data over several days, similar neutral days should be chosen.

In recent years, GPS-tracked vehicle data has become more widely available for private transport journey time measurement, giving a much wider choice of survey dates, times and distances. In particular, it is possible to get an average journey time over multiple days, which provides a more robust value to validate microsimulation models against. ANPR is also now more accessible due to fixed cameras being routinely used for journey time monitoring along the TLRN, and temporary cameras can be installed by survey companies.

Where it is not possible to source GPS or ANPR data, the 'floating car' technique should be used. This involves one or more survey cars driving along prescribed routes within the modelled area and recording travel times between pre-defined points. These points are typically, though not exclusively, signalised stoplines or give-way road markings. The survey car(s) should attempt to balance the number of vehicles overtaking with those being overtaken, while remaining within the speed limit. Where stoplines are used as a datum, segment journey time measurements should begin and end immediately after crossing the stopline. These segmented journey times provide valuable information with respect to signal coordination and queue delay, which can become useful during later model development.

Multiple repeat journey time observations should be collected for each route, during each peak period. Since journey time observations vary greatly in the real world, a sufficient number of observations should be made in order to show an accuracy of ±10% (at 95% confidence level). This accuracy level will determine the required sample size of observed journey times. There may be a practical limit of how many journeys a single vehicle can complete within a survey period, which should be taken into account when planning survey resources. Collecting multiple repeated journey time observations also allows an analysis of journey time variability (range, maximum, minimum and standard deviation). This information is useful to compare against model outputs during Base model validation. Refer to section **B2.3.2.1** for further information on sample sizes.

2.3.4.4 Queue Lengths

Queue length data can be useful for model calibration at locations where queues persist from one signal cycle to the next, and also to support models of priority junctions and roundabouts (discussed in section **B2.1.1.1**) where other validation data such as Ratio of Flow to Capacity (RFC) is difficult to measure. However, for priority junctions and roundabouts, there is greater variation in queue lengths and so ideally queue lengths should be surveyed and averaged over multiple days. Surveyed measurements at signalised sites are normally taken at a consistent point in the signal cycle (for example at the start of green), specified for each traffic lane and measured in metres or PCUs.

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

In order to try and collect maximum queue length data on street, it is best to stand at the back of the queue at the start of green. Where vehicles will start discharging at the front of the queue and vehicles are joining the back of the discharging queue, the maximum length of the queue occurs at the point where an arriving vehicle is no longer delayed by the back of the discharging queue. If there are no arriving vehicles, then the maximum queue length remains the queue at the start of green.

It should be noted that queue lengths are not generally used for model validation, as explained further in **B2.4.2**.

2.3.5 Public Transport

The proposed scope of a traffic model will determine the level of detail required for public transport modelling and should be evaluated through discussion with the scheme Promoter (section **A4.4**). All fixed public transport stopping points and routes within the modelled area during the period of study should be noted, including any rail replacement services that may be in operation. Route maps available from TfL[48] can be used to verify routes and stop locations, although this data must be confirmed on street before it is used in any modelling.

Since 2009, all London buses have had iBus technology installed. iBus is the system that collects real time bus information as buses travel along their routes, which is used to provide real time bus arrival information at bus stops for passengers. The iBus system also records a variety of operational data that can be used for model calibration and validation, which will be discussed in the following sections.

IBus data can be requested from TfL, but any requests must go through a TfL sponsor to ensure the request is valid and formatted correctly.

In central London some coach services operate as bus services, as they have their own routes, timetables and bus stops. This information is not included in the iBus data, so the data should be collected by visiting the relevant service provider's website. Examples of some of the services found within central London are: Big Bus Tours, City Sightseeing, Golden Tours, Green Line and Oxford Tube.

2.3.5.1 Bus Journey Times

iBus data includes multiple journey times between each bus stop pair for each route. Individual bus journey times are averaged to create a mean observed journey time for each stop-to-stop section. Depending on the level of detail required from the model, compiling stop-to-stop journey times or full route journey times is acceptable. An iBus section covers the exit of one bus stop to the exit of the next, including the dwell time at the second bus stop.

Alternatively, where iBus data cannot be obtained, multiple repeat journey time observations should be collected for each route, during each peak period. Where more than one public transport service follows the same route, it is useful to undertake multiple journey time measurements for

48 **http://www.tfl.gov.uk/maps/**

each service to derive a service-specific average journey time. For further guidance on sample size refer to section B2.3.2.1.

2.3.5.2 Bus Stop Usage and Dwell Times

Bus stop usage should be examined during site visits because the layout of a stop, as indicated on site drawings, is not always indicative of how it is used on street. It is useful to consider the interaction with general traffic or other buses that occurs when a bus is waiting at a stop, for example it can be observed whether approaching traffic can pass a stationary bus or whether they give way to oncoming vehicles. This can have an impact on road capacity, and hence journey time validation, for both private and public transport.

Similarly, in order to accurately replicate bus journey times it is important to account for the dwell times of routes using the stop. The dwell time can include passengers alighting, buses waiting due to driver rest stops, driver changeovers and extended layovers used to regulate a timetabled bus service. Depending on the model purpose and type, such as when carrying out dedicated pedestrian modelling, it may also be necessary to capture detailed information on boarding and alighting passengers.

iBus data measures dwell times for each specific bus route, for each full hour, giving a mean actual dwell time for each bus stop. The dwell time given in iBus data is for the destination stop for each section.

2.3.5.3 Bus Lane Usage

The distance at which a bus lane terminates before a junction should be observed during network familiarisation. Bus lanes influence the amount of available road space for general traffic. The methodology used to model bus lanes will vary according to the modelling software being used, and should be examined on a site-by-site basis. It is also useful to note the frequency and volume of buses, cyclists, motorcyclists and taxis using a bus lane especially as, within London, the hours of bus lane operation can vary by day of the week.

2.3.6 Cyclists

Cyclists should be included in any modelling work, especially in inner London, unless there is good justification for omitting them.

2.3.6.1 Cyclist Counts

The most straightforward data collection exercise for cyclists is manually classified counts, in which the number of cyclists can be counted for all movements. This approach is ideal for individual junctions, but more complex for multiple junctions. Cyclist flows are unlikely to balance between junctions, as cyclists can start and end their journeys at almost any point in the network. For further detail on collecting cyclist flows and routing, refer to Chapter **C2** on **Cyclist Modelling**.

2.3.6.2 Cyclist Journey Times

Analysis of cyclist journey times can help inform decision making for schemes to support the Mayor's Transport Strategy[49]. Journey time data can be obtained from GPS fitness apps, although alternative methods are possible.

Observed cyclist data from GPS tracking typically provides cyclist counts and speeds by hour and direction across London. The data is transformed by TfL to align to Ordnance Survey's MasterMap Highways Network (formerly ITN). Highways Network edges represent the area of the network between junctions. The data can be aggregated to provide average travel times and counts by edge and hour for each month, as well as summing edges together between junctions. Median average travel times are used as they are less sensitive to outliers.

Any data obtained from GPS sources should be used for indicative purposes, as they may not be directly comparable to modelled data due to cyclist behaviour. This can be observed when some cyclists disregard red signals, which increases their speed between junctions.

2.3.7 Pedestrians

Pedestrian demand is not usually measured during traffic surveys for TfL unless detailed pedestrian modelling is to be carried out, or where there are significant informal or unsignalised crossings that affect vehicle behaviour.

49 Mayor of London, Mayor's Transport Strategy, March 2018

When examining UTC facilities an appropriate proxy for pedestrian demand is the appearance of pedestrian stages. The frequency of appearance can be obtained from UTC via demand dependency data, as described in **B2.3.8.5**, which can be used for calibration in each modelled period. For non-UTC junctions, the frequency of pedestrian stage appearances should be recorded during traffic surveys.

Toucan and Puffin crossings operate with on-crossing detectors, which allow pedestrian-to-traffic intergreens to vary between minimum and maximum values. The presence of these facilities should be determined during network familiarisation. Where they are operational it is necessary to gather information during traffic count surveys so actual timings can be interpreted to determine average stage and interstage durations. This data can be interpreted directly at Pelican crossings where pedestrian stages operate using fixed minimums as specified on Timing Sheets, however there is a requirement to calibrate the use of the flashing amber period by traffic.

It should be noted that some pedestrian crossing facilities can be operated using UTC timing plans with force bits (see **B2.3.8.3**). In those situations, it is possible for pedestrian stages to operate for longer than their minimums. It is possible for demand-dependent pedestrian stages to have forced demand (DX) within UTC plans, where pedestrian stages can be called without demand being present on street. This can be used for safety reasons or as part of a traffic management strategy. The timing plans of all pedestrian crossing facilities should be analysed to understand the UTC control method.

2.3.8 Signal Timings

Traffic modelling relies heavily on the accuracy of signal timings to correctly represent capacity at signalised intersections. This section briefly describes how signal timing data should be extracted to accurately reflect on-street operation.

> Signal timing data must be captured at the same time as other traffic surveys, and should be recorded separately for each modelled period.

2.3.8.1 Basic Principles

Specific concepts and signal controller terminology should be understood prior to commencing a modelling project. Detailed background information on the basic principles of traffic signals are detailed in the Traffic Signs

Manual[50]. The key terminologies which are applicable to this document include:

- **Phase** – A set of associated movements that are simultaneously controlled by the same traffic signal indication;
- **Phase Minimums** – The minimum amount of green time that can be allocated to each phase;
- **Intergreen** – The safety period between conflicting phases losing and gaining right of way;
- **Stage** – The period during which a group of non-conflicting phases all receive a green signal;
- **Stage Minimums** – The minimum period that a stage is required to run, in order to satisfy the minimum green requirements for all phases in the stage;
- **Interstage** – The period of time between the end of one stage and the start of the next stage, defined when all phases within the stage have received a green signal;
- **Phase Delay** – The adjustment of phase end or start times within the interstage period. These can be defined as Phase Losing delays, where a phase losing right of way is extended into the interstage period to maximise capacity, or Phase Gaining delays where a phase which gains right of way is delayed, generally for safety reasons;

  It is important to note that controller manufacturers have different methods of defining the operation of phase gaining delays. When building a model it is important to note the controller manufacturer's details and how they document phase gaining delays to ensure phase timings are accurately reflected.

- **Cycle Time** – The time period required to complete the full sequence of stages in a signal timing plan;
- **Offsets** – The time displacement between phases or stages at adjacent signalised sites; and
- **Method of Control** – The collection of stages available to operate a junction in order to allow each phase to receive a green signal. This

50 Traffic Signs Manual – Chapter 6 "Traffic Control", Department for Transport, 2019, Chapter 6

can include optional contingency stages that cater for special traffic conditions.

The above list is based on UK signal terminology, however it should be noted that Aimsun Next uses alternative signal terminology which is defined in

Table 8 in Chapter B3 on Aimsun Next Modelling. Key signal information for a signalised site is contained within the site's Timing Sheet and Controller Specification documents, as described in B2.3.1.

2.3.8.2 Types of Signal Control

In general terms, the control of traffic signals can be split into two groups: Urban Traffic Control (UTC) and non-UTC. UTC coordinates the operation of junctions over an area through use of timing plans implemented by a central computer. Non-UTC signals operate under local control, where timings are stored locally on each controller and activated according to a pre-defined timetable.

UTC traffic signal control can be further classified into:

- **Fixed Time (FT)** – These facilities operate fixed signal timings via set plans that are changed by time of day; and
- Split Cycle Offset Optimisation Technique (SCOOT) – These facilities operate via an adaptive system that uses an algorithm to constantly optimise the green split, junction offset and region cycle time for a group of coordinated signals, based on local traffic demands.

Locally controlled, FT and SCOOT sites can all support demand-dependent traffic and pedestrian stages (covered in **B2.3.8.5**), which only appear if demanded by pedestrians or traffic requiring these stages. In the event of non-appearance the demand-dependent stage times can be reallocated to other stages, according to the pre-determined fixed plan structure in the case of FT sites and with the possibility of being more intelligently reallocated under SCOOT depending on local traffic demands.

Furthermore, System Activated Strategy Selection (SASS) and Selective Vehicle Detection (SVD) bus priority are dynamic signal control methods applied within the UTC system for traffic management purposes. When in operation they can trigger pre-determined traffic management strategies based on traffic levels, or vary signal timings according to bus arrivals. It should be determined whether SASS or SVD bus priority is present during network familiarisation. If they are active then it is advised that NP be consulted to determine the best approach for modelling, either to capture average signal timings or more accurately replicate dynamic UTC operation in a microsimulation model with a UTC interface (discussed further in **B7.4.5.3**).

The Surface Intelligent Transport Systems (SITS) programme began in 2014 and aims to respond to the future challenges that face London's road network. The Real Time Optimiser (RTO) will replace TfL's Urban Traffic

Control (UTC) system, it's SCOOT system and Fast-UTC functionality. The RTO system will contain both the SCOOT traffic signal optimiser and the Fusion optimisation algorithm, which will replace SCOOT through a gradual migration programme. The optimiser will behave differently to 'baseline' SCOOT and is able to consume richer data sources to make more intelligent, policy-responsive, multi-modal optimisation decisions. Strategy Manager (StratMan) is the component within RTO that will replace TfL's existing SASS functionality, which automates changes to the operation of traffic signals based on data, performance, and operational status of traffic signals.

2.3.8.3 UTC Junctions

The primary function of the UTC system is to transmit stage change events via timing plans to on-street controllers, which then adjust the amount of green time available for each stage. The UTC signal timing plan details the required stage sequence to be operated within the controller. To do this, the UTC system sends a request to the controller to change stage (force bit), and once the stage change has occurred the controller replies with a confirmation (reply bit). All signal timing plans follow a similar format, which specifies the target controller, the plan number, cycle time, and stage change event times. Closely associated junctions that are under SCOOT control can be grouped together within UTC timing plans (multinodes) to maintain safety-critical offsets, for example where parallel pedestrian streams are positioned on the exit to a junction.

> The process used by NPD to extract on-street signal timings from UTC requires a skilled resource. It is beyond the scope of these Guidelines to detail the process required to manually calculate and audit derived signal timings. The exact approach requires prior knowledge of the UTC control type used to operate the signalised junction.

Fixed time signal timings can be extracted directly from UTC plans as these facilities operate using a constant cycle time with a repeatable sequence of stages and stage lengths. The interpretation of force and reply bit information can therefore be conducted once demand-dependent stage data has been captured, as described in section **B2.3.8.5**. Once all data has been collated it is necessary to translate the stage sequence, as defined by the signal timing plan, to understand where time has been allocated within an average cycle.

2.3.8.3.1 Average SCOOT Timings

It is possible to model full dynamic SCOOT behaviour in a microsimulation environment using TfL's UTC-Vissim interface, which provides full flexibility to test operational traffic management strategies. Where microsimulation models are not being used to replicate dynamic SCOOT behaviour, it is necessary to generate an average timing plan for each SCOOT junction. UTC timing plans must not be interpreted directly when SCOOT is in operation, since SCOOT is an adaptive system which optimises signal timings. Stage durations, offsets and cycle times are therefore able to fluctuate throughout the period being modelled.

To create an average plan, it is necessary to log dedicated SCOOT messages during traffic surveys. These allow the three variable elements (cycle time, stage length and offset) to be recorded for relevant signals, allowing the determination of representative average timing plans for modelling purposes. The following are typically recorded:

- Messages detailing the SCOOT stage pulse points and SCOOT node cycle times, commonly referred to as 'M16' messages;
- Messages detailing the offset between SCOOT stages in seconds, commonly referred to as 'M18' messages; and
- Messages detailing controller stage timings, including the preceding intergreen length and green duration in seconds, commonly referred to as 'M37' messages.

However, multinode relationships may exist within SCOOT to fix stage durations and offsets between separate nodes. Modellers should also be aware that the stage lengths recorded and displayed within M16 and M18 messages are the lengths of SCOOT stages rather than controller stages as defined in **B2.3.8.1**. For this reason, it is a necessary to analyse UTC signal timing plans to understand the relationship between UTC and SCOOT staging prior to extracting average SCOOT signal timings.

SCOOT has the capability to vary region cycle times for groups of coordinated signals, and can provide individual sites the opportunity to double-cycle compared to others in the group. Before collating cycle time information, it is necessary to establish whether any signalised facilities were single-cycling or double-cycling during the modelled period. The average cycle time for each SCOOT node can then be determined. The average controller stage lengths should then be calculated in proportion to the average cycle time, while noting any fixed-length stages defined in the plan. Average controller stage to controller stage offsets can then be calculated and applied for each modelled site according to the defined SCOOT / controller stage relationships.

2.3.8.4 Non-UTC Junctions

Non-UTC signalised sites are operated by the junction controller rather than a centralised system. These facilities are controlled using Cableless Linking Facility (CLF), Microprocessor Optimised Vehicle Actuation (MOVA) or Vehicle Actuation (VA).

CLF-controlled sites operate using timing plans stored locally within the controller. CLF control plans are detailed on Controller Specifications, which should be collated for all sites during network familiarisation. CLF plans are analogous to Fixed Time UTC plans, making it possible to extract average signal timings using a similar method to that described in **B2.3.8.3**. It is advisable to check the accuracy of CLF timings derived from Controller Specifications with NPD, to confirm they are up to date and as running on street.

MOVA and VA allocate green times to different traffic movements between defined minimum and maximum limits. Vehicles detected by the controller during a green phase extend the green period until a gap exceeding a critical value is found, or the maximum is reached. MOVA expands upon VA control, by working in uncongested traffic conditions to disperse queuing and minimise stops and delays for traffic using the junction. Therefore, an approach will not extend its green time unless there is a benefit to the whole junction. In congested conditions, MOVA optimises the signal timings to maximise junction throughput while taking account of oversaturated approaches. MOVA and VA signal timings are not based on structured plans and there can be many different phasing and staging arrangements. When modelling MOVA or VA junctions, further advice should be sought to ensure that operation of the junction is correctly interpreted. In some instances, it may be possible to obtain signal timing logs from these sites directly from the controller, however it is more common that average green times will need to be observed on street. If possible, replication or close approximation of full MOVA or VA behaviour and functionality in a microsimulation model is preferable to use of average timings.

2.3.8.5 Demand-Dependent Stages

A signal controller registers the presence of on-street demands when activated by vehicle detectors or pedestrian push-buttons, and ensures that the stage containing the relevant demand-dependent phase will be called at the next available opportunity. An opportunity for demand to be served is determined by the stage sequence embedded within the controller logic (in the case of VA or MOVA) or signal timing plan (in the case of UTC or CLF). The number of opportunities available for a demand-dependent stage at UTC or CLF-controlled sites is broadly based on the signal timing plan structure and overall junction cycle time. When a demand-dependent stage does not appear within a cycle the unused time will be allocated to one or more stages as defined within the signal timing plan. It is important to understand the signal timing plan structure to determine how the unused time is reallocated to alternative stages.

The UTC system monitors and records the appearance of demand-dependent stages, which can be analysed in 15-minute increments over each 24-hour period. The monitored counts provide the number of demand-dependent stage opportunities against the number of actual stage appearances. It is worth noting that the number of available stage opportunities may be variable under SCOOT control when a node is free to single-cycle or double-cycle. Advice from NPD should be sought if a node has the potential to single-cycle and double-cycle within one monitoring period, as additional cycle time data will need to be captured to calculate the correct number of available stage opportunities.

Demand-dependent stage frequency data for UTC sites can be requested from **AssetOperationsDataLegalRequest@tfl.gov.uk**. Demand dependency data is not available for sites under local control and will have to be measured on site.

2.3.8.6 Flared Approaches

A flare represents a lane at a stopline that is fully used for only a portion of the green time, even during fully saturated conditions. A flare therefore only contributes to stopline capacity for a limited period at the start of green, after which it provides no further benefit.

A flare can be physical (increased road space due to widening of the carriageway before a stopline), or effective (for example through termination of a bus lane or parking area before the stopline). Flares are a common source of modelling error; therefore, consideration should be given to if and how they should be modelled.

Flare length utilisation must be considered according to the proportion of vehicles using the flare, and models need to be calibrated so that flare usage reflects observed data recorded on site, as described in **B2.3.2**. Further guidance on flare layouts and calibration can be found in the software-specific chapters within **Part B**.

2.3.8.7 Non-Green and Flashing Amber

The time used by traffic during non-green or flashing amber periods can influence road capacity and this should be recorded on site and accounted for during model calibration. Additional capacity created by aggressive vehicle behaviour can be recreated within a traffic model but must be based on recorded evidence and identified for audit.

Non-green periods should be accounted for if vehicles are observed on site to behave aggressively at the stopline, for example by accelerating during the starting amber period or crossing a stopline after the start of red. Site observations should record the total time (in seconds) utilised by traffic during non-green periods for each peak period, although usage during the leaving amber period is expected and should therefore be treated as green, unless usage is being recorded separately for each non-green period. For Pelican crossings, traffic usage during the flashing amber period should also be recorded (in seconds) during site observations for each peak period being modelled. A good sample is needed to demonstrate confidence in the model results. For further guidance on data collection refer to section **B2.3.2**.

2.3.9 Saturation Flow

Saturation flow represents a key measurement of on-street capacity and thus the values used within a model must accurately reflect the built environment to correctly model junction performance.

Saturation flow, measured in PCU/hr, can be defined as:

> "…the maximum flow, expressed in equivalent passenger car units, that can be discharged from a traffic lane when there is a continuous green indication and a continuous queue on the approach." [51]

Saturation flow is an expression of the maximum capacity of a lane and is predominantly determined by junction characteristics (including geometry, layout, turning radii and visibility). The saturation flow input for a model should generally not be altered between models or modelled periods unless physical characteristics are modified, such as changes within a Proposed model. Saturation flows should only be altered for each time period where a lane shares more than one turning movement, and site observations have noted that flow patterns vary significantly across the day. In addition, for deterministic modelling, saturation flows may need to be reviewed across different peak periods if there is a significant change to the vehicle class proportion, such as an increased proportion of heavy goods vehicles.

Saturation flows are normally required for each individual lane that is modelled, although multiple lanes can be combined into a single measurement where modelled as a group, if they perform identically in terms of flow, vehicle destination and queuing behaviour. However, this also depends on the proposed use of the model – if, for example, lane usage is expected to change as a result of bus lanes, smart lanes or lane destination (arrow / marking) changes, then it would be necessary to measure each lane separately. If there are any doubts regarding proposals, and time allows, then each lane should be measured separately.

Where fully saturated traffic appears to discharge at a rate less than the saturation flow, such as due to driver behaviour or exit-blocking, this should not be accounted for by changing the saturation flow in a model. This behaviour is not always apparent to an observer when viewing traffic. Therefore, it is recommended that Underutilised Green Time (UGT) is measured to identify and quantify this behaviour, as explained in **B2.3.10.1**.

It is important that saturation flows are measured accurately. Incorrect saturation flows represent a common source of error which can cause delay during model development and auditing. A good sample is needed to

51 Salter R J & Hounsell N B, Highway Traffic Analysis and Design, 3rd Ed, Macmillan, 1996, p292

develop confidence in the model results, and it is recommended that the minimum length of each measurement should be 12 seconds[52]. Refer to section **B2.3.2.1** for further information on sample sizes.

Measurements should be conducted while vehicles are discharging across a stopline in free-flow conditions, and thus unaffected by downstream interference such as congestion or exit-blocking. Conditions need to be sufficiently busy that the link is saturated for an adequate period to allow measurement. The surveyor must be able to recognise the end of saturated conditions during each cycle. In some cases, due to insufficient flow or short green periods, it will not be possible to measure a minimum of 12 seconds of saturated conditions at any time of day. In these circumstances shorter measurements can still be recorded but should be identified in accompanying reports for the MAE, and their validity should be scrutinised by the CE before a MAP submission.

Saturation flow measurements should not include periods of 'lost time' at the start and end of green, as these represent time during which vehicles are accelerating or decelerating and therefore not moving at saturation flow. 'Lost time' parameters can be calculated, but it is unlikely exact values will be known unless recorded using a dedicated survey. It is therefore acceptable to use a default of two seconds start lost time and no end lost time. A common technique to account for start lost time is to ignore the first two vehicles to cross a stopline before recording saturation flow measurements. This prevents accelerating vehicles being counted towards measurements and causing underestimation of the saturation flow.

Situations may occur where satisfactory saturation flow measurement is not possible, for example due to insufficient traffic flows, green time or queuing. These should be assessed on a case by case basis and identified along with an explanation, including the reason why measurement was not possible and the alternative method used to estimate the saturation flows. An common method for estimating saturation flow based on TRL's Research Report 67 (RR67) is explained in the next section.

Careful consideration should be given to saturation flow measurements where cyclists are present on street, either in segregated or non-segregated facilities. For guidance on appropriate methodologies for collecting saturation flows including cyclists, refer to Chapter **C2** on **Cyclist Modelling**.

52 Binning J, Traffic Software News, TRL, September 2007, No. 43, p2

2.3.9.1 Use of Calculation Formula RR67

A method for predicting saturation flows using a standard formula was developed by the UK's Transport and Road Research Laboratory and published in its Research Report 67 (RR67).[53] This was based on analysis of empirical data collected at 64 sites spread across the UK, including 13 in London. RR67 allows saturation flows to be estimated based on geometric data such as vehicle turning radii, lane width and road gradient.

The use of RR67 can be necessary where it is not possible to measure saturation flows on street, such as for new proposals, where stoplines are frequently exit-blocked or where short green times or insufficient traffic queues prevent adequate measurement. Where congestion prevents measurement at a particular time of day it may however be possible to measure saturation flows for affected stoplines outside of congested periods.

While it may sometimes be considered appropriate to use RR67 for some non-critical stoplines, it is generally expected that saturation flows should be measured on street wherever it is possible to do so. Where it is not considered possible for measurement to be carried out at a specific location, an explanation should be provided in accompanying model reports.

> When using RR67, it is important to be aware of the limitations of this approach and any calculated values should be used with caution. If critical modelled saturation flows are not accurate, they are likely to result in modelling discrepancies when trying to validate the model.

Data used in the development of RR67 was restricted to sites classified as 'good' or 'average' in terms of junction performance as defined by Webster and Cobbe[54], with 'poor' locations excluded. A summary of the characteristics for these classifications are provided in **Table 4**.

Given the numerous sources of interference for traffic in London, such as heavy pedestrian movements, poor visibility and parked vehicles, many junctions would fail to meet the 'good' or 'average' classifications assumed by RR67. Use of the RR67 formula can therefore result in overestimation of saturation flows at many signalised junctions in London. A detailed study carried out by TRL in 2012 for TfL found that RR67 overpredicted saturation

53 Kimber R M, Macdonald M & Hounsell N B, The Prediction of Saturation Flows for Road Junctions Controlled by Traffic Signals, Transport and Road Research Laboratory, Department of Transport, Research Report 67, 1986

54 Webster F V & Cobbe B M, Traffic Signals, HMSO, Road Research Technical Paper No. 56, 1966

flows by an average of 15% in London compared to site-measured values.[55]

Table 4: Junction performance classifications based on Webster & Cobbe[54] and updated by TRL[56]

Classification	Characteristics	Example
Good	No interference from: • pedestrian activity • parked vehicles • opposed turning traffic • downstream congestion • upstream / downstream minor side roads Good visibility Adequate turning radii Good junction alignment Good exit width Good quality road surface	Dual carriageway
Average	Some characteristics of good and poor sites	-
Poor	Some interference from: • pedestrian activity • parked vehicles • opposed turning traffic • downstream congestion • upstream / downstream minor side roads Poor visibility Poor junction alignment Poor exit width Poor quality road surface Low average speed Traffic calming measures on entry or exit	Busy shopping street

Where RR67 is applied it is recommended to verify estimated values

55 Emmerson, P, Crabtree, M, Gibson, H, The estimation of saturation flows at traffic lights in London, and the impact of cyclists on saturation flows, Transport Research Laboratory, December 2012
56 **https://trlsoftware.com/support/knowledgebase/saturation-flow-food-for-thought/**

against measured data where possible. A factor should be calculated that accounts for local junction characteristics as compared to the 'typical' junction inherently described by RR67. This factor should be generated by calculating the RR67 predicted saturation flow for a similar stopline at the junction where measurement is possible and comparing against the measured value. This adjustment factor should be applied to predicted values for relevant approaches where measurements are not possible or practical.

Where there is difficulty in calculating an appropriate adjustment factor, an alternative 'rule of thumb' proposed by TRL[59] suggests:

- For 'poor' sites, reduce RR67 predictions by 15-25%;
- For 'average' sites, reduce RR67 predictions by 5-10%; and
- For 'good' sites, increase RR67 predictions by 10%

Whichever approach is used, any RR67-adjusted saturation flows should be highlighted in accompanying reports with appropriate justification for the MAE and audited by the CE during model calibration.

2.3.10 Degree of Saturation

Degree of saturation (DoS) is a key parameter for validating traffic models. We recommend that all those who measure DoS have a thorough understanding of the concept and how to accurately measure it on site. Intrinsic to this understanding is knowledge of the different factors that can influence DoS, both on site and in a model. This section describes the methodology required by TfL for measuring DoS. The method is designed to account for Underutilised Green Time (UGT), as defined in **B2.3.10.1**, which can be calculated from DoS measurements.

A DoS survey should be conducted on all critical approaches for each modelled period. Critical approaches would include those close to saturation, those that determine stage length and those key to scheme proposals. In order to achieve an overall measurement that is representative, data sampling should be distributed across the whole of each period during which DoS is being measured. As described in **B2.3.9**, multiple lanes can be combined into a single measurement only if they are modelled as a group and if they behave identically in terms of flows, destination and queuing. They should not be combined if lane usage is expected to change in Proposed modelling. If there are any doubts regarding proposals, and time allows, then DoS for each lane should be measured separately. For guidance on including cyclists in DoS collection, refer to Chapter **C2** on **Cyclist Modelling**.

2.3.10.1 Underutilised Green Time

Underutilised Green Time (UGT) corresponds to the number of seconds of effective green time within a signal cycle where saturation flow is not achieved, despite the presence of high demand (sometimes known as 'full' demand). High demand is defined as occurring when traffic is continuously passing or attempting to pass the stopline during a green period. UGT is measured in seconds per cycle and is calculated from data recorded during DoS measurement.

UGT is comprised of two elements:

- **Wasted Green** – which describes the period of a cycle during which an approach experiencing high demand receives a green signal, but traffic is unable to progress across the stopline (for example due to downstream exit-blocking); and
- **Sub-Saturation Flow** – which describes the period of a cycle during which an approach receiving a green signal does not fully utilise available capacity despite continuous demand, for example where vehicles fail to achieve the expected saturation flow. This effect can be caused by a number of factors such as signal offsets, downstream congestion or driver behaviour being influenced by issues including interaction with pedestrians, cyclists, buses, large vehicles, zebra crossings, parking, loading, or downstream lane markings.

At times traffic experiencing sub-saturation flow may only be travelling marginally slower than would be the case during unrestricted saturation flow. This may not be noticeable to an on-street observer, but its impact can be captured by calculating UGT following an appropriate DoS survey. UGT is calculated to quantify situations where congestion-related issues prevent discharge at an uncongested saturation flow. It is derived in a form that can be directly applied to available green time in traffic models such as LinSig or TRANSYT by using dummy staging, phase lags and/or bonus greens. It is important to record the potential causes of UGT, as this will determine how UGT values are to be dealt with in Proposed models.

If a negative UGT value is encountered, it indicates that the initial saturation flow measurement was inadequate and that further measurements are required. A negative UGT value highlights that traffic has been observed to discharge at a rate greater than the previously measured saturation flow during the DoS survey.

Figure 11 illustrates a flow profile measured on street for a lane in two different scenarios. The blue curve shows a flow profile for a stopline during uncongested conditions. The orange curve shows a flow profile for the same stopline, but under congested conditions. The shaded area between the curves therefore represents the reduction in flow across the stopline due to congestion.

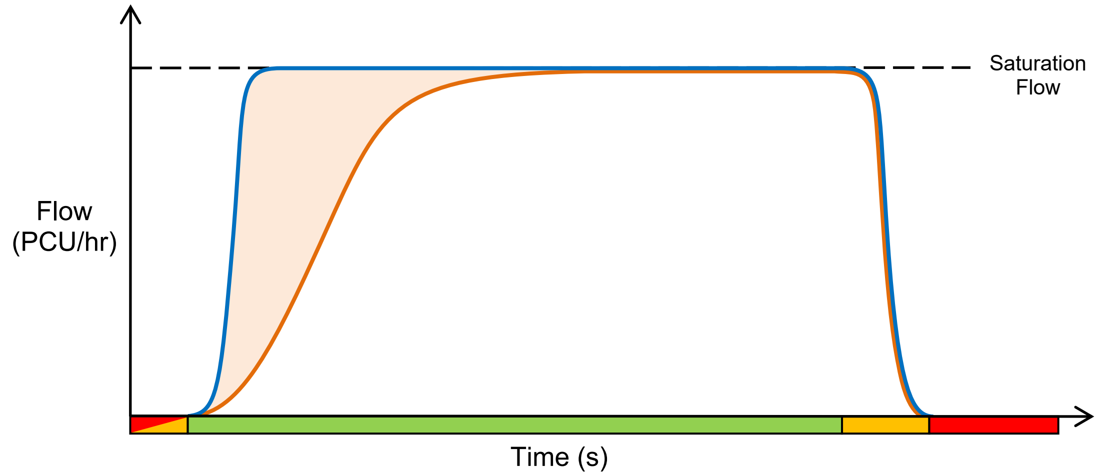

Figure 11: Flow profiles showing 'normal' (blue) and 'congested' (orange) conditions

Figure 12 illustrates how the shaded area, equal to that in **Figure 11**, represents the difference in capacity as accounted for by UGT (the time period during which full saturation flow was not achieved). It also illustrates how these scenarios will be modelled within deterministic traffic models such as LinSig or TRANSYT. UGT calculations are unable to discriminate between time periods where vehicles are 'slow moving' or where vehicles are stationary. This imitates deterministic traffic modelling software such as LinSig or TRANSYT, where vehicles are also assumed to be either stopped or moving at a saturated rate of discharge.

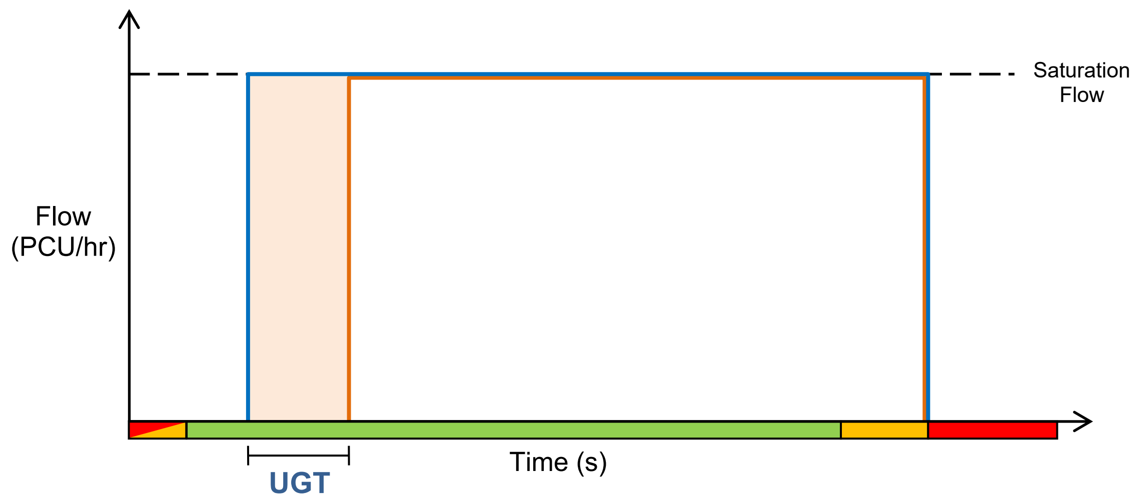

Figure 12: Congested conditions as modelled in LinSig or TRANSYT with UGT

It is advisable to apply UGT to model the effects of congestion, as this technique avoids the need for a modeller to iteratively adjust the saturation flow in a model during calibration and provides quantifiable evidence to justify the approach taken. Whilst it is possible to reduce the modelled saturation flow to achieve an effect analogous to the application of UGT, as shown in **Figure 13**, it is theoretically unsound as the applied saturation flow no longer represents the maximum rate of discharge across a stopline. If the length of effective green time is amended in a Proposed model, the adjusted saturation flow may therefore no longer be appropriate for the extended or reduced green time.

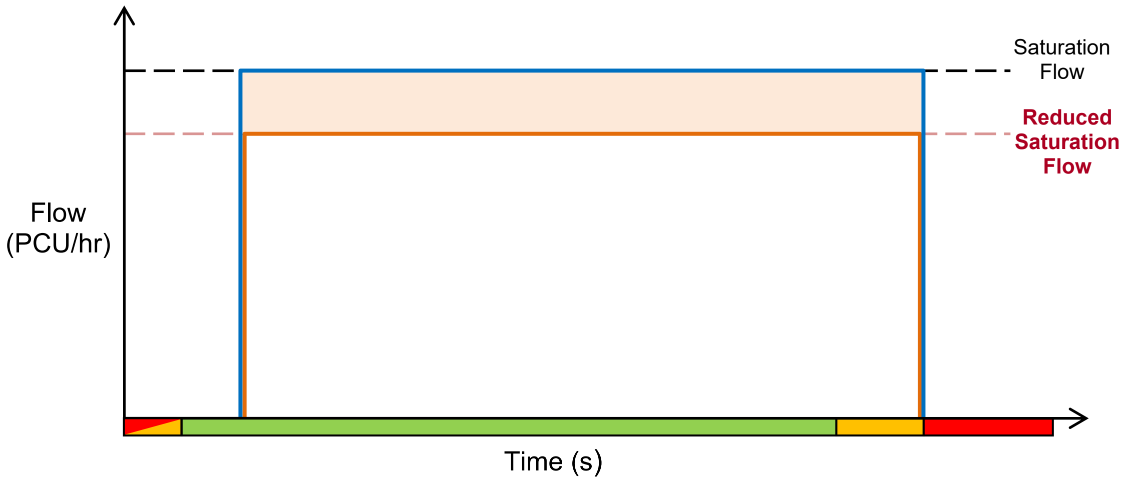

Figure 13: Incorrectly reduced saturation flow analogous to UGT applied in Figure 12

For further details on the calculation of UGT values using data recorded during DoS measurements, refer to **Appendix I**.

2.3.10.2 Measuring DoS

To calculate DoS the surveyor is required to measure the period of high traffic demand. Recognising high traffic demand can require experience, as at times a gap may develop between vehicles even though high demand is still present. This may occur where approaching traffic slows down before reaching a discharging queue, or where queued vehicles accelerate at different speeds. The definition of high demand and low demand periods is detailed below:

- **High Demand** – when a stopline with a green signal has more than two vehicles influencing each other's behaviour at the stopline. This would include discharging in a continuous platoon of vehicles, causing another vehicle to brake, queuing to cross a stopline, or waiting to exit a junction; and

- **Low Demand** – when vehicles behave independently and not as a single platoon of vehicles, commonly this will mean they can approach and cross a stopline without needing to brake for other vehicles.

Examples of high and low demand are shown in **Figure 14** and described in **Table 5**.

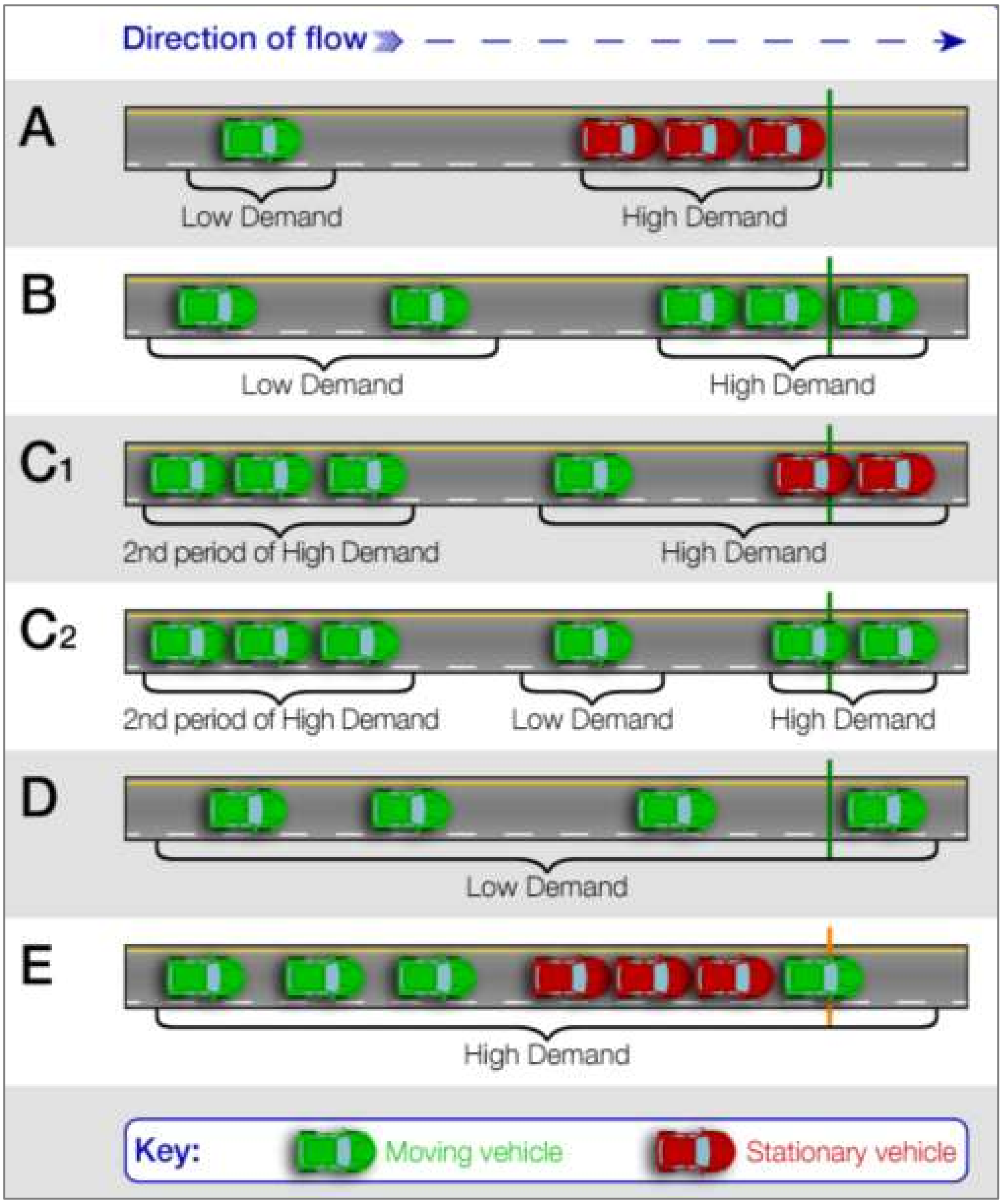

Figure 14: Diagram indicating periods of high and low demand

Table 5: Classifications for high and low demand examples shown in Figure 14

Scenario	Description
A	A queue of three stationary vehicles at the start of green will discharge under high demand, the single vehicle will arrive once the platoon ahead has discharged and will be classified as travelling across the stopline under low demand.
B	A platoon of three vehicles arrive at the stopline together creating high demand, two further vehicles arrive independently as low demand.
C1	Vehicles have a green signal but are waiting for the junction ahead to clear and are therefore creating high demand. A single vehicle then arrives on its own followed by a second platoon of vehicles arriving together. The isolated vehicle will begin to slow down due to the queue ahead and is therefore combined into the high demand period. Depending upon whether the queue at the stopline has cleared the second platoon will join the same period or form a new period of high demand.
C2	A similar situation to C1 but the vehicles ahead are beginning to clear the junction meaning the isolated vehicle will no longer be influenced by the queue and will therefore create low demand. As the situation is now free flowing the second platoon will form their own period of high demand when they reach the stopline.
D	All vehicles behave independently and are therefore classed as low demand.
E	Vehicles have begun to discharge from the stopline but approaching vehicles will join the queue or be delayed, forming a single unit of high demand.

It should be noted that the contribution of any short lane flare towards the duration of high demand at the start of the signal cycle should not be included.

The surveyor is required to record the time from the beginning of each period of high demand (this is from the start of green if a queue is present) until the end of high demand, during which they record the number of PCUs that cross the stopline. The end of high demand occurs when there is no further traffic queuing or flowing continuously at the stopline. The surveyor then records the number of PCUs that cross the stopline during any subsequent periods of low demand. The number of PCUs must be recorded separately during each period of differing demand type. Finally, the total length of the green period should be recorded.

If additional periods of high or low demand occur after the end of the first periods of high or low demand (possibly due to a second vehicle platoon arriving as a result of a closely coordinated offset), these should be recorded separately and added to the first periods of high and low demand in calculations (both in terms of high demand duration and PCUs crossing the stopline during the additional high and low demand periods). If in doubt about whether an apparent second period of high demand is fully saturated (for example where gaps may be seen), it is better to assume it as low demand.

In summary the following information should be recorded:

- Time at start of green;
- Time at start of high demand periods (if different from start of green);
- Number of PCUs crossing the stopline during high demand;
- Time at end of high demand periods;
- Number of PCUs crossing the stopline during low demand; and
- Time at end of green.

For further advice on the number of DoS measurements to be recorded, refer to section **B2.3.2.1**.

2.4 Base Model Development

The initial step in any modelling assessment is to build a model replicating the existing on-street traffic conditions at a given point in time. This Base model presents a baseline that can be used for comparison against Proposed scenarios. A Base model is created for each time period that requires assessment. By comparing results between the Base and Proposed situation, an informed decision can be taken on whether to proceed with the proposal based on its predicted impact.

The process for developing a Base model is detailed in **Figure 15**. The model purpose should be discussed at the onset of a modelling project as part of the Base scoping meeting described in **B2.1.5.1**. At this meeting key elements of the modelling project are discussed and agreed, as explained in **B2.2**. The agreed modelling requirements are subsequently documented in the Modelling Expectations Document for later reference, which is detailed in **B2.1.5.2**.

Following a period of on-site data collection, detailed in section **B2.3**, the Base model is updated and refined as part of the calibration and validation process (sections **B2.4.1** and **B2.4.2**). Once the software-specific validation criteria have been met and the model has been audited as part of the MAP process, as described in **B2.1.5**, it can be used for the assessment of future scenarios. Within the Three Stage Modelling Process, covered in **B2.1.4**, the development of a Base model involves production of deterministic, microsimulation and tactical models, and may involve interaction between the modelling levels as detailed in **Figure 10**.

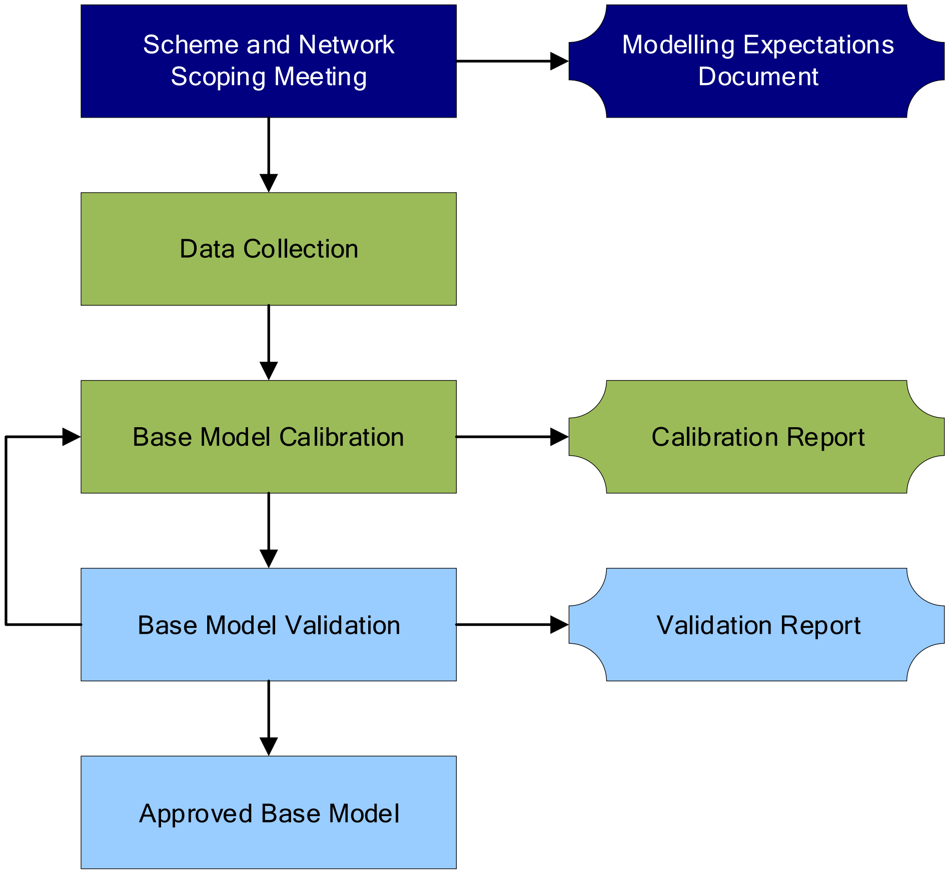

Figure 15: Schematic diagram outlining a generalised approach to Base model development for TfL

2.4.1 Base Model Calibration

Traffic models are as accurate as the calibration process undertaken during development. The most appropriate techniques for model calibration should be carefully considered, as accurately validated models form the basis for Proposed modelling.

The purpose of the calibrated model submission during MAP Stage 2 (**B2.1.5**) is to allow the developer and any model auditor to assess model structure, and the validity of initial input data. At this stage it is possible to identify and resolve issues that may otherwise hinder further model development. For this reason the calibrated model should be accompanied with tabulated data that clearly emphasises model inputs and how they were derived from measured sources.

Calibration describes the process of placing measurable data into a traffic model to replicate observed street conditions. All input data for calibration should be auditable, such as signal timings and on-street measurements (for example lane distance, cruise times and saturation flows). It is usual for this information to have been collected from on-street measurements as described in section **B2.3.2**. Calibration may require adjustment of model parameters to recreate observed behaviour, and for this reason the calibration process should be applied to each period being modelled.

MAP Stage 2, described in **B2.1.5**, defines the requirements necessary to generate a calibrated model. Refer to the individual software-specific chapters within **Part B** for detailed Base model calibration guidance.

2.4.2 Base Model Validation

Validation is the process of comparing model output against independently measured data that was not used during the calibration process. The purpose of validation is to verify that a model has been correctly calibrated, and that there is therefore confidence in its ability to produce valid predictions for Proposed scenarios.

As the overarching aim of validation is to produce a model that is fit for purpose, it is necessary to choose validation parameters that are relevant to the purpose of the model. The model developer should therefore agree suitable validation parameters (such as bus or cyclist journey times) at an early stage of model development and ensure they are recorded at the appropriate time, coinciding with site visits or traffic surveys where possible. Ideally the model developer should be actively involved in on-site data collection, to be satisfied that street conditions represent those which are to be replicated in the traffic model. Common validation parameters such as degree of saturation and journey times are used to show confidence that calibrated model results accurately reflect observed on-street behaviour. Queue lengths are generally not used for validation purposes due to the difficulty in measuring them on street, however comparing modelled levels of queuing to those observed on street can indicate where inaccuracies may exist in a model.

Validation criteria are used to demonstrate that modelled results fall within an acceptable tolerance of observed data. These criteria vary according to the modelling software used and are detailed both in MAP and relevant software chapters contained within these Guidelines. If a model fails to validate it is often an indication that poor data collection practices were adopted or that further model calibration is required. Results for the validation exercise must be taken from a model that accounts for measured demand dependency (**B2.3.8.5**) and the effects of

UGT (**B2.3.10.1**). Validated deterministic modelling and microsimulation models are submitted during MAP Stage 3, as described in **B2.1.5**.

2.5 Proposed Model Development

Proposed model development incorporates the proposal details into the modelling assessment process. Where the Three Stage Modelling Process outlined in **B2.1.4** is being followed, Proposed model development will include the creation of both a Future Base model and a Do Something model. These traffic models are used to analyse and assess the detailed impacts of the proposals so that an informed decision can be made on whether to implement them on street.

The process for developing Proposed modelling is detailed in **Figure 16**. The Proposed modelling process begins with a Proposal Scoping Meeting, to revisit and review the scheme proposals and to agree the Proposed modelling methodology, as described in **B2.1.5.1**. Following this meeting the Modelling Expectations Document should be updated to capture any changes, as described in **B2.1.5.2**.

Proposed models are modified versions of validated and approved Base or Future Base models. Any changes to the Base or Future Base model should be limited to the minimum required to represent the proposal, while ensuring that the model accurately reflects any changes which form part of the scheme. It is common for Proposed modelling to require interaction between different levels of modelling, as described in section **B2.5.5**. Once the Proposed modelling is approved, model outputs should be analysed and reviewed in detail.

On completion of Proposed modelling, reports should be produced to document the Proposed modelling methodology, as described in **B2.6**. NPD will use modelling outputs and analysis to make an informed assessment of the likely impacts of the scheme, and give recommendations to NIST in the SIR (described in **B2.6.5**).

As any proposal is a forecast there is no observable data to validate model outputs against. The validity of a Proposed model is therefore verified by analysis of the approach taken by the model developer, confirming that modelled adjustments from Base / Future Base models are appropriate and through scrutiny of Proposed model outputs.

Figure 16 illustrates the iterative process of using Proposed model results to analyse the predicted impact of scheme proposals. Modelling and/or scheme proposals can then be updated and reassessed as necessary, depending on the impacts predicted.

The remainder of this section details the processes undertaken to ensure that Proposed models are considered fit for purpose.

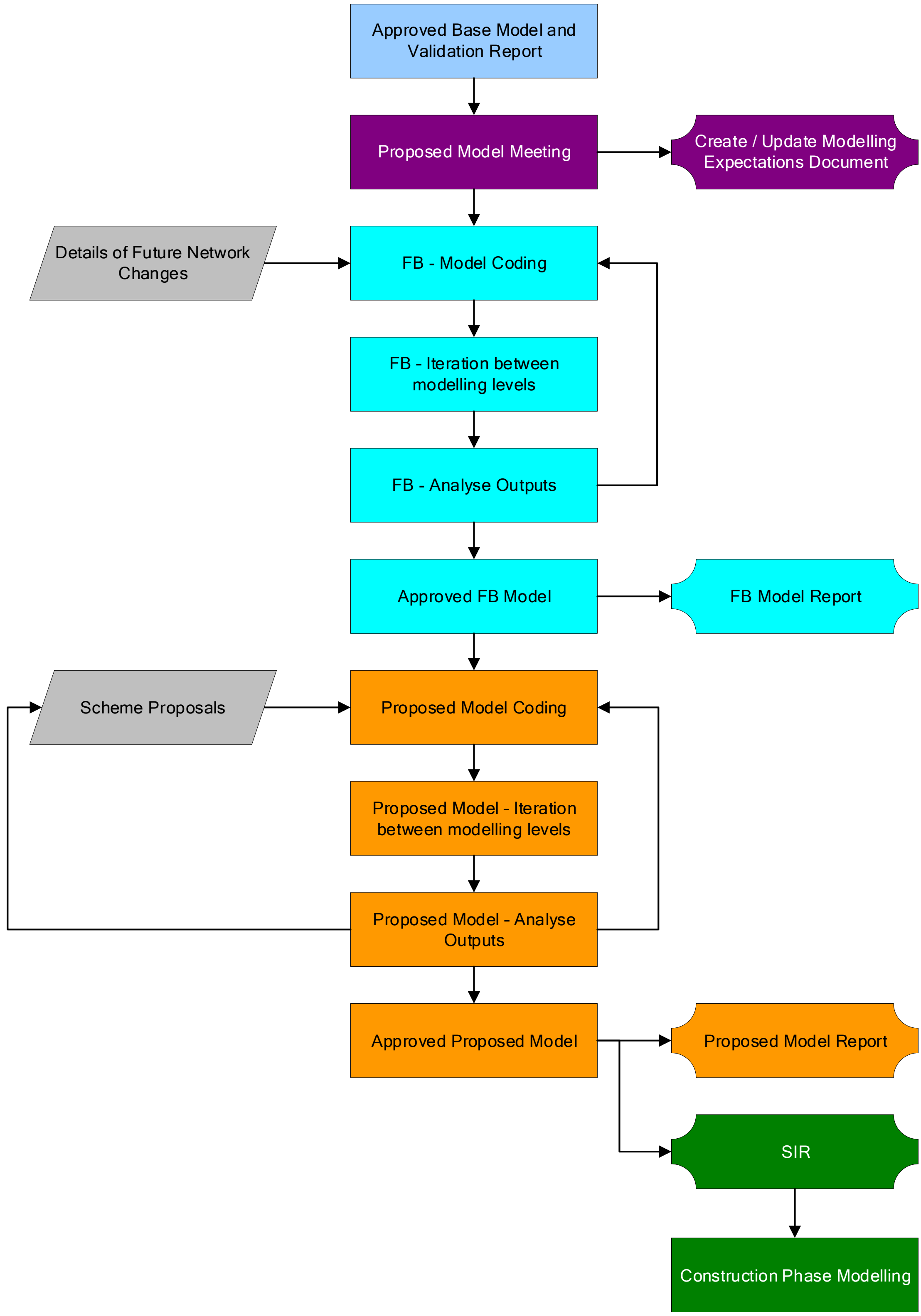

Figure 16: Schematic diagram outlining a generalised approach to Proposed model development for TfL

2.5.1 Future Base

The Future Base model represents the future year in which the scheme under consideration is planned to be implemented but does not include the scheme itself, as explained in **B2.1.4.2**. The key difference between building the Future Base and Do Something models is the addition of the scheme proposal.

A Future Base model is required for all schemes that are assessed using the Three Stage Modelling Process detailed in **B2.1.4**. The requirement for a Future Base model should be discussed and agreed at the Base scoping meeting described in **B2.1.5.1**. At the time of publishing, there is no dedicated MAP stage for Future Base models, however as the process of building a Future Base model is related and similar to that required to build a Proposed model, they should be developed and audited as part of MAP Stage 5, as outlined in **B2.1.5**.

To create a Future Base model, the approved Base model is updated to include any future network changes planned for implementation up to the future year being assessed. Schemes are included using the latest proposals available at the time of Future Base model development, and may be subject to change at a later date. The schemes to be included in a Future Base model, together with their current proposals, should be agreed at the Base scoping meeting. Any changes to the Base model should be limited to the minimum required to incorporate the planned future year changes.

The traffic flows in the Base modelling are likely to require updating to reflect the Future Base demand in the future year being modelled, which is covered in more detail in **B2.5.2.2**.

The guidance in **B2.5** applies equally whether creating the Future Base scenario or the Proposed scenario.

2.5.2 The Scheme Proposal

The Proposed model represents the year in which the scheme under consideration is planned to be implemented, and contains relevant changes to include the scheme itself. It is based on either the Base or Future Base models, depending on whether the Three Stage Modelling Process described in **B2.1.4** is being followed. The scope of a scheme proposal can vary from a minor adjustment of signal timings at a single site to a complete redesign of junction layouts and methods of control across a wide area.

Every proposal is unique, and it is beyond the scope of this document to list all the parameters that may need adjustment. It is the responsibility of the model developer to determine the changes that are required and to justify any applied methodology. Proposed changes that may need to be accounted for within a traffic model include:

- Physical road layout and geometry;
- Lane markings and usage;
- Saturation flows;
- Methods of control at signalised junctions;
- Signal timings;
- Signal staging;
- Signal hardware;
- Traffic flows;
- Traffic compositions;
- Effective flare usage;
- Demand-dependent stage frequencies; and
- Reassignment.

When producing a Proposed model it is important to consider the traffic management objectives of the scheme. Whilst overall network performance measures should be considered, these should not override considerations detailed in **A2.1** such as local policy requirements or the Mayor's Transport Strategy[57].

2.5.2.1 Changes to Junction Design

Modifications to junction designs or methods of control may typically require recalculation of phase minimums and phase intergreens. When calculating these, reference should be made to TfL's SQA-0640 document series[ii], which is covered in **A4.5.2.1** and details design standards for traffic signals in London. Of these, SQA-0644, details pedestrian minimum and intergreen timings for standalone pedestrian crossing facilities. Calculation of traffic phase intergreens must be undertaken in accordance with SQA-0645, which also covers minimums and intergreens for pedestrian phases at signalised junctions. Before any modelling can commence the proposed designs must be signed off by the SAE.

Layout changes within a proposed design may also impact saturation flows. Where existing saturation flows are affected by new issues such as pedestrian movements or parking, the impact of these should be

57 Mayor of London, Mayor's Transport Strategy, March 2018

accounted for in saturation flow values used within Proposal modelling. Where possible, saturation flows should be estimated using RR67 for the Base model geometry (section **B2.3.9.1**) and compared to the Base site-measured value. An appropriate factor for that approach can then be determined to apply to estimated RR67 values based on the proposed geometry.

It is recommended that changes to geometric inputs are assessed by processing a version of the Proposed model incorporating just these changes, before applying changes to signal timings or traffic flows. This will indicate a rudimentary estimate of the impact of physical design changes on the performance of the study area.

A Proposed model should supply junction design information to a level of detail that allows the production of a Controller Specification. In order to reconcile phase-based signal design with stage-based minimums and interstage design it is recommended to use junction design software such as LinSig, and to supply these models with any submitted proposal. Inclusion of these controller models within a proposal provides a clear indication of how stage minimums and interstage designs were calculated and optimised.

Where critical offsets exist within a Base model, such as at closely associated junctions or SCOOT multinodes, it is vital that these are coded accurately. Any fixed relationships should be audited to ensure correct groupings are carried forward into any proposal.

Consideration should always be given to pedestrian linking during junction design. Pedestrian progression through a junction can be assisted by linking pedestrian phases, for example using an associated parallel stage stream pedestrian crossing. Designers should be mindful of optimising phasing and interstage design to maximise opportunities for pedestrians to move smoothly through the network.

2.5.2.2 Changes to Traffic Flow

Proposed modelling should represent any significant changes to traffic flows or flow patterns which are expected to occur as a result of a proposal. The Three Stage Modelling Process uses tactical models to account for traffic reassignment, which can be applied to deterministic and microsimulation models as illustrated in **Figure 10**. Interaction between these modelling levels is covered in more detail in **B2.5.5**. Where the Three Stage Modelling Process is not being followed, there may be a requirement to manually edit flows to account for the introduction or banned turning movements or the addition of development traffic. The methodology to model Proposed flows should be agreed at both the Base and Proposed scoping meetings described in **B2.1.5.1**.

Where cyclists have been included in modelling, the process for obtaining Proposed cycle flows could be achieved by factoring existing cycle flows while maintaining cycle routing from the Base models. Alternatively, Proposed cycle flows and routings could be informed from the Cynemon model, which is described further in **B5.2.1** and **C2.2.3**.

Flare usage should be estimated based on the Proposed flow changes. Some modelling software has functionality to account for this, or alternatively the standalone JCT software LinSat can be used[58]. Where flows are unchanged, flare usage should not be changed from the calibrated values held within the validated Base model.

2.5.2.3 Demand Dependency Adjustments

The validated Base or Future Base model on which the Proposed model is based is likely to have been calibrated with demand-dependent stages appearing for only a proportion of the total cycles modelled. This will have been based on observed data and may be modelled using proxy adjustments such as 'bonus greens', dummy stages or reduced stage lengths. If the cycle time is changed in the Proposed model, then the number of demand-dependent stage appearances may need to be adjusted to account for the change to the total number of cycles per hour that will be modelled. Similarly, if the cycle time does not change but demand (either pedestrian or vehicular) is expected to change then consideration should be given to whether the frequency of demand-dependent stage appearances will need to be adjusted.

When making assumptions on demand dependency adjustments in a Proposed model, it should be considered what option represents the 'worst-case' scenario. This may depend on the level of impact that demand dependency has on network capacity, and sensitivity testing may be required to make an informed decision. If unsure, seek advice from the MAE to determine the best approach. After scheme assessment, when initial controller timings are produced in preparation for implementation, demand dependency adjustments should be removed to generate optimum offsets when demand-dependent stages appear. This is illustrated in **Figure 17** and described in more detail in **B2.5.6.3**.

58 http://www.jctconsultancy.co.uk/Software/LinSat/linsat.php

2.5.2.4 Public Transport Adjustments

The Proposed models should incorporate any changes to public transport resulting from the proposals. This may include amendments to bus routes; changes in service frequency; relocation, removal or addition of bus stops and the introduction or removal of bus lanes.

Bus stop dwell times may also need to be revisited as part of Proposed modelling, where stops for different bus routes are combined or separated, or if additional passenger demand will be generated.

2.5.3 Sensitivity Testing

Sensitivity modelling can be undertaken where necessary to assess the robustness of a design, to allow for uncertainties in modelled assumptions. When required, sensitivity modelling is often undertaken prior to the detailed design stage and can involve assessment of various demand scenarios to determine, for example, how a scheme is likely to operate under varying demand conditions or which critical sites may become oversaturated with increased traffic demand. This may result in the scheme scope being revisited prior to detailed design.

Alternatively, sensitivity modelling can be used as part of the scheme refinement process to aid in the resolution of known issues and as part of contingency planning prior to a scheme being implemented on street, such as assessing various levels of calls for demand-dependent stages at a junction.

An example of how sensitivity testing can be carried out is detailed in the Transport Analysis Guidance (TAG) Supplementary Guidance document[59].

Sensitivity modelling is not a requirement for the standard scheme assessment process, and should only be included if it is deemed necessary at the MAP scoping meetings discussed in **B2.1.5.1**. The guidance within **B2.5** applies equally whether creating sensitivity modelling or the Proposed scenario.

59 **https://www.gov.uk/government/publications/tag-uncertainty-toolkit**

2.5.4 Construction Phases

The modelling of construction phases is not always required as part of the standard scheme assessment process. NIST would review the SIR described in **B2.6.5** and advise if the complexity of the scheme construction phases would require additional modelling to be undertaken. This may be determined by the length of time a construction phase is on-street or the perceived level of impact on the network resulting from a particular construction phase.

Construction phase modelling is normally undertaken by adjusting the Base / Future Base deterministic or microsimulation modelling to replicate the traffic management layout being assessed. Depending on the traffic management phase, in particular the length of time it is on street, a construction phase tactical model may also need to be produced. The requirements for construction phase modelling, such as which model and traffic flows should be used, will differ on a scheme by scheme basis and according to the individual traffic management phase arrangements. Therefore, precise requirements for construction modelling should be agreed with NIST and NPD.

MAP applies in all circumstances where traffic modelling is required for the purpose of assessing operational impacts of permanent or temporary changes on the TLRN or SRN. Therefore, MAP Stage 5 should be followed when building a construction phase model.

The guidance in **B2.5** applies equally whether creating construction phase modelling or the Proposed scenario.

2.5.5 Interaction Between Modelling Levels

The production of Proposed models often requires interaction between different modelling levels, as detailed in **B2.1.4.5**. Clarification should be obtained in the Base and Proposal scoping meetings described in **B2.1.5.1** on which modelling levels are required for Proposed model development.

Traffic flows used in Proposed models following the Three Stage Modelling Process are determined as a result of interaction between the separate modelling levels. Demand matrices within tactical models are factored to reflect the predicted changes in demand for the assessment year. The factoring of demand flow is often influenced by TfL's Strategic HTA models which are described in section **B5.2.1**. Following initial assignment of the tactical models, flows are transferred to deterministic models to produce optimised signal timings for the Proposed scenario. Following iterations of signal timings and flows between the two models to obtain a settled network, the final Proposed flows and routings are determined. The routings and flow change information from the tactical model can then be used to inform the Proposed microsimulation model. Throughout the process, additional mitigation and/or design adjustments may be necessary to reduce the impact of a proposal and to protect the wider network.

Traffic flows from different models may be aggregated over different time periods, therefore adjustments or factoring of tactical model flows may be necessary prior to use in other modelling software. Where peak hours differ between models, flows may require further adjustment to ensure they are comparable for the time periods modelled in the validated Base model. Careful consideration should be taken when deciding whether to use absolute or relative flow change values from tactical models, and both may need to be applied at different locations within the same model.

As microsimulation and tactical models do not have the ability to optimise signal timings, supporting deterministic models are often required. Signal timings may be further refined following detailed pedestrian modelling, where pedestrian stage minimums may need to increase to improve pedestrian comfort levels. For further information refer to Chapter **C3** on **Pedestrian Modelling**.

Larger-scale projects could lead to significant traffic reassignment or modal shift, and therefore there may be a requirement to interact with TfL's strategic modelling suite to refine the Proposed demand.

2.5.6 Model Optimisation

As described in A2.1, TfL has a legal responsibility to carry out its Network Management Duty, ensuring the expeditious movement of traffic across London. It is therefore necessary to coordinate the movement of traffic to enable efficient use of the network's geometric layout. This is achieved through implementation of appropriate traffic management strategies and optimising traffic signal timings to respond to varying traffic demands.

All signalised proposals should therefore undergo optimisation to ensure that the signal timings produced are the optimum timings for the demand scenario being modelled. This can be achieved through use of deterministic optimisation software, such as LinSig or TRANSYT, to generate Proposed signal timings. In congested conditions, microsimulation models can be used to further analyse and refine the signal timings produced by deterministic models.

Figure 17 demonstrates a generalised approach to optimisation, containing each of the three main phases of optimisation that may be required:

- **Phase One** – Initial Optimisation, used to enhance signal timings after the major design changes have been made within a proposal;
- **Phase Two** – Fine Tuning and Impact Assessment, used to hone signal timings and maximise performance within the proposal prior to impact assessment against the Base or Future Base models; and
- **Phase Three** – On-Street Controller Timings, an optional process based on model scope that is used to prepare initial signal timings for implementation on street.

If a decision is made to significantly alter the road network, signal timings, cycle times or other proposal details to improve the performance of the road network, consideration should be given to revisiting the tactical model to assess wider impacts of the revised changes. The Three Stage Modelling Process described in B2.1.4 should be referred to when undertaking this task.

These optimisation phases are described in further detail below, to form a generalised framework within which judgement is needed to maximise the performance of a proposal according to the project scope.

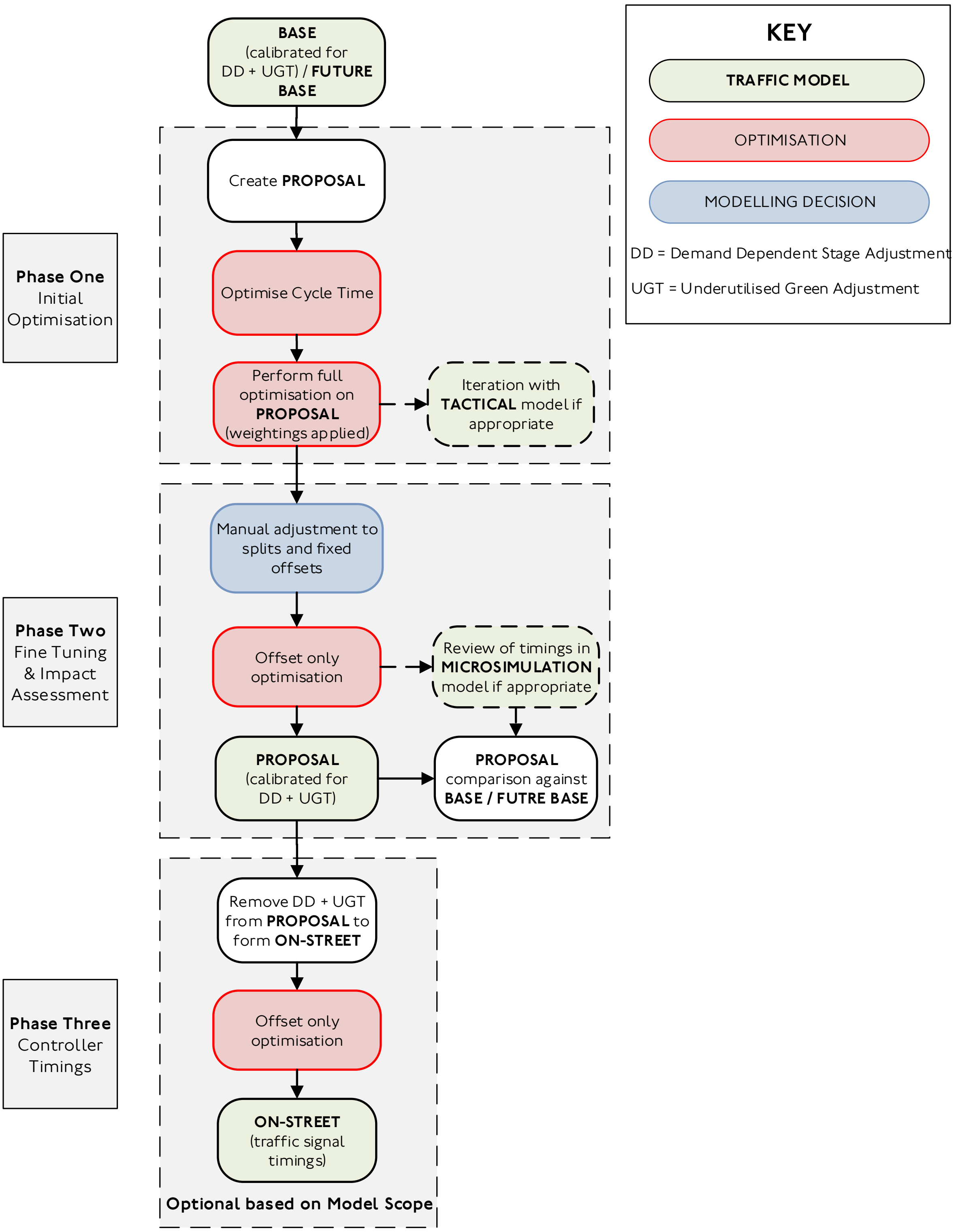

Figure 17: Overview of a proposed approach to traffic model optimisation

2.5.6.1 Initial Optimisation

The initial stage of optimisation provides an opportunity to assess the performance of a proposal after major design changes have been implemented, such as those outlined in **B2.5.2**. A flow chart detailing the initial optimisation phase is shown in **Figure 18**. The initial optimised signal settings are usually automatically generated through an optimisation algorithm such as those employed within deterministic models to reduce delay or increase capacity.

Major design decisions made during proposal development will broadly determine whether it is necessary to influence a software optimiser with weightings and penalties. These can be applied to encourage the optimiser algorithm to produce signal timings which reduce delay or limit queues in particular parts of the proposal, and can be used with care to achieve desired outcomes. For further detail on optimisation weightings, refer to the software-specific chapters within **Part B**.

During the initial stages of optimisation, it is essential to analyse the impact of signal optimisation by considering modelled queue lengths, platoon progression and overall network or junction performance. This should enable the model developer to assess whether the fundamental aspects of the design and signal strategy are likely to be acceptable. An optimised proposal should only move on to the fine-tuning stage once the basic performance of the model is considered appropriate. The remainder of this section highlights issues that may be influential in determining whether a model can progress to a more detailed signal strategy stage.

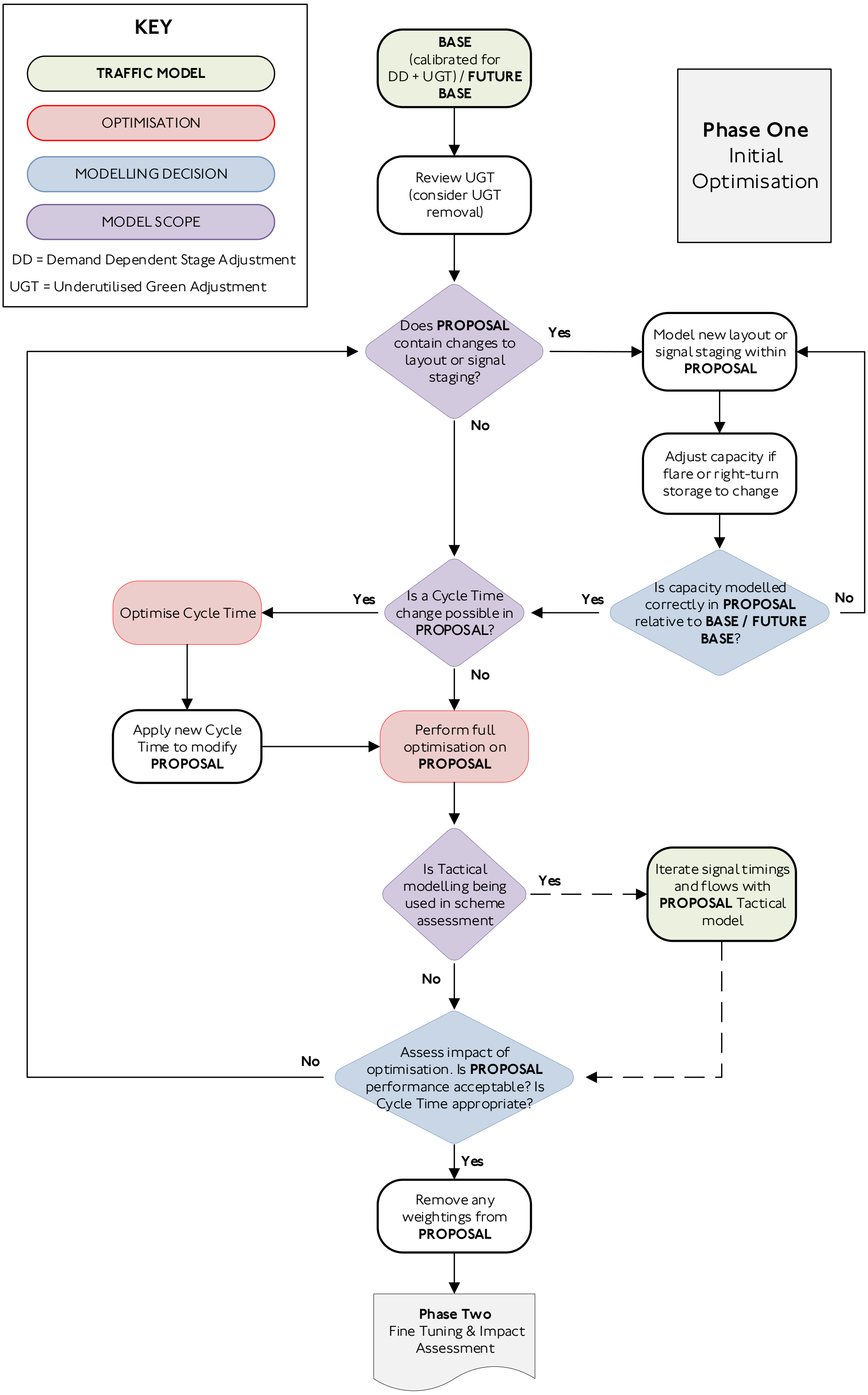

Figure 18: Initial optimisation approach

2.5.6.1.1 Underutilised Green Time

Underutilised Green Time (UGT) may be present in a validated Base model, representing lost time as a result of driver behaviour, localised junction characteristics or due to congestion, exit-blocking and the interaction with pedestrians or cyclists (section **B2.3.10.1**). Where UGT is modelled, it will have been based on site-gathered data and may be represented as negative phase lags, bonus greens or dummy stages.

> UGT adjustments should only be modified if the cause of the original UGT present in the validated Base model is known and expected to change, for example if optimised splits or offsets are expected to reduce the onset of exit-blocking and congestion; interaction with other road users is expected to change or if physical layout changes are expected to influence the local characteristics and/or driver behaviour responsible for UGT. If unsure whether to amend Base UGT values, seek advice from the MAE to determine the best approach.

Where there is exit-blocking from outside the model boundary that is not expected to change, and cycle time amendments are proposed, it may be necessary to recalculate UGT values to match exiting flows with those observed in the validated Base model. This ensures no additional capacity will be modelled that is not expected to be realised.

If cyclist flows are predicted to change in the Proposed model, then consideration should be given to the influence this may have on UGT values. For further information on cyclist UGT treatment refer to **C2.5.2**.

UGT adjustment should be reviewed prior to initial full optimisation, and it may only be appropriate to reapply UGT during assessment of proposal impacts during fine tuning, prior to a final offset optimisation. If a model that has been used for a proposal impact assessment is subsequently used to generate on-street controller signal timings, UGT adjustments should first be removed if the adjustments are not critical for offset calculations.

2.5.6.1.2 Junction Storage Effects

Storage in front of stoplines for opposed turners is sometimes modelled as ‘bonus’ green, in order to account for vehicles clearing during the intergreen period. Where storage bonuses have been modelled, they should not be removed from any optimisation steps unless physical layout or staging changes within a proposal prevent the storage in front of the stopline from being used.

2.5.6.1.3 Cycle Time Optimisation

Scheme designers should choose an optimum cycle time that balances road traffic demand with pedestrian delay. If a change to cycle time is under consideration then it is important to understand its impact upon delay to pedestrians, linking to other signals and the overarching objectives outlined in the Mayor's Transport Strategy[60].

> Where a cycle time change is anticipated at one or more junctions for a proposed scheme, the modelled cycle time should also be adjusted for any other junctions in the UTC control group. Only SCOOT-compatible cycle times[61] should be considered, even in UTC Fixed Time and non-UTC areas.

Cycle times should be kept as low as reasonably practicable to minimise pedestrian delay, and ideally pedestrian waiting times should not exceed 82 seconds. This is due to pedestrian behaviour, as the higher the cycle time the greater the probability of pedestrians becoming impatient and crossing during a red pedestrian signal, potentially risking their safety[62]. The lowest UTC-compatible cycle time is 32 seconds, however SCOOT nodes require an additional 4 seconds over and above the summation of SCOOT stage minimums, meaning cycle times of lower than 64 seconds prohibit SCOOT double-cycling.

Ideally standalone pedestrian crossing facilities should be set to double-cycle where the cycle time allows. The possibility of increasing a junction's cycle time can therefore be investigated to produce pedestrian benefits at other sites within the group. An increase in cycle time can facilitate double-cycling, asymmetrical double greening or allow the provision of an extra stage that could directly benefit pedestrians. Conversely, a proposed cycle time increase at one junction to accommodate a proposed pedestrian facility should not have a detrimental effect on other pedestrian facilities within the operational group. This may create additional delay and result in an overall net disbenefit for pedestrians.

60 Mayor of London, Mayor's Transport Strategy, March 2018
61 Allowable SCOOT-compatible cycle times, in seconds, are: 32, 36, 40, 44, 48, 52, 56, 60, 64, 72, 80, 88, 96, 104, 112, 120, 128 and on some occasions 144
62 **https://content.tfl.gov.uk/factors-influencing-pedestrian-safety-literature-review.pdf**

2.5.6.1.4 Junction Performance

It is necessary to be aware of the relationship between traffic delay and DoS in order to best optimise junction performance during proposal development. The relationship illustrated in **Figure 19** highlights that a network is generally stable below 85% DoS, however delay begins to increase exponentially above this level and can lead to unstable network performance. At junctions operating close to zero Practical Reserve Capacity (PRC), corresponding to approximately 90% DoS, small reductions in capacity can result in a significant increase in delay. For this reason, a DoS of 90% represents an upper limit of practical capacity for signalised junctions, however greater reserve capacity is necessary on strategic routes to help maintain acceptable performance, allowing for flow variation and other random events. Unsignalised junctions typically have a lower practical capacity limit than for signalised junctions, with an upper stable saturation limit in the range 80-85%. Junction capacity relationships are important to consider when designing schemes to ensure that new proposals perform well within the existing network.

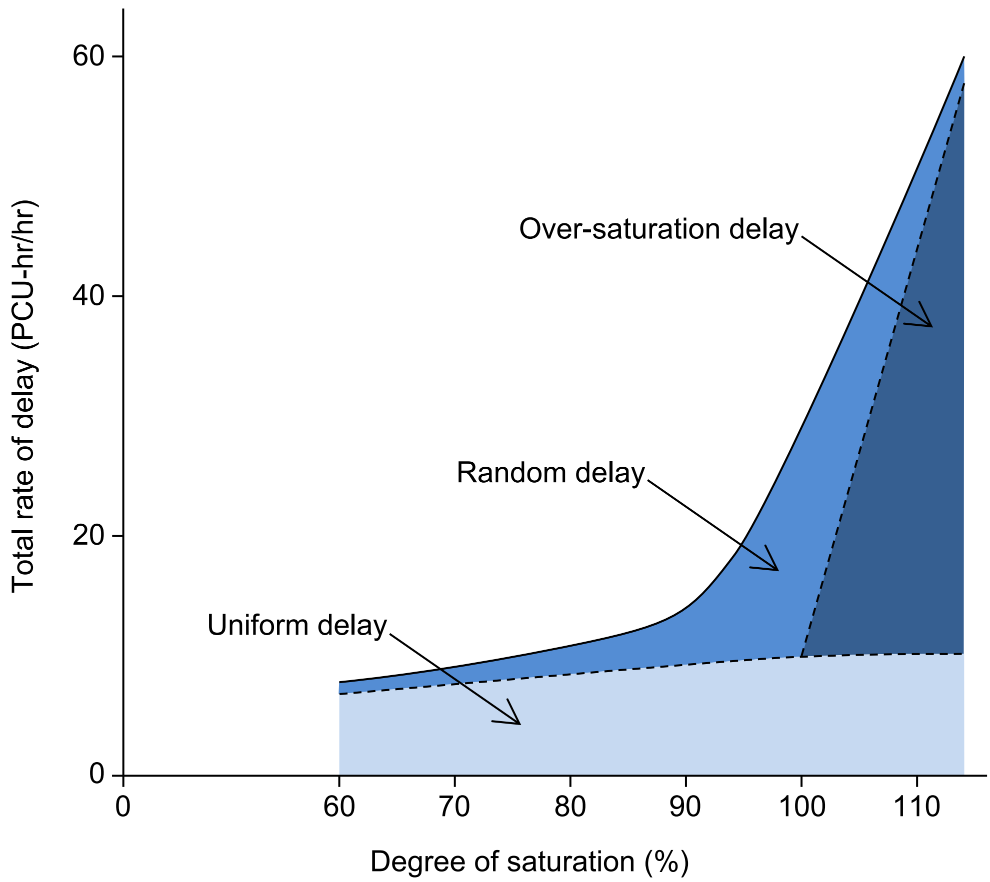

Figure 19: Relationship between junction delay and degree of saturation

2.5.6.1.5 Iteration with Tactical Models

When assessing a scheme using the Three Stage Modelling Process covered in **B2.1.4**, there is a need to iterate signal timings produced by deterministic models and flows produced from tactical models. Deterministic models with the Future Base or Proposed scenario coded should first be optimised with the existing Base or Future Base traffic flows, with relevant adjustments as applicable to the design. The updated timings can then be fed into the tactical model to allow for flow reassignment. The flows from the reassigned tactical model can then be applied into the deterministic model for further optimisation. This iteration process between the tactical and deterministic models continues until traffic reassignment settles.

When generating signal timings during this iterative process, it is important to ensure that signal timings adhere to any on-street constraints or traffic management strategies. NPD should be consulted for advice on any signal timing constraints.

2.5.6.2 Optimisation Fine Tuning and Impact Assessment

The fine-tuning stage of optimisation allows for the manual adjustment of the initial settings automatically generated by a software algorithm. These adjustments provide an opportunity to maximise the performance of the proposed design and minimise wider network impacts. The major design decisions have been completed and acknowledged as fit for purpose, so this stage of the process evaluates how minor modifications to the proposal can improve network performance relative to the Base or Future Base models. A flow chart detailing the optimisation fine tuning phase is shown in **Figure 20**. The following subsections outline a few approaches to fine tuning that can be employed to generate an operable signal strategy.

2.5.6.2.1 Balancing the Network

If model outputs indicate queue storage problems after initial optimisation, it should be considered whether a more balanced loading of the network can be achieved. The available network capacity can be manually adjusted during fine tuning (such as through changes to green splits), with the model then undergoing offset-only optimisation to ensure good platoon progression but with a fixed network capacity.

Fixed relationship junction groups should not be changed from a validated Base model without prior consultation with NPD as these permanent offsets may need to be maintained in the proposed scenario.

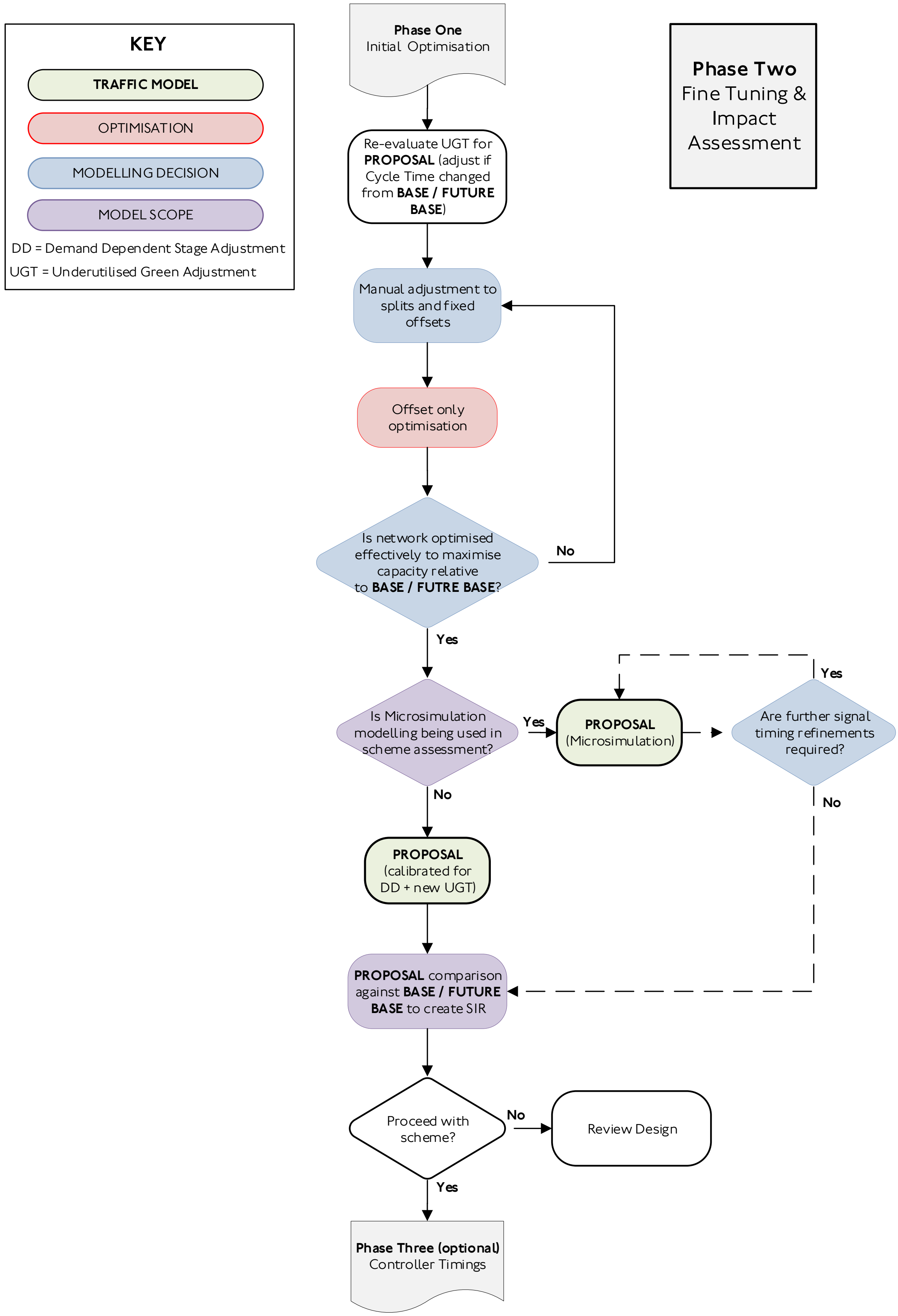

Figure 20: Optimisation fine tuning and impact assessment approach

2.5.6.2.2 Utilisation of Network Capacity

It may be more efficient for a proposal to contain fixed signal offsets to prevent cyclical problems caused by fanning, funnelling or exit-blocking. Within certain network layouts the use of a fixed offset can encourage drivers to fully utilise available capacity.

Underutilisation of upstream lanes can result from traffic funnelling over a short distance, such as a reduction of lanes for general traffic on the exit to a junction. The potential impact of traffic funnelling should be reflected in the upstream lane structure of the model through the introduction of flares or by reducing the saturation flow assumption. Conversely, fanning into a wider carriageway may prevent downstream links from fully contributing towards stopline capacity. Where this is the case, fixed offsets should be manually applied to ensure full lane saturation by only allowing platoon progression once all lane storage has been utilised. Fanning may prevent downstream lanes from contributing to capacity where it is not possible to fix the offset, and in this case reduced upstream saturation flows should be applied to the downstream lanes. However, this would only be necessary where downstream lanes are grouped together, and not if individual lanes are modelled.

Once the internal links operate satisfactorily, manual optimisation can be performed. Cyclic flow profiles can be audited to ensure appropriate front and back end platoon coordination exists between closely associated links. This analysis should confirm whether the proposed traffic control strategy of fixed groupings is being implemented properly and provides an opportunity to further fine tune offsets and promote efficient lane utilisation and platoon compression.

2.5.6.2.3 Protecting the Network

Where a proposed network is operating close to its limit of practical capacity it may be necessary to protect the network from unexpected traffic fluctuations. This risk can be mitigated by manually adjusting green times to saturate any under-saturated external (entry) links. This strategy can be used to prevent internal links becoming overwhelmed with traffic that cannot be stored within the network. Over-saturated internal links can lead to high levels of unpredictable delay and poor journey time reliability within a proposal.

2.5.6.2.4 Interaction with Microsimulation Modelling

Where the project scope allows, the operation of optimised signal timings should be reviewed using microsimulation software. This allows for the timings to be assessed in relation to on-street traffic behaviours and interactions. This assessment is especially useful in congested traffic conditions and where specific traffic behaviours arise, such as merging.

2.5.6.2.5 Improving the Design

When the models have been correctly produced and the results show increased delay to one or more modes, the proposed design should be revisited to mitigate this where possible, in line with the scheme objectives. The local area team within NPD should be consulted prior to amending any designs to ensure any proposed changes can be implemented on street.

2.5.6.3 On-Street Implementation

If the scheme is approved by TfL, the final stage of the optimisation process is the production of initial controller signal timings that will be refined prior to on-street implementation. A flow chart detailing the on-street implementation phase is shown in **Figure 21**.

The first step in this process is the removal of any signal timing adjustments to take account of demand dependency and UGT, unless the adjustments are critical for offset calculation. Once the demand dependency and UGT adjustments have been reviewed, a check should be undertaken to ensure that all signal phases are present and receiving their minimum green time. This may require manual adjustment of the stage lengths generated at the end of the Fine Tuning and Impact Assessment stage to ensure all phases are present. The manually adjusted stage lengths should then have offset-only optimisation performed.

Following optimisation, the signal timings should be carefully checked to ensure they are appropriate and further manual adjustments may be needed to stage lengths and offsets before timings can be tested on street. Once the signal timings are implemented on street is it critical that observations are undertaken during all peak periods to ensure that the timings are operating correctly. At this stage there may be further refinements to signal operation, including the implementation of signal strategies such as SASS and Bus Priority. Refer to **B2.3.8.3** for further details on these.

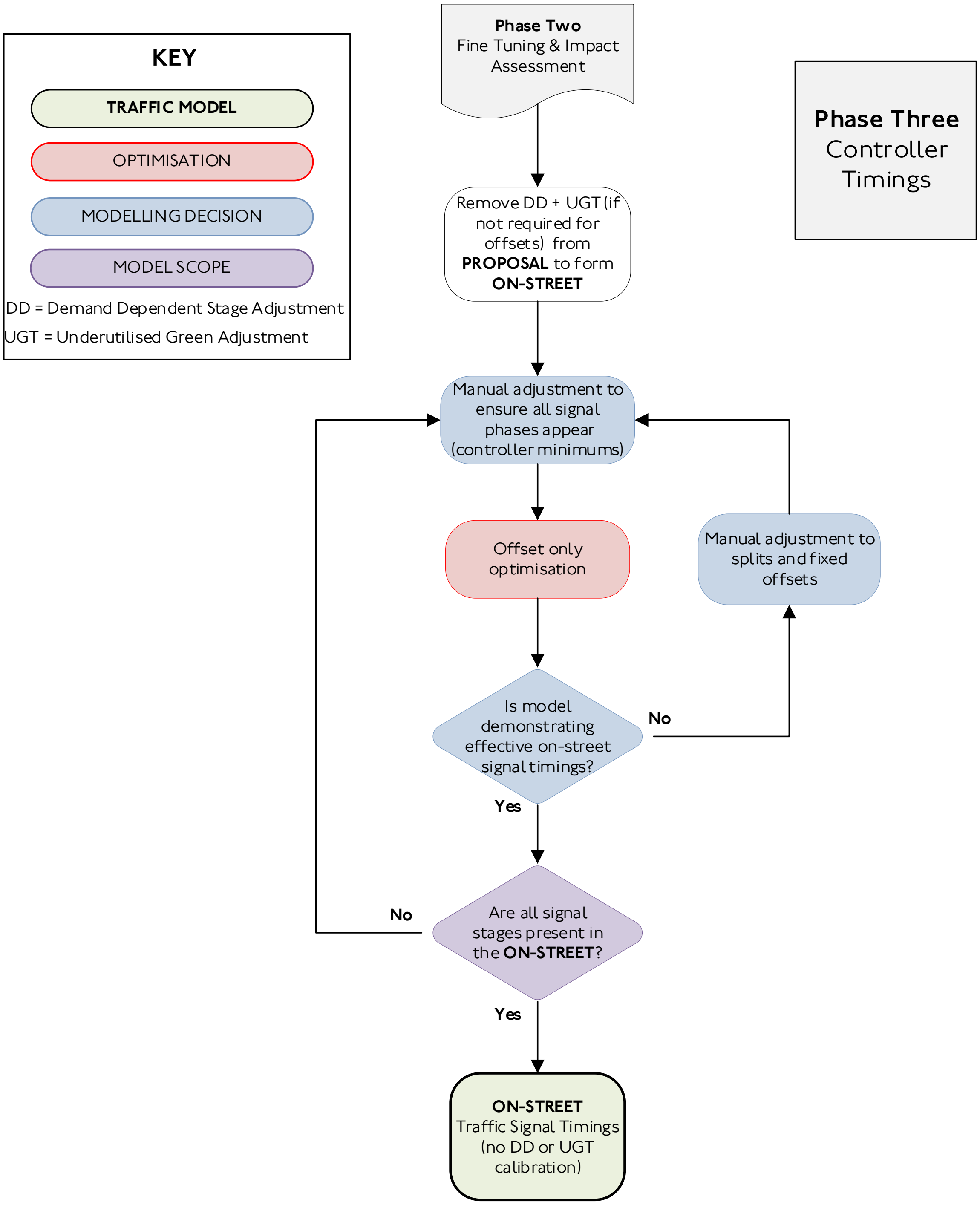

Figure 21: Derivation of on-street controller timings

2.5.7 Model Assessment

Models can generate a wide range of outputs that provide an indication of the performance of the network. Performance statistics that could be provided include:

- Degrees of saturation (DoS);
- Link / lane capacities (PCU/hr);
- Junction practical reserve capacity;
- Maximum average queue lengths;
- Cyclic flow profiles (CFPs) for critical links (short / highly saturated);
- Percentage green per junction wasted due to exit-blocking;
- Percentage of buses per route waiting more than one cycle to clear nodes;
- General traffic journey times;
- Cyclist journey times;
- Delays;
- Excess Wait Times;
- Emissions;
- Mean travel time and standard deviation for private and public transport along pre-defined routes; and
- Mean pedestrian travel time along pre-defined routes.

There may be occasions when it will be necessary to present the impact of a proposed scheme using a selection of these performance indicators, depending on the objectives of the scheme. Where this is the case these should be discussed at the Base and Proposal Scoping Meetings described in **B2.1.5.1**.The selection of performance indicators should be agreed in advance with NPD and other key stakeholders, such as NIST and the London boroughs.

2.6 Model Reporting

Reporting should reflect the logical approach taken to resolve the complex and iterative nature of traffic model development, and should emphasise the sound engineering principles adopted. Without accurate reporting, the process of model development is hindered by a lack of historical information to understand the decisions taken. The following subsections outline an approach to model reporting that should allow a third party to accurately comprehend the decisions made during the development process, from network familiarisation through to proposal evaluation.

A traffic model may be developed over a period of months or even years by a number of different parties. While developing a model, detailed notes should be retained that include a record of all assumptions and modelling decisions. These notes should be kept for future reference and can form the basis for subsequent reporting.

It is the responsibility of the Promoter and their modelling representatives to ensure that all reporting is accurate, thorough, sufficient, and that submitted documents are fit for purpose to adequately support accompanying models.

All modelling reports should be accompanied by electronic copies of all modelling files for that stage of the scheme assessment. The model files should have version control in place so that a full audit trail can be followed.

2.6.1 Calibration Report

A calibration report should present all relevant survey data and include a history of model development.

Model auditing will rely on the report to explain how the model has been calibrated. For this reason, the calibration report should focus on presenting traffic model inputs and detailing how the model has been developed to ensure that it represents existing conditions. In particular, the following should be included:

- The stated purpose of the model;
- A list of all TfL-referenced sites in the model, with addresses and, where required, a note detailing any operational relationships (such as UTC multinodes and subgroups);
- Clear notes on site observations and measurements, covering both the physical network and observed vehicle behaviour. Where

behaviour is specific to a particular time of day this should be noted, along with how it has been accounted for in the model;

- Site data highlighting measured saturation flows, cruise times and effective flare lengths;
- Table of saturation flows for each link in the network, indicating whether values have been measured on site or calculated. If calculated (for example using RR67) a justification describing why measurement was not possible; and
- Description detailing the extraction method used to obtain signal timings, including the source of data (such as fixed time UTC plans, CLF timings, or average timings representing SCOOT operation).

Specific calibration reporting requirements for deterministic and microsimulation modelling are detailed in MAP Stage 2, as described in **B2.1.5**. The reports submitted should be broken down into the relevant MAP sections to help the auditor conduct the review quickly and efficiently.

2.6.2 Validation Report

Validation reports should look in detail at comparisons between calibrated model results and existing conditions. The report should detail the validation process, from on-site surveys through to adjustments made within the model. Any decisions made by the model developer should be captured, especially where model inputs have been adjusted in order to achieve validation.

Validated model results should be tabulated and compared with the surveyed on-street values for all modelled periods. If there are discrepancies between the model outputs and the on-street conditions then these should be identified, investigated and explained. Specific items that could be included in the validation report are:

- Details of traffic flows used, when they were recorded, who recorded them and how the modelled peak periods were chosen;
- Demand dependency calculations, including source data and how demand dependency has been accounted for in the model;
- Validation data, such as vehicle journey times, DoS and UGT;
- Relevant site observations not already included in the calibration report, such as give-way behaviour, exit-blocking, flare / non-green usage, parking / loading and bottleneck details; and

- Evidence of validation, comparing modelled results to on-street observations and measurements. Any discrepancies should be analysed and discussed.

Specific validation reporting requirements for deterministic and microsimulation modelling are detailed in MAP Stage 3, as described in **B2.1.5**. The reports submitted should be broken down into the relevant MAP sections to help the auditor conduct the review quickly and efficiently.

2.6.3 Future Base Report

A Future Base report should accompany Future Base models, which should state the year of the model, identify any proposed schemes included within the tactical model and any modifications made to the validated Base microsimulation and deterministic models.

Future Base model results should be compared to the validated Base model for all modelled periods. Any significant changes from the Base model results should be investigated and explained. Specific items that could be included in the Future Base report are:

- Details of the methodology used for the interaction between different modelling levels, including a record of any adjustments made to the flows and routing information provided from tactical modelling to match assumptions made in the Base modelling;
- A list of all proposed schemes included in the Future Base assessment, including any modifications required in the deterministic and microsimulation model boundaries;
- Any proposed changes to bus routes, bus frequencies and bus stop dwell times;
- Details of any demand dependency and UGT assumptions;
- Any mitigation strategies applied to the model associated with any proposed schemes;
- Details of the methodology used for determining the Future Base cycle demand and routing; and
- A summary comparing model results to those in the validated Base model (described further in **B2.6.7**).

The journey time routes validated in the Base microsimulation models for general traffic and buses should be collected in the Future Base model and a comparison made.

Specific proposal reporting requirements for deterministic and microsimulation modelling are detailed in MAP Stage 5, as described in **B2.1.5**. The reports submitted should be broken down into the relevant MAP sections to enable the auditor to conduct a review quickly and efficiently.

2.6.4 Proposed Model Report

The report accompanying a Proposed model should give a full description of the proposed scheme and objectives, with any expected scheme impacts and changes in demand. The modifications made to the validated Base or Future Base model to develop the Proposed model should all be based on these key details. All changes made in order to develop the Proposed model should be documented, along with the reasoning behind them. Specific items that could be included in the Proposed model report are:

- Scheme summary;
- Scheme objectives;
- Proposed traffic management strategy;
- Evaluation of proposal results;
- Conclusions and recommendations;
- Design summary sheets;
- Model source data; and
- Modelling assumptions, including interaction between modelling levels, influence of other proposed schemes, public transport amendments and cyclist flows.

Results of the Proposed model should be compared to the validated Base model and Future Base model. This should be done for all modelled periods to demonstrate the expected impact of the proposals on the network (described further in **B2.6.7**). The Proposed model report should include a discussion and interpretation of model results. It is useful to include a section detailing the impact of any geometric changes as this enables NPD to make informed comments about preferred design options. Version control should be applied to all design documents to avoid ambiguity, thus ensuring all parties are aware of the current design status for each Proposed model.

Results from the approved Base and Future Base models should be presented alongside the Proposed modelling results. NPD will use modelling outputs and analysis to assess the likely impacts of the scheme. The Base, Future Base (if applicable) and Proposed model submissions will be considered when producing the SIR, therefore it is in the scheme Promoter's interest to ensure Proposed model submissions are provided with detailed analysis.

Specific proposal reporting requirements for deterministic and microsimulation modelling are detailed in MAP Stage 5, as described in **B2.1.5**. The reports submitted should be broken down into the relevant MAP sections to enable the auditor to conduct a review quickly and efficiently.

2.6.5 Scheme Impact Report

As part of the scheme approval process, a Scheme Impact Report (SIR) must be produced and submitted to the Network Impact Specialist Team (NIST). The SIR contains safety information, including the buildability and future maintenance of the scheme, together with information on the integrity of the modelling and the potential impact on the network, broken down by mode. The report is completed by the scheme Promoter, Engineering Services and a representative from NPD.

The SIR should be attached to the respective Scheme Traffic Management Act Notification (TMAN) by the respective scheme Promoter. The SIR helps to clarify the operational impact of the permanent scheme changes and helps to demonstrate how, in the case of a TfL-promoted scheme, TfL is complying with its Network Management Duty (NMD) under the Traffic Management Act 2004 (TMA). TfL's Traffic Manager has a statutory responsibility in this regard, as explained in **A2.1**. In the case of a scheme promoted by a London borough council, which is on or affecting the SRN or TLRN, TfL has oversight of the borough's NMD and will require a Scheme TMAN from the respective borough in this regard. Depending on the nature of the scheme proposal, an SIR and associated modelling may be required as part of this submission to help demonstrate impacts and associated mitigation.

NIST look to ensure appropriate operational balance on London's TLRN and SRN following introduction of a permanent scheme, and also during the construction phase of scheme delivery in line with TfL's statutory obligations. The process involves reviewing a range of operational information to help reach conclusions in this regard. As a result, there may be a need to undertake some modelling work in relation to the construction phases of a project; especially where long term, and/or complex changes to the network are required in advance of the final scheme arrangement being delivered.

2.6.6 Public Consultation

Modelling outputs play a key part in the information presented during Public Consultations, and can give the public an accessible indication of the scheme impacts. Base or Future Base model journey time outputs from microsimulation models are compared against those in the Proposed models. The modes evaluated within the Public Consultation document are as follows:

- **Traffic** – Average journey times (minutes);
- **Buses** – Average journey times on all bus routes through the scheme area (minutes); and
- **Cyclists** – Average journey times (minutes).

The journey times presented are the key routes within the model boundary and, if possible, are validated within the Base model. If there are bus services that take a similar route, they would be amalgamated to show an averaged journey time for these bus services.

Public consultations often detail the total average wait time for pedestrians. This information is extracted from dynamic pedestrian modelling assessments, using LEGION or Viswalk, or static spreadsheet analysis. Refer to Chapter **C3** on **Pedestrian Modelling**, for further information on pedestrian modelling assessments.

Supporting information for public consultations can be provided from tactical and deterministic model outputs. Plots from tactical models can show where traffic flow reassignment is predicted surrounding the scheme, and stopline saturation and signal timings can be provided from deterministic models.

For particularly high-profile schemes, it may also be advisable to include 3D visualisations of the scheme. This is particularly useful to help the public understand the interaction between general traffic, buses, cyclists and pedestrians and to demonstrate any benefits to vulnerable road users.

2.6.7 Presentation of Modelling Outputs

Since modelling is only able to provide a prediction of outcomes resulting from the implementation of a scheme, it would be inappropriate to report on precise results in a granular level of detail, for example journey time differences to the nearest second. It is common for model results to be misinterpreted by a non-technical audience, therefore, it is common for the results of tactical modelling and microsimulation modelling (both traffic and pedestrian) to be banded. For tactical modelling, plots indicating where traffic flows changes are predicted are grouped into bands often of

50 to 100 vehicles per band. Journey time outputs produced by microsimulation models are similarly often banded. **Table 6** shows an example of journey time bands used, where ranges of 1 minute, 2 minutes or 5 minutes are given.

Table 6: An example of reporting time ranges

Base / Future Base Results (mins)	Range used (mins)
1 to 10	1
10 to 20	2
20+	5

For example, if the Future Base journey time was 5 minutes 35 seconds and the Do Something journey time was 16 minutes and 40 seconds, the journey times would be reported as 5 – 6 minutes in the Future Base and 16 – 18 minutes in the Do Something model with a difference of 10 – 12 minutes. Conversely, if a Future Base model had a journey time of 10 minutes and 30 seconds and the Do Something model journey time was 7 minutes 15 seconds, the journey times would be reported as 10 – 12 minutes in the Future Base model and 7 – 8 minutes in the Do Something model with a difference of minus 3 – 4 minutes.

The bandings used to group model outputs are scheme-specific and should be agreed with NPD.

2.6.8 3D Modelling

The traffic modelling outputs produced during the Three Stage Modelling Process can be technical in nature and require a modelling professional to understand and interpret what the outputs represent, The ability to convey modelling analysis through a medium which non-modelling professionals can understand is crucial to ensuring engagement with wider stakeholder audiences. It can also help with comprehension of the benefits a proposed scheme will bring to a local area.

A method to effectively display modelling outputs in an accessible form is to utilise 3D modelling and animation software. This involves recreating the modelled environment and creating a 3D digital representation of the proposals and analysis. To create a 3D representation the following steps are undertaken:

- Converting traffic model vehicle simulations into realistic 3D representations of vehicles, to simulate vehicle movement and behaviour;
- Replicating the highway proposals into a 3D format and assigning materials to represent the various hardstanding surfaces; and
- Generating buildings and landscaping features to give context to the surrounding area.

Figure 22: An example of a static computer-generated image produced for a public consultation

3D modelling software can output static images as shown in **Figure 22**, or render an image sequence to create a video file as illustrated in **Figure 23**. Using postproduction techniques, a voiceover, subtitles and descriptive text can be overlaid on the 3D outputs to help deliver a narrative behind the analysis and to help the audience fully understand and engage with the modelling analysis.

Using a video output with a clear narrative is a proven method to ensure that any audience can engage with modelling analysis, and helps to achieve necessary agreement when trying to implement a scheme, for example during Public Consultations.

There are several forms of 3D outputs that can be produced, including 360° video, Augmented Reality and Virtual Reality, which can be used in different ways to achieve greater audience engagement. It is recommended to consider how these outputs can be produced and utilised, and to identify the benefits of each. This can provide a robust toolset to draw upon when creating outputs for various stakeholder groups.

Figure 23: An example of an animation video produced using outputs from a Vissim model, with the existing image shown above and the scheme image shown below

3 Aimsun Next Modelling

3.1 Introduction

This chapter is designed to provide guidance for experienced practitioners when building microsimulation models of London's road network using Aimsun Next. It augments the general modelling guidance given in Chapter **B2** on **Modelling Principles**.

This chapter outlines TfL's recommended approach for microsimulation modelling with Aimsun Next. However, there will be cases where local conditions or project requirements dictate the use of methods which may be different to those outlined. In these situations, NP should be consulted on the planned methodology where modelling will be submitted for approval by TfL.

3.1.1 Introduction to Aimsun Next

Aimsun Next is transport modelling software made by Aimsun, which is a subsidiary of Siemens Mobility. It is a fully integrated application which includes microsimulation, mesoscopic simulation, macroscopic and travel demand modelling. It also has the capability to combine these in two hybrid simulators: micro-meso and macro-meso. These Guidelines only consider the microsimulation aspect of Aimsun Next.

Aimsun Next microsimulation uses a Lane-Based network layout and a car-following model to accurately reflect the way vehicles move through junctions and roads and interact with each other. The latest version includes integrated pedestrians and has started to include a lateral behaviour model for cyclists. Signals can be modelled using either internal fixed-time control plans or through the API, which essentially means that any signal control system can be used as long as an interface has been coded. At the time of publishing there is no simulated version of UTC that works with Aimsun Next, however future versions of UTC will have Aimsun Next integration.

Aimsun Next can be used to model complex and congested traffic networks, where deterministic modelling cannot provide a realistic representation. In common with other microsimulation software, it is unable to optimise signal timings, and so is usually used in conjunction with deterministic modelling when looking at proposed schemes.

Further information can be found on the Aimsun website[63].

3.1.2 Software Versions

The current version of Aimsun Next is Aimsun Next 20. This release "focuses on modelling pedestrians, bicycles and the interaction between passengers and public transport vehicles"[63]. The TfL Aimsun Next Template contains standard modelling parameters to be used when commencing a modelling project in Aimsun Next for TfL[64].

Whichever version of Aimsun Next is chosen for a modelling project must not be changed throughout the project, and particularly not after the Base model has been validated. Running the same model in a different version of the software will invalidate the results.

3.1.3 Appropriate Use of Aimsun Next

Since this guidance relates to the microsimulation aspect of Aimsun Next, only this type of modelling is considered. As a microsimulation model, some examples of where it is appropriate to develop Aimsun Next models include:

- Where over-saturated conditions exist, and particularly where exit-blocking occurs, or where queues interact with other facilities;
- Where network infrastructure changes dynamically throughout the modelled period (for example VA, demand dependency, bus priority at signals), however, at the time of publishing, there is no interface between Aimsun Next and an offline version of the UTC system, so exact UTC behaviour cannot be replicated;

63 **https://www.aimsun.com/aimsun-next/**
64 The latest TfL Aimsun Next Template is available on request from NP

- Where accurate journey time prediction is important as an improvement measure (such as in a bus priority scheme); and
- Where it is necessary to visually demonstrate the operation of a scheme, traffic management technique or control strategy for use in a stakeholder consultation or Public Inquiry.

Aimsun Next should be used appropriately to complement analyses provided by traditional traffic signal optimisation and design tools such as LinSig and TRANSYT.

3.2 Preparation

General guidance on Base model development is provided in section **B2.4**. This section provides specific guidance for building Base models using Aimsun Next. Model preparation should be discussed at the scoping meeting (section **B2.1.5.1**) and decisions documented within the Modelling Expectations Document (MED, section **B2.1.5.2**).

3.2.1 Model Boundary

Aimsun Next is able to model adjacent CLF or UTC groups operating different cycle times. It can therefore assess the impact of scheme proposals which cover two or more traffic control groups. Where blocking back from one group impacts traffic upstream, Aimsun Next can be used to predict the magnitude and frequency of any operational issues and test proposals for mitigation. For this reason, where possible, junctions which generate significant queuing in the area of interest should be included in the modelled area. If it is not possible, for example if the cause of queuing would significantly increase the size or complexity of the model, then a proxy must be used.

When deciding on the Aimsun Next model boundary the length of external sections (such as those where vehicles are loaded onto the network) should be considered.

> An external section ought to be long enough to contain all traffic expected to enter within the modelled time period, in all scenarios.

There are two reasons this should be done:

- To ensure that any upstream blocking back effects can be easily identified (visually) and mitigated; and
- To ensure that when measuring scheme performance parameters (for example journey time, delay, queue length, average speed) all vehicles are included. If some vehicles are not successfully loaded into the network, the model will produce a biased result which may underestimate the capacity impacts of the scheme.

If the Sections are not long enough then vehicles will queue outside of the modelled area waiting for a space to enter. All Sections should be extended to capture the extent of the queuing.

3.2.2 Data Collection

Prior to building a model in Aimsun Next the following information should already have been obtained, as identified in sections **B2.2** and **B2.3**:

- Network layout (section **B3.2.4**);
- Familiarity with site operation and driver behaviour;
- Traffic flows and turning proportions;
- Traffic flow compositions (according to vehicle classifications);
- Bus frequencies;
- Bus stop locations;
- Bus stop dwell times;
- Signal timings and controller logic;
- Saturation flows;
- Vehicle journey times;
- Queue lengths;
- Mandatory speed limits; and
- Parking and loading.

The following data may also be needed, depending on the purpose of the model:

- Origin-destination (OD) surveys;
- Speed and acceleration profiles;
- Bus boarding and alighting surveys;
- Pedestrian flows; and
- Bus occupancy surveys.

In addition to collecting the above data, skeleton local models should be produced for all junctions to be modelled in Aimsun Next, as detailed in section **B4.1.3.2**. This will ensure signal timings are accurately represented, particularly when modelling stage and interstage relationships.

The remainder of this introductory section provides specific guidance on the collection of some of the above data as necessary for the preparation of Aimsun Next models.

3.2.2.1 Site Observation

Microsimulation models are able to simulate complex interactions between road users and their environment. It is therefore essential that observations are undertaken at sites being modelled so that interactions can be noted and replicated in the model. It is not sufficient to use drawings and aerial photography only to build a model, as these are static sources and may not convey all the dynamic aspects of the site. CCTV may also be used; however, this is not an ideal solution as not all areas are covered and it is easy to pay less attention to areas which cannot be seen. Preferably, CCTV would be used in addition to, rather than instead of, site visits.

Examples of behaviours which should be observed are:

- **Space utilisation** – particularly where usage does not match lane markings;
- **Blocking back** – through junctions, across crossings, yellow boxes and keep clears, anywhere another traffic movement is prevented from continuing on its desired path;
- **Lane changing** – particularly the decision point where vehicles decide to change lanes for turns;
- **Parking** – both legal and illegal if it is persistent and takes space away from moving traffic;
- **Queuing** – locations, lengths, and behaviour; and
- **Gap acceptance** – at give-ways or opposed right turns.

These can significantly affect model results and must understood from site visits in order that they can be accurately replicated in the model.

It is also important, whenever possible, to carry out site observations on days when traffic surveys, for example counts or journey times, are taking place. It is important to verify that the data collected represents a day that is considered typical or the data collection may need to be repeated at a later date.

3.2.2.2 Signal Timings

Guidance on how to collect and use signal timing data is provided in **B2.3.8**. The data requirements include phase, stage and intergreen data from Timing Sheets. For UTC junctions the control plan is also needed, along with the frequency of any demand-dependent stages. For VA or MOVA junctions green time surveys are used to determine the average frequency and duration of each stage.

If more complex forms of dynamic control, such as bus priority, have a significant impact on the behaviour of the junction, then information on this should be collected so that it can be replicated appropriately.

3.2.2.3 Saturation Flows

In most cases, an Aimsun Next model will be developed to complement an existing validated LinSig or TRANSYT model which already contains measured saturation flows, so saturation flows from those accompanying models should be used for calibration of the Aimsun Next model. Guidance on saturation flow measurement is provided in **B2.3.9**. Where a validated LinSig or TRANSYT model is not available, it will be necessary to measure saturation flows for the purposes of calibrating the Aimsun Next model. These are some examples of situations where it is critical to measure saturation flows for an Aimsun Next model:

- Approach has extensive queues, for example a bottleneck;
- Approach is an entry into the Aimsun Next network;
- There are proposed changes to the layout; and
- There are proposed changes to the method of control or intergreens.

This is not an exhaustive list and it remains necessary to exercise good judgement when assessing situations where it is critical to measure saturation flow.

3.2.2.4 Journey Times

It is necessary to have journey time data to validate an Aimsun Next Base model. In recent years, sources of GPS tracked vehicle data have become available which give a much wider range of possibilities when it comes to choosing dates, times and distances. In particular, it is possible to get an average journey time over multiple days, which provides a more robust value to validate against.

Where it is not possible to source GPS data, journey times should be collected at the same time as the other traffic surveys if possible, however for larger networks it may be necessary to conduct the journey time surveys over several days. Journey times in Aimsun Next can be collected and measured over any number of sections, via either Groupings or Subpaths (section **B3.7.2.3**), making it adaptable to available site-measured journey time data. It is recommended that journey time data is collected over smaller distances, in addition to the full routes, as this will help with locating any disparities during validation.

3.2.2.5 Public Transport

Bus data in London is recorded using the iBus system, which collects data on frequencies, journey times and dwell times for each bus. This data can be requested from TfL but any requests must go through a TfL sponsor to ensure the request is valid and formatted correctly.

Information on the running of coach lines should be sourced from the relevant company's website.

3.2.3 Model Time Periods

The model time period should be specified to match the requirements of the analysis to be undertaken and based on the flow data which has been collected. The model must start with a warm-up period that sets the initial conditions in the network and provides the model with costs for the route choice calculation. A cool-down period may also be included if there is the possibility that the proposal could extend the peak hour(s). General guidance on model time periods is given in **B2.3.3**. It should be noted that many of the objects that make up a Scenario, for example the Traffic Demands, signal Control Plans and Public Transport Plans, have their own initial times and durations and these all need to be configured correctly for the model to function properly.

Aimsun Next is not constrained to modelling a single peak hour period. For a broader assessment it is possible to create models which cover three or more hours, which is beneficial for an assessment of traffic during the shoulders of a peak period or where models are sufficiently large that different areas of the model experience localised peaks at different times.

As mentioned above, Aimsun Next models must include a warm-up period in addition to the analysis period. The length of the warm-up period will depend on the network size and congestion level. It is recommended that the warm-up is long enough that the flows within the model are stable and all vehicles can finish their journey. This length of time can be calculated by applying a flat matrix and running the simulation without a warm-up, with a one-minute statistics interval. The time series will show when the number of vehicles within the model is stabilised. This time plus the expected journey time of the longest significant journey will give the minimum warm-up time.

For instance, in **Figure 24** below the model becomes stable after 35 minutes. The longest expected journey in the model was 25 minutes. Therefore, the warm-up should be at least an hour.

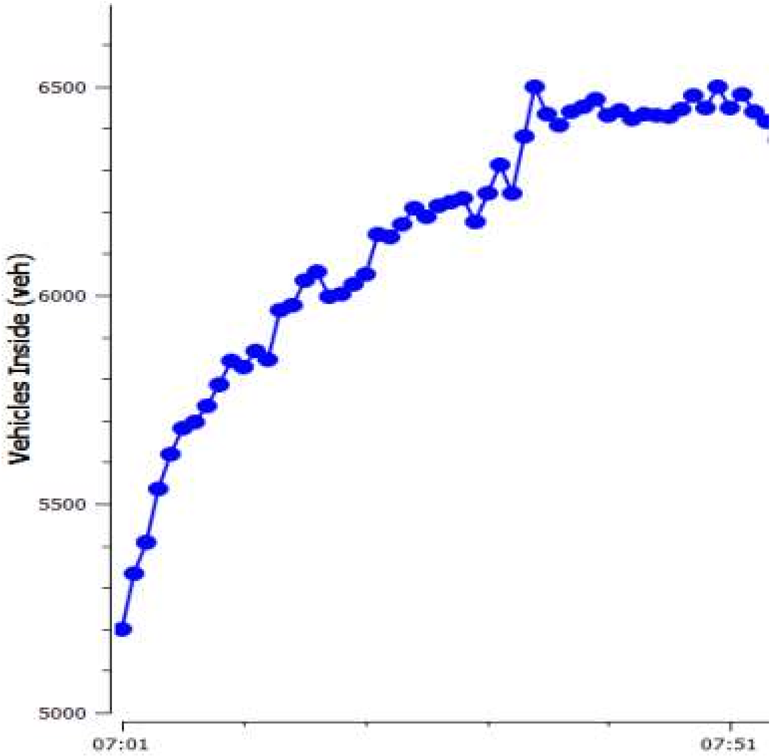

Figure 24: Analysing when the model becomes stable

3.2.4 Network Layout

An Aimsun Next network consists of a set of road Sections linked by Nodes and Turns at the road junctions. The method used to generate the network is determined by the available data sources. The two main methods are:

- Importing from GIS data or from another transport model; or
- Manually editing the network using an image as a background.

3.2.4.1 Network Import

The traffic network may be imported from a GIS system or from Open Street Maps (OSM). If this option is used, the data import must select which road categories are to be used in building the network and which are used to provide graphical annotation only. Once the network has been imported, it should be systematically checked to verify the road categories and attributes are correct and consistent. This is facilitated with the view modes in the TfL Aimsun Next Template (see **B3.1.2**) which can be used to display the static attributes of the network and hence provide a visual means of verifying the network consistency.

Each junction in the network should also be examined, and the node shaped to model the layout of the road network in detail. A typical OSM import will only import the node connectivity, and not necessarily the node geometry and section shapes. Network geometry adjustment may be required as shown in **Figure 25** below.

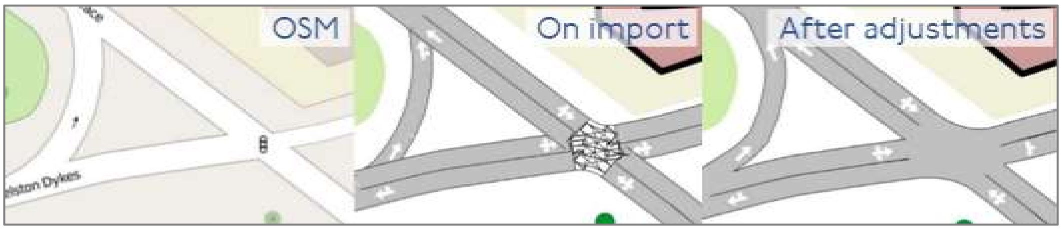

Figure 25: Illustration of network geometry adjustments

3.2.4.2 Transport Model Import

If the road network has already been coded in a pre-existing transport model, Aimsun Next provides a set of importers for most commonly used software to import it from that model. In particular, models can be imported from Vissim, Visum, SATURN and Cube. The Aimsun Next Help documentation provides useful information on which features are maintained and how they are mapped from each software package[65]. The imported model should be systematically checked to verify the road categories and attributes are correct and, as above, that junction geometry is appropriate.

Depending on the source of the data, it may also be possible to import the OD matrices and the Aimsun Next centroid configuration (section **B3.4.4.1**) from the pre-existing transport model.

Calibration data used by other software packages will vary, as the parameters used to calibrate models are different and may not share common definitions. If a network is imported from another software package, it needs to be recalibrated in Aimsun Next.

65 Aimsun Next 20 Help

3.2.4.3 Background Import

The traffic network may be coded on top of background images, such as aerial photographs and detailed topographical drawings. If this option is used, the images should be of sufficient detail and accuracy to give information on relevant network elements such as lane arrangements, stopline positions, give-ways and stop signs, bus stop locations, bus lanes, reserved lanes and lane markings. Before the network build begins it is essential that the background image is scaled correctly, and aerial photos are orthographically correct. As an additional safeguard it is suggested that a scale marker is included on the background which should be at least 100m in length.

It cannot be assumed that drawings and aerial photographs are up to date and accurate, so it is necessary to check layout details during site visits to confirm their accuracy.

3.3 Graphical User Interface

The New Project window, shown in **Figure 26**, is where the fundamental project settings are defined, including which aspect(s) of Aimsun Next is being used and the side of the road traffic drives on. It can also define the background to be used (section **B3.2.4.3**).

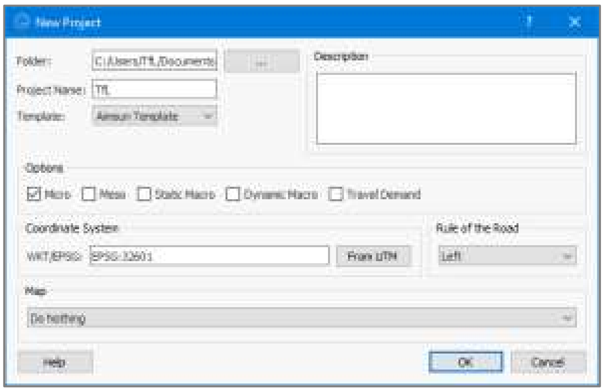

Figure 26: New Project window

The standard Aimsun Next view contains a number of windows which are used when building, calibrating and running a model. Model building tools can be found on the left of the network window, as can be seen in **Figure 27**.

Aimsun Next models are built from objects, for example Traffic Demand objects or Road Type objects, which can be edited in the Project window, on the right of **Figure 27**. This is where most of the model settings are defined. Double-clicking on an item in the list will bring up a dialog box relating to that object and right-clicking brings up a list of options including to create a new object.

Controls for running the model can be found above the network window and a log of actions below it.

The Layers window (bottom right of **Figure 27**) can be used to organise what is displayed and the order in which it appears. This can be useful to focus on particular features, such as the public transport system, or switch between different images or CAD drawings which may be used as backgrounds.

The objects which together determine the structure of the modelling project and how it is run are Scenarios, Experiments and Replications. Dynamic Scenarios hold the key data inputs required to run a simulation. These include the Traffic Demand, the signal Master Control Plan and Geometry Configurations. Additionally, settings related to the generation of simulation outputs, the Aimsun Next API and the use of Strategies and Conditions can be found at Dynamic Scenario level.

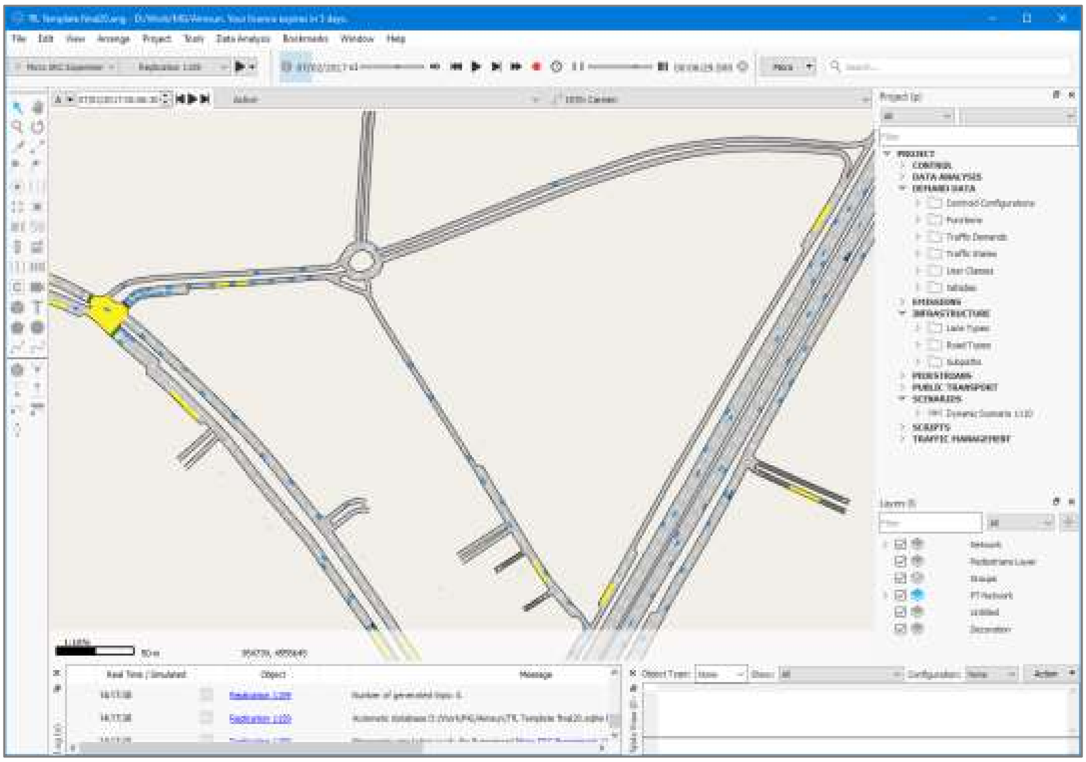

Figure 27: Aimsun Next 20 GUI

Scenarios include one or more Experiments which inherit the data and settings specified in the Scenario. When an Experiment is created, the simulator (microscopic, mesoscopic or hybrid) and Assignment Approach (for example Stochastic Route Choice or Dynamic User Equilibrium, section **B3.4.4**) are selected. The Initial Simulation State, along with driving behaviours such as Car Following and Lane Changing, and the Simulation Step are all set at Experiment level.

It is possible to test the performance of different simulation types and assignment methods by creating multiple Experiments within the same Dynamic Scenario.

An Experiment should contain multiple Replications which each use a different random seed, as described in section **B3.5.1**. These represent different simulation runs of the Experiment and in order to guarantee that the microsimulation results are statistically significant a sufficient number of Replications must be created. The final Experiment results are generated using an Average Replication.

3.4 Base Model Calibration

Once the input data has been collected, it can be used to build and calibrate the model. This section provides guidance on the structure of data in Aimsun Next and how to approach the model build.

A key part of building a properly calibrated and validated Aimsun Next model is observing the model while it is running. Accurate representation of vehicle behaviour is necessary for the model to fulfil its purpose. The animation features of Aimsun Next can be used during calibration to identify irregularities in driver behaviour that may adversely affect model operation. The model should be observed during multiple seeds to gain a rounded picture of its performance and provide reassurance that all the network elements are functioning correctly.

3.4.1 Model Parameters

There are certain parameters which should be agreed and set at the start of model development. Changing these parameters after calibration will invalidate model results.

3.4.1.1 Simulation Step

By default, the simulation step in Aimsun Next corresponds to the reaction time of all vehicles; values that should be used are in the range 0.6-1.0s. Other values should be used only if the study requires different vehicles to have different reaction times.

Note that in Aimsun Next, the simulation step is set in the Experiment and is independent of the controls in the view window which are used to adjust the speed and smoothness of the simulation animation. Similarly, the detection interval for loops is set in the Scenario independently of the simulation step and, if necessary, can be adjusted to satisfy requirements set by an external signal control system.

3.4.1.2 Units

Units can be set both at System and Project levels. They are accessed via Edit > Preferences > Localisation. If a Project is loaded then these preferences will act on this Project, if not then they will act at System level so all new Projects will have these preferences applied.

Units should be set to Metric. This means that all speed limits will need to be converted to kph before they are used.

3.4.1.3 Rule of the Road

As indicated in **B3.3**, the Rule of the Road, or the side of the road that vehicles drive on, is set in the New Project window. If necessary, it can also be changed in Edit > Preferences > Localisation, and should be set to Left.

3.4.2 Network

The Aimsun Next network structure is built using Sections, Nodes and Turns. Road Types define different sets of default behaviour parameters for Sections and Turns. The key elements of the network structure are described in this section, along with some guidance on network editing.

3.4.2.1 Sections

Sections are classified using Road Types (**B3.4.2.6**), a predefined set of templates for road parameters. The types used in the TfL Aimsun Next Template (see **B 3.1.2**) are:

- Bicycle Track / Pedestrian Way is included as a reserved road type separated from the main vehicle flow and for bicycles and pedestrians only;
- Motorway and dual carriageway Road Types are provided with speed limits of 40, 50, 60, and 70mph, with a capacity estimated at 1400veh/hr/lane;
- Rural Single road type with speed limits of 50 and 60mph, the typical rural speed limits; and
- Urban road type with speeds of 20, 30 and 40mph, with an additional narrow classification for a 30mph road type with reduced lane width and capacity.

The Section capacity will be altered automatically if the number of lanes of a Section is changed. Flares (Side Lanes) are not considered when calculating the capacity per lane or the new section capacity.

The use of a Section can be restricted to specified Vehicle Classes by defining its lane type. Lane types contain a list of reserved vehicle classes and specify whether their usage of a lane is optional or compulsory. The lane types used in the TfL Aimsun Next Template (see **B3.1.2**) are listed below, but more can be defined as needed:

- Reserved, Compulsory for Heavy Vehicles;
- Reserved, Compulsory Public Transport;
- Reserved for Bicycles; and
- Reserved for Congestion Charge.

Sections shorter than the length of the longest vehicle, or longer than several km, should be avoided. Sections are also divided into segments, which are the parts of the Section between the points used to build it. Segments can be either straight or curved in order to better fit the road layout. Segments can be used to define speeds, slopes or reserved lanes.

Bus lanes should be modelled as part of a multi-lane Section using lane restrictions. Bus lanes should not be modelled as separate Sections unless this reflects the road layout on street. The lane restriction can be removed with a Traffic Management action or an attribute override if it is necessary to model traffic when the bus lane is not in operation. If the reserved lane is the only one that allows a turning manoeuvre at the end of the Section, vehicles that want to make the turn will ignore the restriction. A specific point after which vehicles can enter the reserved lane can be set by un-reserving the last Segment of a Section.

A bus bay should be long enough to accommodate the longest public transport vehicle plus the minimum distance between vehicles parameter (**Figure 28**).

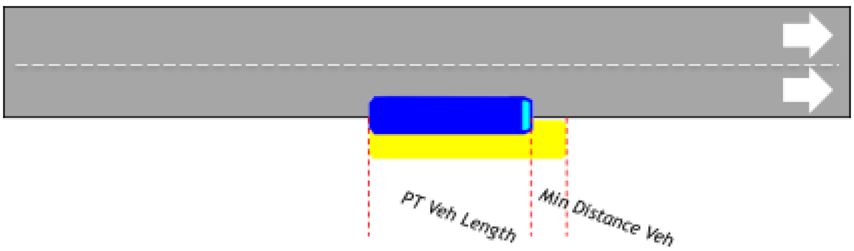

Figure 28: Bus bay length

3.4.2.2 Nodes and Turns

Nodes should accurately represent observed conditions including turning movements, banned turns, yellow boxes, lane to lane connections, advanced stop lines, and appropriate priority rules. Behaviour at nodes has an impact on congestion and vehicle journey times, especially in networks with give-way junctions and opposed movements at signalised junctions.

Lane connectivity between the arms of a junction should be set in accordance with road markings unless alternative lane use is observed on street. Model elements and values which can be adjusted are:

- Lane connectivity and geometry;
- Turn Speed: should usually be calculated automatically;
- Turn Capacity: should usually be calculated automatically;
- Attractiveness: should usually be equal to the capacity; and
- User-Defined Costs: values should be selected in order to manipulate the route choice in a balanced way so as not to over-penalise a route vs the alternatives and to match the observed traffic volumes.

Additionally, most Road Type Turn level parameters (section **B3.4.2.6**) can be overridden at Node level if different behaviour is required.

The Speed and Capacity values are used by the Route Choice functions in Aimsun Next Micro and Meso models depending on how the Attractiveness parameter has been defined.

Look-Ahead Distance and Additional Waiting Time Before Missing Turn (**Figure 29**) for movements should be carefully specified and calibrated as they play a major role in the lane changing behaviour of upstream Sections. There are three different zones in Aimsun Next, each one corresponding to a different lane changing behaviour. These are:

- **Zone 1** – The lane-changing decisions are mainly governed by the traffic conditions of the lanes involved;
- **Zone 2** – The intermediate zone. Vehicles which need to change lanes to make their desired turn adapt their speed to do so; and
- **Zone 3** – Vehicles urgently try to reach the lane they need to make their turn, by looking for gaps upstream and reducing speed. If necessary, they come to a complete stop in order to make the lane change possible.

The zones above are determined by the Look-Ahead Distance, which defines zone 2, and the Critical Look-Ahead Distance, which specifies zone 3. Outside the Look-Ahead Distance, a vehicle is considered to be travelling in zone 1.

An important parameter in defining zone 3 is Additional Waiting Time Before Missing Turn. If vehicles fail to make their turn after waiting their Maximum Give Way Time (section **B3.4.2.6**) plus the Additional Waiting Time Before Missing Turn, they continue in their current lane. This parameter can take values between -3600 and 3600. A negative value will reduce the original waiting time to a minimum of 0 seconds. The default value for this parameter would be 0 seconds, unless a particular problem is noted in the model, such as too many vehicles missing their turns (flagged as lost vehicles in the Node Attributes tab).

Distance zones should be used to make vehicles get into the appropriate lane in advance and stay in the lane. Using Solid Line lane markings at junction approaches is not recommended as vehicles that do not reach the lane they need in time will miss their turn.

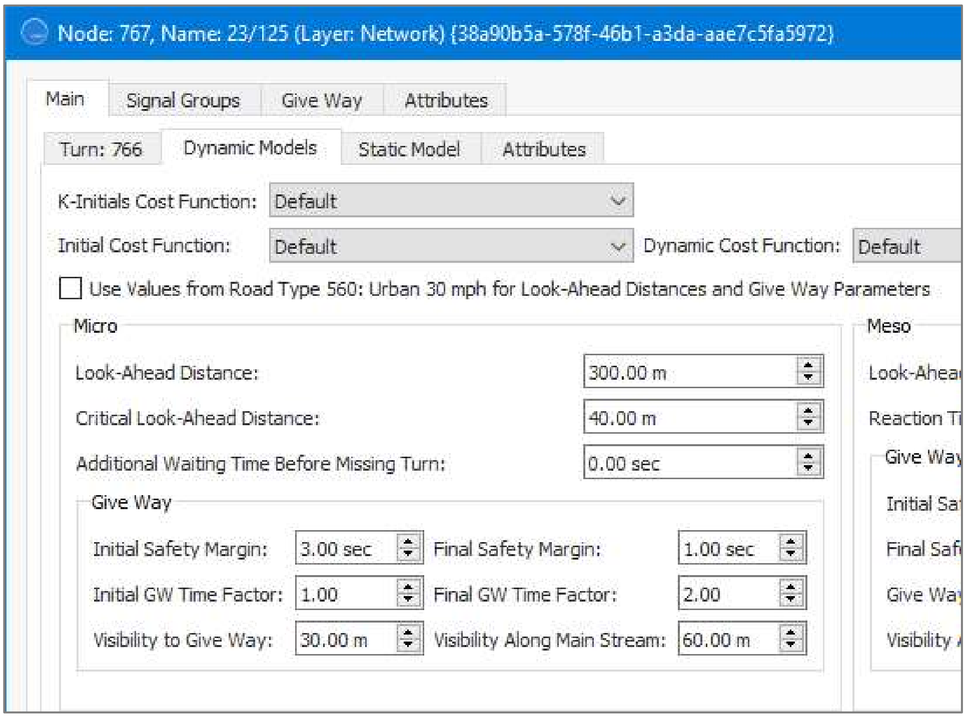

Figure 29: Extract from Node window showing Dynamic Models options

A Section preceding a turn that should be approached at reduced speed should be long enough to allow the vehicles to decelerate prior to entering the turn. Aimsun Next vehicles only become aware of the need for a change in speed in the Section immediately preceding a low-speed turn or Section, so short Sections are discouraged. If a short Section is needed, for a flare or other reason, in between a high-speed Section and a lower-speed turn, then the speed of that Section should also be reduced.

Turn geometry should be checked to ensure that there are no unnecessary conflict zones. In addition, the following features should be observed while the model is running to ensure they are correct:

- Sign associated to turns (for example Give Way, Stop or none);
- Priority rules between two turns;
- Stop line position (at the end of the Section, or an advanced stop line);
- Stop lines within a turn where queuing within a junction is allowed;
- Gap-acceptance model parameters; and
- Yellow box junction parameters.

To define priorities within a node (such as right turn against opposite through movement), specify a movement Warning as Give Way and add a stop line where the vehicles wait, even if there is no sign present on the physical network.

Stop lines controlling where vehicles stop at the end of the Section before moving through the Node should be located appropriately. The default position is at the end of the Section, but they may be moved individually to represent junction geometry or observed vehicle behaviour (**Figure 30**). Advanced stop lines should not be placed in the trajectory of another turn, even where signal timings would not give a conflict. This is to avoid gridlocking in future year scenarios where high levels of congestion may be predicted.

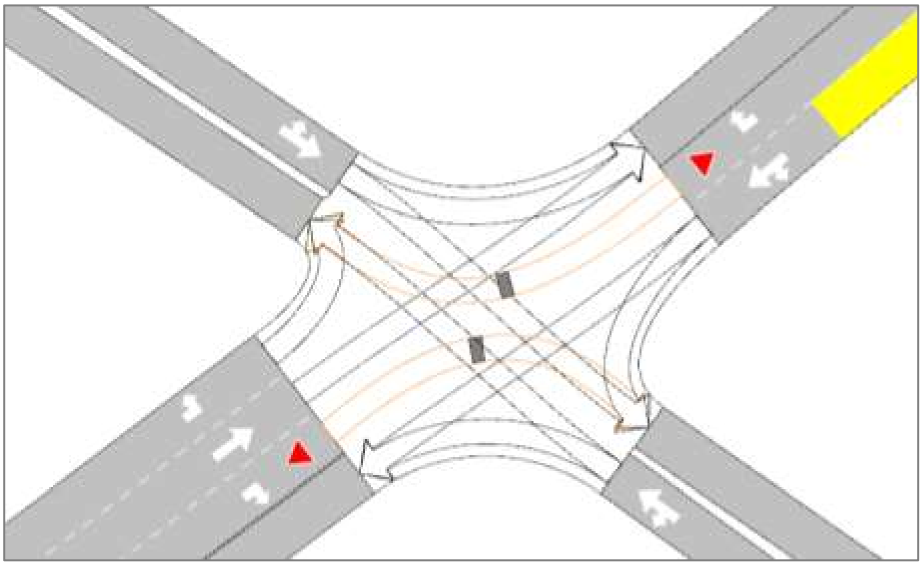

Figure 30: Advanced stop lines (dark grey boxes) at a traffic signal

3.4.2.3 Junction Geometry

Junctions with filters should use separate Sections for the filter where there is a hard barrier between the lanes and the distance from the start of the filter to the junction is greater than 10m.
If there is a waiting area within the central reservation, this should be coded as a Section in order to achieve the correct give-way behaviour at each part of the turn, as shown in **Figure 31**.

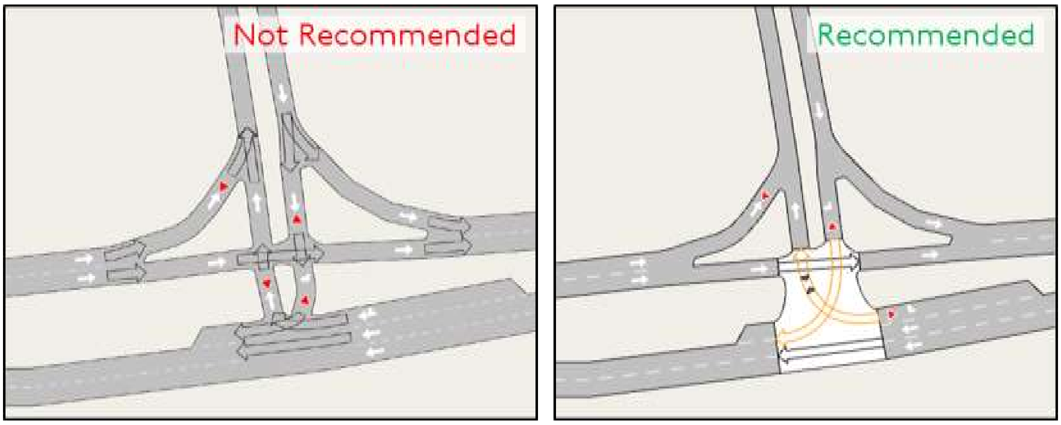

Figure 31: A junction with filters and a central reserve with the recommended construction method on the right

Sharp angles at the entrance or exit of a road Section (**Figure 32**) should be avoided as cars that are adjacent may be considered in different locations, one in turn and one in Section, which can cause issues with conflicts. They may be used in certain circumstances where the stopline is sharply angled, for instance at a roundabout or angled give-way. If this is the case, it is necessary to check that the model behaviour replicates on-street behaviour at this location.

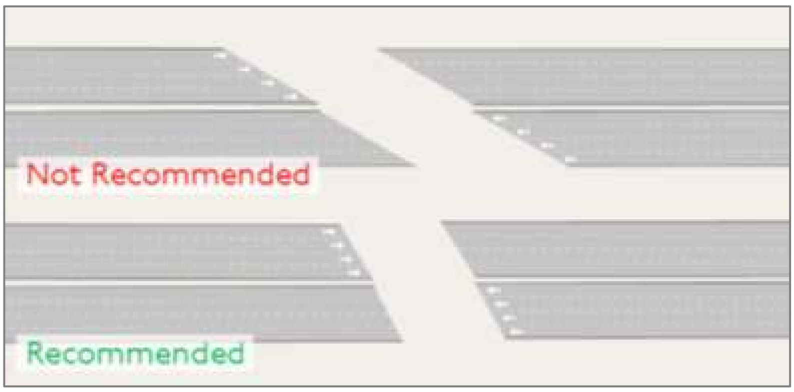

Figure 32: Angled Section entrances and exits. The top row would be considered too sharply angled.

3.4.2.4 Side Lanes

Side Lanes are used to model on-street flares, but should also be used to replicate any kind of merging or diverging behaviour. This section contains advice on the use of Side Lanes.

Connections between lanes where multiple lanes are connected to a single downstream lane, causing conflicts, should be avoided. Instead, Side Lanes should be used to better replicate co-operative behaviour (**Figure 33**). These connections may be justified in certain circumstances, where on-street behaviour necessitates, however their usage is discouraged. The Side Lane on a merge / diverge should extend to the length of the taper on street.

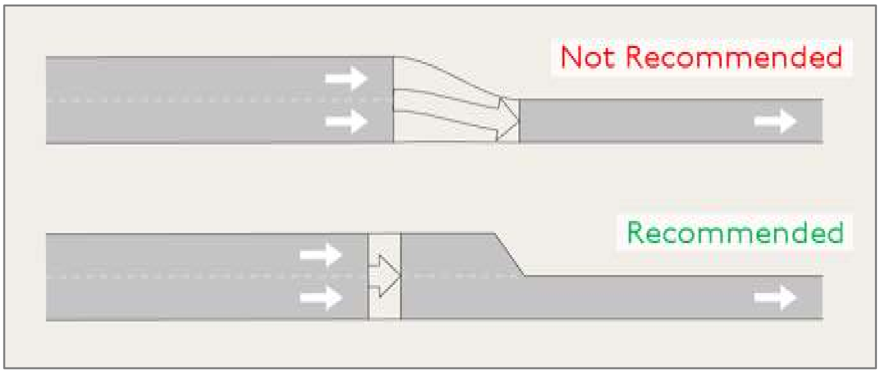

Figure 33: Use of a Side Lane to model a merge

Where there is a Side Lane on the approach to a turn, the Look-Ahead Distance and Critical Look-Ahead Distance must be greater than the length of the Side Lane. This is to ensure queues propagate from the entrance to the Side Lane. In addition, the Side Lane should not exceed half the Section length to ensure that vehicles have time to slow down in order to change lane, as shown in **Figure 34**. Since vehicles only consider the need to slow down to make a lane change on entry to a Section, if their speed exceeds the speed needed to safely change lane, then the vehicle may not be able to change lane and will therefore miss the turn. If it is not possible to make the Section long enough then the speed on the upstream Section may need to be adjusted.

Figure 34: Side lane lengths. The Section on the left is too short.

On-ramps or lanes that drop (with a merging action) should be coded as a single Section with a Side Lane at the start (**Figure 35**);

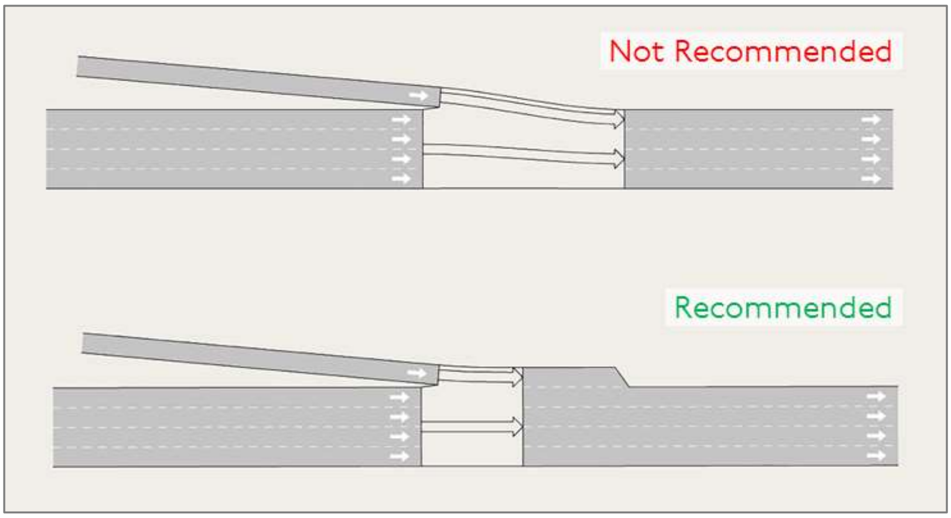

Figure 35: Section On-Ramps with correct Side Lane usage below

For more complex merges, such as ghost island merges, multiple sections should be avoided, instead solid lines and lane connections should be used (**Figure 36**).

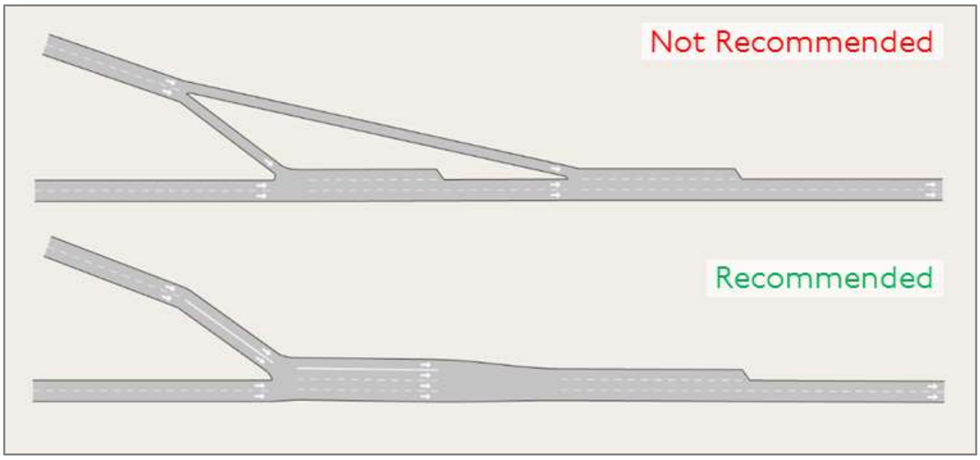

Figure 36: Complex merges

3.4.2.5 Roundabout Geometry

It is recommended that different roundabout types are modelled as described below. This is in order to create consistency for future year testing and to best replicate UK-wide behaviour. There may be cases where these designs are not appropriate, but these should be treated as the exception. This advice applies to priority roundabouts only and not those with signal control.

A mini roundabout should be coded as a Node (**Figure 37**), with all turns assigned as Give Way in the Warning column. Use give-way parameters to ensure that traffic gives way to the right. These can be accessed via Node properties and the Give Way tab.

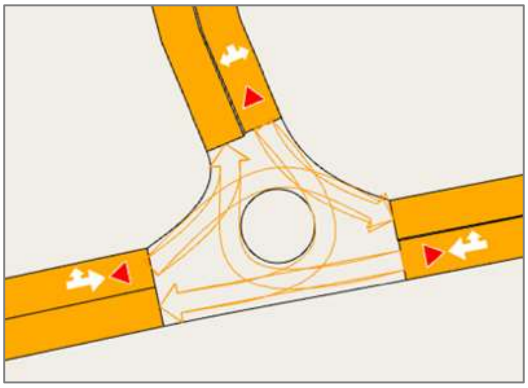

Figure 37: Mini roundabout coded as a Node

A roundabout with a single lane can be modelled using Aimsun Next's roundabout tool (**Figure 38**). This automatically generates Nodes and Sections in a circular layout connecting all Sections that are selected. These can then be modified as normal.

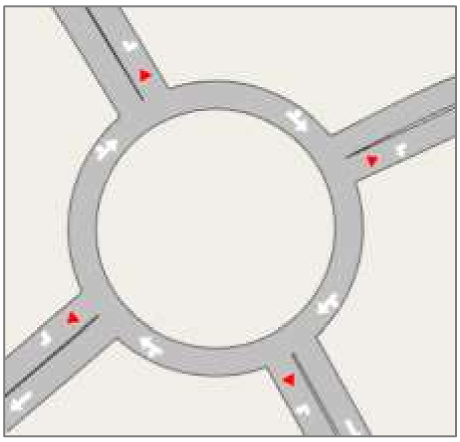

Figure 38: A single lane roundabout generated using the roundabout tool

A priority roundabout with more than one circulation lane should be modelled as a set of give-way junctions. To ensure that the lane assignment is correct from all entries to all exits it can be coded by using a section between the entry and exit arms of the same approach and a node between each arm of the roundabout, as demonstrated in **Figure 39**.

Each possible path that could be taken through the roundabout should be checked to ensure that the lane assignment is correct. Where the roundabout has three circulation lanes, the Advanced Node editor can be used to ensure that the correct lanes are connected.

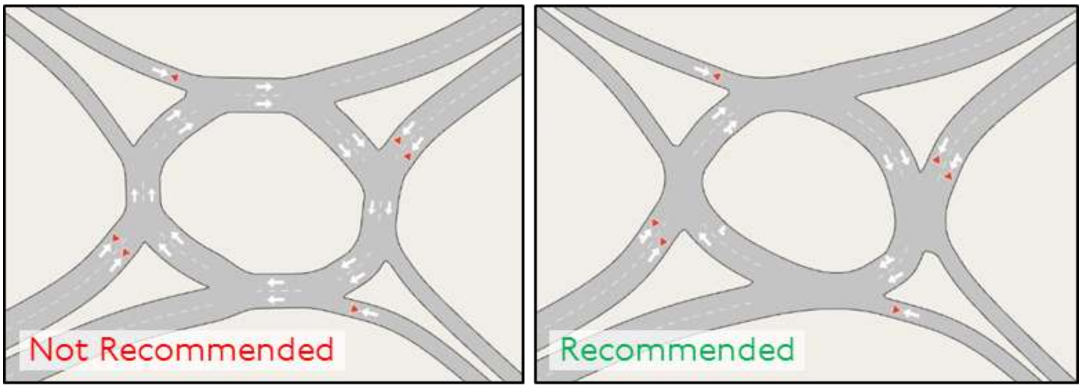

Figure 39: A multi-lane roundabout with the recommended construction method on the right

The Critical Look-Ahead Distance should be at least the circumference of the roundabout plus the Visibility to Give Way, in order that vehicles are in the correct lane on entry to the roundabout. The Look-Ahead Distance should be greater than this value.

3.4.2.6 Driving Behaviour

In Aimsun Next, the parameters that control vehicle behaviour can affect:

- **All vehicles at all locations** – these are set in the Experiment;
- **A subset of vehicles at all locations** – these are set in Vehicle Types;
- **All vehicles at a subset of locations** – these are set in Road Types; and
- **All vehicles at a specific location** – these are set in a Section or Turn (overriding the values set in the Road Type).

Experiment, Vehicle Type and Road Type parameters should be agreed and set at the start of model development. If necessary, new Types can be added later. Section and Turn parameters should be adjusted locally where required during the calibration of the Base model. Once the model is calibrated, changes to any of the parameters will invalidate the results.

The TfL Aimsun Next Template (see B3.1.2) contains default values for the parameters associated to common types of roads (freeway, ramp, arterial, urban road) and common types of vehicles.

Road Type and Vehicle Type parameters can be accessed by double-clicking the relevant item in the Project window and then navigating to the appropriate tab or sub-tab. Figure 40 and Figure 41 below attempt to describe the locations of some of the key parameters.

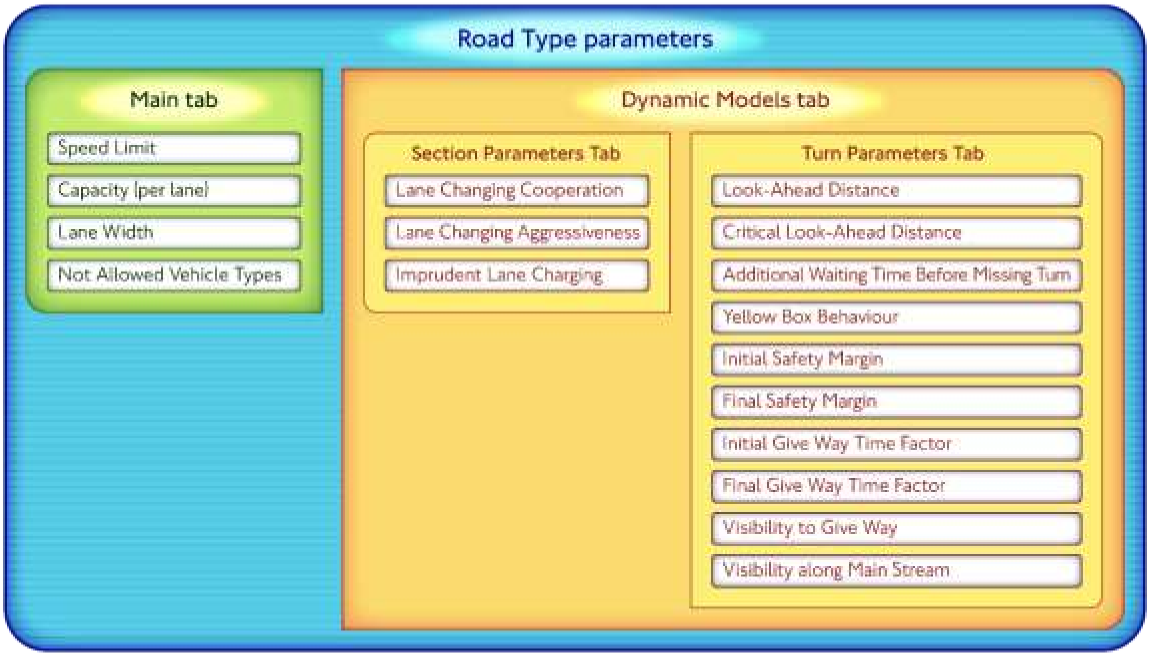

Figure 40: Road Type parameters

These parameters should only be changed if there is sufficient justification and it is preferable to generate new Vehicle or Road Types, to make commonly used changes readily auditable, rather than edit the default types.

It is recommended that Section and Turn parameters are inherited from the Road Type, rather than being defined locally, during the building of the model. Section and Turn parameters should only be modified during the calibration process. If a parameter is to be changed at several locations, it is better to change the Road Type or define a new Road Type rather than changing the local parameter at all locations.

To avoid complicating the maintenance and review of the model, the number of additional Vehicle or Road Types used should be kept to a minimum. Any changes to Vehicle Types, Road Types or Section and Turn parameters should be agreed with the MAE.

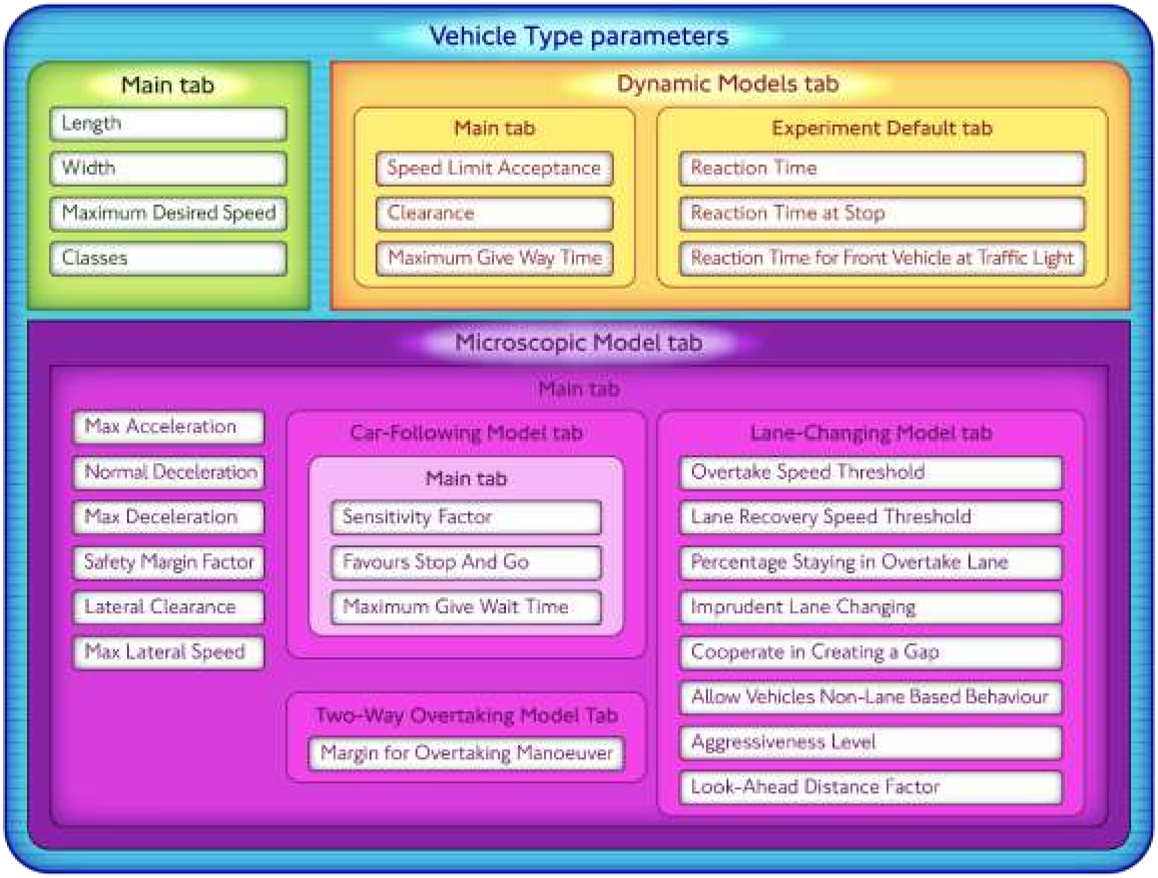

Figure 41: Vehicle Type parameters

3.4.3 Traffic Data

This section contains information on how traffic is modelled in an Aimsun Next model. This includes defining the characteristics of individual vehicles and specifying how vehicles enter the model. There is also some information on modelling public transport, cyclists and pedestrians.

3.4.3.1 Vehicle Types and Classes

Vehicle Types are used to represent vehicles with different physical characteristics and behaviour. They may also define access to restricted lanes in the model, such as bus lanes. Vehicle Types may also be used to refine the Traffic Demand by disaggregating the demand matrices by Type or groups of Types.

Vehicles Types can be grouped into Vehicle Classes, which are only used in reserved lane definitions.

The vehicle characteristics should not be adjusted without justification. Other Vehicle Types can be created if supported by observation, survey results or where required by the scheme. For example, a scheme may be concerned with speed enforcement measures and so an additional Vehicle Type could be included to model the behaviour of speeding vehicles.

When creating a new Vehicle Type, it is essential to assign it to the correct class. A new Public Transport Vehicle Type must be assigned to the 'Public' class so that it can use a reserved lane.

3.4.3.2 Vehicle Network Entry

The time interval between two consecutive vehicle arrivals at the entry points in the network depends on the arrivals profile parameter selected.

The arrival profile is set at an Experiment level but may be overridden for individual centroids for OD traffic demand, or for individual Sections where demand is controlled by Traffic States (section **B3.4.4**). Different options available, as shown in **Figure 42**, are:

- Exponential distribution, the default option;
- Normal distribution;
- Uniform distribution;
- Constant, arrivals at a regular fixed time interval; and
- ASAP, As Soon As Possible, meaning whenever there is a space on the receiving road section.

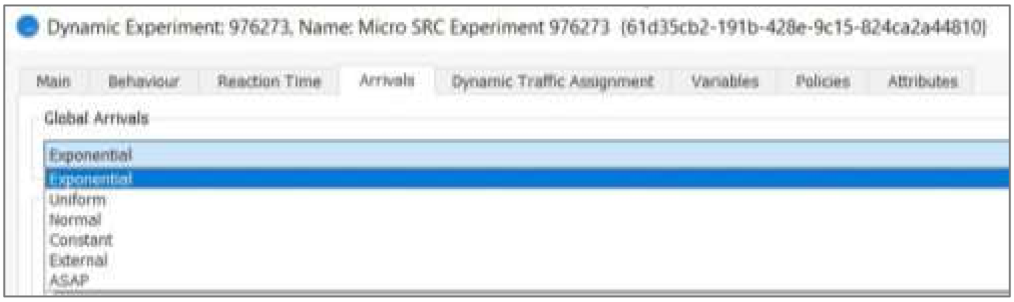

Figure 42: Arrival profile options

The exponential distribution is a default option to represent typical traffic conditions (unless the data collected shows otherwise), the constant distribution may be used for gated traffic entry, and the ASAP mode is useful when simulating intensive demand such as at a car park exit after an event. If the arrival algorithm is changed from the default exponential distribution, this should be noted in the project report.

3.4.3.3 Warm-Up Demand

A warm-up period is specified to populate the network realistically with vehicles when measurements start. The traffic demand should be profiled by using multiple demand items for each Vehicle Type so that the traffic loading to the network varies over time and follows a profile that characterises the pre-peak, peak and post-peak conditions. Loading a flat demand composed by a single Traffic State or OD Matrix per Vehicle Type does not allow the model to reproduce the dynamics of queue building and dispersion that can be observed in reality. Ideally, the simulation should start and finish without congestion in the network for a proper comparison with future scenarios.

The warm-up may be modelled by preloading the network with a saved initial state or by running the simulation for a given amount of time using either a specific warm-up demand or the same demand in use at the study period start time. The decision about which warm-up method to use must be documented in the model report.

3.4.3.4 Public Transport

Public transport lines should be modelled as timetabled so either TfL website data[66] or iBus data (section **B3.2.2.5**) can be used. If iBus data is used, care should be taken to use the scheduled rather than actual data. This is so that any impact is part of the model performance, rather than built in.

Public Transport routes may be imported from a General Transit Feed Specification which defines a common format for Public Transport schedules and associated geographic information. Alternatively, they may be entered through custom scripts or, in a small model, they may be edited manually. **Figure 43** below shows the Public Transport Line data entry window.

Frequency-Based bus departure times should be made variable with a random perturbation in the time interval to prevent all buses appearing in the model at the same time. If bus termini are included, schedule conditionality can be considered, where one service will not depart until another has arrived.

66 **https://tfl.gov.uk/travel-information/timetables/**

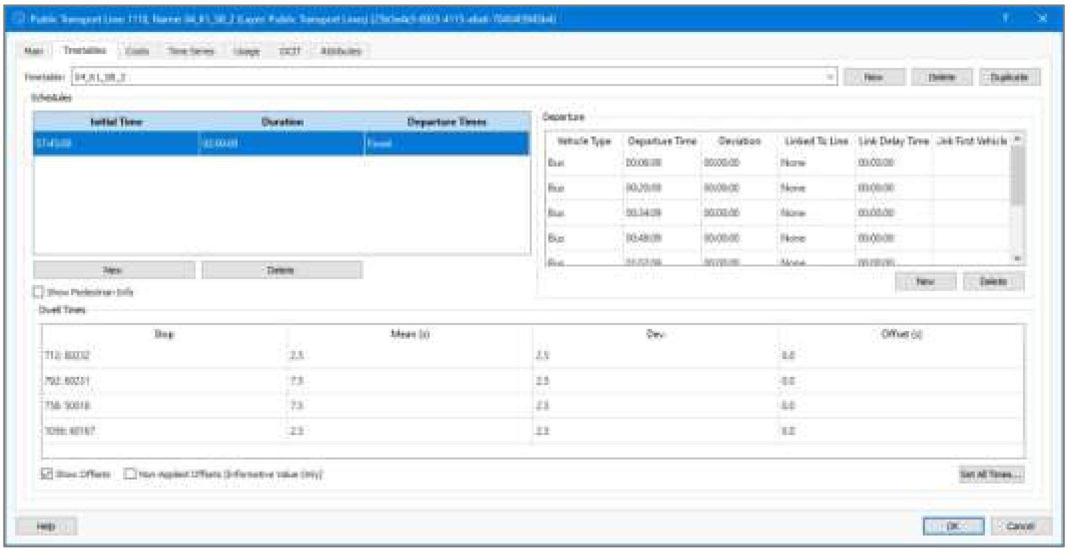

Figure 43: Public Transport Line timetable window

3.4.3.5 Pedal Cycles and Motorcycles

Aimsun Next 20 includes a lateral behaviour model which can be used to simulate the behaviour of powered and non-powered two-wheelers. Although it can model Non-Lane Based movements, it focuses on large-scale performance and aggregated outputs rather than realistic vehicle trajectories[67]. This should be borne in mind when considering the outputs and purpose of the model.

In order to make use of Non-Lane Based behaviour it must be activated at Experiment, Vehicle Type and Section levels:

- At Experiment level, the option is found under the Behaviour tab;
- At Vehicle Type level, the option is in the Lane-Changing Model sub-tab, which is in the Main tab of the Microscopic Model tab; and
- At Section level, the option is on the Dynamic Models tab.

A combination of these settings can be used to produce the desired results at each location in the model.

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3.4.3.6 Pedestrians

Pedestrian modelling is required when modelling uncontrolled or zebra crossings, public transport vehicle interaction and signalised crossings with pedestrian demand calls. The number of pedestrians must be calibrated through site observation and, as with other network bottlenecks, sample counts of traffic passing the crossing will assist model calibration.

Pedestrians may be directly included in an Aimsun Next model from Aimsun Next 20 onwards. Earlier versions of Aimsun Next had the facility for pedestrians modelled using LEGION, with the LEGION for Aimsun simulator, and this is still available in Aimsun Next 20 where more detailed pedestrian modelling is required. It is also possible to model pedestrian phases at junctions without a full pedestrian simulation, and information on this can be found in section **B3.4.5.3**.

3.4.4 Routing

The traffic demand in Aimsun Next is defined by means of a Traffic Demand object which may be coded in two ways: OD Matrices or Traffic States. In addition, it is possible to use Path Assignment outputs from existing Static Assignments or DUE Experiments as input files to define routing. A Static Assignment, in Aimsun terminology, refers to a macroscopic-level model which uses aggregated flows rather than individual vehicles. The choice of Traffic Demand and, if relevant, Path Assignment Plan is set at Scenario level, and settings relating to routing can be found on the Dynamic Traffic Assignment tab at Experiment level.

On the Dynamic Traffic Assignment tab, the Interval refers to how often the shortest path is calculated by whichever algorithm is chosen. The Number of Intervals defines how many intervals of previous data will be considered during the calculation.

3.4.4.1 OD Matrices

An OD Matrix provides the number of trips that depart from each origin zone to each destination zone for each Vehicle Type and time interval. To use an OD Matrix, a set of Centroids must be created and connected to the road network as these define the structure (number of rows and columns) of the OD Matrices. Aimsun Next supports working with multiple sets of Centroids (Centroid Configurations) if the study requires the use of different zoning systems for different traffic components (for example. cars and pedestrians).

Centroids can be connected to more than one Section using multiple Connectors. This should be avoided if information is known about all the locations. By default, the Connectors use a gravity model to assign the 'best' Connector to use for a vehicle to make its journey. If multiple Connectors are used, they should not be connected to the same Section or within Nodes. Percentages should not be used to define which vehicle uses which Connector. If the default solution does not give good splits, the Centroid should instead be split, and the demand adjusted accordingly.

Centroid Configurations and OD Matrix specification can be found in the Demand Data section of the Project. Traffic Demand objects can be used to apply different matrices to different time periods in the model.

3.4.4.2 Traffic States

A Traffic State provides input flows at all road Sections and turning proportions at all Nodes for each Vehicle Type and time interval. Aimsun Next then allocates vehicles to a turn, based on the need to satisfy the turning proportions at that junction without reference to a path or a destination. Due to the high saturation of London's road network, it is not recommended to use this type of traffic demand if Static Assignment or DUE Experiments are used as it is hard to achieve convergence. In addition, journey time data collection is difficult due to the fact that vehicles may not complete the journey time sections. Therefore, Traffic States are only acceptable if there is no reason to model route choice or journey times.

Traffic States are specified in the Demand Data section of the Project. Traffic Demand objects can be used to apply different Traffic States to different time periods in the model.

3.4.4.3 Route Choice Method

If the Traffic Demand is coded with OD Matrices and the modelled network provides routing alternatives, the route choice method used plays a fundamental role in the validation of the model. Where alternative routes do exist, it is necessary to carefully consider the benefits they may provide, and balance this against the added complexity introduced during Base model calibration and option / scheme testing.

TfL does not advise the use of dynamic routing unless fixed routes cannot be established with accuracy. In cases where dynamic routing is justified, the methodology used should be agreed and documented.

Aimsun Next can route vehicles:

- on the shortest paths in the network;
- on paths determined by a Stochastic Route Choice (SRC) method;
- on specified OD Routes;
- on paths derived from a prior validated Static Assignment Experiment;
- on paths derived from a prior Dynamic User Equilibrium (DUE); or
- on combinations of these options.

The selection of a route choice algorithm and whether input path files should be calculated and re-used depends on the application of the model, on the number of routing alternatives available in the modelled area and on observation of vehicle behaviour. An indication of when each of these options should be used can be found in **Table 7** below, which should be considered in conjunction with the following points:

- For the SRC method, other than the limited cases mentioned in **Table 7**, it is recommended that the Logit model is used, unless it is known that there are lots of overlapping paths with small differences, in which case the C-Logit model should be used. The Logit parameters should be used to calibrate the route choice. The choice of SRC Model and accompanying parameters can be found in the Stochastic Route Choice section of the Dynamic Traffic Assignment tab in the Experiment settings;

- If paths from another assignment, for example a Static Assignment, are used (for example if a Path Assignment Plan is selected in the Scenario), this assignment must be calibrated / validated for the same Base year as the model being developed. The assignment will generate a path file (*.apa) which is used as an input to a Path Assignment object. The Path Assignment Plan sets a Path Assignment for each time interval in the model and can be used to combine multiple Path Assignments;

- The percentages defining proportions of vehicles using different route choice methods can be found in the Fixed Routes section on the Dynamic Traffic Assignment tab in the Experiment settings. The columns are cumulative, so the Following OD Routes column acts on all vehicles and the Following Input Path Assignment column acts on the remaining percentage. If the last column is not 100% then the remaining vehicles follow a path based on the route choice model; and

- Usually, a path is assigned to each vehicle when it is generated and it is fixed for the duration of the trip. However, there is an option to define a proportion of vehicles that can update their paths on entry into the network or during their trip. This can be activated by checking the En-Route Path Update option in the SRC settings and then defining the percentages on the corresponding tab.

Table 7: Decision table for determining route choice method in Aimsun Next

Model Type	Route choice
Single junction or corridor with limited route choice. There is no need to measure journey times or evaluate route changes due to future developments.	Use traffic demand based on a Traffic State.
Single junction or corridor with no route choice.	Run SRC with the Model set to 'Fixed Using Travel Times Calculated under Free-Flow Conditions'.
Route choice is available in the model and congestion has an effect on travel times.	Run SRC with the Model set to 'Fixed Using Travel Times Calculated at the End of the Warm-Up Period'.
Complex route choice is available in the model and there is consistent congestion.	Run SRC with an interval time that is the length of the modelled period so that only one set of trips is calculated.
Route choice is available but some drivers are observed to use paths other than those generated in the static initial paths set.	Use one of the above methods for SRC and optionally add user defined OD Routes and assign the proportion of vehicles on designated trips to these routes.
Route choice is available in the model and congestion varies over the modelled period.	Run SRC with a sensible interval time, such as 15 minutes.
Route choice is available in a large model where there is predictable but consistent congestion which drivers anticipate and route to avoid before it occurs.	Use paths from a Static Assignment or use a DUE route choice / Path Assignment with one interval.

Route choice is available in a large model where there is predictable and varying congestion which drivers anticipate and route to avoid before it occurs.	Run DUE with a sensible time interval. Use varying demand in the OD Matrices to model the changing demand over the period.
Route choice is available in the model. Some drivers are aware of congestion, others are not.	Generate a path file from a DUE Experiment or a Static Assignment. Run a simulation in which the percentage of drivers who have no access to dynamic travel time information use paths from the path file, and others follow SRC generated paths.
Route choice is available in the model, there is congestion, recurrent conditions are modelled, the study requires the capture of routing behaviour of drivers who have access to pre-trip or on-trip travel time information.	Generate a path file from a DUE Experiment or a Static Assignment. Run a simulation in which the percentage of drivers who have no access to dynamic travel time information use paths from the path file, drivers who have access to pre-trip information follow SRC generated paths and drivers who have access to on-trip information receive En-Route Path Updates.
Route choice is available in the model, there is congestion, non-recurrent conditions are modelled (examples include. accident or construction).	Generate a path file from a DUE experiment or a Static Assignment representing recurrent conditions (for example no accident, or no construction). Run a simulation in which the percentage of drivers who have no access to dynamic travel time information use paths from the path file, drivers who have access to pre-trip information follow SRC generated paths and drivers who have access to on-trip information receive En-Route Path Updates. Use Traffic Management actions to divert vehicles from their paths (potentially because they see a VMS or other messaging).

3.4.5 Signal Control

Aimsun Next has a few different methods of controlling signals. Which method is used for a particular modelling project depends on the required outcomes and also the complexity of the project and signal control strategies.

3.4.5.1 Controller Logic

The options for the different forms of signal control are:

- **Uncontrolled** – The Node is managed by stops and give-ways. No traffic signal control present at the Node;
- **Fixed** – The Node is managed by traffic signals with fixed timings. Timings may be derived from LinSig or TRANSYT models or average timings from UTC control systems;
- **Actuated** – The traffic signal stages may be called when vehicles pass over detector loops. Actuated signals must be used if demand-dependent signal stages are required;
- **External** – External control policy implemented using the Aimsun Next API Extension;
- **Unspecified** – A node with no control plan information defined. This type is used when working with different zones to let the simulator know that the control plan for the previous zone is still in use; and
- **Ramp Metering** – A node may use a metering to regulate the flow of traffic, for example a ramp metering at a motorway on-ramp.

The choice of controller logic must be documented and justified in terms of the intended purpose of the model.

As Aimsun Next uses different traffic signal terminology to UK practice. Table 8 shows definitions of the terminology used in Aimsun Next.

Table 8: Traffic signal terminology used in Aimsun Next

Aimsun Next	Definition
Signal Group	A set of turn movements that are controlled by the same indications of traffic signals. Phase in UK practice.
Phase	A time period for which the state of all signal groups is same at that node. Stage in UK practice.
Offset	Time displacement that is applied to the node's cycle when the control plan is initialised.
Cycle time	Time period to complete the full sequence of stages.
Green to red: Yellow time	Amber time.
Red to green: Yellow time	Red / Amber time.
Red percentage (%)	Percentage of green to red yellow time that the vehicles consider as red. This depends on driver behaviour.
Flashing Green	Used for display purposes only. It means the signal group will show flashing green instead of a full green signal.
Interphase	Time to model the fixed clearance time between two phases. Interstage in UK practice.

3.4.5.2 Demand-Dependent Stages

If a model features demand-dependent stages, care should be taken to ensure that the turning volumes match those observed in reality, as they impact not only Section volumes, but also signal timings. The modelled demand dependency should be compared to demand-dependent stage frequency data to calibrate the demand dependency percentage (section **B2.3.8.5**). Warm-up and cool down periods should be excluded from the data collection.

If the Vehicle Actuated (VA) logic cannot be modelled using the actuated signals option in Aimsun Next, or the public transport priority logic cannot be coded using the pre-emption option in Aimsun Next, the API should be used to emulate the actual logic.

Figure 44 shows the data entry window for an Actuated Node.

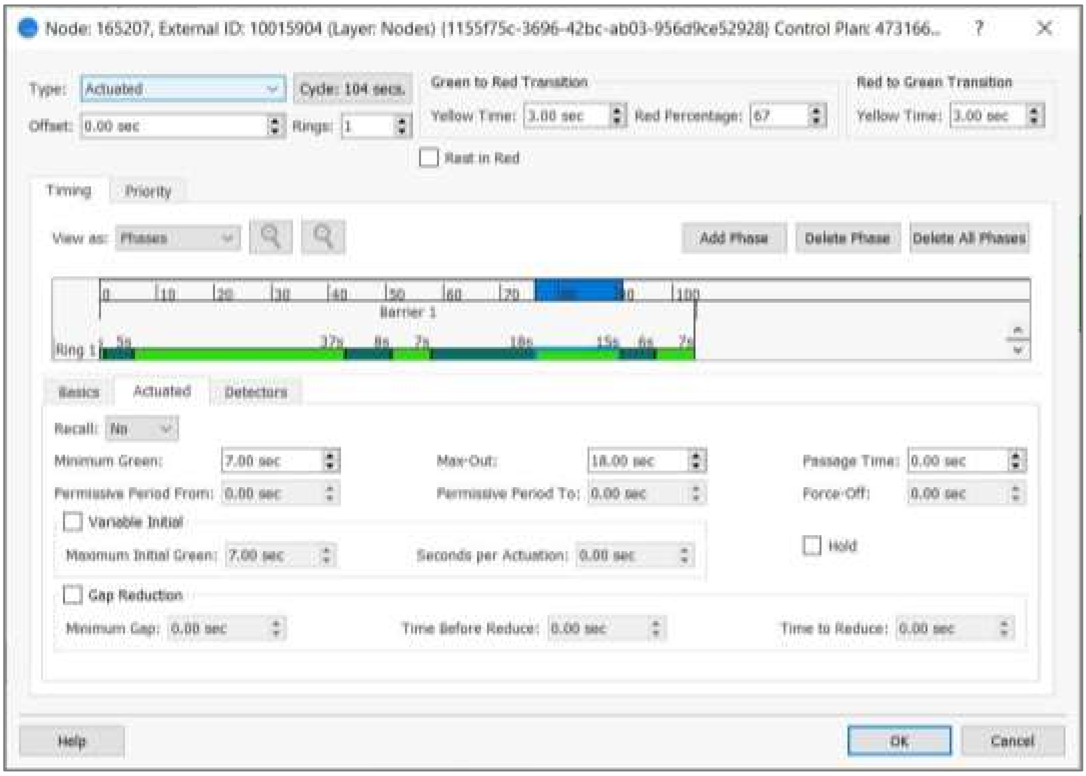

Figure 44: Vehicle actuated (VA) signal control

3.4.5.3 Pedestrian Phases

If pedestrians are not explicitly modelled but pedestrian stages are required, there are three options:

- Code a set of pedestrian crossings at the junction using the Pedestrian Crossing Editor. Use the pedestrian centroids to define entry / exits and define an appropriate number of pedestrians wanting to cross. If no data is available on the number of pedestrians, the number of times that a stage is called within an hour can be used to derive an arrival rate. These crossings can then be added to a signal group and coded as an actuated phase. No detectors are required;
- Code fixed pedestrian phases at each cycle (with double-cycling if the phase is not called every cycle); or
- Write an API application to call the pedestrian phase as required by the API code logic.

3.4.5.4 Give-Ways and Stoplines

Give-ways and stoplines have a significant impact on the throughput at a signalised junction as they define the priority rules between conflicting movements (for example right turn against opposing through route) and the possibility of queuing inside the junction area. Therefore, they are key aspects in calibrating an Aimsun Next Base model to replicate on-street behaviour.

The following parameters are used at a signalised junction to model vehicle movements. Some of them are described in more detail in section B3.4.2.2:

- OD lanes of each turn;
- Lane selection and lane change distance zones of each turn;
- Position of the stoplines at the end of the section;
- Give Way assigned to each conflicting movement;
- Relative priority between two conflicting movements;
- Trajectory (shape) of each turn;
- Conflict areas between turns;
- Intermediate stoplines along a turn;
- Yellow box junctions; and
- Yellow box speed.

With respect to turns that are assigned a Give Way, the gap acceptance parameters may be adjusted to reflect on-street observation. Figure 45 shows the data entry window for assigning turn parameters.

Figure 45: Assigning turn parameters

3.5 Base Model Validation

Base models must demonstrate that they replicate observed conditions to a sufficiently high level of accuracy, as described in **B2.4.1** and **B2.4.2**.

Aimsun Next uses Real Data Sets to load observed data to be compared with simulation outputs. A Real Data Set object should be included in the Aimsun Next model file and used during calibration to identify where the model is close to calibration and where there are still significant errors.

3.5.1 Randomness

A microsimulation model is run for several Replications of the same Experiment using a range of initial seeds to represent day-to-day variations in traffic conditions.

To avoid a biased result, both calibration and validation should be conducted using a minimum of twenty Replications (see **B2.1.5**).

The set of seeds used in the Proposed model and the Base model should be the same. Replications can be run by selecting them in the Project window, right-clicking and selecting the appropriate run option.

The variation in results between Replications should be documented in the model report. The mean and standard deviation of results from multiple Replications should be provided in the validated Base model to demonstrate the variability between simulation runs. The average results can be found in an Average Replication, which can be run independently on the results from specified Replications.

3.5.2 Validated Model Requirements

Validated Base models are submitted during AMAP Stage 3, and all validation threshold figures quoted are from the latest version of MAP, at the time of publishing[68]. Section **B3.7** explains Aimsun Next model outputs in more detail, and the methods described there can be used to indicate that a model has been calibrated and validated according to the thresholds given in this section.

68 SQA-0685, Model Auditing Process (MAP) – Traffic Schemes in London Urban Networks, Version 3.5, Transport for London, March 2017

3.5.2.1 Traffic Flows

MAP recommends that, when comparing modelled flow to observed flow volumes, the target is for GEH (**Appendix II**) values less than five. The report should show all observed and modelled flows together with calculated GEH values. Modelled flows should be averaged over multiple Replications, as described in section **B3.5.1**.

All entry Sections into the network are required to show modelled flows within 5% of observed flows to ensure that all assigned vehicle flows are being successfully loaded into the network during the peak modelled period.

When using traffic counts for validation, the counts measured at road Sections and/or for individual turning movements should be included in the Aimsun Next model as a Real Data Set.

3.5.2.2 Saturation Flows

Saturation flows are used to compare the discharge behaviour of the model at junction stoplines with on-street observation. All observed and modelled saturation flows should be tabulated and the percentage error between the two values reported. Modelled saturation flows values should be within 10% of observed values, or values used in any corresponding validated and approved TRANSYT or LinSig modelling.

During the process of calibration, time headways should be studied. This can be done using the Discharge Rate Evaluation Extension (Micro) extension (section **B3.7.2.2**). The discharge rate evaluation files should be filtered to remove measurements that do not correspond to saturated conditions (for example where there are very large headways). M&V can supply a spreadsheet-based tool which aids the filtering and processing of vehicle headway data. Alternatively, model can be viewed as on street.

> Wherever saturation flows have been measured on street during the relevant time period, providing the model is a fair representation of on-street conditions, it should be possible to measure saturation flows from the Aimsun Next model. An inability to collect saturation flow data across a stopline in Aimsun Next where it was successfully collected on street should be an indication that the model is not performing as desired.

It is possible, however, that saturation flows were measured on street at different times of the day in more appropriate conditions, or that RR67, possibly with a local factor (section B2.3.9.1), has been used to calculate a saturation flow.

There are times when a saturation flow cannot be measured within Aimsun Next that is representative of on-street conditions, for example, where a stopline has low flows crossing it, or where downstream congestion causes queuing which prevents free-flowing movement over the stopline. If this is the case it is acceptable to make a copy of the model and modify it appropriately to generate the necessary traffic conditions. This may be by adding vehicles or removing causes of congestion. This model should be submitted for auditing along with the main model, and appropriate reference made in the model report.

3.5.2.3 Demand Dependency

All demand-dependent stages within the network should show a frequency that is within 10% of that observed on street. The average count for each peak modelled should be reported alongside the control plan statistics produced by Aimsun Next in the MICONTROLPHASEEVENTS table of the output database. This data is collected by selecting Phases Events data collection in the Scenario as shown in section B3.7.1.

3.5.2.4 Journey Times

Modelled journey times should be taken from an average of twenty replications, as described in section B3.5.1, and be within 15% of surveyed on-street journey times (section B2.1.5). Validating over longer journey time distances is favoured over shorter ones although long journey times can be broken into smaller parts for analysis.

Journey times can be collected using either Groupings or Subpaths, as described in section B3.7.2.3. Which of these methods is chosen will depend on the on-street journey time surveys, as the data collection in the model should match the data collection on street as closely as possible and be compared using a similar method of aggregation.

3.5.2.5 Queue Data

Given the difficulty of measuring queue lengths on street in the same way as in a model, a direct comparison of simulated versus observed queue lengths is not a validation criterion; journey time validation is a more reliable indicator of congestion levels. Queues should, however, appear in the model at the same locations and during the same time periods as they are observed in reality, and queuing behaviour in the model should be consistent with site observations.

Queue survey data is useful when determining bottlenecks within a network. It can be used as a measure of the model's performance and for direct comparison with scheme proposals. Modelled and surveyed queues should be compared and presented in accompanying reports. Section **B3.7.2.4** contains information on queue length output in Aimsun Next.

3.5.2.6 Public Transport

Similarly to general traffic, modelled public transport journey times should be averaged over multiple seeds and should be within 15% of surveyed on-street journey times. If Public Transport is specified as an output (section **B3.7**) then data is automatically collected for each route separately.

3.5.3 Check and Fix

As Aimsun Next generates the model for each Experiment based on the options selected in the Scenario and the Experiment, the Check and Fix tool must be run for every Experiment to identify any errors or inconsistencies in the model that may require attention. The log from a Check and Fix run should be included in the model report and annotated to justify any remaining warnings.

The Microsimulation Network Checker should also be run with a sample Replication for an Experiment to report on any missed turns and lost or stationary vehicles. To activate the Microsimulation Network Checker, select the corresponding box in the Aimsun Next APIs tab of the Dynamic Scenario. This is normally used to detect and remove vehicles which are stopped for a time greater than the Maximum Stationary Time. The Maximum Stationary Time, as well as the action to be taken (delete the vehicle, stop simulation, or write in log) on encountering a stationary vehicle, is defined in the Network Checker editor as shown in **Figure 46** below. Ideally, no errors should appear in the Log window during the simulation runs, however, non-critical errors are acceptable within the MAP process (section **B2.1.5**).

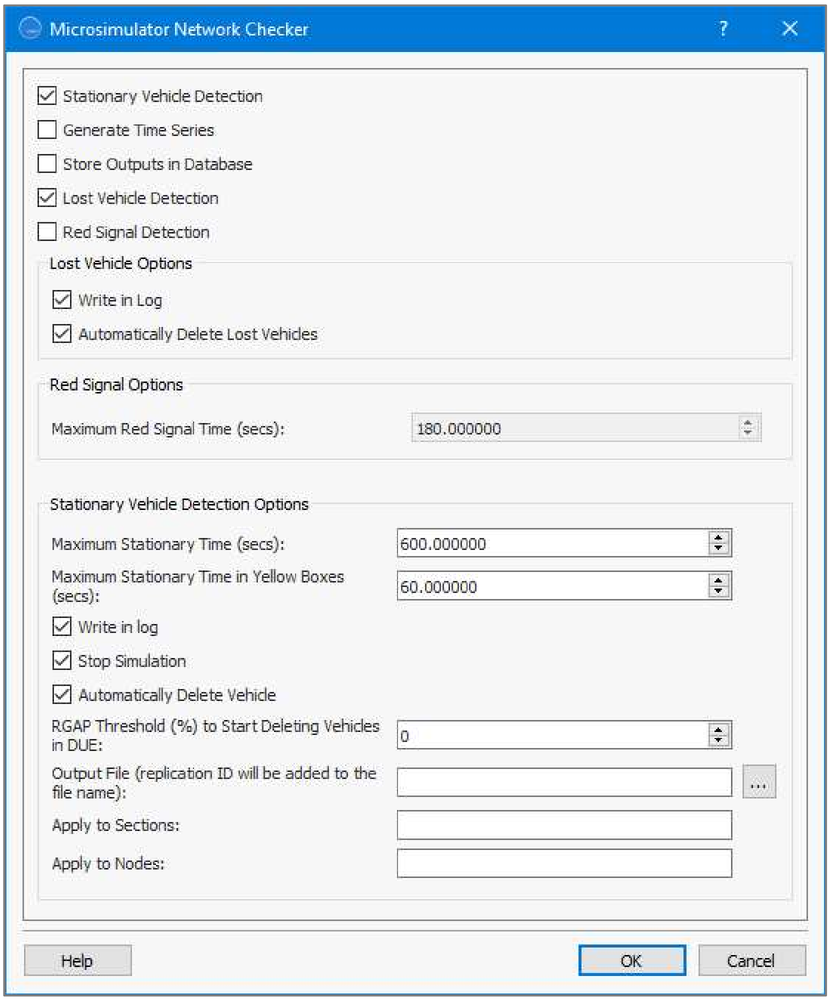

Figure 46: Microsimulator Network Checker window

3.6 Proposed Model Development

It is important that any changes made in a model are both clearly identified and managed to ensure that the multiple different models are consistent and have changes made from the same set of options. For example, NP may opt to test different signal controls and different junction layouts in the context of different levels of demand. Aimsun Next has the ability to create Scenarios and Experiments with different options of network topology, transport demand, signal control and public transport schedules. This provides an efficient method of generating multiple variants of a single model by entering these options once and re-using them in the development option scenarios.

3.6.1 Future Base

The Future Base model bridges the gap between Base and Proposed scenarios and provides a reference when analysing the Proposed results. As described in **B2.5.1**, the Future Base model includes all likely network changes which will occur between the Base year and the year being examined in the proposal, excluding the scheme under consideration. It is built from the Base model by changing as little as possible in relation to each new scheme that has been identified to be added. The guidance in this section applies to creating the Future Base as well as to the Proposed scenarios.

3.6.2 Scenario-Based Workflow

The use of Scenarios and Experiments with reusable components is required when developing option tests in Aimsun Next, to manage the proliferation of model variants and to ensure consistency between them. A typical workflow in option testing is described here:

1. The calibrated and validated Base model is made available. It will contain:

    - The Base Network;
    - A Traffic Demand composed of either one or more Traffic States or one or more OD Matrices which together represent the current level of traffic demand;
    - A Master Control Plan representing the signal control currently in use;
    - A Public Transport Plan representing the public transport schedules currently in use;
    - A path choice method which may include a set of predefined routes cordoned from a wider area model and used to allocate paths to the strategic traffic passing through the modelled area; and

- If a path assignment is to be used, a Path Assignment Plan.

2. The proposed changes for the option test should be coded in the same model file. These may include:

    - Geometry Configurations representing the proposed changes in road layout;
    - OD Matrices or Traffic States which represent the changes in demand. These are integrated with the existing Traffic States or OD matrices to create new Traffic Demand objects, each with a defined set of demands;
    - At each junction where the signal control is changed, a new Control Plan. The new Control Plans for the altered junctions, and the existing plans for unchanged junctions are integrated into a new Master Control Plan;
    - A set of changed public transport schedules for some or all routes, integrated into a Public Transport Plan;
    - A set of parameter changes in an Attribute Override; and
    - A new Path Assignment Plan if the strategic routes have changed.

    The principle underlying these additions is that they are entered once, and reused in the multiple development scenarios

3. A new Aimsun Next Scenario should be created and, under that, one or more Experiments. The objects from the list above are selected in the Scenario with the exception of the Attributes Override, which is selected in the Experiment.

4. The routing is checked for validity:

    - If OD routes, or dynamically created paths are used, no action is required as no path objects were specified in the Scenario;
    - If the Scenario uses paths from a prior static assignment but the strategic road network is unchanged, no action is required;
    - If the Scenario uses paths from a prior DUE or static assignment, and if the future scenario includes changes that alter the network topology, then the APA Fixer should be used to reconnect these paths; or
    - If the Scenario includes paths from a DUE assignment, the paths should be re-evaluated with a new DUE assignment where the warm-up of the new DUE uses the prior DUE paths to evaluate the incremental changes.

5. The Experiment is checked with the Aimsun Next Check and Fix tool and the model Replications for the Experiment are run.

6. Differences between the results from the Base model and the Experiment are displayed in an Aimsun Next View mode, subtracting one from the other. These results are included in the project report.

7. Stages 3 – 6 are repeated with different combinations re-using the model components.

   Changes should not be made to the Base model as part of option testing. In all cases it must still be possible to run the Base model from the same Aimsun Next model file, and all the development changes are to be contained in the changed objects which are then included in the development Scenarios and Experiments.

   When submitting a model to TfL for audit, the model should only include the final set of data and scenario giving the results presented in the report.

3.7 Model Outputs

Aimsun Next can output data for analysis in a variety of different ways, depending on the type of data and how it will be used.

3.7.1 Methods

The key outputs of microsimulations in Aimsun Next can be accessed using the any of the methods described in this section.

The properties of the statistics to be collected, as well as the time interval for their generation, are specified in the Outputs to Generate tab in the Dynamic Scenario menu (**Figure 47**). The detection interval for gathering detector data is also determined in this tab. All the statistics are disaggregated based on the user classes specified in the model.

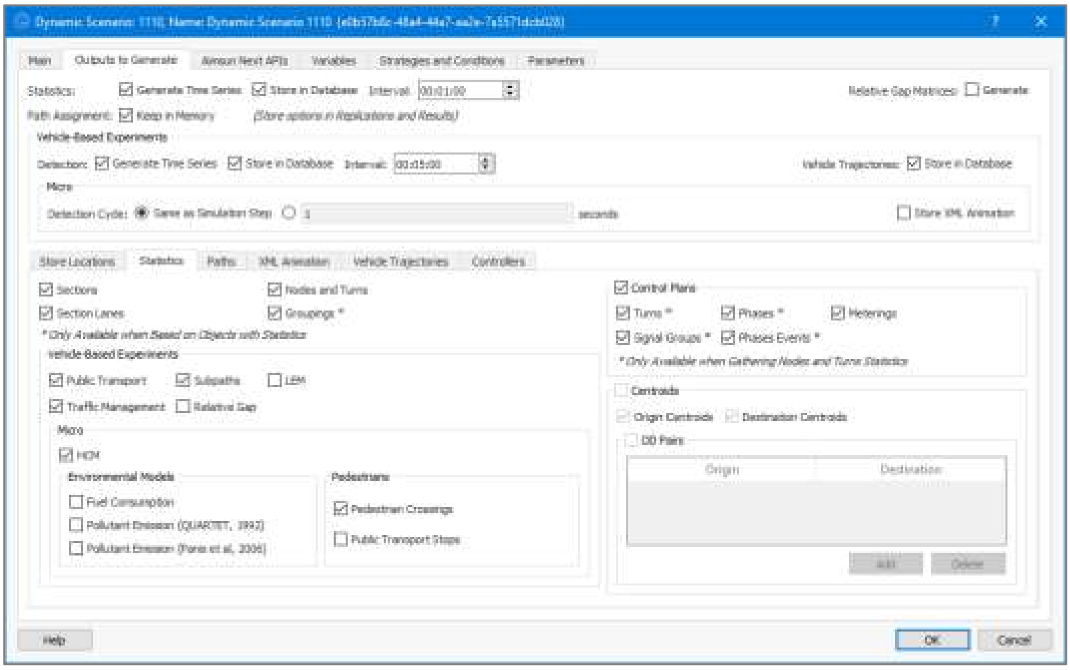

Figure 47: Dynamic Scenario Outputs to Generate tab

In the Statistics sub-tab, the type of outputs required must be specified prior to the simulation. Outputs are provided for the whole network, for Sections, Sections by lane, Nodes and Turns, Subpaths, Groupings and for each public transport line. A full list of statistics which are collected at each level is provided in the Aimsun Next help file[69]. Outputs for signal control can be activated here, including Phase Events which is used for demand dependency validation. Additional microsimulation data such as Highway Capacity Manual (HCM) statistics or the London Emission Module

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outputs can be collected during the simulation if they are activated in this tab.

3.7.1.1 Table View

The Table View is available for all network objects. It is possible to specify the type of object to be listed in the table as well as apply filters and conditions to define which specific objects of the selected type will be shown. Using column visibility, the required data can be selected, and the final table can be copied into a spreadsheet. Table View is accessed via Window > Windows > Table View.

3.7.1.2 Time Series

A Time Series can display the values of a variable over time and can be found in the Object Editor menu. It consists of tables and graphs displaying the value of the selected variable of an object during and after the simulation, as shown in **Figure 48**. It can display multiple parameters at a time, including average results from any Replication or Average Replication. Both the tables and graphs from a Time Series can be copied into a spreadsheet.

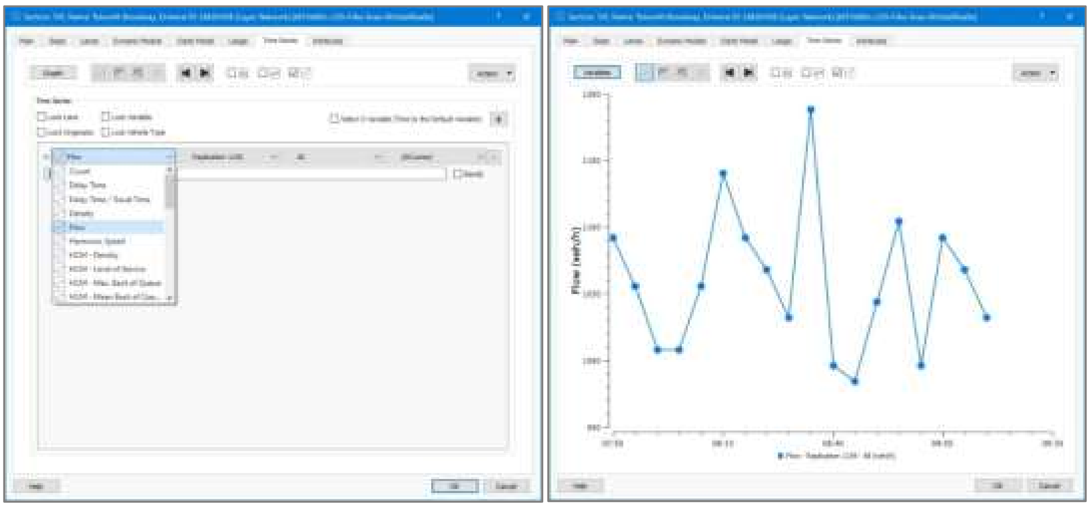

Figure 48: Time Series windows

3.7.1.3 Validation

The Validation tab of a Replication or of a calculated Average can display graphs and tables which show a comparison between the simulated outputs and the corresponding real datasets after the end of a microsimulation. In order to make use of this tool, first a Real Data Set with observed data must be created from the Project menu, via Project > New > Data Analysis > Real Data Set. The observed data from one or more external files can be then loaded into the Real Data Set and the details required to correlate the external files to the Aimsun Next objects and simulated data are specified using the Real Data Simple File Reader Editor (**Figure 49**).

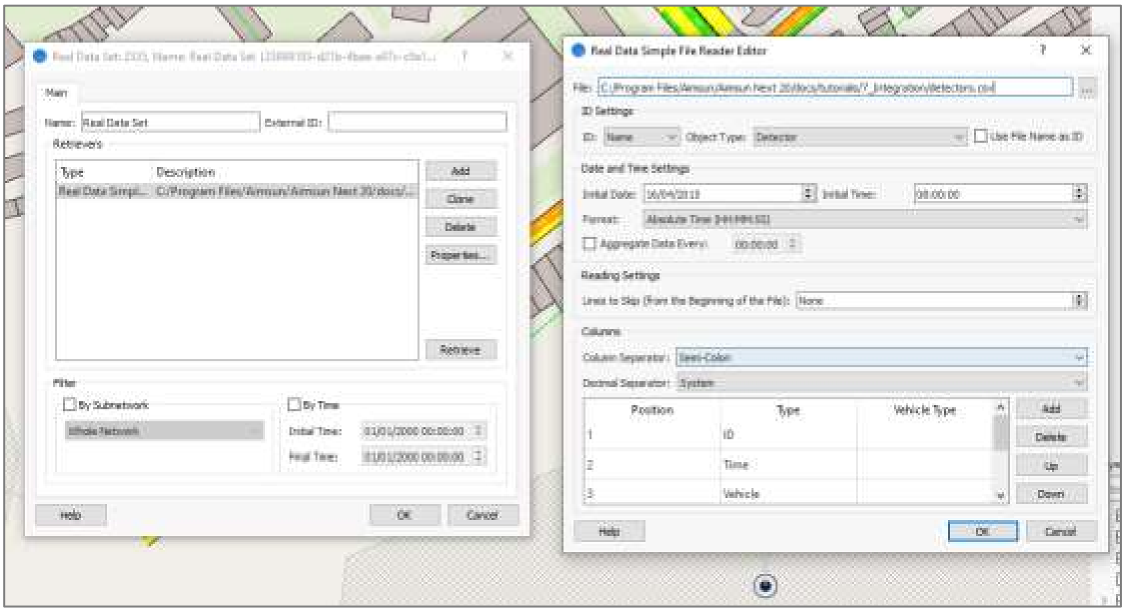

Figure 49: Real Data Set windows

The Real Data Set is selected in the Dynamic Scenario editor and once the microsimulations are complete the Validation outputs can be accessed (**Figure 50**). These comprise comparison outputs as graphs, linear regression or tables where the key validation criteria such as the GEH statistic can be viewed. All tables and graphs can be exported via the Action > Copy Table Data / Graph option for additional analysis or presentation purposes.

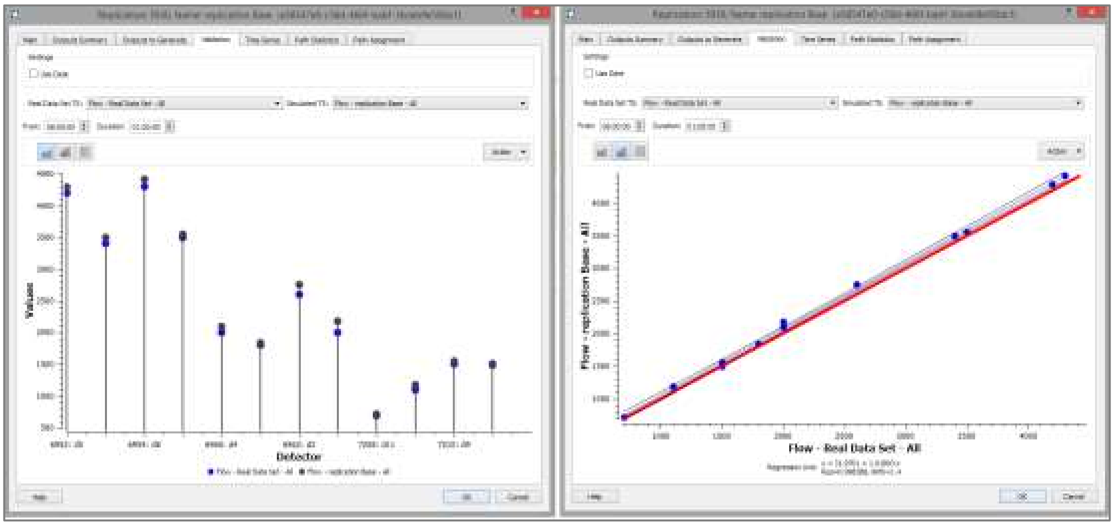

Figure 50: Validation tab of a Replication

3.7.1.4 Database

A database (Access, SQLite or ODBC) with all the simulation information can be generated. The database properties and format are specified using either the Project properties or the Scenario editor menu. Microsimulation outputs are stored in multiple tables and can be extracted by either using a database viewer or by connecting to the database and running SQL queries.

3.7.1.5 Scripting

Aimsun Next scripting, using Python, can be used to automate various tasks including importing and exporting model data. Further information on the key classes and functionalities provided by Aimsun Next can be found in the Aimsun Next scripting documentation, which can be accessed via the Help menu.

3.7.2 Data

While the section above gives general guidance on extracting data from a model, this section provides specific advice on generating the commonly used data outputs.

3.7.2.1 Traffic Flows

The most common ways of collecting traffic flows in specific locations of a model are by using the Time Series data of the corresponding Section or a Detector object. In order to collect the traffic flows of turning movements at key junctions, the use of Subpaths is recommended. Subpaths are defined as a set of consecutive Sections which are connected by Turns, as shown in **Figure 51**. Subpath outputs consist of statistics such as flow, speed, delay time, and travel time, and data is collected only for vehicles that have completed the full length of the Subpath. Therefore, it is recommended that the length of Subpaths used for flow validation is kept as short as possible to guarantee that vehicles can complete their junction turning movement, and so be included in the counts.

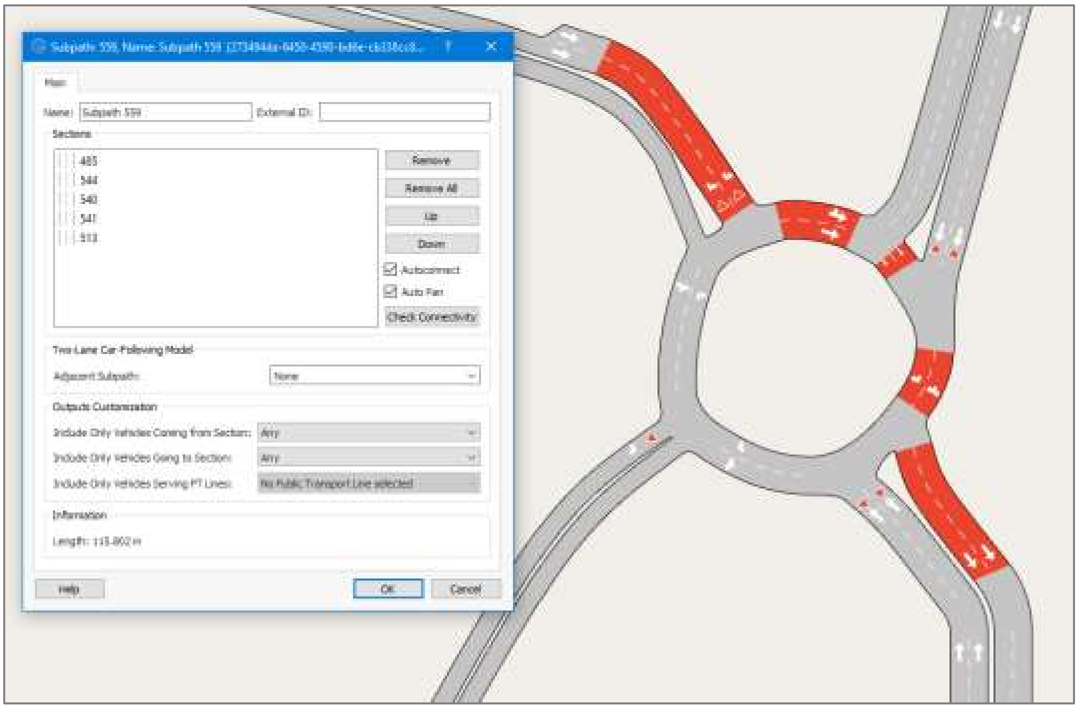

Figure 51: Subpath definition

3.7.2.2 Saturation Flows

By activating the Discharge Rate Evaluation Extension (Micro) extension on the Aimsun Next APIs tab of the Dynamic Scenario menu (**Figure 52**), output text files containing vehicle headways at signalised junctions will be exported to the same location as the model. These outputs can be used to evaluate the saturation flows of signalised junctions. A saturation flow validation spreadsheet can be provided by NP.

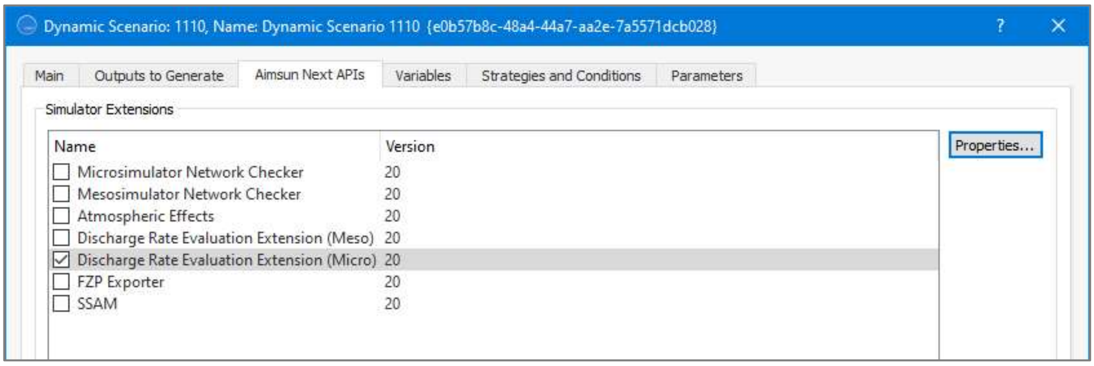

Figure 52: Dynamic Scenario Aimsun Next APIs tab

3.7.2.3 Journey Times

Modelled journey times between two locations can be collected using either Subpaths or Groupings. It is important to highlight that the Subpath statistics will only take into account the journey times of vehicles that have completed the whole length of the Subpath on the specific Sections and Turns which are defined as part of it. In contrast, the journey time of a Grouping will be derived as the sum of the average individual journey times on each Section that is part of the Grouping, vehicles do not have to travel on every Section to be included in the Grouping.

The journey time of the Subpath or Grouping can either be extracted as an average or for each time period and user class using one of the methods outlined in section **B3.7.1**. If Public Transport is specified as an output then data is automatically collected for each route separately.

3.7.2.4 Queue Data

A selection of queuing data, including Mean Queue and Max Queue, is output as part of the general statistics at the various levels of aggregation indicated at the start of section B3.7. The results are given in numbers of vehicles.

3.7.2.5 Signal Timings

Signal Timings are output as part of the Statistics tab and are only available in the database (section B3.7.1.4). The following outputs are provided at Phase, Turn and Signal levels:

- **State** – the colour that is showing (except at Phase level). See the help file[70] for the codes associated to each colour;
- **Active Time** – the time in seconds the Phase or state has been active; and
- **Active Time Percentage** – the percentage of the current statistical period that the Phase or state has been active.

Phase Events are also specified here and can be used for demand dependency validation as they detail the time the event was applied and also the reason.

3.7.2.6 Vehicle Trajectory Files

Aimsun Next has the facility to output vehicle trajectory files (*.fzp) for a variety of uses, for example, emissions modelling (see Chapter **C4** on **Emissions Modelling**), data visualisation and 3D animations. In Aimsun Next, these have a fixed format which consists of simulation time, vehicle information, speed, acceleration and position / orientation data. This is sufficient for emissions modelling and 3D animations, however it limits the data that can be visualised without further processing. The option to activate FZP Exporter is found in the Scenario Editor on the Aimsun Next APIs tab, as shown in **Figure 53**.

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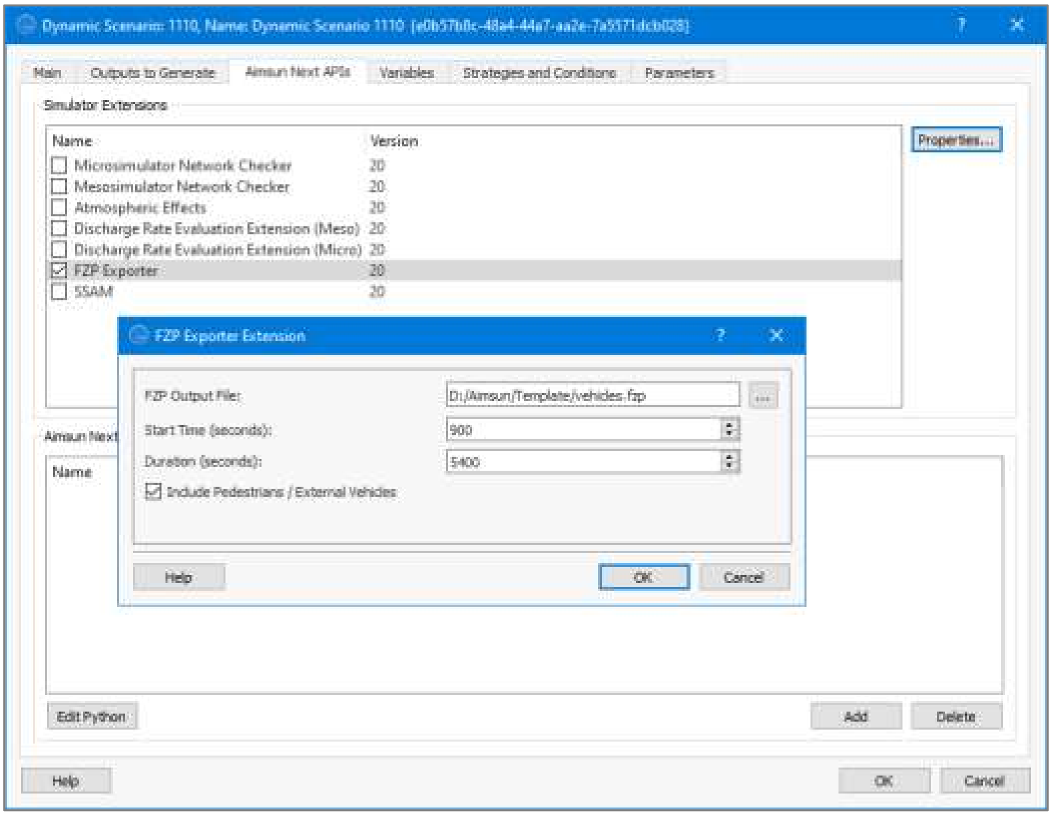
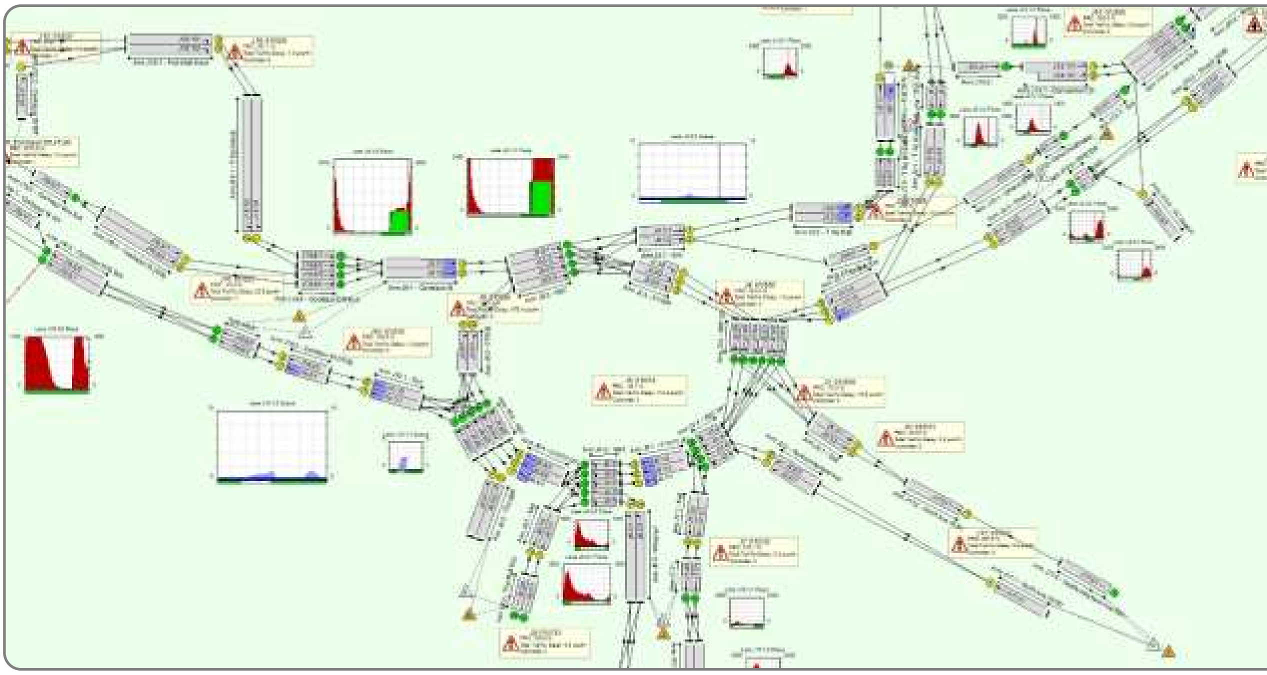


Figure 53: FZP Exporter activation and settings

4 LinSig Modelling



4.1 Introduction

This chapter is designed to assist experienced practitioners when building LinSig models of London's road network. It augments the general modelling guidance given in Chapter **B2** on **Modelling Principles**.

This chapter outlines TfL's recommended approach for modelling with LinSig. However, there will be cases where local conditions or project requirements dictate the use of methods which may be different to those outlined. In these situations, NP should be consulted on the planned methodology where modelling will be submitted for approval by TfL.

4.1.1 Introduction to LinSig

LinSig, developed by JCT Consultancy Ltd (JCT)[71], can be used for detailed junction design, assessment of scheme proposals and the creation of skeleton models for checking against junction Controller Specifications. It combines geometric layout, traffic and controller modelling to ensure that LinSig accurately reflects the way existing junctions work, and how any design proposals would operate if implemented.

In terms of optimisation of junction performance, LinSig allows the efficiency of interstage design to be maximised and is capable of

71 **http://www.jctconsultancy.co.uk**

optimising signal timings to either minimise delay or maximise Practical Reserve Capacity (PRC) at a junction or network level. Signal timings can be manually adjusted by the user to refine the timings or to match site specific safety requirements. Additionally, LinSig has a cycle time optimiser, which allows selection of an optimum cycle time by showing how delay and PRC vary against cycle time increments.

LinSig is used for the design and assessment of isolated signalised junctions, closely associated junctions and the modelling of larger networks using multiple controllers.

4.1.2 Software Versions

LinSig version 3 was released in 2009 and introduced a number of major new features that were not available in previous versions of the software. These changes include:

- **Lane-Based modelling** – previous LinSig versions modelled networks using links, grouping together similar traffic lanes. LinSig 3 uses Lane-Based networks, allowing modelling and data entry for individual Lanes;
- **Multiple controllers** – previous versions of LinSig were restricted to modelling a single signal controller and its associated stage streams. LinSig 3 allows for multiple controllers to be included within a model; and
- **Traffic Flows** – LinSig 3 introduced the capability for Lane-Based flow allocation, while retaining the previous Origin-Destination (OD) Matrix-Based routing method used in previous versions of LinSig.

4.1.3 Appropriate Use of LinSig

This section describes some of the circumstances when it would be most appropriate to develop a LinSig traffic model.

4.1.3.1 Junctions and Networks

LinSig can be used to model isolated signalised junctions or larger networks of signalised junctions.

It is possible to model priority intersections within a LinSig model but this is only appropriate where they form part of a larger network comprised of signalised junctions.

When modelling networks, LinSig is not capable of modelling the causal reasons for poor network performance but can model the effect of exit-blocking upon a junction where input data is manually adjusted (section B4.5.2). However, under these circumstances, consideration should be given to using microsimulation modelling, for example, to model both the cause and effect of pan-network exit-blocking.

4.1.3.2 Skeleton Models

LinSig models do not have to include any modelling of traffic flows when used solely for the purpose of assessing the phase-stage relationship at a junction. These skeleton models are effectively a 'control data only' representation of the controller. A LinSig skeleton model can be used to assess phase or stage minimums and interstage durations. Within a skeleton model the stage sequence should be based on current UTC or CLF timing plans, and stage minimums information can be found by reducing LinSig to the minimum allowable cycle time.

Skeleton LinSig models are best suited to augment junction analysis, and are recommended when further modelling will be conducted separately using other modelling software, such as TRANSYT 12, Aimsun Next, Vissim, or Visum. This benefits both modeller and auditor, as it ensures accurate representation of phases, phase minimums, stages, stage sequence, phase delays, intergreens and signal timing plans.

The JCT software package TranEd include tools to convert phase information to links. However, TranEd does not negate the usefulness of LinSig as an auditing tool, for example, LinSig will allow the correct phase-stage representation of parallel stage streams in separate nodes.

4.1.3.3 Pedestrians

LinSig can be used to determine pedestrian journey time and delay values for pedestrian routes across a junction. These values can be determined using either pedestrian count data or nominal pedestrian flows. This information can be used for comparison between Base models and Proposed scenarios. Pedestrian journey time and delay comparisons should only be taken where pedestrian crossings are signalised, as no interaction with traffic is accounted for at uncontrolled crossings.

Where in depth analysis of pedestrian impacts is required, consideration should be given to using specific pedestrian modelling software (see Chapter **C3** on **Pedestrian Modelling**).

4.1.3.4 Proposed Design Changes

LinSig can accurately represent controller behaviour by taking into account the features and constraints of specific controlling equipment. For this reason, LinSig models should be produced to allow auditing of proposed changes to a junction's method of control.

LinSig models are often sufficient to assess local schemes such as carriageway closures, changes to junction methods of control or signal timing revisions. However, LinSig is often unable to provide suitable representation where more complex situations exist such as vehicle merging, junction exit-blocking, traffic reassignment or the dynamic operation of demand-dependent stages. Although some complex situations can be emulated within LinSig use of other modelling software may be more appropriate, such as tactical modelling or microsimulation.

4.2 Preparation

General guidance on Base model development is provided in **B2.4**. This section provides specific guidance for building Base models using LinSig. Model preparation should be discussed at the scoping meeting described in **B2.1.5.1**, and decisions documented within the Modelling Expectations Document (MED) covered in **B2.1.5.2**.

4.2.1 Model Boundary

The applicability of LinSig for modelling multiple junctions should not simply be determined from the physical distance between intersections, but from traffic behaviour between neighbouring junctions. LinSig can produce optimised timings to progress platoons of traffic through a network. Vehicle platooning can be affected not just by distance travelled but also by friction caused by parked cars, road widths, bends or minor sinks / sources. However, the longer the distance between intersections the greater amount of platoon dispersion can be expected, with an associated reduction in the potential benefits to be gained through traffic signal coordination. LinSig is not restricted to a single cycle time within the modelled network, therefore model boundaries are not constrained to a single cycle time or multiples thereof. The junction(s) to be modelled should be discussed and agreed during LMAP Stage 1 as described in **B2.2.3**.

4.2.2 Data Collection

Prior to building a model in LinSig the following information should already have been obtained, as identified in sections **B2.2** and **B2.3**:

- TfL site numbers and UTC groups to be modelled;
- Site Layout Drawings and SCOOT Link Diagrams (if applicable);
- TfL Controller Specifications and Timing Sheets;
- Site-measured values for link length, flare lengths, cruise time, flare usage and saturation flow. Where measurement has not been possible, estimates should be used with appropriate justification (such as RR67 for saturation flows or extrapolated cruise times if conditions are permanently congested);
- Fully classified stopline traffic flows by turning movement;
- Determination of representative average signal timings, either from the UTC system, site measurement or CLF / FT plans where appropriate (section **B2.3.8**);
- Data on the appearance frequency of any demand-dependent stages; and
- Site observation of traffic behaviour, particularly lane and flare usage.

4.2.3 Model Time Periods

LinSig models typically cover a single hour, which is determined to reflect the peak traffic flow for the period. The Traffic Flows View allows for the manual input of the Flow Group start and end times, and therefore longer peak periods can be modelled if required. General guidance on model time periods is given in section **B2.3.3**.

4.3 Graphical User Interface

A brief overview of the LinSig interface is provided below, describing the main elements of the program window and methods of interaction available. Further detail describing other interface features can be found throughout the remainder of the chapter.

4.3.1 Network Layout View

The Network Layout View displays key elements of the modelled network, including Junctions, Arms and Lanes. These elements can be added by right-clicking in the Network Layout View, and edited or deleted by right-clicking on the modelled element.

This view can additionally be used to graphically display or enter model data, as shown in **Figure 54**, including:

- Input and output data on a Lane and Junction basis;
- Entry and editing of Lane-Based Flows (section **B4.4.6.1**);
- Display of Matrix-Based Flows and their Routes (section **B4.4.6.2**);
- Traffic flow profiles and queue graphs (section **B4.7.2**); and
- Signal timing information, including timing dials and stage diagrams.

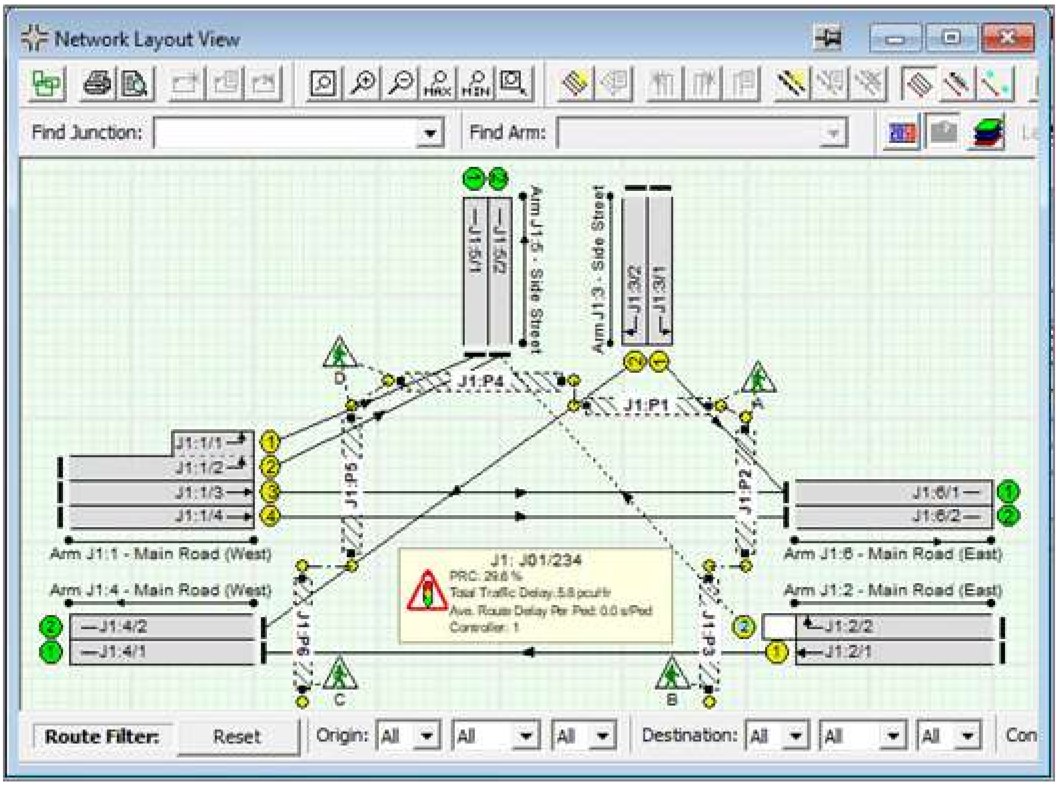


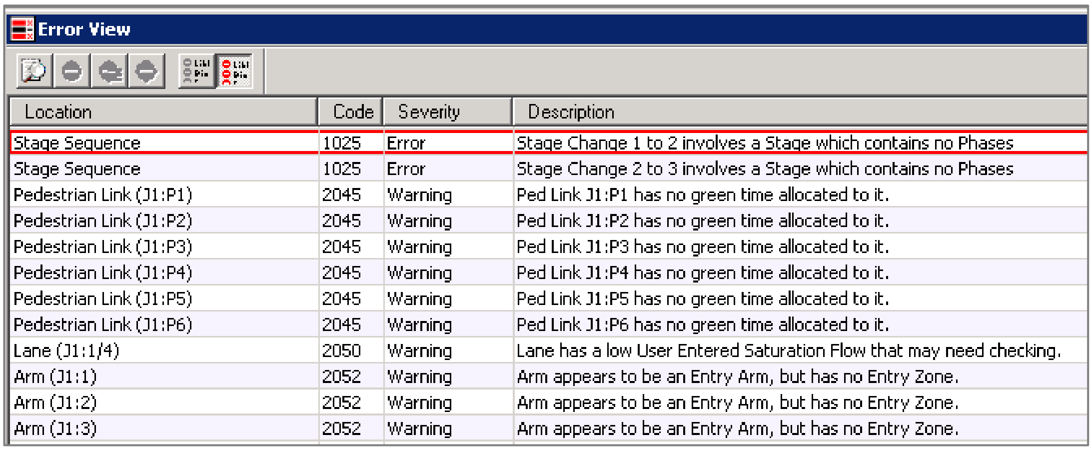
Figure 54: LinSig Network Layout View

It is also possible to add notes and labels to the Network Layout View which can be used to reflect key model assumptions or auditing notes.

4.3.2 Error View

The LinSig Error View identifies warnings and errors within the model. The presence of warnings or errors is highlighted at the bottom of the main LinSig window and further detail is given in the Error View window, as shown in

Figure 55. Warnings identify where items might need to be checked and errors prevent the model from running.


Error View

Location	Code	Severity	Description
Stage Sequence	1025	Error	Stage Change 1 to 2 involves a Stage which contains no Phases
Stage Sequence	1025	Error	Stage Change 2 to 3 involves a Stage which contains no Phases
Pedestrian Link (J1:P1)	2045	Warning	Ped Link J1:P1 has no green time allocated to it.
Pedestrian Link (J1:P2)	2045	Warning	Ped Link J1:P2 has no green time allocated to it.
Pedestrian Link (J1:P3)	2045	Warning	Ped Link J1:P3 has no green time allocated to it.
Pedestrian Link (J1:P4)	2045	Warning	Ped Link J1:P4 has no green time allocated to it.
Pedestrian Link (J1:P5)	2045	Warning	Ped Link J1:P5 has no green time allocated to it.
Pedestrian Link (J1:P6)	2045	Warning	Ped Link J1:P6 has no green time allocated to it.
Lane (J1:1/4)	2050	Warning	Lane has a low User Entered Saturation Flow that may need checking.
Arm (J1:1)	2052	Warning	Arm appears to be an Entry Arm, but has no Entry Zone.
Arm (J1:2)	2052	Warning	Arm appears to be an Entry Arm, but has no Entry Zone.
Arm (J1:3)	2052	Warning	Arm appears to be an Entry Arm, but has no Entry Zone.

Figure 55: LinSig Error View

The Error View is a useful tool for identifying potential errors within a network, however it does not remove the need for manual checking and 241auditing of a model.

4.3.3 Scenarios

Scenarios enable different situations to be modelled within a single LinSig model file, which can be useful when modelling different time periods or assessing different signal strategies.

All information required for an individual LinSig model run is grouped within a Scenario. The information required for a Scenario includes:

- The traffic Flow Group to be modelled;
- Route assignment options for Matrix-Based Flow allocation;
- The Network Control Plan, detailing the signal plans for all modelled junctions;
- Cycle time; and
- Stage timings.

The information on all scenarios within a LinSig model file are shown in the Scenarios View window, as shown in **Figure 56**.

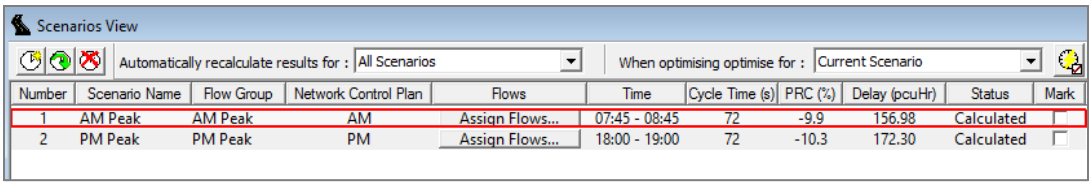


Figure 56: LinSig Scenarios View

4.3.4 Controller Selection

Several windows can be displayed in LinSig to show controller data items, including:

- Phase View;
- Intergreen View;
- Stage View;
- Stage Sequence View;
- Signal Timings View; and
- Interstage and Phase Delay View.

By default, these display controller information for the currently selected controller, as chosen from the Controller drop-down box in the LinSig program toolbar.

It is additionally possible to open multiple instances of these windows within a multiple-controller LinSig model, allowing for comparisons to be made between different controllers. To do this a separate drop-down box is available within each window, allowing the controller to be separately locked for that window to a different controller than the currently selected controller, as shown in **Figure 57**.

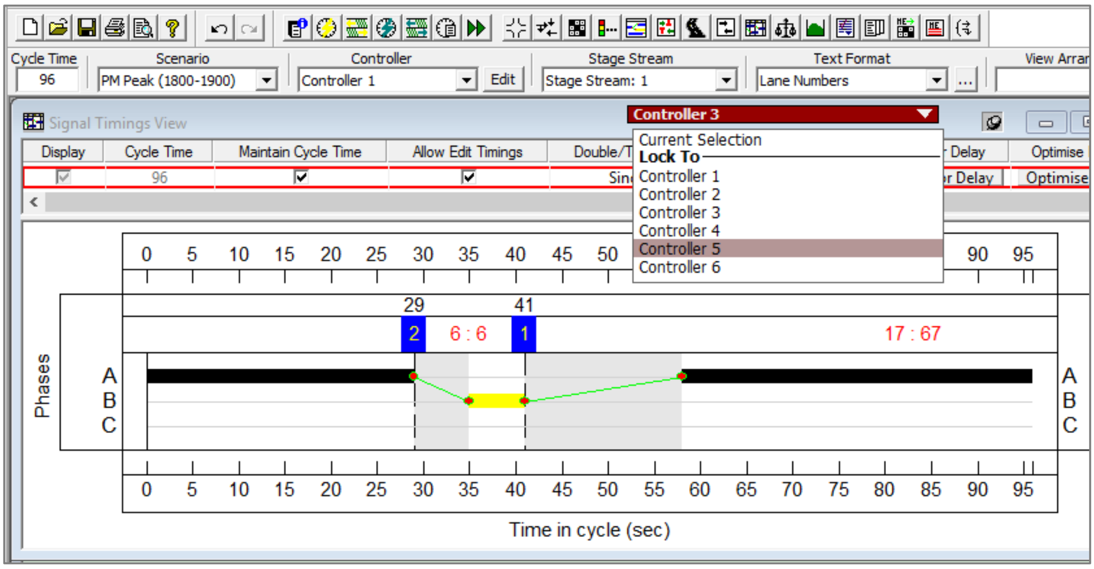


Figure 57: Controller selection within LinSig Controller Data Windows

4.4 Base Model Calibration

Once input data has been collected, the model can be built and calibrated. This section provides guidance on the structure of data in LinSig and how to approach the model build.

4.4.1 Calibrated Model

A calibrated LinSig Base model is defined as being a model which has the appropriate network structure, geometric measurements and signal timing data for the period being modelled and is submitted during LMAP Stage 2, as described in **B2.1.5**. It should contain representative signal timings with no demand-dependent stage adjustments, and should be accompanied with a technical note as detailed in section **B2.6.1**. This should state the purpose of the model, the period being modelled, the LinSig software version used and the details of the study area.

The purpose of the calibrated model is to allow the developer and any model auditor to assess the model structure and arrangement. At this stage it may be possible to identify issues relating to the development of the model and address them at an early opportunity. A copy of the calibrated model should be kept on file for future reference.

4.4.2 Network Settings

The 'Network Settings' within LinSig details the default parameters that are to be used relating to the traffic model, traffic flow assignment and controller. It is recommended that the default values are maintained unless there is a specific reason to change them. Any amendments should be detailed and justified in supporting documentation.

The 'Network Information' section should be completed to aid model auditing by including the location of the junction(s), the purpose of the model and the information sources used to build the model. Useful information could include:

- TfL site reference(s);
- Scheme title;
- Location (such as the identification of intersecting roads);
- Time period being modelled; and
- Whether the model is a Base or Proposed model.

4.4.3 Network Structure

The road network is represented in LinSig as a collection of interconnected Junctions, Arms and Lanes. Creating a suitable Lane structure is one of the most important aspects of building a LinSig model, as it determines how traffic behaviour will be replicated in the final model.

A diagram showing an example junction in LinSig's Network Layout View is shown in **Figure 58**.

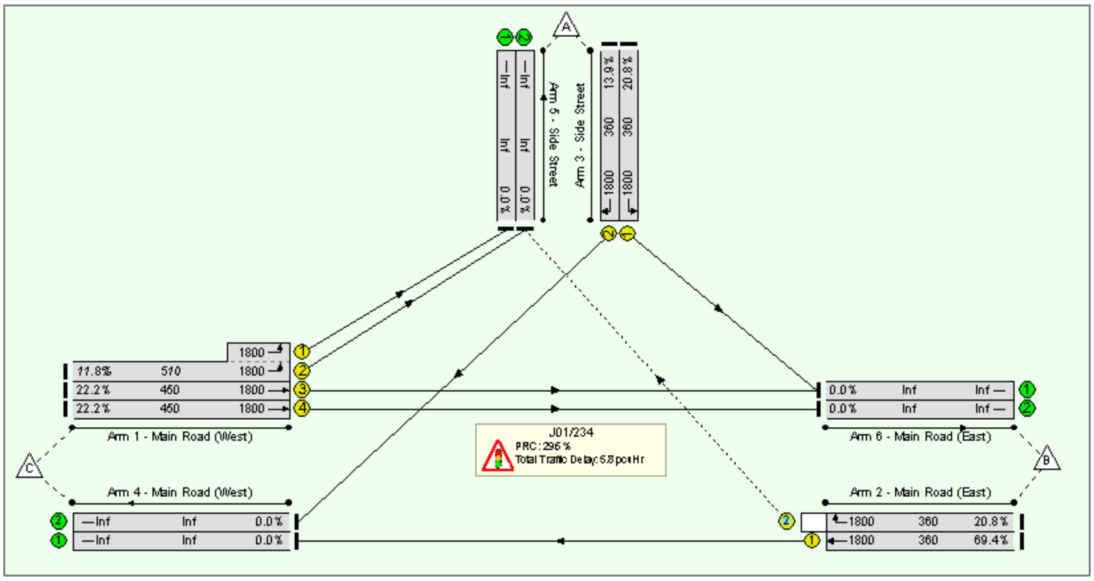


Figure 58: Example junction showing Arms, Lanes, Connectors and Zones in LinSig

4.4.3.1 Junctions

Junctions group all the individual items that represent a junction on street, such as Arms and Lanes, and allow manipulation, optimisation and performance reporting for individual junctions. A Junction can be defined as being signalised or priority-controlled and, if appropriate, the corresponding controller(s) can be allocated. Junctions should also be labelled to describe what they are intended to represent, for example using a junction or stream site reference number.

4.4.3.2 Arms and Lanes

An Arm represents a one-way section of road within the modelled network, which should therefore contain at least one Lane. Arms allow individual groups of Lanes to be graphically manipulated as a single entity. It is important from an auditing point of view that each approach Arm is correctly labelled with the relevant street name (or similar) as the Lane numbering system within LinSig is arbitrary.

Each lane that exists, or is seen to function as a separate lane during on-street observation, must be modelled as a separate Lane within LinSig. A Lane is defined as either long or short. A Long Lane extends sufficiently far back towards the upstream junction that it always behaves as a dedicated lane over the available green time, whereas a Short Lane represents a flare, only contributing as a full lane for a portion of the available green time.

LinSig allows for adjacent Lanes exhibiting identical behaviour in terms of queuing, traffic distribution and signal control to be grouped within Multi-Lanes. These are defined by the number of Lanes and whether the Multi-Lane includes a flared approach. Multi-Lanes can be used to simplify the modelled network, as long as the use is appropriate and the above conditions are met.

4.4.3.3 Connectors

Connectors link the exit point of one Lane to the entry point of another Lane, and define the turning movements permitted from each Lane. In larger networks a chain of successive Lanes and Connectors can be used to define the routes traffic can take through a network. Any Lane within the LinSig model that does not have a Connector leaving the Lane will be treated as an exit Lane.

4.4.3.4 Zones

In LinSig, Zones can be used to define the entry and exit points to the modelled network. These form the basis for routing traffic through the network when using Matrix-Based Flows (section **B4.4.6.2**) and can be used for Route-Based performance analysis. They can also be useful when using Lane-Based Flows (covered in **B4.4.6.1**), such as for bus route calibration or performance analysis for lane sequences along a route.

4.4.3.5 Flared Approaches

Flared approaches are represented in LinSig as short Lanes, which must be grouped with at least one adjacent Long Lane that it will interact with, forming a Lane Group. The physical length of a flare should be included for all Short Lanes, reflecting the number of PCUs that can be stored within the flare when fully occupied.

Flare usage is automatically calculated from the physical length and the impact of blocking by traffic in adjacent Lanes. However, it is possible to override the amount of traffic using the flare by setting custom occupancies to be used instead of the physical length. Custom occupancies can be set at a single value for all modelled Scenarios, or adjusted for individual Scenarios as required and monitored using flare storage graphs (section B4.7.2). The use of custom occupancies should be reported and justified in supporting documentation and be calibrated based on site-collected measurements. It is important to note that custom occupancies used in LinSig 3 are not the same as effective flare lengths that were previously used in LinSig 2.

The Lane-Based modelling approach used in LinSig allows for separate Lane control and signal phasing for Long and Short Lanes. The performance of a Lane Group can be reported as a single combined value or as separate figures for each Long and Short Lane, as shown in Figure 59. This feature can be selected and amended via the Network Settings menu.

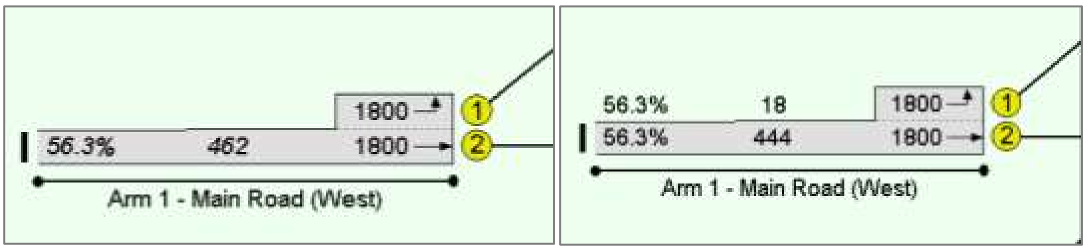


Figure 59: Combined (left) and separate (right) capacity results for Short Lanes

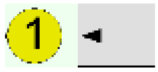
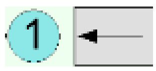
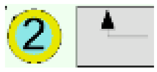
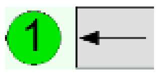
In LinSig a Long Lane can only have one associated Short Lane, therefore assumptions may be required to reflect situations where multiple flares are fed by a single Long Lane.

In certain scenarios it may be necessary to model flared approaches using the Multi-Lane representation. This method does not consider the blocking impacts of adjacent traffic Lanes and therefore the use of Short Lanes is preferred where significant blocking effects may occur.

4.4.3.6 Classification of Lanes

Lane control can be classified into four groups determined by how the lane operates on street and are indicated by different coloured circles at the start of the Lane in the Network Layout View, as shown in **Table 9**.

Table 9: Lane control types in LinSig

Lane Control Type	**Description**	**Network Layout View**
Fully signalised Lanes	Controlled by one or more traffic phase, which do not give way to other movements	
Unsignalised priority-controlled Lanes	Controlled by giving way to an opposing traffic flow, such as minor arms at priority junctions or left turn slips	
Combined signal and priority-controlled Lanes	Controlled by a traffic phase and also giving way to an opposing traffic movement, such as opposed right turning movements at signalised junctions	
Free-flowing Lanes	Commonly used to reflect mid link bottlenecks and exit links. Where used as bottleneck Lanes, these could reflect where traffic flow is limited between junctions, such as carriageway narrowing and carriageway fanning	

Internal junction Exit Arms can be included where multiple junctions are included in a model. Exit Arms act to collect traffic leaving a junction prior to the modelling of the approach Lanes to the subsequent junction (**Figure 60**). When used the Exit Arms should have a short Lane length, such as the distance from the stopline to the junction exit, with the length between junctions applied to the approach Lanes of the downstream junction. The

Connector cruise times should appropriately reflect the Lane lengths used. Exit Arms can be used to allow lane changing and weaving between two junctions.

Pedestrian Links can be added to a junction to represent where pedestrian crossing facilities are provided. The modelling of pedestrian crossings in LinSig is detailed in section **B4.4.8**.

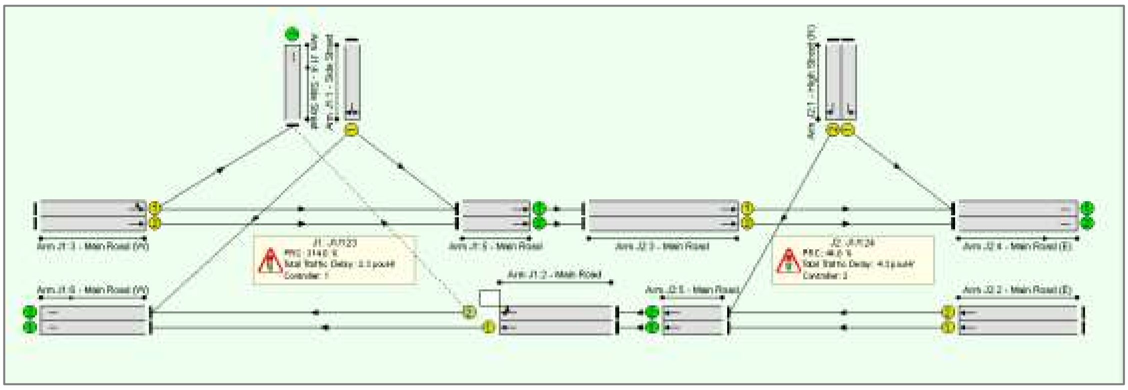


Figure 60: Example of junction Exit Arms being used between two junctions in LinSig

4.4.3.7 Saturation Flows

Saturation flows should be measured on street for all critical Lanes, as described in **B2.3.9**. Saturation flows should be directly entered for each Lane included in the LinSig model. Where on-site measurement is not possible, RR67 values (described in **B2.3.9.1**) can be calculated manually and directly entered into the model or, alternatively, geometric parameters can be entered into LinSig (lane width, gradient and turning radius) from which RR67 values will be calculated automatically. Saturation flows calculated from RR67 should be used with caution, and the suitability of the calculated saturation flow values for the modelled area should be assessed as described in **B2.3.9.1**.

If saturation flows are directly specified for Exit Lanes they should be suitably high (for example 8000PCU/hr) so that artificial and unintended queuing does not occur on the exit of the network, which may be the case if default values are used or if the Exit Arm contains an insufficient number of Lanes. A recommended alternative is to specify all Exit Lanes as being 'unconstrained (infinite saturation flow)' to ensure traffic will incur zero delay when exiting the model. A similar approach should be used when Exit Arms are used between junctions. Where queuing is observed on a downstream exit from a modelled junction then the modelling approach and use of LinSig should be re-assessed.

Saturation flows are required for each Lane or identically performing group of Lanes within the model.

4.4.4 Signal Control

This section covers the implementation of Controller-Based signal timings within a LinSig model, detailing key areas where signal information is entered. It is important to ensure that phase-based signal controller behaviour is accurately modelled.

4.4.4.1 Controller Sets

It is possible to model different cycle times within a single LinSig model. This can be achieved by creating Controller Sets and assigning individual controllers to these sets. The cycle time for each Controller Set can be edited accordingly, although it is also possible to double-cycle or triple-cycle a controller within a single controller set. For advice on how to determine whether the model should include junctions operating at different cycle times, refer to section **B4.2.1**.

Cycle times can be amended in the Scenario View (see **B4.3.3**), main tool bar (see **B4.3.4**) or within the Controller List View, as shown in **Figure 61**.

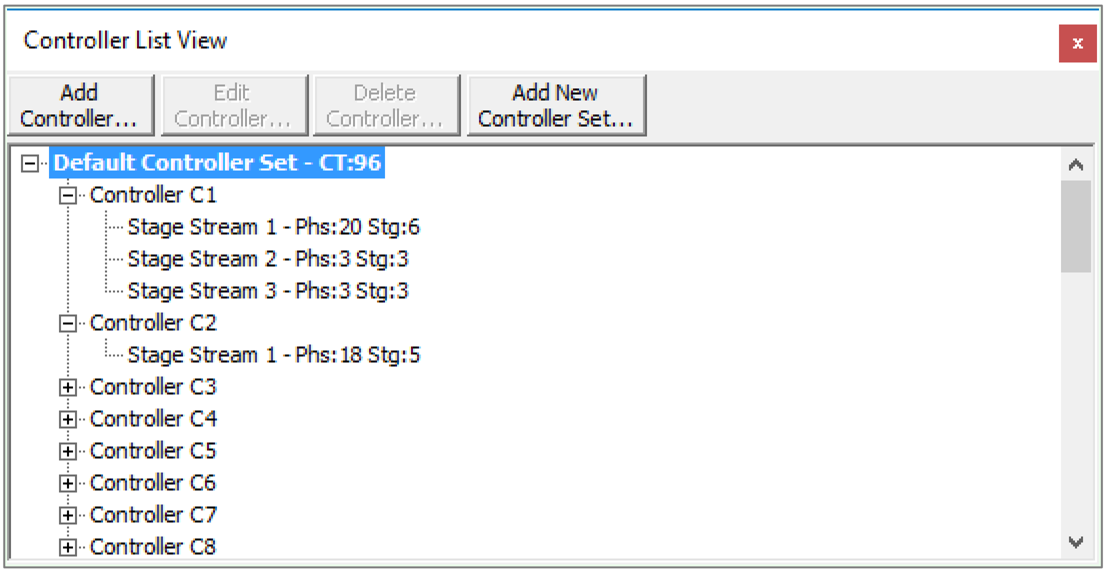


Figure 61: Controller List View, showing Controller Sets and cycle times

4.4.4.2 Controller Input Data

The following information needs to be included for each controller:

- Controller Type;
- Phase Data (including Phase Type, Controller Minimum and Associated Phases);
- Phase Intergreens;
- Stages (defining the Phases within the Stage and the minimum stage time);
- Interstages, Prohibited Stage Moves and Phase Delays (detailing the interstage length, prohibited stage moves and a list of Phase Delays); and
- Stage Sequence.

For an existing junction, the controller type should reflect the manufacturer of the hardware that is on street, as identified in the Controller Specification and/or Timing Sheet.

It is important that the correct controller type / manufacturer is selected as this determines how gaining phase delay values are interpreted and specifying the wrong manufacturer could result in the modelling of incorrect signal timings. Particular care therefore needs to be taken when modelling phase gaining phase delays to ensure they are appropriately represented, as highlighted in **B2.3.8.1**.

For models submitted to TfL it is required that the source of the controller data used to build the model is specified (evidenced by the Timing Sheet issue number and/or Controller Specification issue number).

LinSig can model two types of phase minimums, street phase minimums and controller phase minimums. Street phase minimums are the minimum time a phase must appear on street and includes any time provided by phase losing delays. Controller phase minimums are the minimums entered into the controller, which is the time the phase has to receive green irrespective of any additional green time provided by a phase losing phase delay.

It is important that when modelling existing junctions that the phase minimum type is set to ‘controller phase minimums’ and not ‘street phase minimums’.

4.4.4.3 Stage Sequences and Network Control Plan

The Stage Sequence View lists the different stage orders that can be run by a controller. The Stage Sequence may vary between modelled time periods or in different traffic conditions.

A Network Control Plan is also required and states which stage sequence is used by each controller for each modelled Scenario, as shown in **Figure 62**.

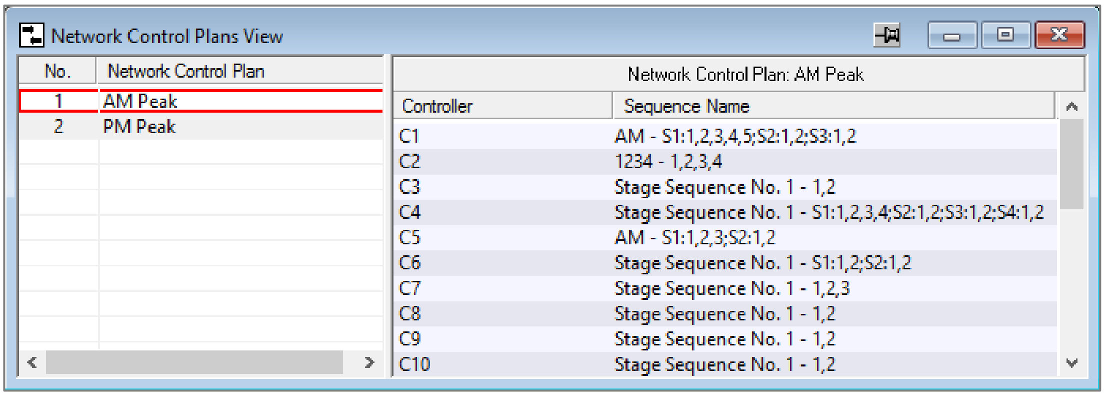


Figure 62: LinSig Network Control Plans View window

4.4.4.4 Signal Timings View

Stage and phase timings can be interactively edited using the Signal Timings View, as shown in **Figure 63**. Alternatively, signal timings can be adjusted via Timing Dials in the Network Layout View.

The information contained within the Signal Timings View includes:

- Stage timings, including stage and interstage lengths;
- Phase timings;
- Interstage details, including phase delays and intergreens; and
- Whether the controller single-cycles , double-cycles or triple-cycles within the controller set's cycle time.

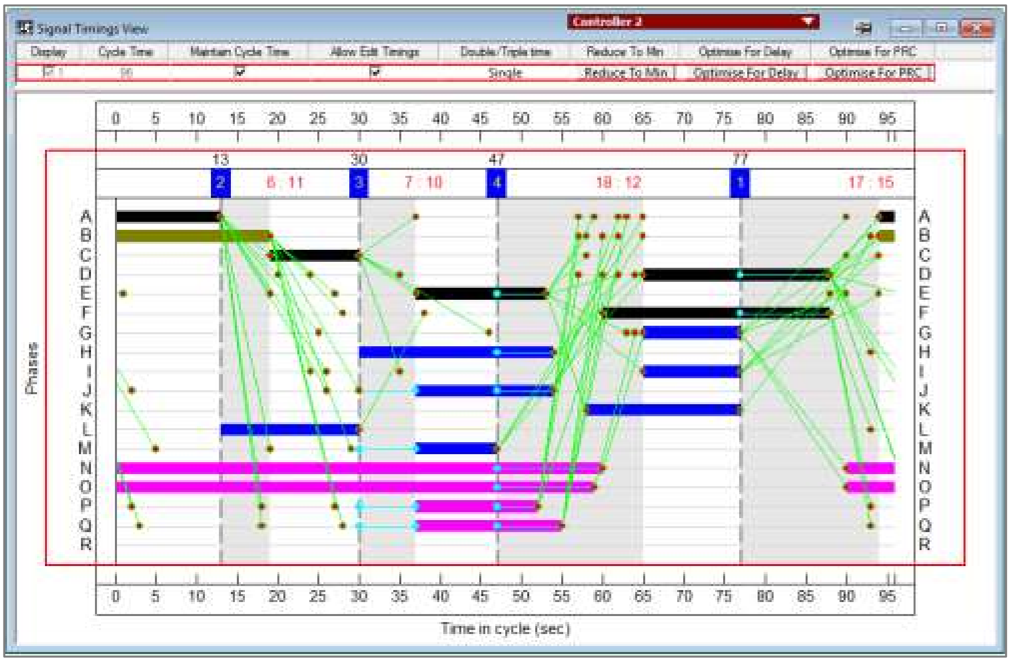


Figure 63: LinSig Signal Timings View window

The controller's signal timings can also be optimised within this view. Refer to section **B4.6.4.1** for further information.

4.4.5 Priority Control

Opposed movements within LinSig can be separately classified as either priority-controlled movements or movements that are both priority and signal-controlled. These priority-controlled elements are represented by different Lane types, as detailed in section **B4.4.3.6**. The parameters required to accurately model priority control within LinSig are detailed in the following sections.

4.4.5.1 Give-Way Parameters

For priority movements that give way, the LinSig model requires the entry of these essential parameters:

- 'Maximum Flow while Giving Way', which describes the maximum flow rate of traffic in the absence of an opposing flow, but while still giving way to the opposing movement. This is often called the intercept, as it represents the intercept with the Y axis when the flow giving way (Y axis) is plotted against the opposing flow (X axis). It is measured in PCU/hr;
- Minimum flow, which represents the minimum amount of flow, in PCU/hr, that can discharge regardless of the level of opposing flow. This parameter should only be used if it is deemed LinSig is underestimating the discharge under high levels of opposed flow. The

use of the Minimum flow parameter should be clearly documented in accompanying reports;

- Details of the opposing Lane and turning movements;
- Clear Conflict time, which details the time for vehicles in the opposing movement to travel from the stopline to the conflict point; and
- Give-way coefficient, which describes the assumed linear gradient (the 'slope') specifying how the flow giving way decreases as the opposing flow increases.

JCT recommends the use of typical give-way parameters for different types of opposed movements as a starting point[72], such as an intercept of 1439PCU/hr and slope of 1.09 for opposed right-turns at signalised junctions and an intercept of 715PCU/hr and slope of 0.22 for give-way-controlled left-turns. These are typical parameters, however it may be appropriate to use more accurately estimated or measured give-way parameters for critical priority movements. This could be achieved by:

- Use of PICADY to estimate give-way parameters at priority junctions;
- Use of ARCADY to estimate give-way parameters at priority roundabouts; or
- Measured on-site data, plotting various opposing and opposed flow rates from which the intercept and slope can be measured.

4.4.5.2 Opposed Right-Turn Parameters

The ability to accurately model opposed right-turning vehicles at traffic signals requires careful site observation and entry of LinSig parameters. Particular attention should be paid to recording and calibrating:

- Storage in front of the stopline;
- Non-blocking storage;
- Maximum number of turners in intergreen (which may be less than the storage in front of the stopline);
- Clear conflict time;
- Right turn move up; and
- Right-turn factor.

The clear conflict time determines how long vehicles giving way have to wait for opposing traffic to travel from the stopline to the conflict point before the opposed traffic can proceed to clear during the intergreen period. This may be of higher importance in larger junctions where

72 Moore P, *LinSig Version 3.2 User Guide*, JCT Consultancy Ltd, V3.2.18, Ch 3, 2014, pp44-45

opposing traffic have longer distances to travel before reaching the conflict point.

The right-turn factor controls the amount of bonus capacity available due to storage in front of the stopline. Its default value is 0.5 and should not be changed unless supported by site observation. Any amendment should be reported and justified based on site-collected data.

For opposed right-turns which are subsequently unopposed (for example indicative arrows), it is imperative to set the 'Flow when opposing traffic is stopped' to the appropriate link saturation flow. This can be important where a Lane contains a mixture of opposed and unopposed movements that can lead to the obstruction of unopposed movements. For right-turns which remain opposed at all times, this should be set to the maximum flow while giving way (as entered in the give-way parameters).

4.4.6 Traffic Flows and Flow Allocation

Traffic flow data for LinSig models should be based on fully classified turning count data and converted to equivalent PCU values, as described in section **B2.3.4.1.1**.

Traffic flows can be entered into a LinSig model using two different methods:

- Lane-Based flow allocation; and
- Matrix-Based flow allocation.

These methods are described in more detail in the following sections. Both methods use Flow Groups, which require start and end times for each period being modelled to be entered. Flow Groups can be specified as either independent from other Flow Groups (a Standard LinSig Flow Group), or mathematically derived from one or more other Flow Groups (a Formula Flow Group), as illustrated in **Figure 64**.

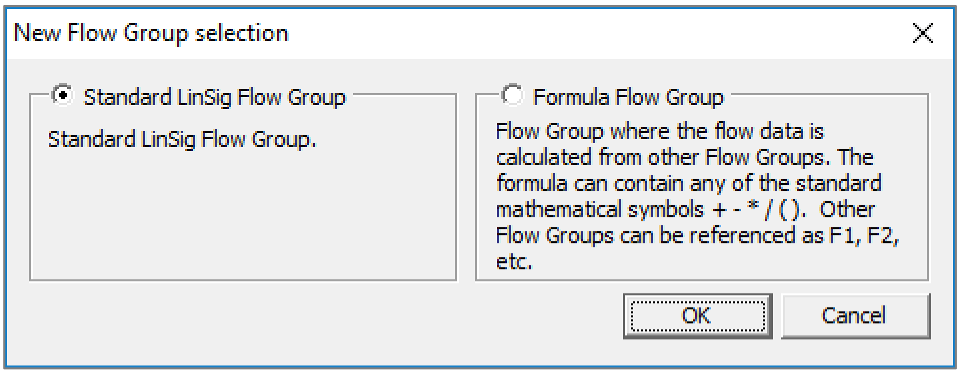


Figure 64: Flow Group definition in LinSig

4.4.6.1 Lane-Based Flows

Lane-Based flows are directly entered onto Lanes and Connectors to reflect the total stopline flow for the Lane and for incoming / outgoing turning movements. They can be separated by traffic mode, or other groups of interest, as shown in **Figure 65**. With Lane-Based flows no routing information through a junction or a network is required.

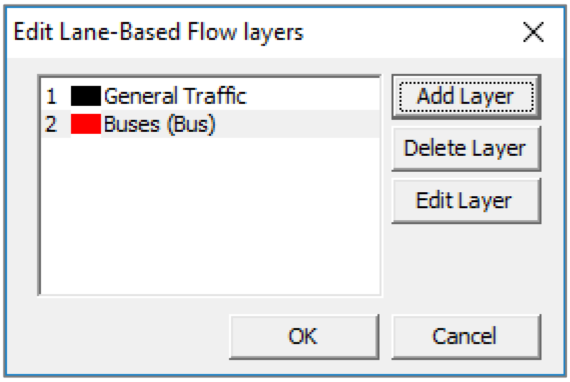


Figure 65: Lane-Based Flow Layers dialog box

The flows are defined in PCUs and can be edited via the Lane-Based Flow Entry Mode (**Figure 66**) or using the Lane-Based Flow Layer tab in the 'Edit Lane View' (**Figure 67**).

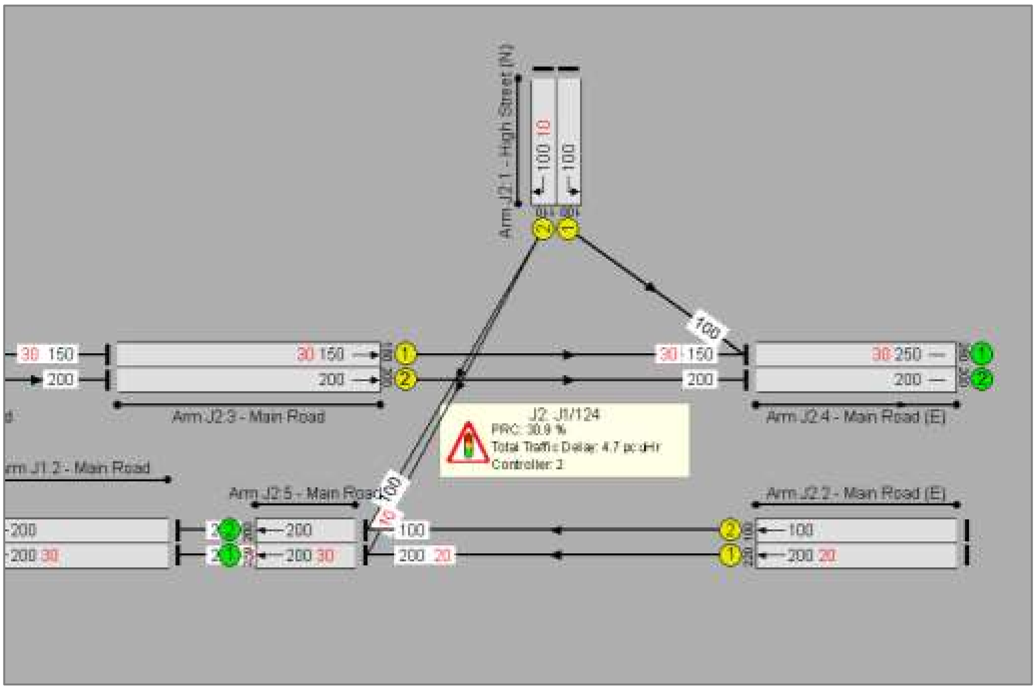


Figure 66: Lane-Based Flow Entry Mode, showing different Flow Layers in different colours

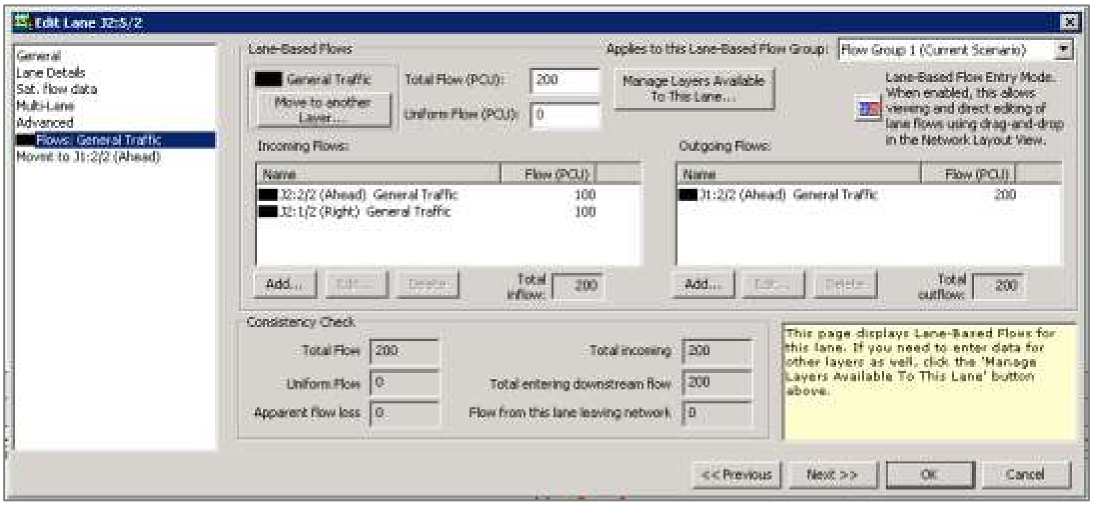


Figure 67: Lane-Based Flow Layer editing in the Edit Lane View

Where multiple junctions are being modelled, checks should be carried out to ensure that turning count data is consistent between adjacent sites, as described in **B2.3.4.1**. The Flow Consistency Mode can be used to visually highlight locations where flow inconsistencies occur, as seen in **Figure 68**, where the size of the blue circle varies depending on the size of the discrepancy. Where multiple Lanes feed a downstream Lane, or where a single upstream Lane feeds multiple downstream Lanes, the split between origin and destination Lanes should be observed and recorded.

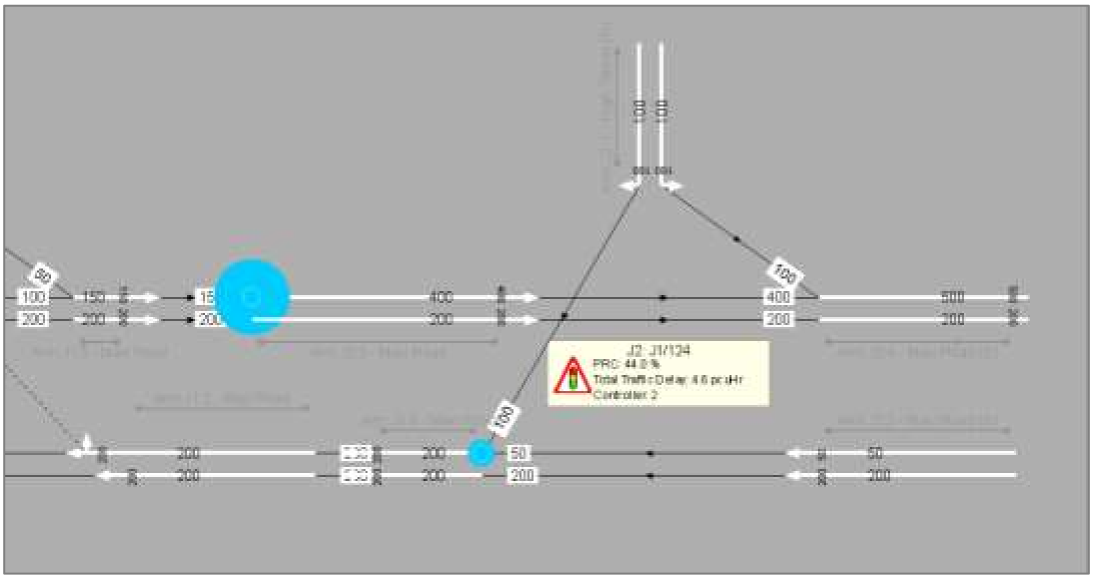


Figure 68: Flow Consistency Mode, with flow inconsistencies highlighted in blue

It is recommended that a different flow layer is used to separate public transport from general traffic. When creating a separate Flow Layer for public transport, it is important that the 'This layer models buses' box is ticked to allow for bus cruise speeds and the impact of bus stops. Where multiple Flow Layers have been created, the Lanes in the network need to reflect which Flow Layer can use them using the 'Manage Layers Available to this Lane' function.

If considered necessary, it is possible to use custom cruise times for specific Flow Groups, Flow Layers or Routes, which override the default Connector cruise times. Any overrides to Connector cruise times should be recorded and justified.

Where a network-wide OD survey isn't available, Lane-Based Flow groups are the preferred method for inputting flows, giving full control over allocation of flow layers to traffic Lanes.

4.4.6.2 Matrix-Based Flows

Traffic flows can be assigned to routes using a Zone-Based OD matrix, with individual entry and exit Arms allocated to different Zones, as shown in Figure 69. Dedicated bus-only Zones can also be specified to define bus routes through the network.

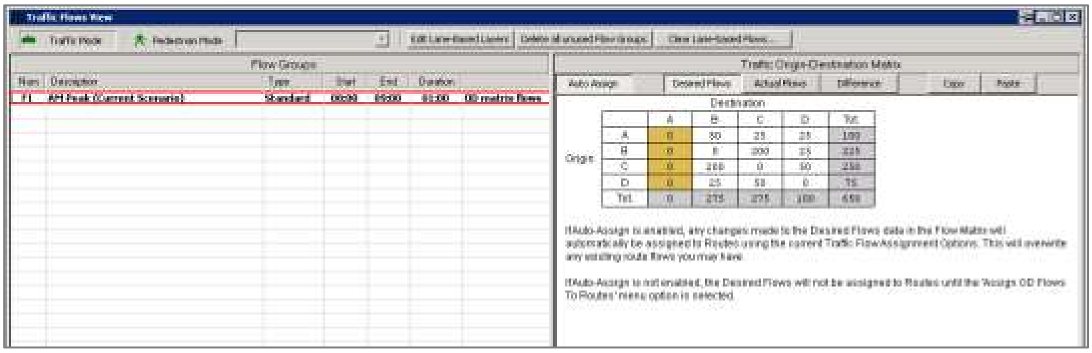


Figure 69: Traffic Flow OD Matrix shown in the Traffic Flows View

For a network of junctions an OD survey should ideally be used to populate the matrix. However, where this is not possible, separate junction turning count surveys can be used and converted into a combined OD format, using manual flow smoothing, or an estimated matrix using a validated assignment model with a verified prior matrix.

When flows have been entered into an OD matrix, they can be applied to all possible zone-to-zone Routes manually or by automatically assigning flows to Routes based on calculated delay or the balancing of flow on entry Arms. When using automatic assignment in LinSig, it is recommended that Delay-Based assignment is used, except in special situations such as the modelling of a signalised roundabouts, where the assignment choice should be documented.

Where multiple Route choices are available within the network, checks should be carried out to ensure that traffic flows have been assigned correctly. If necessary, flows may need be manually ‘locked’ on specific Routes based on site observations. This can be achieved using the ‘Route List View’ (**Figure 70**) to get correct Lane usage, before allowing LinSig to allocate flows to other permitted Routes.

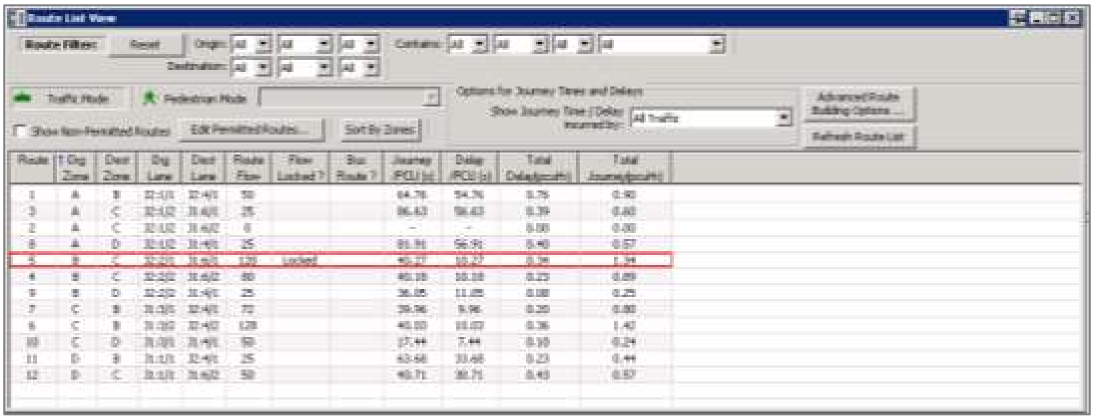


Figure 70: Route List View

If circular routes or U-turns are possible within a model, typically at roundabouts but also with closely associated junctions, these Routes must be manually checked in the ‘Route View’. If unrealistic Routes are generated, such as those that are not observed on street, these should be removed using the ‘Edit Permitted Routes’ feature (**Figure 71**).

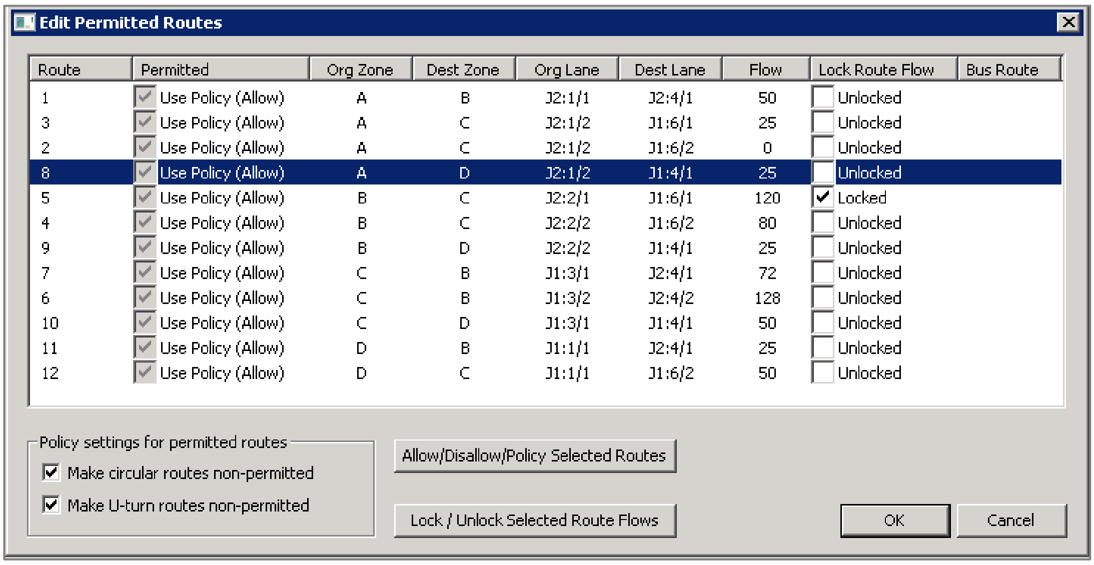


Figure 71: Edit Permitted Routes View

For each scenario being modelled, it is important to verify that the total flow applied to all routes between an OD pair matches the Desired Flow Matrix that has been manually populated from the survey data. The Difference tab on the Traffic OD Matrix highlights any differences between desired and actual flow values (**Figure 72**).

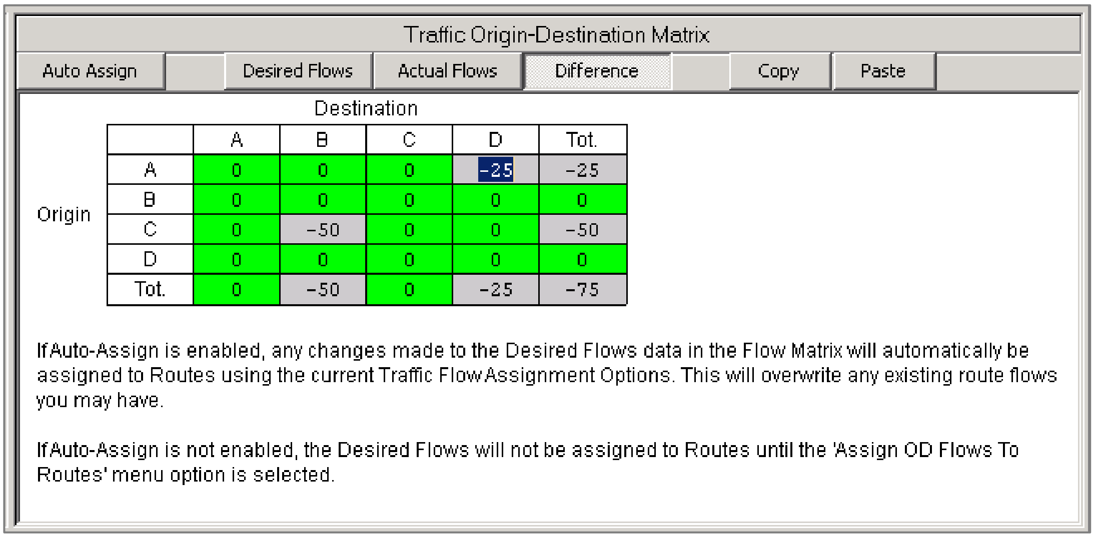


Figure 72: **Traffic OD Matrix Difference view, indicating where desired and actual flows are not matching in grey**

The allocation of flows using a matrix is acceptable for fixed Routes (such as buses) or in smaller models where minimal Lane and Route choice exists or where the OD matrix is known (for example signalised roundabouts). For detailed reporting on journey times the use of a microsimulation model is recommended, however indicative journey times can be extracted from LinSig files which use Matrix-Based layers, as described in **B4.7.3**.

4.4.6.3 Matrix Estimation

JCT suggest that OD matrices for individual junctions and simple networks can often be derived directly from turning count data, however they do not consider this feasible for larger networks of four or more junctions[73]. Matrix Estimation is a method by which OD matrices for a larger modelled network can be derived from individual junction turning counts. In networks where signals are closely spaced, the importance of having accurate OD information is vital to obtain workable offsets.

LinSig uses the long-established Maximum Entropy method for Matrix Estimation, which is widely used in strategic modelling software. It essentially tries to improve the fit between modelled and observed flows by selectively factoring individual cells of the input trip matrix.

While Matrix Estimation may appear to offer an attractive option for generating an OD matrix, it is important to be aware of the limitations and potential pitfalls of the process. The first run of Matrix Estimation shouldn't be accepted and used, the matrix needs careful assessment and further refinements to the traffic counts or network may be necessary to produce an acceptable matrix. It is the modeller's responsibility to ensure that matrices are checked sufficiently before being used in a scheme assessment.

It is not generally recommended that Matrix Estimation is used within LinSig. It is preferred that OD surveys are collected or a tactical assignment model is used. Any use of Matrix Estimation in LinSig should therefore be agreed in advance.

Before undertaking Matrix Estimation within LinSig, it is imperative that the turning count data is checked for consistency as any errors in the data will lead to poor Matrix Estimation. The main checks to be undertaken are:

- There is a good coverage of turning count data;
- The turning count data is sufficiently recent;
- There are no significant inconsistencies between adjacent counts; and
- Any major sinks and sources of flow are accounted for.

73 Moore P, *LinSig Version 3.2 User Guide*, JCT Consultancy Ltd, V3.2/D, Ch 4, 2018, pp200

Within LinSig, the following information will need to be updated for each Flow Group before commencing Matrix Estimation:

- Turning count data, in PCUs;
- Zone OD totals;
- Traffic signal data, including signal timings running at the time of the traffic counts, stage sequences and network control plans; and
- Network structure, including connector structure, saturation flows and cruise times.

For Highway Traffic Assignment models, it is strongly recommended that an old or prior matrix is updated using observed counts, by undertaking Matrix Estimation. The prior matrix will typically be derived from a demand model (using socio-economic and/or other traffic data) or an older version of the model. If no prior matrix is available the model assumes that all trips are equally likely. This can lead to a poor trip length distribution with, for example, too many short or long trips, and unrealistic OD trips. A prior matrix is advisable if an OD matrix is being derived from junction turning flow data in LinSig, as Matrix Estimation won't necessarily assign trips to the correct path even in smaller networks. Therefore, it is recommended that a fully validated tactical model is used for the Matrix Estimation process, using dedicated assignment software and a verified prior matrix.

Another technique to obtain OD matrices for use in LinSig is through Automatic Number Plate Recognition (ANPR) or video data. With this more recent technique, cameras are typically positioned to form a 'cordon' to capture all vehicles entering and exiting the cordon. This technique is the most accurate but also the most expensive. The benefit of a prior matrix is greatly reduced with this technique as OD paths will be captured from video or ANPR data. However, where route choice exists, there may be a requirement to supplement the ANPR data with turning count or screenline data to validate the route choices.

Any matrices that are produced as a result of Matrix Estimation should be carefully checked to ensure that they are of an acceptable standard to be used in further modelling. A process of refining the matrix should be anticipated prior to achieving the final matrix.

4.4.7 Public Transport

Bus flows can be added to a LinSig model using the following options to enable buses to be differentiated from general traffic:

- **Lane-Based Flow Layers** – One or more Lane-Based Flow Layers can be added on each Lane according to their routes. Each additional Lane-Based Flow Layer should be specified as representing buses; or

- **Matrix-Based Routes –** Zone-Based routing can be used to represent bus flow through the network. The permitted routing for bus flow should be edited or fixed to ensure correct Lane usage. Relevant Zones should be specified as Bus Zones.

Where bus stops exist on a Lane, the upstream Connector should be edited to set the average bus dwell time at that stop. If there is more than one stop on that Lane, the Mean Bus Stopped time should reflect the sum of all bus stop dwell times, together with an additional delay to represent the acceleration and deceleration at any additional stops. Bus stop dwell times can be as surveyed on street or appropriate estimated values can be used if necessary. It is possible to customise the Mean Bus Stopped times for an individual Lane-Based Flow Layer or Zone-Based Route, should this level of detail be required for the scheme being assessed.

Where public transport influences general traffic, such as at bus lane setbacks and funnelling at bus lane entries, these conditions should be observed on street and replicated in the modelled network.

If bus lanes do not extend all the way to the stopline, a bus setback is created which allows general traffic to use the short lane in front of the bus lane (for example for left-turning vehicles). This should be modelled as a Short Lane in LinSig, with the bus lane having a negative bonus green applied to represent the time taken for buses to travel from the end of the 'effective' bus lane to the signal stopline. The bus lane setback negative bonus green should be measured for each modelled period as it may vary according to time of day. See section **B4.5.1** for further guidance on the application of bonus greens in LinSig.

The default Bus Delay Weighting currently used in the LinSig optimisation process prioritises bus delay over general traffic delay by a factor of ten. If required this can be adjusted in the Optimiser Settings view, as described in section **B4.6.4.1.3**.

Dynamic control strategies, such as SVD bus priority, cannot be explicitly modelled in LinSig as a typical cycle is modelled. These strategies can be represented by adjusting the signal timings in the network to represent those running on street.

4.4.8 Pedestrians

The pedestrian network in LinSig consists of Pedestrian Links, Pedestrian Link Connectors and Pedestrian Zones, as shown in **Figure 73**.

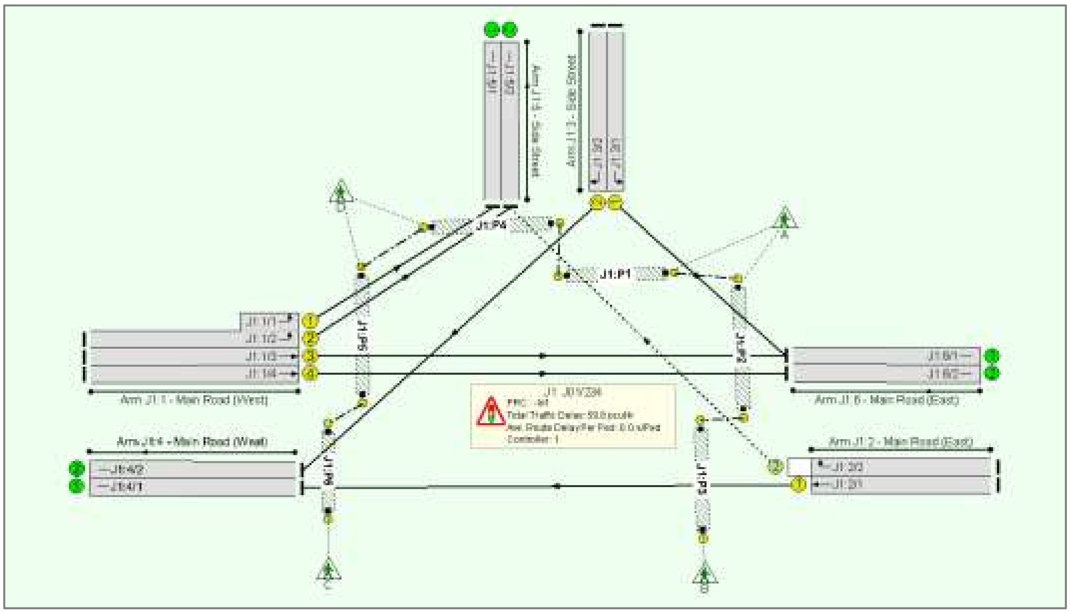


Figure 73: Example junction showing a pedestrian network in LinSig

Pedestrian Links can be added to the modelled network to represent where pedestrian crossings are provided on site. Pedestrian Links at individual junctions can be joined by Pedestrian Link Connectors to form a pedestrian network. Pedestrian Links require the following data to be added:

- Associated junction;
- Controlling Phase, if the crossing is signalised; and
- Crossing Time (sec), generally derived from observed data or by dividing the link length by an average pedestrian walking speed of 1.2m/s.

A mean walking time between crossings (sec) is required on Pedestrian Link Connectors. In the absence of observed data, the walking time can be derived based on a walking speed of 1.2m/s. Due to the complexity of pedestrian behaviour it is not advised to connect Pedestrian Links between junctions.

Pedestrian flows can be added at a junction via Pedestrian Zones and Routings. Either observed data or a nominal value of 1 can be entered into the Pedestrian OD Matrix for all pedestrian movements. It should be noted that LinSig reports pedestrian outputs in terms of PCUs, however the values are referring to pedestrian numbers.

LinSig uses the pedestrian network to determine pedestrian journey and delay times for each Pedestrian Route through the junction. These can be viewed in the Pedestrian Route List. If this involves several crossings LinSig takes account of pedestrian coordination together with the time taken to walk between crossings when modelling delays. Where nominal pedestrian flows have been used, only the journey and delay statistics per pedestrian should be used for comparison. Pedestrian journey time and delay calculations should only be compared for signalised pedestrian crossings as unsignalised crossings are not modelled accurately and are included for delay purposes only.

Where detailed pedestrian analysis is required, consideration should be given to using dedicated pedestrian modelling software to assess any pedestrian impacts of a scheme. For pedestrian modelling information, refer to Chapter **C3** on **Pedestrian Modelling**.

4.4.9 Cyclists

For advice on the modelling of cyclists in deterministic modelling packages such as LinSig, refer to Chapter **C2** on **Cyclist Modelling**.

Within LinSig, cyclist flows can be entered as their PCU contribution in Lane-Based Flow Layers or an OD Matrix. It is possible to override the Connector cruise times by Flow Layer to reflect differences by mode if this level of detail is required. If using Matrix-Based Flows, separate Zones for cyclists are required to override the Connector cruise times. In mixed traffic conditions, modelling outputs in the Travel Time / Delay Matrices will not show how cyclist queuing behaviour is different to other vehicle types on the Lane.

4.5 Base Model Validation

Base models must demonstrate that they replicate observed conditions to a sufficiently high level of accuracy, as described in **B2.4.1** and **B2.4.2**. This section describes the validation requirements with respect to LinSig and additional adjustments to ensure on-street conditions are accurately reflected in the model.

4.5.1 Demand Dependency

The frequency of demand-dependent stage appearance should be measured directly from the UTC system for UTC-controlled junctions, or through on-street observation for non-UTC sites where stage appearance data is not readily available, as described in **B2.3.8.5**.

Demand dependency cannot be explicitly modelled in LinSig, as only a typical cycle is simulated. The appearance of demand-dependent stages is therefore achieved by manipulation of the signal timings.

Bonus greens can be applied to the green period for each Lane to reflect the non-appearance of demand-dependent stages. This is applied in the Lane Timings View and can be seen in **Figure 74**. Bonus greens can be positive or negative, depending on whether a phase gains or loses green time due to demand dependency.

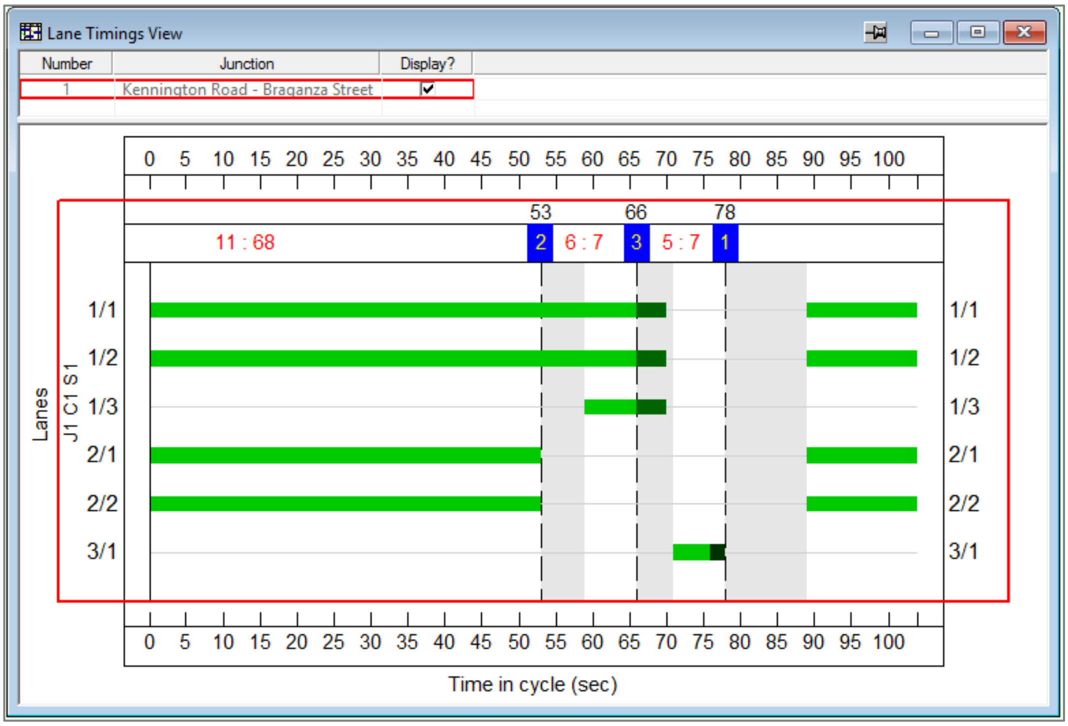


Figure 74: Lane Timings View, showing positive bonus green applied to Lanes 1/1, 1/2 and 1/3, and a negative bonus green applied to Lane 3/1

4.5.2 Exit-blocking / Underutilised Green Time

Wasted green due to exit-blocking can be quantified through on-site measurement of Underutilised Green Time (UGT). UGT accounts for both wasted green due to exit-blocking, during which traffic is stationary, and sub-saturated flow, during which traffic is slow moving due to downstream queuing and congestion.

Exit-blocking can be accounted for in a LinSig Base model through the use of negative bonus greens, which are applied in the Lane Timings View as shown in **Figure 74**. The application of this technique needs to be supported by site observation and empirical data, such as UGT measurements during a DoS survey (discussed further in **B2.3.10**).

> Care should be taken when applying bonus greens for Underutilised Green Times in LinSig. A positive average UGT value should be entered as a negative bonus green value in LinSig, resulting in a reduction of Lane green time.

It is important to note that the cause of exit-blocking cannot be modelled in LinSig. Where extensive exit-blocking exists within a network, consideration should be given to use of microsimulation modelling in order to represent both the cause and effect of exit-blocking.

4.5.3 Sliver Queues

Due to the simplified mathematical nature of a deterministic software model, behaviour can sometimes occur in a model that is not reflected by driver behaviour in the real world. An example of this within LinSig is the formation of 'sliver queues'.

A sliver queue occurs when vehicles approach the back of a discharging queue of traffic. In practice, drivers will typically regulate their speed if they see a queued vehicle in front of them is about to accelerate, whereas in LinSig they are assumed to progress at free-flow speed until they join the back of the stationary queue. This can lead to successive vehicles joining the back of a modelled queue that leads to excessive and unrepresentative queuing behaviour. A modeller can set a 'De-sliver threshold' (in PCUs) in order to prevent the formation of sliver queues. This value is the minimum queue that will actually form on street, meaning LinSig regards any queue length less than this value as a sliver queue.

A modeller can recognise the formation of a sliver queue by examining the LinSig queue data or a uniform queue graph. As **Figure 75** illustrates, the data will highlight a small amount of traffic in the queue relative to the total queue length. The right-hand image shows the same link with an appropriate de-sliver threshold applied.

Where a sliver queue has been identified it is acceptable to enter a de-sliver threshold value of no more than one PCU. It is recommended that the smallest possible value is used to achieve the desired effect of removing the unrealistic queue. Where this function has been used it should be clearly stated within the accompanying model report.

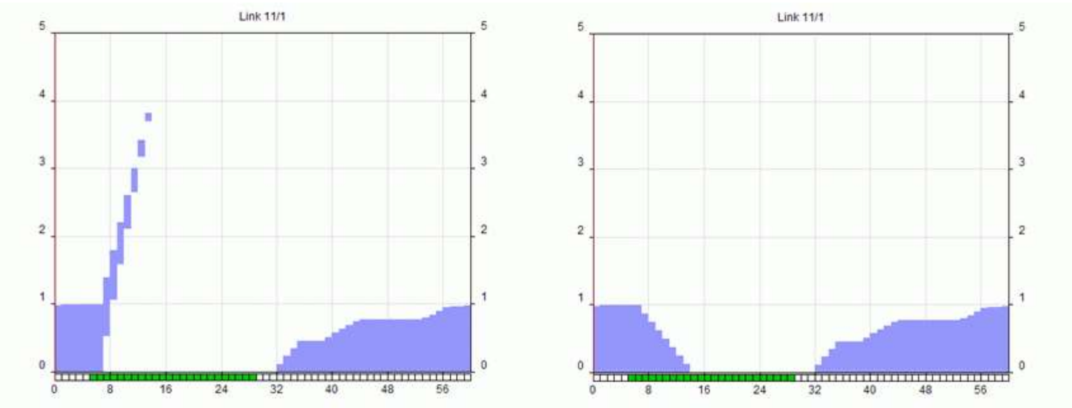


Figure 75: **Formation of a sliver queue in a LinSig uniform queue graph (left) and removal using appropriate de-sliver threshold (right)**

4.5.4 Random Delay

Random delay relates to how random or ordered traffic arrives at a stopline and is a component in the calculation of total delay in LinSig. The LinSig model assumes a level of random delay that sits between very random and very ordered arrival patterns. In some circumstances this assumption may be unrealistic, such as for highly coordinated signals at a signalised roundabout where the majority of traffic will arrive without being stopped at a red signal. In these instances, the Ignore Random Delay function should be ticked to avoid an overestimation of random delay and an improvement in the calculation of queuing.

The Ignore Random Delay feature is applied on a Lane by Lane basis, but should only be ticked when the arrival pattern at the stopline has definite non-random characteristics.

4.5.5 Validated Model Requirements

Model outputs for individual Lanes should be compared with corresponding survey data in order to validate that the model has been calibrated to an acceptable degree of accuracy, as described in **B2.4.2**.

The validated Base LinSig model will be based on the calibrated model approved at LMAP Stage 2, but will also include traffic flows and account for any measured demand dependency or exit-blocking. It is essential that a Base scenario LinSig model is validated against existing network conditions using current signal timings.

Validation criteria for LinSig Base models submitted to TfL are defined in LMAP Stage 3, as discussed in **B2.1.5**. At the time of publishing, these are[74]:

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

If modelled flows are based on surveyed stopline turning counts then Degrees of Saturation (DoS) at those stoplines should not exceed 100%. If any Lane has a DoS above 100% it should be investigated before proceeding, as it is usually a sign that the model is seriously in error.

If instead the modelled flows represent true traffic demand, as determined from an assignment model or survey well upstream of any queue, then the DoS may exceed 100%. If this is the case, validation should focus on comparing the capacity of the Lane in the model against site-measured spot counts.

Possible causes of invalid DoS values in a model include:

- The measured flow data for a particular Lane is inaccurate, or has been entered into the model incorrectly;
- The saturation flow is too low / high;
- Signal timings or UGT have been entered incorrectly; or
- One or more demand-dependent stages have not been modelled correctly.

If a scheme requires reporting on bus journey times, it is recommended that bus journey times are validated using a microsimulation model before reporting scheme impacts on public transport. Any bus results extracted from a LinSig model should be for indicative purposes only.

74 Latest MAP requirements are available at **https://www.tfl.gov.uk/trafficmodelling**

4.6 Proposed Model Development

This section details the considerations to be made when creating a Proposed LinSig model. Proposed models should be implemented using the validated Base model as a starting point, or the Future Base model if following the Three Stage Modelling Process covered in **B2.1.4**. The models should be modified to fully detail the proposed design changes, as described in **B2.5**.

4.6.1 Future Base

As described in **B2.5.1**, the Future Base model includes all likely network changes that will occur between the Base year and the year being examined in the proposal, excluding the scheme under consideration. It is built from the validated Base model by modifying it as little as possible, to include any new schemes falling with the LinSig model boundary. The guidance in the following sections within **B4.6** applies equally to creating the Future Base model as well as to the Proposed scenarios.

4.6.2 Proposed Layout

Modifications should only be made from the validated Base model or Future Base model that reflect changes required as part of the scheme designs. Further amendments to the model to make a model operate within capacity are not acceptable. If a Proposed model will not operate without additional changes it is likely an indication that the design may not be viable.

Where flare lengths have been defined by length, any changes to Proposed flows will automatically be used in flare usage calculations. Where custom occupancies or Multi-Lane flares have been used, consideration will need to be given as to how the proposals and changes in flow will impact the expected flare usage.

When modelling new proposals, the treatment of ‘funnelling’ and ‘fanning’ traffic can become a possible source of error. ‘Funnelling’ occurs when a greater number of Lanes at one signal-controlled stopline exit into a fewer number of Lanes downstream, while ‘fanning’ represents the opposite scenario, where fewer Lanes upstream flow into more Lanes downstream. This behaviour should be reflected in the modelled layout where funnelling forces Lanes of continuous length to behave like flares or with modified capacity where fanning results in underutilisation of downstream stoplines.

4.6.3 Proposed Flows

Proposed traffic flows can be applied to a LinSig model in a number of different ways, as detailed in the subsequent sections. The methodology to be used for Proposed flows should be discussed at the Base scoping meeting during MAP Stage 1 and agreed at the Proposal Scoping Meeting during MAP Stage 4, as described in **B2.1.5.1**. This ensures that the most appropriate methodology is used.

Future year flows of cyclists and pedestrians are typically agreed on a project-specific basis. Refer to Chapter **C2** on **Cyclist Modelling** and Chapter **C3** on **Pedestrian Modelling** for further details.

4.6.3.1 Manual Editing

Traffic flows can be adjusted by manually editing the Lane-Based or Matrix-Based flows in the validated Base or Future Base model. Manual adjustments to traffic flows may be complicated where movements are introduced or banned as part of the proposals. Where this is the case, a decision must be agreed as to how traffic should be rerouted. If the rerouting is likely to be widespread then tactical modelling may be necessary.

Additional Flow Layers or Flow Groups can be created to represent additional development flows within a model when using respective Lane-Based or Matrix-Based flow allocation methods. This allows for development flows to be differentiated from Base flows. Formula Flow Groups can be used to combine multiple Flow Groups together for use in a single model Scenario, or for applying a growth factor to an existing Flow Group.

4.6.3.2 Tactical Modelling

As explained in **B2.5.2.2**, the Three Stage Modelling Process will often lead to traffic flows for Proposed LinSig models being transferred from tactical modelling. The tactical flows and routing can be transferred directly into the LinSig model or they can be used to inform factored values from the Base model flows. If relevant to the proposals, any assumptions made whilst inputting the Base model flows should be maintained in the Proposed models.

Any changes made to traffic flows or routings in the Base model for validation purposes should be carried across appropriately to the Proposed models.

4.6.3.3 Public Transport

Any changes to bus routes as part of the proposals should be included within the Proposed LinSig model. This will require manual adjustments to the flow layer representing buses or to the bus flow matrix.

Any changes to bus stop locations or dwell times should be reflected on the appropriate Connectors.

4.6.4 Proposed Signal Timings

It is important to ensure that Proposed signal designs are audited by a TfL Signals Engineer to ensure that they meet current TfL standards. Once approved, signal timings in the Proposals should be developed and optimised following the methodology and guidance described in **B2.5.3**.

Existing Junction or Controller Stream numbering within a validated Base model should not be changed within a Proposed model unless necessary. New items should be added using an appropriate numbering / naming convention and highlighted within the proposal report.

Where a new junction is to be added to the Proposed model and the controller manufacturer is known, the controller type should be correctly assigned. This is to ensure any gaining phase delays are correctly modelled, as mentioned in **B4.4.4.2**. For a proposed junction that does not currently exist and for which the hardware to be used is not known, the controller type should be set to 'generic'.

4.6.4.1 Optimisation

LinSig can optimise signal timings using two different objectives, by maximising Practical Reserve Capacity (PRC) or minimising total network delay. These can be applied to the network as a whole or to individual junctions and stage streams. These criteria may lead to similar results but the choice of method should be determined based on the design objectives agreed during MAP Stage 1.

LinSig selects initial signal timings using a simple analytical junction model to calculate optimal green splits. A hybrid strategy based on a combination of traditional optimisation methods is then used to determine where changes to initial green splits and offsets could potentially improve network performance. The traffic model then reruns using the potentially improved signal timings. If it is shown that these timings were better than previous results LinSig uses these timings to try and predict further improvements. LinSig monitors progress to target optimisation effort at the areas where most improvements are likely to be realised.

LinSig does not run the optimisation process for a fixed number of iterations. JCT feel a fixed approach can risk the optimiser terminating early with complex networks, leading to signal timings that do not represent optimal network performance. LinSig instead varies the number of iterations according to the complexity of the network and other issues such as the level of traffic in the network. LinSig will let the optimiser continue where significant improvements are gained with a relatively minor extension of the run time. When the optimiser fails to achieve improvements within an acceptable time the optimisation process will terminate.

In addition to the optimisation process, signal timings within LinSig are able to be manually adjusted in order to meet site-specific requirements or during further refinement of optimised timings.

4.6.4.1.1 Cycle Time Optimisation

The Cycle Time Optimisation View can be used to assess the optimum cycle time for a LinSig model. This feature plots PRC and delay results for a model against cycle time, for a specified range of cycle times and cycle time increments.

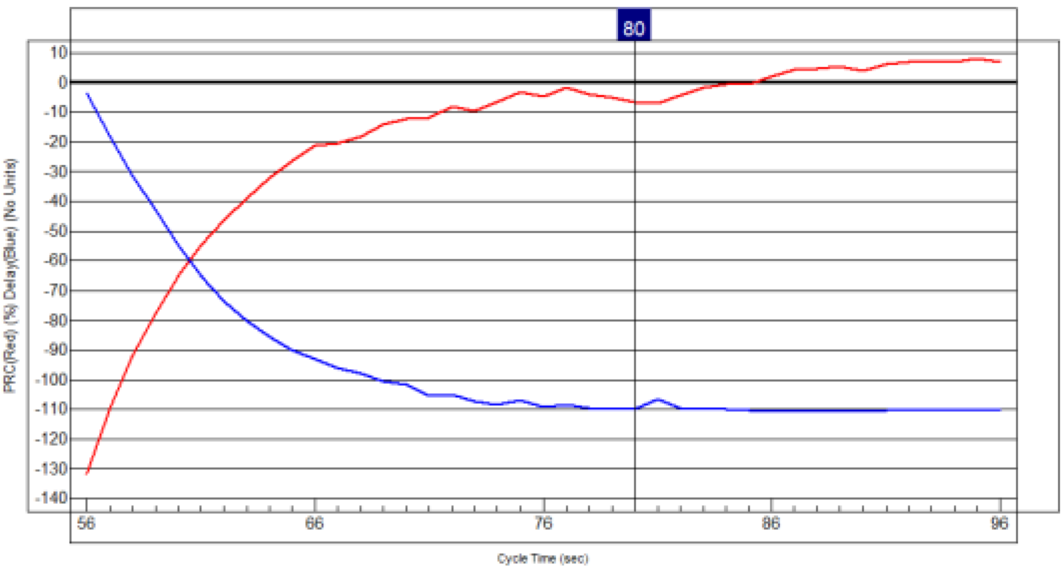


Figure 76: Cycle Time Optimisation View in LinSig, showing PRC (in red) and delay (in blue) for different cycle times

The most appropriate cycle time must be chosen and manually applied in the LinSig model. Section **B2.5.6.1.3** provides guidance on available cycle times, as well as important considerations which may influence the choice of cycle time.

4.6.4.1.2 Signal Timing Optimisation

Stage lengths and/or stage offsets can be optimised either for minimum delay or maximum PRC, depending on which is considered the most appropriate methodology during the initial determination of model scope. A network can either be optimised at a controller level, via the Signal Timings Window or for the entire network via toolbar buttons or the Modelling menu.

The generic procedure for optimising a traffic model is discussed in **B2.5.3**. During the initial optimisation phase, signal timings in LinSig can be influenced through Queue Constraints and Weightings for each Lane. Queue Constraints can be used to prevent queues extending back to upstream junctions, and use the following parameters:

- **Excess Queue Limit (PCU)** – this is used to specify the acceptable limit for a queue on a particular Lane, accounting for limited storage space on the Lane that may lead to blocking back to upstream Lanes. If the queue extends beyond this limit LinSig will attempt to adjust timings to reduce the queue. A suitable excess queue limit needs to consider that the Mean Max Queue (MMQ) reported in LinSig will statistically be exceeded 50% of the time. JCT therefore recommend that a queue limit of three quarters of Lane storage capacity is used. This is to ensure that any queue fluctuations above the MMQ stay within the Lane length;
- **Degree of Saturation Weighting (%)** – this value is only used when optimising for PRC, and determines the aggressiveness LinSig will use in reducing the average excess queue where an excess queue limit has been applied; and
- **Delay Weighting (PCU Hr)** – this serves the same purpose as the Degree of Saturation Weighting, but is used when optimising timings for delay rather than PRC.

Optimiser weightings can be used to prioritise the importance of a Lane when determining signal timings. There are three parameters controlling the optimiser weightings:

- **Optimiser Stops Weighting (%)** – this is used to factor up or down the penalty of any Stops calculated on a Lane. Values less than 100 will reduce the importance of stops on the Lane whereas values greater than 100 will increase the importance;
- **Optimiser Delay / Degree of Saturation Weighting (%)** – Similar to the stop weighting, this weighting factors up or down the importance

of delay or DoS on this Lane, dependent on the optimisation method used; and

- **Degree of Saturation Limit (%)** – This parameter prevents the optimiser choosing signal timings that generate a DoS on a specified Lane exceeding this value.

When using Queue Constraints and Weightings high values may prevent the optimiser producing optimal signal timings. The use of optimiser weightings should be detailed in accompanying model reports.

It is important to note that optimiser Weightings should be used with care. They do not replace engineering judgement and the manual adjustment of signal timings relating to safety constraints or on-site conditions. Any use of optimiser Weightings should be clearly detailed within the technical note, along with a justification for their use.

4.6.4.1.3 Optimisation Settings

The optimisation process within a LinSig model can be controlled within the Optimiser Settings. The parameters included in the settings include:

- **Optimising pedestrian and non-traffic stages lengths to minimums**;
- **Stops Valuation for Delay** – the default value is 6.59 sec per stop/PCU. This considers vehicle stops in the optimisation process, where small increases in traffic delay are preferred over larger decreases in the number of PCUs stopping at traffic signals; and
- **Bus Delay Weighting – t**he default value is 1000%. This default assumes that avoiding bus delay within the modelled network is 10 times more important during optimisation than avoiding general traffic delay, which has a default value of 100%. Decreasing the default value will lower the importance of bus delay and conversely increasing the default value will increase the importance.

Any amendments to the default values should be justified in the supporting documentation.

Within the optimiser settings it is possible to group together controllers or stage streams to fix stage offsets. This process fixes the offsets between the first stage in the stage sequence for each controller or stream that has been included in an offset optimiser group.

The optimisation process can be further influenced within the signal timings view, as follows:

- **Allow Edit Timings** – If this is unticked for a controller or stage stream the timings will be omitted from the optimisation process;
- **Lock Length of Stage when Optimising** – This setting will fix the stage length for the selected stage within the optimisation process; and
- **Lock Offset of First Stage in Sequence** – This setting fixes the pulse point of the first stage in the stage sequence, overriding the optimiser settings or offset groupings.

Any influence on the optimisation process should be carefully considered prior to use and detailed in accompanying documentation.

4.6.4.2 Demand Dependency

When calibrating demand dependency levels in a Proposed model it should be carefully considered whether there is reason to believe they will change from the Base or Future Base model. Where considered necessary, a suitable methodology should be determined to ensure that any estimated demand levels are appropriate. Assuming full demand as a 'worst case' could in fact mask a capacity issue downstream so a judgement on the expected demand should be agreed and documented. For further information refer to **B2.5.2.3**.

4.6.4.3 Underutilised Green Time

Where adjustments have been made in the validated Base model to reflect Underutilised Green Time (UGT), consideration should be given to the cause of the UGT before determining whether any modifications are appropriate or necessary in the Proposed models. If unsure whether to amend Base UGT values, it is recommended that the MAE is contacted to determine the best approach. For further information refer to **B2.5.6.1.1**.

4.6.4.4 Saturation Flows

Saturation flows should only be changed from the Base model if there is clear evidence that they would be different in the Proposed scenario. Reasons for this include:

- A new junction or major layout change;
- Change in lane width; or
- Change in flow volumes for particular turning movements.

If any of these apply then RR67 should be used with an appropriate local factor as discussed in **B2.3.9.1** to implement new saturation flows using the methods described in section **B4.4.3.7**. The reasoning behind any changes must be documented in the accompanying modelling report.

4.7 LinSig Output

LinSig offers a variety of output features that can aid in the analysis and reporting of model performance, which are detailed in this section.

4.7.1 Network Results

The Network Results View allows data and performance statistics to be displayed for every Lane and Pedestrian Link in the model, as shown in **Figure 77**. The exact data that is displayed is user-customisable and can contain a mixture of input data (including flows, saturation flows, phase letters and Lane green times) and output data (including DoS, delay and queue information).

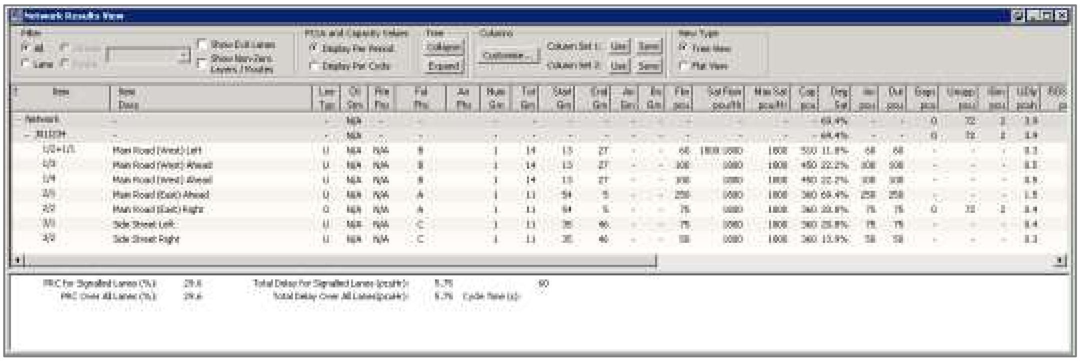


Figure 77: Network Results View

As well as identifying performance parameters for individual Lanes, the Network Results View also displays PRC and delay information for individual junctions or the entire network. Results for individual Lanes can also be further broken down into specific Routes through individual Lanes.

It is possible to filter the data included in the Network Results View, so that results can be shown on the following conditions:

- All Lanes;
- All Routes passing over a selected Lane;
- All Lanes controlled by a selected stage stream;
- All Lanes along a selected Route; and
- Including or excluding Exit Lanes.

4.7.2 Cyclic Flow Profile, Uniform Queue and Storage Graphs

Cyclic Flow Profile (CFP) graphs show traffic flow arrival and discharge patterns for a particular stopline during a typical cycle. These can be plotted for individual Lanes, grouped Lanes, right turn storage areas or for whole routes. Where CFPs are plotted for an individual Lane they can be set up to show arrival and/or discharge flows, and can be further broken down into flows associated with individual Routes. Where a whole Route is plotted, a CFP graph is provided for each stopline along the Route, allowing analysis or platoon progression along the Route selected. An example of a CFP graph is shown in **Figure 78**, where the X axis represents the time in the cycle and the Y axis represents the rate of traffic arrivals / departures in PCU/hr.

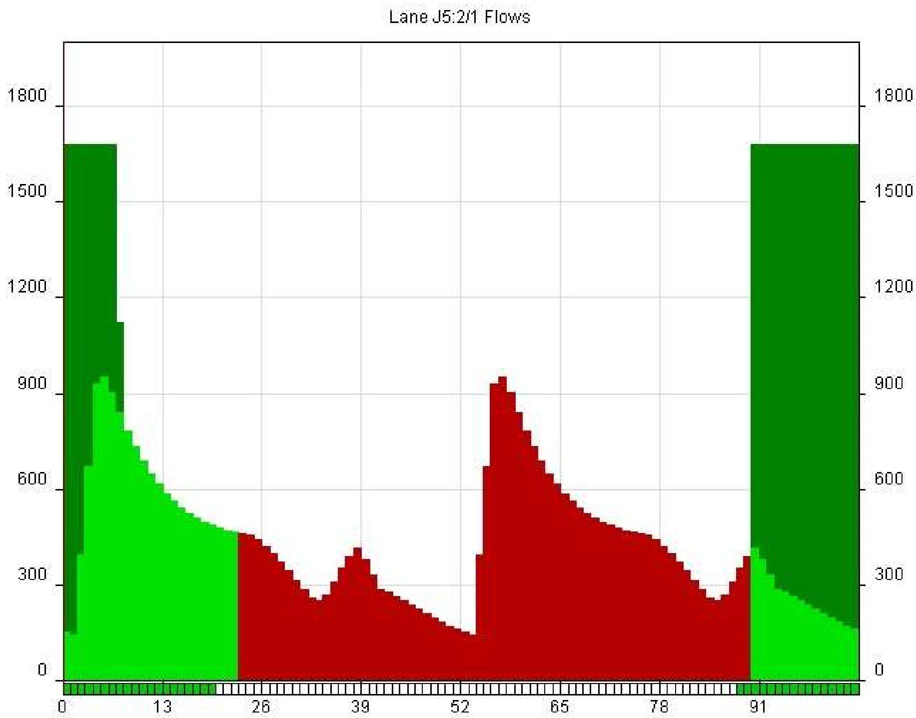


Figure 78: Cyclic Flow Profile graph, showing previously delayed vehicles (dark green), vehicles arriving on green (light green) and vehicles arriving on a red signal (red)

Uniform queue graphs can also be plotted for individual Lanes or grouped Lanes. These show the uniform component of a queue, not including random and oversaturated queue components. An example of a uniform queue graph is shown in **Figure 79**.

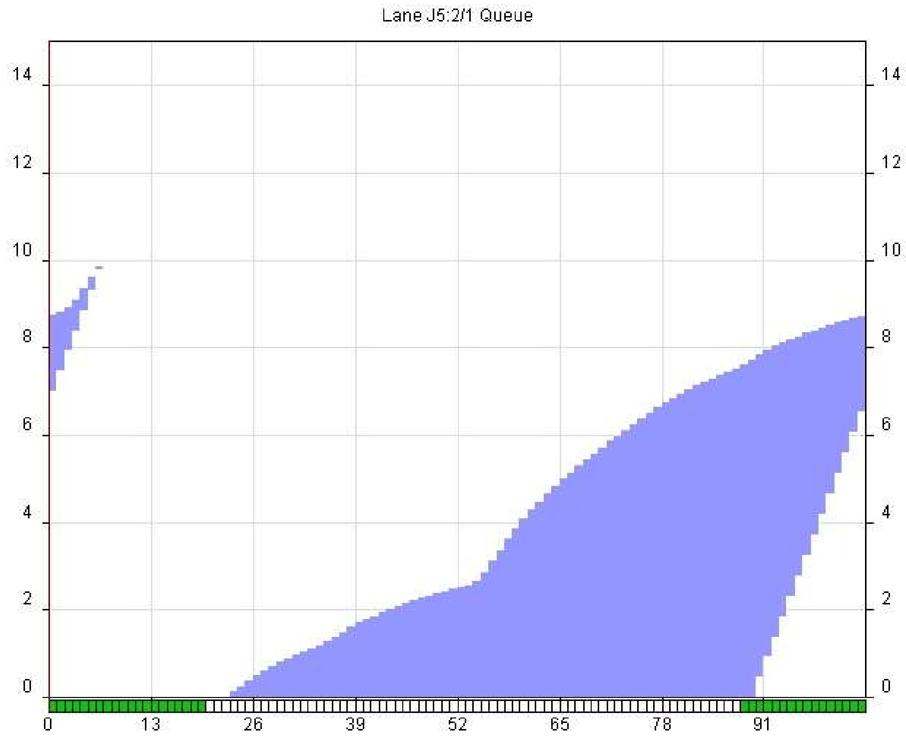


Figure 79: Uniform Queue graph in LinSig

When a Lane has a DoS less than 80% the uniform queue is an accurate representation of the average queue on a Lane, however when operating above 90% the random and oversaturated queue components become more critical and the uniform queue graph should not be relied on to predict queue storage issues.

Optionally the random and oversaturated queue component can be shown on the queue graphs as a flat profile throughout the cycle time.

Storage graphs can be plotted for Short Lanes or right turn storage areas to assess when traffic using these Lanes is likely to start blocking or influencing adjacent Lanes. Storage graphs can also be produced on Long Lanes in a Lane Group to determine when the traffic on a Long Lane will prevent entry to its adjacent Short Lane. Storage graphs can be helpful to check that flare utilisation is as observed on-street and can determine whether a Short Lane custom occupancy is required, as discussed in **B4.4.3.5**. Example storage graphs are shown in **Figure 80**.

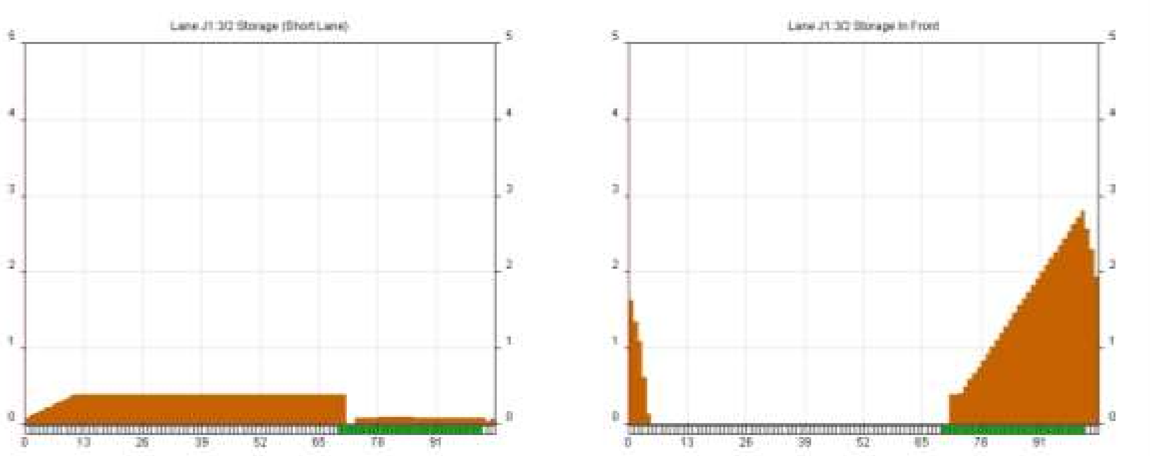


Figure 80: Example of storage graphs in LinSig

4.7.3 Travel Time / Delay Matrix View

LinSig provides details of average travel times between Zones in the modelled network. The travel times included within the matrix are:

- **Average Journey times (s)** – travel time between Zones, a weighted average is provided where there is more than one Route between Zones;
- **Average Undelayed Time (s)** – travel time between Zones, without including delay caused by queuing; and
- **Average Delay per PCU (s)** – the average queue delay encountered by traffic travelling between Zones.

This information can be provided whether Lane-Based or Matrix-Based flows have been applied, and results can be differentiated by routed traffic or by Flow Layer. While reported journey times and delays should be broadly representative for Matrix-Based flows, these values should be treated with caution when using Lane-Based flows. In the latter case the results represent summed average values for traffic on each Lane along the route and is not restricted to traffic travelling between the origin and destination zones. For Lane-Based flows the travel time matrix therefore does not account for differing arrival profiles from upstream lanes and coordinated signal offsets that may benefit some routes over others.

It is recommended that a microsimulation model is used for reporting journey time results. However, if indicative journey time outputs are required from LinSig it is recommended that Matrix-Based flows are used and routing information is based on OD surveys or a tactical model.

4.7.4 Report Builder

The Report Builder allows various LinSig modelling information to be extracted and presented in a customisable manner, either for direct analysis or further editing in word processing software. Such information can include graphical views of almost any of the LinSig program views (including junction layout, stage views / sequences, signal timings and interstage timings) or data in tabular form such as input data or model performance statistics.

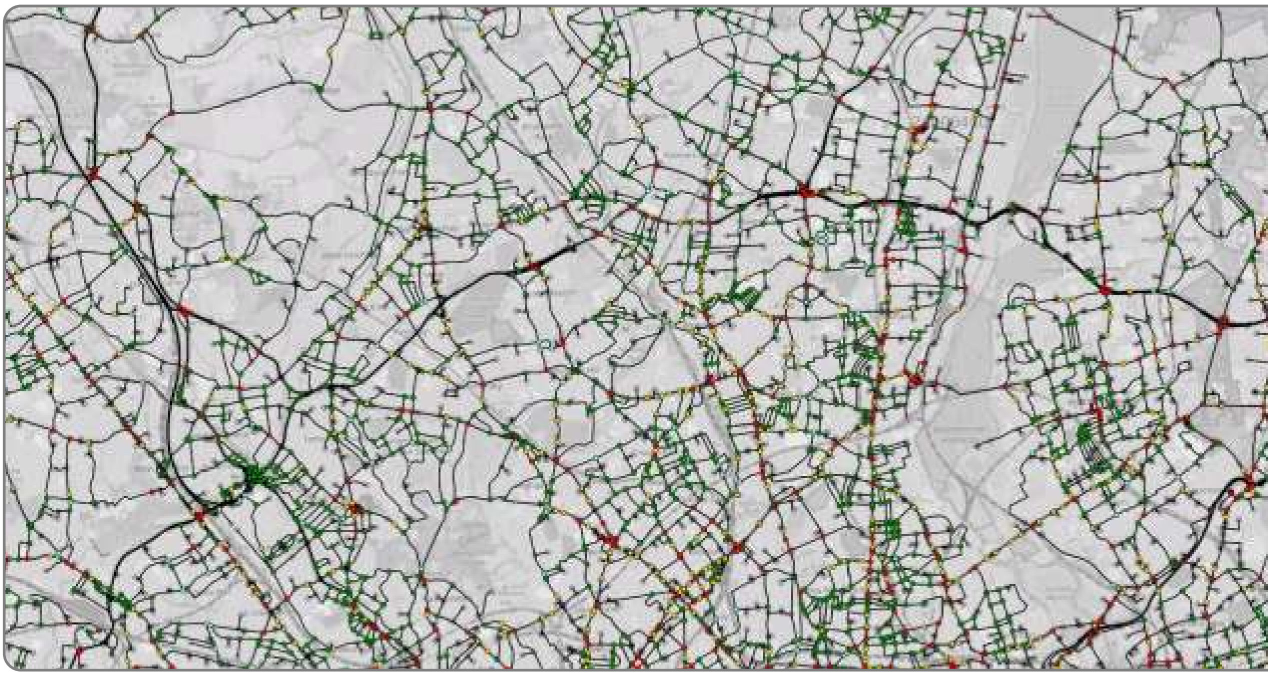
4.7.5 Model Audit View

LinSig has a Model Audit View, where all model input data and results are displayed in a tabular format to assist when reviewing model data. The report is not automatically updated when changes are made within the model, and the Model Audit View window will require refreshing to ensure all data is up to date.

The Model Audit View also has a facility to compare two Scenarios, which can be in separate LinSig files. This shows a comparison of the input data and model results for the specified Scenarios, with changes between them highlighted with both values indicated, as shown in **Figure 81**. This is a useful view for auditing LinSig models when identifying key changes between model submissions.

Figure 81: LinSig Model Audit View, highlighting differences between two compared files

5 Highway Traffic Assignment



5.1 Introduction

In this chapter Highway Traffic Assignment (HTA) is used to describe a distribution of travel demand (trips) on a supply network, where a travel cost equilibrium state is achieved. HTA therefore identifies a set of likely routes among Origin-Destination (OD) pairs and estimates flows such that no vehicle can find a better generalised travel cost by switching its route.

HTA can be classified according to the technology used to derive travel times / delays:

- **Macroscopic** – uses analytical formulae;
- **Mesoscopic** – uses simplified simulation of individual vehicles; and
- **Microscopic** – uses detailed simulation of individual vehicles.

HTA can be classified according to the spatial application scale:

- **Local Area** – typically a small subnetwork; and
- **Global Area** – for example the whole urban area (this category is sometimes called strategic).

HTA can be classified according to the assessment time horizon:

- **Tactical** – short term assessment; and
- **Strategic** – long term assessment.

Theoretically one can have a Local Area Macroscopic HTA model (for example using Visum's Intersection Capacity Analysis (ICA)) or a Global Area Microscopic HTA (for example using Vissim dynamic assignment) model. However, the former is considered to be over-simplification (as a more realistic model can be built easily) and the second one is over-complication given that it would be hard to create and to run.

5.2 Use of HTA Models in TfL

The use of HTA models within TfL is separated into two categories based on the time horizon being modelled. The two categories are defined by TfL as Strategic and Tactical and are described in the following sections. Both the strategic and tactical models are based on macroscopic assignment methodology.

5.2.1 Strategic HTA Models

The Strategic HTA suite predicts the overall demand and the demand responses in London and provides a strategic assessment of transport infrastructure and policy changes. Strategic HTA models can be summarised as follows:

- Have a long-term planning horizon, beyond five years;
- Support planning to meet London's future transport needs;
- Help TfL make key transport investment decisions; and
- Identify the most effective transport interventions for meeting the goals set out in the Mayors Transport Strategy.

TfL's strategic demand model, Model of Travel in London (MoTiON), uses land use assumptions, economic and travel behaviour assumptions and planned transport investment to forecast the total number of trips made, what mode they will use, travel times and determine crowding and congestion. Integrated into MoTiON are the following assignment models: London Highway Assignment Model (LoHAM), Railplan and Cynemon, as shown in **Figure 82**. For further information, contact **StrategicModelling@tfl.gov.uk**.

5.2.2 Tactical HTA Models

TfL's tactical modelling suite, enables a detailed operational assessment of the network and can provide information back to TfL's strategic modelling suite in terms of the actual capacity available on the road network. Tactical HTA models can summarised as follows:

- Having a shorter-term planning horizon, of three to five years;
- Replicating real-life conditions to test proposed schemes and predict outcomes;
- Providing flow and routing information for microsimulation models;
- Supporting operational decision-making by providing those running the network with a balanced and impartial viewpoint; and
- Enabling effective mitigation strategies.

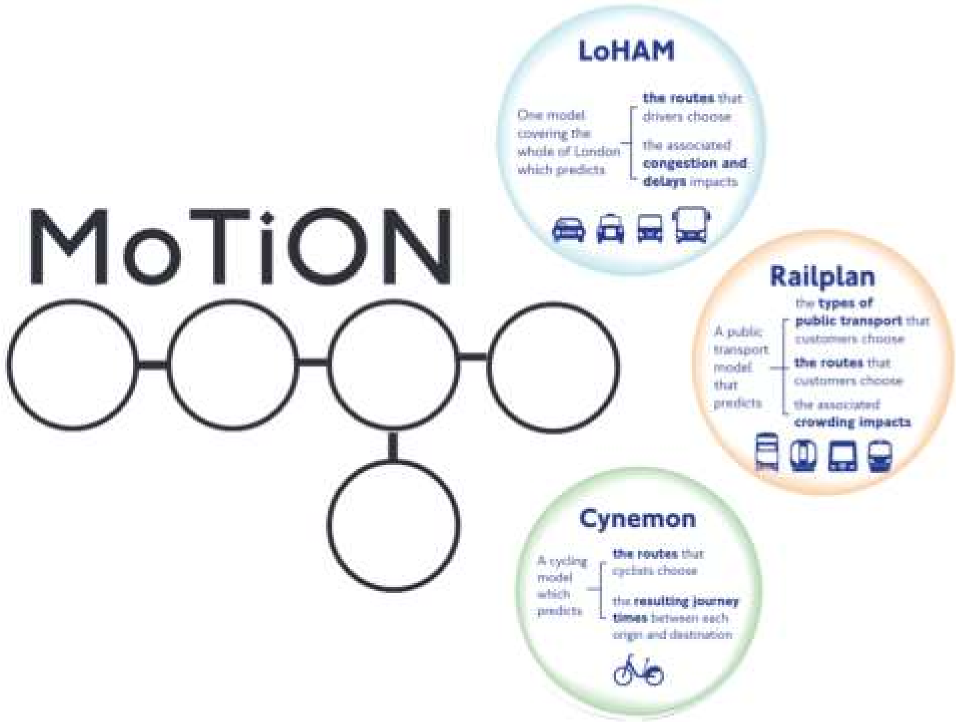


Figure 82: TfL's MoTiON Model

The tactical HTA model used by TfL is called the Operational Network Evaluator (ONE) model. It is used to predict short term global traffic reassignment and congestion impacts due to local network changes.

Assessing the global implications of local network changes, such as improvements to junction layout or signal timings, requires detailed transport network representation and assignment methods capable of estimating congestion effects with high realism. At the time of publishing, the ONE model represents AM and PM peak periods. For further information, contact ONE@tfl.gov.uk.

This chapter provides advice for the development of tactical HTA models and for model application in an operational scheme assessment context and augments the general modelling guidance provided in Chapter B2 on Modelling Principles. However, there may be cases where local conditions or project requirements dictate the use of methods which may be different to those outlined. In these situations, NP should be consulted on the planned methodology.

5.3 Traffic Assignment Requirements

To represent congested conditions realistically it is important that the chosen tactical modelling software meets specific criteria:

- Accurate representation of capacities for signal controlled and priority junctions taking into account the impact of conflicting traffic streams;
- Realistic estimation of travel times (including delays) on links and junctions due to traffic control and conflicting traffic streams;
- Realistic estimation of queues and associated blocking back effects on upstream movement flows; and
- Assignment algorithm should enumerate a realistic set of alternative routes between origins and destinations, model route choice taking into account congestion effects, as well as converge, and produce stable outputs in a reasonable amount of time.

The software commonly used for tactical modelling includes Aimsun Next, SATURN and Visum.

5.3.1 Mesoscopic Models

HTA algorithms have advanced significantly to make simulation-based dynamic assignment methods practically (computationally) feasible for large scale urban networks. These methods are conventionally referred to as mesoscopic assignment.

Mesoscopic assignments are based on the conventional least cost equilibrium principles and employ simplified simulation of individual vehicles aimed at providing more detailed and realistic representation of travel times at junctions and along links.

Mesoscopic models use similar algorithms to those used in microsimulation models, such as car following, gap-acceptance and weaving. Mesoscopic assignments generally aim to provide more detailed representation of vehicles at intersections and adopt simplified car-following models along links. The aim is to represent the dynamic movement of individual vehicles through the network, rather than aggregate averages of traffic volumes as in a strategic or tactical model. Furthermore, in a mesoscopic assignment the demand and supply can be represented dynamically using a finer resolution time series.

Potentially there are more challenges in terms of convergence and run times of the simulations when using mesoscopic models. The advantages for mesoscopic models versus strategic or tactical models are the simplification of microsimulation modelling over a much bigger area with traffic behaviour and vehicle interactions represented.

At the time of publication, a new generation ONE model is being developed with the aim of incorporating a mesoscopic assignment methodology. Once considerable experience is gained through development and use, this section will be updated with advice pertaining to mesoscopic assignment models.

5.4 Preparation

General guidance on Base model development is provided in **B2.3** and **B2.4**. This section provides specific guidance for preparing to develop or use a tactical model.

5.4.1 Model Boundaries

The modelled area in a tactical model is defined by identifying the area within which traffic flows or journey times are likely to experience a significant change as a result of implementing the scheme or intervention. The extent of the modelled area should be agreed with the stakeholders at the model application scoping stage. Tactical models should include all important highway links and junctions within the area of influence of the scheme to enable a more robust modelling of travel times, routing and assignment to be achieved.

The density of the network differs in accordance to its vicinity to the scheme, containing a higher level of detail for the area closest to the scheme in question, with a declining level of detail further away. The simulation area should also have a detailed zoning system for traffic demand.

The remaining areas in the model are where the impacts of interventions are considered to be relatively weak in magnitude, specifically at junction interaction level. See section **B5.5.2.1** for further guidance.

5.4.2 Data Collection

Prior to building a tactical model the following information should already have been obtained, as identified in sections **B2.2** and **B2.3**:

- Topography of highway network, this can be obtained from a reliable and up-to-date mapping database (for example the Ordnance Survey Master Map Integrated Transport Layer);
- Classified turning counts, at a junction level and at the start and end of trips;
- Traffic demand matrices (section **B5.5.1**);
- Bus routes and frequencies;
- Bus stop locations;
- Signal timings, normally supplied from validated deterministic models;
- Saturation flows, normally supplied from validated deterministic models;
- Vehicle journey times; and
- Mandatory speed limits.

5.4.3 Model Time Periods

An appropriate modelled peak hour should be defined by investigating the traffic levels across the peak periods, based on available traffic demand data. General guidance on model time periods is given in **B2.3.3**.

The tactical modelling suite held by M&V have the following peak periods modelled:

- AM peak: 08:00 – 09:00; and
- PM peak: 17:00 – 18:00.

5.5 Base Model Calibration

Following the collection of model input data, it can be used to build and calibrate a tactical assignment model. A calibrated tactical model should have as a minimum:

- Accurate representation of capacities for signal controlled and priority junctions taking into account the impact of conflicting traffic streams;
- Accurate representation of junction geometry and link attributes; and
- Realistic estimation of travel times (including delays) on links and junctions due to traffic control and conflicting traffic streams.

5.5.1 Travel Demand

This section details the different elements that comprise the Transport Demand within a tactical assignment model.

5.5.1.1 Travel Demand Data

This guidance refrains from giving advice on travel demand development and assumes that reliable matrices representing travel demand by user class are available and ready to be used within a tactical model. Travel demand matrices could be obtained from travel demand models that utilise a wide range of data sources, such as TfL's strategic demand model, MoTiON (section **B5.2.1**).

M&V advises differentiating at least four user classes: cars, light goods vehicles, heavy vehicles and taxis, where heavy vehicles include all private vehicles larger than light goods vehicles. This minimum set of user classes is justified by significantly different travel patterns, differences in the value of time and different preferences in route choice. It is important to ensure that all required user classes are differentiated when requesting traffic surveys.

5.5.1.2 Zones

Zones describe the position of origins and destinations of trips within a tactical model, representing residential areas, shopping centres, schools and car parks for example. Generally, the zoning system should be defined taking into consideration relevant administrative boundaries, the demand model zoning system that the tactical model is linked to, as well as the level of mobility taking place in particular areas. Higher mobility density leads towards smaller zone sizes. As a guideline, zones should be small enough to have no more than 200-300 trips arriving and departing to / from a zone.

5.5.1.3 Connectors

A connector is a special type of link that connects a zone to a node / junction in the road network. It represents the point or points at which all traffic accesses the network. Connectors should be coded realistically and, where possible, represent actual means of access to and egress from the modelled network such as a car park or side road. It is advisable that connectors do not connect directly into a junction, connectors should use secondary links or nodes to account for the access / egress arrangements to the road network.

The number of connectors for each zone should be minimised, where possible limited to one connector per zone. Connectors for neighbouring zones should not to load on to the same node / junction. Refer to Traffic Analysis Guidance (TAG) for a more detailed practical advice on this topic[75].

It is advised that network connectors are reviewed to avoid queuing on the connector itself. The presence of queues on the connectors would result in an underestimation of the demand entering the road network.

5.5.2 Network

The model network of a tactical model forms the transport supply component of Highway Assignment. This section details the different elements that comprise the Transport Supply network.

5.5.2.1 Buffer Network

In tactical models there are two levels of network details, the key area (simulation) and buffer network. The buffer network is a skeleton network that feeds demand into the key area without detailed junction representation. The simulation provides accurate information of the junction operation including the signal timings (section **B5.5.2.3**). The buffer network, surrounding the simulation area, represents the roads as opposed to the junctions. It is coded in very coarse detail as it is only a source for external trips to or from other regions in the wider extent of the network to enter or leave the model. The buffer network also allows the tactical models to cover a much wider network than the key area. The feeder buffer network is fully integrated with the key model area as an assignment network.

75 TAG Unit M3.1, 2020, Section 2.4, pp 4 – 6

In different software packages the buffer network is also known as the external area or wider area.

5.5.2.2 Links

Any complex original dataset needs to be reduced to a manageable set of links on which the assignment is to be performed. However, it is important to retain all non-local links and 'rat runs' that play an important role in travel route choice both in the Base situation and in relation to the proposals.

Network data sources typically contain attribute information detailing functional class, speed limits and number of lanes which are automatically loaded into a model, however, these networks often need to be verified against independent data sources to ensure their accuracy.

Link speeds entered in the model are assumed to be constant throughout the length of the links and equal to their speed limit (or alternatively free-flow speed measured using a moving observer method during uncongested conditions).

The number of lanes on a link represents the number of through lanes between the two nodes connected by the link. Where flares exist, these can be accounted for on a node level.

Unrestricted speeds and number of lanes must be verified, either using up-to-date aerial overview applications such as internet mapping services or undertaking site visits.

Where bus lanes exist along a link, care must be taken to represent their operation accurately, especially where operation hours vary throughout the day. Subject to local traffic regulations, bus lanes usually create additional capacity not only for buses but for taxis as well. Bus stop locations and dwell times should be replicated and linked to relevant bus routes.

5.5.2.3 Nodes

Junctions are dominant sources of delay in congested urban networks. It is therefore critical that junctions are coded accurately, and that the modelling software correctly simulates the operation and capacity of junctions. Different tactical modelling software packages simulate junction capacity using different methods; however, it is common that junction attributes will include data that defines junction geometry and the average method of traffic control.

The coding of geometric elements should represent information obtained from various sources such as site layout diagrams and site observations. These allow for the specification of the number of lanes per approach, permitted turns and the effective flare lengths[76]. Software packages usually provide a mechanism to define prohibited movements by user class.

It is recommended that U-turning movements are not included at nodes within tactical models, this ensures realistic routing choices are made and to ensure that the number of calculations undertaken during the assignment procedures are minimised.

5.5.2.3.1 Signal Controlled Junctions

In congested urban networks signal controlled sites are very frequent and precise coding is of paramount importance. Detailed representation usually encompasses several elements such as the definition of phases (including allocation to lane turning movements), stages, interstages (including intergreens and phase delays), and stage sequences, as well as the coding of representative cycle times and stage durations. Depending on the assignment model, the discharge rate may be governed either via saturation flows or other means (such as a car following model). Opposed right turning movements may require additional gap acceptance parameters to be applied at the node level.

Within tactical models, due to the average peak hour representation of the traffic conditions, only a typical signal cycle is reflected. Therefore, the signal timings should be manually adjusted in order to replicate the impact of demand-dependent stages on phase green times. The use of validated deterministic models, such as LinSig and TRANSYT, can assist with the correct interpretation of phase-based signal timings as the following will already have been accounted for: demand dependency, underutilised green time (UGT) and phase delays. Where the tactical modelling software takes

76 The effective length of a pocket lane (flare) is the position at which the flared approach allows two vehicles to queue side by side

account of blocking back, timing adjustments, such as UGT, that have been included in the deterministic modelling to reflect this, do not need to be transferred into the tactical model. However, it is important to check that the cause of the UGT is not caused by factors other than blocking back before adjusting the timings (section **B2.3.10.1**). Therefore, any green time adjustments for UGT should only be included if the cause is at the junction being modelled and not by a downstream junction. It is advised that when signal timings are taken from validated deterministic models, 1 second of effective green is added when coding timings to ensure realistic representation of signal operation. Where the software allows, the capacity of turning movements can be accurately reflected by using saturation flow information from validated deterministic models.

5.5.2.3.2 Priority Junctions

The layout of priority junctions is modelled with the same level of detail as signal-controlled junctions. In most software packages, the capacity of priority junctions is estimated via junction geometry and the gap acceptance parameters of traffic exiting the side road. In some software packages, it is possible to amend the parameters governing capacity values at priority junction movements, these parameters are known as 'critical gap' and 'follow up gap' or 'GAP'. The critical gap defines the temporal distance between two successive vehicles in the main flow that a vehicle on a side road requires to enter the main flow. Follow-up time defines the additional time required for a second vehicle to accept a gap in the opposing traffic. This parameter indirectly defines saturation flows.

Where the software allows, it is important that the major traffic flow at a priority-controlled junction is accurately specified. This allows for the correct calculation of the gap acceptance parameters and capacity of the approaches.

5.5.2.3.3 Roundabouts

The approach used to code roundabouts in assignment models is dependent on the size of the roundabout. The different approaches are discussed in the following sections.

Large roundabouts, generally with a diameter greater than 40m, are modelled as a series one-way links and either signal or priority-controlled nodes depending on the operation of the roundabout. The approach and exit lanes for the roundabout are modelled using a single lane. This method of coding allows link lengths of the gyratory to be included within route choice during the assignment process.

Roundabouts at major or grade separated junctions are modelled in a similar way, however the approach and exit lanes are modelled separately.

The approach lanes should be attached to signalised or priority-controlled nodes as appropriate, with the exit lanes leaving the circulating carriageway using an unspecified node (section **B5.5.2.3.4**). Where a slip road exists at a roundabout, allowing vehicles to move through the junction without having to stop and give way to opposing traffic, a link is coded alongside the circulatory to allow this movement to avoid the roundabout.

At small priority-controlled roundabouts, delay is calculated using the Kimber / TRL method which requires detailed geometric information for each approach arm[77]. The geometric information required includes entry width, flare length and approach width. These are the same measurements that would be required for other roundabout junction modelling software, such as ARCADY.

5.5.2.3.4 Unspecified Nodes

Unspecified nodes are used in all software packages to represent changes to link attributes which do not impact on capacity or there is no interaction between vehicles. In different software packages these are known as Dummy or Unknown nodes.

5.5.2.3.5 Main Nodes / Junctions

Complex and/or large junctions (such as dual carriageway junctions) are often not represented by a single node, but instead by a group of nodes. One individual node then corresponds to only one part of an actual junction, which could result in erroneous modelling results. To resolve this issue all nodes comprising a given intersection are grouped into a single main node / junction.

Main nodes may also be used where there are banned movements between closely located junctions, for example where only traffic from certain approaches at an upstream junction can make a turning movement at a downstream junction due to lane allocation or physical barriers.

In different software packages these are known as spider nodes or Supernodes.

77 Kimber, R M (1980). “The traffic capacity of roundabouts”, Department of Environment Department of Transport, TRRL Report LR 942: Crowthorne: Transport and Road Research Laboratory

5.5.3 Public Transport

Public Transport services in tactical models are incorporated as fixed demand, also known as a pre-load. The main considerations are the frequency of buses and the number of routes on specific links. Bus pre-loads should be based on the on-street timetables and added to the highway network on a link-by-link basis for each modelled time period. The bus pre-load is considered during the highway assignment, whereby the pre-load is multiplied by a PCU factor and subtracted from the link and turn capacity. This accounts for the loss of capacity due to presence of the public trips on the network.

5.5.4 Cyclists

It is important to identify the key cyclist volumes for inclusion in TfL's tactical models due to the increasing prevalence of cycling in London. Cyclists are only considered in the tactical model for their impact on motorised traffic, and therefore only included where limited or no segregation is present between cyclists and motorised vehicles.

Similarly to public transport, cycle flows are imported into tactical models as static pre-load onto link volumes in each time period. This reduces the available link capacity for motorised traffic. A suitable conversion factor should be used to convert cycle flows to PCU units for tactical model assignments.

This implementation is independent of the software chosen and motorised traffic is impacted by the link volume / delay functions, resulting in reduced speeds and restricted volumes due to the presence of cyclists on the road.

Cycle demand information can be obtained from the CYNEMON model, as described in section **B5.2.1** and **Figure 82**.

5.5.5 Calibration Tools

Tactical modelling software packages supply functionality facilitating network integrity checking tasks. This includes as a minimum:

- Connectivity test, which ensures the existence of routes between all OD pairs; and
- Redundant elements test, which ensures that model does not contain isolated network elements such as nodes or links.

These automated tests should follow manual network layout and traffic control checks and generally work as an additional inspection layer.

Once confidence in network accuracy is established, the enumerated routes and travel demand distribution are checked to see if they are reasonable.

Route choice in the model can be examined, by using tools available in the software packages:

- Visualisation of minimum cost routes between OD pairs;
- Visualisation of enumerated routes and volumes between OD pairs; and
- Visualisation of enumerated routes and volumes on links (such as in select link analysis).

5.5.6 Matrix Estimation

Having designed a network structure and sensible set of routes, it may be necessary to calibrate prior trip matrices by means of matrix adjustment. OD pairs whose values are derived from road-side interviews and are deemed to be reliable should be frozen during matrix calibration.

TAG[78] emphasises that count constraints in matrix estimation should generally be applied at the short screenline level as the mismatch between modelled flows and counts at any one location (individual site) may be due to a number of reasons and not due solely to deficiencies in the trip matrices. Employing constraints at individual sites is likely to exacerbate the tendency of the matrix estimation procedure to compensate for deficiencies in other aspects of the model (zoning system, network structure, centroid connectors, and route choice coefficients).

As the primary purpose of matrix estimation is to refine estimates of trips that have been synthesised as opposed to being intercepted in surveys, screenlines independent of the roadside interview screenlines are required. In addition, screenline counts used as constraints in matrix estimation should be derived from representative ATCs with the vehicle type proportions being obtained from MCCs or other reliable means.

Initially, prior trip matrices are checked by comparing modelled flows and observed screenline counts. A matrix estimation procedure follows if the discrepancies are deemed significant and matrices may potentially fail the validation requirements. TAG[79] recommends monitoring the changes brought about by matrix estimation by the means identified in **Table 10**.

78 TAG Unit M3.1, 2020, Section 8.3.6, pp 36
79 TAG Unit M3.1, 2020, Section 8.3, pp 36 – 38

Table 10: Matrix estimation monitoring

Monitoring Method	Acceptability Criteria
Scatter plot of matrix zonal cell values, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R^2 values)	1. Slope between 0.98 and 1.02 2. Intercept near zero 3. R2 in excess of 0.95
Scatter plot of zonal trip ends, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R^2 values)	4. Slope between 0.99 and 1.01 5. Intercept near zero 6. R2 in excess of 0.98
Trip length distributions, prior to and post matrix estimation, with means and standard deviations	7. Means within 5% 8. Standard deviations within 5%
Sector to sector level matrices, prior to and post matrix estimation, with absolute and percentage changes	9. Differences within 5%

Changes falling outside acceptability criteria are deemed as significant and should be examined and assessed for their importance. After matrix calibration is complete, differences between modelled flows and counts on calibration screenlines should be reported.

5.6 Convergence Criteria

High levels of convergence should be achieved in tactical models. With poor assignment convergence, there is little confidence in typical modelled outputs, examples of which include link flows and travel costs. Strong convergence indicators also provide confidence that any differences in modelling outputs between Base and Proposed networks can be attributed to the effects of the scheme being tested rather than to uneven degrees of convergence (model noise).

Concerns regarding convergence are discussed in detail in TAG, on which TfL practice relies significantly. M&V believes that convergence in practice needs to be measured in terms of two desirable properties:

- Proximity to the assignment objective (such as Wardrop equilibrium); and
- Stability of the model outcomes between consecutive iterations.

Proximity indicators measure the degree to which the assignment has achieved its stated mathematical objective. In the case of equilibrium assignment this means the degree to which Wardrop's equilibrium has been achieved.

There are two types of stability indicators that measure the change between consecutive model iterations:

- Aggregate stability indicators, that provide network-wide comparisons of parameters such as total costs, distances, times and average speeds; and
- Disaggregate stability indicators, which provide Link-Based comparisons of typical parameters such as flow, cost and time.

TAG recommends the convergence measures detailed in **Table 11** are to be used when developing a Base model[80].

Table 11: Convergence indicators from TAG[80]

Measure of Convergence	Base Model Acceptable Values
Delta and %GAP	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P)<1%	Four consecutive iterations greater than 98%
Percentage of links with cost change (P2)<1%	Four consecutive iterations greater than 98%
Percentage change in total user costs (V)	Four consecutive iterations less than 0.1%

It should be noted that each specific tactical modelling software adopts different principles for measuring convergence. The criteria should be interpreted in the context of the application of the models. It is recommended that the TAG guidance is followed, but alternative convergence indicators could be accepted following detailed justification.

In conclusion, both stability and proximity criteria should be satisfied for four consecutive iterations before convergence can be judged to be acceptable. These values should always be reported, and any deviations explained with a reasoning behind any poor convergence performance.

80 TAG Unit M3.1, 2020, Section 3.4.17, pp 24

5.7 Base Model Validation

Model validation data must be independent from data used during calibration. This data independence ensures that validation statistics are a true measure of validation. It is not appropriate to supplement validation data with data used during calibration in order to improve the quality of model validation. A Validation Report should document validation results for matrices and assignment.

5.7.1 Matrix Validation

Matrices are validated using an independent set of validation screenlines that are different from those used in roadside interviews and matrix calibration. TAG recommends that differences between modelled flows and counts should be less than 5% on all or nearly all screenlines[81].

5.7.2 Assignment Validation

The validation of the traffic assignment within tactical models has separate criteria for the validation of traffic flow and journey times. The criteria are detailed in the following sections. In addition, checks should be carried out to ensure there is a realistic estimation of queues and associated blocking back effects on upstream movement flows.

5.7.2.1 Traffic Flow Criteria

Generally, traffic flows can be validated on a link or turning movement basis. TAG points out that it is rare that turning movements will have been counted using automatic methods over a number of days[82]; most likely, the available or affordable counts will be single day MCCs. For this reason alone, turning movements may not validate to the standards achieved for link flows. Nevertheless, both Turn-Based and Link-Based modelled flows and counts should be compared and assessed using criteria and acceptability guidance given in **Table 12**.

Model performance in terms of these validation acceptability criteria should be reported for each modelled user class and each time period.

81 TAG Unit M3.1, 2020, Section 3.3.7, pp 19
82 TAG Unit M3.1, 2020, Section 9.3.2, pp 39

Table 12: TAG traffic flow validation criteria

Criteria	Description of Criteria	Acceptability Guideline
1	Individual flows within 100veh/hr of counts for flows less than 700veh/hr	> 85% of cases
1	Individual flows within 15% of counts for flows from 700 to 2,700veh/hr	> 85% of cases
1	Individual flows within 400veh/hr of counts for flows more than 2,700veh/hr	> 85% of cases
2	GEH < 5 for individual flows	> 85% of cases

5.7.2.2 Journey Time Validation

The validity of an operational tactical model should be assessed by comparing the model travel times against on-site observations on a selected set of routes. The routes for the validation of journey times should cover the modelled area as evenly as possible and include the most critical links and junctions. TAG points out that the validation routes should not be excessively long (greater than 15 km) nor excessively short (less than 3 km) and should not take longer to travel than the modelled time periods[83].

These comparisons will demonstrate how well link travel times and junction delays are represented, which is of paramount importance in accurate tactical models.

TfL recommends the journey time validation requirement given in TAG, that 85% of all validation route journey times to be within 15% of observed mean times for the full length of route[84]. This is generally demonstrated by generating observed and modelled travel time plots along the journey time validation routes.

83 TAG Unit M3.1, 2020, Section 4.3.3, pp 26
84 TAG Unit M3.1, 2020, Section 3.3.15, pp 21

It is worth reiterating that good quality data is required for model validation. The accuracy (half of 95% confidence interval or 1.96 of standard error) of observed counts must be within a GEH of two of the mean value. The accuracy (half of 95% confidence interval or 1.96 of standard error) of measured travel times must be within ±10% of the mean value. An assessment of the accuracy of the data is only possible where the information has come from automated collection sources such as ATCs for counts and GPS tracked vehicle data for travel times.

5.8 Proposed Model Development

Proposed models should be created by amending the validated Base model or in the Future Base model, if following the Three Stage Modelling Process, to include the scheme proposals. These changes should be made by only making changes to the elements of the model that are modified due to the scheme, as outlined in **B2.5**.

This section deals with items which particularly need to be considered when building a Proposed tactical model.

5.8.1 Future Base

As described in **B2.5.1**, the Future Base model includes all likely network changes which will occur between the Base year and the year being examined in the proposal, excluding the scheme under consideration. It is built from the validated Base tactical model by modifying as little as possible in relation to all schemes likely due to be implemented prior to Future Base year.

TfL have Future Base tactical models available which include multiple schemes due to be implemented by the Future Base forecast year. However, it is advisable to make sure the schemes included are updated to include the latest information available at the time of the model build, including any additional schemes, especially in the vicinity of the scheme to be assessed.

The guidance in this section applies to creating the Future Base model as well as to the Proposed scenarios.

5.8.2 Traffic Demand

There may be a requirement to amend the travel demand used in the tactical model to reflect the estimated changes in demand for the Proposed year. This can be achieved by applying an agreed factor to the demand matrices used in the Base model. The factoring of demand flow is often influenced by TfL's strategic HTA models (section **B5.2.1**).

If the scheme under consideration is anticipated to significantly impact highway travel costs, the traffic demand matrices for all user classes may need revisiting as a result of possible modal shift. An iteration process between tactical and strategic HTA models would be required to refine the demand matrices to be use in the Proposed models.

5.8.3 Signal Timings

Proposed signal timings should be provided from deterministic models that have been updated to represent the scheme proposals. Initially, the signal timings in the deterministic models will be optimised based on Base model or Future Base model traffic flows, or with manual assumptions of traffic reassignment. It is therefore recommended that an iteration process is undertaken, where tactical model traffic flows are transferred to deterministic models, then the signals are re-optimised and the resultant signal timings are fed back to the tactical model for assignment until the assignment flows in the tactical models stabilise.

Where demand dependency and UGT have been replicated in the supporting deterministic models, consideration should be given to including these in the tactical model signal timings. Where the tactical modelling software takes account of blocking back, any UGT that has been reflected in deterministic models for this purpose does not need to be replicated in the tactical model. However, the cause of the underutilised green time should be carefully checked and any green time adjustments for UGT should only be included if the cause is at the junction being modelled and not by a downstream junction. The inclusion of signal timing adjustments for demand dependency in a Proposed model should be considered on a scheme basis, taking account of what might reflect the worst-case scenario for that scheme. For further guidance refer to section **B2.5.2.3**.

5.8.4 Saturation Flows

Where the software allows, the capacity of turning movements can be updated using saturation flow information from Proposed deterministic models. Saturation flows should only be changed from the Base model if there is clear evidence that they would be different in the Proposed scenario

5.8.5 Public Transport

Where proposals include any changes to bus routes, individual routes should be appropriately reallocated in the tactical model. Where new bus stop locations are required it is important to include appropriate dwell times for each route, it may be appropriate to determine dwell times from adjacent or relocated stops. The removal or addition of bus lanes should be applied on a link level.

5.9 Model Outputs

Tactical models can provide a variety of model outputs to aid in the analysis and reporting of scheme performance. In most cases this includes:

- Comparison of traffic performance statistics (average speeds, travel times and mileages for example) for aggregated areas such as boroughs;
- Comparison of traffic flows on links or turns; and
- Comparison of traffic routing between particular origins and destinations across the network.

Commonly data from tactical models can be extracted for use in other models, such as deterministic models, microsimulation models and Air Quality and Noise assessments.

5.9.1 Model Noise

When the model outputs are being used to compare scheme proposals, it is important to be able to distinguish differences due to the scheme being assessed from those associated with different degrees of convergence, known as 'model noise'.

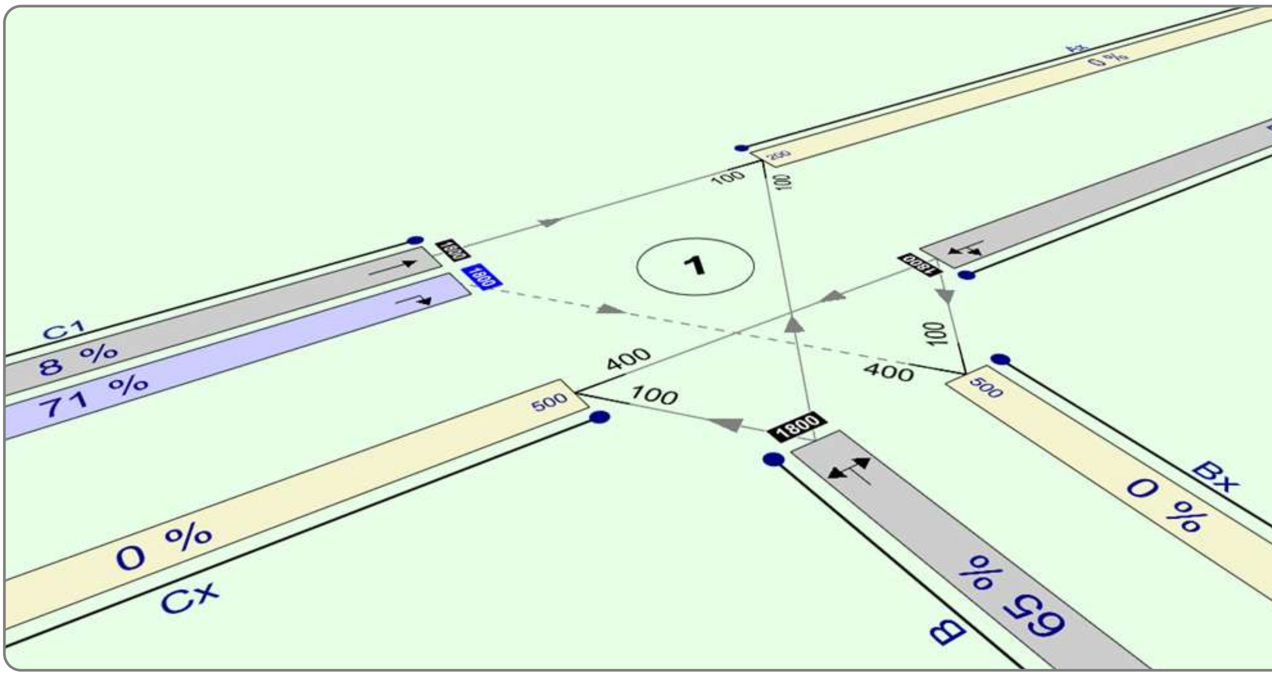
Tactical models utilise an equilibrium assignment methodology, wherein it assigns trips between all origins and destinations to their least cost path and assumes that drivers have perfect network knowledge when selecting routes. At the outset the traffic model algorithm assesses, for each origin trip, all the possible route permutations to every destination, it then selects the lowest cost route and assigns trips through the network. This infers that the trip has perfect knowledge of the delays and congestion along each and every route and therein makes decisions about the lowest cost route before departing. Routing decisions will differ between the with and without intervention scenarios as a result of the changes made and the point at which a new route is chosen can be some distance from the changes themselves. Consequently, the impacts of reassignment can be dispersed over a large area, and evidence of 'model noise' might be observed.

Tactical models require a high level of validation in the area of influence and also for key strategic routes through the area. The model also needs to be sufficiently responsive to test a range of development and network related scenarios without these effects being lost in 'model noise'. Given the size of the tactical models, typically with in excess of 2000 zones and a simulation area covering wide areas, the magnitudes of scheme impacts can often be of the same order as model noise, despite the extremely high degree of model convergence routinely achieved across the models.

TAG[85] states that before the results of any traffic assignment are used to influence decisions, the stability (or degree of convergence) of the assignment must be confirmed at the appropriate level. The importance of achieving convergence is related to the need to provide stable, consistent and robust model results.

85 TAG Unit M3.1, 2020, Section 3.4.1, pp 22

6 TRANSYT Modelling



6.1 Introduction

This chapter is primarily intended to assist traffic modelling practitioners when building, auditing or otherwise using TRANSYT models as part of a scheme submission to TfL, typically under MAP. It augments the general modelling guidance given in Chapter **B2** on **Modelling Principles**.

Whilst this document outlines TfL recommendations in respect of TRANSYT modelling there will be cases where local conditions or project requirements dictate the use of methods which may be different to those outlined. In these situations, NP should be consulted on the planned methodology where modelling will be submitted for approval by TfL.

For more detailed explanations of specific TRANSYT features and functionality it is advisable to refer to the interactive help menus and TRL documentation supplied with the TRANSYT version being used, or consult the TRL Knowledge Base[86].

6.1.1 Introduction to TRANSYT

TRANSYT (TRAffic Network StudY Tool), produced by TRL, is a deterministic traffic modelling application that allows the optimisation of signal timings, to minimise the stops and delay experienced by road users while also

86 https://trlsoftware.com/support/knowledgebase/

displaying performance metrics for assessment using indicators such as capacity utilisation and queue prediction. It is widely used within London, across the United Kingdom and globally for impact assessment of proposed schemes and for the initial preparation of signal timing plans prior to implementation.

6.1.2 Software Versions

The version of TRANSYT in most common usage within TfL remains TRANSYT 12 (henceforth referred to as T12), therefore much of the guidance contained in this document references this version.

The latest major version of TRANSYT released by TRL at the time of publishing is TRANSYT 16 (henceforth referred to as T16, and while this is not yet widely used within TfL an effort has been made to update guidance to reflect this version where possible. As T16 becomes more widely adopted it is anticipated that the content in this document will be updated as more experience is gained with this version. Intermediate versions between T12 and T16 are not directly covered in this document, although much of the content remains relevant.

Where significant content within this document is specific to a particular TRANSYT version, this is highlighted using the terminology below:

- [T12] – content is specific to TRANSYT 12; and
- [T16] – content is specific to TRANSYT 16.

6.1.3 Principles of TRANSYT

The mathematical evaluation and optimisation process within TRANSYT consists of two main components – a traffic model and a signal optimiser.

The traffic model predicts a Performance Index (PI) for a network based on an initial set of signal timing plans and traffic flows. The PI is a measure of the overall cost associated with congestion and delay and is a weighted combination of total vehicle delay and stops experienced by traffic within the modelled network. For convenience, it is expressed in financial units based on the cost of occupants' time for delay and vehicle running costs (fuel consumption and wear) for stops.

The signal optimisation component within TRANSYT iteratively modifies signal timings across the modelled network and assesses whether those adjustments have reduced or increased the PI. This process continues until an optimum set of signal timings producing a minimum PI is found, as illustrated in **Figure 83**.

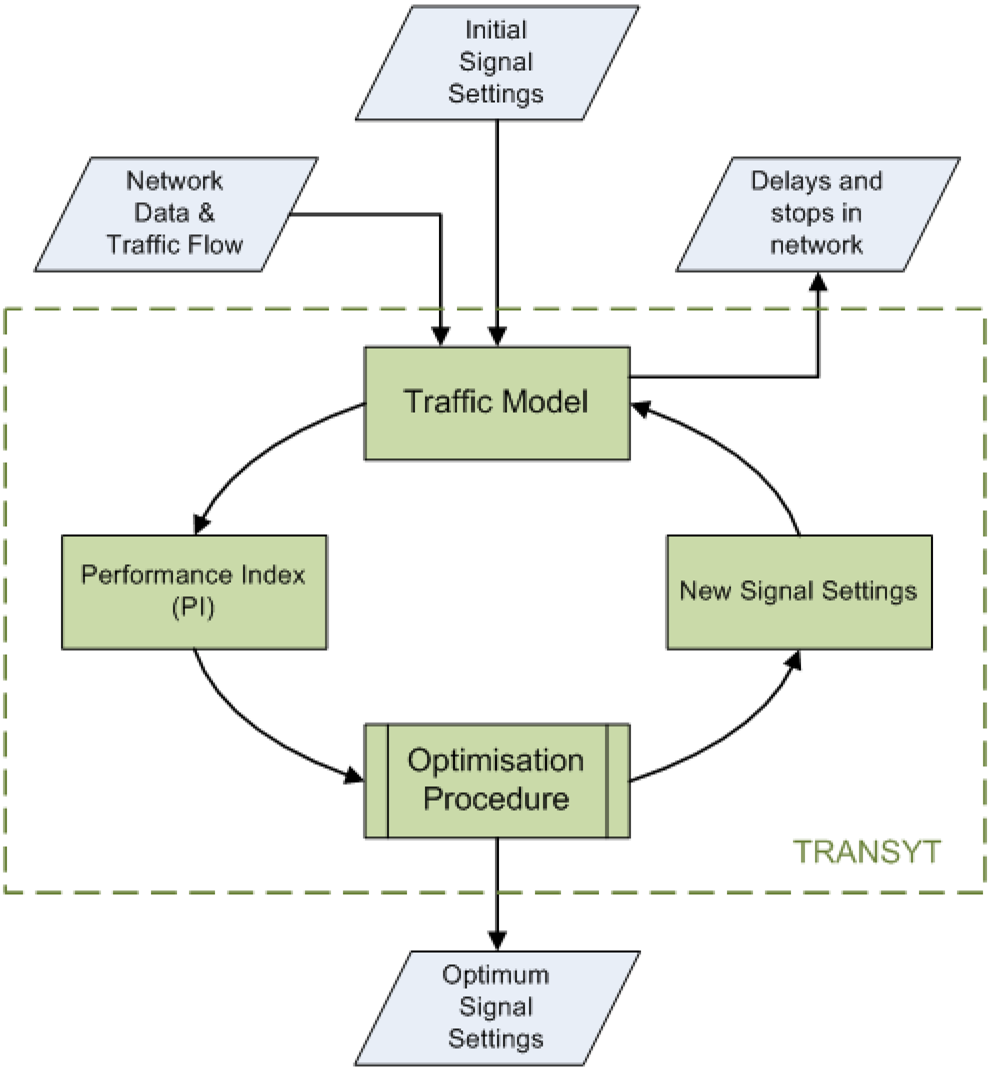


Figure 83: The TRANSYT optimisation process, adapted from the TRANSYT 12 user guide[87]

6.1.4 Appropriate Use of TRANSYT

T12 is appropriate for modelling coordinated networks of signalised neighbouring junctions based on a common cycle time. Priority junctions can also be included within a model, however this is only appropriate where they form part of a larger network comprised primarily of signalised junctions.

87 Binning J C, Crabtree M & Burtenshaw G, TRANSYT 12 User Guide, Application Guide 48 (Issue C), TRL, 2005

TI6 can further include neighbouring signalised networks based on differing cycle times, and priority junctions can be more accurately modelled when not part of a larger signalised network.

When modelling networks, TI2 is not capable of modelling the causal reasons for poor network performance such as exit-blocking, but this can be accounted for through manual adjustment of model input parameters based on site-collected data (section **B6.4.5.6**). TI6 provides some ability to account for blocking effects when using the Cell Transmission Model or Simulation Model, however when using other models blocking effects need to be accounted for in a similar manner as for TI2.

Where significant congestion is observed and leads to exit-blocking within a model, consideration should be given to the use of microsimulation modelling (section **A5.2**), to model both the cause and effect of pan-network exit-blocking.

6.2 Preparing to build a TRANSYT Model

Prior to building a model in TRANSYT the following information should already have been obtained, as identified in **B2.3**:

- Site Layout Drawings and SCOOT Link Diagram (if applicable);
- TfL Controller Specifications and Timing Sheets;
- Site-measured values for distances, cruise times, flare usage and saturation flows. Where measurement has not been possible, estimates should be used with appropriate justification (such as RR67 for saturation flows or extrapolated cruise times if conditions are permanently congested);
- Stopline traffic flows by turning movement;
- Determination of average signal timings, either from the UTC system or site measurement; and
- Site observation of traffic behaviour, particularly lane usage and effective flare length.

In addition to collecting the above data, skeleton LinSig models should be produced for all junctions to be modelled in TI2. This is necessary in order to verify correct controller phase representation (detailed further in **B4.1.3.2** and **B6.4.5.2**). This is not necessary for TI6 models since controller phases are directly modelled.

6.3 Graphical User Interface

The TRANSYT interface has changed over time and therefore varies significantly between versions. A brief overview is provided below describing the main elements and methods of interaction.

6.3.1 Network Visualisation

TRANSYT has built-in functionality that allows graphical representation of a network, using the Network Construction Editor (NetCon) in T12 or the Network Diagram view in T16. These also provide a convenient method for interaction with a TRANSYT model, both for data entry and visualisation of model results. **Figure 84** shows an example of the Network Diagram window in T16.

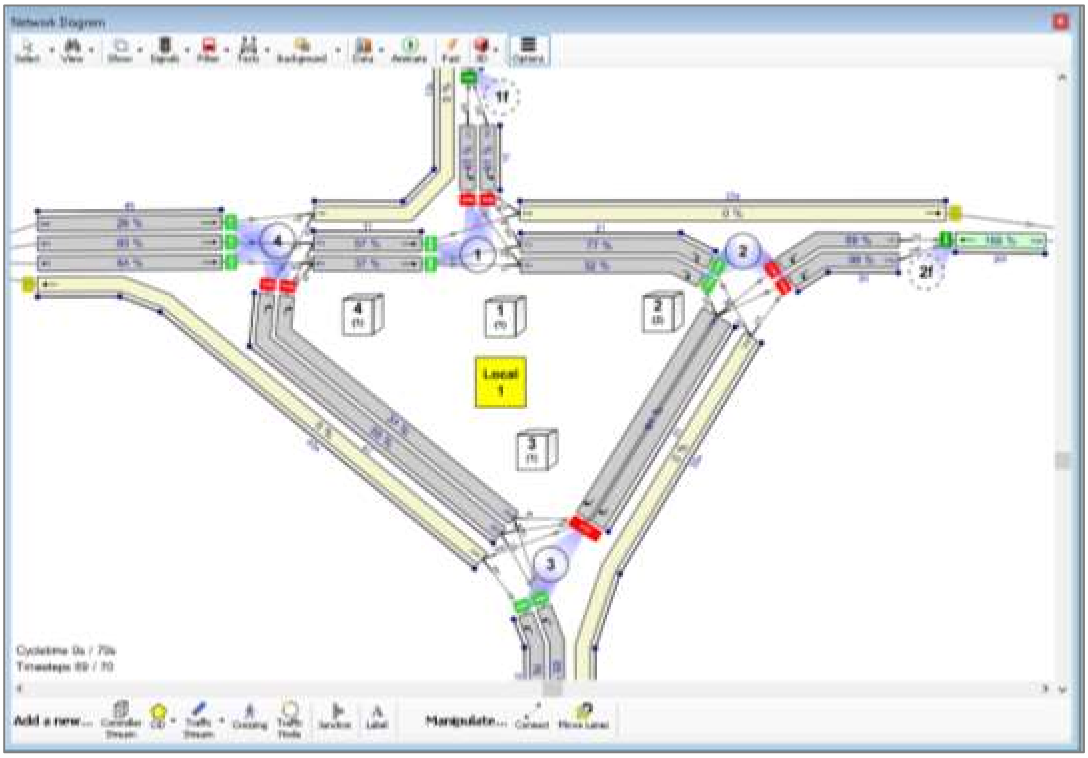


Figure 84: T16 Network Diagram window

6.3.2 TranEd interface to TRANSYT 12 [T12]

It is common for T12 models to be built using TranEd, a JCT software product that provides an alternative graphical interface to the underlying TRANSYT 12 program. The TranEd interface allows translation of controller phase information into TRANSYT 12 Link and stage data, and the network diagram to be coded graphically as part of the input file.

The TI2 content within this document applies equally whichever interface is used as the underlying functionality of TranEd is provided by TI2. No preference for either software interface to TI2 is expressed or implied within these Guidelines.

6.3.3 Data Input and Output Files

In TI2, input data is stored within a text-based (*.dat) file in logical groupings of related data referred to as Card Types, a historical reference to separate punched cards that were used with early versions of the program. Such references are used throughout the TI2 interface and in accompanying documentation.

In TI6, model data is stored within a proprietary (*.TI6) binary model file, which can only be accessed via the TI6 application. A number of Library File templates are provided for common intersection layouts in order to speed up initial model building tasks.

TI2 output data is contained within text-based (*.prt) files that are produced following TRANSYT runs. Basic TI6 output results are stored within the TI6 file, while more detailed results can be generated by running the model. More details on data output options are covered in **B6.7**.

6.3.4 Data Outline, Data Editor, Data Grids and Data Finder [TI6]

In TI6 there are several ways to view and edit model parameters, including use of program menus, toolbar icons and interaction with the Network Diagram. Three complementary options that can be accessed directly include the Data Outline, Data Editor and Data Grids, as described below.

The Data Outline, shown in **Figure 85**, is visible by default when launching the application and provides an overview of all categories of data contained in the model. The Data Outline is arranged in a logical hierarchy, which can be navigated and expanded / collapsed as desired to show any model parameters from global model options down to properties of individual model objects.

Also shown in **Figure 85** is the Data Editor, which can be opened by double-clicking an item within the Data Outline or by clicking on its toolbar icon. Once opened, the Data Editor shows all model parameters that can be viewed or edited for the currently selected item in the Data Outline or Network Diagram. Parameters shown within the Data Editor can be editable, read-only, if derived from other model parameters, or hidden, if currently unused or inapplicable. Additionally, model result values are highlighed in green to show they are up to date or red if they are out of date, indicating whether a new optimisation or evaluation run needs to be performed. When clicking on individual parameters in the Data Editor a short description is provided at the bottom of the Data Editor window, with further details available via the Glossary reference in the Help menu.

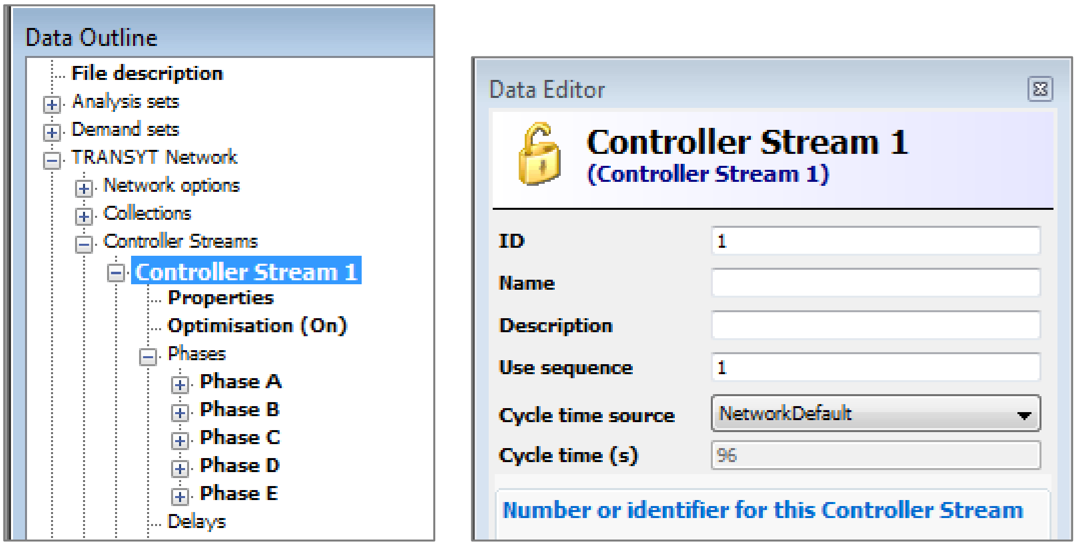
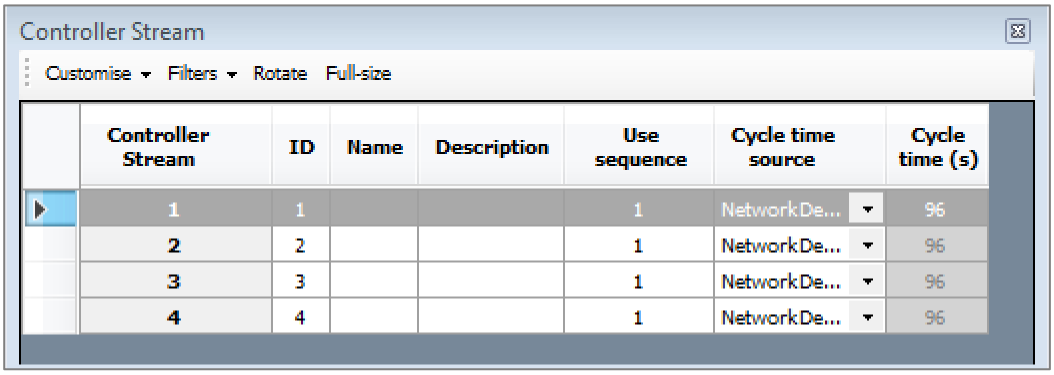


Figure 85: TRANSYT 16 – Data Outline and Data Editor windows

The content of the Data Editor window changes according to the item selected in the Data Outline or Network Diagram. The padlock symbol can temporarily override this behaviour, locking the current window content to the specific item clicked on, items of the same type, or frozen at that point in time without further updates being reflected. Additional Data Editor windows can be opened while the original remains locked.

The last and potentially most useful option to view or edit model parameters is the Data Grid (**Figure 86**), which is accessible by clicking on its toolbar icon or by right-clicking an item in the Data Outline. This shows data for all model objects of the same type within a single editable table, allowing a larger amount of model data to be viewed or changed at the same time.

The Data Grid behaves similarly to the Data Editor, with its content updating to reflect the item currently selected in the Data Outline or Network Diagram. The padlock symbol can similarly be used to lock the contents when required, allowing multiple Data Grids to be kept open at the same time. It is also possible to copy Data Grid content to and from external spreadsheet software.



Controller Stream

Customise ▾ Filters ▾ Rotate Full-size

Controller Stream	ID	Name	Description	Use sequence	Cycle time source	Cycle time (s)
1	1			1	NetworkDe...	96
2	2			1	NetworkDe...	96
3	3			1	NetworkDe...	96
4	4			1	NetworkDe...	96

Figure 86: TRANSYT 16 – Data Grid window

6.3.5 Analysis Sets and Demand Sets [T16]

In T16, Analysis Sets enable different situations to be modelled within a single file, supporting use of alternative signal timing plans and variation of some model parameters. These can be useful for modelling different time periods, assessing alternative strategy options or for separating future proposals, although significant layout changes are not supported.

Where model parameters can be changed between different scenarios, a folder icon is displayed next to the relevant parameter in the Data Editor indicating if they are unique for that Analysis Set or shared with others.

Demand Sets are used to contain collections of traffic and pedestrian demand flows, with each allocated to a specific time of day and scenario description. Demand Sets can be used by themselves or combined with other Demand Sets and applied to any Analysis Sets.

When entering model data it is important to remember that the displayed values are relevant for the currently selected Analysis Set and Demand Set as shown in the drop-down menus at the top of the main program window and identified with asterisks in the Data Outline, as shown in **Figure 87**.

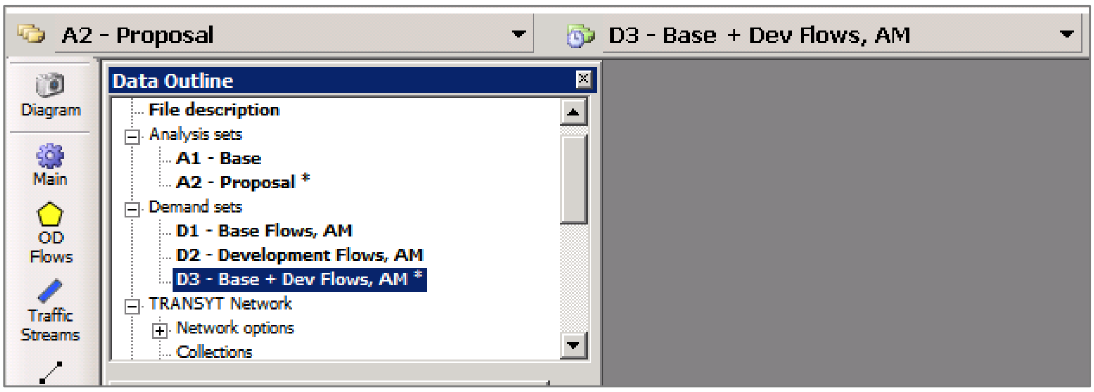


Figure 87: TRANSYT 16 – Selected Analysis Set (A2) and Demand Set (D3)

6.4 Base Model Calibration

This section provides guidance to support appropriate calibration of a TRANSYT Base model.

6.4.1 Calibrated Model

A calibrated TRANSYT Base model is defined as being a model which has correct network structure and geometric input data, and is submitted during Stage 2 of TMAP as identified in **B2.1.5**. It should contain representative signal timings for the period being modelled with no demand-dependent stage adjustments. The model should be accompanied with a technical note as detailed in section **B2.6**. This should state the purpose of the model, the modelled period, TRANSYT version number and study area.

6.4.2 Network Options

Before commencing model development, particular attention should be paid to the following TRANSYT network options which need to be appropriately specified.

> If using T16, it is recommended that the menu option 'Data / Use Advanced Mode' is selected in order to ensure that all network options and modelling parameters are accessible.

- **Monetary Value of Delay and Stops for Vehicles** – These terms represent the monetary values applied when calculating the cost of modelled delay and stops for vehicles, and their resulting contribution towards the network's overall Performance Index. The default values used in TRANSYT are:

  Value of delay: 1420 pence per PCU-hour

  Value of stops: 260 pence per 100 stops;

- **Number of Steps in Cycle / Resolution** – the number of steps should typically be equal to the cycle time. In T16, the related Resolution parameter defines the number of steps per second during the cycle, therefore a Resolution of 1 gives the same number of steps as there are seconds in the cycle time;

- **Simulated Time (minutes)** – this represents the period in minutes over which the modelled flows are assumed to exist. This is commonly set to 60, as a peak hour is modelled using hourly flow rates. However, if peak flow conditions exist for two hours on-street, even though only one hour is being modelled by TRANSYT, the simulated time value should be set to 120. This allows more accurate calculation of queues and vehicle delay. The default value in T12 is 120 whilst in TranEd and T16 it is 60;

- **Start / End Effective Green Displacements** – these account for the periods after the start and end of green when in reality vehicles are either accelerating or starting to brake. In TRANSYT's simplified traffic models vehicles are considered to be either stationary or moving at cruise speed during the displacement periods. The default parameter values are considered representative for typical conditions and should not be changed unless a specific survey is conducted for each stopline within a modelled area;

- **Flow Scaling Factor** – this should be unchanged from the default value unless modelling a change in flow volume (for example when looking at predicted increase / decrease in demand or using a 'flow-factoring' technique to model a peak for which specific flow data are not available). See section **B6.4.7** for further information on demand flow specification and allocation;

- **EQUISAT (T12) or Auto Redistribute (T16)** – for a Base model these should be disabled in order to maintain existing signal timing settings. EQUISAT or Auto Redistribute can be enabled as a starting point for the optimisation process when generating new timings;

- **Cruise Times / Speeds** – this should be set to use cruise times, as measured on-street and as detailed in section **B2.3.4.2**;

- **Cruise Time / Speed Scaling Factor** – this should remain unchanged from default unless specifically required for a particular purpose (such as a proposed change in speed limit);

- **Level of Optimisation** – for a Base model, this should be set to 'No Optimisation' in T12, or untick 'Enable optimisation' in T16. This will provide performance results based on existing timings in the model. Offset optimisation and offset / green split optimisation should be used during the optimisation process for Proposed modelling. See section **B6.6.4.1** for further information on signal timing optimisation;

- **Enhanced Optimisation (T16)** – this option forces TRANSYT to cycle through the hill-climbing process multiple times in order to achieve optimal signal timings. As it takes longer than regular optimisation, its use is not typically recommended until fine tuning of final signal timings;

- **Enable OUT Profile Accuracy (T16)** – when this option is selected, local stop and delay values are not fully recalculated during the optimisation process if local flow profiles have not significantly changed. This speeds up optimisation and is therefore enabled by default, however unticking can increase optimisation performance;
- **Optimisation Type (T16)** – while T12 uses a standard Hill Climb process for all optimisation methods, T16 offers additional options including 'Shotgun Hill Climb' and 'Simulated Annealing'. These may be able to find improvements in optimised signal timings but take longer to run, and are therefore not recommended until fine tuning final signal timings;
- **Exclude Pedestrians from PI Calculation (T16)** – typically this should always be enabled unless specifically trying to influence pedestrian splits or offsets during the optimisation process. It can alternatively be set at the Link / Traffic Stream level (see **B6.4.4.2**), which is the default method in T12;
- **Random Delay Mode (T16)** – for new models this parameter should be set to 'Complex', which is a more accurate method of estimating random and oversaturation delay that has been used as the default since TRANSYT 13. The alternative 'Simplified' method replicates the method used in TRANSYT 12, and should be used for backwards compatibility if importing older models to produce similar results;
- **Type of Vehicle-in-Service (T16)** – this parameter is used in the calculation of vehicle delay, and relates to how random or platooned vehicle discharge behaviour is assumed to be and therefore how likely vehicles are to slow down or stop (typically 'Uniform' for signalised approaches, as used in T12, and 'Random' for priority approaches, as used in PICADY / ARCADY). This should generally be set as 'Automatic', unless there is good reason to change it (seek advice if necessary); and
- **Type of Random Parameter (T16)** – this parameter is used in the calculation of queues and delay, and relates to how random or ordered queuing is assumed to be (typically 'Uniform' for signalised approaches, as used in T12, and 'Random' for priority approaches, as used in PICADY / ARCADY). This should generally be set as 'Automatic', unless there is good reason to change it (seek advice if necessary).

6.4.3 Traffic Behaviour Models

TRANSYT seeks to minimise vehicle stops and delays by adjusting signal timings to optimally coordinate platooned traffic arrivals and departures at stoplines. It therefore simulates the arrival, queuing and departure behaviour of vehicles at all stoplines throughout the modelled network using one or more pre-defined traffic models. TRANSYT's traditional macroscopic traffic models do not model individual vehicle behaviour but use average traffic demands during each modelled time step of a typical cycle.

TI2 uses a single network-wide model to simulate traffic behaviour, known as the Platoon Dispersion Model (PDM), which is also the default traffic model in TI6. Additionally, TI6 offers further traffic behaviour models, including the Link-by-Link PDM, Cell Transmission Model (CTM), Congested Platoon Dispersion Model (CPDM) and Simulation Model. TI6 similarly employs a network-wide default traffic model, however alternative traffic models can be specified for specific locations within the network. Each of the above traffic models are described in this section, along with their benefits and limitations.

6.4.3.1 Platoon Dispersion Model

In the Platoon Dispersion Model (PDM), vehicles are assumed to proceed undelayed until they arrive at a stopline. If the signal is red or there is a queue of one or more stationary vehicles, they join the stationary queue, otherwise they will proceed undelayed. The simplified queue model in the PDM treats vehicles as queuing vertically at the stopline, meaning it takes no account of the physical space that would be occupied by queuing traffic on street.

The PDM assumes that during a green period queued traffic discharges at a rate determined by the relevant saturation flow until the queue clears or the modelled green period ends. This arrival, queuing and departure behaviour is captured in the form of histograms called Cyclic Flow Profiles (CFPs), showing for each stopline the vehicle arrivals and departures (vertical axis) during each time increment within the modelled cycle time (horizontal axis), as shown in **Figure 88**. CFPs are covered in more detail in section **B6.7.2.2**.

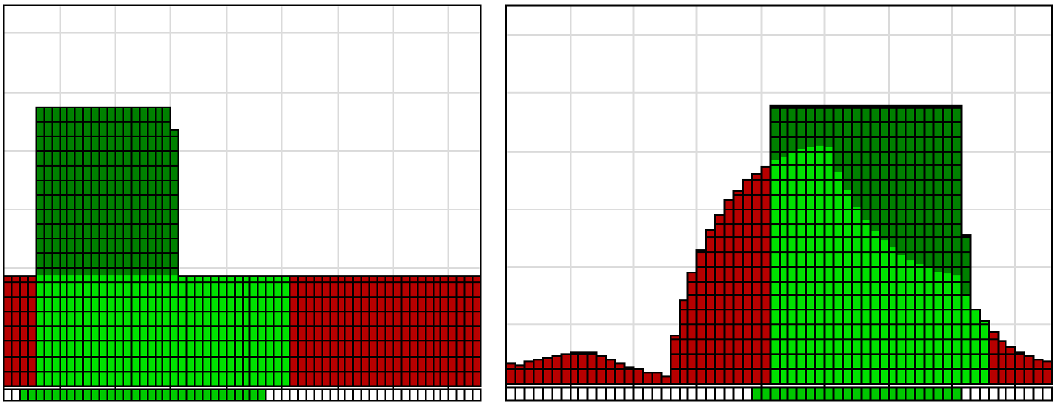


Figure 88: Cyclic Flow Profiles for neighbouring stoplines (viewed in TranEd)

TRANSYT aims to progress platoons of traffic through the network with an optimal set of signal timings. When traffic initially discharges from a stopline it is tightly grouped into a well-defined platoon, however as it progresses along a lane there is a tendency for the platoon to increasingly spread and become less well defined, which is referred to as 'Platoon Dispersion'. This is visible in **Figure 88**, with a rectangular OUT profile at the upstream stopline becoming a wave shape at the downstream IN profile. Vehicle platooning can be affected not just by distance travelled but by friction due to parked cars, road widths, bends or minor sinks / sources. However, the greater the distance between stoplines the larger the likely amount of dispersion, resulting in reduced potential benefit from traffic signal coordination.

Platoon Dispersion is accounted for in the PDM through exponential smoothing of the upstream OUT profile, taking account of the travel time to the next stopline and a 'Platoon Dispersion Coefficient' (K). The default value of K for normal traffic is 35, which should generally not be changed unless justified by sufficient supporting evidence. Similarly for buses and trams there are equivalent default dispersion coefficients that also take account of stationary dwell times between stoplines.

6.4.3.2 Link-by-Link Platoon Dispersion Model [TI6]

The Link-by-Link PDM is a simpler implementation of the PDM within TI6 that offers faster optimisation performance than the standard PDM, similar to the approach used in TI2. The main constraint of the Link-by-Link PDM is that other traffic models are not supported within the same network, therefore only TI2-style Quick Flares (section **B6.4.4.4**) can be used that do not rely on use of the CPDM or CTM to model flare lane blocking effects.

6.4.3.3 Congested Platoon Dispersion Model (CPDM) [TI6]

The CPDM is an extension to the standard PDM model that accounts for local blocking effects where traffic lanes feed flares or turning bays, however it is not suitable for modelling junction exit-blocking. While the CPDM accounts for reduced capacity of lanes due to adjacent queues, it may still be necessary to manually reallocate blocked traffic to other lanes where lane choice exists and uneven lane usage is observed or likely.

It is not possible to manually specify use of the CPDM in TI6, although it will be used automatically when the model is specified as a 'Flare' and a short TI6 lane is used (it is not used for TI2-style 'Quick Flares').

6.4.3.4 Cell Transmission Model [TI6]

The Cell Transmission Model (CTM) seeks to address the limitation of the PDM by accounting for the effects of exit-blocking. Like the PDM, it models the arrival and departure of vehicles at successive time steps during a typical cycle, again dealing with aggregate flows rather than individual vehicles. Unlike the PDM however, the CTM also models the movement of traffic within discrete increments in space along a length of road, allowing spatial occupancy to be represented. Each road section (represented by a Link or Traffic Stream) is therefore divided into homogeneous sub-sections called cells, as shown in **Figure 89**, which can each accommodate a finite amount of traffic at any time. The lengths of the cells are automatically calculated and are the same for all cells within a single Link / Traffic Stream.

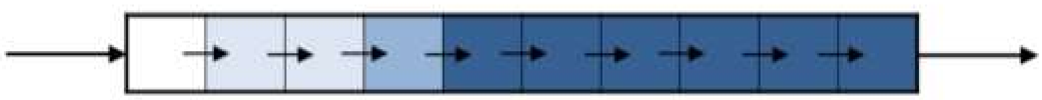


Figure 89: Cells within a CTM section, coloured by traffic occupancy

At any specific point in time, the occupancy of each cell is known and will be somewhere between zero and a maximum value defined by the cell's available storage space. After each time step, traffic is able to flow between adjacent cells and any other upstream / downstream sections, providing downstream cells have sufficient available capacity to receive it. The automatically calculated cell lengths are sufficient to allow any traffic movement to be accommodated within a single time step (traffic cannot move further than a single cell length within one time step).

Should there be insufficient downstream capacity, only a portion of the flow from upstream cells will be accepted (or none at all in the case of exit-blocking). Assuming downstream capacity is available, any traffic will be supplied from upstream cells at a rate limited by the relevant saturation flow. Note that for CTM road sections, two saturation flows are allowed, for:

- Stopline saturation flow (equivalent to the PDM saturation flow); and
- Cell saturation flow (equivalent to a saturation flow for the road section upstream of a stopline).

The specification of separate stopline and CTM cell saturation flows is intended to allow for variation in headways along a long road section to be accounted for, such as changes in the number of lanes, lane widths and parking, which may result in traffic congestion or gapping out either on the road approaching the stopline or at the stopline itself. When using Traffic Streams, T16 provides an option to auto-calculate cell saturation flows based on an assumed 1800PCU/hr per lane. Alternatively, for shorter road sections where headway variation is less likely, cell saturation flows can be manually set to match downstream stopline saturation flows as an initial estimate. Whichever approach is used, it should be revised where necessary to represent observed or expected behaviour and confirmed during model validation.

Care should be taken to ensure that no unintended discrepancies between stopline and upstream saturation flows result in unrealistic congestion or gapping out. This is particularly important where a low cell saturation flow may cause stopline starvation, preventing full stopline saturation flows from being achieved during a saturated green period.

Give-way behaviour is treated differently when using the CTM to represent capacity in a more realistic manner during congested conditions. This is covered in more detail in section **B6.4.6.6**.

While stops, queues and delays are defined as for the PDM, it is important to note that degree of saturation (DoS) is defined differently when using the CTM. Since 'wasted' green time due to blocking is inherently taken account of in the CTM, the DoS value is considered only to represent the proportion of available capacity that is used, meaning any wasted green time is deducted from the total green time. This may cause difficulty for validation where CTM is used, particularly where sub-saturation flow is experienced, as traditional DoS survey techniques may not be suitable and direct application of site-measured UGT (section **B2.3.10.1**) is not possible.

The following limitations also apply when using the CTM:

- It is more computationally demanding than the PDM, which may affect model run times depending on network size and congestion levels;
- It is not possible to model traffic with different cruise times when using Link Shares (see **B6.4.4.3**), for example to account for different travel speeds and stopping time for buses / trams compared to general traffic;
- The minimum length for a CTM section is defined by the distance travelled in a single time step (which depends on the entered cruise speed and network time resolution). The CTM may therefore not be suitable for short sections; and
- The maximum length for a CTM section should be no more than 200m.

6.4.3.5 Simulation Model [TI6]

The Simulation Model introduced in TI6 is based on simplistic modelling of individual vehicle movements and allows more realistic representation of queuing behaviour, including blocking effects. It does this by simulating individual vehicle arrivals throughout the modelled time period and assigning them to individual Traffic Streams based on their desired destinations. Although detailed vehicle behaviour such as acceleration, deceleration, gap accepting and merging are not modelled, lane choice is considered whenever the available number of lanes changes or where Traffic Stream connectors lead to different destinations.

The arrival times and desired destinations of vehicles entering the network are influenced by randomness, therefore multiple simulation trials are required to give results that are representative of average behaviour. Stop Criteria specified in the Simulation Options are used to determine the number of simulation trials needed, which can be based on convergence of a suitable network parameter (default is Delay) or a simple maximum number of trials or simulation run time.

Since both randomness and the entire modelled time period are simulated, it is also possible to model dynamic effects such as demand dependency and the interaction between Controller Groups with different cycle times.

Once all simulation trials are complete, average model results for PI and Delay are reported in the Results Summary window. Average or percentile queues across all trials can also be visualised on the Network Diagram window throughout the modelled time period. Animations of individual vehicle movements and queuing / blocking can also be visualised on the Network Diagram using the animation controls; however, it should be noted that these represent a single trial only and do not therefore necessarily reflect typical behaviour across all trials. By default, the Random Seed in Simulation Options is set to -1, giving a different random seed every time simulation mode is run, so model results are likely to vary. If repeatable results are needed, the Random Seed should be set to a fixed positive value.

In summary, the Simulation Model in TI6 provides the following benefits:

- More realistic queuing and associated blocking in congested conditions;
- Modelling of dynamic effects such as demand dependency and interaction between controller groups with different cycle times; and
- Visualisation of individual vehicles movements and average / percentile queues.

When deciding to use the Simulation Model in TI6 It is also important to be aware of the following limitations:

- Link-based network structures are not supported;
- Signal optimisation is not supported;
- No dedicated modelling of buses (treated the same as general traffic);
- Platoon dispersal is not modelled;
- DoS result data is not available;
- Models for complex networks can take longer to run; and
- Networks can sometimes become locked up.

6.4.3.6 Guidance on Traffic Model Choice

The PDM, as used in TI2 and the default model in TI6, is quick and effective when modelling uncongested conditions where queuing traffic does not cause blocking effects. It is therefore recommended that this is used as the default traffic model when building a model. The Link-by-Link PDM in TI6 (highlighted in **Figure 90**) can offer faster optimisation performance than the standard PDM, however is less suitable where flare blocking effects need to be modelled.

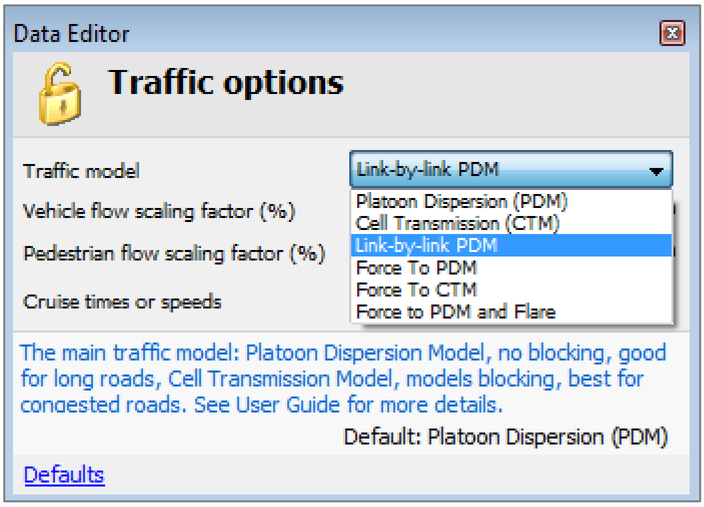


Figure 90: Traffic Model selection

Care needs to be taken where queuing traffic is observed or likely to occur however, such as at junction exits and turning bays or wherever reported traffic queues exceed available storage space (indicated by excess queues in model results, as discussed in **B6.7.1**). Blocking needs to be manually accounted for when using the PDM to ensure that capacity is correctly represented. This may include revision of signal timings to relocate queues (for example by using queue limit penalties) or through adjustment of modelled green times to account for any UGT (section **B2.3.10.1**) if queues cannot be relocated. It may also be necessary to account for alternative lane choice when allocating traffic flows to represent resulting uneven lane use. It is also important to consider how these adjustments affect the optimisation process and any comparison between Base and Proposed models.

The traditional PDM flare model in TI2 (known as a 'Quick Flare' in TI6) provides some allowance for partial utilisation of flares caused by blocking through specification of an effective flare utilisation, which can be surveyed or predicted using tools such as TRL's QueProb feature within TRANSYT or JCT's LinSat.

In TI6, the CPDM provides a more accurate way of modelling blocking caused by flares and turning bays. This model cannot be manually selected but will be automatically used by TRANSYT for short flares. For longer flares, TRANSYT automatically uses the CTM for TI6 flares.

The CTM provides the ability to model blocking back, however it is more computationally demanding than the PDM and may therefore slow down model run times. With the CTM there are restrictions on minimum / maximum road section lengths and limited ability to use Link Shares (see **B6.4.4.3**) for bus modelling. It is important to be aware that DoS is measured differently under the CTM compared to the PDM, which may cause some difficulty for DoS surveys and model validation. Care should also be taken where there are discrepancies between cell and stopline saturation flows to ensure there are no unintended consequences (such as stopline starvation).

It is recommended that the CTM is not used for initial model runs, and only considered for specific congested Links if its use is considered advantageous, bearing in mind the restrictions mentioned. Alternatively, traditional techniques to account for blocking with the PDM should be used (for example application of UGT). It should never be necessary to use the CTM for entry or exit Links.

The Simulation Model in TI6 provides a further useful tool for analysis and visualisation of network behaviour in lightly congested conditions. It does not however support optimisation, Link-Based network structures or dedicated bus modelling. It should therefore be seen as an additional tool that is useful for analysing models with some congestion or to assess dynamic impacts such as demand dependency or the interaction between different cycle times. It is therefore not a replacement for TRANSYT's other traffic models and is also not a suitable replacement for more detailed microsimulation modelling where significant network congestion exists.

6.4.4 Network Structure

TRANSYT uses an abstract representation of the road network in order to display relationships between traffic and pedestrian movements, using a series of intersections and one-way road sections. Road sections take the form of either Links (T12 and T16) or Traffic Streams (T16), which are explained further in this section. There are a number of different types of Links and Traffic Streams, and both Links and Traffic Streams can also be mixed within a T16 network (section **B6.4.4.2**). Relationships between road sections are defined so that traffic is transferred from upstream sections to downstream sections according to the specified road layout.

As well as road sections, a number of other types of network element are defined to further describe traffic behaviour and control, which will be covered in the following sections. These include:

- Nodes;
- Controller streams;
- Priority Objects; and
- Pedestrian Crossings.

6.4.4.1 Nodes

Nodes are graphical objects that are associated with road intersections and allow graphical manipulation of intersecting road sections as a single entity. Nodes should not be used to represent physical phenomena within the carriageway such as road narrowing or widening.

In T12, Nodes are essential items that are required to describe the controlled behaviour of conflicting traffic movements, whether due to traffic signals (section **B6.4.5**) or priority control (section **B6.4.6**). The amount of Node input data required depends on which form of control is to be modelled and is discussed further in the above sections. Non-signalised priority Nodes are treated as a separate Node type in TranEd.

In T16, Nodes are optional items, as the relationship between conflicting traffic movements is defined at the Link or Traffic Stream level, with traffic signal behaviour modelled within Controller objects. Nodes in T16 are mainly used for graphical identification and manipulation of individual junctions, and for providing routing refinement options during matrix-based flow allocation (section **B6.4.7**). T16 Nodes also allow model results to be grouped by junction and their use is therefore recommended.

When using Nodes in T12, a recommended Node numbering convention is provided in **Appendix III**. This relates Node numbers to TfL junction references in a consistent manner and allows for the maximum supported

Node number limitation within TI2. For TI6 the required Node ID does not have the same limitation as in TI2, however for convenience the same numbering system can be used.

6.4.4.2 Links and Traffic Streams

Links and Traffic Streams both define one-way sections of road containing streams of similar traffic, and can represent one or more physical lanes. Traffic Streams can be used in TI6 and provide a simplified and more intuitive appearance for the user by using an equivalent underlying Link structure that is not visible, as shown in **Figure 91**. Some of the differences between Links and Traffic Streams are detailed in **Table 13**.

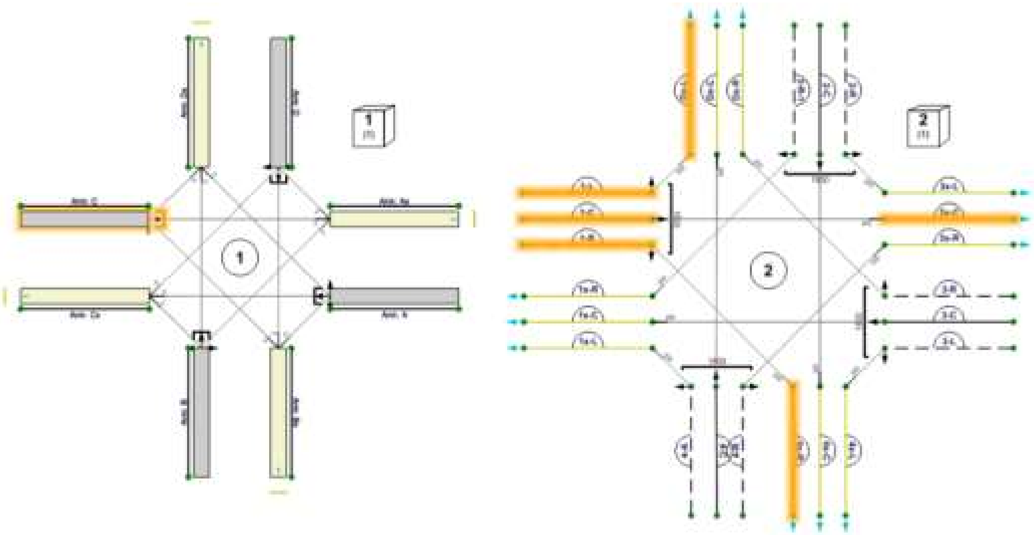


Figure 91: Traffic Stream structure (left) and equivalent Link structure (right)

Multiple lanes can be grouped together within a single Link or Traffic Stream only if they behave identically, that is:

- Flows must be distributed equally across all lanes;
- All lanes must queue evenly;
- All lanes must contain the same predominant traffic movements; and
- All lanes must share a common method of control.

If using Traffic Streams in TI6, individual physical lanes should be defined for each Traffic Stream. This provides graphical representation of the number of lanes and also allows separate specification or calculation of individual lane saturation flows. All Traffic Streams on a single approach road are collectively grouped into an Arm for graphical presentation and manipulation.

When using Links, there is no representation of individual lanes and a single saturation flow is entered to represent the capacity of all lanes within the Link. A recommended Link numbering convention for T12 is provided in **Appendix III** that makes efficient use of the supported Link number range. This can similarly be adopted in T16, however as T16 Link / Traffic Stream IDs can accommodate up to 10 alphanumeric characters, other conventions can be used.

Table 13: TRANSYT Link and Traffic Stream comparisons

Consideration	Link	Traffic Stream
Lanes	Not directly modelled, however a Link can be used to represent one lane	Individual lanes modelled
Capacity	Overall capacity directly entered. Can be calculated with RR67 estimation tool if additional lane and turn data provided.	Overall capacity can be directly entered or calculated from individual lane capacity contributions - these can similarly be directly entered or calculated with RR67 estimation tool.
Flow disaggregation	Link Shares allow flows of interest to be disaggregated (for example. buses, circulatory traffic, cyclists)	Flows automatically disaggregated based on route and traffic type (General, Bus, Tram)
Underlying Network Structure	Simpler – may give faster performance due to reduced number of path segments	More complex – higher number of path segments may slow down performance
Flow entry method	Flows can be directly entered or assigned using OD matrices	Flows must be assigned using OD matrices
Time-varying flow entry	DIRECT, GUASSIAN and FLAT flow profiles supported	DIRECT flow profiles required
Simulation Model Supported	No	Yes

Where multiple lanes exist that do not behave identically, they must be treated as separate Links or Traffic Streams, even if they share the same destination. The traffic flow on each Link or Traffic Stream should be proportioned according to observed lane usage during flow allocation.

6.4.4.3 Major and Minor Links (Link Shares)

If using Links in TI2 or TI6, there are two main types of Link – Major and Minor. A collection of associated Major and Minor Links (also known as a Link Share) represents all traffic at a stopline, with Minor (or 'shared') Links sharing the Major Link's capacity and queue while allowing separation of Cyclic Flow Profiles for particular flows of interest. The Minor Link occupies the same physical road space as its associated Major Link but represents only a proportion of the Link Share's flow and queue. Minor Links therefore facilitate analysis and optimisation of vehicle progression through the network by distinguishing between platoons from different sources, where in reality they form a single queue at the stopline. Up to seven separate traffic flows of interest can be disaggregated through use of Link Shares in TI6, while TI2 can support five.

Traffic Streams in TI6 do not support user-creation of minor shares, as all traffic using a Traffic Stream is separately distinguishable by traffic type (Normal, Buses, Trams) and also by route through the network if using Matrix-Based flow allocation.

Link Shares can be useful where user-defined disaggregation of flows is required, for example for separate analysis of individual bus routes. It is important to note that the choice of which Link is Major or Minor is arbitrary since they share all input data, so there is no effect on model output. For this reason, model output values from Major and Minor Links should not be summed as by nature there is only one value for DoS and queue length. The use of Link Shares can be helpful where complex travel patterns occur, such as at signalised roundabouts. Here it is desirable to optimise offsets between entry and circulating traffic so that excessive queuing does not occur on internal Links with limited storage capacity, which would interfere with efficient operation of the roundabout. It is also possible to model bus movements with Link Shares, unless there is a dedicated bus lane which should be modelled with a discrete Link.

6.4.4.4 Flared Approaches

Flared approaches may be physical, behavioural or environmental in nature, for example resulting from termination of a bus lane, funnelling on the exit of a junction, provision of a short turning lane or due to the presence of on-street parking. They are defined in TI2 by specifying a Link as flared and entering the number of additional flare lanes available, together with their respective saturation flows and average utilisation in PCUs per cycle. This provides an increase in capacity above the Link's saturation flow for the duration the flares are utilised.

The same approach is supported in TI6, where flares of this type are referred to as 'Quick Flares'. Before Quick Flares can be used, they first have to be enabled by choosing the option 'Enable Quick Flares', which is found within the Data / Model and Result Options menu.

As described in **B2.3.8.6**, flare utilisation should be determined from site-based measurement, for each period being modelled. Only where site measurement is not possible should alternative estimation techniques be used, such as use of TRANSYT's QueProb feature or JCT's LinSat software.

It is important to note that the simple flare modelling used in TI2 and TI6 Quick Flares do not inherently model any blocking effects caused by queuing in adjacent lanes, although site measurement or estimation of flare utilisation using QueProb or LinSat will account for flare starvation. Blocking of flows in adjacent non-flare lanes may need to be manually accounted for however, for example by reallocating flows to neighbouring lanes to reflect increased use of non-blocked lanes.

In TI6, improved flare blocking can be modelled by creating short lanes in the flared area with their traffic model specified as 'Flare', as shown in **Figure 92**, although this is not possible when using the network-wide Link-by-Link PDM. Where the Flare traffic model is specified, short lanes use either the CPDM or CTM to model blocking effects between the flare lanes and upstream lanes. TI6 automatically determines which of the CPDM or CTM is most appropriate to use based on the flare length.

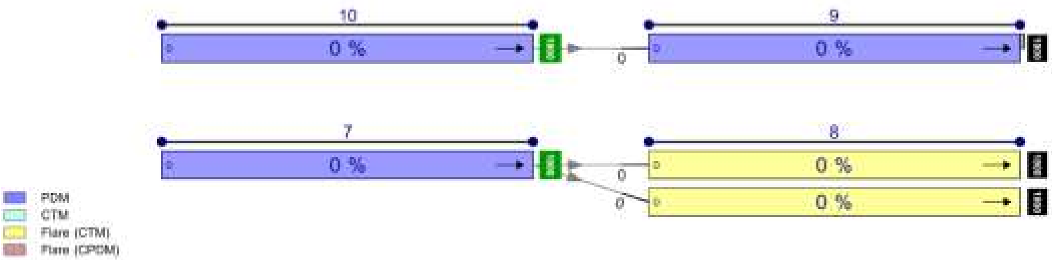


Figure 92: Alternative fare representations in TI6 using a Quick Flare (above) and with the Flare traffic model (below)

6.4.4.5 Classification of Links and Traffic Streams

Traffic Streams and Major / Minor Links are distinguished by how they operate on street, and are commonly classed as Signalised, Priority (non-signalised give-way), Bottleneck, Exit, or Pedestrian:

- **Signalised Links or Traffic Streams** (for example Link 6611 in **Figure 202**) represent traffic movements that are controlled by one or more signalised traffic phases at a junction;
- **Priority Links or Traffic Streams** represent traffic movements that are controlled by giving way to an opposing flow. They can either be pure give-way Links, modelled as green all the time and only controlled by the opposing flow, or signalised and therefore obeying signal control in addition to giving way to other traffic (as demonstrated by Link 6610 in **Figure 202**, which represents a signalised opposed right-turn);
- **Bottleneck Links or Traffic Streams** attempt to represent flow-limiting behaviour which occurs between intersections rather than at stoplines or give-way lines, for example:
- Where platoons progress through a narrowed carriageway;
- To restrict entry to additional downstream lanes during carriageway fanning; or
- Due to localised influences such as right-turn bays, loading bays, frequently used bus stops, start of bus lanes or uncontrolled pedestrian crossings.
- Bottlenecks are effectively treated as permanently green, where traffic throughput is solely determined by a specified saturation flow. Bottlenecks that cause queuing within a model should only be used where site observations suggest this is necessary to model mid-link phenomena and their impact on signal coordination;
- Exit Links or Traffic Streams can be used to represent traffic leaving the network (as shown by Link 6699 in **Figure 202**). In T12, Bottleneck Links should be specified using an artificially high saturation flow, typically 8000PCU/hr, to avoid the creation of unintended and unrealistic queues. In T16, Unrestricted Links or Traffic Streams should be used, requiring the 'Has Saturation Flow' Link / Traffic Stream property to be unticked).

- If queuing is observed to exist on-street from a downstream intersection outside the modelled network, then the modelling approach and use of TRANSYT should be re-assessed; and

- **Pedestrian Links** are normal signalised Links used within TI2 to represent movements controlled by signalised pedestrian phases (TranEd provides a 'Display as Pedestrian Link' option for visual identification). Each individual pedestrian phase should be modelled as a separate Link, especially where they run in parallel with traffic phases (as shown by Links 6650, 6651, 6652 and 6653 in **Figure 202**). Pedestrian Links should use proxy flows, Link lengths and saturation flows. All-round pedestrian stages may be modelled as a single Link even though there are several phases that run in that stage. However, if this approach is employed the largest clearance period must be used to determine the stage minimums. If using TI2, appropriate start and end lags should be calculated and checked against a skeleton LinSig model. In TI6, pedestrian Links are no longer used and Pedestrian Crossing objects should be used instead (section **B6.4.9**).

The Link input data required by TRANSYT varies according to the Link type and how it is to be modelled.

6.4.4.6 Properties of Links and Traffic Streams

All Traffic Streams or Major Links need to have the following properties specified:

- **Cruise time** – representing the average time for an un-delayed platoon to travel from the upstream stopline to the current Link's stopline.

- Cruise times represent a critical input parameter in TRANSYT, as they will be used to calculate optimum offsets during any optimisation. If cruise times are underestimated, the green signal will come in too early and the back end of a platoon may fail to clear the stopline. In contrast if cruise times are overestimated, the green signal will come in too late and result in the bulk of the platoon arriving on a red signal. Note that if prompted for cruise speeds rather than cruise times, program settings should be checked to ensure that cruise time entry has been enabled (section **B6.4.2**). In TI2, cruise speed will always need to be entered for bus Links, in kph (section **B6.4.8**);

- **Link length** – preferably measured on-street with a measuring wheel, or from suitably scaled, high resolution aerial photography that has been checked against on-street observations. TI6 provides the option to measure lengths automatically from a scaled background image;

- **Saturation flow** – as derived from on-street measured values (discussed in **B2.3.9**), or estimated where this is not possible. This parameter is only required for priority movements if they are also signal controlled. Saturation flows calculated from RR67 should be used with caution, and the suitability of estimated saturation flow values for the modelled area assessed as described in **B2.3.9.1**.
- Saturation flows need to be directly entered for Links in TI2, while in TI6 they can be directly entered for Links and Traffic Streams or calculated from lane measurements using RR67. When using the built-in RR67 calculation functionality in TI6, it should be noted that unless using Traffic Streams with a scaled background diagram and the 'Use connector turning radius' option selected, turning proportions need to be manually specified and will not be automatically updated to reflect changes in modelled flows;
- **Modelled traffic flows** – these will either be directly specified or automatically determined from Matrix-Based demand flows, depending on the selected flow allocation method (section **B6.4.7**);
- **Traffic type** [TI6] – for TI6, the traffic types (Normal, Bus or Tram) that are able to use the Link or Traffic Stream need to be specified; and
- **Traffic model** [TI6] – this will typically be set to the network-wide default traffic model, however alternative traffic models can be selected when necessary. This will most commonly be the case for flares or where the CTM is used to account for localised blocking effects.

The following advice relates to properties for specific types of Links or Traffic Streams:

6.4.4.6.1 Minor Links

Minor Links in a network need to be associated with a Major Link. Since a Minor Link occupies the same physical road space as the Major Link, the majority of key variables are inherited from the Major Link. Modellers should be aware that in a TI2 input file the saturation flow quoted for a Minor Link will instead be a reference to the associated Major Link.

6.4.4.6.2 Bottleneck Links / Traffic Streams

The correct capacity for a Bottleneck can be assessed by conducting a fifteen-minute traffic spot count for each modelled period where on-street bottlenecks have been observed to result in mid-Link delay or queuing. If the model contains unrealistic queuing originating from a Bottleneck Link the saturation flow can be set to an artificially high value, but this must be explicitly stated and justified in the calibration report. In TI6, this can be achieved through use of an Unconstrained Link or Traffic Stream (by disabling the 'Has saturation flow' property).

Where Bottlenecks are used with the Platoon Dispersion Model, it is important to ensure that any resulting queue does not extend beyond the Bottleneck's storage capacity. Where this occurs, upstream signal timings will need to be adjusted, as described in **B6.4.5.6**. As a rule of thumb, if a Bottleneck is less than 50m in length then any queue should not be allowed to extend beyond two-thirds of the Link length.

6.4.4.6.3 Entry and Exit Links / Traffic Streams

Since entries to (and exits from) the modelled network do not have upstream (or downstream) stoplines, their Link lengths and cruise times are arbitrary in nature. It is common therefore to use default values of 200m for entry / exit lengths and 18s for cruise times, based on an average speed of 40kph (~25mph), though the cruise time can be adjusted if observed vehicle speeds are significantly different.

In TI2, exits should have their stop and delay weightings set to -9999, as recommended for pedestrian Links, so that they do not affect the overall network PI. In TI6 the same effect can be achieved by ticking the option to 'exclude from results calculation'. The saturation flow for exits in TI2 should be set to 8000PCU/hr, as explained in **B6.4.4.5**, while in TI6 the option 'Has saturation flow' should be disabled to define no saturation flow restriction.

6.4.5 Signal Control

This section details the implementation of signal timings within a TRANSYT model, using either Nodes in TI2 (section **B6.4.5.3**) or Controller objects in TI6 (section **B6.4.5.4**). Whichever method is used it is important to ensure that phase-based signal controller behaviour is accurately modelled, as described in **B6.4.5.2**.

In TRANSYT the defined stage sequence for each controller is considered to recur throughout the modelled time period, therefore representing a 'typical' or average cycle. Further issues that require consideration discussed within this section include:

- Network cycle times (section **B6.4.5.1**);
- Demand dependency (section **B6.4.5.5**); and

- Underutilised Green Time, or UGT (section **B6.4.5.6**).

6.4.5.1 Network Cycle Time

TI2 should only be used to model signalised junctions which operate with a common network cycle time or fractions of a common cycle time, such as double-cycling, triple-cycling or quadruple-cycling. It is normally only practical to model one CLF or UTC group within a single TI2 model. If it is determined that a proposal will influence traffic conditions in more than one region then it may be necessary to create two or more models to be run separately to represent the complete zone of influence and further microsimulation modelling may be necessary if they are expected to interact. The scope and area to be modelled should be discussed and agreed during TMAP Stage I as described in **B2.1.5.**

TI6 provides support for controllers to have different cycle times to the global network cycle time. Where this is the case, if neighbouring controllers share the same cycle time then platooned arrival profiles between them will be maintained. If this is not the case, then flows are maintained between the neighbouring sites, but uniform arrival profiles are assumed unless using Simulation Mode. Whether there is any perceived benefit in grouping differing cycle times within a single model is therefore a matter of judgement, and microsimulation modelling should be considered if significant interaction is expected. TI6 also provides the option to limit cycle time choice to SCOOT-compatible values (section **B2.5.6.1.3**), which is recommended where timings will be implemented under SCOOT control.

6.4.5.2 Phase-Based Controller Behaviour

In order to accurately model phase-based signal timings as observed with on-street signal controllers, it is important to be aware of the following key differences and limitations with signal representation in TRANSYT:

TI2 does not model controller phase green times, but instead uses Link green times relative to the start and end of stages. In addition, stages in TI2 are defined as starting when the first phase in the previous stage loses green, unlike controller stages which start when all phases in the current stage become green (this results in TI2 stages referring to the controller stage plus the preceding interstage).

Due to these differences, skeleton LinSig models should be used to provide assurance that Link signal timings are accurately represented in TI2, particularly with respect to start lags, end lags and phase delays (described in more detail in section **B6.4.5.3**).

TranEd includes the 'Phase Intergreen Converter Tool' to help convert phase-based intergreen matrices into Link-Based timings when building a TRANSYT model. If this is used, phase lettering in TranEd should match those shown on TfL Controller Specifications and Timing Sheets.

TI6 offers improved modelling of phase-based controller behaviour, however, it does not provide visibility of controller values for phase gaining delays, as shown in TfL Controller Specifications. Instead, when entering values, the user must determine whether they should be entered as absolute or relative, and whether further manufacturer-specific adjustments are appropriate. Phase gaining delays should therefore be carefully checked in TI6 if using existing values from TfL Controller Specifications or Timing Sheets (section **B2.3.8.1**).

6.4.5.3 Node-Based Signal Timings [TI2]

In TI2, signal timing information is coded within Node data (Card Types 10, 11 and 12) and Link data (Card Type 31) for all signalised Nodes and Links.

Node data that needs to be entered includes:

- Number of stages; and
- Whether the Node double-cycles.

For each defined stage within a Node, the following parameters are also specified:

- Time of change to the current stage – note that this refers to the start of a TI2 stage as described in section **B6.4.5.2**, and not a controller stage;
- Interstage between the previous and current stages; and
- Minimum stage green time.

For signal-controlled Links, the following Link data values need to be entered:

- Signalised Node controlling the Link;
- Number of Link green periods per cycle;
- Stages the Link starts and ends in; and
- Start and end lag times, representing the period after the stage start and end times that the Link commences and terminates green. These should be set according to Link intergreen requirements and must also take account of any phase delays that are present (specified separately in TranEd).

6.4.5.3.1 Adjustment of Start and End Lags

Situations where it may be appropriate to further modify start and end lag values from those determined by intergreens and phase delays include:

- Demand dependency (section **B6.4.5.5**);
- Accounting for exit-blocking / Underutilised Green Time (section **B6.4.5.6**);
- Modelling bus set-backs (section **B6.4.8**);
- 'Bonus' storage effects (such as storage in front of a stopline for opposed right-turners which clear in the intergreen, and indicative arrows);
- Aggressive driver behaviour at particular junctions, resulting in usage of the starting amber and red periods; and
- Vehicle usage of flashing amber periods at Pelican crossings.

This list is not exhaustive and other situations may be encountered where other start and end lag adjustment is appropriate. It is up to the modeller to justify any decisions taken, and to fully report on all adjustments. This is particularly important where multiple adjustments are made on the same Link, as it can become impossible to audit signal timings if modifications are not well documented.

Where TranEd is used, start and end lag adjustments should be made using 'bonus green', which allows modelling adjustments to be separated from timings dictated by interstage design, such as Link delays and intergreens. Stage timings, intergreens, Link delays and bonus green adjustments can be visually distinguished using TranEd's Stage Timings View.

6.4.5.4 Controller-Based Signal Timings [TI6]

In TI6, signal timing data is no longer stored within Nodes but within separate Controller Stream objects, which can be applied to either Link or Lane-Based networks.

Controller Streams can be added using the dedicated Controller Stream button within the Network Diagram window, or by right-clicking on the Controller Streams entry within the Data Editor. Once created, the following data needs to be specified:

- **Controller Stream ID** – a unique identifier for the Controller Stream;
- **Cycle Time** – 'Network Default' uses the defined network-wide cycle time, however other cycle times can be manually specified or derived from another Controller Stream ID;

> Note that if multiple-cycling is required, this should be specified within the Stage Sequence data rather than entering a lower Controller Stream cycle time here, which would result in uniform arrival profiles and loss of platoon coordination.

- **Phases** – including phase letter, phase, type minimum / maximum green values and, if required, any modelled green start / end adjustments;
- **Stages** – Stage ID reference (the stage number), phases within the stage and minimum stage time. Defined stages are stored within a Stage Library and allocated a Library Stage Number, which is arbitrary and should not be confused with the Stage ID;

- **Stage Sequences** – taking note of any prohibited stage moves or alternative stage moves where necessary; and
- **Phase Delays** – note that care needs to be taken when entering phase gaining delay values from Controller Specifications or Timing Sheets. Phase gaining delay values must be correctly interpreted as either absolute or relative, and take account of manufacturer-specific differences (Siemens gaining delay values do not include the Red / Amber period for traffic phases).

Once the Controller Stream has been defined, the Intergreen matrix can be entered using the Matrices screen, together with details of any banned stage movements. Specific signalised Links or Traffic Streams need to be associated with the relevant Controller Stream and controlling phase(s) by specifying the Controller's ID within the Link or Traffic Stream's Signals properties.

Stage timings can be interactively edited using the Timings Diagram window or via Timing Wheels within the Network Diagram window.

6.4.5.5 Demand-Dependent Stages

As TRANSYT's traditional macroscopic models only model a 'typical' cycle with a fixed stage sequence, all stages are assumed fully demanded. They do not therefore inherently capture the effects of demand dependency, where stage demands may vary from cycle to cycle (although this can be modelled using T16's Simulation Model, which is covered in **B6.4.3.5**).

It is, however, important to capture the effects of demand dependency during model assessments, either to ensure the network remains within capacity or to test traffic management strategies during oversaturation. This can be achieved through manipulation of the modelled signal timings to reduce or increase green times, accounting for alternative stage sequences that may appear.

Demand-dependent stage frequency can significantly affect the amount of green time received and can vary by time of day. The modeller must ensure that all modelled adjustments result in appropriate green times, and that their calculation and implementation are adequately recorded. For example, if a junction has been modelled with a pedestrian stage being activated every cycle, when in reality it is only called 50% of the time, then the model is likely to underestimate the capacity available to one or more movements.

There are two common methods used for manipulation of modelled green times to account for demand dependency:

- In TI2, start or end lags can be adjusted so that modelled green times are extended or reduced for specific Links to provide green time to other stages when a demand-dependent stage does not appear. This can similarly be achieved in TranEd through the use of Node Bonus Greens, which offer the advantage of preserving controller interstage design as existing intergreens and Link delays remain unchanged, which is helpful both for auditing and subsequent use of the model. In addition, Links sharing the same controlling phase can be independently adjusted. There is a limitation on how much green time adjustment is possible using this method however as Links cannot be active in stages they are not assigned to in the junction's method of control. This may necessitate additional use of a dummy stage.

  In TI6 the start and end of green times for Links and Traffic Streams are determined from their associated phases. It is possible to use a similar technique using Relative Start or End Displacements for the phases in question, however it is important to be aware that this affects all Links / Traffic Streams sharing the same controlling phase. If necessary, an equivalent dummy phase can be created to control a specific Link or Traffic Stream if it shares the same controlling phase as others and needs to be independently controlled, however this should be recorded and explained; and

- Another method involves the creation of a dummy stage to use in place of the demand-dependent stage in the stage sequence, with its stage length reduced proportionally to represent the frequency of demand observed. The timing of the dummy stage appearance should then be adjusted to take account of how the time is shared between the preceding and following stages in the event of non-appearance of the demand-dependent stage (section **B2.3.8.5**). The dummy stage method is discouraged unless necessary as Proposed models are required to have all stages modelled with controller minimum stage lengths in order to optimise junction performance and distribute spare green time.

6.4.5.6 Underutilised Green Time (UGT)

The standard Platoon Dispersion Model (PDM) within TRANSYT (described in section B6.4.3.1) stores queues vertically and thus has difficulty considering the impact of queuing from the stopline. TRANSYT models based on the PDM cannot therefore automatically take account of the effect on adjacent or upstream Links if a queue extends beyond a Link's storage capacity.

Wasted green due to exit-blocking can be quantified through direct measurement of Underutilised Green Time (UGT) during an on-site DoS survey (described in section B2.3.10). UGT accounts for both wasted green due to exit-blocking, during which traffic is stationary, and sub-saturation flow, during which traffic is slow moving due to downstream queuing and congestion.

To account for blocking back, the effective lost time has to be manually applied to relevant lane movements. This can be achieved by modifying Link start and end lags in TI2 (or Bonus Greens in TranEd), as explained in section B6.4.5.3.1, or by applying Relative Start or End Displacements to relevant phases in TI6, as discussed in B6.4.5.5. Where these methods are not possible due to TRANSYT program constraints, dummy phases and stages can also be used. It is important that any manipulation of signal timings to account for UGT should be stated within the model validation report and supported by accompanying survey data.

In TI6, the Congested Platoon Dispersion Model (CPDM) is able to take account of limited blocking effects caused by queuing in adjacent lanes and the Cell Transmission Model (CTM) can take full account of blocking caused by any upstream queuing. It is therefore not appropriate to model wasted green caused by stationary queuing where these models are used, however these models do not account for additional lost time caused by slow-moving queues in sub-saturation flow conditions. The wasted green reported by TI6 may therefore be less than that measured during a site survey, and if this is the case some further adjustment of Relative Start or End Displacements may be necessary. It is important to note that the DoS reported by TI6 when using the CTM is based on the proportion of available green time used (not including wasted green periods) rather than the total green time, therefore this needs to be accounted for when validating against site-collected DoS data.

6.4.6 Priority Control

Priority movements are traditionally modelled in TRANSYT assuming linear relationships between give-way capacity and any opposing flows. Empirically-derived parameters are used to describe these relationships, which are dependent on the nature of the priority movement, junction geometry and other site-specific characteristics. The behaviour of a priority movement can also depend on whether it is signal-controlled or in close proximity to opposing signal-controlled movements. This section provides further detail on appropriate calibration of priority control in TRANSYT.

6.4.6.1 Opposed Movements at Signals

Where right-turning movements are opposed at signalised junctions, the following first need to be defined for each priority movement:

- The Links or Traffic Streams containing opposing traffic movements; and
- For T16, the percentage of vehicles from the opposing Link that each opposed movement gives way to.

T12 allows up to two opposing Links to be specified, while T16 supports up to sixteen opposing Links or Traffic Streams. For Links a proportion of the Link's flow can be specified to give way only to the first opposing Link, while for Traffic Streams give-way behaviour can be applied to all movements or separately for individual opposed movements.

It is important to be aware that when specifying multiple opposing Links they cannot be separate lanes of the same opposing movement, for instance where an opposed right-turn gives way to multiple lanes of traffic in the other direction. In this situation multiple opposing Links should be combined into a dummy Link so that a single opposing Link can be specified in the opposed Link give-way parameters. If it is desirable to keep the flows distinct in the combined dummy Link, a Link Share can be used to separate the flows.

Once the opposing flows have been defined, there are two possible approaches for modelling the actual give-way behaviour – a simple linear relationship based on average flows within the modelled period, or a more complex relationship based on geometry, storage and conflict analysis that is available in T16 only, which is separately calculated for each simulation step.

6.4.6.1.1 Traditional Give-Way Model

The traditional approach used in T12, and also available in T16, defines a linear relationship between the average opposing and opposed flows within a modelled period. This requires consideration of the following:

- The number of vehicles able to turn during gaps in the opposing flow(s);
- The number of vehicles that turn during the interstage period;
- The controlling movements opposing the opposed flow; and
- Whether right-turning vehicles share lanes with other movements that are blocked.

The numbers of right-turners that are able to make use of gaps in the opposing flow(s) are determined by specific give-way parameters, describing the linear relationship between opposed and opposing flows:

- **Maximum flow while giving way** – known as the 'intercept', identifying the maximum flow giving way while no opposing flows are present; and
- **Give-way coefficient** – known as the 'slope', describing how the opposed flow varies with increasing opposing flow.

Typical values are often used as a starting point for these parameters, representing commonly encountered give-way scenarios. Reasonable values suggested by TRL for an opposed right-turn at a signalised junction giving way to straight-ahead traffic are[88]:

- Maximum flow of 1000PCU/hr; and
- Give-way coefficient of 0.5 (entered as 50 [$x10^{-2}$] in T12 / TranEd).

These values assume an opposing DoS above 50% where the opposed movement is non-critical to junction performance, although they will be conservative if the opposing flow is less saturated. The values can be further modified if supported by more accurate data, such as site-based measurements from the location in question. This is especially important if the opposed movement is considered critical to junction performance.

The number of opposed turners that turn during the intergreen period can be accounted for by adding a 'bonus effect' to the signal timings. This is achieved in T12 by increasing the end lag for the opposed Link, or in the case of TranEd by the addition of bonus green, as discussed in section **B6.4.5.3.1**. The additional time added should be long enough to clear the number of vehicles that are able to store in front of the stopline. It is common to add two seconds per vehicle for opposed movements that do

88 Binning J C, TRANSYT 16 User Guide, Application Guide 73 (Issue B), TRL, 2019, pp 397

not have an unopposed period, and one second per vehicle if an unopposed period follows (for example an early cut off for an indicative arrow stage). This is not necessary in TI6 if storage in front of the stopline is explicitly modelled as a short Link or Traffic Stream with the traffic model set to 'Flare', as the bonus effect of traffic storage in front of the stopline is accounted for. In this case, the upstream Link feeding the storage area should not be defined as giving way.

Where an opposed right-turn movement shares a single lane with an unopposed ahead movement, this can lead to interference and blocking. This is modelled by specifying a proportion of the opposed flow as giving way to nothing (the ahead movement), while the remainder (the opposed right-turn) gives way to the opposing Link or Traffic Stream. This combines the effect of right-turners giving way and the ahead movement discharging at the Link's saturation flow. It does not account for any vehicles entering the junction without blocking the ahead movement and may therefore slightly underestimate capacity.

In TI2, if an opposed right-turn movement shares a lane with unopposed ahead traffic, but a separate ahead lane also exists, then an allowance should be made for the likelihood of right-turners blocking the shared lane. This reduction in ahead capacity can be achieved through modification of the saturation flow if the ahead lane is modelled as a single Link, though this is not recommended. The preferred approach is to split the ahead movement into separate Links and allocate flows between them according to observed lane usage for each modelled period.

Again for TI2, if a right-turn bay exists that allows some storage of right-turning traffic separate from any ahead lanes, the modelling approach taken depends on whether right-turn traffic will queue back and block the adjacent ahead lane or not. If blocking back does not occur, the right-turn and ahead lanes should be modelled as separate Links, however the ahead lane may experience reduced capacity due to the effect of slowing right-turning traffic. This should be accounted for with UGT, or if necessary, by appropriate reduction of the ahead lane's saturation flow. If blocking back occurs, the right-turn bay and adjacent ahead lane should be modelled as a single Link using the give-way parameters detailed previously, with a proportion of the flow opposed by nothing and the remainder opposed by a specific Link.

In TI6, the right-turn bay and adjacent ahead lane should be modelled as short Links or Traffic Streams, with the traffic model set to 'Flare', as described in section B6.4.4.4. This will account for the associated capacity loss due to lane blocking effects.

6.4.6.1.2 Step-wise Opposed Turn Give-Way Model

T16 includes a new give-way model, called the Step-wise Opposed Turn (SwOT) model, that can be used for opposed right-turn movements at signalised junctions. This model is based on research contained within TRL's Research Report 67 (RR67, section **B2.3.9.1**), and calculates give-way capacity at each modelled time step based on actual opposing flows rather than for the entire modelled period based on average opposing flows as in the traditional approach. TRL consider this method to be superior to the traditional approach described above that is used in earlier TRANSYT versions.

The SwOT model is enabled for specific give-way Links or Traffic Streams by clicking the 'Use Step-wise Opposed Turn Model' option within the give-way model options. It then requires the following parameters to be entered:

- **Number of storage spaces** – this is the storage space in front of the stopline in which turning traffic can store without blocking straight-ahead traffic. This parameter should be set to zero if downstream turning storage has been explicitly modelled with its own Link or Traffic Stream;
- Note that this parameter is not used to calculate the bonus effect due to turners during the intergreen period, which should continue to be modelled as for the traditional give-way method if downstream turning storage has not been modelled;
- **Radius of turn** – the radius of curvature for opposed turning vehicle paths. There is an option to automatically calculate this from the connector radius if a scaled background diagram is used, however this should not be relied on and any calculated value should be checked for accuracy;
- **Conflict Shift** – for each opposed movement, this is the time from the opposing traffic passing the stopline to clearing the give-way conflict. It is dependent on junction geometry and is typically expected to be a small positive number of seconds; and
- **Conflict Duration** – for each opposed movement, this is the delay after the conflict has cleared before opposed traffic is considered to discharge (similar to a start displacement following a green signal). It is normally expected to be two seconds, with lower values being more aggressive and likely to give optimistic results.

6.4.6.2 Mutually Opposed Traffic Movements

TI2 cannot model mutually opposed Links, the means a Link that is opposed cannot itself be specified as opposing another Link, although this is possible in TI6. As a workaround for TI2 when mutually opposed movements occur, the saturation flow for one Link (usually the one with the lower opposed flow) can be manually adjusted to account for its actual capacity and the other specified as the opposed Link.

In TI6, the following give-way coefficients are recommended by TRL as a starting point when modelling mutually opposed Links or Traffic Streams[89]:

- Maximum flow while giving way = 715PCU/hr; and
- Slope coefficient = 0.22

6.4.6.3 Opposed Movements near Signals – Indirect Traffic Control [TI6]

TI6 allows discharge from a unsignalised priority movement to be influenced in the vicinity of opposing upstream signals, due to driver knowledge of the upstream signal state. This is referred to as Indirect Traffic Control and can be used when modelling situations such as:

- Nearside slip lanes giving way to traffic exiting a signalised junction; and
- Priority movement downstream of a signalised pedestrian crossing.

To set up Indirect Traffic Control, a give-way Link or Traffic Stream should have a saturation flow set in addition to give-way parameters. If the opposing Link or Traffic Stream is signalised no further action is necessary, however if the opposing Link or Traffic Stream is unsignalised then the option 'Upstream signals visible' option needs to be ticked. This allows discharge to be limited by the give-way relationship when opposing traffic is expected but by the saturation flow when it is known to be absent. This allows for higher discharge when drivers know that they do not need to give way.

6.4.6.4 Priority Junctions and Roundabouts

It is possible to model priority junctions and roundabouts within a TI2 model but this is only appropriate where these form part of a larger network comprised of chiefly signalised junctions. TI6 however can model

89 Binning J C, TRANSYT 16 User Guide, Application Guide 73 (Issue B), TRL, 2019, pp 381

priority junctions and roundabouts in both signalised and fully unsignalised environments.

Priority give-way junctions in T12 are modelled as 'virtual' signal-controlled junctions (TranEd provides a dedicated 'Non-Signalled' Node type), with stoplines representing give-ways. A similar approach can also be used in T16, although Priority Objects can also be used (discussed further in section **B6.4.6.5**). For Links or Traffic Streams that give way to opposing movements, up to two opposing Links can be specified in T12, and up to 16 for Links or Traffic Streams in T16.

For each opposed movement it is necessary to specify:

- Which Links or Traffic Streams oppose the priority movement;
- The maximum unopposed flow at the give-way line (the intercept);
- Give-way slope coefficients – for each opposing movement, describing the linear relationship between the opposed and opposing flows; and
- Where more than one conflicting movement is specified, a percentage needs to be entered to describe the proportion of vehicles that give way to each conflicting movement. For Links, this is entered as the proportion that gives way to the first conflicting Link only, with the remainder assumed to give way to all conflicting Links.

The give-way intercept and slope coefficients determine gap-seeking behaviour, and for priority-controlled junctions are recognised to depend on the following:

- Width of the give-way approach;
- Width of the main road;
- Visibility to the right;
- Visibility to the left; and
- Volume of the controlling flow(s).

These are described in further detail in the appendix of TRL report LR888 and in subsequent TRANSYT user guides. Similarly, the intercept and slope coefficients for give-ways at standard roundabouts are recognised to depend on:

- Widths of the approach and roundabout entry;
- The extent of flaring at the give-way line;
- Inscribed diameter of the roundabout;
- The conflict angle between entry and circulating traffic; and
- Entry radius for entering traffic.

Typical values are often used as an initial estimate for give-way coefficients in chiefly signalised networks, representing commonly encountered give-way scenarios. Where priority junction performance is considered critical to a model however, it is appropriate to use more accurately estimated or measured give-way parameters in TRANSYT. This can be achieved by using:

- PICADY for estimating give-way parameters at priority junctions;
- ARCADY for estimating give-way parameters at priority roundabouts; or
- Measured on-site data, plotting various opposing and opposed flow rates from which the intercept and slope can be measured.

Reasonable values suggested by TRL for an opposed left-turn from a T-junction side road, queuing in a single lane and giving way to vehicles approaching from the right, are[90]:

- Maximum flow of 715PCU/hr; and
- Give-way coefficient of 0.22 (entered as 22 [$x10^{-2}$] in T12 / TranEd).

Similarly, reasonable values for an opposed right-turn from a T-junction side road, queuing in a single lane and giving way to vehicles from both directions, are[91]:

- Maximum flow of 600PCU/hr;
- First give-way coefficient (for traffic approaching from right) of 0.22 (entered as 22 [$x10^{-2}$] in T12 / TranEd); and
- Second give-way coefficient (for traffic approaching from left) of 0.19 (entered as 19 [$x10^{-2}$] in T12 / TranEd).

Where a single queue of side road traffic at a T-junction includes both left and right-turning movements, the above values can be used as a starting point in a Link-Based network but with the parameter '% giving way to first Link only' used to proportionally account for some traffic giving way to traffic approaching from the right only. Alternatively, for Links in T16 a Link Share can be used with separate give-way parameters for each Link to allow for the different movements as described in the T16 manual. When using Traffic Streams in T16 this is unnecessary as give-way parameters can inherently be specified separately for individual movements.

T16 includes further support for the modelling of priority junctions and roundabouts, with the inclusion of PICADY and ARCADY modules, as discussed in **B6.4.6.5**.

90 Binning J C, TRANSYT 16 User Guide, Application Guide 73 (Issue B), TRL, 2019, pp 530
91 Binning J C, TRANSYT 16 User Guide, Application Guide 73 (Issue B), TRL, 2019, pp 531

6.4.6.5 Priority Objects [TI6]

Priority Objects in TI6 allow priority intersections to be easily represented within a TRANSYT network, and include support for T-junctions (as shown in **Figure 93**), crossroads, staggered junctions and roundabouts. These utilise PICADY and ARCADY modules to accurately estimate appropriate give-way parameters based on site-specific geometry, with all relevant conflicts accounted for. As PICADY and ARCADY functionality is used, licences for these TRL products are required in addition to a TRANSYT licence.

In order to utilise a Priority Object within a TRANSYT network, it is possible to import a pre-built priority junction or roundabout using a relevant Library File, which includes pre-configured Links / Traffic Streams and associated conflicts. Alternatively, an 'empty' Priority Object can be added to an existing model which then needs to have specific Links or Traffic Streams associated with entry and exit arms based on PICADY / ARCADY arm-labelling conventions.

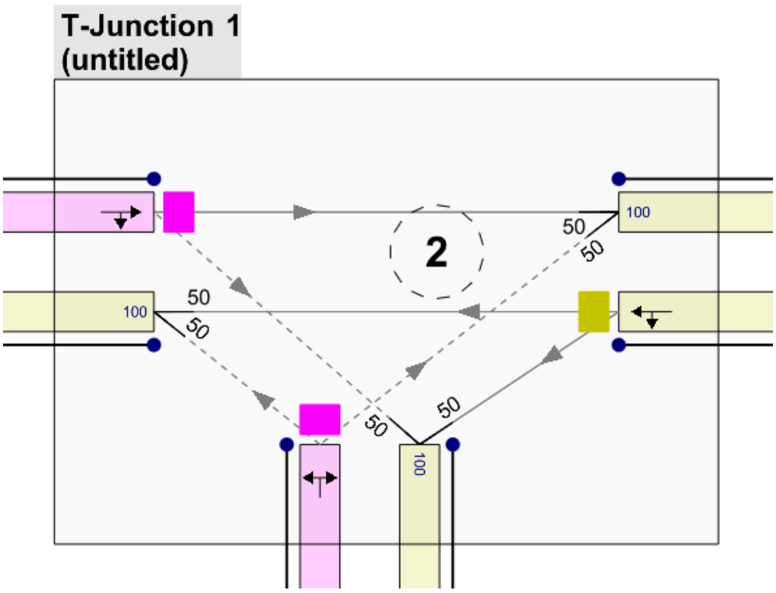


Figure 93: T-Junction Priority Object as seen in the TI6 Network Diagram

It should be noted that Priority Objects do not include the full functionality of PICADY and ARCADY, such as allowance for pedestrian crossings on entry and exit arms, estimation of queue variability or accident prediction. Where this level of modelling is required use of PICADY or ARCADY may still be necessary, either in addition to or instead of TRANSYT – the relative benefits of each should be assessed against modelling requirements for specific projects.

As the capacity of any priority approach is dependent on the time-varying nature of opposing traffic arrivals, consideration should be given to the use of time-varying demand flows in TRANSYT (section B6.4.7.4) where priority junction performance is critical or of particular significance.

6.4.6.6 Congested Priority Behaviour in the Cell Transmission Model [TI6]

The CTM in TI6 allows congested priority behaviour to be modelled, accounting for more realistic give-way capacity during these conditions. This is based on an extension to TRANSYT's traditional linear give-way model, assuming that from the onset of congestion give-way capacity increases to a user-defined 'Maximum Congested Give-Way Capacity' before decreasing linearly as opposing flows fall due to the effects of congestion. These uncongested and congested linear relationships are illustrated in Figure 94.

If no user-defined value is provided then the Maximum Congested Give-Way capacity will be assumed the same as the minimum uncongested capacity at the onset of congestion.

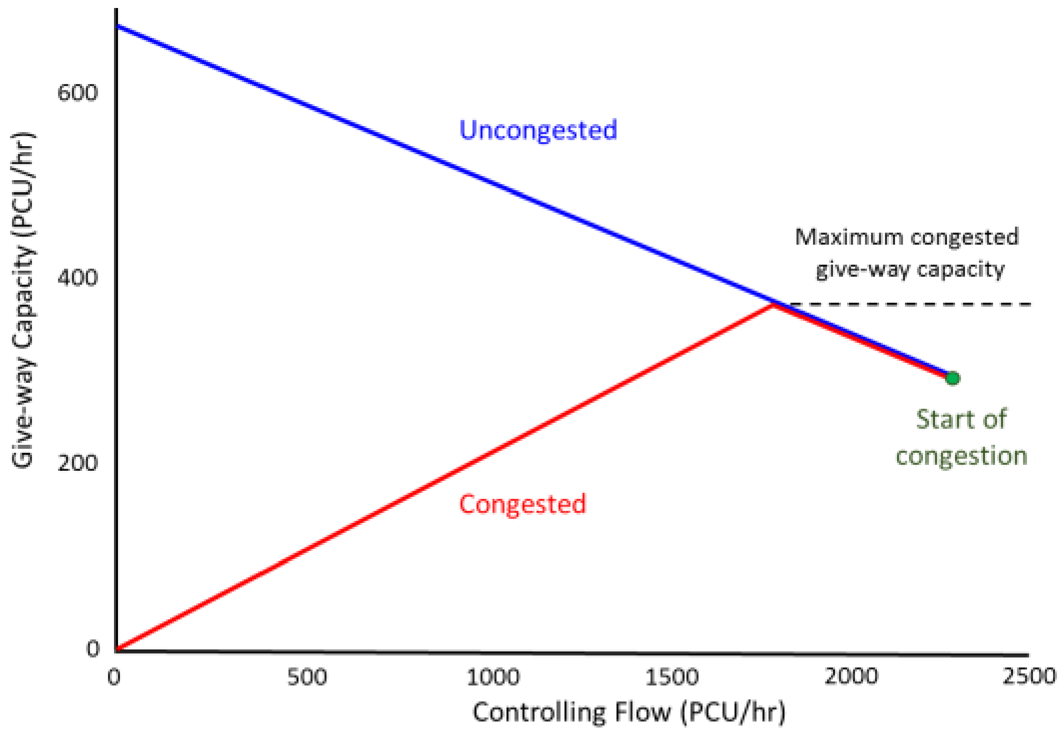


Figure 94: Congested give-way behaviour in the Cell Transmission Model, adapted from the TRANSYT I6 user guide[92]

92 Binning J C, TRANSYT 16 User Guide, Application Guide AG73 (Issue B), TRL, 2019

6.4.7 Traffic Flows and Flow Allocation

Traffic flows can be allocated to individual Links or Traffic Streams using different methods, depending on the network structure and TRANSYT version being used.

For Link-Based networks, flows can be entered directly for each Link (the only method supported in T12), while in T16 flows can also be allocated from user-entered flow matrices (this is the only method supported for Traffic Streams).

These flow entry methods are discussed in more detail within this section.

6.4.7.1 Direct Flow Entry (Link-Based Networks)

Flows can be directly entered for individual Links in a Link-Based network, and this is the only option supported in T12. For each Link or Link Share, the following information needs to be supplied:

- Total flow across the current Link's stopline;
- Contributing source flows from upstream Links; and
- Cruise times from upstream Link stoplines to the current Link's stopline (or bus speed for bus Links).

In T12 flows are entered in PCU/hr, while in T16 the flow unit is determined from the 'Data / Unit…' menu settings (either vehicles or PCUs per hour can be chosen).

In addition to contributions from upstream Links, a uniform flow source can also be specified to represent a source or sink along the Link that has not been explicitly modelled as an entry or exit from the network. This is an additional flow that is either added or removed from the Link with a uniform arrival profile.

It is not a requirement in TRANSYT for the total flow on a Link (the output flow) to exactly match the sum of the contributing flows (the input flows). If the total flow is different from the flow inputs on a Link, TRANSYT assumes that the total flow is accurate and will therefore proportionally increase or decrease the upstream flow values in order to achieve the total Link flow entered. This methodology works reasonably where Link input flows are roughly equal to the output flows. However, where there is a significant Link flow discrepancy, it can lead to inaccurate modelling and result in downstream flows that are in excess of upstream stopline saturation flows. To prevent this, it is desirable to ensure surveyed flows are consistent before entry into TRANSYT and it is also necessary to check for any subsequent flow inconsistencies within a model. TranEd and TRANSYT have facilities to assist with this, including Network Diagram overlays (see B6.7.2.1) and other visual aids as shown in Figure 95. It is not acceptable to combine flow surveys from different peak periods into the same model.

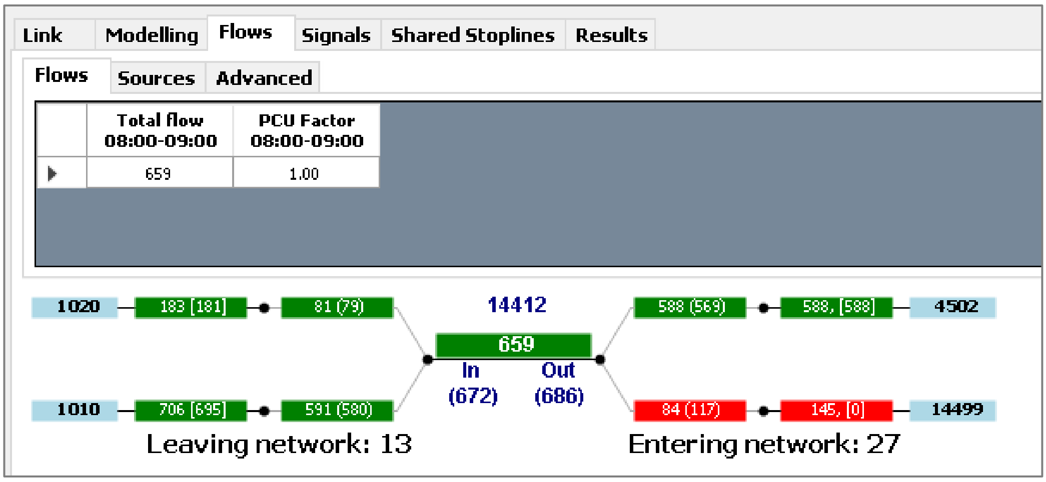


Figure 95: Link flow inconsistency shown in the TI6 flow entry window

Most TRANSYT models are built using stopline flows from classified traffic count surveys. If a model is to be built using flows from an Origin-Destination (OD) survey these will need to be converted into Link-Based flows for entry into TRANSYT, or in TI6 flows can be entered in matrix form (sections B6.4.7.2 and B6.4.7.3). To convert an OD matrix into Link flows requires the creation of a lane-flow diagram based on the network layout. This can be completed manually or by using bespoke software such as JCT's FlowRound. Section B2.3.4.1 highlights basic guidance for reconciling surveyed traffic flow differences within a modelled network.

6.4.7.2 Local OD Matrix Flow Entry [TI6]

In TI6, local OD Matrices can be used for flow entry at a junction level where OD flow information is available. In order to use a Local OD Matrix, Locations need to be specified for all local OD pairs and flows entered for each traffic type (Normal, Bus and/or Tram). Paths represent all available Link or Traffic Stream sequences between each pair of defined Locations, and can be generated automatically by TRANSYT using the 'Calculate Paths' or 'Auto Calculate' options, or can be manually defined if necessary.

It should be noted that a Local OD Matrix is not intended for use over a large area – it should be limited to individual junctions or groups of closely associated junctions where behaviours of individual junction movements are well known (examples include a signalised roundabout, SCOOT multinode or junctions in close proximity with route-specific queuing behaviour).

The number of possible Paths can become large where a Local OD Matrix covers more than one junction or where there are many possible Link or Traffic Stream sequences between Locations. This will increase model run times, therefore unrealistic or unused Paths should be avoided – these can be deleted manually, or various rules can be applied to prevent unwanted routes being automatically generated, as shown in **Figure 96** and explained further detail in the TI6 manual. The number of underlying Links (path segments) is reported in the bottom-right of the TI6 application window.

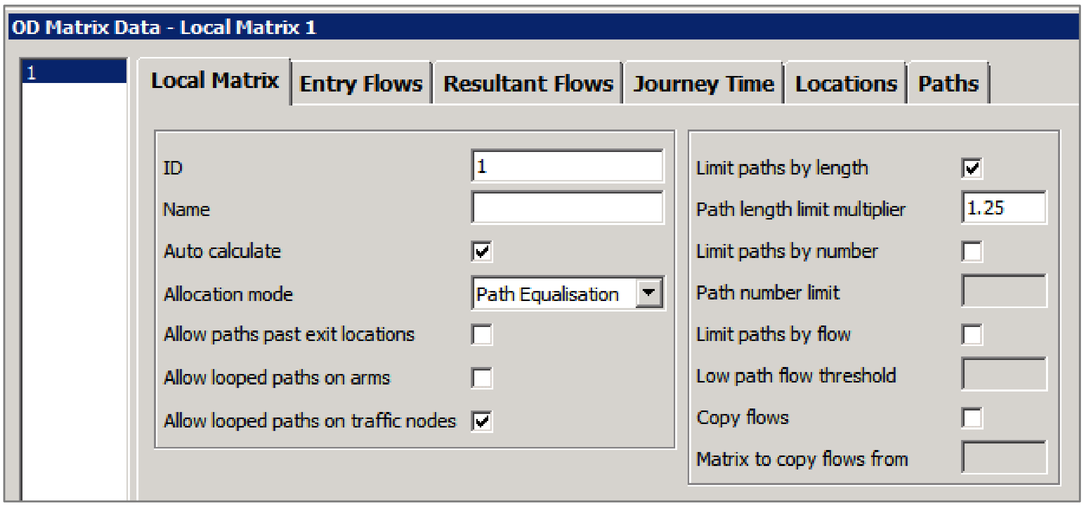


Figure 96: Local OD Matrix flow allocation options

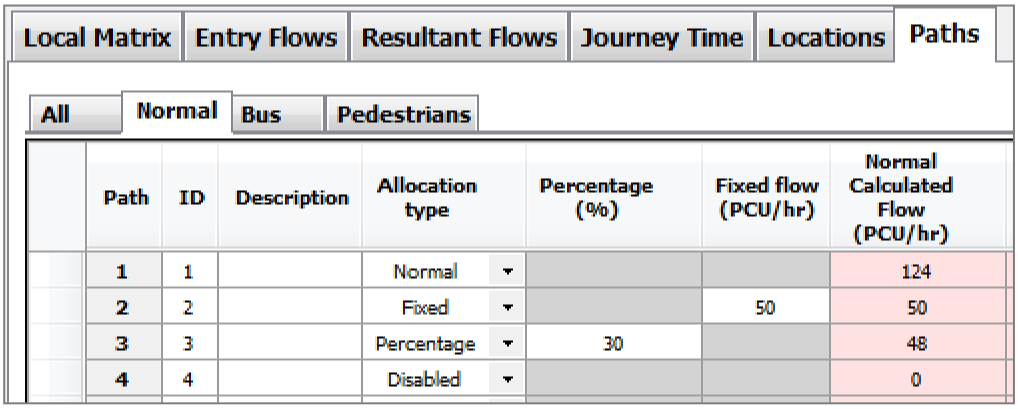
Flows defined in the Local OD Matrix are automatically allocated to the available Paths between OD pairs using one of the following methods:

- **Path Equalisation** – flows equally split between all possible Paths;
- **Lane Balancing** – DoS balanced equally across all entry Links or Traffic Streams (typically representative for individual junctions or roundabouts); or
- **Local Assignment** – flows allocated based on user-equilibrium assignment (used where alternative routes exist through a complex junction).

It is important to check that flows are allocated to Paths in a realistic and representative manner – allocated flows should not just be assumed to be correct. Any discrepancies between the entered OD flows and allocated flows can be seen in the Resultant Flows tab, where differences will be highlighted.

Where necessary, flows on individual Paths between OD pairs can be further refined by adjusting the Allocation Type for each of the defined traffic types. The following Allocation Types are available, as shown in Figure 97:

- **Normal** – flows allocated using the defined automatic flow method;
- **Fixed** – user-entered flow allocated to the Path;
- **Percentage** – user-specified percentage of the total OD flow; and
- **Disabled** – no flows will be allocated to the specified Path.



Path	ID	Description	Allocation type	Percentage (%)	Fixed flow (PCU/hr)	Normal Calculated Flow (PCU/hr)
1	1		Normal			124
2	2		Fixed		50	50
3	3		Percentage	30		48
4	4		Disabled			0

Figure 97: User-specified flow Allocation Types for individual Paths

Where multiple Local Area Matrices exist within a model, care needs to be taken at matrix boundaries to ensure that any lane-specific arrival patterns are maintained across each boundary. If single Locations are used across multiple Links or Traffic Streams then flows will be allocated according to the chosen allocation method (for example they may be evenly split). In order to maintain lane-specific flows, multiple Locations should be used to distinguish between flows entering and exiting in specific lanes, as shown in Figure 98.

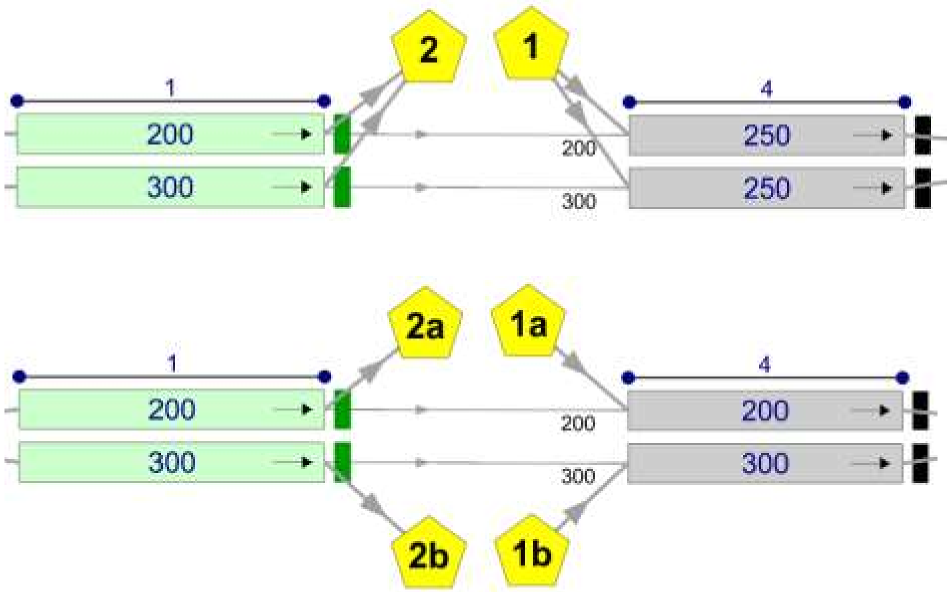


Figure 98: Maintaining lane-specific flows at Local Location boundaries

6.4.7.3 Wide Area Flow Matrices [TI6]

In TI6, Wide Area Flow Matrices can be used to automatically populate Local Area Flow Matrices within a model where an OD is known over a larger area, for example when derived from a Highway Assignment Model (see **B5 Highway Traffic Assignment** for more details) or an ANPR survey. As for Local Area Flow Matrices, Wide Area Locations need to be specified for all origins and destinations over the wider area and flows entered for each allowed traffic type (Normal, Bus and/or Tram).

Each Wide Area Location needs to be associated with a Local Area Location on an entry to (or exit from) the modelled network. If a Wide Area Location is mistakenly associated with a Local Area Location internal to the modelled network then flows will not be correctly assigned. While it is possible to use Multiple Wide Area Matrices with a single network, their areas should not overlap.

Unlike Local Area Flow Matrices, with a Wide Area Flow Matrix there is no choice of flow allocation method – Wide Area Flows are allocated through Journey Time User Equilibrium assignment. This utilises an iterative process to ensure that the cost to traffic in terms of journey time is equalised on all routes between OD pairs. Once flows have been entered into the Wide Area Flow Matrix, the ‘Assign Flows’ button within the Flow Assignment Tool can be used to assign flows to the available Wide Area Paths, which are automatically generated during the Assignment process.

As for Local Area Paths, options are available to limit the Wide Area Paths generated and further refinement of assigned Path flow volumes is possible through adjustment of Assignment Cost Weightings for individual Links / Traffic Streams, as shown in **Figure 99**. Once any options or weightings are changed, the 'Assign Flows' process should be repeated to take account of the changes made. Again, as for Local Area Matrices the Resultant Flows should be checked to ensure that there are no discrepancies between the entered Wide Area Matrix flows and the assigned flows.

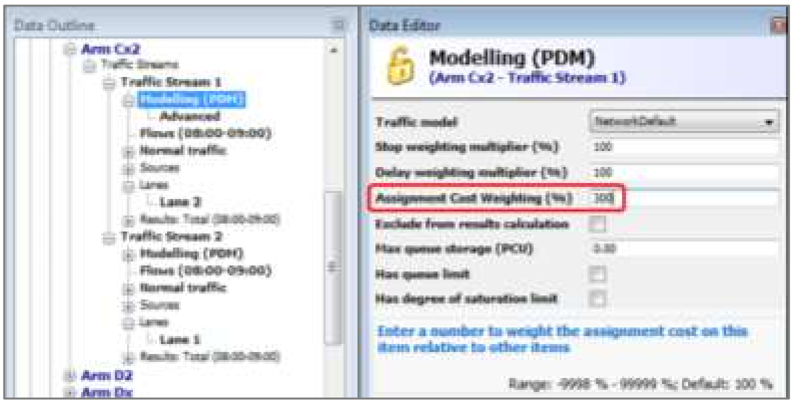


Figure 99: Use of Assignment Cost Weightings to influence assigned flows

Following Wide Area Flow Assignment, relevant Local Area Matrix flows will be overwritten with values from the assignment and Local Path flows updated, except where individual Local Path flows have been fixed by the user.

6.4.7.4 Time-Varying Flow Profiles [TI6]

Unlike TI2 which supports only a single, uniform simulated time period, TI6 provides the ability to model multiple time segments within a modelled time period, allowing varying flow profiles to be used (this feature requires Advanced Mode to be enabled). The number of time segments required and their durations can be entered in the Main Data dialog window, as shown in **Figure 100**, or under Network Timings in the Data Editor.

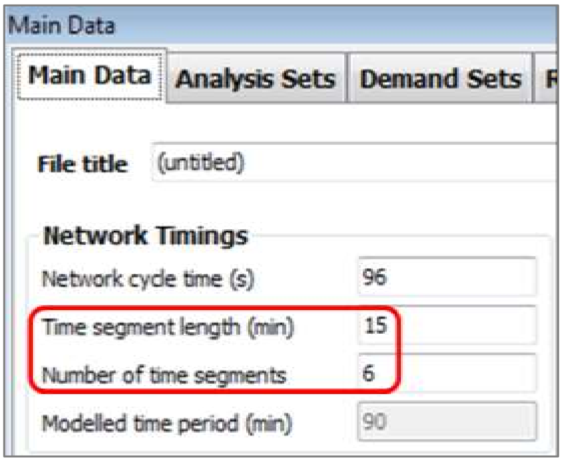


Figure 100: Specifying multiple time segments within a TI6 model

For Links, traffic flows for each time segment can be specified using the following options in Link Flows within the Data Editor:

- **FLAT** – a uniform flow is assumed across all time segments, as in TI2;
- **DIRECT** – a constant flow is specified for each separate time segment; or
- **GAUSSIAN** – a normal distribution is applied to the entered total flow, representing an assumed typical peak flow profile (similar to 'ODTAB' in PICADY / ARCADY or 'ONE HOUR' in Junctions).

For Traffic Streams and Links using Matrix-Based flow entry, the above choice is not available and flows must be specified separately for each time segment (effectively equivalent to the DIRECT method). This is achieved through use of a separate flow matrix for each time segment.

Specific time segments can be individually selected using the Time Segment drop-down menu in the top-right of the TRANSYT application window, as shown in **Figure 101**. This allows segment-specific data entry in the case of Matrix-Based flows, and viewing of model results for specific time segments with either flow entry method. A further 'Summary' option is available, which shows aggregated model results over the entire modelled time period where available.

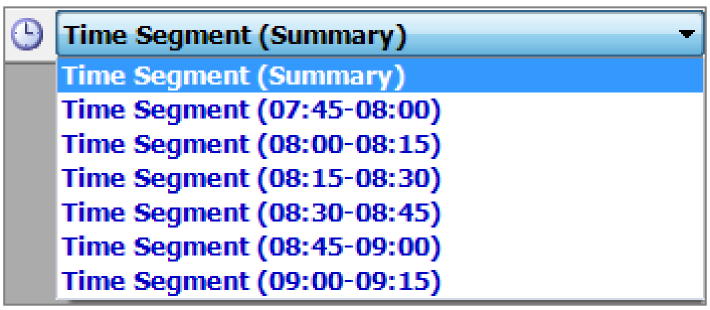


Figure 101: Time Segment drop-down selection menu

It should be noted that when optimising a model containing multiple time segments, TRANSYT optimises performance for the whole modelled time period and not just for the worst performing time segment. The single set of optimised signal timings is applied across all time segments, which may therefore require further refinement if performance in the worst performing time segment is considered unacceptable.

6.4.8 Public Transport

In a Link-Based network, buses should be modelled using Minor Links (see **B6.4.4.3**) where they share the carriageway with general traffic, and Major Links where they are segregated in dedicated bus lanes. This Link structure allows public transport delay and optimisation to be assessed separately from general traffic. Whichever Link type is used, the Links should be specified as dedicated Bus Links.

In TI6 separate Traffic Streams are not required for buses, however the Traffic Stream's traffic type must be set to include all relevant traffic categories that are able to use it (Normal, Buses and/or Tram), as described in section **B6.4.4.6**. Once these have been defined, flows for each traffic type can be entered within the relevant OD Flow matrix (**B6.4.7.2**).

It should be noted that one of the limitations of the Cell Transmission Model in TI6 is that it cannot model traffic within a single Traffic Stream or Link Share as having different cruise speeds. The CTM is therefore not generally suitable for use where bus stops are present or where there is a significant difference between observed cruise times for buses and general traffic during the period being modelled. In these cases the Platoon Dispersion Model should be used (section **B6.4.3**).

Where bus flows are specified on a Link or Traffic Stream using the PDM, the following parameters need to be entered:

- Bus cruise speed, in kph (regardless of whether cruise speeds or cruise times are specified in the TRANSYT program options); and
- The time stationary on each Link or Traffic Stream, representing the total dwell time at any bus stops.

> Note that the 'Tram' traffic type in TI6 does not have a dedicated traffic model and is based on same traffic model as buses, however the Tram's dispersion parameters, cruise speed and stopped times can be specified separately from buses. In the absence of real trams, the 'Tram' traffic type can be used to represent any other discrete traffic category of interest with appropriately specified dispersion parameters and cruise speed / stopped time parameters.

If no bus stops are present then the stationary time should be left as zero. If more than one bus stop is visited on a Link the stationary time should represent the sum of all bus stop dwell times, with an additional contribution representing acceleration and deceleration periods at the additional bus stops (TRANSYT already accounts for bus acceleration and deceleration due to the first bus stop). Where bus stops are not visited by all passing bus routes, or dwell times at the same bus stop vary significantly between routes, route-specific cruise times can be modelled using multiple Minor Links in a Link-Based network or with path-specific cruise times when using Traffic Streams.

Bus stop dwell times should ideally be surveyed on-street or derived from iBus journey time data, particularly in areas of significant interest. It may however be agreed that estimated default values are acceptable in other areas where bus flows are low or where bus performance is not being reported on.

If bus lanes do not extend all the way to the stopline, a bus set-back is created which allows general traffic to use a short lane in front of the bus lane (for example for left-turning vehicles). This should be modelled as a flare for general traffic with a separate Link or Traffic Stream for buses. The bus Link / Traffic Stream should have its start lag (or Start Displacement Time in TI6) increased by the average time taken for queued vehicles stored in front of the bus to clear the signal stopline, which should be measured separately for each modelled period as it may vary by time of day. Note that for TI6 start / end displacements are applied to controller phases rather than directly to Links as in TI2, therefore a duplicate ‘dummy’ phase should be created for delayed buses with appropriate start / end displacement adjustments so that general traffic controlled by the original phase is not affected.

As TRANSYT is based on average signal timings during a typical cycle, dynamic control strategies like SVD Bus Priority cannot be explicitly modelled. Instead their effect can only be represented by the average signal timings within the model. If detailed modelling of dynamic bus priority is required then microsimulation should be considered.

6.4.9 Pedestrians

In TI2, pedestrian Links should be placed in the model wherever there are signalised or significant priority crossings. Since TRANSYT cannot model the complexities of priority crossings, their impact should be accounted for through use of dummy signalised staging in order to quantify their impact on capacity.

TI2 is not typically used for detailed modelling of pedestrians, therefore when entering Link data for pedestrian Links it is common to use standard values, such as saturation flows of 10000PCU/hr and dummy flows of 10 PCU. Link lengths can be entered from site-measured crossing distances, and cruise times calculated by dividing Link length by an assumed pedestrian walking speed of 1.2m/s. Pedestrian Links should be specified as Bottleneck Links, with stop and delay weightings typically set to -9999 so that they do not affect network PI values.

In TI6, Pedestrian Links can no longer be created and instead Pedestrian Crossing objects should be used to represent signalised crossings and significant priority crossings. It is no longer necessary to enter dummy flows for pedestrians in TI6, although these can be added for simplified analysis of pedestrian performance. To specify pedestrian flows, each side of the crossing should be associated with a dedicated pedestrian OD Location or connected to an adjacent Pedestrian Crossing object, and flows assigned via a pedestrian flow matrix. Dummy saturation flows should be entered for each side as for TI2, and crossing distances entered with a pedestrian cruise speed of 1.2m/s (4.32kph)[93]. Where pedestrian flows are entered but not intended for optimisation, the setting 'Exclude pedestrians from results calculation' should be enabled in the model's global Traffic Options (this can also be enabled locally for each side at individual Pedestrian Crossing objects).

TI6 can be used for more detailed modelling of pedestrian delay if suitable pedestrian survey and saturation flow data is available. A 'Walk on Red' model also exists that treats the pedestrian green and blackout periods as effective green, with gap-acceptance occurring at other times. Non-compliance with pedestrian signals is not typically modelled however and specialist guidance should be sought before considering its use. Where detailed pedestrian modelling is required, consideration should instead be given to the use of dedicated pedestrian microsimulation modelling software as described in Chapter **C3** on **Pedestrian Modelling**.

93 1.2m/s represents the pedestrian walking speed typically recommended for signal design by the DfT. For detailed modelling of pedestrian delay, a more representative average value may be considered appropriate, which should be verified on site (the default value in TI6 is 1.5m/s).

6.4.10 Cyclists

For advice on the modelling of cyclists in deterministic modelling packages such as TRANSYT, refer to the detailed guidance in Chapter **C2** on **Cyclist Modelling**.

For Link-Based networks in TI2 / TI6, cyclist flows can be directly entered on Links where appropriate based on their PCU contribution, and distinguished from other flows through use of dedicated Links or Link Shares. This allows the use of separate cruise times from vehicular traffic to more realistically represent observed cyclist speeds.

For Matrix-Based flow allocation in TI6, whether using Links or Traffic Streams, it is not possible to distinguish cyclists from private vehicles on individual Paths when using the Normal traffic type. Link Shares or dedicated Links / Traffic Streams can still be used with suitable cruise times, however it may be necessary to fix cyclist flows on these Paths. In order to model mixed vehicles and cyclists on individual Paths, another unused traffic type could be used to represent cyclists, such as Trams - this would however require careful modification of the Tram dispersion parameters and specialist advice should be sought.

6.5 Base Model Validation

Model outputs for individual Links / Traffic Streams (discussed further in section **B6.7**) should be compared with corresponding survey data in order to validate that the model has been calibrated to an acceptable degree of accuracy.

Validation criteria for TRANSYT Base models submitted to TfL are defined in TMAP, as discussed in **B2.1.5**. At the time of publishing, these are currently[94]:

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

6.5.1 Flow Inconsistencies

The validation of a calibrated model can only occur once traffic flows have been introduced in to the TRANSYT model. A validated Base model, submitted during TMAP Stage 3, should not contain traffic flow discrepancies unless previously agreed with NP.

Where there is a discrepancy in traffic flows the modeller should examine the raw flow data used for modelling. It may be necessary for the model developer to adjust modelling inputs from the calibrated model in order to validate against on-site surveyed conditions. However it is not acceptable to progressively adjust model inputs to achieve validation. Any changes should be justifiable, based on sound engineering principles and documented in accompanying validation reports.

6.5.2 Oversaturation

Base TRANSYT models should not show results for DoS over 100% where stopline traffic counts have been used rather than demand flows, such as at entries to the network. All surveyed stopline traffic should clear associated stoplines within TRANSYT, therefore if a Link or Traffic Stream with surveyed stopline flows has a DoS over 100% then discrepancies may exist for one or more of the following parameters: saturation flow, Link / lane structure, green time and/or stopline flow.

94 Latest MAP requirements are available at **https://www.tfl.gov.uk/trafficmodelling**

6.5.3 Excess Queues

While queue lengths are not considered suitable criteria for validation purposes (as discussed in sections **B2.3.4.4** and **B2.4.2**), excess queues are highlighted in TRANSYT outputs (section **B6.7.1**) and indicate where queues exceed available storage capacity on individual Links or Traffic Streams. Where this occurs, the following parameters should be assessed to determine whether they are correct – green times, offsets, saturation flows and traffic flows. If these parameters have been correctly modelled, it may be necessary to adjust modelled signal timings to remove excess queues, as carried out when accounting for exit-blocking through appropriate representation of Underutilised Green Time (section **B6.4.5.6**).

6.6 Proposed Model Development

Proposed TRANSYT models should be created from a validated Base model, or Future Base model if following the Three Stage Modelling Process described in **B2.1.4**. The Proposed models should be modified with the minimum number of changes necessary to fully describe the Proposed scenario.

This section details considerations to be made when creating a Proposed TRANSYT model.

6.6.1 Future Base

As described in **B2.1.4.2**, the Future Base model includes all likely network changes expected to occur between the Base year and the year being examined in the proposal, excluding the proposed scheme under consideration.

It is built from the validated Base model with the minimum number of changes necessary to include any new schemes falling with the TRANSYT model boundary. The guidance in the rest of this section applies equally whether creating the Future Base or Proposed model.

6.6.2 Proposed Layout

Modifications should only be made to elements of the validated Base model or Future Base model that reflect the changes required as part of the scheme designs. Further amendments to the model to make a model operate within capacity are not acceptable. If a Proposed model will not operate without additional changes it is an indication that the design is not viable or the Base model may not be fit for purpose.

During scheme design, model outputs should be used to assess the scheme's effectiveness and, if necessary, consider suitable design changes prior to full re-optimisation of signal timings as described in **B2.5.6.2**.

Where flows are predicted to change following implementation of a scheme, effective flare lengths should be estimated using QueProb or LinSat when using T12, and in T16 if using Quick Flares.

Cruise times should not be changed to reflect a proposal that is expected to reduce queuing and delay since cruise times represent free-flow conditions. However, cruise times should be re-measured if proposals are expected to involve changes that impact cruise speed, such as a reduction in parked vehicles, introduction of speed reduction features or stopline-to-stopline distances being changed.

When modelling new proposals, the treatment of 'funnelling' and 'fanning' traffic can become a possible source of error. 'Funnelling' occurs when a greater number of lanes at one signal-controlled stopline exit into a fewer number of lanes downstream, while 'fanning' represents the opposite scenario, where fewer lanes upstream flow into more lanes downstream. This behaviour should be reflected in the modelled layout where funnelling forces lanes to behave like flares or with modified capacity where fanning results in underutilisation of downstream stoplines. However, this would only be necessary where downstream lanes are grouped together, and not if individual lanes are modelled.

Existing Link and Traffic Stream numbering within a validated Base model should not be changed within a Proposed model unless necessary. New items should be added using an appropriate numbering / naming convention and highlighted within the proposal report.

6.6.3 Proposed Flows

The methodology for determining and implementing Proposed flows should be agreed at both the Base scoping meeting during MAP Stage 1 (section **A4.4** and **B2.1.5.1**) and Proposal Scoping Meeting during MAP Stage 4 (section **A4.5** and **B2.1.5.1**) to ensure that the most appropriate methodology is used.

Future year flows of cyclists and pedestrians are typically agreed on a project-specific basis. Refer to Chapter **C2** on **Cyclist Modelling** and Chapter **C3** on **Pedestrian Modelling** for further details.

In TranEd separate Flow Groups can be used for Base and Proposed flows that use the same network structure. In T16, Proposed flows can similarly be separated from Base flows for clarity using individual Demand Sets. If necessary these can be combined within a Compound Demand Set and applied to the Analysis set representing the Proposal (section **B6.3.5**).

6.6.3.1 Tactical Modelling

As explained in **B2.5.2.2**, the Three Stage Modelling Process will often lead to traffic flows for TRANSYT models being transferred from tactical modelling. The tactical flows and routing can be transferred directly into the TRANSYT model or they can be used to inform uplift values from the Base model flows. If relevant to the proposals, any assumptions made whilst inputting the Base model flows should be maintained in the Proposed models.

Any changes made to traffic flows or routings in the Base model for validation purposes should be carried across appropriately to the Proposal

6.6.3.2 Public Transport

Any changes to bus routes and service frequencies in the proposals should be included within the Proposed model. This will require manual adjustments to bus flows directly entered on Links or to bus flows entered within relevant OD Flow matrices.

Where any existing routes have been diverted or new routes added, the network structure should be reviewed to ensure that new bus flows can be properly represented and analysed. This may involve use of additional Link Shares or modification of existing Traffic Streams to support the Bus traffic type.

Any changes to bus stop locations or dwell times should be reflected on the appropriate connectors.

6.6.4 Proposed Signal Timings

It is important to ensure that proposed signal designs are audited by a TfL Signals Auditing Engineer to ensure that they meet current TfL standards. Once approved, signal timings in the proposals should be developed and optimised following the methodology and guidance described in **B2.5.3**.

TI2 model submissions should be accompanied by skeleton LinSig models for auditing purposes as described in **B6.2,** to ensure correct representation of proposed signal phasing. Full details of the LinSig phase / TRANSYT Link relationships should be provided, however this is not necessary when using TI6 as controller phases are directly modelled.

Any new Nodes or Controller Streams representing proposed signalised junctions should be numbered using an appropriate numbering / naming system – a recommended approach is a single digit starting at one, rising in increments of one. Where existing Nodes, Links or Traffic Streams are converted in type, for example from unsignalised to signalised, care should be taken to ensure existing data is maintained where applicable.

> Existing Node or Controller Stream numbering within a validated Base model should not be changed within a Proposed model unless necessary. New items should be added using an appropriate numbering / naming convention and highlighted within the proposal report.

6.6.4.1 Optimisation

As described in section **B6.1.3**, TRANSYT's traffic models are used to evaluate the overall impact of stops and delay for a network using the numerical monetary value of the Performance Index (PI). The goal of optimisation in TRANSYT is to find a set of signal timings that produces the smallest possible overall PI value, therefore minimising the impact of stops and delay on the network.

The following key steps are detailed in this section, which contribute towards the overall optimisation strategy as discussed and illustrated in **B2.5.3**:

- Initial signal timings;
- Evaluating existing network performance;
- Optimisation algorithms;
- Cycle time optimisation;
- Optimising green splits and offsets; and
- Optimiser constraints and weightings.

Whichever optimisation strategy is used, it should be recognised that TRANSYT is a tool based on a series of approximations, representing a simplified version of reality. While it is possible to influence optimisation according to specific criteria or interests, further manual refinement may be required and the determination of whether timings are optimal ultimately requires engineering judgement. Where time-varying flow profiles have been used (section **B6.4.7**), it is important to remember that TRANSYT optimises timings for the whole modelled time period and not just for the worst performing time segment.

6.6.4.1.1 Initial Signal Timings

TRANSYT requires an initial set of signal timings for every signal-controlled Node or Controller Stream prior to optimisation. These timings are used to generate an initial reference PI value against which subsequent optimisation attempts can be compared.

Since final signal timings after optimisation can be dependent on the initial timings used, the choice of initial signal timings requires some consideration. If optimised timings are expected to be similar to existing timings, then existing timings should be used as a starting point. For a Base model these are typically derived from existing signal timing plans or observed measurements.

Where existing timings are unavailable, or if optimal signal timings are expected to differ significantly from existing timings, TRANSYT can automatically calculate evenly balanced initial starting timings to reduce the influence of previous timings. This is achieved using the EQUISAT (TI2) or Auto Redistribute (TI6) features, which overwrite pre-existing timings when a full model run is carried out.

To further reduce the influence of specific initial signal timings on optimisation, and potentially find improved optimised timings, algorithms such as Shotgun Hillclimb can be considered.

6.6.4.1.2 Existing Network Performance

The network performance for an existing set of signal timings can be assessed in TI2 by running the model with 'No Optimisation' selected. When doing this, care should be taken to ensure that EQUISAT is not enabled, which would otherwise overwrite existing signal timings.

In TI6 existing network performance can be assessed by performing an Evaluation Run of the model, or a Full Run with optimisation disabled in the model's network options (see **B6.4.2**).

6.6.4.1.3 Optimisation Algorithms

The following optimisation algorithms are available in TI2 and TI6, and are specified within a model's network options (see **B6.4.2)**:

- Hill Climb (TI2 / TI6);
- Shotgun Hill Climb (TI6); and
- Simulated Annealing (TI6).

The default Hill Climb process starts from an initial set of timings and tests whether incremental changes to splits and offsets reduce network stops and delay. Once no further improvements can be found then timings are assumed to be optimal.

In TI6, the additional optimisation algorithms Shotgun Hill Climb and Simulated Annealing are available. The first provides a more thorough Hill Climb evaluation by starting from multiple random signal states, reducing the influence of initial signal timings and increasing the chance of improved optimisation. Simulated Annealing provides further flexibility to test a wider range of possible signal states during early optimisation which is refined as the optimisation progresses.

Ultimately, the choice of optimisation algorithm is a matter of balancing speed against thoroughness. For preliminary analysis the standard Hill Climb process provides the fastest results, however for later modelling stages the additional optimisation algorithms in TI6 can be used to ensure maximum effort to find the most effective signal timings.

6.6.4.1.4 Cycle Time Optimisation

TRANSYT's cycle time optimiser tools can be used to help indicate the most appropriate cycle time for a modelled network.

The internal cycle time optimiser (CYOP) feature in T12 takes a simplified approach and models each Node as a distinct entity, using timings that give equal DoS to critical approaches, but disregarding the influence of applied groupings, weightings or penalties. CYOP calculates the PI for each Node over a series of cycle times, then highlights where a common cycle time may force a Link to exceed 90% DoS and recommends where double-cycling may be beneficial. When using CYOP engineers should be mindful of junction delay as mentioned in section **B2.5.6.1.4**.

T12 and later versions can also generate cycle time graphs to illustrate network performance for a range of cycle times. Unlike CYOP, these are based on full optimisation and include the influence of signal coordination and any applied weightings or penalties. Cycle time graphs can complement the CYOP approach in T12 as cycle time graphs do not produce double-cycling recommendations, although in T16 graph options allow them to be manually investigated. While T12 simply shows network PI values on cycle time graphs, TranEd and T16 can additionally show network delay and maximum DoS / Practical Reserve Capacity, as shown in **Figure 102**.

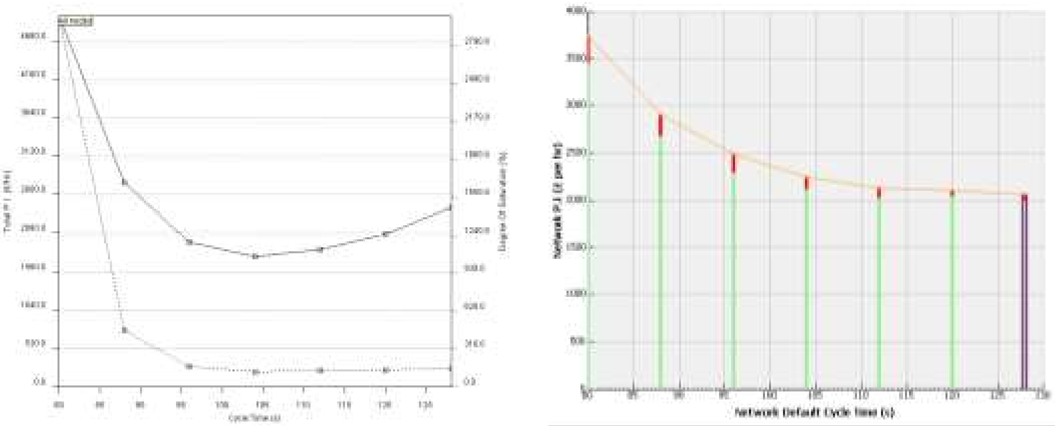


Figure 102: Cycle time optimisation graphs showing PI and saturation information in TranEd (left) and T16 (right)

Although TRANSYT can illustrate cycle time options, the modeller must ultimately decide the most appropriate cycle time, taking into account factors such as Mayoral transport policies and local network management strategies. Section **B2.5.6.1.3** provides guidance on available cycle times and important considerations which may influence cycle time choice.

6.6.4.1.5 Optimising Green Splits and Offsets

During an optimisation run, TRANSYT will optimise signal timings for all Nodes listed in the Node List (T12) or for all Controller Streams listed in the Optimisation Order (T16). As specified in a model's network options (**B6.4.2**), signal timings can either be optimised for offsets only, leaving existing green durations (splits) intact, or for both green durations and offsets together.

Further constraints can be imposed to preserve specific offsets between neighbouring signals while allowing others to be optimised. This is particularly important for fixing critical offsets within SCOOT multinodes or UTC / CLF subgroups. Offsets can be constrained using Node Groups in T12 or Stage Constraints in T16. Where a Node Group is defined, offsets between all member Nodes are maintained. Offset optimisation can similarly be disabled for individual Controller Streams in T16, however T16 Stage Constraints provide finer control by allowing individual offsets to be fixed relative to the start or end of specified stages at neighbouring Controller Streams.

TRANSYT's optimisation procedure is influenced by which stage occurs first in the signal cycle. As the initial start stage may change during optimisation, derived timings may not be exactly the same as those produced by a previous calculation. Modellers should be aware that this effect can sometimes generate different results when repeating back to back TRANSYT optimisations. An initial optimisation should therefore be carried out to balance the network, using EQUISAT or Auto Redistribute if necessary, with subsequent optimisation iterations based on already optimised timings.

Simplified assumptions within some of TRANSYT's traffic models may mean they do not accurately predict the performance of networks operating close to capacity. As a result, after initial signal optimisation, model outputs such as traffic profiles and queue graphs should be reviewed (section **B6.7.1.1**). It is possible to use this information to establish when in the cycle different approaches are likely to suffer from exit-blocking or poor performance.

Once the reasons for a loss of capacity are known and understood new stages in relevant methods of control can be considered and full optimisation repeated. In order for a proposal to consider all underlying traffic management requirements within a proposal it may be necessary to influence TRANSYT during initial optimisation with appropriate penalties and weightings, as covered in the following sections. It may also be beneficial to reiterate optimisation for specific Nodes or Controller

Streams by repeating them in the Node List / Optimisation Order so that they are optimised twice within the same optimisation cycle.

> It is important at all stages of optimisation to assess model output to ensure proposed signal timings are fit for purpose relative to the scope of the project and overarching considerations, as outlined in **Part A**.

6.6.4.1.6 Stop and Delay Weightings

Stop and delay weightings are used to apply penalties for stops and delays on Links or Traffic Streams by increasing their cost within the PI calculation used for optimisation. Weighting values are entered as percentages which are directly applied to the costs for specified Links or Traffic Streams when calculating the cost of stops and delays across the network as a whole. A value below 100% therefore reduces the cost of stops and/or delays and a value above 100% increases the cost.

Since TRANSYT will always attempt to minimise the overall network cost (in terms of the PI), these weighting values determine the amount of effort TRANSYT will put into minimising stops and/or delays on the particular Link or Traffic Stream relative to costs incurred elsewhere in the model. Weightings of less than 100% are therefore likely to increase the number of stops and/or delays on the Link if this leads to a reduction in cost elsewhere in the model.

It should be noted that the default value of 0 in T12 and earlier versions is the same as 100, representing a weighting of 100%. In T16 however, a value of 0 represents a weighting of 0% and 100 represents 100%. InT12 and earlier versions, a weighting of 0% is specified as -9999.

6.6.4.1.7 Queue Limits

Queue limit penalties can be imposed in order to discourage the formation of queues on specified Links or Traffic Streams during the TRANSYT optimisation process. In a similar manner to stop and delay weightings, this penalty imposes an additional cost towards the network PI when the average queue on a Link or Traffic Stream extends past a user-defined or calculated value. The two values required for a queue limit are:

- Queue length limit for the Link or Traffic Stream (in PCUs); and
- The penalty to be applied when the Mean Maximum Queue (MMQ) on a Link exceeds the specified queue limit, in pence (T12) or pounds (T16).

Queue limits can be useful to prevent the formation of disruptive queues where these are seen to occur, such as on circulating Links within a gyratory, or on short internal Links where queuing can cause wasted capacity within a junction.

It is important to be aware of what the MMQ represents in TRANSYT when deciding on an appropriate queue limit value. The MMQ does not refer to the queue at the end of red, but rather the position reached by the back of the queue as the queue discharges, in other words the furthest point at which a queue delays newly arriving traffic. The MMQ is therefore the mean number of PCUs that have queued up to the time when the back of the queue finally clears. As discussed in section B6.4.3.1, the simplified queuing model within PDM does not reflect realistic driver behaviour as vehicles approach a queue. Consequently, the time at which the maximum queue occurs is generally later in TRANSYT than on street.

The MMQ value may statistically be exceeded in 50% of cycles during the period being modelled. Similarly, for over-saturated Links the MMQ will be the mean of a queue that is increasing over the modelled period. This means that the queue on-street at the end of the period being modelled can be up to twice the MMQ provided in the model output in extreme cases. If time-varying flow profiles are used in T16, queue values can be seen at the end of each modelled time segment in addition to the MMQ for the whole modelled period.

When specifying a suitable queue length limit it is necessary to make an allowance for queue length variation above the MMQ, so that the queue on-street will never exceed the maximum allowable value as determined by junction layout. A queue limit of half to two-thirds of the actual storage capacity of a Link is often used, so that the Link not only accommodates the MMQ, but also has sufficient extra storage space for more extreme queues that may develop.

6.6.4.1.8 Degree of Saturation Limits [T16]

Degree of saturation limit penalties can be used in order to favour timings that keep DoS on a specified approach above or below a user-defined value, in a similar fashion to queue limit penalties. When the DoS on the approach exceeds the nominated value, a user-defined Excess Degree of Saturation Penalty can be applied. Similarly, if DoS falls below the specified value a user-defined Low Degree of Saturation Penalty can be applied. The applied penalties need to be suitably severe to have an appreciable effect, however, while they can influence final timings, there is no guarantee that DoS limits will always be satisfied.

6.6.4.2 Demand Dependency

When calibrating demand dependency levels in a Proposed model it should be carefully considered whether there is reason to believe they will change from the Base or Future Base model. Where considered necessary, a suitable methodology should be determined to ensure that any estimated demand levels are appropriate. Assuming full demand as a 'worst case' could in fact mask a capacity issue downstream so a judgement on the expected demand should be agreed and documented. For further information refer to **B2.5.2.3**.

6.6.4.3 Underutilised Green Time

Where adjustments have been made in the validated Base model to reflect Underutilised Green Time (UGT), consideration should be given to the cause of the UGT before determining whether any modifications are appropriate or necessary in the Future Base or Proposed models. If unsure whether to amend Base UGT values, it is recommended that the MAE is contacted to determine the best approach. For further information refer to **B2.5.6.1.1**.

6.6.4.4 Saturation Flows

Saturation flows should only be changed from the Base model if there is clear evidence that they would be different in the Proposed model. Reasons for this may include:

- A new junction or major layout change;
- A change in lane width; or
- A change in flow volumes for particular turning movements.

If any of these apply then RR67, with an appropriate local factor (section **B2.3.9.1**), should be used to implement new saturation flows using the methods described in section **B6.4.4.6**. The reasoning behind any changes must be documented in the modelling report.

6.7 Model Outputs

TRANSYT can provide a number of outputs to help understand model results and modelled network behaviour. These allow analysis and refinement of signal timings to improve operation and minimise adverse impacts on-street, as required during proposal fine tuning (**Figure 20**).

Model results can be obtained for the entire network, individual Links / Traffic Streams or grouped items of interest. In TI2 it is possible to define specific routes through a network to examine performance statistics for a particular pathway or vehicle group. In TI6, Collections can similarly be defined to provide aggregated data for grouped network elements, such as those representing junctions, routes or specific vehicle groups.

Available TRANSYT model outputs can be broadly distinguished as being predominantly numerical or graphical in nature:

6.7.1 Numerical / Table-based Outputs

In TI2, the model input / output file (*.prt) mentioned in section **B6.3.3** is produced whenever a TI2 model is run. The file consists of a structured fixed text format, with input data categorised according to 'card types' (section **B6.3.3**). Model outputs include optimised timings and performance predictions for individual Links as well as the whole network.

TranEd and later versions of TRANSYT, including TI6, allow user-configurable reports to be generated, containing input and output data of interest as well as simple images. TI6 also provides a Network Summary when run, providing an overview of network results and the worst performing locations in the network.

The model input / output (*.prt) and generated report files form a comprehensive reference for checking models, understanding their behaviour and optimising overall performance. Their use is recommended and documented further in the TRANSYT Model Auditing Process (TMAP), detailed in section **B2.1.5**. Key model outputs include initial and optimised signal timings, Link / Traffic Stream predictions for DoS, MMQ (section **B6.6.4.1.7**), PI, average excess queue and the separate components of delay (**Figure 19**). Additionally, overall network summary data is available for total distance travelled, total monetary value for stops and delay, mean journey speed and total network PI, although this data should not be used to assess the merit of proposed signal timings in isolation.

Model outputs can also be used to check for errors, inconsistencies and sources of poor network performance. The following symbols are used to highlight Links or Traffic Streams with potential issues:

- The 'less than' (<) symbol indicates that flow into a Link or Traffic Stream has been reduced by more than ten percent. This may indicate that an upstream junction has become over-saturated and resulted in downstream flow starvation. In this case upstream Links or Traffic Streams should be checked to identify the flow bottleneck as starved Links will not validate against measured data;
- The 'plus' (+) symbol highlights that an excess queue has formed in the model, with the average queue length exceeding storage capacity on the indicated Link or Traffic Stream. These should be checked to ensure that signal offsets are not generating artificial queues and to ensure that adequate upstream stacking capacity exists. Where this is not the case upstream signal timings should be adjusted to relocate the queue to a more appropriate location, either through a preferred traffic management strategy or through representation of Underutilised Green Time at upstream signals. Queue limit penalties (discussed in section **B6.6.4.1.7**) can also be used during optimisation to deter TRANSYT from forming queues in undesirable locations; and
- TRANSYT estimates storage capacity as a function of Link / Traffic Stream length and saturation flow, although this value can be overridden by a user defined maximum queue storage value if the TRANSYT estimate is considered to be overly optimistic.

Traffic Stream Results

			SIGNALS			FLOWS		PERFORMANCE			
Arm	Traffic Stream	Name	Traffic node	Controller stream	Phase	Calculated flow entering (PCU/hr)	Calculated sat flow (PCU/hr)	Actual green (s (per cycle))	Wasted time total (s (per cycle))	Degree of saturation (%)	Practical reserve capacity (%)
A	1	(untitled)	1	1	A	100	1800	8	0.00	25	265
Ax	1	(untitled)				430	Unrestricted	40	30.00	0	Unrestricted
B	1	(untitled)	1	1	B2	50	1800	22	0.00	5	1763
	2	(untitled)	1	1	B1	380	1800	8	0.00	94	-4
Bx	1	(untitled)				150	Unrestricted	40	28.00	0	Unrestricted
C	1	(untitled)	1	1	C1	50	1800	22	0.00	5	1763
	2	(untitled)	1	1	C2	100	1800	9	0.00	22	305

Figure 103: Example of model results shown in the T16 Report Viewer

6.7.1.1 Model Data Comparison Tool [TI6]

TI6 has a facility to compare model input and output data for specified Analysis and Demand Sets, which can be accessed from the 'Tools / Compare Files or Data Sets' menu option. This can be useful when auditing models to determine key changes between model submissions. The compared data can either be from separate Analysis / Demand Sets within the same model file, as shown in **Figure 104**, or from different files.

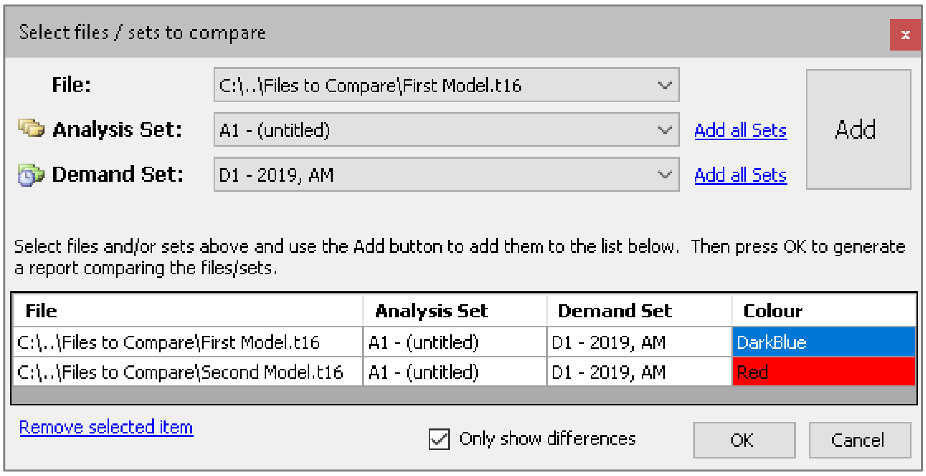


Figure 104: Specifying TI6 model data for comparison

Once the relevant Analysis / Demand Sets are specified for comparison, model input and result data is shown in the Report Viewer, with differing values between the compared sources displayed adjacently and colour-coded as shown in **Figure 105**. It is important to ensure that evaluation runs are performed prior to running the comparison tool to ensure that all displayed model data values are up to date.

Traffic Streams

Arm	Traffic Stream	Name	Description	Auto length	Length (m)	Has Saturation Flow	Saturation flow source	Saturation flow (PCU/hr)	Is signal controlled
A1	1								
B1	1								
C1	1								
xB1	1								
11	1							2274 1315	
x11	1								
13	1							2244 899	
x13	1								
15	1							1249 1490	

Figure 105: Highlighting of model differences within the Report Viewer

6.7.2 Graphical Outputs

In addition to table-based outputs, graphical outputs can also be provided by TRANSYT to aid analysis of model behaviour and results. These include:

6.7.2.1 Network Diagram Overlays

T12, TranEd and T16 allow many model results and calibration parameters to be displayed directly on the Network Diagram, including DoS, queues, storage utilisation and flow information. This is typically the simplest way to quickly assess network performance following a model run. Further options include animation of signal states and queues / occupancy during a typical cycle.

Where time-varying flow profiles have been used in T16, the Time Segment drop-down selection menu also allows displayed data to be shown at various points during the modelled time period, in addition to an overall summary of the entire modelled period.

An example of a Network Diagram Overlay in T16 is shown in Figure 106, displaying queue and flow information.

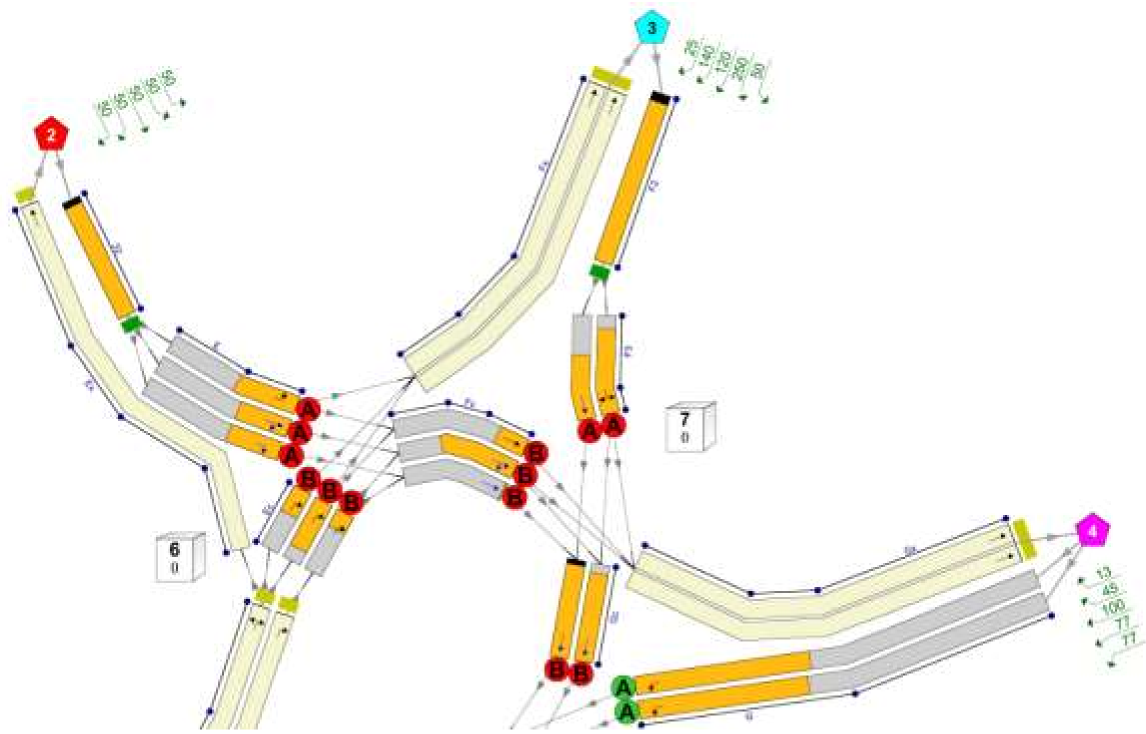


Figure 106: T16 Network Diagram Overlay showing queue and flow data

6.7.2.2 Queue and Flow Graphs

TRANSYT can produce histograms of queues and flows for individual Links or Traffic Streams, showing the number PCUs queuing, arriving or discharging at a signal-controlled stopline during a modelled cycle.

A queue graph shows both the rate of discharge from the front of the queue during green and the distance of the back of the queue from the stopline throughout the cycle, as shown in **Figure 107**. TRANSYT forms queues based on three components of delay – uniform, random and over-saturation (illustrated in **Figure 19**).

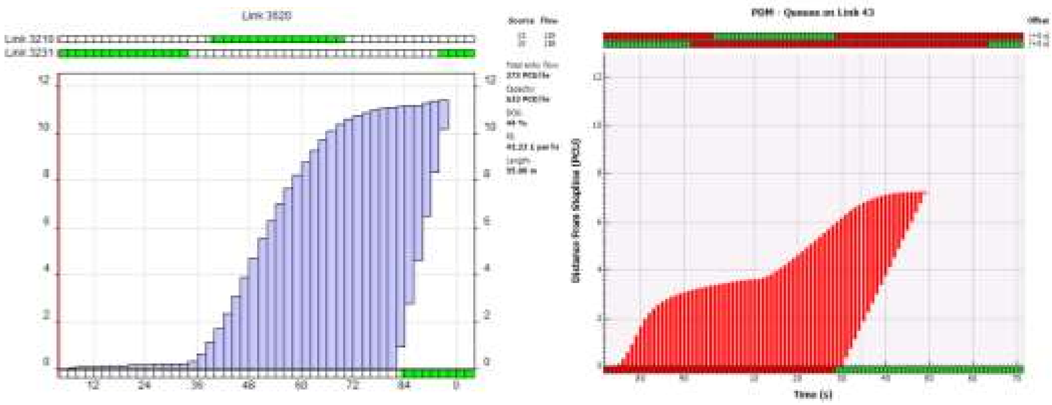


Figure 107: Uniform queue graphs, viewed in TranEd and TRANSYT 16

> TRANSYT queue graphs display only the uniform component so should not be used instead of excess queue calculations to predict where queue storage problems may occur. The facility remains useful as it can highlight queuing occurring during green periods, this would be where flow along a Link is greater than saturation flow.

Cyclic Flow Profile (CFP) graphs show the traffic flow rate (in PCU/hr) across a stopline at different time increments during the cycle, as shown in **Figure 108**. These examples combine both the 'In Profile' (traffic arriving at the stopline) and 'Out Profile' (traffic discharging from the stopline) in one view, though they can be viewed independently in T16.

CFPs are useful for assessing offset progression between stoplines as the timing of platoon arrival and queue discharge can be compared between upstream and downstream stoplines.

The different movement profiles within a CFP can be analysed to understand the amount of spare stopline capacity available at different points within the cycle. For example, areas of the CFP in **Figure 108** use the following colour key:

- **Dark green / blue** – previously delayed vehicles discharging from a queue;
- **Light green** – vehicles arriving during a green signal; and
- **Red** – vehicles arriving during a red signal.

The CFP also provides an indication of the Mean Modulus of Error (MME) for the Link or Traffic Stream. MME is a numerical value between zero and two, indicating how bunched a travelling platoon remains as it progresses along a Link / Traffic Stream. The MME is an important parameter when deciding whether a particular Link / Traffic Stream should be coordinated with an upstream neighbour - a higher value indicates potential benefits in coordinating signal timings, as platoons remain clearly defined and are therefore more likely to benefit from offset progression. A value of MME below 0.3 suggests there may be little benefit in stopline coordination, with a value of zero indicating a uniform arrival pattern. It is important to remember that MME is a theoretical concept, because TRANSYT can only model platoon dispersion due to different vehicle speeds and not mid-Link friction caused by parking, loading and minor sinks or sources.

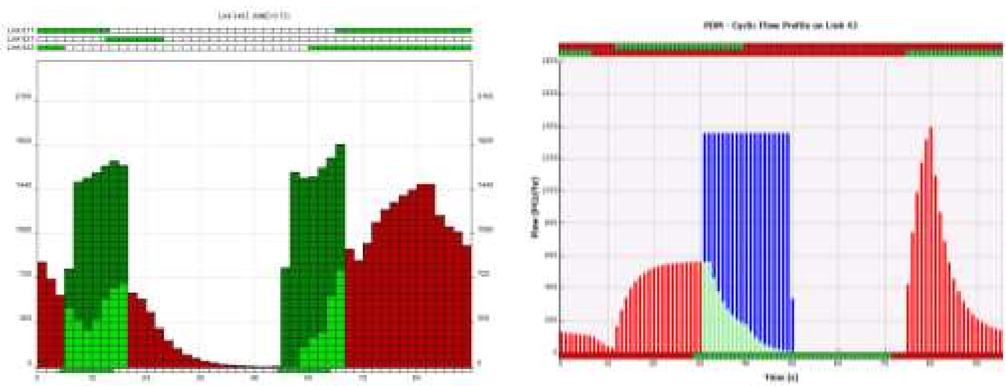


Figure 108: Cyclic Flow Profile graphs, viewed in TranEd (left) and TRANSYT 16 (right)

6.7.2.3 Performance Index Graphs

A PI graph (**Figure 109**) can be used to indicate the likely impact to Link / Traffic Stream PI following a change in signal offset between upstream and downstream stoplines. The histogram plots the Link / Traffic Stream PI on the Y axis against the offset-difference on the X axis. The graph illustrates how PI may vary if the offset-difference is altered by an amount varying between zero and the user-defined cycle time. Generally, the lower the PI the better the coordination between associated signalised stoplines.

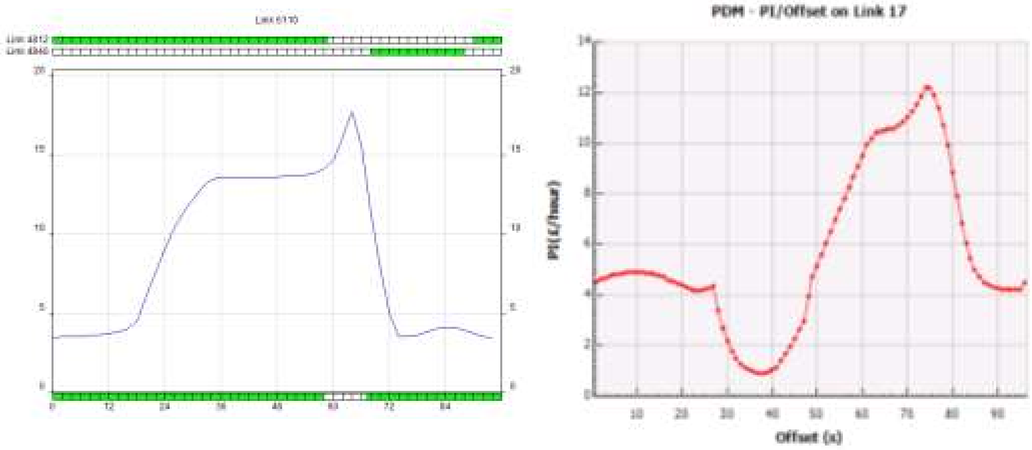


Figure 109: Performance Index graphs, viewed in TranEd and TRANSYT 16

6.7.2.4 Cycle Time Optimisation Graphs

While the CYOP feature in TI2 provides table-based outputs for cycle time assessment, TranEd and later versions of TRANSYT can provide visual indications of network performance measures against a user-defined range of cycle times, as shown in Figure 110. These can provide a useful initial estimate of the most appropriate cycle time to take forward for further analysis.

Available network performance measures that can be plotted include PI, delay and highest DoS / minimum Practical Reserve Capacity. Further options also allow the investigation of multiple cycling options for individual controllers.

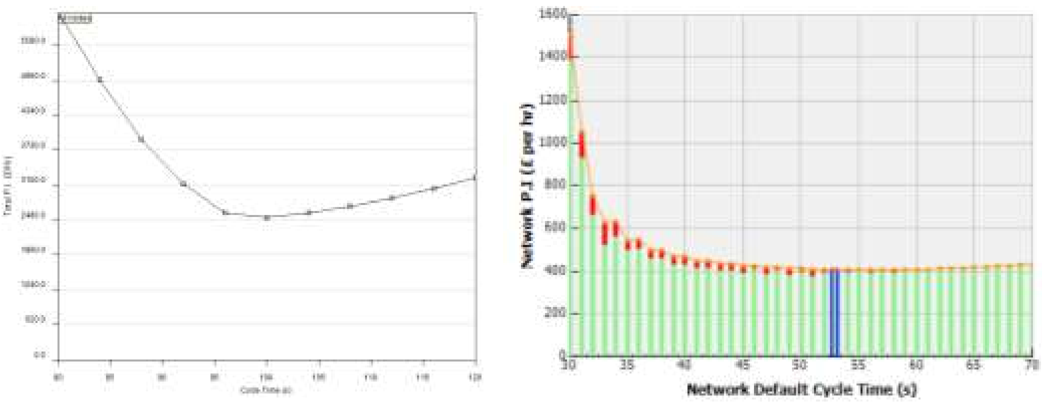


Figure 110: Cycle Time Optimisation graphs in TranEd and TRANSYT 16

6.7.2.5 Time-distance Graphs

A time-distance diagram (**Figure 111**) illustrates platoon progression along a complete route, and can be used when seeking to provide priority for specific movements. The diagram allows a modeller to minimise encountered stops and delays through appropriate modification of successive signal offsets. This can be a useful feature when assessing the output of a proposal to check front and back end progression along a critical route.

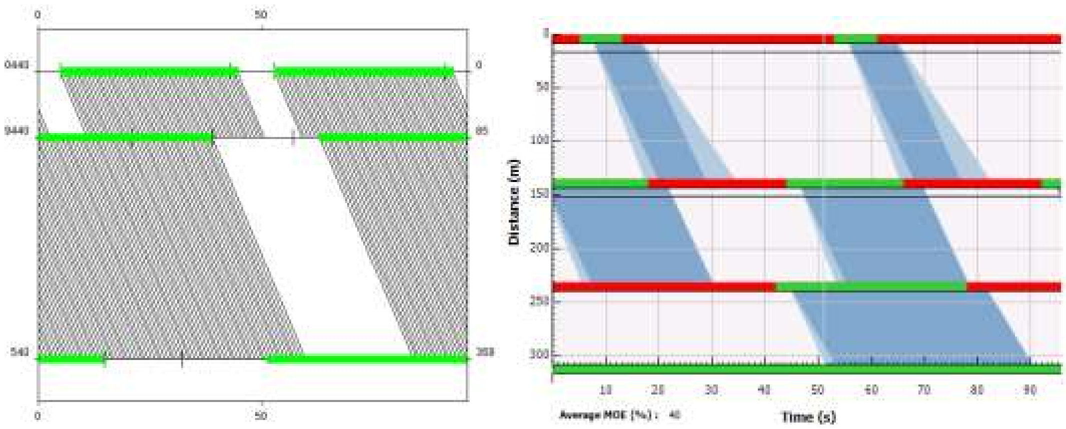


Figure 111: Time-Distance graphs in TranEd and TRANSYT 16

6.7.2.6 Analyser – X-Y and Time Graphs [TI6]

The Analyser feature in TI6 is a useful tool that enables any model output parameter to be analysed in detail. Two types of plots are supported – X-Y Graphs and Time Graphs.

X-Y Graphs, as shown in **Figure 112**, allow any model outputs to be plotted against a user-specified range of a chosen model input. To plot the graph, multiple independent TRANSYT runs are performed to gather the necessary data. This is particularly suitable for sensitivity analysis to determine the influence of key design parameters..

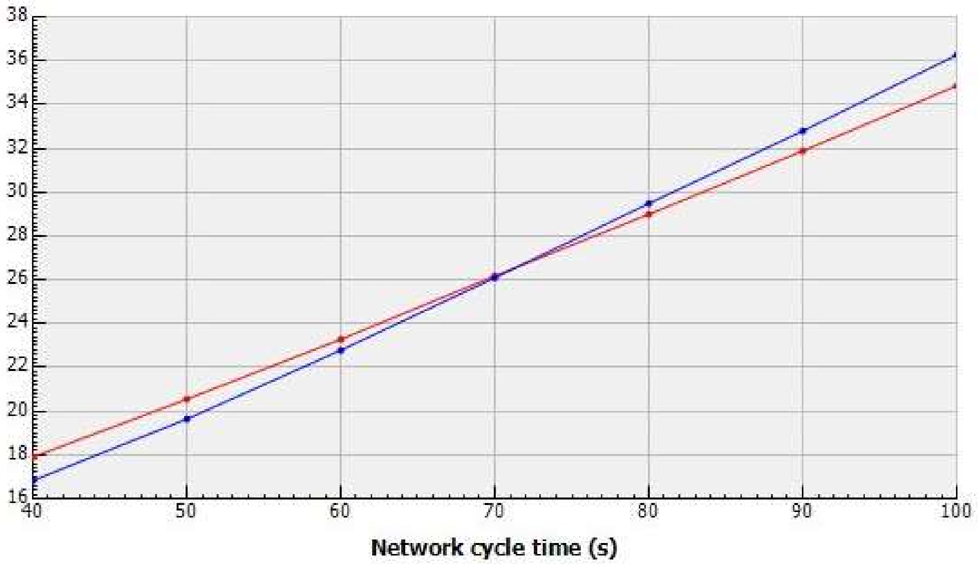


Figure 112: TI6 Analyser (X-Y) graph showing P.I. versus cycle time for two Collections

Time Graphs provide the ability to plot specified model output parameters over time, showing any variation during the modelled time period where multiple time segments have been specified. This can be useful to help visualise time-dependent phenomena, for example when the maximum queue or DoS occurs on a critical Link / Traffic Stream, and the resulting impact on wider network performance.

6.7.2.7 Traffic Simulation [TI6]

When using TI6's Simulation Model (discussed in section B6.4.3.5), several visualisation options are available that can be used to observe queuing behaviour and assess network performance at any point during the modelled time period. These include:

- Animation of individual vehicles during a single random seed trial (Figure 113);
- Display of average queue lengths across all simulation trials; or
- Display of percentile queues, indicating the probability of queue length occurrence as shown in Figure 114. Either a specific percentile threshold can be displayed, or shaded percentile queues can be shown indicating the range of queue probabilities observed across all simulation trials.

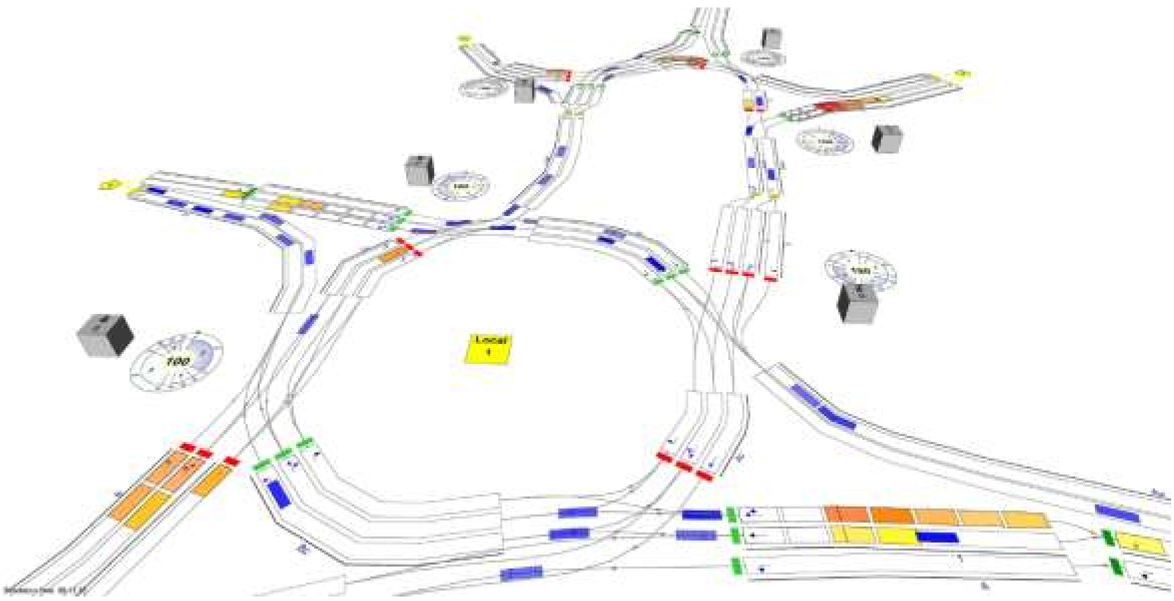


Figure 113: Animation of individual vehicles in a Traffic Simulation random seed trial

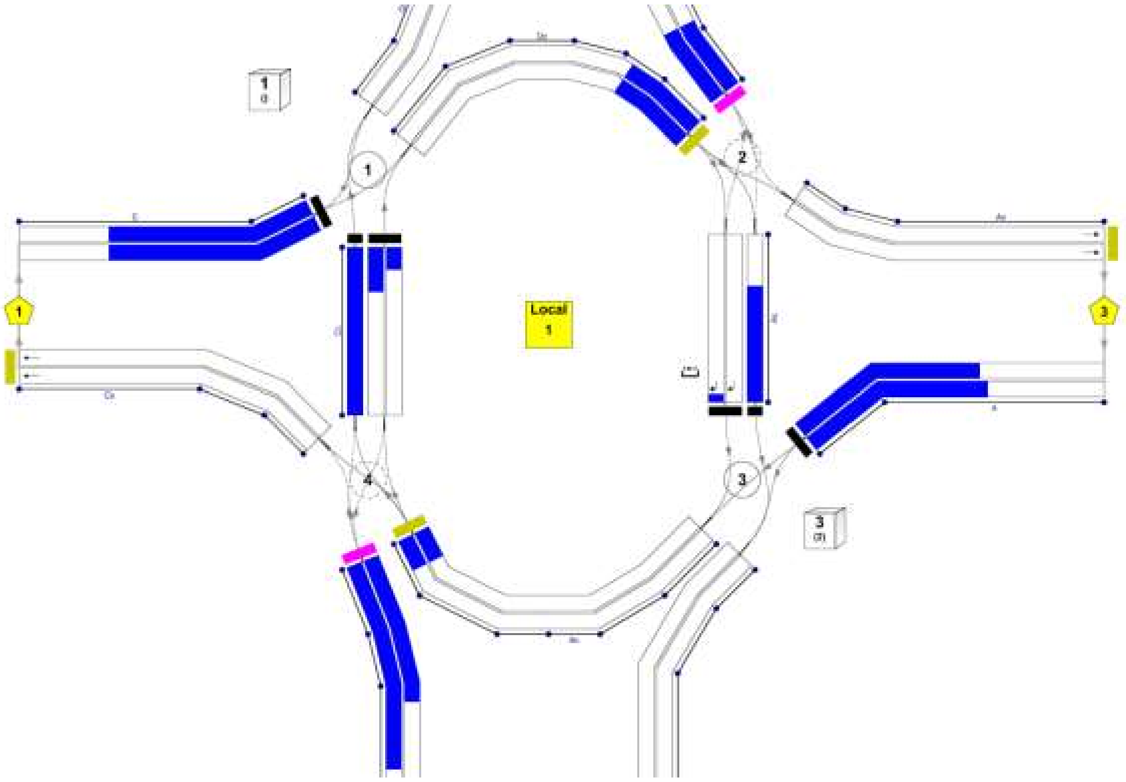


Figure 114: T16 simulation showing 90th percentile queues

Observation of individual vehicles can be helpful to visualise the dynamic nature of queuing behaviour, including associated blocking effects. It is however important to remember that as this represents only a single random seed and other simulation trials may need to be observed.

The Signals Log, shown in **Figure 115**, provides a further visual aid to observe signal operation during the simulation. It can also be displayed with optional queue and flow data for specified Traffic Streams,.

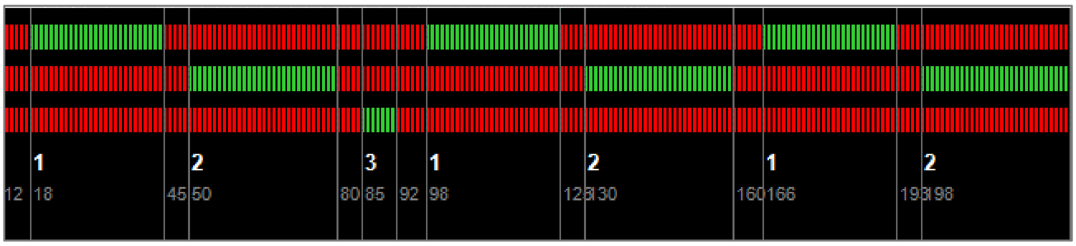


Figure 115: Signals Log in TRANSYT 16

7 Vissim Modelling

7.1 Introduction

This chapter is designed to provide guidance for experienced practitioners when building microsimulation models of London's road network using Vissim. It augments the general modelling guidance given in Chapter **B2** on **Modelling Principles**.

This chapter outlines TfL's recommended approach for microsimulation modelling with Vissim. However, there may be cases where local conditions or project requirements dictate the use of methods which may be different to those outlined. In these situations, NP should be consulted on the planned methodology where modelling will be submitted for approval by TfL.

7.1.1 Introduction to Vissim

Vissim is microsimulation software made by PTV Group (PTV). The name stands for Verkehr In Städten – SIMulationsmodell, which translates as Traffic in Cities – Simulation Model. Vissim uses a Lane-Based network layout and a car-following model to accurately reflect the way vehicles move through junctions and roads and interact with each other. It also has the capacity for lateral behaviour within lanes, which makes modelling features such as cyclists and overtaking possible. Signals can be modelled using either internal fixed-time plans, through Vehicle Actuated

Programming (VAP) which can use detector inputs to vary timings, or through the API, which essentially means that any signal control system can be used as long as an interface has been coded. TfL has the UTC-Vissim Interface, which replicates TfL's Urban Traffic Control system within Vissim (section B7.4.5.3).

Vissim has traditionally been used to model complex and congested traffic networks, where deterministic modelling cannot provide a realistic representation. In common with other microsimulation software, it is unable to optimise signal timings, and so is usually used in conjunction with deterministic modelling when looking at proposed schemes.

Further information can be found on the PTV Vissim website[95].

7.1.2 Software Versions

The latest version of Vissim at the time of publishing is Vissim 2021.TfL has developed templates for Vissim with recommended parameters for many Vissim versions, which are available upon request[96].

There was a significant change to the program user interface between Vissim 5.4 and Vissim 6, which introduced new features and new ways of working. Throughout this section, 'later' versions of Vissim will generally refer to the current (at the time of publishing) state of the software and 'earlier' to previous states. This will often correspond with the change from Vissim 5.4 to Vissim 6, but this is not a fixed rule as the software continues to be developed and new features introduced.

> Whichever version of Vissim is chosen for a modelling project must be used for all the models in that project. It is not acceptable to build the Base model in one version and then Proposed scenarios in a more recent version, as the results change between versions.

The version a Vissim model was last saved in can be found at the top of the model file (*.inp / *.inpx) when opening it in a text editor such as Notepad.

7.1.3 Appropriate Use of Vissim

Vissim should be used appropriately to complement analyses provided by traditional traffic optimisation and design tools and often tactical modelling, where the purpose of the modelling requires more detailed

95 **https://www.ptvgroup.com/en/solutions/products/ptv-vissim/**
96 The latest TfL Vissim Template can be requested from NP

representation of vehicles' behaviour and interactions. The list below gives some examples where it is necessary to develop Vissim models in order to meet the purpose of a modelling project:

- Where over-saturated conditions exist, and particularly where exit-blocking occurs, or where queues interact with other facilities;
- Where network infrastructure changes dynamically throughout the modelled period (such as VA signal control, demand dependency, bus priority at signals);
- To model UTC-specific dynamic signal timing strategies (for example SCOOT, SASS, gating) through use of the UTC-Vissim Interface (section **B7.4.5.3**);
- Where detailed cyclist behaviour (Chapter **C2** on **Cyclist Modelling**) or pedestrian behaviour (Chapter **C3** on **Pedestrian Modelling**) is required;
- Where accurate journey time prediction is important as an improvement measure (for example a bus priority scheme); and
- Where it is necessary to visually demonstrate the operation of a scheme, traffic management technique or control strategy for use in a stakeholder consultation or Public Inquiry.

7.2 Preparation

General guidance on Base model development is provided in **B2.4**. This section provides specific guidance for building Base models using Vissim. Model preparation should be discussed at the scoping meeting (section **B2.1.5.1**) and decisions documented within the Modelling Expectations Document (MED, section **B2.1.5.2**).

7.2.1 Model Boundary

Vissim is able to model adjacent CLF or UTC groups operating different cycle times. It can therefore assess the impact of scheme proposals which cover two or more traffic control groups. Where blocking back from one group impacts traffic upstream, Vissim can be used to predict the magnitude and frequency of any operational issues and test proposals for mitigation. For this reason, where possible, junctions which generate significant queuing in the area of interest should be included in the modelled area. If it is not possible, for example if the cause of queuing would significantly increase the size or complexity of the model, then a proxy must be used. See section **B7.4.2.6** for more details.

When deciding on the Vissim model boundary, the length of external links (such as those where vehicles are loaded onto the network) should be considered.

> An external link ought to be long enough to contain all traffic expected to enter within the modelled time period in all scenarios.

There are two reasons this should be done:

- To ensure that any upstream blocking back effects can be easily identified (visually) and mitigated; and
- To ensure that when measuring scheme performance parameters (examples include; journey time, delay, queue length, average speed) all vehicles are included. If some vehicles are not successfully loaded into the network, the model will produce a biased result which may underestimate the capacity impacts of the scheme.

If the Links are not long enough then vehicles will queue outside of the modelled area waiting for a space to enter. All Links should be extended to capture the extent of the queuing.

7.2.2 Data Collection

Prior to building a model in Vissim the following information should already have been obtained, as identified in sections **B2.2** and **B2.3**:

- Background images (section **B7.2.4**);
- Familiarity with site operation and driver behaviour;
- Traffic flows and turning proportions;
- Traffic flow compositions (according to vehicle classifications);
- Bus frequencies;
- Bus stop locations;
- Bus stop dwell times;
- Signal timings and controller logic;
- Saturation flows;
- Vehicle journey times;
- Queue lengths;
- Mandatory speed limits; and
- Parking and loading.

The following data may also be needed, depending on the purpose of the model:

- Origin-Destination (OD) surveys;
- Speed and acceleration profiles;
- Bus boarding and alighting surveys;
- Pedestrian flows; and
- Bus occupancy surveys.

In addition to collecting the above data, skeleton determinsitic models should be produced for all junctions to be modelled in Vissim, as detailed in section **B4.1.3.2**). This will ensure signal timings are accurately represented, particularly when modelling stage and interstage relationships.

The remainder of this section provides specific guidance on the collection of some of the above data as necessary for the preparation of Vissim models.

7.2.2.1 Site Observation

Microsimulation models are able to simulate complex interactions between road users and their environment.

> It is therefore essential that observations are undertaken at sites being modelled so that interactions can be noted and replicated in the model. It is not sufficient to use drawings and aerial photography only to build a model, as these are static sources and may not convey all the dynamic aspects of the site.

CCTV may also be used; however, this is not an ideal solution as not all areas are covered and it is easy to pay less attention to areas which cannot be seen. Preferably, CCTV would be used in addition to, rather than instead of, site visits.

Examples of behaviours which should be observed are:

- **Space utilisation** – particularly where usage does not match lane markings;
- **Blocking back** – through junctions, across crossings, yellow boxes and keep clears, anywhere another traffic movement is prevented from continuing on its desired path;
- **Lane changing** – particularly the decision point where vehicles decide to change lanes for turns;
- **Parking** – both legal and illegal if it is persistent and takes space away from moving traffic;
- **Queuing** – locations, lengths, and behaviour; and
- **Gap acceptance** – at give-ways or opposed right turns.

These can significantly affect model results and must be understood from site visits in order that they can be accurately replicated in the model.

It is also important, whenever possible, to carry out site observations on days when traffic surveys, for example counts or journey times, are taking place. As described in section **B7.5.1**, it is important to verify that the data collected represents a day that is considered typical or the data collection may need to be repeated at a later date.

7.2.2.2 Signal Timings

Guidance on how to collect and use signal timing data is provided in **B2.3.8**. As described in section **B7.4.5**, the two main methods for controlling signals used at TfL are VAP and UTC-Vissim. Where VAP is used to control signal timings, the data requirements include phase, stage and intergreen data from Timing Sheets. For UTC junctions the control plan is also needed, along with the frequency of any demand-dependent stages. MOVA sites record log files containing signal timings. These are stored for a limited time and must be downloaded from the controller so TfL must be consulted if this is required. Alternatively, for VA or MOVA junctions green time surveys can be used to determine the average frequency and duration of each stage.

If more complex forms of dynamic control, such as bus priority, have a significant impact on the behaviour of the junction, then information on this should be collected so that it can be replicated appropriately. Alternatively, it may be preferable to use the UTC-Vissim Interface, a software interface between Vissim and a copy of TfL's UTC system. The interface allows TfL engineers to simulate the real behaviour of the UTC system and associated applications including SCOOT, SASS and bus priority. If this method is being used it is necessary to verify that the data included in the UTC cell is from the appropriate date for the model. See section **B7.4.5.3** for further information on UTC-Vissim.

7.2.2.3 Saturation Flows

In most cases, a Vissim model will be developed to complement an existing validated LinSig or TRANSYT model which already contains measured saturation flows, so saturation flows from those accompanying models should be used for calibration of the Vissim model. Guidance on saturation flow measurement is provided in **B2.3.9**. Where a validated LinSig or TRANSYT model is not available, it will be necessary to measure saturation flows for the purposes of calibrating the Vissim model. These are some examples of situations where it is critical to measure saturation flows for a Vissim model:

- Approach has extensive queues, for example a bottleneck;
- Approach is an entry into the Vissim network;
- There are proposed changes to the layout; and
- There are proposed changes to the method of control or intergreens.

This is not an exhaustive list and it remains necessary to exercise good judgement when assessing situations where it is critical to measure saturation flow.

7.2.2.4 Journey Times

It is necessary to have journey time data to validate a Vissim Base model. In recent years, sources of automated survey data have become available which give a much wider range of possibilities when it comes to choosing dates, times and distances. In particular, it is possible to get an average journey time over multiple days, which provides a more robust value to validate against. The sources of data include Automatic Number Plate Recognition (ANPR) cameras and aggregated records from sat-nav companies. It is also possible, if required, to commission video surveys of an area or use CCTV to manually match vehicles along a particular stretch of road. Where it is not possible to source other forms of data, journey times should be collected using the 'floating car' technique (section **B2.3.4.3**).

Journey time data should be collected at the same time as the other traffic surveys if possible, however for larger networks it may be necessary to conduct the surveys over several days. Journey times in Vissim can be collected and measured over any length of any route making it adaptable to available site-measured journey time data. It is recommended that journey time data is collected over smaller distances in addition to the full routes, as this will help with locating any disparities during validation.

7.2.2.5 Public Transport

Bus data in London is recorded using the iBus system, which collects data on frequencies, journey times and dwell times for each bus. There is a standard data format that is used for microsimulation models which aggregates by the hour, however, if the modelling requires more granularity then this is also possible. This data can be requested from TfL but any requests must go through a TfL sponsor to ensure the request is valid and formatted correctly.

Information on the running of coach lines should be sourced from the relevant company's website.

7.2.3 Model Time Periods

The model time period should be specified to match the requirements of the analysis to be undertaken and based on the flow data which has been collected. In addition, a warm-up period to pre-load the network with traffic and generate queues prior to the study period should be included. General guidance on model time periods is given in section **B2.3.3**.

Vissim is not constrained to modelling a single peak hour period. For a broader assessment it is possible to create models which cover three or more hours, which is beneficial for an assessment of traffic during the shoulders of a peak period or where models are sufficiently large that different areas of the model experience localised peaks at different times.

Vissim models must include a warm-up period in addition to the evaluation period. The extent of the warm-up period will depend on the network size and congestion level. The warm-up period should be at least as long as a typical journey through the network but in most cases a 15 to 30-minute warm-up is sufficient. Therefore, Vissim models with a single hour of analysis will cover 1.25 hours as a minimum. A cool-down period may also be included if there is the possibility that the proposal could extend the peak hour(s).

7.2.4 Background Images

The primary source of background data for the areas surrounding junctions should be Site Layout Drawings (SLDs) as these contain detailed information on the location of traffic infrastructure. Aerial photographs and detailed topographical drawings may be used to supplement SLDs, but they should not be used in isolation for building the traffic network. Background drawings on which the traffic network is built should be of sufficient detail and accuracy to give information on relevant network elements such as signal stoplines, give-ways, bus stop locations and lane marking arrangements.

Before the network build begins, it is essential that the background is scaled correctly. This should automatically be the case when loading SLDs which have been saved in Model view, but it should always be checked. As an additional safeguard it is suggested that a scale marker is included on the background which should be at least 100m in length.

Vissim uses a generic Cartesian coordinate system rather than any particular map projection. At TfL the British National Grid (BNG) coordinate system is used for SLDs and any Vissim modelling, and therefore its background imagery, should also use this system. Although Vissim has the capability to load online mapping from sites such as Bing and Open Street

Map, this is not recommended as it will not match the BNG coordinates and also the imagery changes over time so the references used to calibrate the Vissim network may be lost.

Finally, as described in **B2.3.1** and **B2.3.2**, it cannot be assumed that drawings and aerial photographs are up to date and accurate. Therefore, it is necessary to check layout details during site visits to confirm their accuracy.

7.3 Graphical User Interface

While the traffic model in Vissim has remained broadly similar between different versions, as indicated above, there was a significant change in the interface after version 5.40. This section gives a brief introduction to some of the newer features.

The main theme behind these features is user configurability, so each interface element comes in its own window which the user can place wherever they like on the screen. It is possible to control viewing and editing of network elements separately, so all network elements can be viewed at the same time, which is useful when it comes to looking at the relative positioning between elements.

7.3.1 Network Objects

The Network Objects window (**Figure 116**) determines which objects are displayed (in the left-most column), whether they can be selected (second column), whether the label is displayed (second from right) and how they are displayed (right-most column). It also highlights the type of object which can currently be created. Right-clicking on an entry is the easiest way of accessing the List (section **B7.3.2**) for that object type and can also be used to change the way the object and its label are displayed via the Edit Graphic Parameters option.

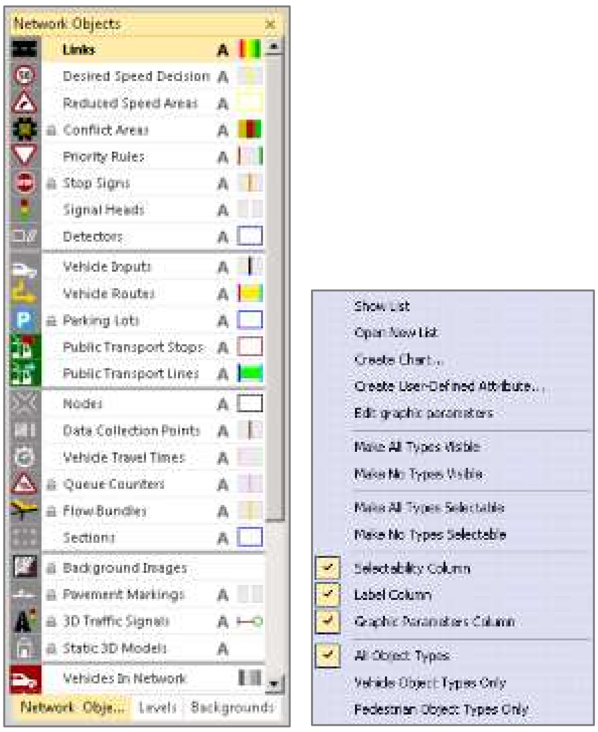


Figure 116: Network Objects window and a typical right-click menu

7.3.2 Lists

The key feature of later versions of Vissim is the List window. This is similar to the window which appeared on right-clicking the background in earlier versions of Vissim, except the contents of the List is user-customisable and editable, and it is possible to display the Lists of multiple objects or datasets at the same time. Multiple cells can be edited to the same value at the same time by selecting them together.

It is possible to display two linked lists together. One useful example is Links / Static Vehicle Routes, which shows, on the right, the Routes which use whichever Link is selected on the left (**Figure 117**).

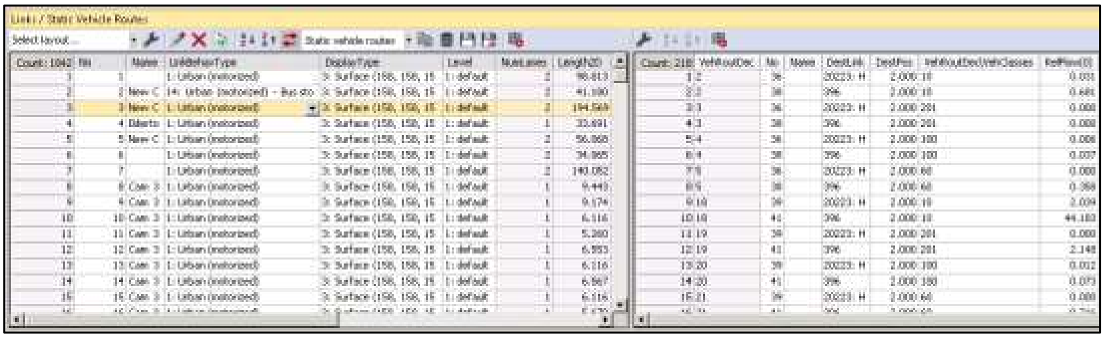


Figure 117: Linked Lists with Links on the left and Static Vehicle Routes on the right

Another example is Public Transport Lines / Public Transport Line Stops, which shows all the stops a bus route travels through and whether they are active or not. In **Figure 118** below, a column showing the Dwell Time Distribution for each stop has been added through the Attribute Selection button.

Figure 118: Linked Lists with Public Transport Lines on the left and Public Transport Line Stops on the right

User Defined Attributes (UDAs) can also be added to the Lists. These can consist of data from external sources (such as validation data) or formulae using data already in the model. Finally, Lists also display results data so outputs can be viewed inside Vissim. **Figure 119** below shows an example of Node results, and further information can be found in section B7.7.

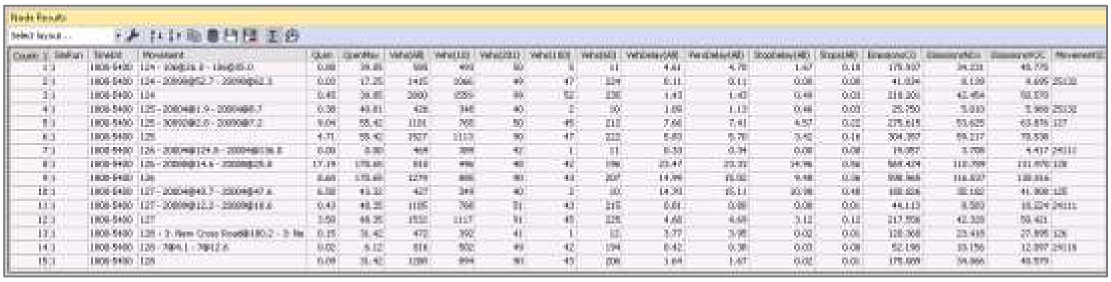


Figure 119: Node Results List

Since the Lists can be sorted by any of the columns in either of the linked Lists, the List view can be used to edit the display properties so that, for example, Links and Lanes with the same characteristics can quickly and easily be given the same colour. In Figure 120, stopline Links have one behaviour (dark green), there is a merging behaviour on the exit to the junction (light green), and Lanes which are closed to particular Vehicle Classes are highlighted (red).

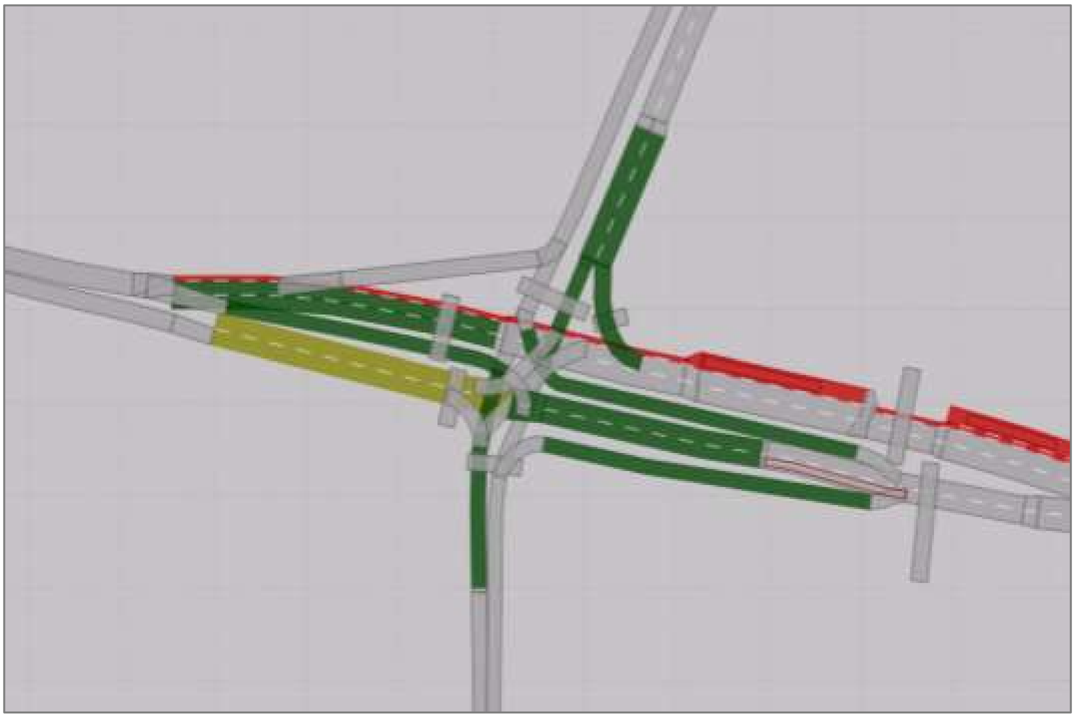


Figure 120: Screenshot showing Link characteristics in different colours

7.3.3 Quick View

The content of the Quick View window is dependent on the network element which is selected. Each element type has a user-configurable selection of data, including UDAs, which can be displayed and also edited in the window.

Quick View is a useful tool during calibration for interrogating the model and working out why vehicles are displaying a particular behaviour (**Figure 121**). It is configurable to show a large variety of data about any vehicle which is clicked on during a simulation run, and can therefore be used to find out the interactions which are currently acting on the vehicle.

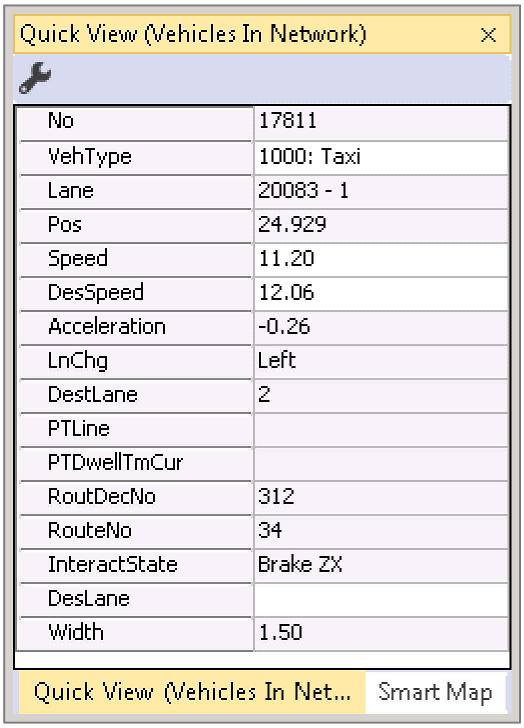


Figure 121: Quick View (Vehicles In Network) window

7.3.4 Scenario Management

Scenario Management enables multiple scenarios to be assessed within a single input file (*.inpx). Operating multiple scenarios in the same file provides some benefits to the development of models, however, when it comes to submission to TfL for auditing, it is recommended that each scenario should be submitted as a single input file (*.inpx). One reason for this is the potential problems which may be caused by different external signal control files applying to different scenarios, particularly when UTC-Vissim is in use, as is explained in section B7.6.2. A scenario can be exported via File > Scenario Management > Project Structure, Scenarios tab, then selecting the relevant scenario and clicking the Export Selected Scenarios button, as shown in Figure 122. Further information on Scenario Management can be found in section B7.6.2.

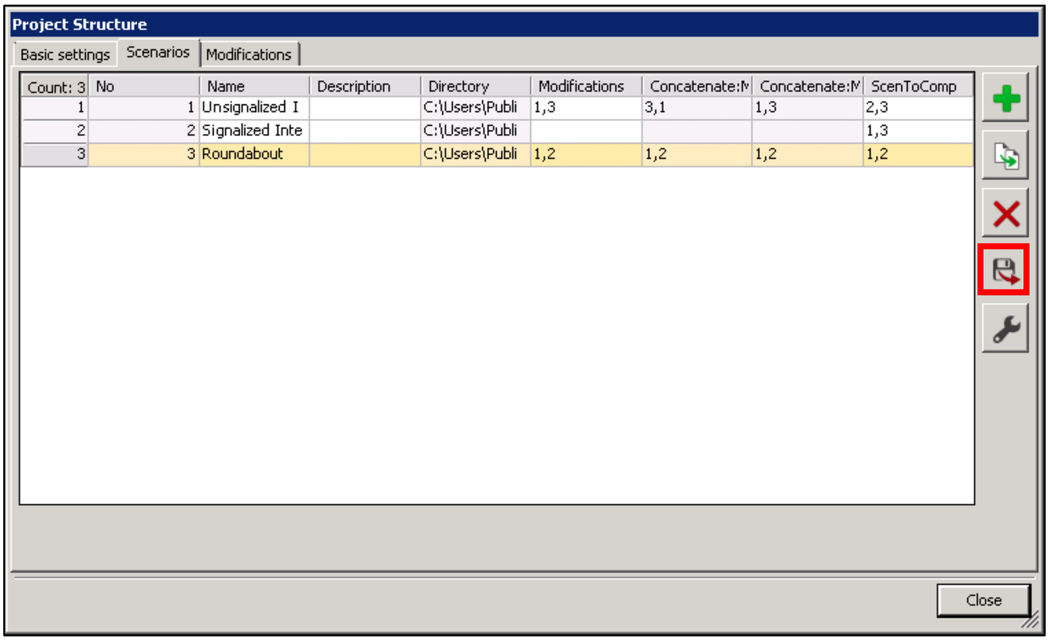


Figure 122: Project Structure window

7.4 Base Model Calibration

Once the input data has been collected, it can be used to build and calibrate the model. This section provides guidance on the structure of data in Vissim and how to approach the model build.

A calibrated Vissim model should have as a minimum:

- Correct fundamental parameters and units;
- The correct, appropriate link structure which replicates traffic behaviour on street;
- Reduced speed areas placed at appropriate places in the network, and used as a mechanism to calibrate saturation flows;
- Accurately modelled priority rules / conflict areas that result in correct reflection of existing on-street conditions in the model;
- Appropriate and correct traffic flow and routing using data from on-street surveys, in accordance with the scope and purpose of the model;
- Correct public transport data collected from reliable sources and modelled accurately. The level of detail of public transport modelling is dependent on the purpose of the model; and
- All the correct on-street signal control data with representative signal timings for the network during the period under consideration.

A key part of building a properly calibrated and validated Vissim model is observing the model while it is running. Accurate representation of vehicle behaviour is necessary for the model to fulfil its purpose. The animation features of Vissim can be used during calibration to identify irregularities in driver behaviour that may adversely affect model operation.

> The model should be observed during multiple seeds to gain a rounded picture of its performance and provide reassurance that all the network elements are functioning correctly.

7.4.1 Model Parameters

There are certain parameters which should be agreed and set at the start of model development. Changing these parameters after calibration will invalidate model results.

The Vissim Simulation Parameters dialogue for an example model is shown in **Figure 123**.

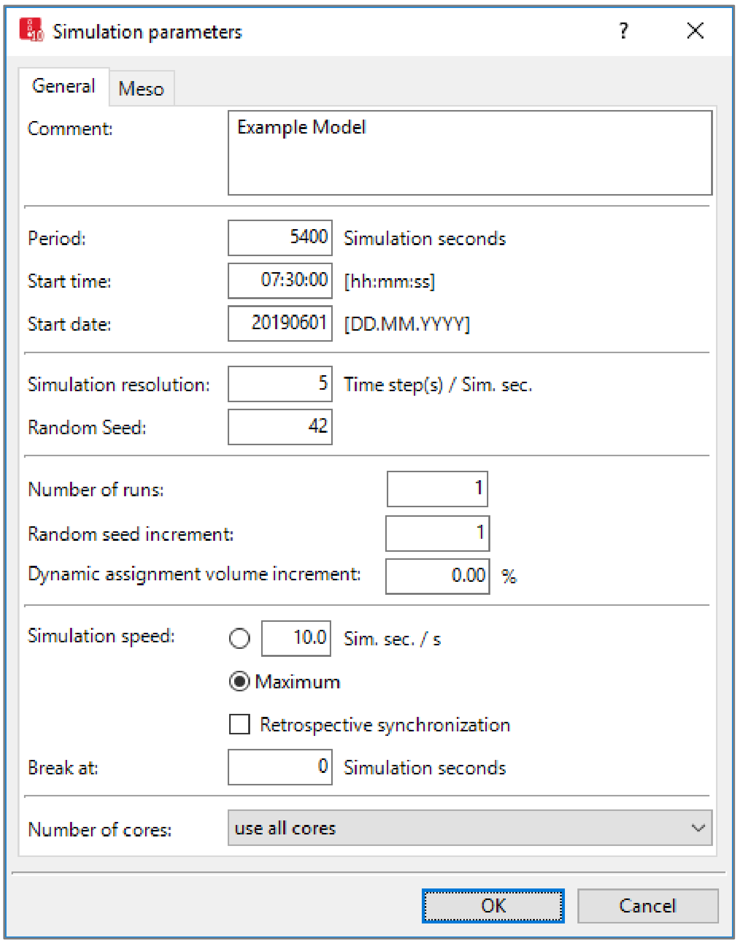


Figure 123: Simulation Parameters window

7.4.1.1 Start Time and Date

For most models the Start Time and Start Date parameters are useful to indicate the modelled time and date. For UTC-Vissim models, however, this data is essential as it tells the UTC cell what time the model is representing so UTC can load the correct signal timings using its internal timetable. Further information on UTC-Vissim can be found in section **B7.4.5.3**.

7.4.1.2 Simulation Resolution

Simulation Resolution is the number of time steps, or how often vehicles are moved and their positions recalculated, in a simulation second. This should be set to 5 steps per simulation second (resulting in 0.2 seconds per step), unless autonomous vehicles are being modelled, in which case consideration should be given to higher values as machines can react more quickly than humans. The Simulation Resolution must be chosen before calibration. The Simulation Resolution cannot be changed later without the need for model re-validation as driver behaviour, and therefore model results, will be changed.

This parameter should not be used to increase the speed of the simulation. Whilst reducing this value does result in faster simulation run times there is an impact on model accuracy. Instead, simulation run times can be reduced by removing the animation of vehicles, or by reducing the animation refresh interval.

7.4.1.3 Random Seed

The use of random seed values for model validation is explained fully in section **B7.5.1**, however it should be noted that during calibration, when observing the model running, it is good practice to change the seed regularly in order to avoid overfitting the model to one particular set of conditions. Changing the seed value may also reveal issues which are not present in every run.

7.4.1.4 Units

The following settings are recommended for units (Base Data > Network Settings… > Units), as shown in **Figure 124**:

- Distance: Set to m and km;
- Speed: Set to mph and m/s; and
- Acceleration: Set to m/s^2.

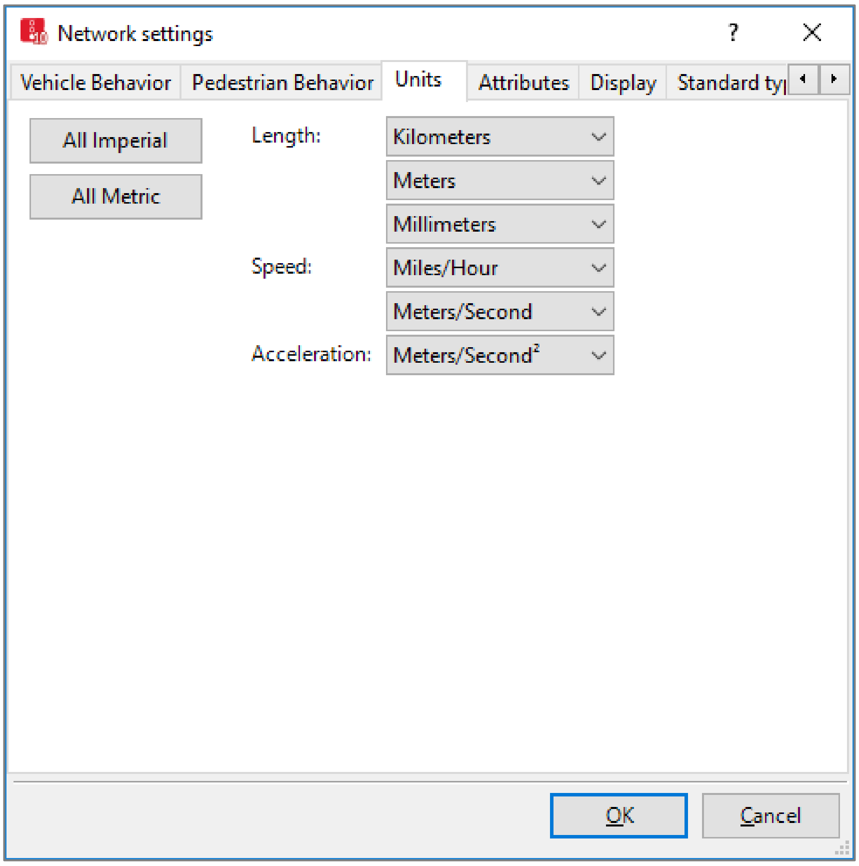


Figure 124: Network Settings window

7.4.1.5 Traffic Regulations

Traffic should be set to drive on the left (Base Data > Network Settings… > Vehicle Behavior) as this will impact any overtaking or multi-lane link behaviour.

7.4.2 Network

Any traffic model includes a representation of the road network with various rules to control the vehicles moving on it. This section contains information on how the Links and Connectors, and objects such as Reduced Speed Areas and Priority Rules, should be placed to generate realistic traffic movements.

7.4.2.1 Links and Connectors

The Vissim network structure is built using Links and Connectors. As a general rule, the number of Links and Connectors should be minimised and Connectors should be kept short. Where Connectors join to Links, overlapping should be avoided as this creates unrealistic capacity if vehicles can use both the Connector and continuing Link. Care should also be taken that Connectors starting at the end of Links start as close to the end of the Link as possible. This avoids the situation where network objects (such as Signal Heads, Priority Rules, Data Collection Points) are accidentally placed after the Connector leaves the Link. An object on a Link is ignored by a vehicle which has already left that Link across a Connector which started upstream of the object. It is advisable to check, after any network editing, that vehicles still travel over all the network objects that they need to.

All turning manoeuvres should occur across connectors, including all movements through the interior of junctions, as connectors allow lane discipline and queuing behaviour to be enforced using the lane change and emergency stop distance parameters.

When modelling lane gain (for example a flare) or loss, a single Connector should be used rather than multiple lane-to-lane Connectors, and the Link extended as necessary to allow diverging and merging at the correct location, as illustrated in **Figure 125**. If necessary, more Connectors can be added to enforce observed behaviour. However the starting point should be that shown in **Figure 125** to enable Vissim to control the vehicle interactions, particularly on merges. Advanced merging should be enabled in the driving behaviours in order for this to operate correctly. Where rigid queuing behaviour is observed on street, normally due to local knowledge and often observed at right-turns, Links can be split to model each lane separately to allow explicit routing along that Link. Alternatively, short Connectors can be placed within the lane (meaning they connect a Link with itself) allowing routing paths to be specified across those connectors. This is a last resort solution which rigidly enforces queuing behaviour. If using Dynamic Assignment (section **B7.4.4.2**), parallel Links or Connectors should be avoided because this leads to additional paths and unnecessary additional lane changing, making convergence more difficult.

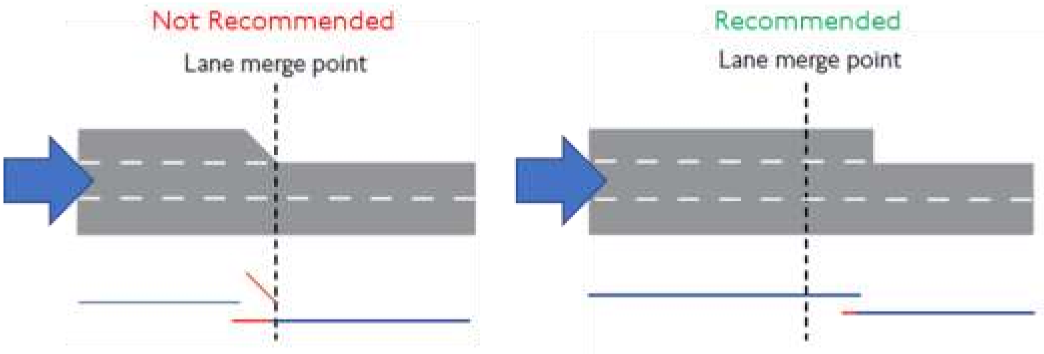


Figure 125: Lane merge layout options with the recommended layout on the right

The merge point can be influenced using the Lane Change distance option, available in the Connector attributes dialog. The Lane Change distance value is used to govern the movements of vehicles that follow a Route, or, in Dynamic Assignment, a Path. It is the distance before the Connector those vehicles whose Route or Path leads across this Connector start trying to change lanes to reach it.

On highways this value needs to be increased and the use of the Per Lane option is recommended for Links with more than two lanes. In later versions of Vissim, the Lane Change distance can also be specified as a distance distribution which makes it possible to spread out the start positions of lane changes over a longer area. It can also be defined by Vehicle Class so that, for example, vehicles with good route knowledge could change lanes earlier.

Bus lanes can be modelled as part of a multi-lane Link using lane closures. This is preferable to modelling bus lanes as a separate link, which forces taxis and powered two-wheelers to choose between using bus or general traffic lanes and doesn't allow buses to overtake stationary buses by using an adjacent general traffic lane. This approach also allows the same Link / Connector structure to be used for time periods where the bus lane is not in operation. If a bus lane is not modelled as a separate link then separate connectors are recommended for the general traffic and bus lanes, with connectors closed to specific vehicle classes to reduce Dynamic Assignment Paths. This allows vehicles to be routed into the correct lanes in advance to avoid vehicles entering bus lanes during congested periods.

7.4.2.2 Link Driving Behaviour

It is recommended that default Driving Behaviours should be used during the Base model build. Adding new Driving Behaviours at this early stage complicates the model development process. Further Driving Behaviours can be defined later, during the calibration stage, as necessary. The number of additional Driving Behaviours used should be kept to a minimum.

Additional behaviours should be discussed with MAE prior to being added to the model.

Driving Behaviours are assigned to Links via Link Behaviour Types. Link Behaviour Types consist of a default Driving Behaviour together a list of exceptions linking Vehicle Classes with associated Driving Behaviours.

For London urban networks the Wiedemann 74 model[97] should be used and the model build started using the default Urban (motorised) behaviour which is assigned to the default Urban (motorised) Link Behaviour Type. However, it is recommended that the following parameters be changed in the default Urban (motorised) behaviour:

- Links that allow lateral behaviour should increase the value of Min. Look Ahead Distance from 0 to 30m (at 30mph speed limits). This will ensure that vehicles see each other and obey traffic signals when vehicles can queue next to each other in the same lane;
- Amend the Average Standstill Distance to 1.2m for all link types; and
- All Driving Behaviours used on Links approaching signal-controlled intersections should adjust the Driving Behaviour parameter Behaviour at Red / Amber Signal to the value Stop (same as red). This prevents vehicle discharge during the red / amber period.

It is advised that all other Driving Behaviour parameters are left at their default values unless supported by site observation and measurement. Care should be taken when adjusting default Driving Behaviours, as a parameter change will affect all the Links with which that Behaviour is associated.

It may sometimes be necessary to apply modified Driving Behaviours where drivers behave more aggressively, such as at specific junctions or where more forceful merging is required. Similarly, if modelling cyclists, additional behaviour types may be needed at bus stops or on the approach to traffic signals (see Chapter **C2** on **Cyclist Modelling**). Should default values need to be modified, any changes should be minimal, confined to specific locations / link behaviour sets and documented for assessment through MAP.

In later versions of Vissim, a Reaction Time Distribution has been introduced. If the reaction time to the green light is considered important in a particular project then data should be collected to inform the

97 Wiedemann R, Simulation des Straßenverkehrsflusses, Schriftenreihe des IfV, 8, Institut für Verkehrswesen, Universität Karlsruhe, 1974 (in German)

distribution used, and should be included in the validation report. Otherwise it should be left blank, which assumes a reaction time of 0 seconds (**Figure 126**).

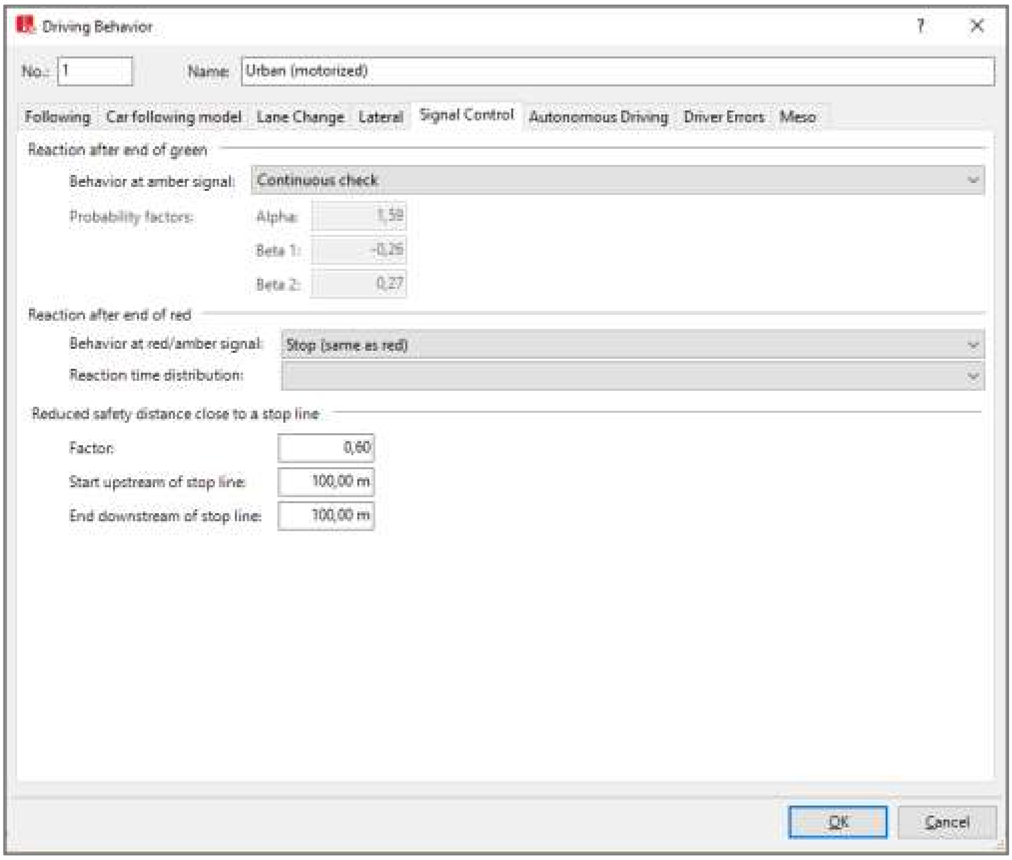


Figure 126: Driving Behaviour window

7.4.2.3 Reduced Speed Areas and Desired Speed Decisions

Reduced Speed Areas (RSAs) are required wherever on-street road geometry causes drivers to decelerate (for example at bends, corners, humps or poor visibility). For turning manoeuvres, it is advised that a set of speed distributions are created, each one applying to a certain range of turn radii, with smaller radii using slower speed distributions. Larger vehicles, including buses and HGVs, should have their own set of speed distributions. This aids calibration, as changing a specific speed distribution will affect all turning movements of a particular radius for that vehicle type.

Vehicles will automatically decelerate before entering an area and speed up again after leaving the reduced speed area or after travelling for a distance equal to the length of the RSA, whichever is longer. If the RSA is coded with a speed distribution faster than a particular vehicle's class-specific speed, the vehicle will not accelerate to this speed distribution before reaching the RSA. Once within the RSA, the vehicle is assigned the higher speed decision distribution. Once leaving, the original speed decision is reassigned to the vehicle.

It is strongly recommended that RSAs are not used for the creation of artificial queues. Queues form for many reasons, for example exit-blocking, parking and merging behaviour, and these should form in the model as on street. If these features are not included within the model boundary then RSAs could be used as a proxy to slow vehicles down (section **B7.4.2.6**). They can be used, however, to model the effect of physical speed restrictions, such as width restriction bollards or speed bumps.

Desired Speed Decisions (DSDs) are normally used where vehicles move between one mandatory speed limit and another, for instance where entering or leaving a motorway. They are also the best method for controlling speeds used in gyratory networks, with DSDs placed across all entries and exits. The vehicle will not change speed – either accelerating or decelerating – until after it has crossed the DSD. This will ensure circulatory speeds are appropriate and all vehicles return to normal speeds on exiting. RSAs should be used sparingly within gyratory links, as any vehicles crossing the start of the RSA will travel at the specified speed for a distance equal to the whole length of the RSA, whether they are still in the RSA or not. DSDs should also be used in preference to unduly long RSAs.

7.4.2.4 Saturation Flows

For models with closely spaced signal-controlled junctions, as is the case in much of London, it is important to get the rate of discharge correct across the major stoplines. There is no way to enter a value for saturation flow directly into Vissim. Instead, the resulting saturation flow is influenced by other input parameters. The two main factors that influence saturation flow are the speed of the vehicles and the distance between them. The distance between vehicles is dictated by Driving Behaviours (the parameters of Wiedemann 74 that influence saturation flow are the Average Standstill Distance, Additive Part of Safety Distance and Multiplicative Part of Safety Distance), however, the standard Driving Behaviour parameters in Vissim typically produce models which appear to run too freely at stoplines. For example, using standard Driving Behaviours and the 20mph Desired Speed Distribution[98] from the TfL Vissim Template

98 Transport Statistic Bulletin: Vehicle Speeds in Great Britain 2005, Department for Transport, 2006

(section B7.1.2) provides an indicative saturation flow of 1900 – 2100 in free flow traffic. Creating excess numbers of Driving Behaviours is not recommended (section B7.4.2.2), so the preferred approach is to use RSAs to calibrate the saturation flow.

It is recommended that RSAs are used at all stoplines to calibrate junction approach saturation flows. These RSAs should extend both upstream and slightly downstream of the signal stopline and be 10 - 15m in length, as shown in Figure 127.

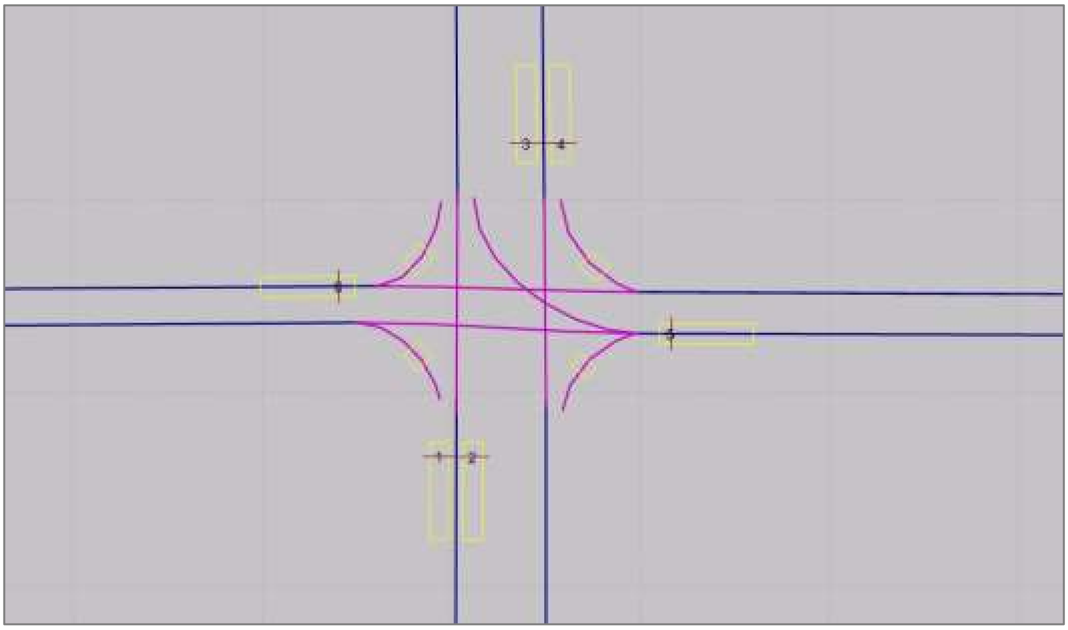


Figure 127: Placement of RSAs for saturation flow calibration

The stopline saturation flows should be calibrated by systematically changing the RSAs and comparing the model against observed saturation flows. M&V can provide a spreadsheet to compile Vissim output information and aid collation of saturation flow data.

7.4.2.5 Priority Rules and Conflict Areas

Priority Rules and Conflict Areas are the two options Vissim has available to control movements within signalised junctions, such as opposed right turns, and at all unsignalised junctions. A model can use either priority rules or conflict areas or a combination, however, given the congested nature, density and spatial constraints of London's road network, TfL recommends the use of Priority Rules in most situations. This is because they are individually placed within the road network, which gives them more flexibility to replicate observed conditions. Conflict Areas can be more beneficial for pedestrian crossings as they are quick to insert and the stopping locations are well defined.

There are a number of useful examples of both types in the Vissim User Manual[99].

7.4.2.5.1 Priority Rules

Priority Rules can have a significant impact on vehicle journey times, queues and congestion when used in networks containing give-way junctions and unsignalised roundabouts. Multiple Priority Rules may be necessary for a single movement through a junction, and Priority Rules can also be set up separately for individual Vehicle Classes. Priority Rule calibration is one of the most difficult aspects of model development as model outputs can be extremely sensitive to Priority Rule settings. It is therefore vital to have sufficient experience in use of Priority Rules to correctly replicate on-street behaviour.

The default parameters are usually suitable for simple priority movements at junctions, although their behaviour should still be checked. A typical consideration is to look at the location of Conflict Markers in relation to the ends of Connectors. If the Conflict Marker is downstream from the Connector then the Headway and Gap Time parameters will look along both possible routes, which may not be the intended behaviour (**Figure 128**).

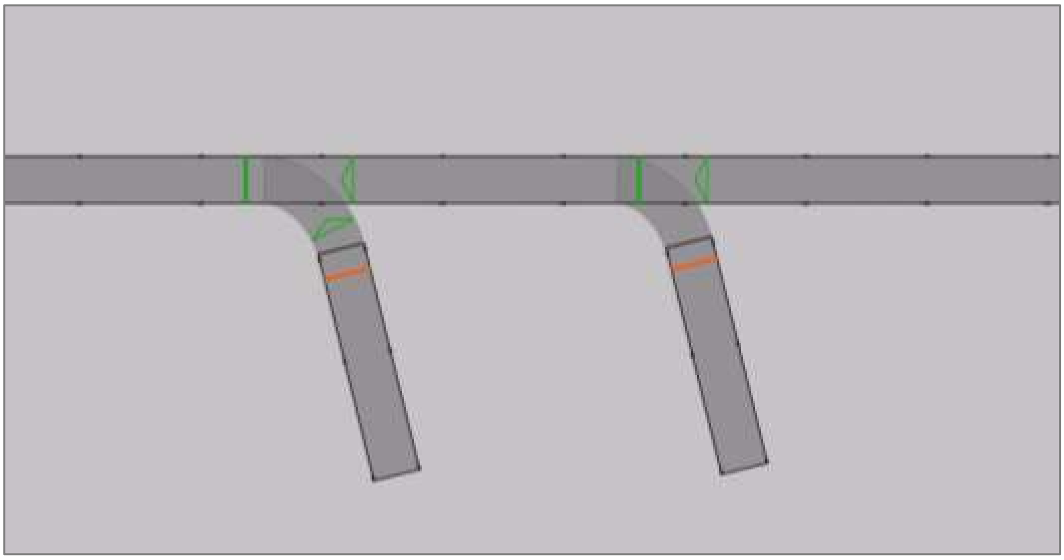


Figure 128: Priority Rule configurations showing the effect of different placements of the Conflict Marker

Some examples of more complex Priority Rule usage are shown below:

It may sometimes be necessary to place Conflict Markers with Gap Time and Headway parameters set separately, with the other parameter set to

99 PTV Vissim 10 User Manual, PTV AG, September 2018

zero, where on-street conditions cause the conflicts at different speeds to happen in different places. Typically, the Headway marker would be downstream of the Gap Time marker as this allows vehicles at the Stop Line marker to move off more quickly when the traffic they are waiting for is moving faster. If this technique is used, then the Headway marker should have its Max Speed limited so it only recognises slow-moving vehicles, as illustrated in **Figure 129**.

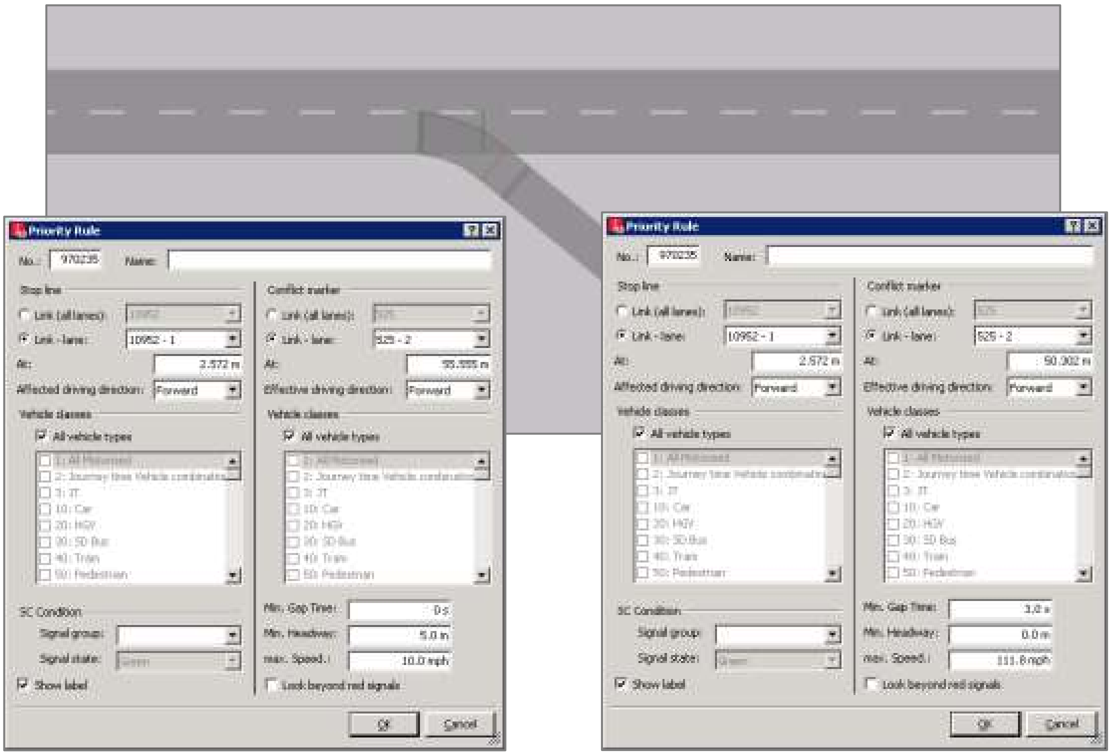


Figure 129: Configuration of Priority Rules to account for Headway and Gap Time separately

At a yellow box or keep clear (**Figure 130**), key points to remember are:

- The Conflict Marker should be placed so that there is space for one vehicle between it and the location of the conflict. Depending on behaviour, this may make it necessary to have a separate Priority Rule for longer vehicles;
- Check the Vehicle Classes for both the Stop Line and Conflict Marker – cyclists should not be included;
- The Min. Gap Time should be zero;
- The Min. Headway should cover the distance from the Conflict Marker to the Stop Line; and
- The Max. Speed should be low enough that free-flowing traffic ignores the Priority Rule, this is dependent on the location, but 8-10mph is a good starting point.

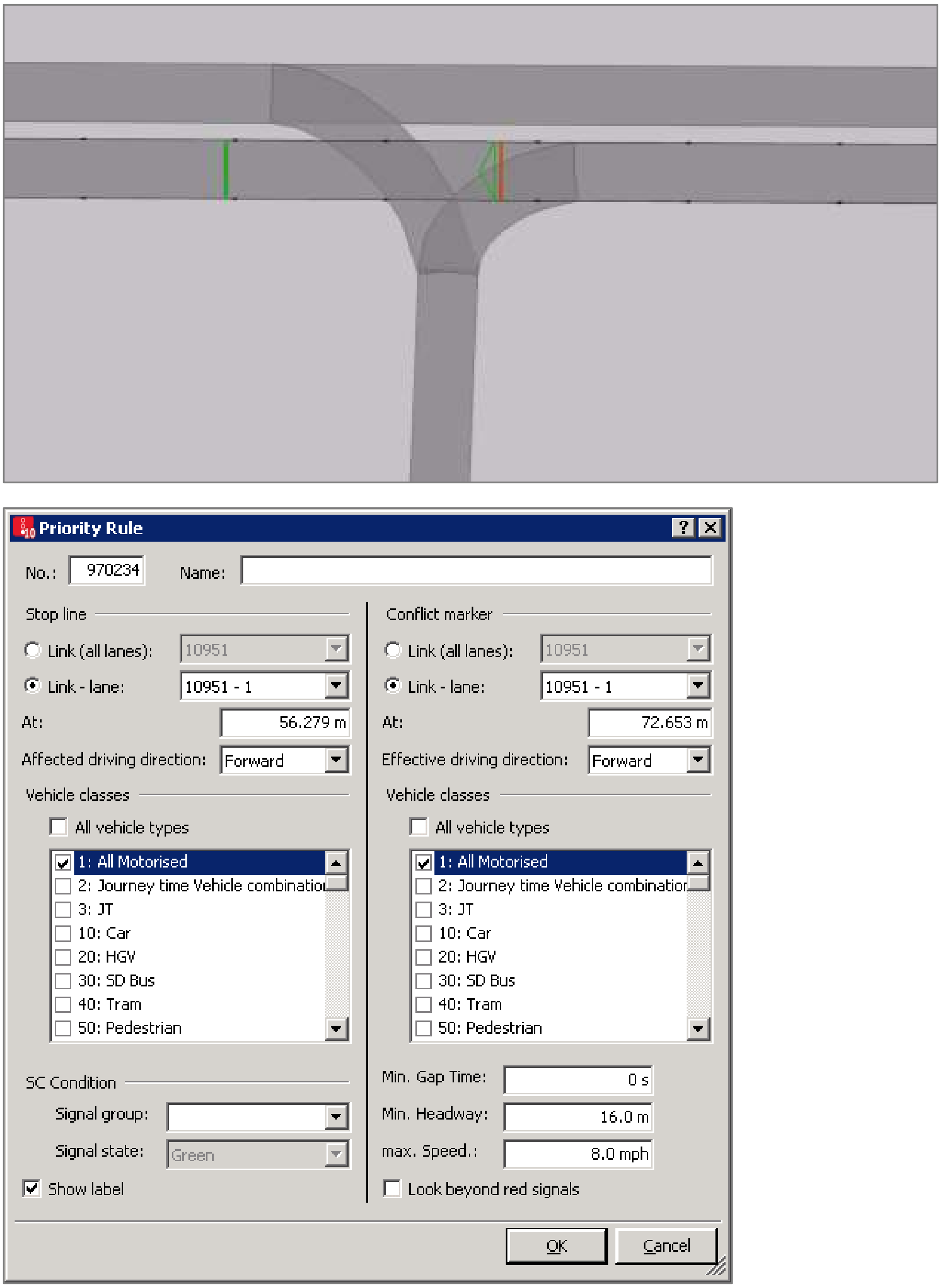


Figure 130: Example of a 'yellow box' Priority Rule setup

It is necessary to observe the behaviour of vehicles under a variety of different traffic conditions to verify that the Priority Rules perform as expected and do not produce unrealistic behaviour in any scenario.

7.4.2.5.2 Conflict Areas

Conflict Areas are an alternative method for controlling vehicle interactions at junctions. The list below contains a few basic features, but the key point is that parameters should be set up so that vehicles behave as they do on street.

- Passive Conflict Areas are automatically set up by Vissim whenever Links or Connectors overlap. When activated, the main movement with right of way to enter the area (green) can be specified along with the minor yielding movement (red), or alternatively both movements can be given equal priority (both red);
- Conflict Areas prevent two vehicles being present in the defined area at the same time and use a number of different parameters to define how vehicles act in order to avoid this;
- Vehicles with right of way will brake or stop if there is a vehicle from the minor yielding movement blocking the area, and will avoid entering the Conflict Area if their exit is not clear based on the Avoid Blocking the Minor Flow percentage;
- Vehicles in the yielding stream will use gap parameters to decide when to cross / join the flow with right of way. They will also avoid entering the Conflict Area if their exit is not clear, unless the Avoid Blocking the Major Flow parameter is unchecked;
- For undetermined (both red) Conflict Areas, neither stream has priority and vehicles enter in the order in which they arrive; and
- Visibility parameters govern the point at which vehicles on each link can see the other.

7.4.2.6 Externally Generated Congestion

As indicated in section **B7.2.1**, there are situations where it may not be possible to include all junctions which generate congestion in the area of interest within the model boundaries. It is nevertheless important that this queuing is present in the model to properly represent the existing conditions. There are a few methods which can be used as a proxy to generate queuing; which one is the most appropriate depends on the cause of the congestion and the behaviour of the queuing traffic. This should be observed on site visits. The key aim is to match the observed capacity.

- RSAs: If the queue moves slowly and consistently then RSAs can be used. The speed distribution(s) used can be calibrated to generate the desired behaviour and queue length. RSAs can also be applied only for a specific time period if the queuing changes throughout the peak. If necessary, more than one RSA could be used to cover different time periods, although care should be taken not to 'overfit' the data by using too many;

- Stop Signs: For queues caused by give-way junctions, Stop Signs may be effective. The Time Distribution can be calibrated to give the desired behaviour and capacity; and
- Signal Heads: Where queuing is caused by a signalised junction which is not being modelled, the simplest proxy is to add the single signal head (with a signal controller) which is causing the queue and give it the same timings as are found on street. If the behaviour is more complex, for example due to the interaction between multiple downstream junctions, then it is possible to add another signal head on a different signal controller running different timings. This will lead to more randomised queuing behaviour, and the capacity can be calibrated by adjusting the timings of this signal head.

7.4.3 Traffic Data

This section contains information on how traffic is modelled, including defining the characteristics of individual vehicles and specifying the number and composition of vehicles entering the model. There is also some information on modelling public transport, cycles and pedestrians.

7.4.3.1 Vehicle Models, Types, Categories and Classes

Vehicles can be categorised and grouped in various ways which are combined when vehicles are generated and acted upon.

- **Vehicle Types:** Group vehicles with the same technical driving characteristics;
- **Categories:** Define a vehicle's basic behaviour in traffic. Can be one of Car, HGV, Bus, Tram, Pedestrian, Bike;
- **Models:** Determine a vehicle's size and appearance. These are applied as a distribution so vehicles with the same driving characteristics can have more than one appearance;
- **Functions and Distributions:** Describe how the vehicle accelerates and decelerates, as well as the weight, power and occupancy. Further information can be found in section **B7.4.3.2**;

- **Vehicle Classes:** These group Vehicle Types which share particular traits, for example, a Vehicle Class might contain all motorised vehicles or vehicles allowed in bus lanes. Network objects such as Routing Decisions, Detectors and Reduced Speed Areas operate on Vehicle Classes and they are also used to collect aggregated output data. A Vehicle Type can belong to more than one Vehicle Class; and
- **Vehicle Compositions:** These also group Vehicle Types but are used solely by Vehicle Inputs. They specify the proportion of each Vehicle Type generated by the Input. See section B7.4.3.3 for further details.

Figure 131 below gives an example Vehicle Class to demonstrate how they fit together. Note that this is a simplified example and not a recommendation as to how this class should look.

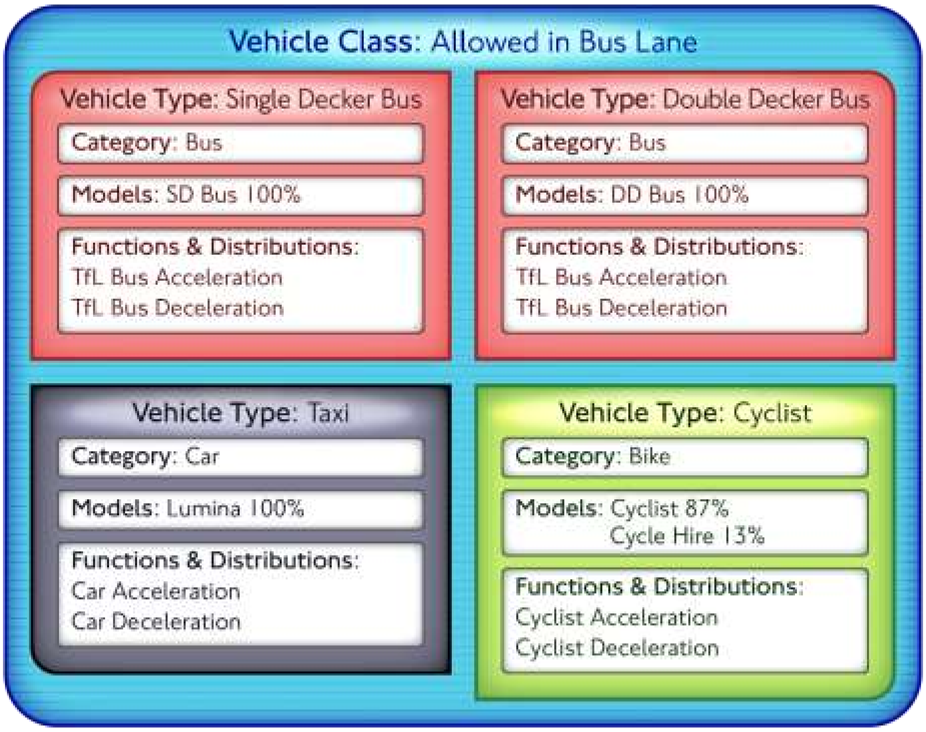


Figure 131: Example Vehicle Class

The default Vehicle Models and Types provided by Vissim are adequate for most networks. In addition to those defaults the following are often required for TfL models:

- Taxi: this can be a copy of the default 'Car' type and is often needed as taxi behaviour and routing can be significantly different from other road users;
- Double-Decker bus; and

- MGV: this type is often made up of Vehicle Models that cover a range of vehicle lengths / characteristics.

Other Vehicle Types can be created if supported by observation, survey results or where required by a scheme. For example, a scheme may be concerned with speed enforcement measures and so an additional Type could be included to model the behaviour of speeding vehicles. When creating Vehicle Types, it is essential that the correct Category is assigned to the Type, as Categories define certain rules of Behaviour. It is also important to check that the correct Functions and Distributions are assigned to the Vehicle Type; this is a common error and can seriously affect model calibration.

7.4.3.2 Functions and Distributions

Functions define the acceleration and deceleration of vehicles in the network, and without site evidence default settings should not be changed. TfL has conducted surveys of acceleration profiles for some vehicle types, notably articulated buses (no longer in use) and HGVs. These profiles can be obtained on request and provided via a template file supplied by TfL (section **B7.1.2**).

TfL has also developed a range of other speed distributions for cars, buses, cyclists and motorcycles, for different UK road speed limits and these are also included in the TfL Vissim Template (section **B7.1.2**). These distributions are based on data published by the Department for Transport[100].

7.4.3.3 Compositions and Demand

It is recommended that a Vehicle Composition is created for each Vehicle Type, so effectively each input Link has a separate Vehicle Input for each Vehicle Type. This means values can be transferred directly from survey data without the need to create any other Vehicle Compositions.

This method involves a significant amount of data entry if it is done manually so, alternatively, it is also acceptable to create Vehicle Compositions for input Links. If this method is used, it is not always necessary to create a vehicle composition for each input link. Survey data can be checked, and a practical decision made about the number of compositions to be used. A single composition should suffice where input links vary in composition by 10% or less. However, Links loading significantly different compositions should have specific Vehicle

100 Transport Statistic Bulletin: Vehicle Speeds in Great Britain 2005, Department for Transport, 2006

Compositions, for example Links that load high proportions of taxis, HGVs or two-wheelers.

Traffic surveys usually come in 15-minute intervals, so this is the time period most commonly used for Vehicle Inputs. It is large enough to contain meaningful numbers of vehicles but small enough to show variations in flow across a peak hour. If a different length of time period is to be used, consideration should be given to the behaviour of the network, such as specific times of flow increases and decreases caused by events such as school runs and industrial site shift changes.

Vehicle inputs should specify 'Exact Volume' rather than 'Stochastic Volume' unless otherwise agreed. It is important to be aware that traffic volumes are defined for each time interval in vehicles per hour, even if the specified time period is different from one hour.

7.4.3.4 Public Transport

Public Transport Lines should be modelled as timetabled, so either TfL website data[101] or iBus data (section **B7.2.2.5**) can be used. If iBus data is used, care should be taken to use the scheduled rather than actual data. This is so that any impact is part of the model performance, rather than built in.

As shown in **Figure 132**, public transport departure times can be entered with a start offset (Begin), a frequency (Rate), and an end time (End). In this way, start times can be adjusted if the frequency changes across the modelled period. At the beginning of the model, the start offset should be used to avoid buses from different routes all entering the model at the same time.

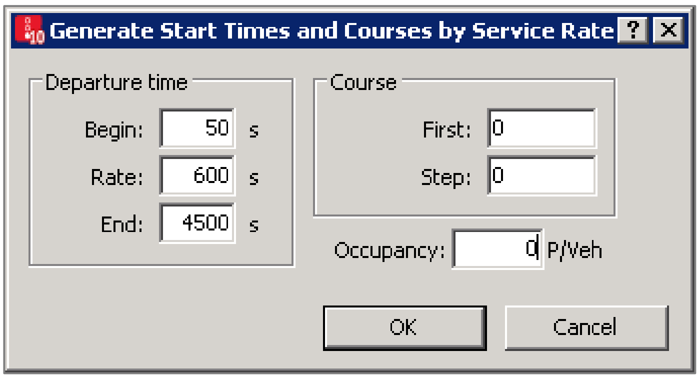


Figure 132: Public Transport Line departure times generator window

It is preferable that each Public Transport Line is given its own Vehicle

101 https://tfl.gov.uk/travel-information/timetables/

Type. This is to enable journey time reporting for each route independently.

7.4.3.5 Cyclists and Motorcycles

Cyclists should be included in any modelling work unless there is good justification for omitting them. Particularly in central London, cyclist outputs are often a key requirement. There are further details on modelling cyclists in Chapter **C2** on **Cyclist Modelling**. The TfL Vissim Template file (section **B7.1.2**) includes appropriate parameters to simulate cyclists in Vissim through altered Driving Behaviour and Link Behaviour types. As with all forms of modelling, the key point is to ensure the model replicates the situation on street as closely as possible, so adjusting parameters is acceptable if it can be justified.

For traffic engineering purposes, modelling two-wheelers in Vissim is more challenging than modelling general traffic. This is partly because this form of modelling is relatively new, and partly because their behaviour is less predictable. Some of the difficulties encountered in modelling two-wheelers in Vissim are:

- Measurement and calibration of saturation flow;
- Additional calibration effort for specific behaviour (lateral behaviour parameters);
- The lack of a consistent PCU value that is independent of flow; and
- Sensitivity of capacity to network characteristics (lane width in particular).

Modelling motorcycles has similar difficulties to modelling cyclists. In general, motorcycles do not take up much road space which could be used by other vehicles as they weave into gaps in queues, and they do not need special provision in terms of cycle lanes or separate phasing at junctions.

7.4.3.6 Pedestrians

Vissim models can include pedestrians modelled as small, slow moving vehicles, usually using the driving behaviour ‘Footpath’ with the ‘No Interaction’ following model. Generally, pedestrians are included in these models to activate demand-dependent pedestrian stages at signalised junctions or to replicate traffic delay occurring at un-controlled or zebra crossings.

In the case of un-controlled or zebra crossings the number of pedestrians using the crossing and controlling priority rules (or conflict areas) requires fine-tuning, supported by site observation, in order to achieve the correct result. As with other network bottlenecks, sample counts of traffic passing the crossing will assist model calibration. Note that exact pedestrian numbers are not necessarily useful in this case, as the entities do not behave like real pedestrians and the only aim is to replicate the impact on other traffic.

Alternatively, Vissim models developed in version 5.1 or later are able to use a specific model (PTV Viswalk) for pedestrian behaviour. This approach, called the 'social force model'[102], can be used in lieu of the 'small, slow moving vehicles' approach, where pedestrian behaviour is of interest. If the pedestrians are only being used to demand pedestrian stages at junctions then the social force model is not necessary.

Many schemes are interested in the interaction of vehicles with pedestrians and the effect they may have on each other. If modelling shared spaces or areas where pedestrians move between vehicles, the use of Viswalk pedestrians is recommended over the 'no interaction' pedestrian. Standard Vissim licences are restricted to 30 Viswalk pedestrians, which is usually insufficient for this type of modelling, so a licence with a larger number will need to be purchased. If full pedestrian modelling is being carried out in Viswalk then Chapter **C3** on **Pedestrian Modelling** should be consulted.

7.4.4 Routing

Routing in Vissim is either static, involving Routing Decisions which dictate the proportions of traffic heading to each destination via specified Routes, or dynamic, which is based on iterated simulations where traffic is assigned to paths based on results of preceding runs. TfL predominantly uses static routing, often with the route assignment carried out in tactical modelling and the resulting routes transferred to the Vissim model. The process of transferring routes between the modelling levels is undertaken during the Three Stage Modelling Process (section **B2.1.4**)

7.4.4.1 Static Routing

There are various methods of obtaining static routing information for a Vissim model. Which one is used is dependent on the data available and the complexity and size of the area to be modelled. The ideal scenario would be to have global OD information for each vehicle to be modelled and simply input this into the model. With the advent of GPS vehicle tracking this is closer to becoming a reality, however, at the time of

102 D. Helbing and P. Molnár (1995). Social force model for pedestrian dynamics. In Physical Review E 51(5), p. 4282-4286

publishing, only smaller networks that can be covered by cameras on all entries and exits have this complete dataset.

If tactical modelling is available for the modelled area, and particularly if it will be used to model the proposal, then routing information can be transferred to the Vissim model in the form of global OD routes. Since the Vissim model has to be validated against junction turning counts (section **B7.5.2.1**), it is important that the tactical model is updated to include these, and that the networks of the two models match. It is also necessary to verify that all the generated routes are realistic. Depending on the tactical model used, it may be possible to automate the route transference, but in general there is a certain amount of manual matching that must take place, even when tools are used to speed up the process.

Although the use of global OD routing is preferred, if global data or tactical modelling is not available, then junction turning counts can be converted into local Routes for each individual junction. Where this is done, close attention should be paid to any unrealistic weaving that may occur between the end of one Route and the start of another. It is also necessary to ensure that Routing Decision start points are placed sufficiently upstream of any Connectors to allow vehicles to get into the appropriate lanes without causing unrealistic congestion or blocking. In later versions of Vissim, the option Vehicle Routing Decisions Look Ahead is available in the Driving Behaviour parameters. If set, this enables vehicles to anticipate an upcoming Routing Decision on the destination Link of their current Route. The Route to be used from the upcoming Routing Decision is selected when the vehicle passes the previous Routing Decision, and that Route is used in lane choice decision making. A Routing Decision must have the flag Combine Static Routing Decisions set, in order to activate this behaviour. Once volumes have been finalised, it is possible to combine these routes together, however, care should be taken during this process as it may generate unrealistic routes, particularly at gyratories or where there is route choice. Even when local junction routing is used, it is desirable to have flows between junctions balanced as far as possible. Section **B2.3.4.1** highlights recommended methods for reconciling surveyed traffic flow differences within a modelled network.

Whichever method is chosen, Routes must be audited to ensure the correct Link-Connector sequence has been defined from start to finish. It is not acceptable to rely on the default path defined by Vissim. It should be noted that it is also possible to change the Connectors in a Route by accident when editing either spline points on the Route or Links and Connectors along the Route, so repeated checking during calibration is recommended. This also applies to Public Transport Lines.

Vehicle flows within Routing Decisions are relative. They can be specified as either proportions (percentages) or as total flow and this choice should be carried over to any future scenario models.

All Vehicle Inputs require at least one Routing Decision. In the absence of this, Vissim does not produce warnings, but routes traffic across the first Connector encountered (provided the Desired Direction attribute of the Connector is set to All). This is also the case if there is no Routing Decision for a particular Vehicle Type, so care must be taken that all Vehicle Types are covered, particularly when the Vehicle Classes specified in the Routing Decisions are not the same as the Vehicle Compositions used for the Inputs. The choice of how to group Vehicle Classes into Routing Decisions will depend on how the routing information is obtained, however, it is preferable to choose one system for the whole model rather than, for example, having most of the Routing Decisions split into Lights, Heavies and Taxis, with a few applying to All Vehicle Types. It is simpler for auditing purposes, as well as future users of the model, to be consistent.

7.4.4.2 Dynamic Assignment

Dynamic Assignment (DA) is a method of traffic assignment that assigns traffic to competing alternative routes, where they exist, based on the difference between the modelled costs on those routes.

In many cases, Vissim models developed for use in London do not include any significant alternative routes and using DA is therefore typically not necessary. Where route choice does exist within a model, it is often more appropriate to use available assignment models to inform routing.

It should be carefully considered whether the benefits of calibrating a model using DA are outweighed by the additional time required to calibrate the model. The decision to use DA should be agreed at MAP Stage I in order that all parties understand the additional time required to undertake the modelling.

In cases where dynamic modelling is justified, a combined static-dynamic assignment is preferred, with the proportion of DA based on consideration of routes which will not reassign under any circumstances. Where this is the case, OD demand matrices must be generated for the DA traffic. It is recommended to produce matrices at a minimum of 900-second intervals.

There are some special considerations and extra steps for the building of Vissim networks being developed with DA:

- Dynamic assignment nodes should be placed in the network at every junction or merge point;

- Link-connector structure should be as simple as possible in order to reduce the number of parallel routes through the network; and
- Route / edge closures may be required to remove unrealistic or duplicate routes.

The Vissim manual explains in more detail how to use DA within Vissim.

7.4.4.2.1 Convergence

The guidance provided in TAG[103] (section **A3.6.1**) on Assignment does not specifically cover microsimulation models and states that for microsimulation-based route choice:

> "The concepts of equilibrium and convergence are difficult under such conditions and stability becomes a more crucial concern for micro-simulation based assignments, particularly for models of large areas."

TAG does not state any specific convergence requirements for DA models, however convergence should be monitored.

Convergence and model stability will be deemed to have been satisfactorily achieved when the following criteria have been met over the modelled peak hour:

- 95% of all path traffic volumes change by less than 5% for at least four consecutive iterations; and
- 95% of travel times on all paths change by less than 20% for at least four consecutive iterations.

Model convergence criteria will require analysis of path volumes and travel times after each simulation run. If convergence has been achieved for four iterations but is then lost in subsequent iterations, a note should be made of the number of iterations when convergence was achieved. Assignment and validation should then be performed with the use of the cost and path files (*.bew, *.weg) from the last of the four converged iterations.

Additional monitoring of the model through convergence using Vehicle Network Performance Indicators will give the modeller confidence of model stability. Two methodologies and additional troubleshooting that may help in achieving convergence using DA in Vissim are outlined in **Appendix IV**.

The methods and specific parameters used to converge a model should be reproducible and all steps must be documented.

103 TAG Unit M3.1, Appendix B and Appendix C

7.4.5 Signal Control

Vissim has a few different methods of controlling signals. The two main methods used by TfL, and discussed in this section, are VAP and External. The external method in this case is UTC-Vissim, which refers to connecting a Vissm model to a simulated version of TfL's Urban Traffic Control system. Which method is used for a particular modelling project depends on the complexity of the project and signal control strategies, the required outcomes and whether it is possible to gain access to the UTC-Vissim Interface, which contains proprietary software.

7.4.5.1 VAP Controller Logic

For simple projects, or if UTC-Vissim is not available, VAP is the preferred method for implementing signal control logic and timings in Vissim, even for fixed time signal plans (section **B2.3.8**). VAP is flexible enough to model any UTC plan using phases, stages and intergreens as found in signal controllers on street. It can also run many of the features found in VA or MOVA junctions, although in this case the routines can get quite complex and simplifications may need to be agreed. Where it is necessary to simulate VA junctions, NP should be consulted and Controller Specification documentation should be thoroughly understood.

7.4.5.2 Demand-Dependent Stages in VAP

VAP is capable of accurately modelling demand dependency using either detector activations or directly input frequencies. Where a stage is called by vehicles on street then the VAP routine must use vehicle detection, and the frequency is determined by the number of vehicles making the movement. For pedestrian-only stages, however, there are two different options, both of which make use of demand dependency stage frequencies recorded from UTC (section **B2.3.8.5**):

- Use pedestrian Inputs and place Detectors in the model in a similar method to traffic stages. Even where pedestrian counts have been surveyed it may be necessary to adjust the flows further to achieve the desired frequency. The VAP function 'TRACE' can be used to generate calibration data which specifies the number of stage appearances relative to the number of demand-dependent opportunities; and
- Enter the UTC percentage directly into the VAP routine to automatically achieve the desired frequency.

7.4.5.3 UTC-Vissim

The UTC-Vissim Interface is a fully functional copy of the UTC system which controls London's traffic signals. It can be used to model many dynamic UTC traffic control scenarios including SCOOT, SASS, Gating and SVD Bus Priority without the need to use average signal timings. Each stream on street has a Signal Controller in the model, and all Detectors on street (SCOOT, bus, and demand) also have a modelled equivalent. These model objects are linked to their UTC counterparts via object naming conventions, so it is critical when setting up a UTC-Vissim model that all the elements are named correctly. This similarly applies to the model filename (*.inpx), which should not be changed once there are Signal Controllers in the model as links to the UTC controller configuration files will otherwise be lost. It is also important to ensure that all Detectors are activated by the correct Vehicle Classes so that, for example, regular vehicles do not activate the Detectors for bus priority.

Demand-dependent pedestrian stage frequencies can be directly entered into the UTC-Vissim Interface as a percentage based on observed appearance recorded from the UTC system. This facility should only be used for stages demanded by pedestrians where pedestrians are not being modelled. Any stages called by vehicle detection should be modelled using Detectors with the appropriate naming convention so that these stages are only called when relevant vehicles are present.

As indicated in **B7.2.2.2**, a UTC-Vissim model requires one or more UTC cells that have been copied from the live system at a particular point in time. This must then be checked to ensure that the signal control data matches that which was running on the day the model represents. NPD should be consulted to ensure the signal timings used are appropriate as they have access to historical UTC data.

NP must be consulted when a UTC-Vissim model is required. This is particularly the case since multiruns need special treatment to check that cells start correctly before each model run and are reset appropriately between model runs to ensure repeatability. Further technical advice is available from NP on request. It should also be noted that at the time of publishing TfL is in the process of upgrading its UTC system, so a new microsimulation interface is being developed (see **B2.3.8.2** for further details).

7.5 Base Model Validation

Base models must demonstrate that they replicate observed conditions to a sufficiently high level of accuracy, as described in **B2.4.1** and **B2.4.2**. This section describes validation requirements with respect to Vissim and section **B7.7** indicates how outputs can be obtained from Vissim to prove they are met.

7.5.1 Randomness

Traffic conditions vary day-to-day as a result of random driver behaviours such as speed selection, lane changing, route choice, bus and parked vehicle dwell times. The stochastic microsimulation traffic model in Vissim attempts to replicate this day-to-day random variability by altering individual driver decisions based on random numbers. The set of random numbers is generated from an initial 'seed' value specified at the start of a simulation run. A single set of random numbers, generated by a single seed value, therefore represents one potential outcome, or one particular day of traffic operation. The actual value of the seed has no significance; however, the seeds from different runs must be different from each other to produce different outcomes. Basing results on a single seed value has the potential to randomly bias the overall result.

An accepted method of reducing potential bias is to run several simulations using a range of initial seeds and to present mean average results. For this reason, both calibration and validation should be conducted using a minimum of 20 seed values, as stated in MAP.

Ideally any on-site surveys would be carried out over multiple days to mirror the number of seeds, however this is not usually possible. Where surveys are carried out on a single day, as is the case with most manual classified counts, observations should be conducted to ensure the traffic conditions are considered typical and unaffected by significant disruption. These observations can be backed up by analysis of background data, including SCOOT data and incident records. This checking reduces (or highlights) potential bias in the observed data and provides reassurance that it can be used to validate average microsimulation results (or an indication that the data collection exercise should be repeated on a more typical day).

It is important to note that the more saturated a network becomes, the more variable the results. This occurs because small adjustments in model behaviour (such as lane changes) have an amplified impact within a congested network. It is usual that more simulation runs be used for saturated models. It is possible to calculate the number of simulations necessary to produce a reliable result if the required confidence level is known for a traffic model, but as a guide 20 simulation runs are normally sufficient.

The use of seed values should be described in technical notes. A sample range of results, using different seed values, should be provided for the validated Base model to demonstrate variability between simulation runs.

All seed values used should be included in the report. 'Cherry picking' seed values biased toward validation targets is not acceptable, so the seed values chosen should form a continuous range with a fixed increment. This also ensures that results can be easily reproduced. It is expected that the same seed values are carried over to Proposed modelling runs.

The initial random seed, seed increment and number of runs are set in the Simulation Parameters window (section **B7.4.1.3**).

7.5.2 Validated Model Requirements

Validated Base models are submitted during VMAP Stage 3, and all validation threshold figures quoted are from the latest version of MAP (section **B2.1.5**), at the time of publishing[104]. It is required that the following outputs are reported to indicate that a model has been calibrated and is validated.

7.5.2.1 Traffic Flows

The GEH parameter (**Appendix II**) should be used to demonstrate that traffic flows within the model (on internal mid-links, stoplines and individual turning movements) match traffic counts to an acceptable level of accuracy.

When comparing modelled flow to observed flow volumes, the aim is for GEH values of less than five. However, GEH values of less than three are strongly recommended for all important / critical links within the model area. Results should be reported to include data showing all observed and modelled flows together with calculated GEH values. Modelled flows should be averaged over multiple seeds, as described in section **B7.5.1**.

All entry links into the network are required to show modelled flows within 5% of observed flows. This requirement should be achieved, since

104 SQA-0685, Model Auditing Process (MAP) – Traffic Schemes in London Urban Networks, Engineer Guide for Design Engineer (DE), Checking Engineer (CE) and Model Auditing Engineer (MAE), Version 3.5, Transport for London, March 2017

vehicle flows on external links are direct input values, and ensures that all assigned vehicle flows are being successfully loaded into the network during the peak modelled period.

7.5.2.2 Saturation Flows

Saturation flows are used to compare the discharge behaviour of the model at junction stoplines with on-street observation. All observed and modelled saturation flows should be tabulated and the percentage error between the two values reported. Modelled saturation flows values should be within 10% of observed values, or values used in any corresponding validated and approved LinSig or TRANSYT modelling.

During the process of calibration, time headways should be studied. This can be done using Discharge Record evaluation files in later versions of Vissim (section **B7.7.2.2**), or special evaluation files in earlier versions. The discharge record evaluation files should be filtered to remove measurements that do not correspond to saturated conditions (for example where there are very large headways). M&V can supply a spreadsheet-based tool which aids the filtering and processing of vehicle headway data. Alternatively, models can be viewed and measured as on street.

> Wherever saturation flows have been measured on street during the relevant time period, providing the model is a fair representation of on-street conditions, it should be possible to measure saturation flows from the Vissim model. An inability to collect saturation flow data across a stopline in Vissim where it was successfully collected on street should be an indication that the model is not performing as desired.

It is possible, however, that saturation flows were measured on street at different times of the day in more appropriate conditions, or that RR67, possibly with a local factor (section **B2.3.9.1**), has been used to calculate a saturation flow.

There are times when a saturation flow cannot be measured within Vissim that is representative of on-street conditions, for example, where a stopline has low flows crossing it, or where downstream congestion causes queuing which prevents free-flowing movement over the stopline. If this is the case it is acceptable to make a copy of the model and modify it appropriately to generate the necessary traffic conditions. This may be by adding vehicles or removing causes of congestion. This model should be submitted for auditing along with the main model, and appropriate reference made in the model report.

7.5.2.3 Demand Dependency

All demand-dependent stages within the network should show a frequency that is within 10% of that observed on street. The average count for each peak modelled should be reported and supplied along with any output files generated for each simulation run.

Demand dependency can be observed in the model or using the Signal Times Table (section **B7.7.2.5**), analysed from the Signal change model output (section **B7.7.1.1**), using TRACE files (*.trc) for VAP models, or checked in the UTC-Vissim Interface using a similar method to the live UTC system.

In UTC-Vissim models, a demand frequency for pedestrian stages can be entered into the settings so validation of these stages is not necessary. As stated in section **B7.4.5.3**, stages which are demanded by vehicles should use Detectors rather than being entered in settings, so it is a good idea to check these stage frequencies as if they are incorrect it may indicate a problem elsewhere in the model.

7.5.2.4 Journey Times

Modelled journey times should be averaged over multiple seeds, as described in section **B7.5.1**, and be within 15% of surveyed on-street journey times. Validating over longer journey time distances is favoured over shorter ones, although long journey times can be broken into smaller segments to identify problem areas. Journey time output can be analysed as the cumulative journey time obtained by all vehicles that follow smaller journey time segments, as well as complete journey times for vehicles that follow the entire journey time surveyed route. **Figure 133** shows an example of using the cumulative journey times of smaller segments (1 to 8) to indicate the location of a validation problem (segment number 4) with the whole route journey time, which means more modelling focus can be applied to this area.

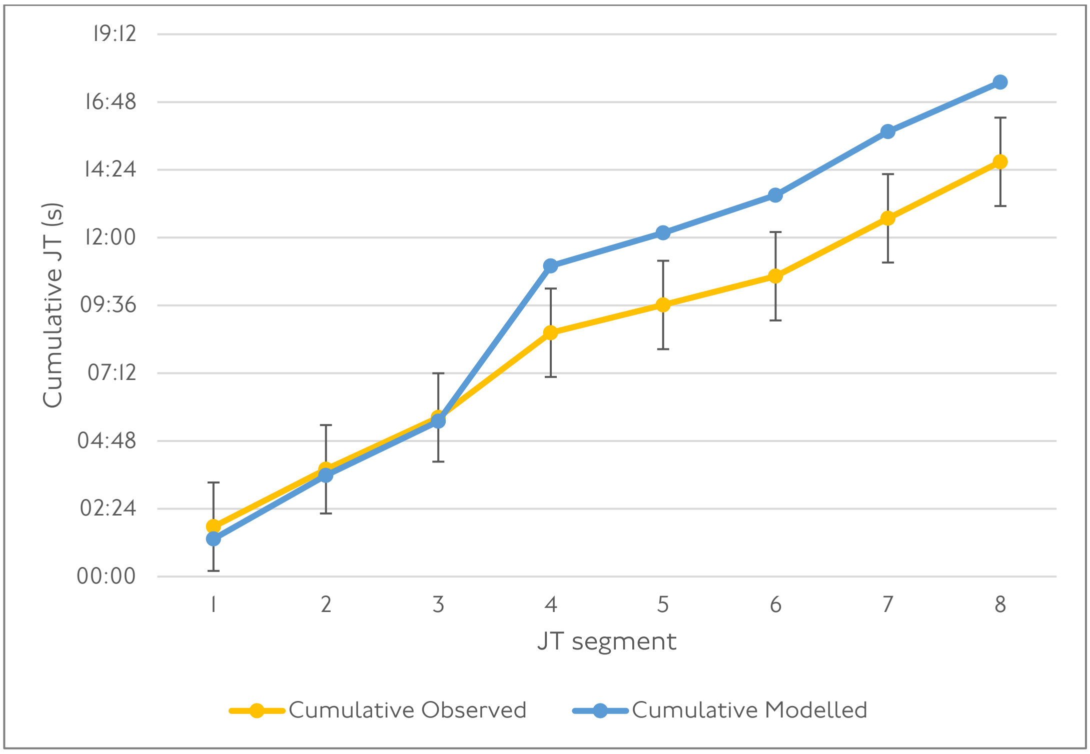


Figure 133: Example of cumulative observed vs. modelled journey times

Travel Time Sections should match the distances over which the data was collected on street as closely as possible. Information on how to output journey time data for validation can be found in section **B7.7.2.3**.

7.5.2.5 Queue Data

Given the difficulty of measuring queue lengths on street in the same way as in a model, a direct comparison of simulated vs. observed queue lengths is not a validation criterion; journey time validation is a more reliable indicator of congestion levels. Queues should, however, appear in the model at the same locations and during the same time periods as they are observed in reality, and queuing behaviour in the model should be consistent with site observations.

Queue survey data is useful when determining bottlenecks within a network. It can be used as a measure of the model's performance and for direct comparison with scheme proposals. Modelled and surveyed queues should be compared and presented in accompanying reports. Section **B7.7.2.4** contains information on queue length output in Vissim.

7.5.2.6 Public Transport

Similarly to general traffic, modelled public transport journey times should be averaged over multiple seeds and should be within 15% of surveyed on-street journey times. As mentioned in section **B7.4.3.4**, it is preferable to report on each route separately, although this is dependent on the purpose of the modelling. Any grouping of routes for reporting or validation purposes should be agreed in advance.

Counts should be checked to ensure that there are no problems with the inputs or Travel Time Sections, and that no buses are being removed from the network due to modelling issues.

7.5.2.7 Error Files

Vissim generates error files (*.err) while running, which should be analysed after the simulation run. If there are any VAP Signal Controllers in the model, a VAP error file is also generated. These files should be thoroughly audited as they may contain indication of errors such as:

- Vehicles and Public Transport Lines being removed from the network;
- Vehicles reaching the end of links while still searching for routes;
- Vehicles not being loaded onto the network (latent demand). Note that in later versions of Vissim this is only reported at the end of the simulation, rather than for each time interval;
- Circular routes indicated by Travel Time measurements;
- Minimum green and/or minimum stage length violations; and
- Unusual stage change sequences.

Ideally, no error files should be produced at the end of the simulation runs. However, small error files with non-critical error messages are acceptable within VMAP.

In later versions of Vissim, errors in the network are displayed in the Messages window. This allows errors to be checked prior to and during a simulation run. Between runs, this window offers an opportunity to fix the errors.

7.5.3 Use of Multithreading

The use of multiple processor cores may help Vissim to run faster. Since version 5.30, Vissim output data can be reproduced when using multiple processor cores. The use of multithreading is therefore recommended during model development and validation.

7.6 Proposed Model Development

As is outlined in section **B2.5**, the Proposed model should be implemented in the Base model (or Future Base model if the Three Stage Modelling Process is being followed, see section **B7.6.1** below) by only modifying elements which will change as part of the scheme, including any signal timing changes. Adjusting other elements, which will not change on street, 'to make it work better' is not acceptable. If the Proposed model will not work without additional changes then this is a sign that either the proposed design is not viable or the Base model was not fit for purpose and should be revisited. As noted in section **B7.1.2**, the same version of Vissim must be used for Base and Proposed scenarios.

This section deals with aspects which particularly need to be considered when building a Proposed Vissim model. For a more general overview refer to section **B2.5**.

7.6.1 Future Base

The Future Base model bridges the gap between Base and Proposed scenarios and provides a reference when analysing the Proposed results. As described in section **B2.5.1**, the Future Base model includes all likely network changes which will occur between the base year and the year being examined in the proposal, excluding the scheme under consideration. It is built from the Base model by changing as little as possible in relation to each new scheme that has been identified to be added. The guidance in this section applies to creating the Future Base model as well as to the Proposed scenarios.

7.6.2 Scenario Management

The preferred method for generating a new scenario is to copy the model folder and use the copy to build the Proposed model. Alternatively, however, Scenario Management may be useful when testing different options. The scenarios are set up with a Base network that is common to all scenarios. Once Scenario Management has been enabled via File > Scenario Management > Place Under Scenario Management… scenarios are controlled in the Project Explorer window (**Figure 134**).

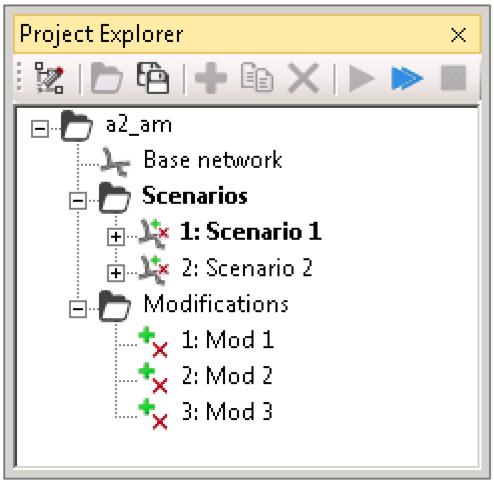


Figure 134: Screenshot of Project Explorer window

Care must be taken when using Scenario Management with external signal control files, as changing timings in one file will affect every scenario which uses it. With VAP control (section B7.4.5.1), this can be solved by using separate VAP (*.vap) and PUA (*.pua), if necessary, files for each scenario, however, with UTC-Vissim (section B7.4.5.3), this is not possible as the signal configuration files are linked to the model input file name (*.inpx). For this reason, it is preferable that Scenario Management is not used with UTC-Vissim models and a copy of the model folder is made for each scenario. It is recommended that if Scenario Management has been used for any interim modelling a full description should be added for each scenario and any modification files.

It is down to personal preference as to whether the use of Scenario Management would be beneficial in comparing scheme options, however, as indicated in section B7.3.4, each scenario should be submitted to TfL for auditing as a single model input file (*.inpx).

7.6.3 Proposed Flows and Routing

Proposed flows and routing can be obtained in a number of different ways. The methodology should have been agreed in the MAP Stage 4 Proposal Scoping Meeting (section B2.1.5.1), but also considered at the MAP Stage 1 Base scoping meeting as the Base model build will dictate the appropriate methods for the proposal, to some extent. The methodology should be suitable for the purpose and timescales of the modelling. Once the new routing is implemented, the advice in section B7.4.4 still applies with regard to checking that the routes function properly.

Future year flows of cyclists and pedestrians is usually decided on a project basis. Refer to Chapter C2 on **Cyclist Modelling** and Chapter C3 on **Pedestrian Modelling** for further details.

7.6.3.1 Input Adjustments

The simplest method is to use the same Routing Decisions, with a percentage change, or no change, to the Vehicle Inputs. This is most likely if tactical modelling is not being used. If this is the case, then any network changes involving Link-Connector sequences should avoid breaking the existing Routes. After the network changes have been made, the full length of Routes must be checked as it is possible to change the Link-Connector sequence when adjusting Connectors.

This method can be complicated if movements are banned or introduced as part of the proposal. For example, a turning movement at a junction may be removed for safety or efficiency reasons. In this case, a decision must be agreed as to how traffic should be rerouted. If the rerouting is likely to be widespread then tactical modelling may be necessary.

Conversely, a new traffic source / sink may be added as part of a proposed development. In the absence of tactical modelling, this extra traffic can be modelled by leaving existing flows and routing in place and introducing duplicate Vehicle Types and Vehicle Inputs with separate Routing Decisions leading to and from the new location. These would be informed by projections of the usage of the proposed development.

7.6.3.2 Tactical Modelling

As explained in section **B2.5.2.2**, the Three Stage Modelling Process will often lead to routing information for Vissim models being transferred from tactical modelling. If this is the case, the tactical routing can be transferred directly into the Vissim model. The tactical flows should be used to assess the change in flow from the Base tactical model. Each traffic input in the microsimulation model should be reviewed to determine whether applying a factor or an absolute change in flow from the Base model is more applicable.

Any changes made to tactical routing in the Base model for validation purposes should be carried across appropriately to the Proposal.

7.6.4 Proposed Signal Timings

Signal timings in VAP models are updated by creating new VAP files (*.vap), along with new PUA files (*.pua) if the method of control (section **B2.3.8.1**) has changed. The new signal timings will come from an optimised deterministic model or models, which include any junctions whose timings may be changed by the proposal. Once these have been imported, the timings can be refined in Vissim to meet any scheme objectives.

Signal timing changes in a UTC-Vissim model (section **B7.4.5.3**) should be made in a copy of the Base cell, so the Base model can still be run against the original cell. The link to the cell must be updated in the Simulation Parameters. It is often the case, however, that even in UTC-Vissim models new junctions will have signal timings implemented using VAP, while the rest of the model continues to run UTC-Vissim. As with VAP models, the new signal timings would come from optimised deterministic models. The remaining junctions run their original timings, or may be used to test mitigation measures, depending on the needs of the project.

> Demand dependency levels should be carefully considered if there is reason to believe they will change from the Base scenario (**B2.5.2.3**). Assuming full demand as a worst case could mask a capacity issue downstream so a judgement on the expected levels must be agreed.

Any new methods of control will need to be signed off for SQA-0640 compliance as part of VMAP Stage 5.

7.6.5 Proposed Saturation Flows

Saturation flows should only be changed from the Base model if there is clear evidence that they would be different in the Proposed scenario. Reasons for this include:

- A new junction or major layout change;
- Change in lane width; or
- Change in flow volumes for particular turning movements.

If any of these apply then RR67, with an appropriate local factor (section **B2.3.9.1**), should be used to implement new saturation flows using the methods described in section **B7.4.2.4**. The reasoning behind any changes must be documented in the modelling report.

7.6.6 Proposed Public Transport

Any changes to public transport must be coded into the Proposed model. These may include routes that have been diverted due to the proposal, bus stops which have been moved and bus lanes that have been introduced or removed. It is also possible that dwell times may be adjusted, for example due to stops for different routes being combined or split, or a new development which is expected to generate more bus passengers. Any change in dwell times must be justified in the report.

7.7 Model Outputs

Vissim can output data for analysis in a variety of different ways, depending on the type of data and how it will be used. The most commonly used outputs of earlier versions of Vissim were all in the form of text files, which were generally imported into spreadsheets for analysis. In later versions the situation is more complex; there are various interlinked methods for accessing the results of models, which are described in the following section.

7.7.1 Methods

Vissim has the capability to output data in various formats, both during and after a simulation run, and also provides facilities to visualise different data while the model is running.

7.7.1.1 Numerical Outputs

Different types of numerical outputs are available, including:

- The List window for each type of result. With the addition of UDAs, these can be used to display validation results directly, or they can be copied to spreadsheets for further analysis;
- Attribute (*.att) files, which are text files that can be exported from the List window either during or after the simulation;
- Database (*.db) files, which are saved to the <model filename>.results folder in the model folder. They contain the data which populates the List windows so deleting them will remove the data from Vissim. They can be accessed directly through a database or SQL reader; and
- Text output files are still available for certain parameters, but generally only for raw (rather than compiled) data.

Whether results get generated at all, and also some of the configuration settings, are determined in the Evaluation Configuration window. The Result Management tab (**Figure 135**) determines whether anything is recorded:

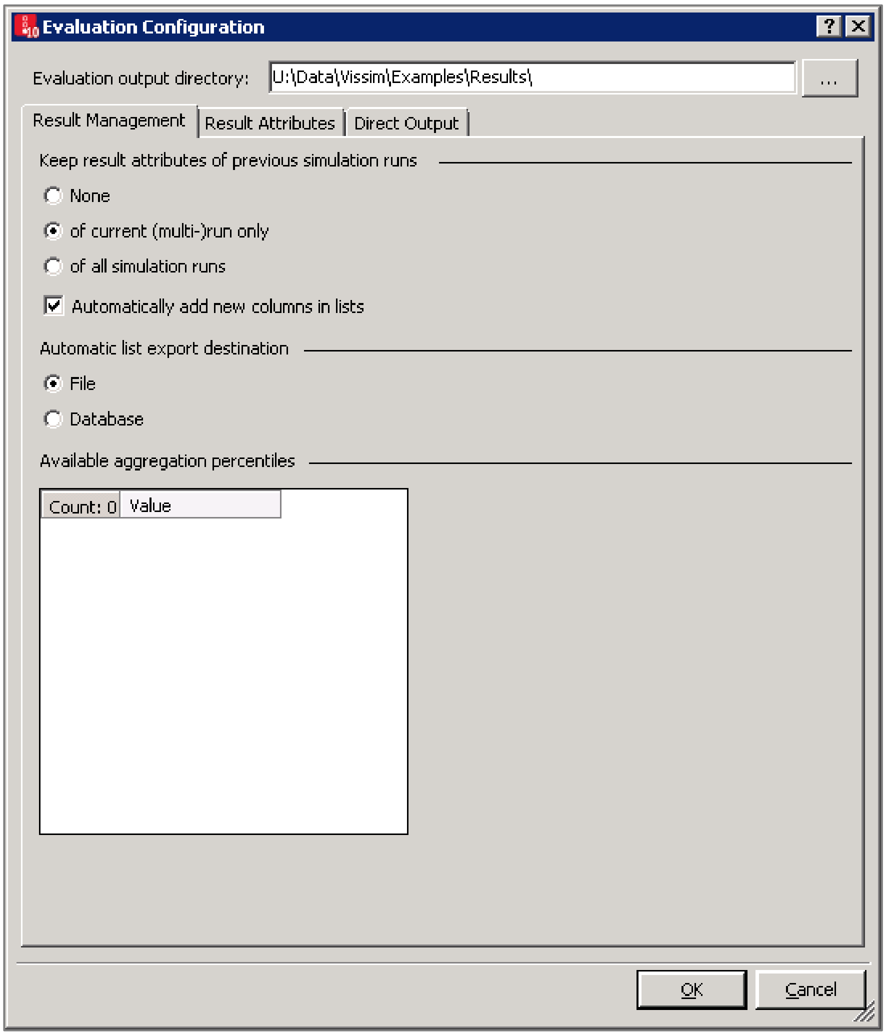


Figure 135: Evaluation Configuration window, Result Management tab

The Results Attributes tab (**Figure 136**) controls the data which appears in the results List windows, including the time periods and intervals it is collected over. This tab also contains the list of Vehicle Classes the data will be collected and aggregated for. The Direct Output tab (**Figure 137**) controls the data which is written to text files.

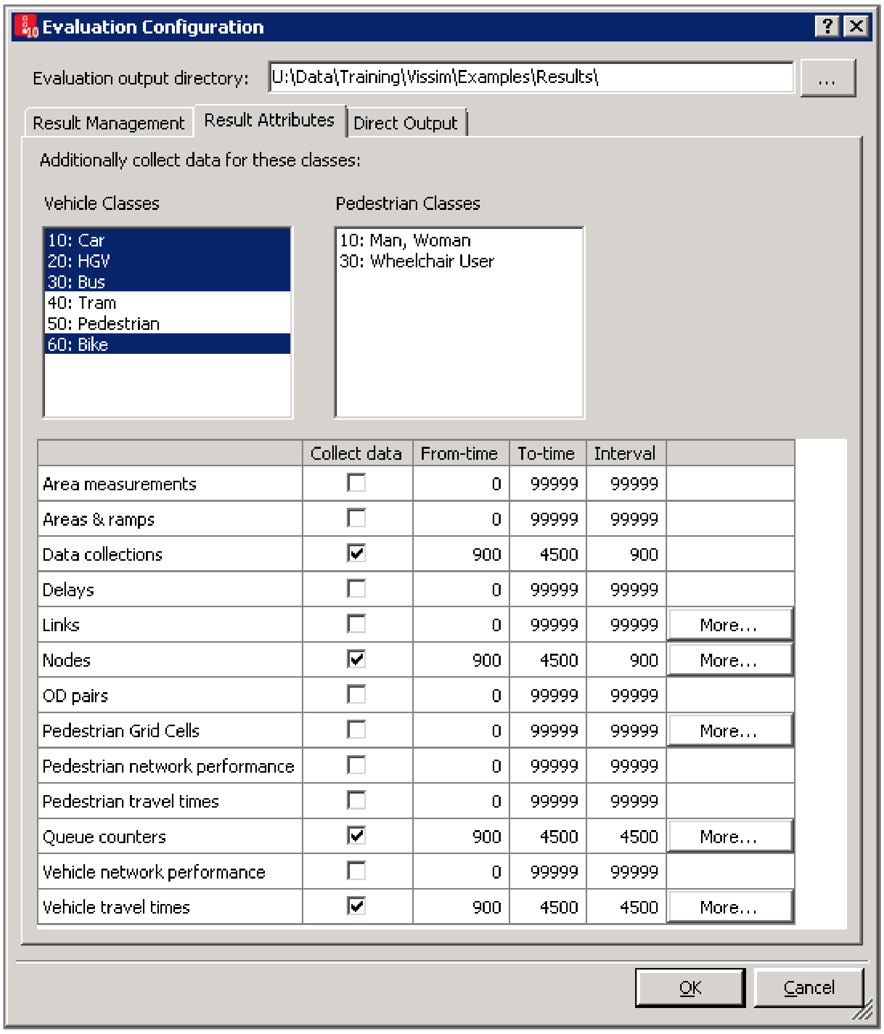


Figure 136: Evaluation Configuration window, Result Attributes tab

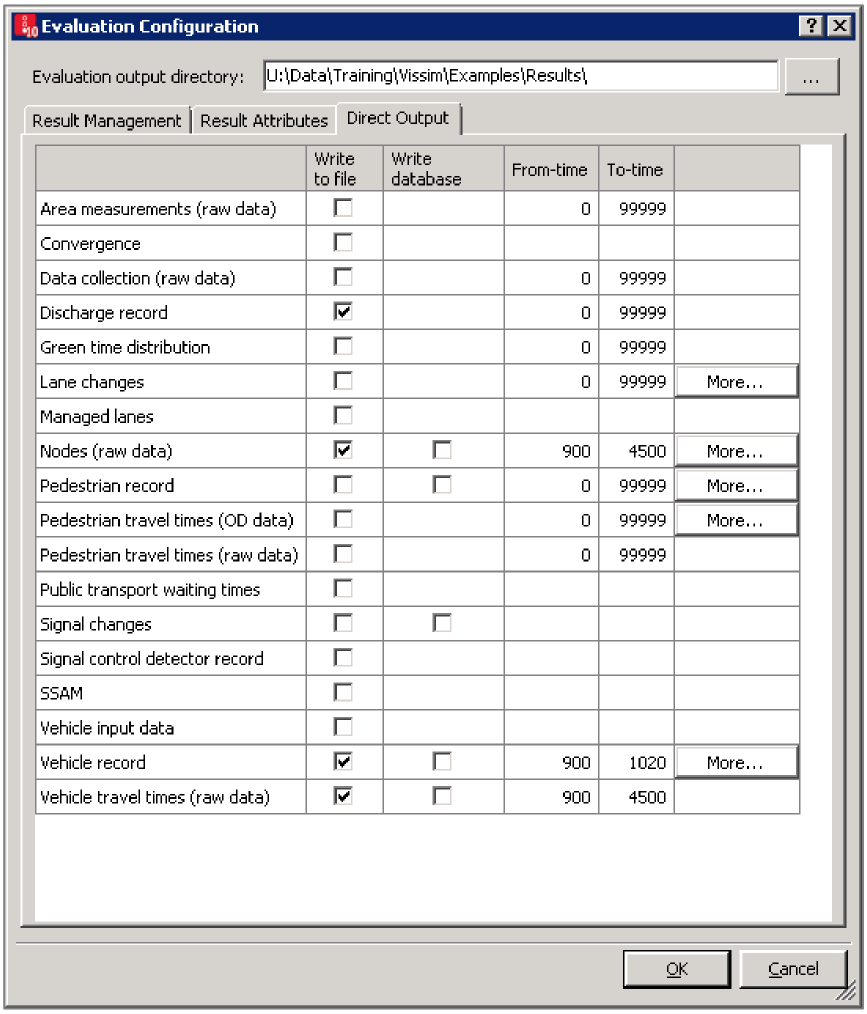


Figure 137: Evaluation Configuration window, Direct Output tab

The controls to output Attribute files are found in the individual results List windows (**Figure 138**). The buttons can be set to automatically output the file after the simulation run, or a file can be output manually, containing the data that is currently in the List.

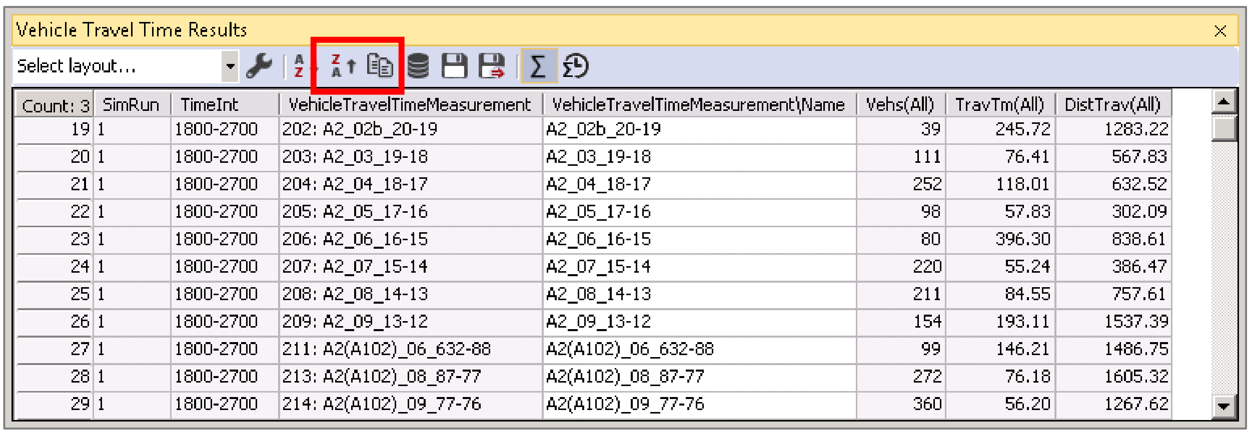


Figure 138: Results List window

7.7.1.2 Network Object Display

As mentioned in section B7.3.1, the Network Objects window controls how objects are displayed. Various options are available in the Edit Graphic Parameters box, depending on the network object. These options include:

- **Label Attribute:** can show, for example, the Link name, Signal Controller number or Detector name;
- **Label Colour Scheme**;
- **Colour scheme:** can display simulation data including Link volumes, speeds (shown in Figure 139) or UDA values; and
- **Link bar:** shows similar data to a Link colour scheme in bar form.

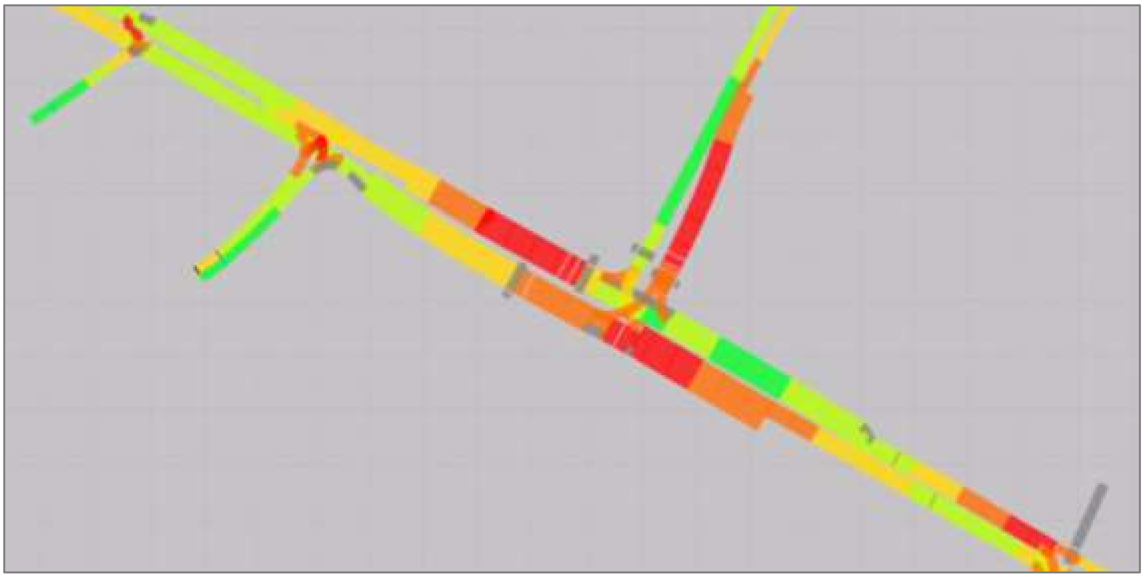


Figure 139: Links with a colour scheme based on speed

7.7.1.3 Charts

The Create Chart option in the View menu provides the ability to create bar or line charts of input data, attributes of objects in the network or results data. Charts can also be created by selecting appropriate data in a List, right-clicking, and choosing the Create Chart option. Figure 140 shows an example Chart displaying Delay Measurements. Depending on the data type, the Chart will display instantly or update during the simulation. Note that Charts do not update when Quick Mode is active. If required, Charts can be exported as an image file or copied and pasted into another program.

More information on how to set up and adjust the settings for Charts can be found in the Vissim User Manual[105].

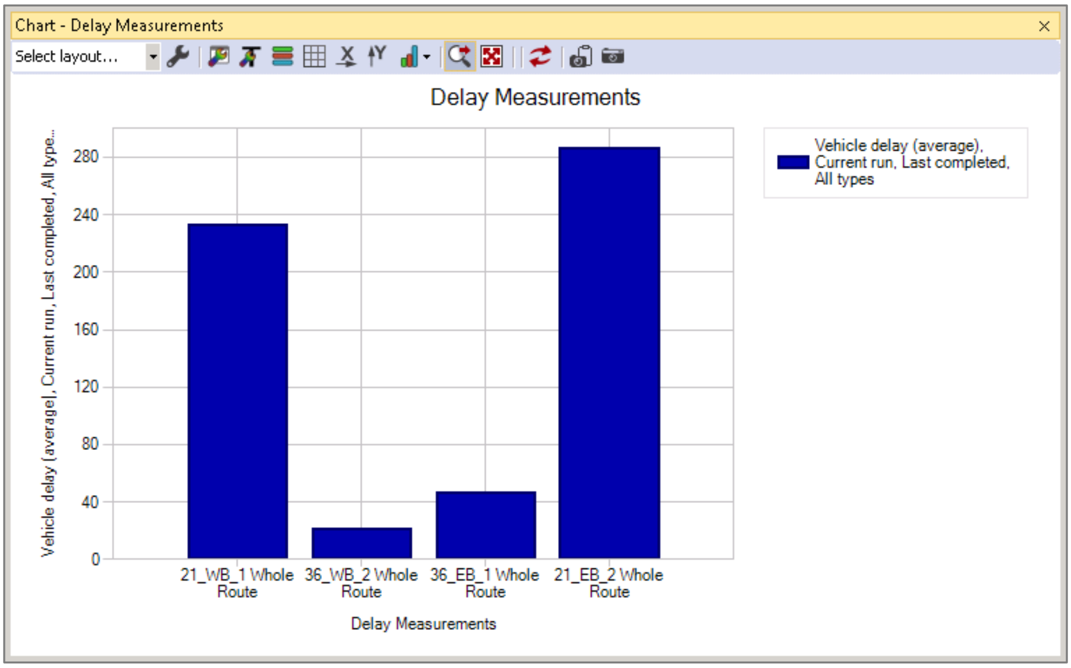


Figure 140: Example of a Chart

7.7.1.4 Scripting

Vissim scripting, using Python, can be used to automate various tasks including importing and exporting model data. Further information on the key classes and functionalities provided by Vissim can be found in the Vissim scripting documentation, which can be found under the Help menu.

7.7.2 Data

While the section above gives general guidance on extracting data from a model, this section provides specific advice on generating the commonly used data outputs.

7.7.2.1 Traffic Flows

A convenient method for assisting with traffic flow calibration and validation is Node Evaluation. This can be output as a raw file or displayed in a List window, which can be directly copied and pasted into a spreadsheet or exported as an Attribute file. All critical junctions can be defined as Nodes, from which Vissim can collect multiple pre-defined

105 PTV Vissim 10 User Manual, PTV AG, September 2018

parameters for every turning movement, Vehicle Type and time period. Such parameters can include traffic flow by Vehicle Type, average delay by Vehicle Type, average queue lengths per Link and maximum queue lengths per Link.

Since the movements that are evaluated rely on the Link-Connector structure in the model, it is important to set up the Nodes in a consistent manner, taking into account all the surrounding geometry. Nodes should include all Connectors which carry junction turning movements and cut through as few Links as possible. Older versions of Vissim run slowly with more than ten Links crossing any Node boundary, so if the road layout requires more than this then Travel Time Sections can be placed across each turning movement as these also collect vehicle counts. Depending on the Link structure, it may be necessary to include one or two intermediate Nodes in between pairs of junctions. An example is shown in **Figure 141**. The Nodes should have Use for Evaluation checked, and Dynamic Assignment should be unchecked as this speeds up simulation times.

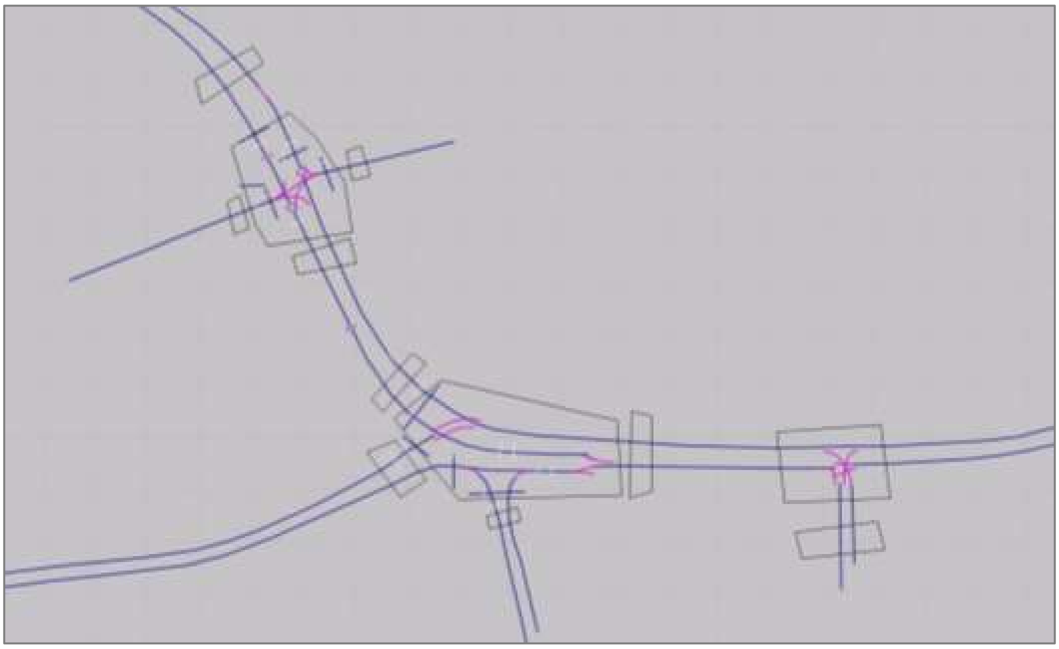


Figure 141: Example Node layout

Alternatively, when observed traffic data is entered in Vissim as a Link or Connector UDA, the GEH per movement can be calculated by using the specific GEH formula UDA. Once the GEH has been calculated, the values can be visualised on the Links or as labels in different colours, which gives an indication of where to target calibration effort (section **B7.7.1.1**).

7.7.2.2 Saturation Flows

As mentioned in section B7.5.2.2, saturation flows in later versions of Vissim are measured by using Discharge Record evaluation files (*.dis). These are activated individually for each Signal Head (Figure 142), and Discharge Record must be turned on in the Direct Output tab of the Evaluation Configuration window (section B7.7). A saturation flow validation spreadsheet can be provided by M&V.

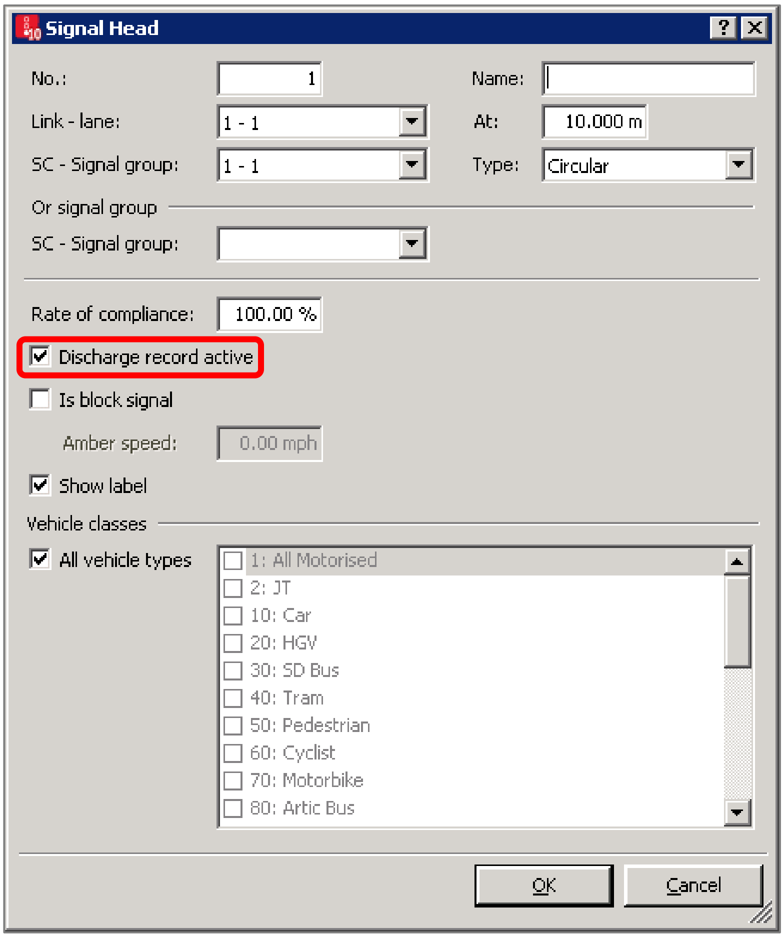


Figure 142: Setting to record saturation flows from Signal Heads

7.7.2.3 Journey Times

Journey times are collected using Travel Time Measurements, which can be set up between any two points on the network, even if there is no route between them (although, in this case, they would record nothing). If there is more than one route, Vissim will count any vehicle which crosses the start and end markers regardless of the route in between, so care should be taken when there is route choice in the model.

Travel Time data can be output as a raw file or aggregated in a List window. The aggregated data is usually used for validation as it is easier to work with. Different Vehicle Classes can be set up to study each Vehicle Type separately as well as aggregating them together. To make sure of collecting the appropriate Vehicle Types it is good practice to set up a Vehicle Class specifically for journey time measurements. The travel times options should be set to aggregate by time of passing the destination section, as in **Figure 143**, so that model results do not change depending on whether a cool-down period is run or not.

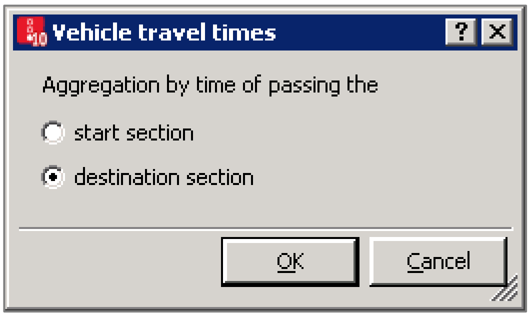


Figure 143: Vehicle travel times setting

7.7.2.4 Queue Data

As mentioned in section **B7.7.2.1**, average queue lengths per Link and maximum queue lengths per Link can be output using Nodes. In addition, Queue Counters can be set up where required in the network, and these output aggregated data in a List window.

It should be noted that Vissim measures queue lengths according to a set of parameters based on vehicle speeds and headways. Changing these parameters will result in different queue lengths being reported where in fact queues have not actually changed. Apart from the Max Length, the default queue configuration parameters should be used. The Max Length should be checked, and increased if necessary, to ensure all modelled queues are properly captured.

Queue length data is available in later versions of Vissim as a graphic parameter for Queue Counters and/or Nodes as shown in **Figure 144** below.

Show queue lengths	✔
Queue length attribute	QLenMax(Current,Avg)
Queue length color	(150, 219, 164, 255)
Show queue length label	✔

Figure 144: Queue length bars

7.7.2.5 Signal Timings

Signal timings can be output as raw data, using the Direct Output tab, with a line written every time a Signal Group changes state. The data includes the Simulation Time, cycle time, Signal Controller, Signal Group, and colour of the signal. Signal timings can also be checked while the simulation is running using Evaluation > Window > Signal Times Table (**Figure 145**). This displays the selected Signal Controllers in a format similar to that used in LinSig or TRANSYT, which means this is usually the easiest method of determining whether signal timings are correct. It can also be used as a visual check that all stages are being called.

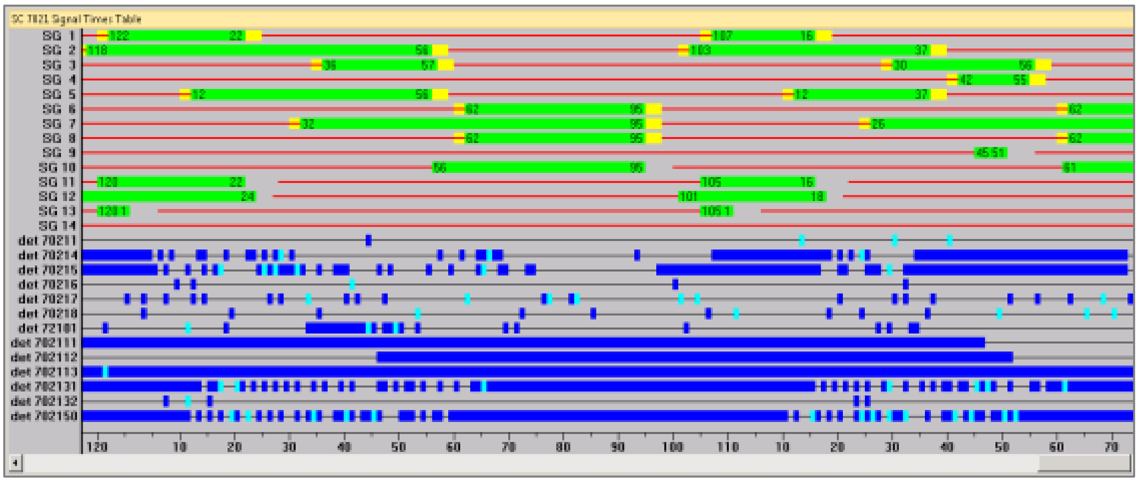
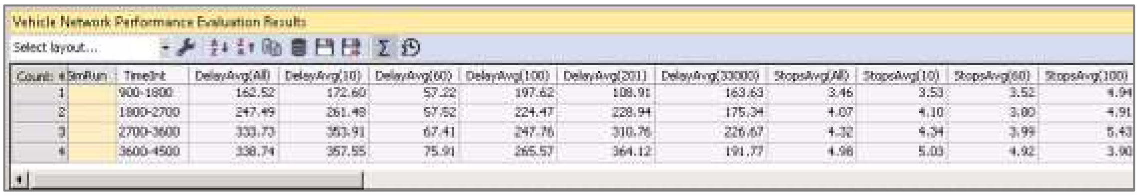


Figure 145: Signal Times Table

7.7.2.6 Network Performance

A quick method for indicating the performance of a network is the Vehicle Network Performance Evaluation (**Figure 146**), which is output in a List, as described in section **B7.7.1.1**. This outputs network-wide performance statistics such as stops, delay and speed for all vehicles and also the Vehicle Classes specified in the Result Attributes tab, which allows for a simple cost / benefit analysis.



Vehicle Network Performance Evaluation Results

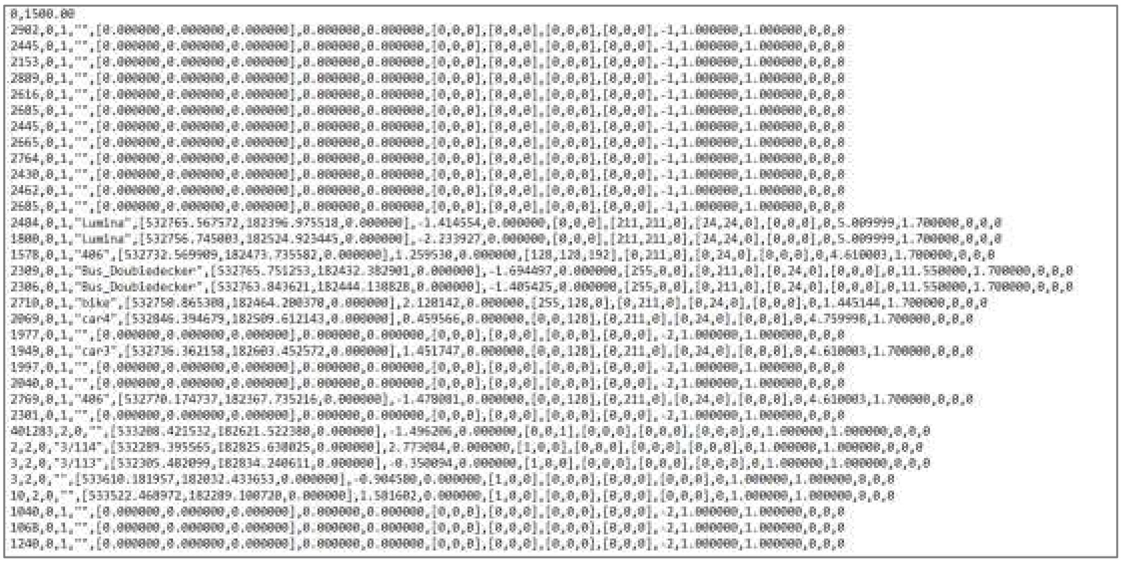
Count: 4	SimRun	TimeInt	DelayAvg(All)	DelayAvg(10)	DelayAvg(60)	DelayAvg(100)	DelayAvg(201)	DelayAvg(33000)	StopsAvg(All)	StopsAvg(10)	StopsAvg(60)	StopsAvg(100)
1		900-1800	162.52	172.60	57.22	197.62	108.91	163.63	3.46	3.53	3.52	4.94
2		1800-2700	247.49	261.48	57.52	224.47	228.94	175.34	4.07	4.10	3.80	4.91
3		2700-3600	333.73	353.91	67.41	247.76	310.76	226.67	4.32	4.34	3.99	5.43
4		3600-4500	338.74	357.55	75.91	265.57	364.12	191.77	4.98	5.03	4.92	3.90

Figure 146: Vehicle Network Performance Evaluation Results

7.7.2.7 Vehicle Trajectory Files

Vissim can output vehicle trajectory text files for a variety of uses, for example, emissions modelling, data visualisation and 3D animations. There are two different output files:

- Animation files (*.ani.txt), include vehicle and pedestrian positions over time (**Figure 147**), which are primarily for 3D animations and work with PTV's 3ds Max import MAXScript. Apart from specifying the time period and area of coverage, these files are not configurable. They are not available on a standard Vissim licence and require the Export 3DS MAX module; and




```
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2153,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-1,1.000000,1.000000,0,0,0
2889,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-1,1.000000,1.000000,0,0,0
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2764,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-1,1.000000,1.000000,0,0,0
2430,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-1,1.000000,1.000000,0,0,0
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2484,0,1,"Lumina",[532765.567572,182396.975518,0.000000],-1.414554,0.000000,[0,0,0],[211,211,0],[24,24,0],[0,0,0],0,5.009999,1.700000,0,0,0
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1578,0,1,"406",[532732.569989,182473.735582,0.000000],1.259530,0.000000,[128,128,192],[0,211,0],[0,24,0],[0,0,0],0,4.610003,1.700000,0,0,0
2309,0,1,"Bus_Doubledecker",[532765.751253,182432.382901,0.000000],-1.694497,0.000000,[255,0,0],[0,211,0],[0,24,0],[0,0,0],0,11.550000,1.700000,0,0,0
2306,0,1,"Bus_Doubledecker",[532763.843621,182444.138828,0.000000],-1.405425,0.000000,[255,0,0],[0,211,0],[0,24,0],[0,0,0],0,11.550000,1.700000,0,0,0
2710,0,1,"bike",[532750.865308,182464.200370,0.000000],2.128142,0.000000,[255,128,0],[0,211,0],[0,24,0],[0,0,0],0,1.445144,1.700000,0,0,0
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1977,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-2,1.000000,1.000000,0,0,0
1949,0,1,"car3",[532736.362158,182603.452572,0.000000],1.451747,0.000000,[0,0,128],[0,211,0],[0,24,0],[0,0,0],0,4.610003,1.700000,0,0,0
1997,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-2,1.000000,1.000000,0,0,0
2040,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-2,1.000000,1.000000,0,0,0
2769,0,1,"406",[532770.174737,182367.735216,0.000000],-1.478081,0.000000,[0,0,128],[0,211,0],[0,24,0],[0,0,0],0,4.610003,1.700000,0,0,0
2301,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-2,1.000000,1.000000,0,0,0
401283,2,0,"",[533208.421532,182621.522388,0.000000],-1.496206,0.000000,[0,0,1],[0,0,0],[0,0,0],[0,0,0],0,1.000000,1.000000,0,0,0
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3,2,0,"3/113",[532305.482099,182834.240611,0.000000],-0.350894,0.000000,[1,0,0],[0,0,0],[0,0,0],[0,0,0],0,1.000000,1.000000,0,0,0
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10,2,0,"",[533522.460972,182289.100720,0.000000],1.581602,0.000000,[1,0,0],[0,0,0],[0,0,0],[0,0,0],0,1.000000,1.000000,0,0,0
1040,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-2,1.000000,1.000000,0,0,0
1068,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-2,1.000000,1.000000,0,0,0
1240,0,1,"",[0.000000,0.000000,0.000000],0.000000,0.000000,[0,0,0],[0,0,0],[0,0,0],[0,0,0],-2,1.000000,1.000000,0,0,0
```


Figure 147: Animation file (*.ani.txt) example

- Vehicle Record files (*.fzp), which can be used for many purposes and whose content is completely user-specified (Figure 148). Specification of Vehicle Record files is found in the Direct Output tab in the Evaluation window (section B7.7). More information on the use of Vehicle Record files in emissions modelling can be found in Chapter C4 on Emissions Modelling.

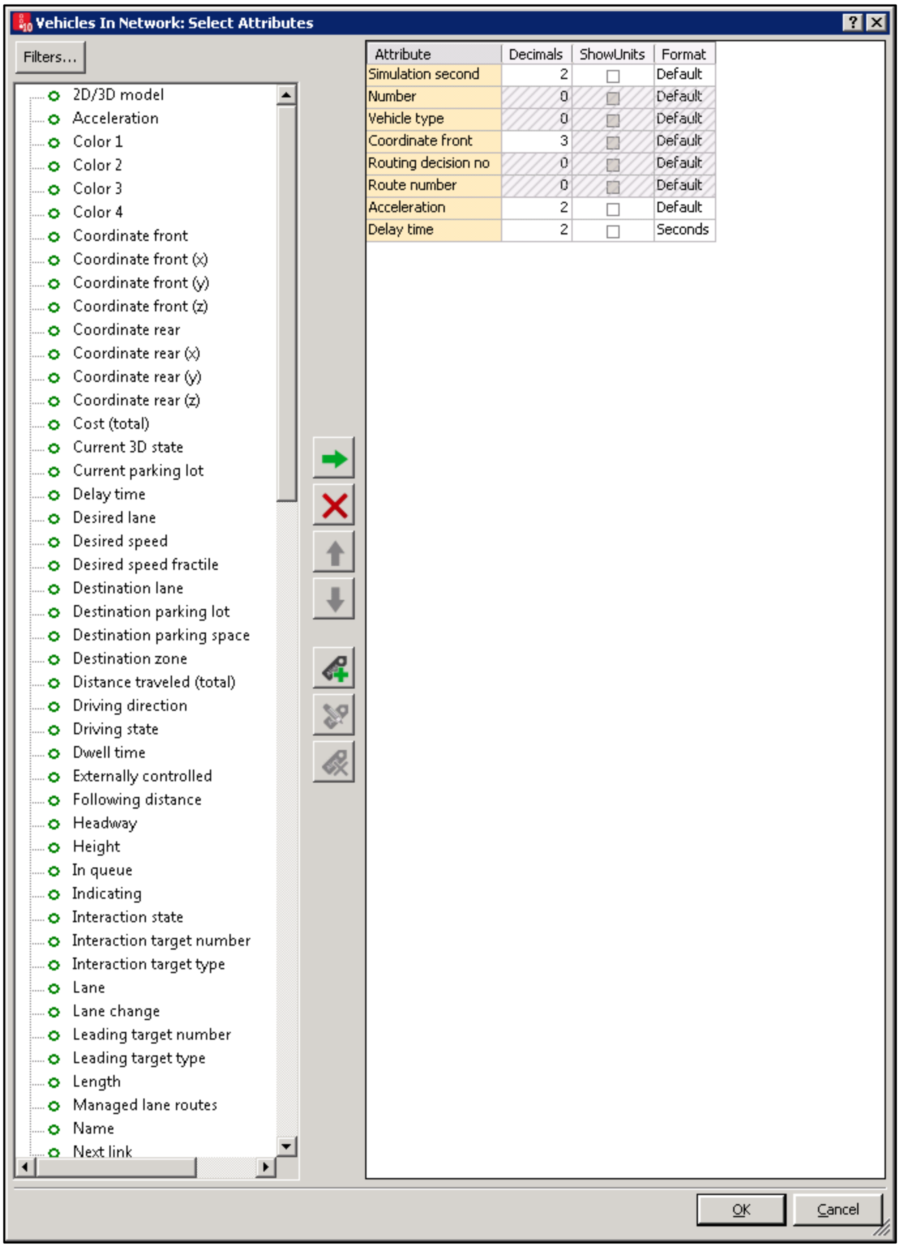


Figure 148: Vehicle record file (*.fzp) data selection

PART C – THE HEALTHY STREETS APPROACH

1 Introduction to Part C

The Mayor's Transport Strategy (MTS)[106] sets out the Healthy Streets Approach[107] for active, inclusive and safer travel that aims to deliver improvements to walking and cycling environments in order to encourage more trips via these active travel modes. Enhancements to pedestrian and cycling facilities allow short to medium length journeys to be conducted actively and sustainably. A significant part of the environment for these modes is influenced by air quality, which will also be improved by people switching away from motor vehicles. In the MTS, it is estimated that 5 million car journeys per day in London could potentially be walked or cycled. One of the aims in the MTS is to transfer a sizeable proportion of these journeys to active travel modes.

In TfL Surface Transport, Network Management (NM), has a responsibility to support the assessment and delivery of a wide range of road transport schemes, which requires consideration of benefits and impacts for all road users. There has therefore been a focus in recent years on evolving modelling capabilities to ensure that scheme assessments better capture the relative benefits for both powered vehicles and non-powered road users. There has also been a growing emphasis on sustainable transport provision and associated planning considerations when delivering road schemes in London, prioritising improvements for both public transport

106 *Mayor's Transport Strategy*, Greater London Authority, March 2016
107 Healthy Streets for London, TfL, February 2017

and active travel modes including pedestrians and cycles. This part of the Modelling Guidelines covers modelling techniques to assist with:

- Cycling schemes and assessment of cycle infrastructure provision (see Chapter **C2** on **Cyclist Modelling**);
- Walking schemes and assessment of pedestrian infrastructure provision (see Chapter **C3** on **Pedestrian Modelling**); and
- Emissions studies undertaken as part of road network scheme assessment (see Chapter **C4** on **Emissions Modelling**).

For illustration, real-world examples are presented relating to modelling projects covering each of these areas. Each case study is briefly outlined alongside the modelling tools used for assessment, with the benefits and limitations explored. The approach taken for each project is contrasted against previous and existing methodologies in order to highlight the improvements and set out aims for the future.

The remainder of each chapter looks in more detail at the processes involved in the different types of modelling, referring to relevant software packages where appropriate.

Before reading this section, it should be considered a pre-requisite to be familiar with the content contained within Chapter **B2** on **Modelling Principles**. Further technical detail on specific modelling software covered within **Part B** should also be consulted as necessary.

Some of the modelling advice presented within this part of the Guidelines, particularly in the **Cyclist Modelling** and **Emissions Modelling** chapters, represents initial guidance based on TfL's experience to date and continues to be developed. TfL welcomes discussion of alternative methods used in the wider industry, is eager to engage on advancing modelling capability and continues to collaborate with software suppliers on these topics.

2 Cyclist Modelling

2.1 Introduction

The number of cyclists in London is growing, especially during peak periods. For example, in the Congestion Charging Zone it has reached 16% of total vehicle flow[108]. As growth in cycling is integral to the Mayor's vision for increasing the use of sustainable modes in London, it is important to consider the role and impact of cyclists in the network.

In recent years there has been progress towards ensuring the provision of a more balanced transport impact assessment for all schemes, particularly for those with an emphasis on Healthy Streets. One result of this change in focus was to highlight that established modelling approaches using existing tools were not entirely suitable, as is outlined in more detail in the case study below. TfL has evolved existing road scheme assessment techniques so that they are more appropriate for modal interaction and ultimately more reflective of the modern road network.

This chapter explores the updated traffic modelling approach when applied to a cycle infrastructure scheme assessment. It considers currently available modelling tools and best practice methodology, within existing constraints and limitations, focusing on traffic modelling software that has been covered in **Part B**. The aim is to provide a point of reference to those

108 Harryman, M., Traffic Note 3 – TfL Cordon & Screenline Surveys 1971-2018, Transport for London, 2019

considering Healthy Streets schemes that specifically focus on cycling provision enhancements, as well as traffic schemes that incorporate cycle facilities into the wider scope of the proposals.

Any effects of a proposed scheme on cycling, and any possible growth in cycle demand, need to be carefully considered before selecting the most appropriate software for a modelling project. Particularly in inner London, cyclists should typically be considered in any modelling work unless there is reasonable justification to exclude them.

The cyclist modelling advice presented within this chapter represents initial guidance based on TfL's experience to date and continues to be developed. TfL welcomes discussion of alternative methods used in the wider industry, is eager to engage on advancing cyclist modelling capability and continues to collaborate with software suppliers on this topic.

2.1.1 Case Study

This case study has been included to illustrate the difficulties in modelling cyclists using previous approaches and techniques and to highlight the improvements that have been made.

As part of the Mayor's Cycling Vision[109], a segregated East-West Cycle Route (EWCR), which incorporated the existing Cycle Superhighway 3 (CS3, the eastern end of the route, opened in 2010), was proposed to run along the City Route corridor from Barking in east London to Wood Lane in the west. One of the proposed routes through the central section is shown in **Figure 149**.

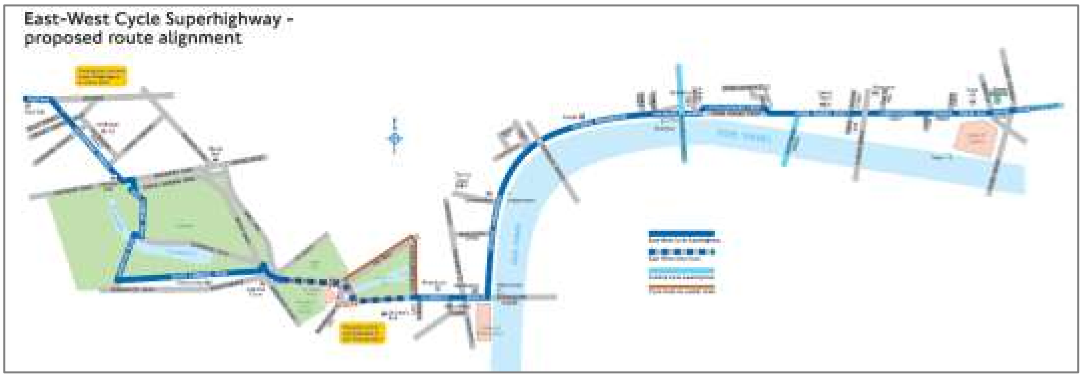


Figure 149: East-West Cycle Superhighway proposed route alignment

109 The Mayor's Vision for Cycling in London – An Olympic Legacy for all Londoners, Greater London Authority, March 2013

At the time of publishing, a long section of the route has been completed, from Barking to Lancaster Gate. A large part of it is on TfL roads and all of it needed to be modelled. Like many of the latest cycle schemes planned or delivered in London, a large proportion of this route is physically segregated in order to provide a safer environment for cyclists. Dedicated infrastructure is implemented at signalised junctions to provide a safer, smoother transition for those using the route.

Prior to Cycle Superhighways, cyclists were rarely explicitly modelled, either in deterministic or microsimulation modelling (section C2.4.1). When they were included it was as a capacity constraint in deterministic modelling or, in microsimulation, as an aesthetic addition which did not interact with other vehicles. This was due to difficulty in modelling their behaviour accurately but, since they were often low in number, it was not a significant problem. EWCR represented a number of reasons these approaches were no longer sufficient:

- EWCR was a high-profile scheme along a highly visible part of the TLRN with some vocal opponents. It was necessary to carry out a thorough investigation into the potential impacts of the scheme in order to support the business case;
- Since the scheme was specifically intended for the benefit of cyclists it was important to produce modelling results, such as delay and journey times, for cyclists as well as other modes of transport;
- The scheme was predicted to attract high numbers of cyclists so it was important to give some confidence that the new facilities would have sufficient capacity;
- The aim was to provide complete segregation for cyclists wherever possible, which required separate phasing at signalised junctions and led to more complicated methods of control than before (Figure 150); and
- Any visualisations of the scheme which could be used to show stakeholders how it would operate would need to include cyclists.

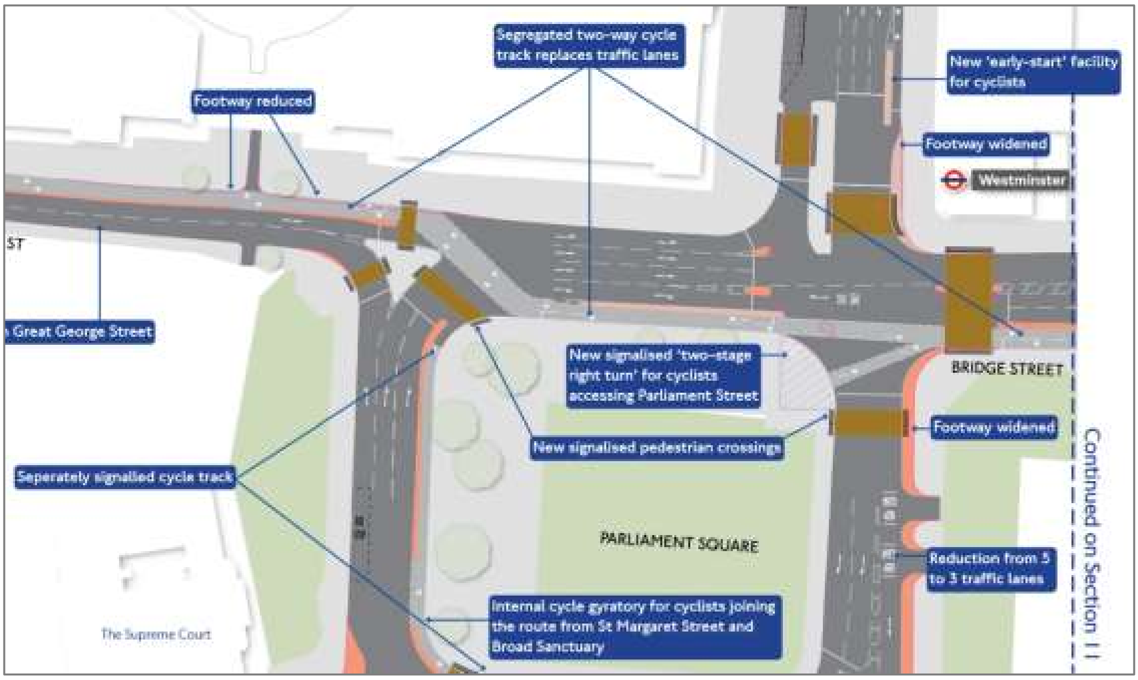


Figure 150: Proposed changes at Parliament Square for EWCR

In order to facilitate this work, Modelling & Visualisation (M&V) liaised with Network Performance Delivery (NPD) to review performance data gathered from cycle infrastructure based on on-street observations across London. This led to desktop studies with a focus on better application of techniques and behavioural models using existing modelling tools. Development has continued in recent years with a succession of similar schemes employing the modelling tools that are required for Three Stage Modelling (sections **A3.5** and **B2.1.4**) of cycle infrastructure delivery projects. It also includes a requirement to produce deterministic models to derive signal timings and understand the capacity constraints of the new infrastructure.

The key objectives of the revised methodology are:

- To realistically model cyclist capacities along varying widths of segregated cycle lanes (modelling cyclist saturation flow);
- To model cyclist behaviour in a manner suitable for presentation; and
- To minimise the modelling effort by categorising behaviour scenarios.

Attempts have also been made to improve the modelling of cyclists on mixed traffic links. Rather than focusing on cyclists' impact on traffic, assessment of cycle progression and performance relative to other modes in a shared road environment is key. In order for cyclists to be explicitly included in the modelling, improved techniques were required in the following areas:

- Deriving capacities and signal timings in deterministic modelling; and
- Lateral behaviour in microsimulation modelling, including cyclist interactions with general traffic as well as how they behave in segregated lanes.

All of this work led to a successful opening of the central section of EWCR, from Tower Hill to Parliament Square, in April 2016 (**Figure 151**). The usage of the route increased from an average of 22,500km cycled per day in 2014 to a daily average of 35,000km in 2016[110].

Figure 151: Cyclists on EWCR

110 https://www.london.gov.uk/questions/2016/1837

2.2 Research

This section includes research on cycling that has been carried out or commissioned by TfL, and which provides the basis for cyclist modelling work.

2.2.1 TfL Research

The following research was conducted within TfL by M&V.

2.2.1.1 Cyclist-Vehicle Interaction at ASLs[111]

Research was carried out, in preparation for the introduction of Cycle Superhighways in 2010, to better understand the impact of cyclists at junction stoplines with ASLs on the discharge rate of motorised vehicles. Cyclists moving away from an ASL on a green signal can delay vehicular traffic for a short period of time, effectively reducing the vehicle discharge rate and causing Underutilised Green Time (UGT).

The study concluded that although the number of cyclists waiting in the ASL did not entirely account for the time taken for cyclists to clear – junction geometry also played a significant role – there was enough evidence to introduce a figure of two seconds UGT per green period when the number of cyclists exceeded 470 per hour. This figure is only used in deterministic modelling with high volumes of cyclists, and when it is used cyclists should not be included in the modelled flows. This research was carried out on both one- and two-lane approaches.

2.2.1.2 Cyclist Saturation Flows at Segregated Stoplines[112]

Observations were made of cyclist discharge rates and behaviour at five segregated stoplines on existing Cycle Superhighways in 2013, and further updated in 2017 to include two busier stoplines. The method used was similar to that used when collecting vehicular saturation flows. Analysis of these observations led to the following conclusions:

- The discharge rate of segregated cyclists is related to the lane width and the number of queues that can form;

111 Hooper, D., Green, J., Farren, R., Hook, C., Cyclist and Vehicle Interaction Study – Preliminary research into the relationship between cyclist traffic and vehicular traffic at Traffic Signals, Transport for London, September 2009
112 Bulmer, S., Investigation into Cyclist Saturation Flows, Transport for London, May 2013

- On narrower lanes of around 1m, where only one queue can form, a reasonable saturation flow is around one cyclist per second;
- Once the lane is wide enough for two queues to form (between 1 and 2 metres), the discharge rate is also related to the volume of cyclists. The higher the cyclist volumes, the more use is made of the extra queuing width, and so the higher the discharge rate; and
- A good rule of thumb is that for fully saturated approaches with no unusual geometry, for example a straight, flat road, a stopline can discharge a maximum of one cyclist per second for every metre of lane width, as is shown in **Table 14**.

Table 14: Observed discharge rates of cyclists at segregated stoplines

Width of Cycle Lane (metres)	Cyclists per second	Saturation Flow (PCU/hr)
1	1	720
1.5	1.33 – 1.5	960 – 1080
2	1.67 – 2	1200 – 1440

2.2.2 TRL Research

TRL has performed a number of research projects on behalf of TfL. This section outlines the results of two studies relevant to cyclist modelling.

2.2.2.1 Cycle Behaviour and Dispersion Research

TfL commissioned research from TRL[113], which looked at cyclist behaviour at eight junctions across central London. It investigated the questions of dispersion and overtaking on links and at junctions. It is dated 2014-2015, which is towards the beginning of the relatively recent rise in cyclist numbers and should be viewed in that light. The key points to take away from this research, from a modelling point of view, are:

113 Crabtree, M., TfL cycle behaviour and dispersion research, Pilot study – Items to measure from video captured 12th and 13th August 2014, Transport Research Laboratory, September 2014
Emmerson, P., TfL cycle behaviour and dispersion research, Pilot study – Initial analysis, Transport Research Laboratory, October 2014
Emmerson, P., Crabtree, M., TfL cycle behaviour and dispersion research, Main study - Analysis, Transport Research Laboratory, April 2015

- Cyclist speeds are higher in the AM than inter-peak or PM, as shown in **Table 15** below:

Table 15: TRL-measured cycle speeds[113]

Period	Speed (m/s)	Standard Error
AM	6.64	0.05
IP	5.20	0.09
PM	4.05	0.1

- Cyclists on cycle hire bikes were, on average, 1.1m/s slower than other cyclists.
- Potential cyclist dispersion factors were derived using three different estimation methods; however, two of the three derived factors indicate that cyclists disperse less than cars, which seems counterintuitive due to the high variability in cyclist speeds and the relative ease with which they can overtake. More research with higher numbers of cyclists is therefore considered to be needed on cyclist dispersion. Until this has been carried out, existing dispersion factors for vehicles should be used as there is insufficient evidence to alter them.

2.2.2.2 Impact of Cyclists on Saturation Flows

In 2012, TfL commissioned TRL to investigate discharge at traffic signals[114] in the presence of cyclists. The key relevant findings were:

- At stoplines with ASLs, the PCU value of cyclists was estimated at about half that for stoplines without ASLs. The range of values for different scenarios fell between 0.05 for a Cycle Superhighway with an ASL and 0.8 for no ASL; and
- As cyclist volumes increased, the PCU value of cyclists decreased.

The report acknowledges that more research is required to investigate and confirm these findings, however they can be borne in mind when modelling cyclists.

114 Emmerson, P, Crabtree, M, Gibson, H, The estimation of saturation flows at traffic lights in London, and the impact of cyclists on saturation flows, Transport Research Laboratory, December 2012

2.2.3 Cynemon

Cynemon is a strategic cycling model, built by TfL City Planning Strategic Analysis on the Cube platform, which estimates cyclist routes, flows and journey times at a strategic level across London for scheme and policy appraisal.

Demand data is taken from a number of sources, including the London Travel Demand Survey, Census, cycle hire OD data, and various other surveys, and put into a gravity model[115]. The network comes from the Integrated Transport Network (ITN) layer from Ordnance Survey's MasterMap, since superseded by the Ordnance Survey MasterMap Highways Network layer, with added TfL GIS layers. A route choice algorithm was developed from observed GPS data collected through an online survey and mobile phone application. Observed routes were used to determine the value that cyclists place on road type, cycle infrastructure, bus lanes, traffic volume and gradients when choosing their routes.

This model can be used to assess options and appraise schemes that have a strategic impact on cycling. Methodologies for transferring data into local or microsimulation models are currently being developed. For further information, contact **Cynemon@tfl.gov.uk**.

115 A gravity model uses the relative sizes and distance between two places to predict the amount of flow between them. For example, people are more likely to travel further to go to a supermarket than a corner shop.

2.3 Data Collection

Collecting site data on cycling can be challenging, however cyclist behaviour can be key to understanding the operation of a junction or facility. On-site observation of existing conditions and cyclist behaviour is essential for the development of accurate models of current situations and, where possible, similar facilities should be observed to inform proposed designs.

It is important to note that at different times of day or days of the week, different types of cyclists are likely to use the same facilities. For example, data collection during weekday peak periods will likely result in a high proportion of commuter cyclists, whereas weekend observations will include larger numbers of cyclists riding for leisure. This will have an impact on routing behaviour and cyclist speeds. In addition, seasonality causes large changes in the number of cyclists observed using the network, as can be seen in **Figure 152**.

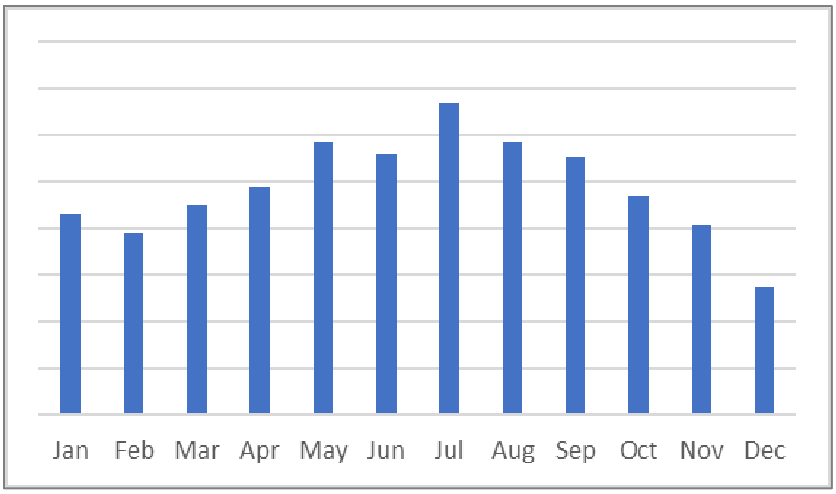


Figure 152: Cyclist trips throughout 2019 [116]

Conducting surveys in the colder months could lead to a significant underestimation of cyclist volumes and have an impact on the viability of design proposals.

Both general traffic and cyclists should be considered when deciding on an appropriate time to carry out surveys. A neutral month should be chosen if possible, however adjustments can be made to cyclist flows if required.

116 Strava Metro dashboard - 2019 data

Figure 153: Cyclist not impeding other traffic

When collecting saturation flows, Degrees of Saturation (DoS) and queue lengths for general traffic, a decision must made as to whether to include cyclists. It is important that this decision is consistent across all of these measurements.

As a rule, cyclists that queue separately to the side of the traffic and discharge without impeding it should not be included in these measurements (Figure 153). Any cyclists that sit in the traffic queue should be measured, traditionally with a PCU value of 0.2 (see section B2.3.4.1.1 for PCU table).

2.3.1 Flows and Routing

The most straightforward data collection exercise is manual classified counts, in which the numbers of vehicles, including cyclists, are counted for all movements through a junction. This should be sufficient for localised models, which represent the design of a single junction or proposed facility. If cyclist counts are collected at multiple sites it is very likely that flows will not be balanced between sites, as cyclists can start and end their journeys at almost any point in the network. Cycle parks and stands should therefore be included in counts as they represent significant sources and destinations for cyclists.

In some cases, where a high level of detail is needed, it may be necessary to divide cyclists into cycle hire and non-cycle hire. This is the one category of cyclists that is easy to distinguish and therefore possible to count. Also, as mentioned in section **C2.2.2.1**, cycle hire bikes are generally slower than normal bikes, so this added level of detail may be useful. If cycle hire bikes were not included in the original counts, then spot counts can be carried out to determine their proportion. Alternatively, in central London, the average proportion of cyclists using cycle hire bikes was found to be 13% in 2017. Updated figures, in some cases with site-by-site breakdowns, can be obtained from **ModellingData@tfl.gov.uk.** Clearly, this distinction can only be made within the cycle hire area[117].

Some schemes may require a more detailed understanding of cyclist origin and destination points in order to model cyclist routes. Since cyclists are not uniquely identifiable in the same way as other vehicles with registration plates, postal surveys may be required to identify key routes. After postal surveys, further assumptions would be required to obtain a full Origin-Destination (OD) matrix of cyclist movements, using matrix estimation for example, as it is impractical to collect data for all possible origins and destinations. Alternatively, there is the potential to use Cynemon for determining cyclist routing (section **2.2.3**).

117 **https://tfl.gov.uk/modes/cycling/santander-cycles/find-a-docking-station**

2.3.2 Journey Times

When considering journey time validation, one difficulty is acquiring the data to validate against. In recent years, TfL has started to use GPS data from social fitness networks for this purpose. The cycling data is aggregated and anonymised before matching the GPS tracks to OS MasterMap Highways Network edges (edges are sections of the network between junctions).

Data may be collected for each edge each hour per direction, consisting of the number of cyclists and the median average time it took cyclists to travel the length of the edge. These can be further aggregated to provide average travel times and counts by edge and hour for each month as well as summing edges together between junctions. Median average travel times are used as they are less sensitive to outliers. This is important because it is possible for users to accidentally be tracking a cycle trip while actually using another type of vehicle or walking.

Additional types of cyclist data that are important for modelling are speed and acceleration / deceleration rates. This data is needed if journey time analysis is required or there is an interest in progressing cyclists through a series of facilities with minimal delay and stops.

2.4 Cyclist Modelling

Cyclist modelling lacks the industry-wide research and experience that has built up over many years with respect to general traffic. This is partly because until relatively recently cyclist numbers have been quite low, and partly because modelling cyclists is more difficult than for general traffic.

Cyclist behaviour is considerably less predictable than for other vehicles, as they have a large variety of potential (legal and illegal) routing choices. These include actions such as red light violation[118] and cycling on the pavement, as well as cycle-only routes, segregated lanes and filtering through traffic. Cyclists also vary widely in their speed, ability and assertiveness. Any traffic model involves simplification and this is particularly the case when modelling cyclists due to the wide variety of observed behaviours. It can also be challenging to capture suitably detailed data for the purpose of calibration and validation. It is important to observe cyclists' behaviour in the area of interest and capture the relevant features.

In addition, it is important to take account of the behavioural responses of all road users to proposed designs, for example, how different modes react to lane markings on the approach and through junctions. For this reason, microsimulation is often the most appropriate assessment tool. Capacity constraints of cycle lanes should be modelled accurately, including situations where cyclist demand may exceed the capacity.

Models of proposed designs should generally assume full compliance with signals and lanes, as proposed infrastructure should be designed to cater for all demand. In order to provide a fair comparison, this means that full compliance should also generally be modelled in Base scenarios, even where this is not the case on street. Further advice should be sought in the case where there is a high degree of non-compliance that is affecting validation. A possible exception in the case of Proposed modelling would be if it was anticipated that new infrastructure would increase compliance levels. This would have to be agreed with NP in advance, in accordance with the model purpose, and detailed records made of the nature and level of non-compliant behaviour.

118 Road Network Performance & Research Team, RNPR Traffic Note 8 – Proportion of Cyclists Who Violate Red Lights in London, Transport for London, June 2007

On street, cycling can be split into two categories:

- **Segregated** – cyclists occupy a dedicated cycle lane and have no interaction with other traffic; and
- **Non-segregated** – cyclists influence, and are influenced by, other vehicles as they share road space.

When modelling cyclists, the recommended approach depends on the nature of the modelling software being used, typically deterministic or microsimulation (see Chapter **A5** on **Which Traffic Modelling Software? Why?**).

This chapter therefore considers the modelling methodologies for the following four groups:

- Deterministic segregated cyclists;
- Deterministic non-segregated cyclists;
- Microsimulation segregated cyclists; and
- Microsimulation non-segregated cyclists.

2.4.1 Deterministic or Microsimulation?

It is often the case that factors other than cyclists determine which type of modelling will be used, however, cyclists should always be included in the decision-making process. Points to consider are:

- **Interaction** – the more interaction cyclists have with other traffic, the more useful microsimulation becomes in generating realistic modelling;
- **Volume** – higher cyclist numbers are likely to need microsimulation as they are more likely to interact with general traffic or require special consideration;
- **Objectives** – if the scheme has specific cycling objectives then microsimulation is likely to be required;
- **Results** – if journey time comparison is necessary then microsimulation should be used. Journey times are difficult to validate successfully, even in microsimulation models (sections C2.3.2 and C2.6.7), so deterministic modelled journey times should be treated with caution; and
- **Outputs** – high-profile schemes are likely to require some form of animated visualisation of the modelling results.

2.5 Deterministic Modelling

Deterministic traffic modelling software can only reflect the aggregate impact of a scheme by directly modifying parameters that influence junction performance, such as saturation flows and signal timings.

Traditionally, cyclists were not always explicitly included in deterministic traffic models due to difficulty in modelling their queuing behaviour accurately, and since they were often low in number. As described in section **C2.1.1**, the significant growth in cyclist numbers in London over recent years, including the introduction of Cycle Superhighways and separately phased cycle lanes, means that approach is no longer viable in many locations.

2.5.1 Segregated Cyclists

For segregated cycle lanes, measuring saturation flows can be carried out in a similar manner to that for motorised vehicles. For this purpose, cyclists can generally be treated as a single vehicle class although measurements with a particularly slow-moving cyclist may need to be omitted from counts, as a motorised vehicle measurement would be if, for example, a vehicle stalled. This may need to be revisited if electric scooters become more prevalent or in particular areas with large numbers of cargo bikes or cycle rickshaws. It is rare that cyclists will suffer from junction exit-blocking as motorised vehicles do, however, if cyclists are regularly impeded by other vehicles then this should be captured using UGT.

The methodology used when modelling the proposed introduction of Cycle Superhighways has been to fix the green time for the cycle lane, based on the proposed lane width and the predicted number of cyclists, and then to optimise the other stages around it. The green times used in these calculations come from the following formula:

$$Green\ time = \frac{Predicted\ flow}{\left(Cyclists\ per\ second * \left(\frac{3600}{Cycle\ time}\right)\right)}$$

The number of cyclists per second in the formula is derived from the lane width, using the observations from existing Cycle Superhighways detailed in section **C2.2.1.2**. The cyclists per second value can also be adjusted to take account of any site-specific junction geometry. Since the observations were taken in ideal conditions with an average of 30 cyclists per green period, the value of one cyclist per second for every metre of lane width in a single direction should be taken as a maximum.

Without fully calibrated and validated cyclist flows in a Base model, as will be the case for new segregated cycle lanes, this method of fixing green times in Proposed models is the recommended methodology. For example, a 2m lane can discharge two cyclists per second in ideal conditions. If the predicted flow is 900 cyclists per hour at a junction with a 96 second cycle time, using the formula above gives a green time of 12 seconds. This should be calibrated in the model using an appropriate fixed stage length before any optimisation is carried out. The application of this methodology in a deterministic model is shown in **Figure 156**.

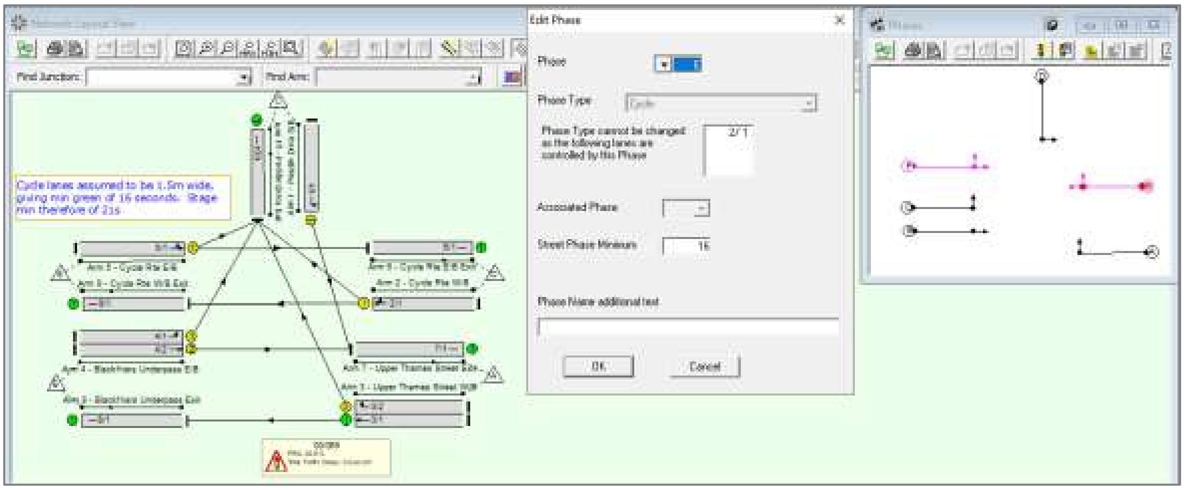


Figure 154: Modelling of a segregated cycle lane in a deterministic model. with fixed green times based on cycle lane widths

Since there is a growing need to optimise offsets for cyclists as well as general traffic, it is recommended that cyclist cruise times are measured in key locations.

2.5.2 Non-Segregated Cyclists

The key point to consider when modelling cyclists in mixed-traffic conditions is to observe the impact cyclists have on traffic capacity and try to replicate it. If cyclists entirely queue and discharge beside vehicles without impeding them, at all junctions in the model, they can be excluded without affecting modelled capacity. Including cyclists as additional PCUs serves no useful purpose when the aim is either to validate a Base model or to optimise a Proposal, as it adds unrealistic PCUs to the vertical queue model, making queues appear longer than they really are.

If any cyclists queue with traffic and occupy space that would otherwise be taken up by vehicles, at any stopline, then these should be included in the model as part of the flow, saturation flow and DoS measurements. An appropriate PCU value should be used in these cases. A value of 0.2 is traditionally used (section B2.3.4.1.1), although findings from the TRL research in section C2.2.2.2 may be relevant if issues are encountered.

If cyclists are not being included as PCUs, ideally a vehicular saturation flow would be measured with as few cyclists present as possible. This means that any increase in cyclist numbers and interaction can be accounted for using the UGT method of collecting DoS. The UGT can usually be modelled using negative bonus greens, or by adding a dummy stage which does not include the relevant phase in order to decrease the green time, where bonus greens are unavailable. Adjusting phase delays and intergreens is a possibility but is not recommended as it interferes with the audited controller configuration. Care must be taken when using these methods in Base models that they are transferred appropriately to any Proposed models.

As described in section C2.2.1.1, when an ASL is present or it is anticipated that cyclists will behave as if there is, site observations have shown that the impact of cyclists on vehicular traffic amounts to 2 seconds of UGT per green period when the number of cyclists exceeds 470 cyclists per hour[119]. This can be applied in Proposed models where the proposal includes a new ASL and there are no Base measurements to carry across. As above, it can usually be modelled with a 2-second negative bonus green, or by adding a dummy stage which does not include the relevant phase in order to decrease the green time.

If it is difficult to distinguish whether cyclists queue in the same manner as vehicles, cyclists significantly interfere with vehicular traffic or the impact of the cyclists is unpredictable from one cycle to the next, then it is possible that deterministic modelling is not suitable and that microsimulation should be considered.

119 Hooper, D., Green, J., Farren, R., Hook, C., *Cyclist and Vehicle Interaction Study*, Transport for London, August 2009

2.6 Microsimulation Modelling

Microsimulation traffic modelling software is capable of modelling general cyclist behaviour and can highlight potential design issues that other tools cannot. As with any microsimulation modelling, the key consideration is to replicate observed behaviour to the level of accuracy necessary for the modelling purpose. Fundamental aspects to consider when modelling cyclist behaviour are:

- Cyclist trajectories;
- Lane positioning;
- Lateral clearances;
- Queuing formations; and
- Performance (speeds and acceleration profiles).

All of the above points need to be modelled accurately if the inclusion of cyclists in a traffic model is to yield reliable modelling outputs and inform the design process in a constructive manner. Poorly modelled cyclist behaviour can be detrimental to the analysis of model outputs and reflect badly in the evaluation of otherwise viable schemes. Modelling cyclists, whether segregated or not, requires the modelling of overtaking behaviour so the chosen modelling software should support this.

The parameters M&V developed in order to produce modelling for the East-West Cycle Route[120] have been incorporated and further refined into the latest TfL Vissim Template (section **B7.1.2**). This section includes details of these parameters along with advice on how to use them. While the parameter names are specific to Vissim, the techniques can be applied in other microsimulation software where equivalent parameters are available.

2.6.1 Links and Behaviour Parameters

The link and connector network structure for cyclists can be modelled using the four main behaviour types defined in the TfL Vissim Template (section **B7.1.2**):

- Segregated links;
- Segregated stopline links;
- Non-segregated (mixed) links; and

120 Green, J., Cyclist Modelling Briefing Note East-West Cycle Super Highway, Transport for London, April 2014

- Non-segregated (mixed) stopline links with an ASL, or equivalent behaviour, present.

Lane and vehicle widths are particularly important when modelling cyclists, as lateral behaviour, such as vehicles overtaking in the same lane, plays a significant role in their movements and interactions.

2.6.1.1 Segregated Links

In order to prevent unrealistic two-way overtaking manoeuvres, segregated links should have a width of 0.25m less than the design width so that two-way paths have a 0.5m clearance between them[121]. As is shown in **Figure 155**, the gap also helps cyclists maintain the safe separation that they would on street.

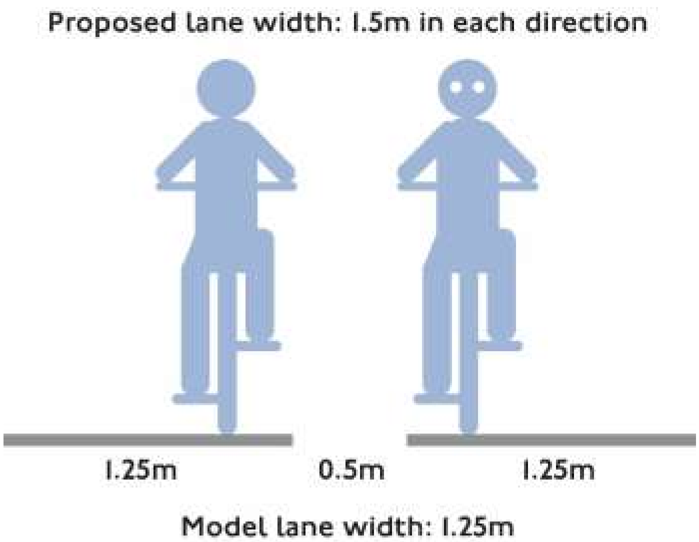


Figure 155: Lane widths showing 0.5m clearance between opposite directions

Segregated stopline links should be modelled using the entire design width specified. As a starting point, they should begin approximately 8m before the stopline and terminate approximately 8m after the stopline. However, when the exit of a stopline link is connected to a segregated link of lesser width some bunching and snagging can occur, due to cyclists not having dispersed adequately and alternative lateral behaviour parameters taking effect. It may therefore be necessary to increase the length of the segregated stopline link beyond the stopline to reduce this snagging. In addition, it is also helpful to reduce the link widths following a segregated stopline link in increments to further reduce snagging. In **Figure 156**, with cyclists travelling from left to right, the width of the cycle lane is 1.5m

121 Local Transport Note 2/08 – Cycle Infrastructure Design, Department for Transport, October 2008

which increases to 2m at the stopline (stopline behaviour applied) and tapers back to 1.5m via a 1.75m Link to help cyclists disperse smoothly.

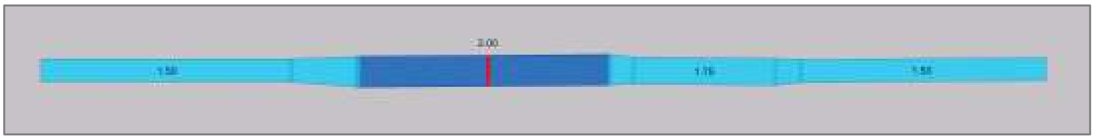


Figure 156: Stopline location and decreasing link widths

2.6.1.2 Non-Segregated Links

For junction turns it is often beneficial to provide cyclists with their own connectors, separate from other vehicles, as cyclists generally take different paths through turns to motorised vehicles. This is one of the most challenging areas of modelling cyclists and a significant amount of testing and calibration is required. Conversely, ahead movements can work better using one connector for all traffic, particularly if cyclists delay other traffic discharging from the stopline.

The recommended starting point for modelling the different cycle facilities provided in mixed traffic conditions are summarised below:

- **Mandatory cycle lane, separated from traffic with wands (semi-segregated)** – Due to the physical separation between cyclists and traffic, these cycle lanes should be modelled using the segregated link behaviours (section **C2.6.1.1**);
- **Mandatory cycle lane, with little or no incursion** – it is recommended that a separate cycle only lane is modelled, with the on-street width of the mandatory cycle lane reflected. The 'observe adjacent lane(s)' parameter should be applied for all vehicle types;
- **Advisory cycle lane, with little or no incursion** – these should be modelled in the same way as a mandatory cycle lane with little or no incursion;
- **Advisory cycle lane, with incursion or narrow width** – it is recommended that the carriageway is modelled as a single wide lane with non-segregated (mixed) traffic behaviours; and
- **No cycle lane** - it is recommended that the carriageway is modelled as a single wide lane with non-segregated (mixed) traffic behaviours.

For further information on how to model the different cycling facilities listed above, please refer to the TfL Vissim Template guidance documentation (section **B7.1.2**).

Where cycle lanes have been provided on a shared link, the traffic lane adjacent to the cycle lane should be open to cyclists to allow realistic overtaking behaviour, while any other offside lanes should be closed unless in the vicinity of right turns. The starting point to allow lane changing for right turns should be carefully calibrated from site observations.

Particular consideration should be given to links where cyclists can overtake buses at bus stops. The model should be configured so that buses stop on the left-hand side of the link and cyclists can overtake on the offside only. Link widths and lateral behaviours should be set up so that vehicles can only overtake the bus if they are able to on street, for example, it may be the case that cyclists and cars can overtake where lorries cannot. **Figure 157** shows a cyclist completing an overtaking manoeuvre and a car attempting to start one. The lane width has been increased to allow these manoeuvres to happen as they do on street. A behaviour type has been included in the TfL Vissim Template (**B7.1.2**) to assist with modelling cyclists at bus stops.

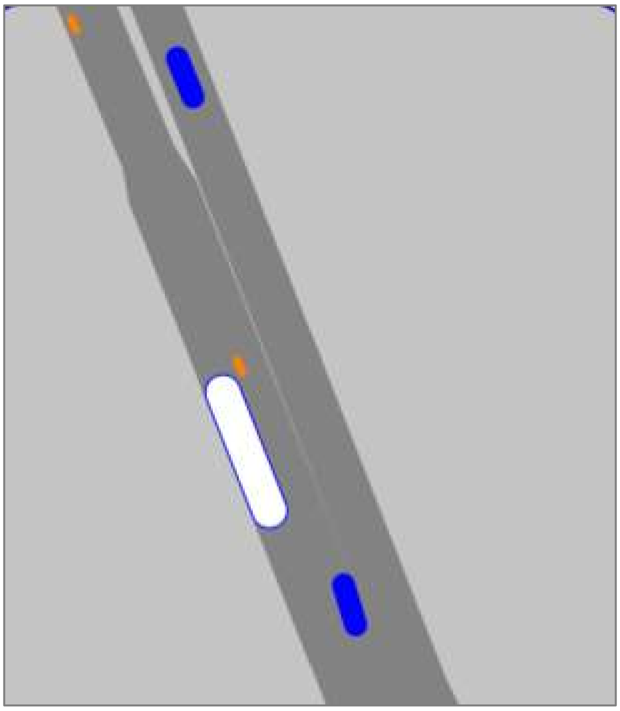


Figure 157: Cyclist overtaking a bus at a bus stop

2.6.1.3 General

Cyclist-cyclist driving behaviour can be challenge to model correctly in high-volume cyclist situations. Priority rules for cyclist–cyclist conflicts have been seen to work effectively by adjusting the typical Min Gap Times and Min Headways values used for general traffic conflicts. The calibration starting point for these values are demonstrated in the TfL Vissim Template (section **B7.1.2**) and supporting guidance documentation.

Where cyclists make turns an appropriate reduced speed distribution should be used and the Connector's Desired Direction set to All, Right or Left accordingly. This causes cyclists (and vehicles in general) to adopt the correct lane position before turning and prevents blocking of other movements. It should be noted that use of the Desired Direction parameter may cause unrealistic single file queues, so it could subsequently be necessary to set it back to All or adjust the positioning of the connector in relation to the link.

Since a large part of cyclist modelling is dependent on observation, regular reviews of the models should be performed in 3D mode to check that behaviour looks acceptable. A general principle of modelling cyclist behaviour can be stated, "if it looks wrong then it probably is"[122]. If this is the case, then further adjustments will need to be made. Feedback on unusual situations is welcome and should be sent to **TfLModellingGuidelines@tfl.gov.uk**.

2.6.2 Composition

For cycling-specific schemes in central London where a high level of detail is required, it may be necessary to split cyclists into general and cycle hire bikes. See section **C2.3** for further details.

2.6.3 Speed and Acceleration

The TRL research discussed in section **C2.2.2** suggests that the main influencing factors on cycle speeds are time of day, and whether the cyclist is using a cycle hire bike or not. Speed distributions have been included in the TfL Vissim Template files (section **B7.1.2**) to cover these possibilities.

The speed distributions in the TfL Vissim Template have been based on observed data; however, a limited number of sites with differing characteristics were involved so they should only be considered as a

122 Green, J., Cyclist Modelling Briefing Note East-West Cycle Super Highway, Transport for London, April 2014

starting point. Adjustments may be required depending on turning movements, gradients or other factors.

Similarly, preliminary acceleration profiles have been added to the Template.

2.6.4 Routes

As with general traffic (section **B7.4.4**), it is preferable to use end-to-end routing for cyclists if possible. Depending on the proposed scheme, simply implementing turning counts as local routes through a junction in a microsimulation model can cause problems when moving to the proposed design, for example if junction layouts have changed or movements banned.

A simple matrix estimation exercise can be used to generate routes from turning counts if no other information is available. Caution should be used, however, as this can generate unrealistically long routes in larger models and can lead to some inappropriate routing.

This is one possible use for Cynemon (section **C2.2.3**), and methods of using Cynemon routing data in microsimulation models are being explored at the time of publishing.

2.6.5 Stopline Capacity for Segregated Cyclists

As is the case for deterministic modelling, cyclists should be calibrated to achieve the stopline capacity derived from the research outlined in section **C2.2.1.2**. The TfL Vissim Template (section **B7.1.2**) includes parameters for segregated link stoplines, which can be used as a starting point (**Figure 158**).

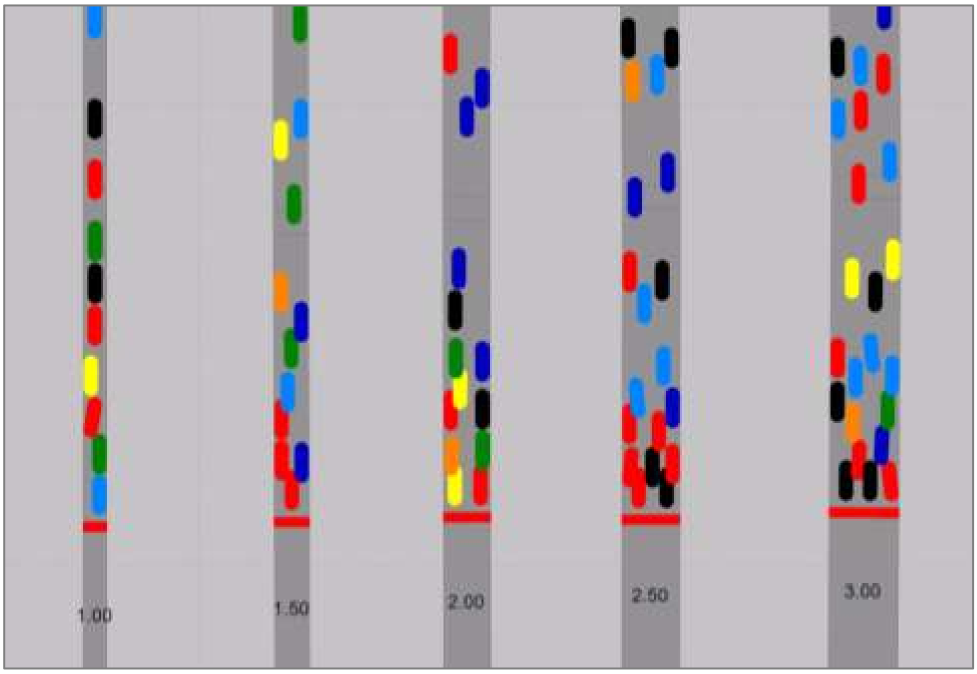


Figure 158: Vissim cyclists forming queues at various lane widths

If the link is at, or intended to be at, capacity, then the stopline discharge rate is achieved if the cyclists use all the green time but no queues form between green periods. Otherwise, the discharge rate can be checked manually against the required capacity by observing the model. As indicated in section C2.6.1.3, it is good practice to watch each stopline in any case, as this will help identify any other modelling issues.

2.6.6 Stopline Capacity for Non-Segregated Cyclists

Modelling cyclists in mixed traffic conditions is often more challenging than for segregated situations, as there is more interaction at the stopline. It can be particularly difficult to measure and calibrate saturation flows at these stoplines. An ideal methodology would be:

- Measure the traffic saturation flow at a time of day when there are few cyclists, or when cyclists do not affect the vehicular discharge rate;
- Measure the traffic saturation flow with cyclists present. Note that cyclists should not be included in the vehicles counted unless they form part of the main queue;
- Calibrate the modelled saturation flow without cyclists present; and
- Introduce cyclists into the model and verify that the saturation flow matches the on-site value including cyclists.

Whether this amount of effort is justified depends on the purpose of the modelling. In theory, it should deliver good results, but it is not a complete solution. The exact methodology to be used should be discussed and agreed in the MAP Stage 1 Base scoping meeting (section **B2.1.5.1**).

2.6.7 Validation

Before attempting to validate cyclists in a model, it should be considered whether validation is necessary. This will depend on the purpose of the model and should be agreed in MAP Stage 1.

Cyclist flows can be validated against surveyed counts in the same way as for general traffic. Any routing should be checked to ensure that it looks sensible. In addition, there should be a visual validation of cyclist trajectories to ensure they match those observed on site.

The observed average travel times from GPS data (section **C2.3.2**) can be used to validate microsimulation Base model results. For each validation route the validation of cyclist travel times should be carried out in a similar way to other traffic and using the standard validation criteria.

Based on research TfL has undertaken, it is recommended junction approaches are excluded from validation using GPS data. Travel time markers should be placed beginning in the centre of one junction and ending 10m before the stopline of the next junction (**Figure 159**). This has been found to improve validation. A potential reason for recommending this is due to the compliance level of cyclists at red signals. As described in section **C2.4**, to provide a fair comparison with proposals, cyclists should be assumed to be compliant with red signals in Base and Future scenarios.

Figure 159: Diagram showing Travel Time Section start and end locations

3 Pedestrian Modelling

3.1 Introduction

The Mayor's Transport Strategy has placed a focus on improving London's walking environments in order to promote active, inclusive and safe travel. More appealing streets and footways encourage people to walk more, improve the quality of journeys that are already walked all or part of the way, and enable everyone to make the most of their local area. This is particularly important in town centres, around homes, workplaces, schools, and transport hubs.

In recent years there has been progress towards ensuring the provision of a more balanced transport impact assessment for all schemes, particularly for those with an emphasis on Healthy Streets. As such, there is requirement to consider pedestrian assessments for any scheme in Greater London which includes signalised crossings, TLRN footways, TfL bus stops or any other TfL assets. For schemes that are anticipated to affect a large number of pedestrians or have significant impacts on movement at street level, pedestrian modelling would be considered a requirement. TfL has evolved existing road scheme assessment techniques so that they are more appropriate for modal interaction and ultimately more reflective of the modern road network.

This chapter explores the modelling approach applied to a pedestrian / walking infrastructure scheme assessment. It considers currently available modelling tools (LEGION, described in section C3.3.2.1 and Viswalk, described in section C3.3.2.2) and the best practice methodology. The aim is to provide a point of reference to those considering Healthy Streets schemes that specifically focus on walking provision enhancements, as well as traffic schemes that incorporate pedestrian facilities into the wider scope of the proposals.

This chapter is intended to assist both a technical and non-technical audience, and to provide guidance to transport professionals assessing pedestrian conditions in the surface level environments of Greater London. These environments include but are not limited to:

- Pedestrian areas on the TLRN;
- Areas that contain TfL assets such as traffic signals (for example pedestrian crossings) or bus stops;
- Surface level public transport hubs which serve TfL services such as buses, coaches and trams; and
- Areas around rail stations which serve TfL services such as the Underground, Overground and DLR.

The objective is to produce safe, pleasant and functional pedestrian environments by establishing a consistent approach to the planning and implementation of modelling. Schemes should deliver improvements for pedestrians that are well-designed, fit for purpose, cost effective, and sustainable.

3.1.1 Case Study

This case study has been included to showcase the improvements in pedestrian modelling processes which have been brought about over recent years in order to provide robust assessments of network changes on pedestrians.

The Parliament Square Streetscape Project (PSSP) examined the feasibility of developing and implementing a scheme of security, public safety and public realm improvements in the vicinity of Parliament Square, outside the Palace of Westminster and Westminster Abbey. It was proposed by the Mayor of London, TfL and Westminster City Council with the aim of improving the local environment for workers, visitors and residents alike. As part of the design, sections of Parliament Square and the road from Lambeth Bridge roundabout are closed to through traffic, so the proposals affect pedestrian and vehicular movements in and around the square. As such, modelling was undertaken to understand the impact of the proposed alterations on pedestrian flows and journey times through the area, to inform the design and next stages of the project.

Figure 160 shows the layout of the proposal and the modelled area. The detached area to the bottom left depicts the underpass which stretches from Westminster Bridge, through Westminster Underground station, to the lower end of Whitehall, as in LEGION different vertical levels are modelled separately and linked together. The underpass is linked via relevant staircases to the rest of the model.

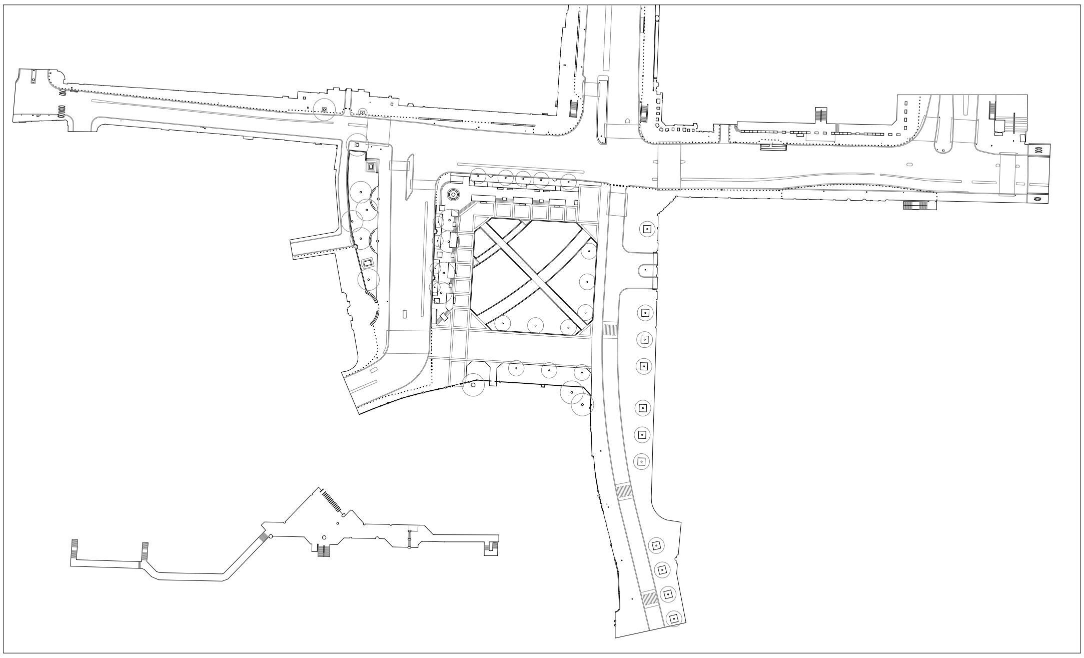


Figure 160: Layout of PSSP proposal

Until relatively recently, surface pedestrian modelling has been carried out on an ad hoc basis and has not been subject to the same prescribed processes as vehicle modelling. Change has come about due to the increased focus on Healthy Streets and the need to quantify benefits to pedestrians where schemes are intended to provide improvements, and to ensure they are considered and not disadvantaged by other schemes.

A pedestrian modelling study should be an expected contribution to a more balanced transport impact assessment for all schemes, and particularly those that have an emphasis on Healthy Streets. This is in order to better understand the operational impact and interactions between modes sharing road space, and more effectively capture relative performance measures as part of a cost benefit analysis exercise. The traditional approach that only considers the impact of pedestrian provision on traffic performance is no longer appropriate for modern transformational scheme assessment.

Specific aims of pedestrian modelling include:

- Understanding route choice;
- Identifying potential safety issues;
- Identifying potential points of congestion;
- Testing signal timings for pedestrians;
- Verifying that footway and crossing widths are adequate; and
- Deriving pedestrian journey times and social costs which can be used in scheme assessments.

The methodologies used in PSSP were peer-reviewed by an external consultant to verify that they provided a robust assessment process which could be taken forward to future schemes. Parliament Square provides a wide-ranging example of street-level pedestrian modelling as it contains many different features which are obstacles to pedestrians, including trees, bollards, lamp posts and hostile vehicle mitigation. It has a tube station, bus stops and crossings and also includes different types of pedestrian, including commuters who know where they are going and large numbers of tourists who stop to look around and take photos. All these features needed to be included in order to make the model as close to reality as possible and achieve the aims of the modelling assessment.

In order to incorporate these features, data from multiple sources was used, including passenger numbers for Westminster station, passenger numbers and timings for local bus routes, and interchange data to estimate the numbers who changed between bus and train or between bus routes. Innovative methods were used to combine these datasets to produce an OD matrix (section **C3.4.6**) and assist in more accurate routing. An advantage for PSSP was that the pedestrian modelling was planned from the beginning of the project. This meant the pedestrian models could be built in parallel with traffic models to ensure consistency between the signal timings, and any possible impacts of vehicles on pedestrians or vice versa could be reflected in the modelling.

Figure 161: Heat map showing the Cumulative Mean Density for pedestrians across the peak 15 minutes, using Fruin's LoS for walkways

Lasting improvements have also been made to the pedestrian modelling assessment and reporting processes. These have carried through to future projects and include:

- Creation of a pedestrian-focused Modelling Expectations Document (section B2.1.5.2) outlining the requirements for all stakeholders at the start of the project, including software versions, scenarios, programme estimates and outcomes;
- Calibration and validation recorded and reported on in a clearer way (including diagrams with tables to outline flow differences);
- Detailed reporting that can be used as the basis for future pedestrian modelling reports;
- Ability to calculate social costs (section C3.6.4) within modelling, using pedestrian journey times and weightings based on type of movement (walking / queuing / waiting);
- Routine use of heat maps (Figure 161) showing the average level of service experience, giving a better understanding of the implications of the scheme and which areas experience most congestion; and
- Creation of 3D visuals for high-profile schemes.

A further goal is to include pedestrian modelling in the upcoming version of MAP (section B2.1.5), so that all surface-level schemes and types of modelling will be subject to similar levels of verification and oversight.

At the time of publishing, PSSP has not progressed past the feasibility stage, however it is already possible to get an idea of how the scheme would look since the project included producing 3D visualisations, as shown in **Figure 162**. Including 3D visuals in the modelling outputs gives all stakeholders a clearer picture of how the scheme would work and is useful for conveying technical data to a non-technical audience.

Figure 162: 3D visualisation of the PSSP modelling

3.2 Relevant Guidance Documents

The TfL publications outlined in this section are important references for pedestrian planning studies. Information provided in these documents should be used to supplement street level modelling studies as appropriate. For pedestrian assessments which will be submitted for approval by TfL, the guidance in Modelling Guidelines should be followed in conjunction with more detailed technical guidance provided in these TfL documents.

Pedestrian modelling has been used by London Underground (LU) for many years and, although based around station design, their guidance documents provide a useful reference when carrying out street-level modelling.

The Pedestrian Comfort Guidance for London (PCGL) and Legion Best Practice Guide (LBPG) are heavily referenced in this document as they have the most relevance to street-level pedestrian modelling. Station Planning Standards and Guidance (SPSG) may be useful if the area to be modelled contains a station or other building where the configuration inside is relevant. The Planning for Walking Toolkit contains guidance on designing, rather than modelling, pedestrian spaces but is a useful reference. Finally, the two software manuals provide specific advice on how to get the most out of the pedestrian modelling software.

3.2.1 Pedestrian Comfort Guidance for London

The PCGL[123] (with supplementary spreadsheet templates) is aimed at anyone involved in planning London's pedestrian spaces. It is intended to ensure that the design of footways and crossings is appropriate for the volume and type of users. The guidance is applicable whether evaluating a new design or an existing footway. Outputs include Pedestrian Comfort Levels (PCL, sections **C3.3.1.1** and **C3.6.1.2**) and can be used to derive appropriate signal timings or crossing widths (section **C3.3.1.2**).

123 PCGL **http://content.tfl.gov.uk/pedestrian-comfort-guidance-technical-guide.pdf**

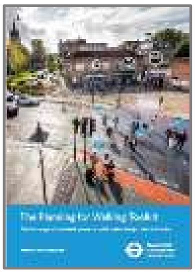
3.2.2 LEGION Best Practice Guide

The LBPG[124] summarises the key steps for modelling TfL stations using LEGION pedestrian simulation software. At the time of publishing, specific guidance on modelling footways and crossings is due to be added to the latest version. It promotes a consistent approach to LEGION modelling studies through the creation of robust models that deliver accurate and reliable results.

3.2.3 Station Planning Standards and Guidelines

The SPSG[125] document is LU's source document for space planning in stations. It establishes the requirements for all station works that affect passenger movement or that have an impact on overall station size. Further information can be found in section **C3.3.1.4**.

3.2.4 Planning for Walking Toolkit



The Planning for Walking Toolkit[126] is a handbook providing advice for planners and designers involved in the redesign or creation of pedestrian areas, including streets, off-road footpaths and public spaces across London. It aims to embed good practice urban design principles in the planning and design process, setting out these principles alongside recommended analytical tools. It provides guidance on subjects from data collection and identifying existing issues through to supporting the development of the design brief in order to set the vision for creating good environments for walking.

124 LBPG
125 G371A – Station Planning Standards and Guidelines, Issue A4, Transport for London, May 2012
126 **http://content.tfl.gov.uk/the-planning-for-walking-toolkit.pdf**

3.3 Modelling Approach

When changes are made to a surface level pedestrian environment as part of redesigns, planned works or events, the impact on pedestrians should be considered. Changes which should be assessed include:

- Adjustments to the street-level space provided to pedestrians (for example footways);
- New or redesigned pedestrian crossings;
- Changes to walking routes; and
- Redesign of public transport stations.

It is advisable to consult with NP to confirm if an assessment of pedestrian conditions is required. Any scheme that may have an impact on pedestrians should be considered and a decision made based on pedestrian demand, location and scheme objectives. Once the need for pedestrian modelling has been identified, a decision can be made as to what type of analysis is required.

Pedestrian modelling can be split into two distinct types, static and dynamic (also known as microsimulation). Static assessment is usually carried out in spreadsheets and is described in full in this section. Dynamic modelling involves specialist pedestrian modelling software and is far more complex to carry out. It is covered in the remainder of the chapter. An individual scheme may require static or dynamic modelling, or a combination of the two approaches.

3.3.1 Static Modelling

A static assessment is a form of deterministic modelling (section **A3.4.1**) as the results are fully determined by the inputs, meaning the same inputs will always give the same outputs. NP have developed a number of spreadsheets that can be used when looking at different aspects of the pedestrian experience. These are applied to schemes where it has been decided that full dynamic pedestrian modelling is not necessary or possible. Static assessment can be undertaken to provide technical reassurance when assessing the condition, with regard to pedestrian usability, of public spaces across different scenarios.

The two main forms of static assessment that are used are:

- Pedestrian Comfort Levels (PCLs) on footways and crossings; and
- Journey times and delay at signalised pedestrian crossings.

The limitation of static assessment is that it does not consider variable flow rates, which may occur due to conditions such as the arrival of pedestrians exiting a bus. Consequently, static assessment is best suited to projects that do not have complex requirements or are constrained by the project timescales. Static assessment may be more appropriate for small-area, low population, studies such as a section of footway or a simple pedestrian crossing design.

Conversely, static assessments have very low data and time requirements. They will usually only need:

- Diagrams of the layout, which can be measured in order to determine the dimensions of the areas available to pedestrians;
- Current or predicted pedestrian volumes in the form of hourly bi-directional flows at each section of footway or crossing being evaluated; and
- Signal timings of the crossings.

Once these are available, the spreadsheets can be filled in and the results generated for any scenario or time period which is required.

When a surface level pedestrian environment is being assessed statically, a best-fit approach using the most appropriate published guidance should be adopted, with all assumptions documented as part of a technical note. This should identify whether it is pedestrian comfort, signal timings or specific design elements that need to be assessed and detail which static assessment technique(s) is being used. It is recommended that agreement is reached, on a case-by-case basis, with all relevant stakeholders, on the approach and guidance that will be used. It may be necessary to undertake a mixture of assessments or even a combination of static and dynamic modelling. This approach has proved useful for producing PCL outputs for future (predicted) conditions where pedestrian flows on footways are measured from a dynamic model and used as inputs for PCL spreadsheets.

The different static assessment methods are outlined below.

3.3.1.1 Pedestrian Comfort Levels

For surface level static assessments, the most common requirement is the calculation of PCLs. Section **C3.6.1.2** shows how measurements of people per metre each minute (ppmm) are converted into PCLs and gives a description of what each level is like for a pedestrian to experience. Whether each level is considered acceptable is dependent on the type of area that it is applied to. For example, a retail area such as a high street would become unacceptable to pedestrians at a lower PCL than a transport hub. Pedestrians may consider going elsewhere if a high street reached PCL B- or C+, whereas they could tolerate the transport hub up to PCL C- or D. **Figure 163** shows PCLs applied to different sections of footway. It highlights general areas which may have capacity problems.

Figure 163: Pedestrian Comfort Levels applied to sections of footway

PCL calculations require footway dimensions and average and peak hourly pedestrian flow rates. If a crossing is to be assessed then the signal timings are also required. Further information on how PCLs are measured and applied can be found in TfL's guidance document, Pedestrian Comfort Guidance for London (PCGL)[127], which also includes a spreadsheet that contains the calculations.

Following this process can provide information to those assessing the validity of a scheme by way of offering high-level outputs demonstrating how crowded pedestrian areas may become. For proposed schemes, levels of crowding are derived from forecasted pedestrian flows and the proposed dimensions of pedestrian spaces, and can be used to assess how these levels compare to the existing situation.

127 Pedestrian Comfort Guidance for London – Guidance Document, Version 2, Transport for London, 2019

3.3.1.2 PCLs and Signal Timings at Crossings

As mentioned in the previous section, PCL calculations can be used to assess pedestrian crossings. This also includes any islands that may be part of a staggered crossing.

The following input data is required:

- **Pedestrian phase green time [gt] (s)**;
- **Pedestrian phase blackout [bl] (s)** – this is a safety-critical value based on the length of the crossing[128] (the width of the road). Depending on the type of crossing, it may include flashing amber or pedestrian countdown;
- **Pedestrian crossing width [w] (m)** – the distance between the rows of crossing studs;
- **Cycle time [ct] (s)**; and
- **People per Hour [pph]** – Hourly pedestrian flow, at average and peak levels.

The spreadsheet then calculates the following:

- **Percentage Time available to Cross [%tc]** – This is the proportion of time in a signal cycle that people can cross the road (during the green man and blackout periods). Given as; $\%tc = \frac{gt+bl}{ct}$; and
- **Relative People per Hour [rpph]** – This figure is used in the assessments and describes the equivalent number of people per hour that would cross the crossing if it was permanently on green and the crossing rate remained the same. It is calculated by dividing the pph by the percentage of time available to cross. Given as; $rpph = \frac{pph}{\%tc}$.

Using these values, a PCL is derived from Figure 177 in section 3.6.1.2 using the following formula:

$$ppmm = \frac{rpph}{60 * w}$$

This ensures that the PCL only applies to the crossing when it is in use.

As well as assessing existing and proposed PCL levels, PCL calculations can be used in reverse to provide indications of optimal pedestrian green times or required crossing widths for a particular proposed PCL, based on existing and future pedestrian flows.

128 SQA-0645, Traffic Signal Timings, Issue 3, Transport for London, December 2013

In order to decide on appropriate crossing timings given a fixed width (w), predicted flows (pph) and a required PCL (for example, B+ which is 9 ppmm), manipulating the above formulae gives the following:

$$\%tc = \frac{pph}{rpph} = \frac{pph}{60 * w * ppmm}$$

The %tc value can be used in conjunction with the cycle time and the blackout to obtain a minimum green time for the pedestrian phase. The ppmm value should be assumed to be within the range of the required PCL. It should be no greater than 17, which is the cut off for the B- comfort level. Once these timings have been produced, the spreadsheet then compares the proposed green and red pedestrian times with the required ones to see if they would be viable.

If the %tc is greater than or equal to 100% it indicates that the crossing is not wide enough to accommodate the flow of pedestrians. The people per hour must be less than the relative people per hour (pph < rpph). This assessment method cannot calculate meaningful signal timings if the crossing width is not wide enough. The minimum width can be calculated and input in order to continue and test signal timings. Any issues with the proposed crossing width should be fed back to the scheme designer.

To calculate the minimum width required for a specified PCL the following formula is us used:

$$w = \frac{rpph}{60 * ppmm}$$

The spreadsheets can be used on multiple crossings and the cycle times can be adjusted to test further mitigations and impacts. It is important to take note of traffic signal arrangements such as SCOOT regions and minimum green times.

For further information on this method of assessment refer to the PCGL[129] and for further guidance contact **StreetsPedestrianModelling@tfl.gov.uk**

3.3.1.3 Wait Times at Signalised Crossings

NP has created a spreadsheet that can be used to assess average wait times and journey times at signal-controlled pedestrian crossing facilities. It can be used for up to four linked crossings to assess direct and staggered configurations.

129 Pedestrian Comfort Guidance for London – Guidance Document, Version 2, Transport for London, 2019, accessible at **http://content.tfl.gov.uk/pedestrian-comfort-guidance-technical-guide.pdf**

The spreadsheet calculates the wait time and journey time for a pedestrian arriving at the crossing at each second of the cycle time. It uses these values to identify the average, minimum and maximum wait times and journey times.

Where staggered crossings are involved, the offsets between the crossing signal timings and walking time between the crossing points are considered. The walking speed is assumed to be 1.2m/s, although this can be adjusted if required. Calculations are automatically produced for both crossing directions. The following input data is required:

- Pedestrian phase start of green (s);
- Pedestrian phase end of green (s);
- Pedestrian crossing length (m);
- Distance between crossings (m); and
- Cycle time (s).

In some cases, such as asymmetric double-cycling of staggered crossings, the spreadsheet may need to be manually adjusted.

The spreadsheet can be used to provide a high-level comparison of pedestrian impacts between different junction designs and/or different sets of signal timings.

For access to the spreadsheet email **StreetsPedestrianModelling@tfl.gov.uk**

3.3.1.4 Station Planning Standards and Guidelines

Although the focus of these Guidelines is street-level modelling, there may be occasions where it is necessary to consider pedestrian behaviour inside structures, for example, for the assessment of elements within surface level public transport stations. TfL has produced a guidance document "G371A - Station Planning Standards and Guidelines" (SPSG)[130] which forms a guide to LU's Station Planning Standard number S1371. The Station Planning Standard is LU's source document for space planning in stations and applies to all LU stations, existing and planned. It establishes the requirements for all station works that affect passenger movement or that have an impact on overall station size. The guidance document includes examples of static assessment approaches based on spreadsheet calculations which may be relevant to any public transport station. These calculations focus on short time intervals (such as peak minutes) and outputs are typically limited to identifying the minimum size and quantity of discrete elements, such as staircases and ticket gates. The inter-

130 G371A – Station Planning Standards and Guidelines, Issue A4, Transport for London, May 2012

relationship of such elements is usually beyond the model's capability. For further guidance in relation to a particular scheme contact **StreetsPedestrianModelling@tfl.gov.uk**.

3.3.2 Dynamic Modelling

Dynamic pedestrian modelling, which is a form of microsimulation modelling, provides a more detailed representation of pedestrian movement than static modelling, as it simulates individual pedestrians and how they interact. Different types of pedestrians, for example men, women, tourists and commuters, can be modelled if required and the data is available. These can be given different speeds and routing based on research and data collected on site. For example, tourists with suitcases take up more space and are likely to move more slowly than commuters who travel to the area every day. This variability means that dynamic models are a more accurate representation of real life and can provide valuable insights into the performance of pedestrian spaces.

Dynamic modelling has the visual benefit of being able to present crowding maps and videos of recognisable two-dimensional plans, which can easily highlight problem areas and display the model outputs to a non-technical audience. It also measures pedestrian walk times which can be used to demonstrate the performance of various layouts and also to provide social cost outputs for different options and scenarios, which can be used for assessing schemes. Further information on dynamic outputs can be found in section **C3.6**.

Dynamic modelling requires a large amount of data which in turn takes longer to process compared to a static assessment. When a need for dynamic modelling is anticipated, it is recommended that NP is consulted at an early stage so resources can be allocated and data requirements identified.

The software involved in pedestrian microsimulation can be specifically designed to model pedestrians only or it may be integrated as part of traffic microsimulation. The two pedestrian modelling software packages used by NP are LEGION, which only models pedestrians, and Viswalk, which is integrated within Vissim (see Chapter **B7** on **Vissim Modelling**) . Any pedestrian modelling which will be submitted for approval by TfL should therefore be completed in either of these packages.

The rest of this chapter applies to all dynamic pedestrian modelling, whether LEGION or Viswalk is used (any exceptions will be noted).

3.3.2.1 LEGION

LEGION is pedestrian modelling software developed by Bentley Systems[131] which represents pedestrians as adaptive agents and treats pedestrian movement as a multi-agent complex system. The interactions between individual pedestrians lead to crowd behaviour emerging naturally rather than being explicitly modelled. LEGION uses inputs along with other types of object such as direction modifiers and drift zones, in order to best represent pedestrian movement and interaction in the modelled area. LEGION has been used for many years by LU to model passenger behaviour in stations and is also often used to model high-profile surface schemes. A screenshot from the LEGION Model Builder is shown in **Figure 164**.

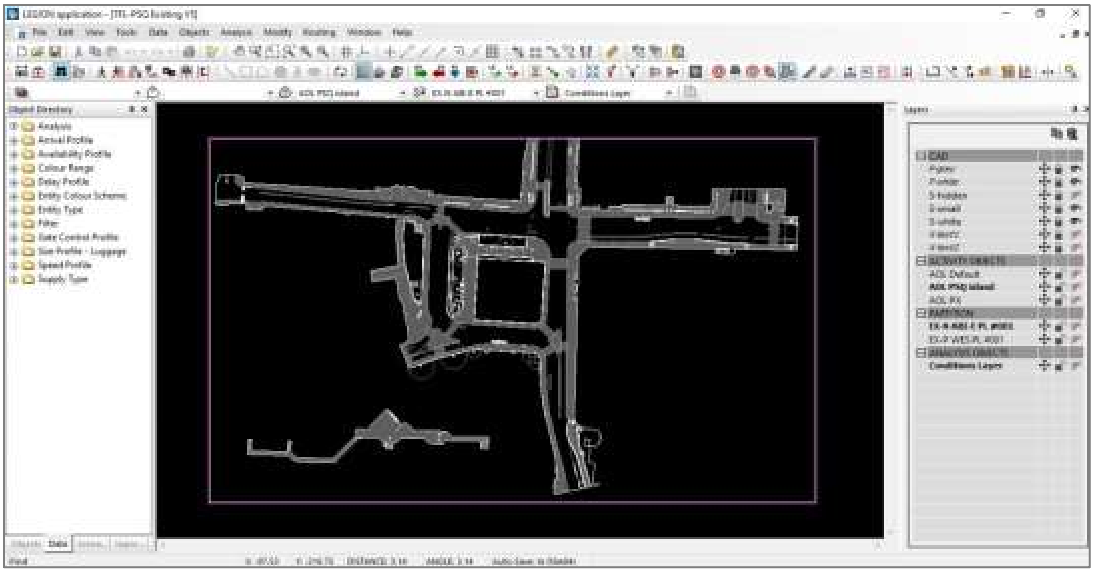


Figure 164: LEGION Model Builder screenshot

LEGION cannot explicitly model signalised junctions or crossings. Signal control is simulated using waiting zones, where pedestrians are stationary for a defined and fixed period of time, so adaptive timings are not possible. In addition, LEGION does not include vehicles and so cannot predict situations where vehicles may affect pedestrian movements or vice versa.

More technical guidance which sets out best practice that modellers should adhere to when using LEGION can be found in TfL's Legion Best Practice Guide[132]. This contains reference to numerous different scenarios encountered on TfL projects, including those at a surface level. This

131 **https://www.bentley.com/en/products/brands/legion**
132 Modelling with LEGION: TfL Best Practice Guide, v4.0, Transport for London, June 2019

document is available on request when working on a project for or on behalf of TfL.

3.3.2.2 Viswalk

Viswalk, developed by PTV AG[133], specifically models pedestrians in urban areas. Pedestrian movement in Viswalk is built on a 'social force' model, so movement is based on forces assumed to be exerted by pedestrians and obstacles. Viswalk uses inputs in order to best represent pedestrian movement and interaction in the modelled area. The key benefit of Viswalk over other pedestrian modelling software is that it is integrated seamlessly within Vissim, so it can take advantage of all Vissim's signal control capabilities and investigate the impact of interactions between vehicles and pedestrians. Viswalk can also model in 3D, so that features such as footbridges, underpasses and stairs can be built in the correct location with the appropriate height or depth. **Figure 165** shows the Network Objects window in Vissim with the objects which are available for use when modelling pedestrians.

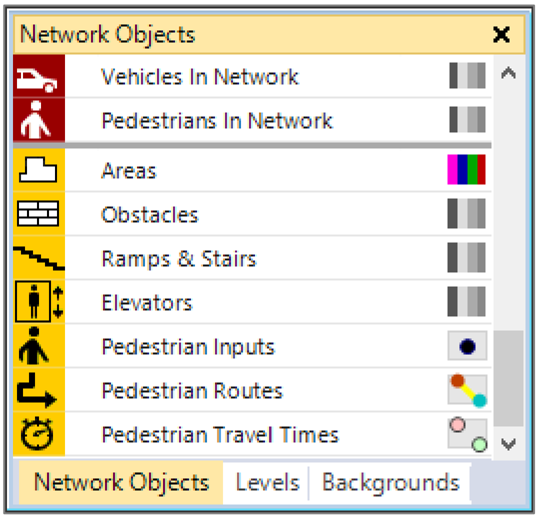


Figure 165: Pedestrian part of the Network Objects window in Vissim

For the purposes of this document, it is assumed that Viswalk is being run from within Vissim to gain the full benefit of pedestrian-vehicle interaction, further information on the use of Vissim can be found in Chapter **B7** on **Vissim Modelling.** TfL's use of Viswalk is relatively new therefore further detailed guidance is not yet available.

133 https://www.ptvgroup.com/en/solutions/products/ptv-viswalk/

3.4 Preparation

Once a decision has been made to carry out a dynamic modelling assessment, there are various requirements before modelling can begin. Preparations and inputs may vary from project to project but should always consider the elements described in the following section.

3.4.1 Modelling Expectations Document

A successful Modelling Expectations Document (MED) will aid efficient production of the necessary preparations and inputs required to complete a pedestrian modelling project. Section **B2.1.5.2** contains a detailed summary of the information that should be included in an MED, however, pedestrian modelling has a separate MED as there are some particular aspects which need to be considered. The amount of detail to be included should be proportionate to a study's scale and complexity.

Pedestrian modelling should be considered from the start of the project, in particular, the aims of the modelling and how both the modelling process and these aims could be integrated into the wider modelling work. Pedestrian modelling has specific data requirements which should be considered and recorded as early as possible to ensure that site visits can be arranged which cover the relevant time periods.

> Pedestrian time periods may need to be different to those of any associated traffic modelling. If this is the case it should be recorded, along with the reasoning and the expected source of signal timings for any extra periods of pedestrian modelling.

Pedestrian models require a high level of detail for the street environment. Existing CAD drawings should be examined to ensure that they are suitably detailed to provide a realistic assessment of the environment, for example, there may be a recent topographical survey. If this is not the case, then more time may need to be allocated to record the locations of street furniture and relevant features.

Finally, the MED should record the data sources that will be used to calibrate and validate the models, and any validation criteria that will be required. It should also detail the outputs that are expected, based on the type of modelling assessment and the results that are needed to demonstrate the outcomes of the scheme.

3.4.2 Time Periods

Typically, as a minimum, two peak periods of a day in terms of demand are modelled. These are generally the recognised weekday AM (07:00-10:00) and PM (16:00 to 19:00) peak periods. However, the actual peaks should be measured from demand data and utilised in the modelling. Likewise, other periods may also be relevant if it is known that a site is busy on weekends or outside of the usual peak periods, or if an assessment is being made for an event at a particular time of day.

If it is deemed that a three-hour model is not necessary then, as a minimum, the models should cover the actual peak hour period being assessed. The warm-up and cool-down periods are recommended to be 30 minutes but should cover, as a minimum, the length of time required for pedestrians to complete their journey within the model or 15 minutes, whichever is longer. Therefore, an absolute minimum period of 90 minutes per scenario should be modelled.

3.4.3 CAD Preparation

Once the study area and layouts of the pedestrian modelling have been agreed on as part of the project scoping, CAD drawings should be used that provide adequate detail to perform a realistic assessment of pedestrian space. CAD files are typically organised in layers so that different features, such as kerb lines, buildings and bollards, would be on different layers. Logical organisation of layers can significantly improve model building.

The assessment of pedestrian space is based on a two-dimensional representation of what the pedestrian experiences and can be considered in the same way as viewing a map. Therefore, all street furniture that acts as an obstacle at ground level should be included, such as lampposts, cycle racks, barriers, bollards and bus shelters. For street level assessments it is preferable to use topographical CAD, as this will contain sufficient detail of these obstacles.

Even with a topographical survey, it is recommended to complete a site inspection to check there are no changes to the area that impact pedestrian space. Also, time should be taken to detail any temporary objects that may not have been included in the CAD, such as café tables and chairs and pop-up advertising signs. For areas without a topographical survey, an OS tile can be used, however most street furniture must be added, and correct building and kerb lines checked. In this case it would be required to undertake a site visit to confirm the dimensions given by the

CAD as OS data has a relative accuracy of ±1.1 metres[134], which could be significant when dealing with pavement widths, for example. An example is shown in **Figure 166**, where the OS tile pavement outline is shown in blue and the topographical survey is shown in red. The top right corner of the image demonstrates a significant difference.

Figure 166: CAD showing an OS tile and topographical drawing

Consideration should be given to the appearance of the CAD when presenting modelling work to a non-technical audience, so the CAD and layout of the models are as easily recognisable as possible. It is recommended that this is considered at the beginning of a project, to ensure consistency between modelling work and presented results, and because changing background data late in the project is not advisable. Street layouts should reflect how they appear on most maps, with north at the top. The CAD drawings of all existing and proposed layouts should be aligned with each other to assist the audience in visualising how the assessed future year will look in comparison to the existing layout.

Consideration should also be given to what CAD is presented and what should be hidden. It is recommended that separate CAD layers are used appropriately, so that CAD included for simulation purposes only can be hidden and, conversely, CAD that should be viewed can be presented but have no impact on the simulation. For example, a street level model may include a pedestrian crossing. In this case the kerb line should be visible

134 **https://www.ordnancesurvey.co.uk/business-government/tools-support/mastermap-topography-support**

but not serve as an obstruction. This line should therefore be in a presentation layer but not a simulation layer. This applies more to LEGION than Viswalk as CAD cannot be used directly as a simulation object in Viswalk, although appropriately formatted data can be converted for use.

More detail on CAD preparation can be found in the relevant pedestrian modelling software guidance.

3.4.4 Public Transport Hubs

It is common for a surface level model to include a transport hub such as a train or bus station. Pedestrian flow generated by the hub can dominate other flows in the area so it is important that this is captured and modelled in sufficient detail for its impact to be represented. If the hub has multiple access points then these may need to be modelled separately, or it may even be necessary to include key areas such as ticket halls and gatelines. The level of detail required should be agreed prior to data collection so that the appropriate surveys can be specified.

3.4.5 Data Collection

Pedestrian modelling has more complex data requirements than other types of modelling due to the fact that pedestrians can start and end their journeys at any point in a network and, within reason, are not constrained to any particular route in between. They can travel at any speed and may pull bags behind them, use a wheelchair or mobility scooter, concentrate on their phones or travel together in groups. Their behaviour also changes depending on their journey purpose and whether they know the area well. Whilst it may not be possible to collect all this information and it may be too detailed for the modelling project, it is useful to be aware of the general characteristics of people that usually frequent the scheme area. This section provides guidance on the data collection process required for the assessment of pedestrian environments. Further information on data collection can be found in section **B2.3**.

3.4.5.1 Site Observation

Dynamic models can simulate complex interactions between pedestrians and their environment. It is therefore essential that on-street observations are undertaken at sites being modelled so that interactions can be noted and replicated in the model. It is not sufficient to use drawings and aerial photography only to build a model, as these are static sources and may not convey all the dynamic aspects of the site. CCTV may also be used; however, this is not an ideal solution as not all areas are covered and it is easy to pay less attention to areas which cannot be seen. Preferably, CCTV would be used in addition to, rather than instead of, site visits.

Site visits and surveys should include observations about pedestrians' behaviour and decision making. Features and conditions that induce unexpected decisions should be noted. A site visit can be helpful in understanding pedestrian routing, in particular identifying:

- Any preferences for routes that avoid congested areas but involve longer journeys, or a dislike of pedestrian crossings with long wait times;
- Situations where pedestrians congregate in large numbers and may be present at the start of a study period, for example queuing or waiting;
- Points of Influence, waypoints or intermediate destinations. For example, ticket machines, cash points or queues;
- The impact of sinks and sources, which include shops, cafes and other buildings not considered a main entry or exit point to the analysis; and
- Informal crossing points where pedestrians cross the road away from a designated crossing. This behaviour should be noted adjacent to existing crossings to ensure that these movements are captured in the demand for the crossing points, and also in situations where no crossing is present, if significant numbers of pedestrians are involved.

These can significantly affect model results and must understood from site visits in order that they can be accurately replicated in the model.

It is also important, whenever possible, to carry out site observations on days when other surveys, for example counts or journey times, are taking place. It is necessary to verify that the data collected represents a day that is considered typical or the data collection may need to be repeated at a later date.

Useful information on site visits for pedestrian data collection can be found in the appendices to PCGL[135].

3.4.5.2 Dates and Times

Whenever possible, pedestrian surveys should be undertaken for different time periods on the same day to ensure consistency. It may be appropriate to repeat counts on multiple days to ensure that the survey day is representative. In addition, there may be a need to amalgamate data from other sources such as rail, tube or bus data, where applicable.

135 Pedestrian Comfort Guidance for London – Guidance Document, Version 2, Transport for London, 2019, accessible at **http://content.tfl.gov.uk/pedestrian-comfort-guidance-technical-guide.pdf**

There is a need to consider the time periods for which data is collected. This can vary depending on the project requirements. For example, collecting data in 5- or 15-minute time periods might be appropriate for a larger model site, but for a project involving a single pedestrian crossing it might be more appropriate to collect data every minute or each cycle time of the junction.

Unless the assessment is specifically looking at a particular scenario, it is important to ensure that the data collected is not impacted by any events or incidents in the immediate or wider area. When trying to survey for an average day or time, ensure there are no events such as protests, football matches, tube closures or rail replacement buses. Counts should usually be carried out on a standard working day during term time.

The weather can have a huge impact on pedestrian movements, so it is vital to take this into account when surveying. Poor weather can mean higher use of private vehicles or public transport which could skew an assessment.

3.4.5.3 Flows and Journey Times

There are several sources of flow data that can be collected to assist a pedestrian modelling assessment, these can include:

- Manual Classified Counts, which involve a person on street counting different types of pedestrians making particular movements, for example across a crossing or along a section of footway;
- Video surveys, for counts and journey times; and
- Wi-Fi / Phone signal / Bluetooth capture methods.

When commissioning pedestrian count or journey time surveys it is important to consider the locations of each camera, enumerator and survey point carefully. It is necessary to ensure that there is no bias or impact on pedestrian movement as a result of obstructive surveying methods. When considering locations of cameras, it is recommended to locate these on existing infrastructure whilst also being careful to think about potential obstructions to the view. For example, if the camera is set up on the southern footway looking at the northern footway will the camera view be obstructed by a bus or large lorry? Are there any trees in the area that may move in the wind obscuring the view? For enumerator locations, are they in a suitable place for someone to stand without obstructing the usual flow of pedestrians?

It is necessary to capture the total flows at each entry and exit point, as well as a suitable number of internal footways and crossings for calibration and validation purposes. With dynamic models of pedestrians, careful consideration needs to be taken of sinks and sources. It will not be possible to model every single entry and exit point of a surface level model, for example individual houses, workplaces or shops. However, it is important to model all the main entry and exit points, such as schools, large offices and housing developments.

For journey time data it is necessary to collect pedestrian journey times on the key routes for model validation. Journey times should be collected across each peak hour being modelled, ensuring a random selection of pedestrians is chosen. It is important that enough pedestrians are surveyed for each PRM type to ensure a robust average.

It is necessary to ensure that all data collected and used in a project is GDPR-compliant and that individual pedestrians cannot be identified. For further information or details contact **StreetsPedestrianModelling@tfl.gov.uk**.

3.4.5.4 Public Transport Data

If an area is being surveyed for pedestrian flows then it is important to include any public transport impacts such as bus, coach or tram stops and rail and underground station entries and exits. Boarding and alighting at each of these should be included in any pedestrian surveys undertaken. Where this is not possible, or it is known that adjustments to services or routes are planned then specific data can be requested from TfL. This will typically be average data or figures derived through some form of model and will therefore not exactly match any other survey data. Before requesting any data, contact **StreetsPedestrianModelling@tfl.gov.uk** to ensure that it is suitable for the intended purpose.

Rail data comes from a tool called NUMBAT which can be used to inform the total numbers of people entering and exiting a station. This model represents a typical autumn weekday, Saturday and Sunday for all TfL-run rail and tram stations. Data is split into 15-minute intervals throughout the day and assumes a perfect service is operated.

Bus boarding and alighting data has two different sources:

- ODX data can report exact boarding, alighting, bus to bus and bus to tube interchange data by route and stop in 15-minute time periods. However, this data is subject to GDPR and has specific terms of use. Use of ODX data should be discussed before modelling to determine if it is suitable and/or available for the project; and
- BUSTO is an annual bus demand tool representing a typical autumn weekday, Saturday and Sunday. Data is extracted from ODX and averaged across days of the same day type. As this is aggregated data

it is not subject to GDPR and can therefore be shared externally where necessary.

In addition to usage data, it is important to have either the timetable or average arrival times of the buses to create a profile for boarding and alighting. Actual bus arrival, dwell and departure times are recorded via the iBus system. This data should be requested from a TfL sponsor to ensure the request is valid and formatted correctly. If it is not available then scheduled timetables can be found on the TfL website[136].

Information on the running of coach lines should be sourced from the relevant operator's website.

3.4.5.5 Signal Timing Data

For models that include signalised crossings it is important to collect traffic signal data. Guidance on the collection and use of signal timing data can be found in section **B2.3.8**.

Signal timings for Base models can be derived from deterministic models built for the scheme or obtained directly from NPD. Where available future year signal timings should be taken from a TfL approved Proposed model of the scheme.

This data should include the following for each pedestrian phase:

- Cycle time;
- Start of green;
- Green time; and
- Any other signal data, such as double-cycling.

Demand-dependent pedestrian stage appearances can be extracted from the Urban Traffic Control (UTC) system. This data is available in aggregated over 15-minute time intervals (section **B2.3.8.5**).

Since Viswalk can make use of Vissim's signal control capabilities Chapter **B7** on **Vissim Modelling** should be consulted when collecting signal data for Viswalk models.

136 https://tfl.gov.uk/travel-information/timetables/

3.4.6 Demand

The total number of pedestrians within a pedestrian model should be represented in the form of an Origin-Destination (OD) matrix. An OD matrix forms the basis for all model demand inputs as it contains all the sources and sinks which will be modelled. It should cover the agreed model duration.

A difficulty of street level modelling is the potential to require many OD pairs. Where possible, OD matrices should be limited to those essential to the study in order to maintain a usable model structure. It may be beneficial to combine minor roads into a single OD or combine entrances of a station where the station interior is not being modelled.

One way of converting count data into an OD matrix is by a method called Furnessing. This can be carried out in a spreadsheet template using the total number of entities (the visual representation of pedestrians within the model) entering and exiting a model at each location. M&V has an OD Furnessing template that can assist with this process.

Another method of generating OD data is by matrix estimation performed in 'dummy' pedestrian assignment models. This approach uses assignment modelling software such as Visum to build a pedestrian network and enter count data. The model can then be assigned before using the software's matrix estimation procedure to match the count data and generate the OD matrix.

In LEGION, as well as an OD matrix, all entries should have an associated arrival profile in time periods of no longer than 15 minutes, giving a breakdown of the total pedestrian flow every 15 minutes by each entry. Arrival profiles can be generated by the LEGION Data Template (LDT), as shown in **Figure 167**. An example of the arrival profile for single run, when imported into LEGION, is shown in **Figure 168**. Public transport hubs such as bus stops and stations should have their arrival profiles based on the service timetables, or 5-minute time periods if timetables are unavailable. For further information on these methods contact **StreetsPedestrianModelling@tfl.gov.uk.**

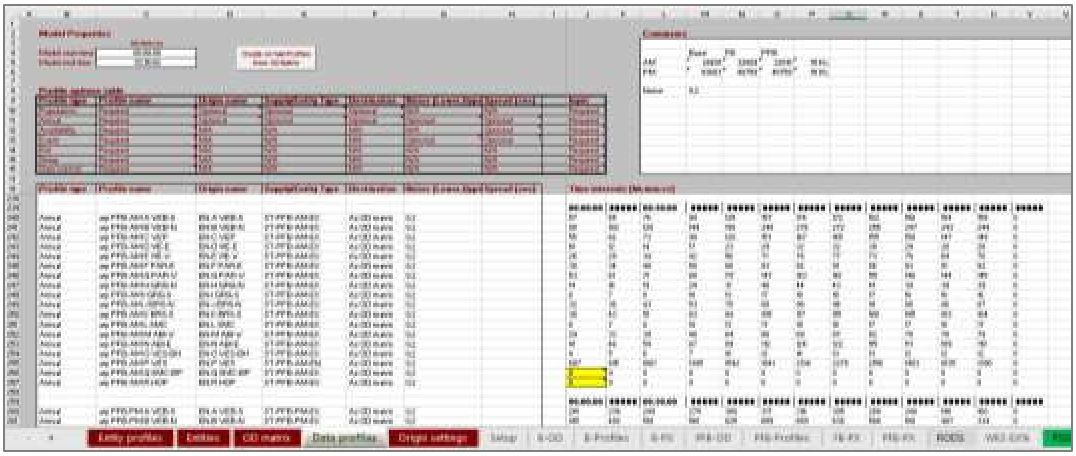


Figure 167: Example of the LDT with arrival profiles in 15-minute sections, noise between 0 and 2 and random arrival within that time period

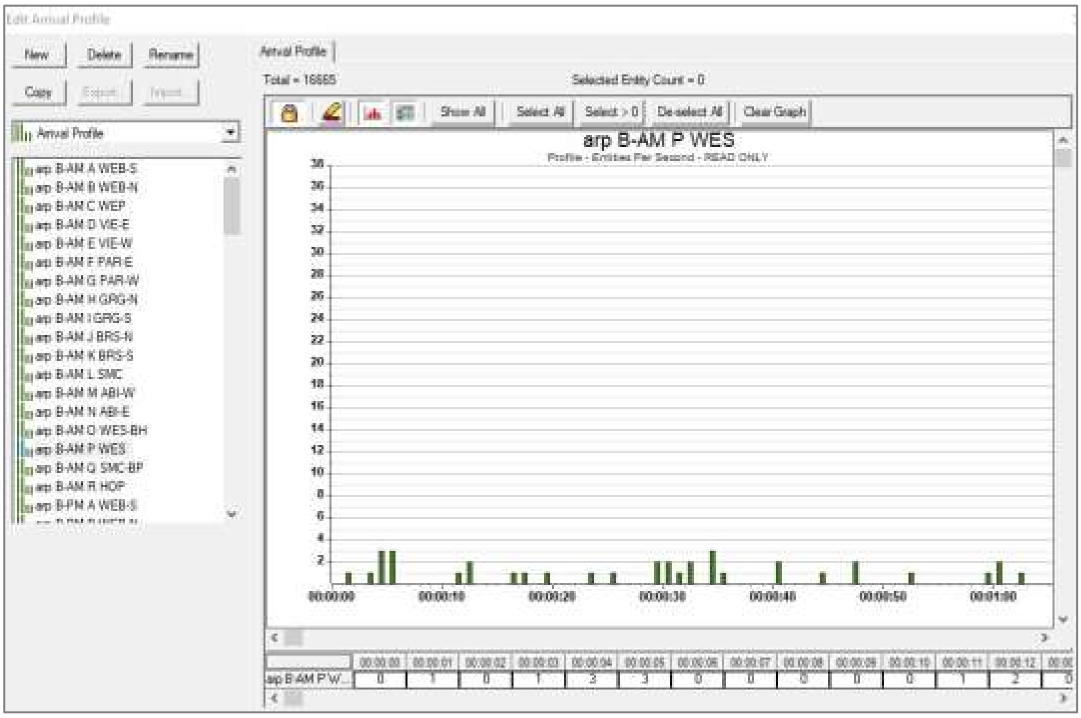


Figure 168: Example LEGION arrival profile

Viswalk pedestrian inputs are entered in OD matrices for each time period, as shown in Figure 169. Vissim automatically varies the exact entry time of each pedestrian in different random seeds (section C3.5.6.1), whilst still matching these values. The numbers in the OD matrices are in persons per hour, however long the time period which the matrix covers.

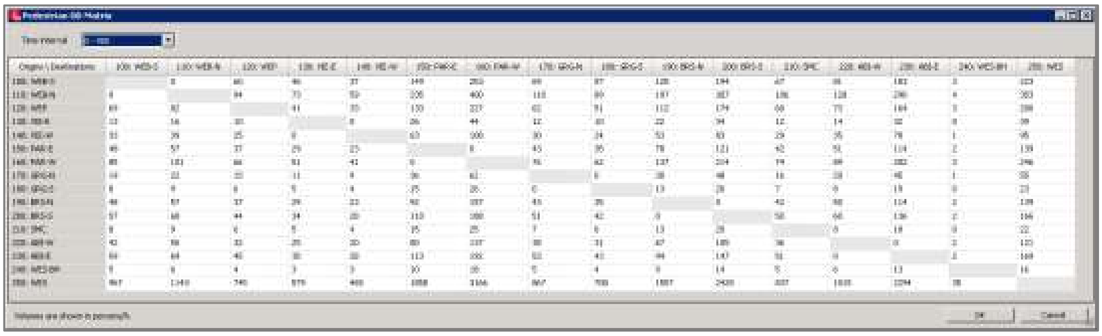


Figure 169: Viswalk pedestrian OD matrix

3.4.7 Pedestrian Types

When modelling pedestrians there are three main parameters that should be considered: speed, size and choice of route. Pedestrian modelling software should be able to reflect variance in these three parameters, and models should be reflective of the population being modelled.

Differing pedestrian types, including Persons with Restricted Mobility (PRMs), commuters and tourists, should be considered in all models, and have appropriate speed, size and routing profiles assigned. The proportions of PRMs for surface level models should be agreed as part of the project scope, and should be reflective of site survey data where available. Where site-specific proportions are not available it may be appropriate to use the default values as outlined below.

A 50:50 split of male and female pedestrians should be assumed where there is no site-specific data to suggest otherwise.

3.4.7.1 PRM Types

For modelling purposes, TfL has divided PRMs into categories according to the degree to which mobility is restricted. These categories can be used to define behaviour and routing characteristics such as speed and stairs / lift usage. They are defined in **Table 16**.

Table 16: PRM type definitions

Entity Type	Description	Examples of accompanying items
N	Non-PRM	Handbags, backpacks, umbrella, laptop case, pocket dogs, single shopping bags
A	Wheelchair users	Wheelchairs
B	Passengers with permanent or temporary physical mobility impairments	Walking sticks, guide dogs
C	Non-disabled passengers with heavy luggage	Rucksacks, sports bag, tennis racket bags, multiple shopping bags, toolbox, wheelie case (flight cabin luggage), fold bikes, fishing rods, golf bag, guitar case, (walking) dogs
D	Non-disabled passengers with large luggage	Cello case, all suitcases and large bags (including wheelie cases that are bigger than flight cabin luggage), full-size bikes, flat pack packages
E	Adults with young children (including with pushchairs)	Young children, pushchairs

3.4.7.2 Default PRM Proportions

Proportions of PRMs should be obtained from site surveys wherever possible. The proportions of PRMs defined in **Table 17** were developed for stations and so may not be suitable for a street environment, however, where no site-specific data exists they may be used as a starting point. Decisions on appropriate entity proportions should be agreed during the Base scoping meeting (section **B2.1.5.1**).

Table 17: PRM proportions

	Overall Proportions	Time of day variants		Station type variants		
Entity Type	Default	Inter-peak	Weekend	Outer Suburb	Euston, Paddington, King's Cross St Pancras	Victoria, Waterloo
N	89.40%	86.40%	88.50%	88.75%	85.40%	88.60%
A	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%
B	1.00%	1.50%	1.00%	1.20%	1.00%	1.00%
C	6.00%	7.20%	6.00%	6.00%	9.00%	6.60%
D	2.00%	2.40%	2.00%	2.00%	3.00%	2.20%
E	1.50%	2.40%	2.40%	1.95%	1.50%	1.50%

3.4.7.3 Default PRM Speed Distributions

The speed distributions for PRMs defined in **Table 18** were developed for stations and so may not be suitable for a street environment, however, where no site-specific data exists they may be used as a starting point. Decisions on appropriate entity speeds and sizes should be agreed during the Base scoping meeting (section **B2.1.5.1**).

Table 18: PRM speed distributions

Entity Type	Speed (m/s)								
	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90
N	5%	8%	12%	16%	18%	16%	12%	8%	5%

Entity Type	Speed (m/s)
	0.58
A	100%

Entity Type	Speed (m/s)
	0.80
B	100%

Entity Type	Speed (m/s)								
	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90
C	5%	8%	12%	16%	18%	16%	12%	8%	5%

Entity Type	Speed (m/s)								
	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70
D	5%	8%	12%	16%	18%	16%	12%	8%	5%

Entity Type	Speed (m/s)								
	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80
E	5%	8%	12%	16%	18%	16%	12%	8%	5%

3.5 Model Building and Development

Once the input data has been collected, it can be used to build and calibrate the model. This section provides guidance on how to approach the model build.

A calibrated pedestrian model should have as a minimum:

- Correct fundamental parameters and units;
- The correct, appropriate pedestrian area structure which replicates behaviour on street;
- Appropriate and correct flow and routing behaviour, in accordance with the scope and purpose of the model;
- Correct public transport data collected from reliable sources and modelled accurately. The level of detail of public transport modelling is dependent on the purpose of the model; and
- Appropriate signal control data with representative signal timings for the network during the period under consideration.

A key part of building a properly calibrated and validated pedestrian model is observing the model while it is running. Accurate representation of pedestrian behaviour is necessary for the model to fulfil its purpose. The animation features of LEGION and Viswalk can be used during calibration to identify irregularities in behaviour that may adversely affect model operation. The model should be observed during multiple runs to gain a rounded picture of its performance and provide reassurance that all the network elements are functioning correctly.

3.5.1 Entity Routing

When building dynamic pedestrian models, it is recommended that entities should be left to auto-navigate to their final destination as specified by the OD matrix or hard coded to match observed behaviour. Any intervention by the modeller to control the entities' route and decision-making should be clearly defined and should only be included to make movement more realistic rather than reducing entity congestion in order to make the model run more smoothly.

The overarching aim is that models achieve a good level of realism. To this end it is recommended that the following factors are considered as a minimum when calibrating a model:

- Unrealistic pedestrian movement or behaviour; and
- Unrealistic route choices.

Behaviour should be adjusted with as little intervention as possible and that intervention, when required, should be straightforward and transparent so that it can be understood by anyone reviewing the model.

In LEGION, primary routing between OD pairs should be based on Final Destination assignment and shortest path auto-navigation. User-defined fixed routes to intermediate targets should only be used where essential and the reason for taking this approach should be documented. Before pedestrian crossing operation is introduced, it is important to simulate the shortest-path auto-navigation between OD pairs in order to get the true shortest distance.

For Viswalk, entity routing should be hard coded based on survey data or site observations. It is important to observe entity behaviour during model runs, as anomalous routing may be a sign of an error in the coding of pedestrian areas, particularly at crossings or when Levels are used to model bridges or underpasses.

3.5.2 Street Level Footways

Since pedestrians can usually access any part of a street environment, decisions must be made in the model about which areas should be available for pedestrians to use. A busy road would not be included in the usable area, so the kerbline would mark the edge of the footway space which entities could use. Less busy roads with high pedestrian flows, however, may be regularly used by pedestrians and so could be modelled as part of the usable area. Decisions should be based on site observations and all assumptions should be agreed and recorded.

In LEGION, areas where pedestrians can occupy the same geographic location but at different heights, such as bridges and underpasses, must be offset within the model. When the different levels are connected at staircases or ramps, entities are automatically moved between them if their route requires it. An example is shown in **Figure 170**; the staircase in the centre links street level (left) to the tube station (right). The background CAD must be split into sections to account for this and consideration should be given to the layout so it is as clear as possible which levels connect and where.

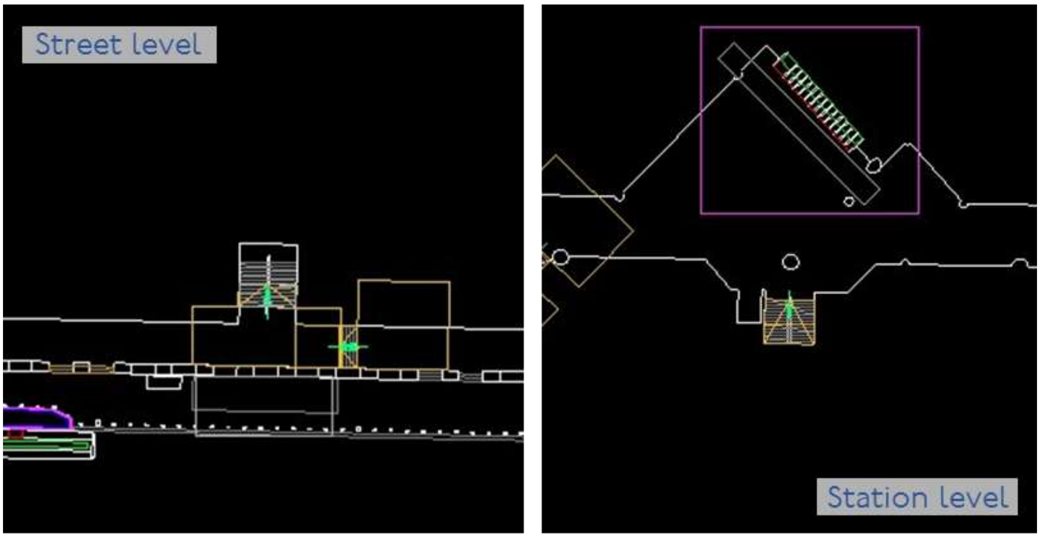


Figure 170: A staircase linking levels in a LEGION model

In Viswalk each area can have a 'z' coordinate so that features can be built in their exact location. Levels may be used so that areas of different heights can be connected by stairs or ramps. In **Figure 171**, street level footways and crossings are shown in light green and the underpass, in dark green, is connected by stairs.

Figure 171: Vissim screenshot showing different levels

3.5.3 Bus Service Intervals and Dwell Times

Most TfL bus service timetables are specified by frequency rather than departure time. This, along with changing traffic conditions, means that the headways between individual buses can be variable. Buses from different routes, or even different buses on the same route, can arrive at the same stop concurrently so bus stops should be modelled to take account of this. Site observations can be used in conjunction with iBus data to understand how the stops are used by buses.

Buses on street do not have fixed dwell times at stops; the dwell time is dictated by the number of passengers that need to board or alight. However, depending on the software, it may be necessary to model a fixed dwell time. If bus capacity is known to be an issue at a particular stop then site observations should be carried out to determine if any passengers are regularly left behind.

3.5.4 Bus Stops

Behaviour at bus stops can have an impact on pedestrian movements in the area. A bus shelter will cause a width restriction of the footway at all times, but the queuing behaviour of those waiting for a bus can also cause a temporary obstruction which should be accounted for in modelling. The key points that should be observed on site are:

- Type of bus stop / shelter;
- Queuing behaviour of the people waiting for a bus; and
- Routing and behaviour of pedestrians passing the stop.

Figure 172 shows an example of a bus stop where people usually wait under the shelter and those passing the stop have to fit into half the usual footway width in order to pass it. If the number of waiting passengers regularly exceeds the capacity of the shelter then site observations should determine where the surplus passengers prefer to wait.

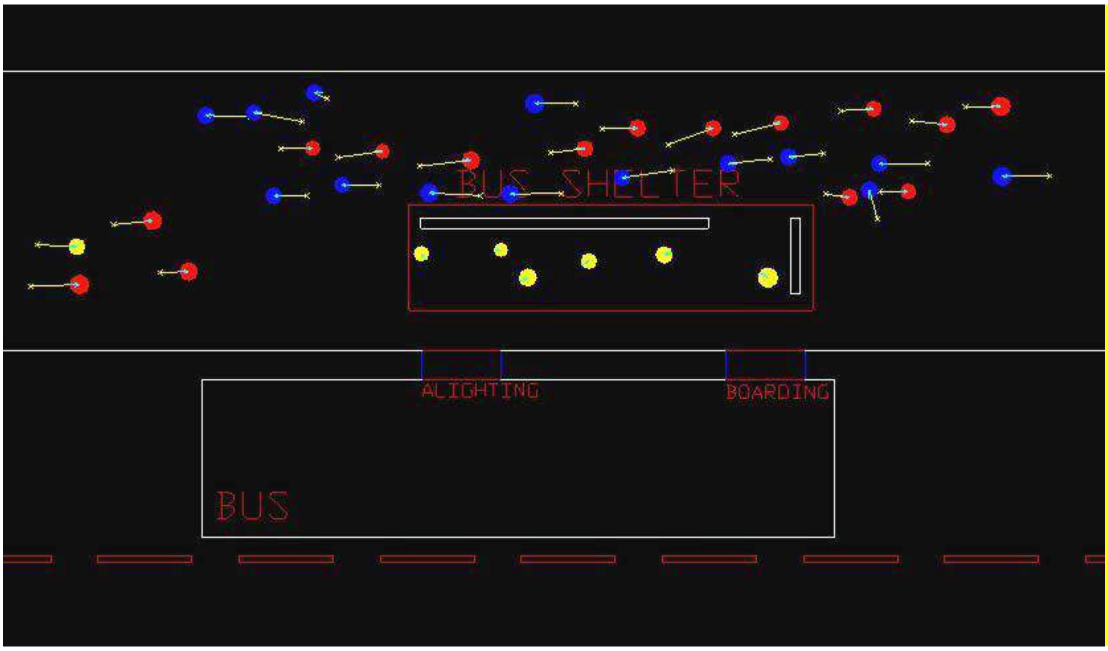


Figure 172: Example Bus Stop with shelter in LEGION

3.5.5 Pedestrian Crossings

Pedestrian crossings on street fall into four categories:

- Signalised crossings at junctions or crossings that are part of UTC-controlled groups of signals. These have a fixed or variable cycle time and the crossing can only turn green at a certain point in the cycle;
- On-demand crossings which are locally controlled. There may be a delay after the push-button is pressed, dependent on traffic levels and how recently the crossing last went green;
- Zebra crossings, where pedestrians have priority and can cross as soon as they are sure the traffic is stopping for them; and
- Informal crossings, where pedestrians cross between traffic outside designated crossing areas.

Modelling of these types of crossing depends on the software used. In LEGION the main methods are availability or delay profiles, with specific guidance in the LBPG. In Viswalk they can usually be modelled using the timings or rules that are found on street. Further detail is outlined in Chapter **B7** on **Vissim Modelling**.

For each model period, site visits should be conducted to review pedestrian behaviour, including waiting and crossing, at both formal and informal crossings.

3.5.5.1 Signalised Junctions

In LEGION, signalised junctions should be assumed to work on a fixed cycle time. The cycle time should come from plans, SCOOT messages or deterministic modelling. The minimum green that the pedestrian phase can receive can be found in the timing sheet, however, at a junction where pedestrians run in parallel with vehicles, it may receive longer. Further information on collecting signal timing data can be found in section **B2.3.8**. The crossing timings should be modelled using availability profiles, as shown in **Figure 173**. These can be generated with the LDT using a similar method to arrival profiles (section **C3.4.6**). On-demand crossings connected to a wider junction, such as those that share a controller, should also be modelled with fixed time availability profiles. LEGION only assesses pedestrian movements (not vehicles) and cannot model variable availability profiles based on demand, so the crossing is green at every opportunity for the pedestrian stage to come in.

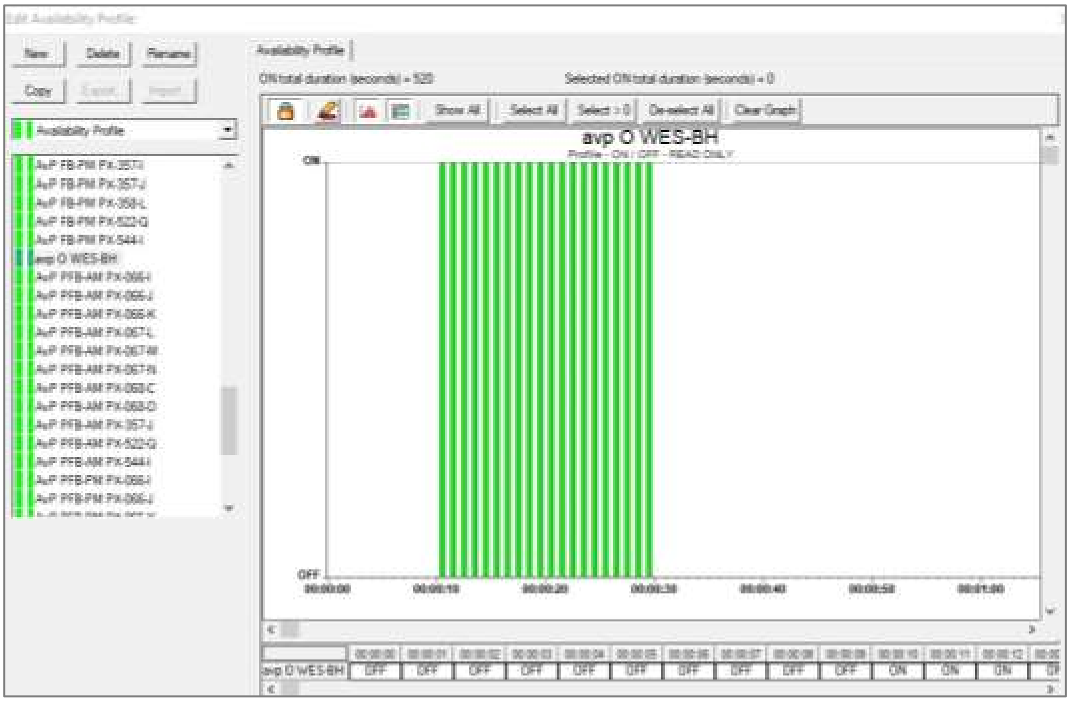


Figure 173: Availability profile for a crossing in LEGION

An example of LEGION pedestrian crossings is shown in **Figure 174**, where three crossings meet at a central island. Direction modifiers are shown in pink and waiting areas in dark blue. Availability profiles are assigned to each of the crossing arms. Specific guidance on model objects and set up can be found in the LBPG.

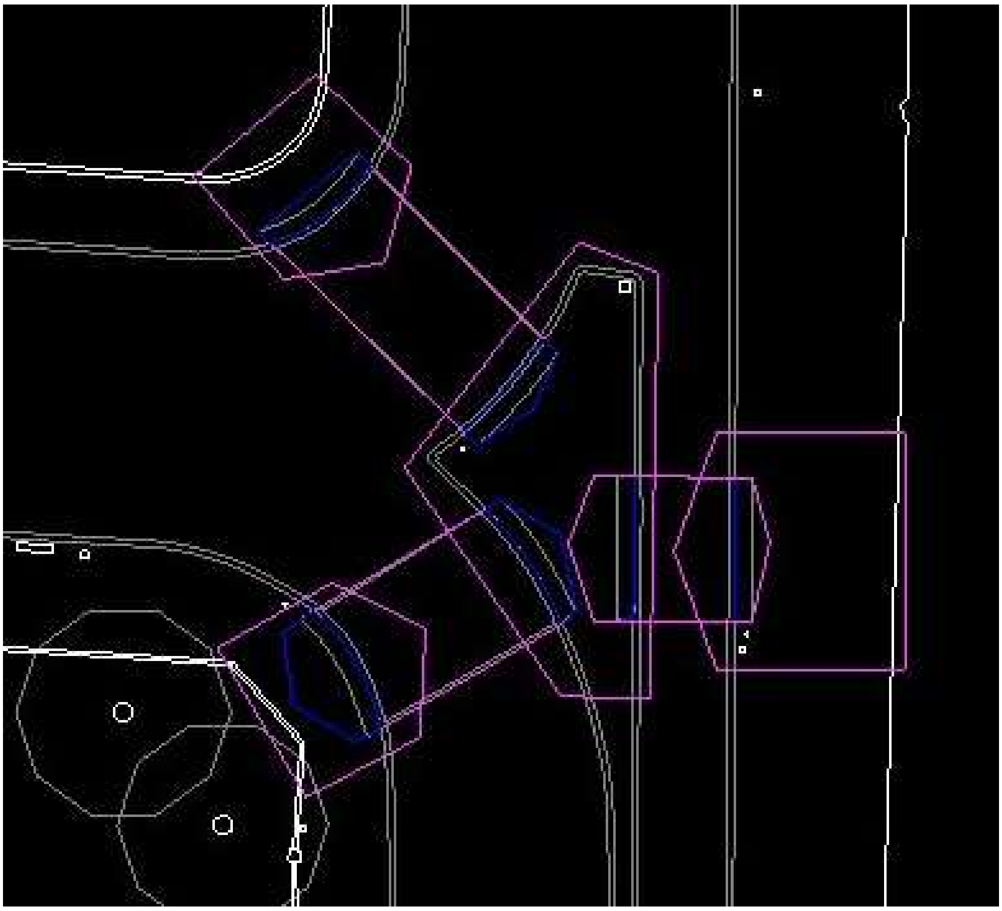


Figure 174: Example of pedestrian crossings in LEGION

UTC-controlled junctions can be modelled in Vissim using the UTC-Vissim Interface (**B7.4.5.3**), so any pedestrian phases should be modelled using signal heads in the same was as for vehicles. In order to apply a Signal Head to pedestrians, a Link must be used, with the 'Is pedestrian area' check box activated. Signal Heads cannot be applied to pedestrian areas directly

It is important to ensure that the Signal Heads are applied to the Link in the correct direction on each side of the road. If the crossing is not rectangular then a pedestrian area can be used to fill in any gaps, with pedestrian links on either side to hold the Signal Heads. In **Figure 175**, the pedestrian Links with Signal Heads on are in a slightly darker green, with the pedestrian area which has been used to fill the gap on the left of the crossing outlined in yellow. It is important that the area does not overlap the Signal Head or pedestrians could use this area to bypass the Signal Head and get onto the crossing.

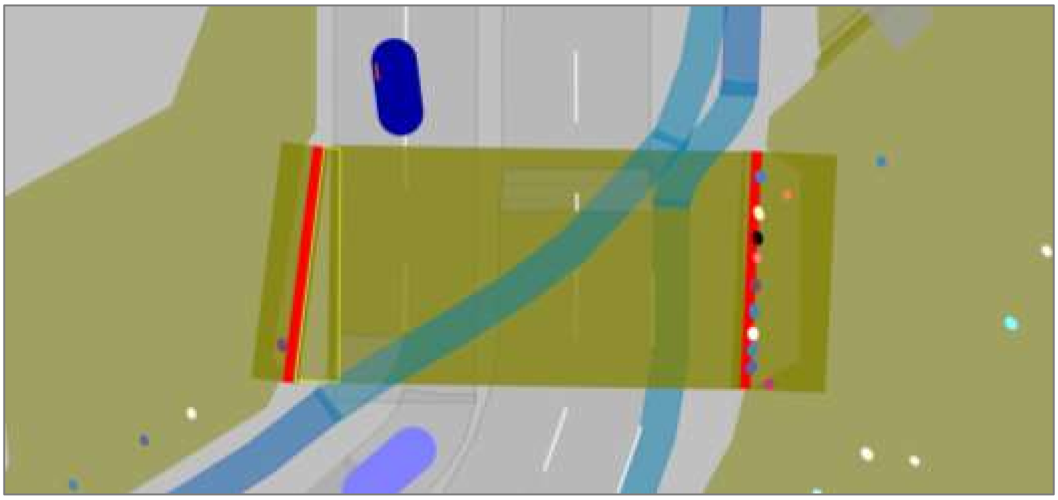


Figure 175: Signalised pedestrian crossing in Vissim

3.5.5.2 On-demand Crossings

Timings for on-demand crossings which are locally rather than UTC controlled are dependent upon the geometrical features of the junction and can be found in the timing sheet. It is necessary to check how often the crossing is called, to verify that appropriate timings are used.

In LEGION, on-demand crossings can be modelled as Zebra Crossings (section **C3.5.5.3**), with a delay profile representing the average amount of time between pressing the button and the green man being displayed to cross. There is no way to represent the minimum time before the signal can be green again for pedestrians, as LEGION works with fixed availability / delay profiles.

In Vissim, the same method of building crossings with signal heads and links should be used, however, since these crossings are not controlled by UTC, the signals should be controlled using VAP, as described in Chapter **B7** on **Vissim Modelling** (section **B7.4.5.1**).

3.5.5.3 Zebra Crossings

Although pedestrians have right of way on zebra crossings, there is usually some delay before traffic has stopped and the pedestrian decides it is safe to cross. Surveys can be conducted to determine the average delay to each pedestrian.

In LEGION this delay is modelled using delay profiles, while in Viswalk priority rules or conflict areas should be used (section **B7.4.2.5**). Conflict areas are quicker to apply, whereas priority rules are more flexible. Both rely on a validated traffic model so the vehicle flow is appropriate.

3.5.5.4 Informal Crossing

A certain amount of crossing away from designated pedestrian crossings is likely to occur occasionally in most areas. Usually the interaction between pedestrians and vehicles is relatively limited and impacts are negligible. Modelling any interaction between pedestrians and vehicles should be avoided outside crossings unless there is considerable delay to pedestrians (or vehicles) and it is necessary to validate the model, or where the informal crossing is regular and the level is significant. In this case NP should be consulted as to the possible and preferred methodologies which can be used to capture the impact of this crossing.

3.5.6 Validation

Base models of the existing layout with the latest available data should be validated against real life data from pedestrian surveys to ensure they replicate observed conditions to a sufficient level of accuracy.

> Models should run without errors or significant warnings before validation is attempted.

A model should be validated to:

- Provide evidence that it reflects the on-street conditions;
- Give confidence to stakeholders, including public consultations, that the modelling can be trusted; and
- Provide a basis to build Proposed models.

Base models should be validated using real-life data collected through surveys. Data used for model validation should be agreed at the MAP Stage 1 meeting (section **B2.1.5.1**).

For information on LEGION modelling refer to the LBPG where there is specific guidance on validation criteria. Key assumptions which differ from TfL standards should be referred to in the project-specific Modelling Expectations Document (section **C3.4.1**) for agreement early in the process.

3.5.6.1 Randomness

Exact conditions on street vary day-to-day as a result of random pedestrian behaviours such as speed and route choice, and also as a result of external factors such as the weather. Dynamic pedestrian models attempt to replicate this day-to-day random variability by altering individual pedestrian decisions based on random numbers. The set of random numbers is generated from an initial seed value specified at the start of a simulation run. A single set of random numbers, generated by a single seed value, therefore represents one potential outcome, or one particular day of pedestrian movements. The actual value of the seed has no significance; however, the seeds from different runs must be different from each other to produce different outcomes. Basing results on a single seed value has the potential to randomly bias the overall result.

An accepted method of reducing potential bias is to run several simulations using a range of initial seeds and to present mean average results. For this reason, both calibration and validation should be conducted using at least 5 seed values.

Ideally any on-site surveys would be carried out over multiple days to mirror the number of seeds, however this is often not possible. Where surveys are carried out on a single day, observations should be conducted to ensure the conditions are considered typical and unaffected by significant disruption. These observations can be backed up by analysis of background data, including signal control data and incident records. This checking reduces (or highlights) potential bias in the observed data and provides reassurance that it can be used to validate average results (or an indication that the data collection exercise should be repeated on a more typical day).

All seed values used should be included in the report. 'Cherry picking' seed values biased toward validation targets is not acceptable, so any seed values chosen which are replaced because they cause blocking must be noted. Results from the different runs will ideally be relatively consistent. One method of testing this consistency in LEGION is to look at the social cost value for each run (section **C3.6.4**). Typically, the difference in social costs between model runs is around 2%. If this is not the case, then more runs should be carried out to ensure a robust average.

Where possible the same seed values used in Base models should be carried over to Proposed modelling runs.

3.5.6.2 Requirements

Pedestrian flows should be validated by comparing the OD Matrix against entry and exit counts in the model to ensure the correct number of pedestrians are present. It is also necessary to include pedestrian flow counts at key locations, such as crossings and important footways, in the flows that are compared. Although validation criteria may differ between projects depending on the data available, in general, pedestrian flows should be within 5% of the expected values.

Pedestrian journey times on key routes should be recorded from models and compared to real world values. The routes that are used should be agreed between all stakeholders. The simulated journey times along these routes should be within 10% of surveyed journey times.

An important part of validation is ensuring that model behaviour replicates on-street behaviour. Visual validation should be carried out by comparing model movements with observations on site to ensure they are realistic and representative of real-life behaviour. Any unrealistic entity movement or blocking should be eliminated as far as possible.

3.5.7 Proposed Models

As is outlined in section **B2.5**, the Proposed model should be implemented in the Base model (or Future Base model if the Three Stage Modelling Process is being followed, section **C3.5.7.1** below) by only modifying elements which will change as part of the scheme, including any signal timing changes. Adjusting other elements, which will not change on street, 'to make it work better' is not acceptable. If the Proposed model will not work without additional changes then this is a sign that either the proposed design is not viable or the Base model was not fit for purpose and should be revisited.

This section deals with aspects which particularly need to be considered when building a Proposed pedestrian model. For a more general overview refer to section **B2.5**.

3.5.7.1 Future Base

The Future Base model bridges the gap between Base and Proposed scenarios and provides a reference when analysing the Proposed results. As described in section **B2.5.1**, the Future Base model includes all likely on-street changes which will occur between the Base year and the year being examined in the Proposal, excluding the scheme under consideration. When applied to pedestrian modelling, this will normally only involve changes in pedestrian flows. Flows are adjusted to reflect demand changes from Buses, LU, predicted background demand and any other schemes in the area. Public Transport demand changes should be agreed with the scheme Promoter and M&V and based on knowledge of the area and relevant supporting data. Predicted flow changes from nearby schemes can be found in the transport assessment for each scheme or informed from the scheme Promoter or M&V.

3.5.7.2 Proposals

Proposed models should be built in the Base (or Future Base) model whilst changing as little as possible. The main changes that will be required are to the layout, signal timings and flows. The new layout should come from proposed CAD drawings which should include as much detail as possible on street furniture and footway and crossing widths. Any changes to signal timings can be transferred from other traffic modelling work being carried out for the scheme.

The flow changes that are introduced at this point should be those that are a direct result of the scheme. Depending on the type of scheme, these flow changes can be sourced from different locations:

- Changes to public transport, for example new bus stops or changes in bus routes, come from Public Transport Service Planning (PTSP) within TfL;
- Estimated demand generated by a new development would be provided by the transport assessment from the developer or City Planning; or
- If the scheme only involves layout changes to the road or pedestrian space then there will usually be no changes to Base (or Future Base) flows.

In LEGION, this new routing can be implemented by adding any new entries and exits that are required and updating the OD matrix. In Viswalk, some assumptions may be required about the route choice of any additional demand.

3.6 Model Outputs and Analysis

In any scenario where pedestrian impact assessment is deemed necessary, the following outputs should be considered:

- Crowding levels;
- Journey times; and
- Social costs (including generalised journey times and congestion factors).

In addition, there are various visual outputs which can be used to demonstrate modelling results and scheme operation.

Table 19 summarises the different modelling methods that are required for each type of output. They are explained further in the rest of this section.

Table 19: Modelling methods required for different output types

Output Type	Data	Static Assessment	Dynamic Modelling
Analysis	PCL	PCGL Spreadsheet	
	Counts	PCGL Spreadsheet	LEGION / Viswalk
	Density / Space utilisation maps		LEGION / Viswalk
	Journey times	TfL Spreadsheet	LEGION / Viswalk
	Generalised journey times / Congestion factors		LEGION / Viswalk
	Social costs		LEGION
Visualisation	Simulation screenshots / videos		LEGION / Viswalk
	Integration with Vissim		Viswalk
	3D visualisations		Viswalk

3.6.1 Crowding Levels

When assessing a pedestrian environment, a key output is how busy or congested that environment becomes under certain defined conditions. It is very important to consider how much space and comfort a pedestrian will experience as part of changes to the street and surface level layout. The two most widely used measures of pedestrian experience at TfL are Fruin Levels of Service (LoS) and Pedestrian Comfort Levels (PCL).

3.6.1.1 Fruin's Levels of Service

Fruin's Levels of Service[137] were developed in 1971 to give an idea of crowding levels in pedestrian areas. They are one of the outputs from pedestrian modelling software and are commonly used when assessing the performance of a scheme for pedestrians. They are particularly useful when displayed as plots, as is explained in section **C3.6.2**.

The LoS are based on the amount of space available to each pedestrian at any given moment. The LoS for a particular area of walkway is usually a result of averaging the levels for that area over a 15-minute period. There are different thresholds for walkways, stairs and queues which are summarised in **Figure 176**.

137 Fruin, J, Designing for Pedestrians: A Level-of-Service Concept, The Port of New York Authority, 1971

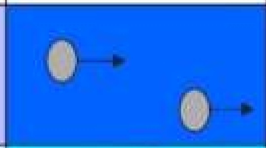
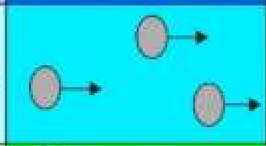
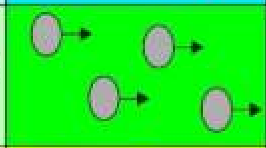
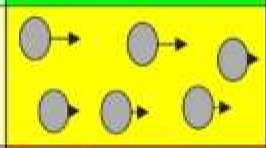
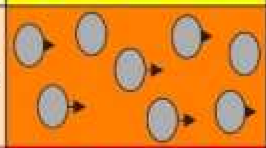
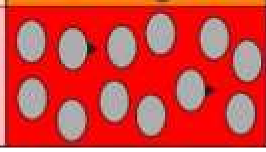
Level of Service	Persons per square metre (Walkways)	Persons per square metre (Stairs)	Persons per square metre (Queues)	Visual Indication (Walkways)	Description (Walkways)
A	< 0.31	< 0.54	< 0.83		Free movement
B	0.31 – 0.43	0.54 – 0.72	0.83 – 1.08		Free movement with only minor conflicts
C	0.43 – 0.72	0.72 – 1.08	1.08 – 1.54		Slightly restricted movement and difficulty passing. Bi-directional flow possible.
D	0.72 – 1.08	1.08 – 1.54	1.54 – 3.59		Restricted movement. Bi-directional flow difficult.
E	1.08 – 2.15	1.54 – 2.69	3.59 – 5.38		Restricted movement. Intermittent stopping. Bi-directional flow very difficult.
F	> 2.15	> 2.69	> 5.38		Breakdown in movement with many stops.

Figure 176: Fruin's Levels of Service for walkways, stairs and queues

3.6.1.2 Pedestrian Comfort Levels

PCLs were developed as a result of research commissioned by TfL which aimed to use new methodologies to understand pedestrian comfort. The research built on and updated LoS and provided a new set of levels which are tailored to the area types found on London's streets. The full list of PCLs is shown in **Figure 177** and a table defining how these levels are applied to different area types can be found in the PCGL document[138]. Further information on how PCLs are measured and applied can also be found in this document, which includes a spreadsheet containing the calculations. The document outlines the process step-by-step and recommends the appropriate levels of comfort by area type, including at pedestrian crossings and on crossing islands. It also provides insights into the surveys on pedestrian behaviour that went into developing the levels.

In contrast to LoS, which work on an area-based estimation of how much space each pedestrian has, PCL is a more time-based measure of people per metre per minute (ppmm) walking along a footway. This allows surveys of pedestrian flows past a point to be used to calculate the comfort levels, which makes them easy to use. The Restricted Movement column in **Figure 177** refers to the percentage of people who had to change their speed or route, or who brushed against or bumped into someone else.

When applying PCLs to future scenarios, measurements can be made from dynamic modelling or recommendations can be made based on flow rates and widths or accessible space in the proposed design.

138 Pedestrian Comfort Guidance for London – Guidance Document, Version 2, Transport for London, 2019, accessible at **http://content.tfl.gov.uk/pedestrian-comfort-guidance-technical-guide.pdf**

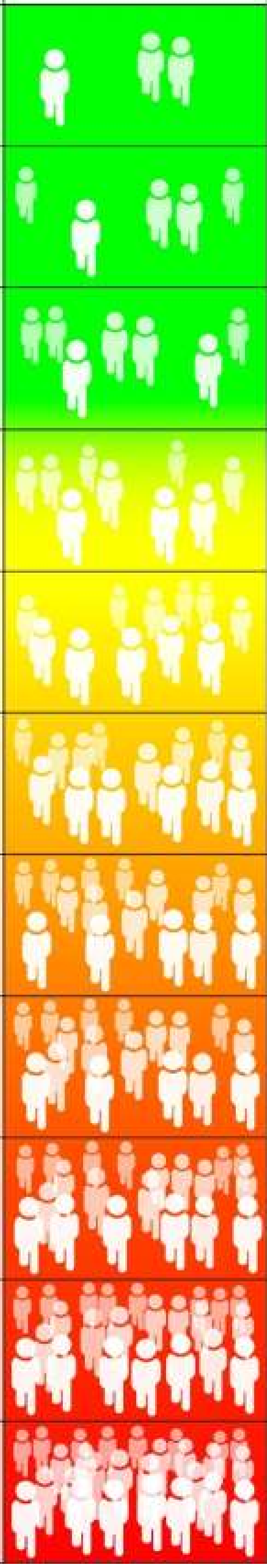
PCL	ppmm	Restricted Movement	Visual Indication	Description
A+	< 3	< 3%		Very comfortable environment where pedestrians have enough space to walk at the speed and route they choose.
A	3 – 5	13%		
A-	6 – 8	22%		
B+	9 – 11	31%		B+ is the recommended level for all area types. At B and B- normal walking speed is possible, but conflicts are more frequent and pedestrians are less comfortable.
B	12 – 14	41%		
B-	15 – 17	50%		
C+	18 – 20	59%		Environment is increasingly uncomfortable with frequent conflicts and bi-directional movement becoming difficult.
C	21 – 23	69%		
C-	24 – 26	78%		
D	27 – 35	100%		Walking speeds are restricted and overtaking is difficult.
E	> 35	100%		Very little personal space with speed and movement extremely restricted.

Figure 177: Pedestrian Comfort Levels

Table 20 shows an example of how the PCLs are applied to the pedestrian experience on a high street, which is one of the area types (the full table can be found in PCGL). It also gives an indication of how the levels relate to Fruin LoS thresholds.

Table 20: PCLs related to high street pedestrian experience and Fruin LoS for walkways

PCL scale	ppmm upper limit	Restricted movement	High Street suitability	LoS walkways scale
A+	<3	<3%	Comfortable	A
A	6	13%	Comfortable	A
A-	9	22%	Comfortable	A
B+	12	31%	Comfortable	A
B	15	41%	Acceptable	A
B-	18	50%	At Risk	A
C+	21	59%	Uncomfortable	A
C	24	69%	Uncomfortable	B
C-	27	78%	Uncomfortable	B
D	35	100%	Uncomfortable	CDEF
E	>35	100%	Uncomfortable	CDEF

3.6.2 Plots

Calculations as part of a dynamic assessment are able to provide a level of understanding of how conditions at street level might look. This is achieved by incorporating non-linear flow events, such as the arrival of a bus, and taking into account how flow rates may be affected as conditions become more congested. Pedestrian modelling software provides the facility to output heat map style plots for a variety of different datasets. Heat maps are based on flow rates and widths or areas of accessible space. The maps usually reflect differing LoS (section **C3.6.1.1**), which can be applied to different assessment conditions; walkways, stairways and queuing areas. Different LoS categories can be represented in a single plot, however, this usually only involves walkways and stairs as these areas can be easily differentiated. Walkways LoS and queuing LoS should not be shown in the same plot as it may be hard to determine which areas the different scales apply to. Queuing LoS plots are rarely produced and should only be used if there is a particular project requirement. Plots should clearly identify which LoS have been used and which areas they apply to.

Plots are output from one model run, so once the modelling results are finalised using multiple runs with different seeds (section C3.5.6.1) the run that is nearest to average is chosen to produce the plots.

The plots to be produced should be agreed with stakeholders in advance of the analysis, however, the main plot would usually cover the busiest 15-minutes in the modelled period, as defined by the total number of people in the model. Plots of the other three 15-minute periods in the peak hour should be provided in report appendices. Different types of plots, such as the Cumulative Mean Density and Cumulative High Density plots detailed below, should cover the same time periods so their information can be directly related.

3.6.2.1 Cumulative Mean Density

A commonly used plot is the Cumulative Mean Density (CMD) plot, which displays the mean level of density in an area over the specified period. Plots are usually coloured according to the Fruin LoS, although a legend should be included to explain the colour scheme. The average calculation only includes time that the area is occupied, so areas which occasionally experience extremely high levels of activity will show as higher up the scale than areas with constant low levels of movement. This helps to highlight any crowding problems which may be caused by irregular events such as waiting for crossings or buses arriving, as well as any areas which are constantly busy. Smoothing should not be applied to CMD heat maps.

Figure 178 shows an example where the highest level is at the waiting area for the crossing in the bottom right. The crossing areas are also busy, where pedestrians from both sides meet and walk past each other.

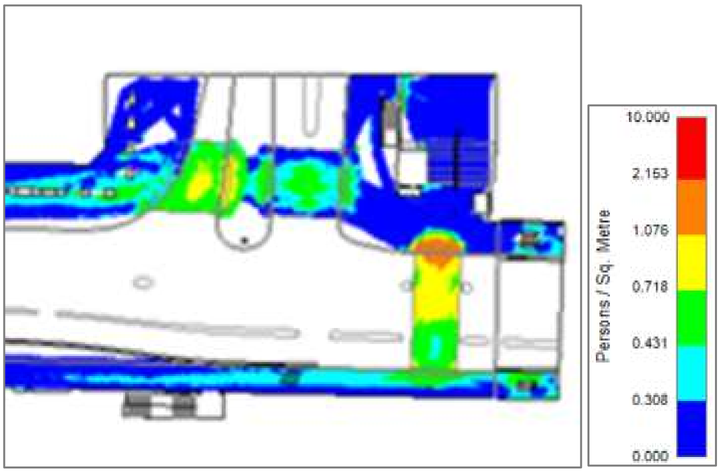


Figure 178: Example heat map showing Cumulative Mean Density, with Fruin's LoS for walkways

3.6.2.2 Cumulative High Density

Cumulative High Density (CHD) plots take a given density level and are coloured according to how much time is spent above that value. A white-pink-purple colour scheme is recommended, with the darker colours used for areas with longer times spent above the threshold. These plots are useful for highlighting areas which are constantly at a high density.

The CHD density level used for most projects will be time spent above 1.08 persons per square metre. This is the threshold for exceeding LoS D on walkways, LoS C on stairs and LoS B on queuing areas. Figure 179 shows an example which has the darkest areas at the waiting areas for crossings, in particular in the bottom right, where the footway is narrow.

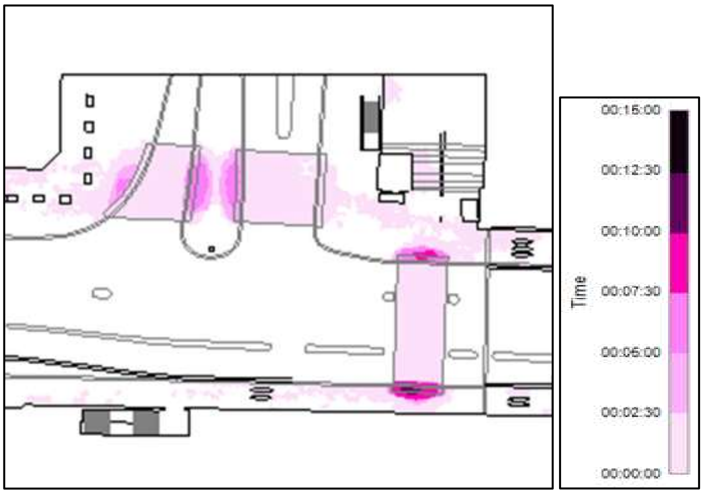


Figure 179: Example heat map showing Cumulative High Density: Time spent above LoS D using Fruin's LoS for walkways

3.6.2.3 Space Utilisation

Although not a required output, space utilisation plots can be useful for identifying shortest routes that pedestrians prefer to take. This information can be used to identify locations where it would be beneficial to locate signage and where it would be better not to put street furniture to minimise obstacles to pedestrian journeys. Colours in the plots represent how often the space is used within the relevant time period, with brighter colours representing longer times. Figure 180 clearly shows the used areas in blue with highly used desire lines in green / yellow and congested areas in red.

Figure 180: Space utilisation plot

3.6.3 Journey Times

Journey times, or the times taken for pedestrians to walk between two points, are another key output of pedestrian modelling. Due to the nature of the output, journey times are normally only derived from dynamic modelling, although the spreadsheet tool mentioned in section C3.3.1.3 can produce a simplified crossing time based on the signal delay.

Pedestrian models can be analysed to give a walk time for a single pedestrian making a defined movement, or an average for all pedestrians that are making that movement. Journey times can be used to help validate models, by comparing model walk times with those observed from surveys. They also are valuable in assessing the performance of different options against the Base or Future Base scenario.

3.6.4 Social Costs

Social costs assign a monetary value to pedestrian journey times, which enables cost comparisons to be made between different layouts and options. These comparisons can be used to support scheme assessments and are a key output from dynamic modelling.

To calculate social costs, pedestrian journey times need to be broken down into separate elements that include walking, waiting, queuing, walking on stairs, and travelling on escalators. Each element has a weighting applied to it based on how desirable that element of the journey is to the pedestrian, walking upstairs has a weighting of 4.0, whereas travelling on an escalator has a weighting of 1.5, for example. This method of applying a weighting to each element of a pedestrian journey time gives an output that is known as a generalised journey time.

In addition to the production of generalised journey times, a value known as the congestion factor is calculated by pedestrian modelling software. This congestion factor represents the perceived cost of delays to a pedestrian's journey due to crowded conditions.

The sum of appropriate generalised journey times and congestion factors gives the social cost. The latest weightings for journey times and congestion factors can be found in the TfL Business Case Development Manual (BCDM) data book. This can be obtained by contacting **StreetsPedestrianModelling@tfl.gov.uk.**

Social costs can also be represented annually by estimating the number of journeys over a calendar year, calculating the costs and then multiplying them by the number of working days over the year.

3.6.5 Screenshots and Videos

A key benefit of dynamic modelling is the ability to observe entities move through the model, and thus give a deeper understanding of how future layouts might operate. Screenshots can be taken at any point within the model to illustrate a point of interest, and can be a useful tool when reporting on key findings.

Dynamic models are based around the interactions between pedestrians and their environment. During model calibration, simulations are particularly useful to see issues which may not be picked up statically, for example, pinch points or safety concerns. Once the model has been finalised, pedestrian modelling software can generate 2D or 3D videos which can be used to visually demonstrate the pedestrian movements. These videos are very helpful in scheme consultations and provide an excellent visual aid when presenting the performance of complex scheme designs to a non-technical audience, for example, **Figure 181** shows pedestrian movements along a pedestrianised street.

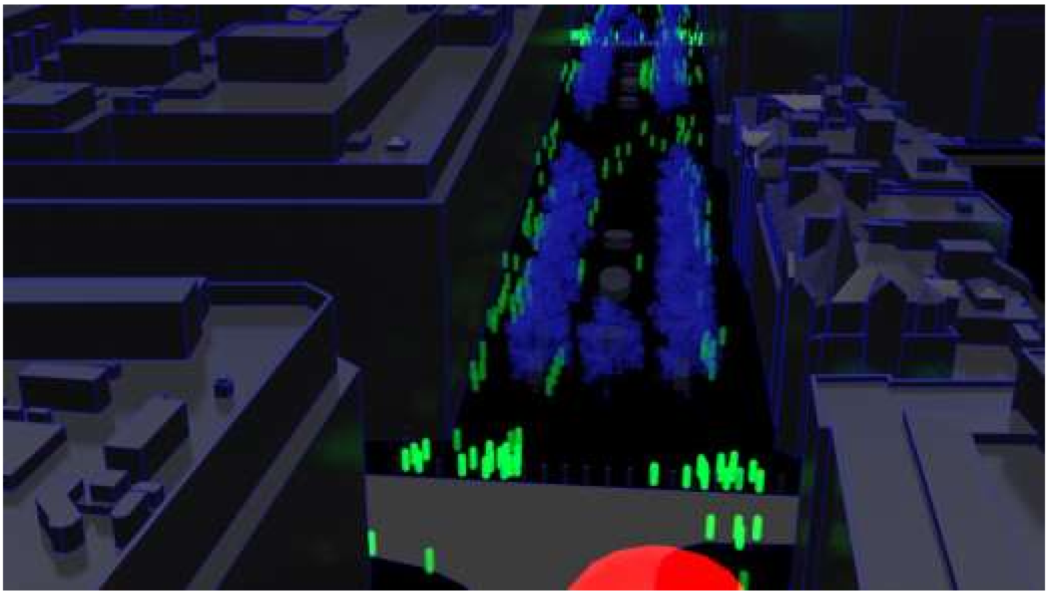


Figure 181: Modelled pedestrians in a 3D scene

4 Emissions Modelling

4.1 Introduction

Air pollutants are substances in the air that can harm human health and affect quality of life. The Mayor's London Environment Strategy[139] details the specific challenges surrounding air quality and the measures which are planned to overcome them. Air pollution causes thousands of Londoners to die sooner than they should (estimated over 9000 Londoners died prematurely from long-term exposure to air pollution in 2010[139]). Children, the elderly and people already suffering from pulmonary or cardiovascular disease are particularly vulnerable. In order to tackle these issues, the London Environment Strategy aims to reduce car use and switch to cleaner fuels to ensure that London's transport system is zero emission by 2050. It also prioritises reduced air pollution at locations such as schools, nurseries, care homes and hospitals.

Road transport contributes significantly to the emission of air pollutants in London[140]. Air pollutants from transport sources can broadly be divided into two categories:

139 London Environment Strategy, Greater London Authority, May 2018. Can be accessed at **https://www.london.gov.uk/what-we-do/environment/london-environment-strategy**
140 Air Quality Team, *London Atmospheric Emissions Inventory 2016*, Greater London Authority, 2019

- Pollutants that have an impact on local air quality and human health. The most significant of these pollutants, and the focus for TfL, the GLA and London boroughs include the following:
    - **Nitrogen dioxide (NO2) –** NO_2 is mainly formed in the atmosphere from nitric oxide (NO) emitted by road vehicles, but it is also emitted directly. By convention, the sum total of NO and NO_2 is termed 'nitrogen oxides' (NO_x).
    - **Airborne particulate matter** – Different classifications are used to describe particulate matter according to their physical characteristics[141], the most common being PM_{10} and $PM_{2.5}$; and
- Greenhouse gases, which have an effect on the global environment. The most important of these, due to the total volume of production, is carbon dioxide (CO_2). Other pollutants, such as methane (CH_4) and nitrous oxide (N_2O), are stronger greenhouse gases but are emitted in smaller quantities and are not a focus for TfL.

The emissions produced by road traffic are influenced by a large number of factors including vehicle type, fuel type, vehicle age, driving behaviour, traffic conditions and road gradient. Hence the accuracy of emissions estimates depends on which of these factors are used as input information and the quality of the data behind them.

The most widely used approach to estimate road traffic emissions is based on the type of vehicle and its average speed on a section of road (further information can be found in section **A4.5.6**). This approach can be used with outputs from deterministic or tactical models, however, since these do not produce the second-by-second data of an individual vehicle it cannot capture the emissions produced as a result of the instantaneous acceleration of the vehicles. Hence, this approach may not estimate the emissions very accurately in an urban environment, where a lot of stop-start actions take place. In such areas, detailed emissions modelling using an instantaneous emissions model should be used when emissions need to be estimated more accurately. Microsimulation traffic models are needed to provide the detailed individual vehicle outputs needed for use by an instantaneous emissions model. This chapter focuses on this type of detailed emissions modelling.

141 PM_{10} and $PM_{2.5}$ relate to particulate matter with a diameter of less than 10µm and 2.5µm respectively

4.1.1 Scope

This chapter provides details on the methodology and requirements which were defined as a result of the Putney High Street study described below. It includes guidance on the estimation of vehicle emissions with purpose-built emissions modelling software, using the individual vehicle data collected from microsimulation models. Details are provided on the modelling methodology, including the parameter inputs required for both the emissions and microsimulation software, and the additional considerations for microsimulation modelling when used for emissions outputs. There are also sections on specifically how this is applied when using the commercially available software packages EnViVer (section **C4.3**) and PHEM (section **C4.4**).

Although vehicle emissions contribute to the air quality of an area, this guidance does not attempt to cover air quality modelling since it is dependent on many factors other than localised vehicle emissions. Detailed air quality models therefore require increased complexity involving other relevant sources of air pollution, dispersion modelling and environmental science expertise.

Meeting specific objectives is necessary for the success of any scheme. However, it is equally important that scheme designers, modellers and traffic engineers consider wider strategic transport objectives. This chapter provides a point of reference to the modeller when considering an approach to road traffic schemes that incorporate emissions studies as part of the air quality and environmental assessment requirement.

4.1.2 Case Study

A study was carried out around Putney High Street in south west London in 2017 and 2018. The area is well known for poor air quality attributed to the traffic and local topographic features. Putney High Street is a narrow road with tall buildings on either side creating a canyoning effect which causes emissions to disperse more slowly. It also has a high number of junctions in a short distance so, prior to the study, traffic moved slowly through the area and there was a lot of stop-start queuing behaviour which generates more emissions than free-flowing traffic. This combination of features, together with the large number of pedestrians in the area, meant that it was necessary to implement measures to improve the air quality. Although it is hard to measure a direct link as air quality is dependent on many factors, reducing vehicle emissions in an area has a positive impact.

The aim of the study was to explore the use of a traffic signal gating strategy to influence vehicle emissions. The control strategy was developed by the corridor manager for the area, as they had the local knowledge necessary and would be responsible for implementing the timings on street. Signal timings were adjusted to decrease green times into Putney High Street so northbound queues were held on Putney Hill, an open area with fewer pedestrians, and away from the busy shopping area.

In order to investigate the impacts of this study in a simulated environment and test out different signal timing scenarios, microsimulation modelling of the area was carried out. This was used to check that the measures did not cause too much disruption to buses in particular, but also to general traffic. Since the goal of the measures was to reduce vehicle emissions in the target area, the modelling was also used to verify that this was achieved. Outputs from the microsimulation model, containing vehicle speeds and accelerations every second, were used as an input to the emissions model and the emissions results were reported based on the two defined areas of Putney High Street and Putney Hill. The results were also verified against on-street data using the second-by-second records from the iBus system, which could also be used as an input to the emissions software.

In addition to traffic and emissions results, the objectives of the modelling project were as follows:

- There was no history of emissions microsimulation modelling at TfL, so it was necessary to develop a methodology which could be used in future projects;
- Emissions modelling has a requirement for a vehicle fleet composition to be defined in terms of fuel types and engine standards, so this information needed to be collected for London; and
- To investigate any additional requirements in terms of data and microsimulation modelling techniques.

The remainder of this chapter details the results of these objectives.

4.2 Methodology

The methodology adopted in this guidance is based on the combination of a microscopic traffic simulation model (such as. Vissim or Aimsun Next) and a microscopic emissions model (for example PHEM or EnViVer). In this process, the traffic model simulates individual vehicles and their interactions using model parameters such as flows, speeds, junction control, and vehicle types. The behaviour and positions of these individual vehicles are captured in output files, which are used as inputs for the emissions model to estimate resulting emissions. This approach takes the speed / acceleration of a vehicle into account at discrete time intervals when estimating emissions. An example speed profile for one vehicle is shown in **Figure 182**.

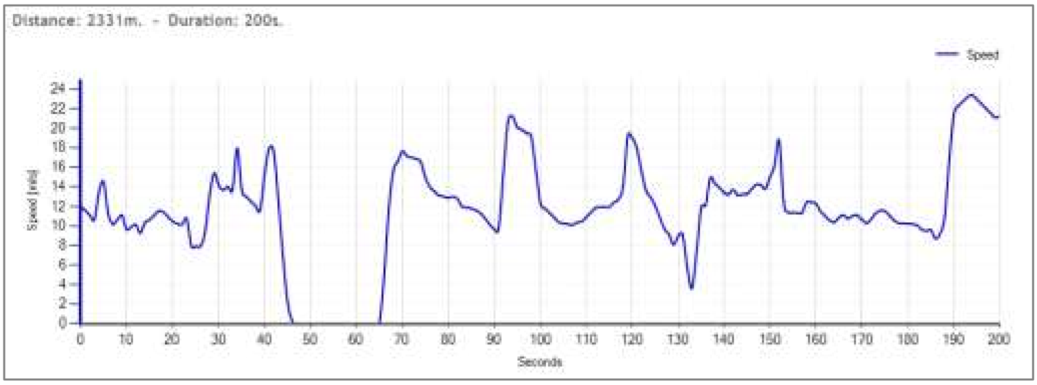


Figure 182: Speed profile of a vehicle

This type of model can therefore better account for the influence of congestion upon emissions levels than a deterministic or tactical model. The broad methodology is shown in **Figure 183**.

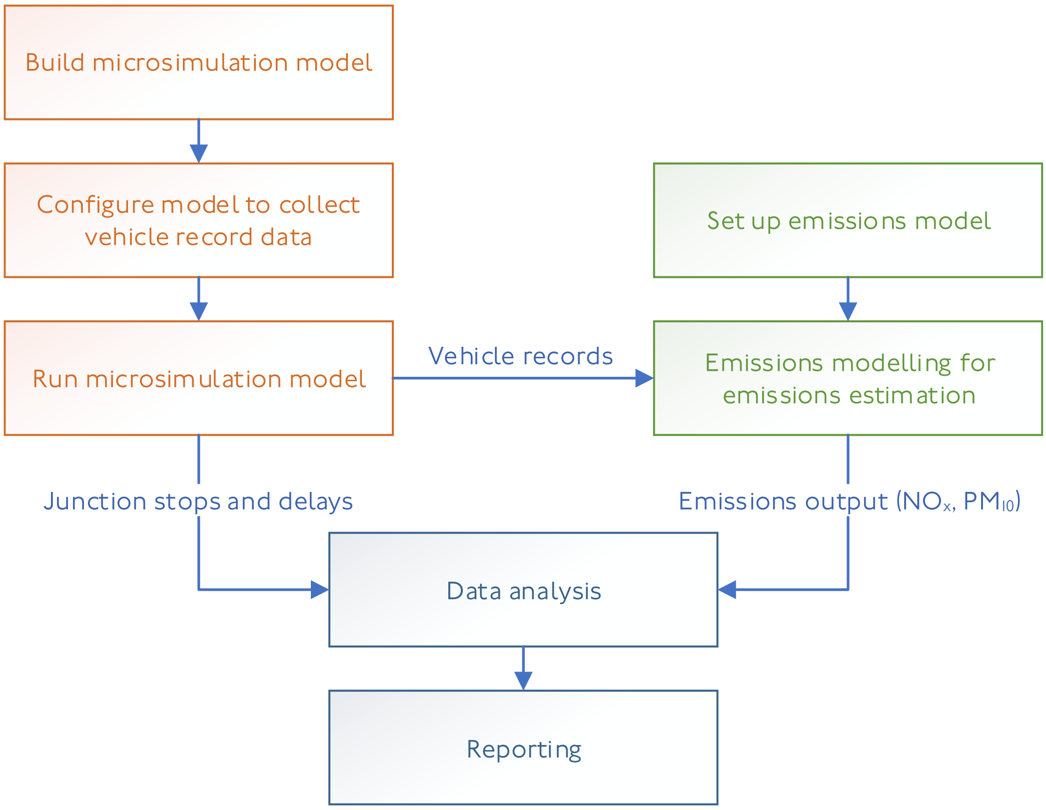


Figure 183: Emissions modelling process

As with most types of modelling, emissions modelling will usually be carried out to compare scenarios, either Base and Proposed or various Proposed options. The differences between these scenarios will be in the microsimulation model only; the emissions model fleet parameters should remain the same for all scenarios to ensure a fair comparison, unless a change in fleet composition is expected as part of the Proposed scenario.

4.2.1 Microsimulation Modelling

Microsimulation modelling is usually carried out to compare different scenarios with relation to a particular objective, for example reducing bus delay or improving cycle safety, where the network is too complex or congested for a simpler type of modelling. If the objective is to study detailed emissions outputs, then microsimulation modelling is used as a source of the individual vehicle data which is an input to emissions modelling.

The microsimulation software packages covered in these Guidelines are Vissim (in Chapter **B7** on **Vissim Modelling**) and Aimsun Next (in Chapter **B3** on **Aimsun Next Modelling**), and these chapters should be referred to for specific guidance on building the microsimulation models. The decision to undertake emissions modelling should be made at MAP Stage 1 as there are specific data requirements which must be determined before modelling commences.

4.2.1.1 Model Boundaries

Modelling should cover the area of influence, which is the area where it is anticipated that the proposed measure will have an effect, rather than just the area where the proposal is implemented.

4.2.1.2 Vehicle Types

As the emissions characteristics of vehicles differ from each other (even for the vehicles having the same PCU factor), vehicles with different emissions characteristics should be categorised separately as far as possible, depending on the level of detail required in the outputs. For example, cars, taxis, LGVs, rigid and articulated HGVs, single-decker and double-decker buses and coaches can be modelled as different vehicle types. The relevant manual for the emissions software being used should be consulted to determine the vehicle classifications. Some of these classifications, particularly the difference between car and LGV, are not counted separately during a standard survey, so if they are required it should be determined at MAP Stage 1. The fuel type and Euro engine standards are taken into account at the emissions modelling stage (section **C4.2.2**) and do not need to be separately considered in the microsimulation modelling.

4.2.1.3 Vehicle Dynamics

Vehicle emissions are greatly influenced by the dynamics of vehicles (acceleration and deceleration) hence the parameters used in a microsimulation model should reflect the characteristics of the vehicles in the network. Empirically derived vehicle dynamics values, based on the observed data, should be used if possible. In the absence of such data, default values from the relevant TfL microsimulation template may be used. If there is any doubt about the default values, the vehicle acceleration output can be checked by plotting the acceleration (every second) of a sample of vehicles to see if it looks sensible.

4.2.1.4 Road Gradient

Road gradient affects the amount of energy needed for a vehicle to travel through a road section and therefore the power output and emissions from an engine. For example, queuing traffic accelerating away from a traffic signal emits more emissions if pulling away on a steep uphill slope than on a downhill approach. Therefore, as far as possible, road gradient should be taken into account when estimating emissions.

The gradient is specified as the percentage of altitude difference per unit length of a road section. The altitudes of both ends of the road section can be obtained from sources such as Ordnance Survey data or Google Earth. With the known length of the road section, the average gradient is calculated as:

$$Gradient = \frac{Altitude\ of\ downstream\ point\ (m) - Altitude\ of\ upstream\ point\ (m)}{Length\ of\ the\ section\ (m)} * 100\ \%$$

In this case, a positive value relates to an uphill gradient and negative means downhill.

If no road gradient is used in a microsimulation model, the output text file could still be edited to include the road gradient if needed for an emissions model. If no road gradient is provided, the emissions calculation will be based on the assumption that the roads are flat (0% gradient).

4.2.1.5 Model Calibration and Validation

The microsimulation models used for emissions modelling should be developed and audited following MAP. The decision to undertake emissions modelling should be taken at the start of the process, in MAP Stage 1, so the scope of the model and the validation criteria can be set in order to capture the detailed output data which will be used for emissions modelling. The **Aimsun Next Modelling** and **Vissim Modelling** chapters (**C3** and **C7**) contain more information on calibrating and validating microsimulation models.

Vehicle emission outputs themselves cannot be validated without detailed data collection on tailpipe emissions from vehicles. Fixed air pollution measurements are dependent on many other factors and so roadside emissions collection cannot be used. This means emissions predictions are highly dependent on accurate vehicle behaviour in the original microsimulation model. Some typical modelling practices, such as using RSAs to account for high street friction, might not accurately capture repeated stop-start behaviour, so more effort should be made to model the reasons behind any changes of speed, so the behaviour is represented accurately.

4.2.1.6 Model Output Configuration

Emissions modelling requires individual vehicle trajectory data, including position, speed and acceleration. The microsimulation model needs to be configured to collect this vehicle trajectory data into a vehicle record file. This data gives information about the state of each vehicle in a network at every second. The requirements for the vehicle record output might be slightly different depending on the emissions model used.

In Vissim, the main network element is a Link and in Aimsun Next it is a Section. For emissions modelling, the grouping of the Links or Sections to form Segments is done to reduce the analysis burden of data processing. A Segment is a group of one or more Links / Sections with similar characteristics in terms of the scheme impact, usually grouped by location. Note that this is not the same as a Segment in Aimsun Next. Segment IDs can either be allocated in the microsimulation software, via some kind of naming convention, or added to the output files later. In order to conduct proper analysis, each Segment must have a unique ID.

To collect the appropriate data, the following items need to be configured in the microsimulation model outputs:

- Vehicle types: as described in section C4.2.1.2, all types of motorised vehicles producing emissions should be selected to generate output;
- Links / Sections: as described in section C4.2.1.1, all Links / Sections in the area of interest should output data;
- Time resolution of data collection: should be set to one second for compatibility with common emissions modelling software; and
- Vehicle parameters data collection: at a minimum, the parameters selected for output should include:
    - Simulation Time;
    - Vehicle ID;
    - Vehicle Type;
    - Speed;
    - Coordinate X;
    - Coordinate Y;
    - Link / Section / Segment ID; and
    - Gradient, if available.

4.2.1.7 Running the Model

As with all outputs from microsimulation, it is recommended to carry out 20 simulation runs with differing random seeds in order to produce a range of results. More information on running microsimulation models can found in the relevant sections for Vissim (section **B7.5.1**) and Aimsun Next (section **B3.5.1**). Depending on the emissions software used, the results can be combined and averaged before, during or after the emissions modelling process.

4.2.2 Emissions Modelling

In a microsimulation model, different vehicles with similar traffic characteristics (for example the same PCU value) may be grouped into one vehicle type. However, the vehicles within a vehicle type may be different in terms of other characteristics, such as fuel type and Euro engine standard, which will affect the level of emissions produced. For an accurate estimate of emissions using traffic model outputs, the proportions of vehicles with different characteristics within a vehicle type need to be inputs to the emissions model. Such proportions should be based on observed data, although existing London-wide proportions can be used if the precise vehicle types were not recorded during surveys.

The emissions software covered in this document calculates instantaneous vehicle emissions on a second-by-second basis, so the appropriate use is to carry out detailed emissions modelling using second-by-second vehicle data. For example:

- vehicle trajectories from a microsimulation model;
- any second-by-second automatic vehicle tracking data recorded from site, for example, appropriate GPS data or London's iBus system; or
- vehicle trajectories collected using an instrumented vehicle, for example floating car data.

The software links this data to an emissions model for estimation of CO_2, NO_x and PM_{10} emissions. The emissions calculations are based on the speed-time profiles of the vehicles.

4.2.2.1 Fuel Types

The emissions produced from a vehicle are heavily influenced by its fuel type, namely: petrol, diesel, electric or hybrid. Hence, the proportion of these fuel types should be input and, as already mentioned, this will usually come from London-wide data.

4.2.2.2 Euro Engine Standards

The Euro engine standards are regulations across the EU and EEA member states which define acceptable limits for exhaust emissions of new vehicles. These standards have become stricter over the years so vehicles complying with the latest Euro standard produce far less emissions in comparison to their predecessors. For light vehicles, the standards range from Euro I introduced in 1992 to Euro 6 introduced in 2014, and for heavy vehicles Euro 0 was introduced in 1988 and Euro IV in 2012. Specific details on the standards can be found on the European Commission website[142].

In order to model emissions, the appropriate proportion of vehicles with different Euro engine standards for each fuel type should be given. This results in vehicle categories such as Euro 2 petrol or Euro 6 electric. These can be obtained for London and also for the Ultra Low Emissions Zone (ULEZ) which was introduced in April 2019 from a TfL sponsor.

4.2.2.3 Running the Model

Running an emissions model, once the inputs are set up, is usually as simple as providing links to any input files and hitting a Start or Calculate button. Depending on the emissions software used, the microsimulation data can be combined and averaged before, during or after the emissions modelling process. If multiple microsimulation seeds are processed separately they can be combined as part of the analysis or post processing.

142 https://ec.europa.eu/environment/air/sources/road.htm

4.2.3 Output Reporting

Reporting of emissions modelling should include details of the microsimulation model and how it is linked to the emissions model. The report should also state the assumptions made and the inputs used in the emissions model. Content will be software specific but should include:

- The objectives of the project including any aims for the emissions outputs;
- All the assumptions made along with their implications. For example, if no road gradient is used in an emissions model it assumes that all the roads are flat. This may be an issue in an area where there are a lot of roads with steep gradients;
- The sources of any supporting information. For example, if the proportion of the vehicle mix is based on the observed data or from any other study in the area, it needs to be clearly stated;
- Emissions estimations, produced for:
    - Each vehicle type; and
    - Each modelled link / section / segment;
- If possible, a geographical representation of the results. This should be produced for easy demonstration of changes (examples can be found in the relevant emissions software output sections);
- Analysis of the results. Any anomalies where results aren't as anticipated should be clearly highlighted and discussed; and
- A comparison of the results between different scenarios. Where multiple scenarios are being tested results should be compared, with the relative differences highlighted and explained.

The purpose of the modelling should be considered when reporting the results. Any proposals which cause a change in emissions will generally aim to move queuing traffic from a sensitive area, such as a high street or outside a school, to a location where emissions can disperse with less impact on other road users. In this case, localised changes in vehicle emissions can be more important than totals across the entire model.

As mentioned earlier, it may not be possible to collect observed data to configure all the parameters of the microsimulation and emissions models which influence the emissions output. Assuming the same data is used across all scenarios, any changes in emissions predictions should be the consequence of implementing the proposal in the microsimulation model, so the results can be compared. By producing relative results rather than absolute values, any error in the estimation of the emissions should be consistent between scenarios. For this reason, it is advisable to report the results in terms of the change in emissions rather than the absolute values from each scenario.

4.3 EnViVer

EnViVer (Environmental Vissim-VERSIT+ simulations) is an emissions modelling software package specifically designed to calculate emissions based on the simulated traffic data from Vissim. It is developed by TNO (the Organisation for Applied Scientific Research) in the Netherlands. The vehicle emissions calculation in EnViVer is based on VERSIT+micro, which is a version of VERSIT+ that works on individual vehicle data with a one-second frequency. VERSIT+ is a collection of emissions models derived from measuring and analysing the emissions behaviours of more than 20,000 vehicles under different traffic situations. A screenshot of the EnViVer user interface is shown in **Figure 184**, and a full description of the functionality can be found in the EnViVer Manual[143].

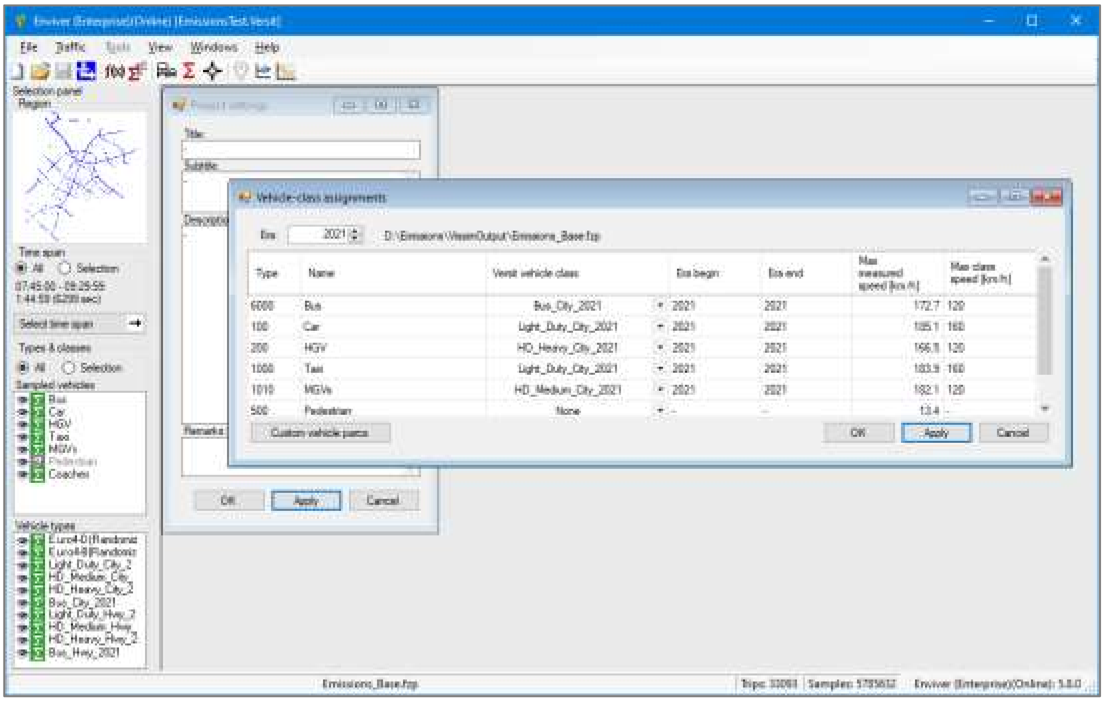


Figure 184: EnViVer main page

EnViVer allows users to define their own vehicle fleet models by configuring fuel type, vehicle age distribution and Euro engine standard proportions (section **C4.2.2.2**) so that the emissions calculations can be estimated based on local data. EnViVer also has batch processing and post-processing functionality which can be used to calculate, analyse and compare results for multiple different traffic scenarios.

143 Eijk A., Ligterink N and Inanc S. (2014). EnViVer Pro and Enterprise Manual, TNO (the Organization for Applied Scientific Research in Delft, the Netherlands)

4.3.1 Inputs

As outlined in section C4.2, emissions modelling requires inputs on the emissions modelling side, relating to vehicle emissions characteristics, and on the microsimulation modelling side, relating to vehicle movements. This section details how these specifically relate to EnViVer.

4.3.1.1 Vehicle Record Data

EnViVer uses individual vehicle record data (known as *.fzp files in Vissim and Aimsun Next) which can be output from a microsimulation model. The vehicle record data should be collected at one second intervals for the required area and vehicle types. Vehicle record files are user configurable in Vissim (section B7.7.2.7) and should be set up to contain the following information at a minimum:

- Vehicle number: The unique number of each vehicle in the network;
- Vehicle type: The number of each vehicle type. At a minimum, this should include Car, HGV and Bus;
- Vehicle type name: The name of the vehicle type;
- Time: The simulation time as time of day [hh:mm:ss] (or simulation time in seconds);
- Speed: The speed of a vehicle at the end of the simulation second in kph;
- X-coordinate: The x-coordinate of a vehicle (vehicle front end at the end of the simulation step). This is not necessary for emissions modelling, but can be used for creating output plots;
- Y-coordinate: The y-coordinate of a vehicle (vehicle front end at the end of the simulation step). This is not necessary for emissions modelling, but can be used for creating output plots;
- Link: The unique number of each link / section / segment; and
- Gradient: The gradient of the link / section the vehicle is travelling on, if this is available.

In order for EnViVer to import the vehicle record file, the file and column headers need to be in one of two specific formats, relating to the formats output by older and more recent versions of Vissim (section B7.1.2). The older version is shown in Figure 185, and is the easiest to replicate if manipulating outputs from software other than Vissim (the column spacing is not required). If using more recent versions of Vissim, it is important to note that the Vehicle Type column header needs to be VEHTYPE\NO and not simply VEHTYPE, or the import will not work. This can be achieved by selecting the vehicle type attribute from the expanding Vehicle Type list, rather than the main list, in a similar way to the Vehicle Type Name. Also, if required, the combined 'Coordinate front' attribute should be selected, rather than the separate X and Y coordinates. Detailed requirements for the Vissim vehicle record data formatting can be found in the EnViVer manual[144].

```
Vehicle Record

File:     D:\Emissions\TestModel001.inp
Comment:  Emissions modelling
Date:     21 January 2021 11:50:28
VISSIM:   5.40-12 [44923]

VehNr       : Number of the Vehicle
Type        : Number of the Vehicle Type
VehTypeName : Name of the Vehicle Type
ToD         : Simulation Time as Time of Day [hh:mm:ss]
vMS         : Speed [m/s] at the end of the simulation step
WorldX      : World coordinate x (vehicle front end at the end of the simulation step)
WorldY      : World coordinate y (vehicle front end at the end of the simulation step)
Link        : Number of the Active Link
Grad        : Gradient [%] of the current link

    VehNr; Type; VehTypeName;        ToD;    vMS;      WorldX;      WorldY;  Link; Grad;
        1;  100;         Car; 07:15:01.0;   3.85; 537843.3344; 173977.2418; 30030; 0.00;
        1;  100;         Car; 07:15:02.0;   6.40; 537840.9230; 173972.8483; 30030; 0.00;
        3;  100;         Car; 07:15:02.0;   3.98; 537840.3201; 173977.4653; 30030; 0.00;
        4;  100;         Car; 07:15:02.0;   6.38; 537146.0004; 173317.2937; 30057; 0.00;
        2;  100;         Car; 07:15:02.0;  15.19; 536797.1596; 173280.9819; 30070; 0.00;
        1;  100;         Car; 07:15:03.0;   9.08; 537837.2978; 173966.0368; 30030; 0.00;
        3;  100;         Car; 07:15:03.0;   6.42; 537837.8212; 173972.9123; 30030; 0.00;
        4;  100;         Car; 07:15:03.0;   8.15; 537149.0653; 173323.8494; 30057; 0.00;
```

Figure 185: Format of the vehicle record data file (*.fzp) needed for EnViVer import

4.3.1.2 Vehicle Fleet Definition File

As a default, the four main categories which are used in VERSIT+micro are:

- Light duty vehicles (these include passenger cars and other vehicles with a mass ≤ 3500 kg);
- Buses (such as public transport buses, tour buses and coaches);
- Heavy duty medium (mass ≥ 3500 kg and 2 axles); and
- Heavy duty heavy (mass ≥ 20000 kg and 3 or more axles).

In addition, separate models have been created for urban areas, bus-only urban and a rural / highway combination. One of the main differences between them is that the vehicle fleet for an urban area contains a higher proportion of older cars and petrol cars compared to a rural / highway area.

144 Eijk A., Ligterink N and Inanc S. (2014). EnViVer Pro and Enterprise Manual, TNO (the Organization for Applied Scientific Research in Delft, the Netherlands)

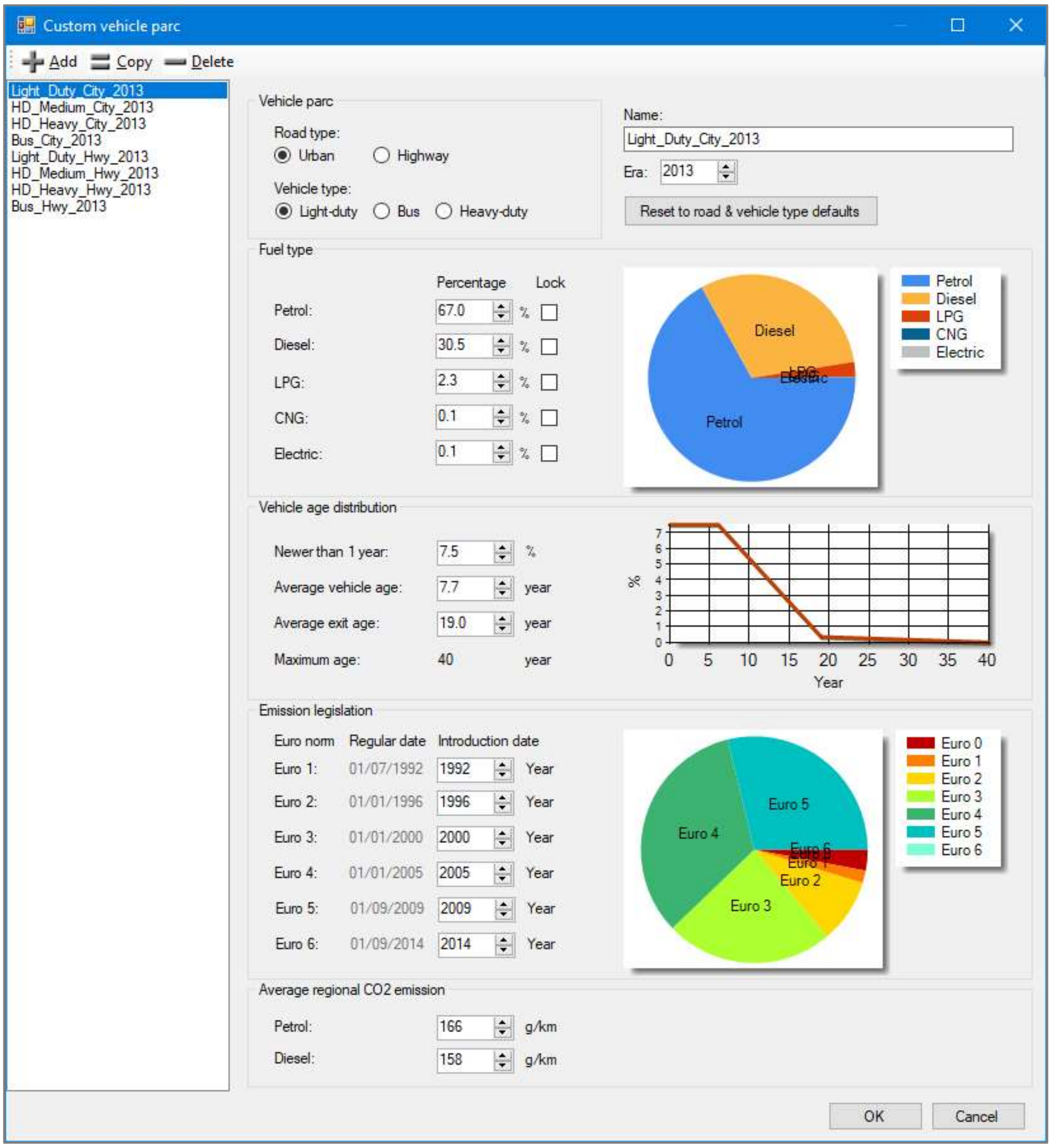


Figure 186: EnViVer custom vehicle distribution configuration window

To reflect local (city or country) vehicle characteristics, EnViVer facilitates the definition of a vehicle fleet using customisable properties (as shown in **Figure 186**):

- Fuel type proportion;
- Age distribution;
- Euro engine standard introduction date;
- Era; and
- Average CO_2 emissions for diesel / petrol vehicles.

For accurate emissions estimates, these proportions should be representative of modelled traffic and hence should be collected from the study area if possible. However, if this information is not available, the composition should be based on TfL City Planning Directorate's vehicle composition data for London and/or ULEZ via a TfL sponsor.

EnViVer calculates the proportion of Euro engine standards of vehicles on the basis of vehicle age distribution and emissions legislation. The age distribution, combined with the specified era, results in a Euro-class distribution which should be cross-checked against the actual proportion from observed data, if available. Further information can be found in the EnViVer manual[145].

4.3.1.3 Assigning EnViVer Emissions Classes

Once vehicle record data from a microsimulation model has been imported into EnViVer, the vehicle types defined in the microsimulation model must be linked to vehicle emissions classes. EnViVer automatically shows the Vehicle-class assignments screen (**Figure 187**) after importing a new vehicle records file. The availability of the emissions classes depends on the selected era. All simulated vehicles with the emissions class set to 'None' are excluded from the emissions calculations, therefore appropriate values for matching vehicle types should be entered before starting the emissions calculations.

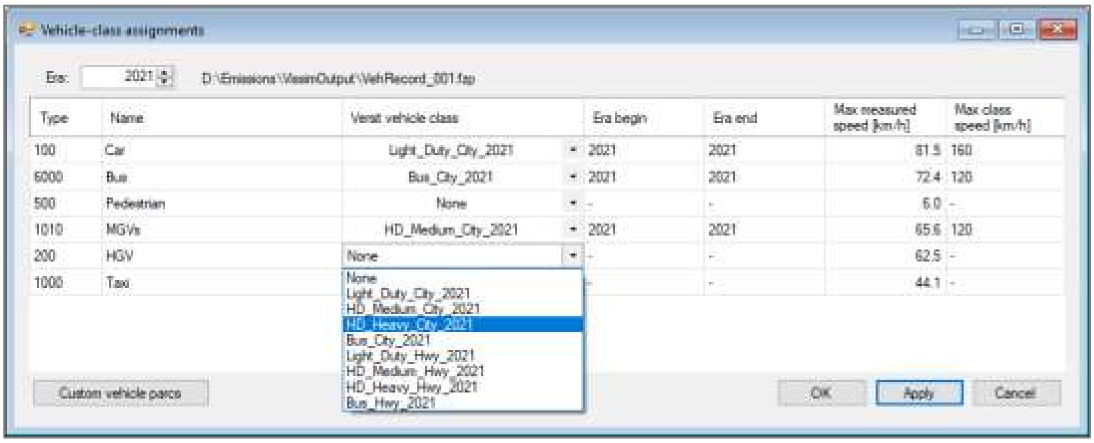


Figure 187: Vehicle-class assignments window screenshot

Emissions calculations in EnViVer are based on either pre-defined or user-defined vehicle emissions classes. The pre-defined vehicle emissions classes are based on the average Dutch fleet composition and are fixed, meaning that the user cannot change the contents of the underlying emissions model. If the data is available, the user should create a custom vehicle fleet that is more suitable to their specific situation by using user-defined vehicle emissions classes in EnViVer (section **C4.3.1.2**). Whichever

145 Eijk A., Ligterink N and Inanc S. (2014). EnViVer Pro and Enterprise Manual, TNO (the Organization for Applied Scientific Research in Delft, the Netherlands)

emissions classes are used, they must be the same across all modelled scenarios to give a fair comparison.

4.3.1.4 Data Verification

The analysis performed by EnViVer is reliant on realistic speed-time profiles being generated for each vehicle that is included. As indicated in the EnViVer manual[146]:

> "accelerations over 3m/s² are quite severe, especially at higher speeds (V>50kph). The maximum acceleration should not exceed 4 to 5m/s². Decelerations are in general maximum -3 to -4m/s². The decelerations sometimes exceed these values but can never exceed approximately 10m/s²."

EnViVer provides tools to examine the data in the vehicle record file.

The Speed-Acceleration plot provides a visual representation of the relative frequencies of speed-acceleration combinations over all vehicles in the vehicle record file. Blue shows occurrences, with higher frequencies moving towards red. **Figure 188** shows a reasonable range of values as the bulk of the points at all speeds are between +3m/s² and -3m/s², with a few larger decelerations.

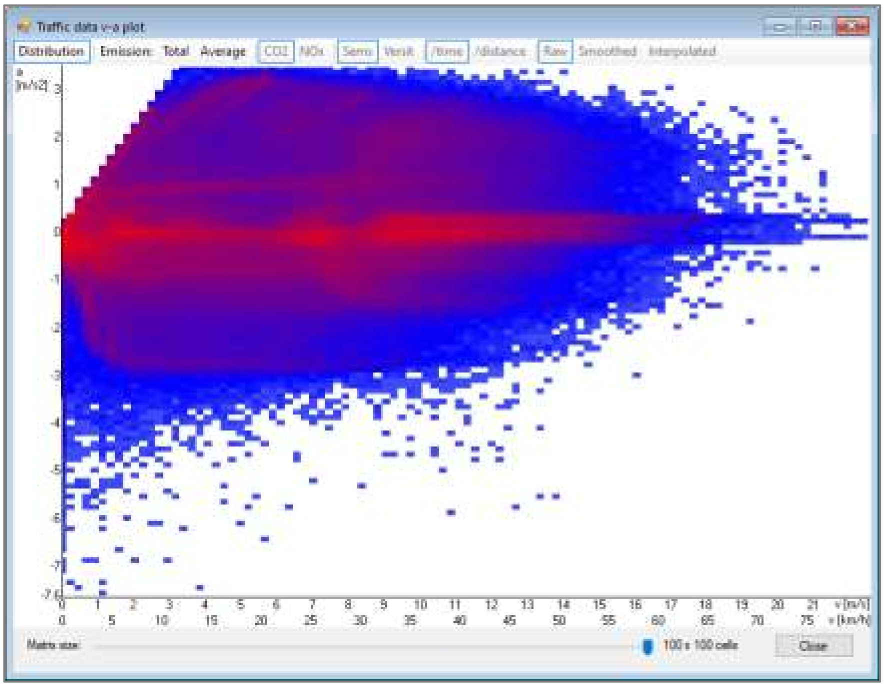


Figure 188: EnViVer Speed-Acceleration plot

146 Eijk A., Ligterink N and Inanc S. (2014). EnViVer Pro and Enterprise Manual, TNO (the Organization for Applied Scientific Research in Delft, the Netherlands)

As already mentioned, the basis of EnViVer emissions calculations is the speed-time curves produced by each vehicle. It is possible to view these profiles for individual vehicles via the Samples per trip plot (**Figure 189**). This has a list of all the vehicles on the left, together with a status column which highlights any vehicles that have anomalous speed or acceleration values. If too many of these errors are highlighted then the cause should be investigated before carrying out emissions calculations.

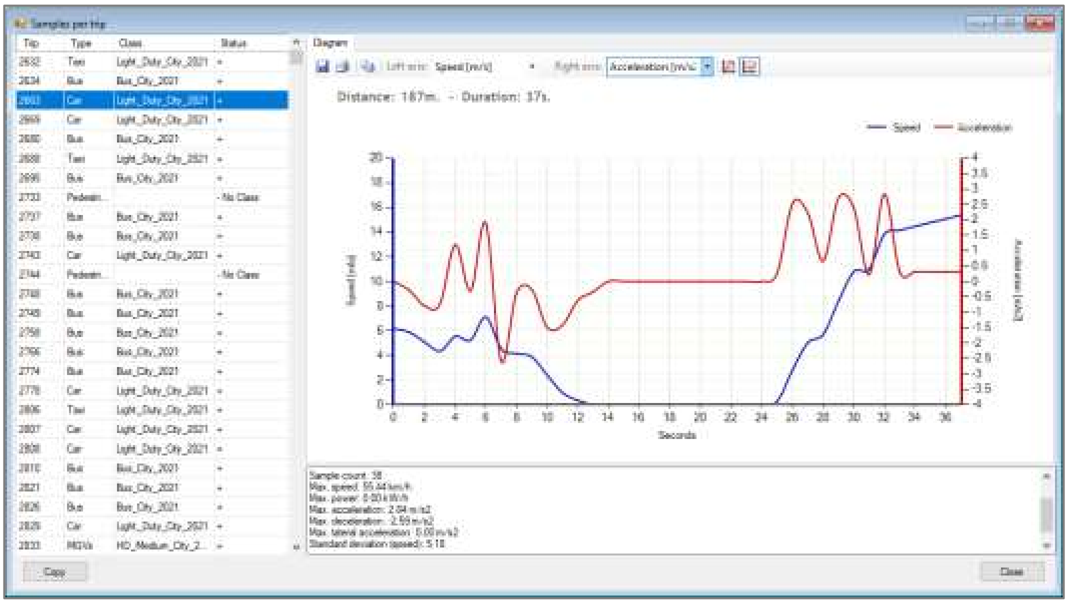


Figure 189: EnViVer speed and acceleration plot for an individual vehicle

4.3.2 Outputs

Based on the analysis of the EnViVer output, a report should be produced as described in section **C4.2.3**. EnViVer provides tools to produce the content for this report.

4.3.2.1 Report

EnViVer produces a concise report file (*.emissions) giving total emissions for the study area and for each vehicle emissions class. For more detailed analysis, EnViVer allows the selection of specific areas of the network, time intervals or vehicle emissions classes.

4.3.2.2 Plots

EnViVer has facility to plot vehicle emissions in the study area (**Figure 190**). Such plots are useful for visual identification of the impacts of any proposals, for example, hot spots of vehicle emissions or congested areas.

The plots can be set up with a grid size of 5m, 10m or 25m. The options available are traffic flow data (count per grid cell, average speed, sum of distance travelled), total emissions (per grid cell) and emissions per kilometre.

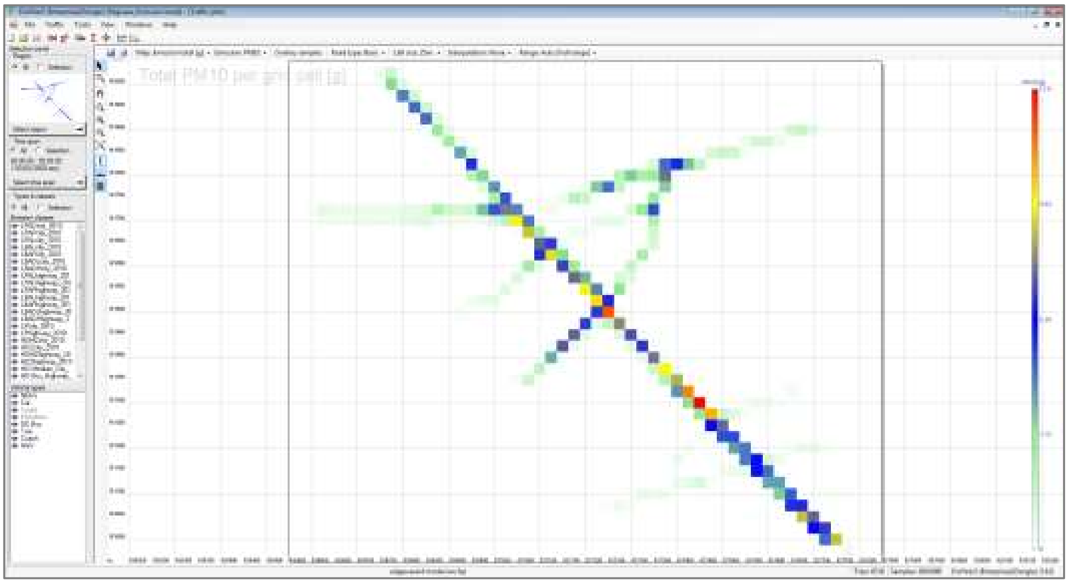


Figure 190: A screenshot showing EnViVer plot of PM_{10} emissions

EnViVer can also output text files for use in external software, using the Save map data to Raster GIS file button in the plot window (Enterprise version of EnViVer only). Figure 191 shows an EnViVer output file (*.asc) with the values plotted and colourised in a spreadsheet.

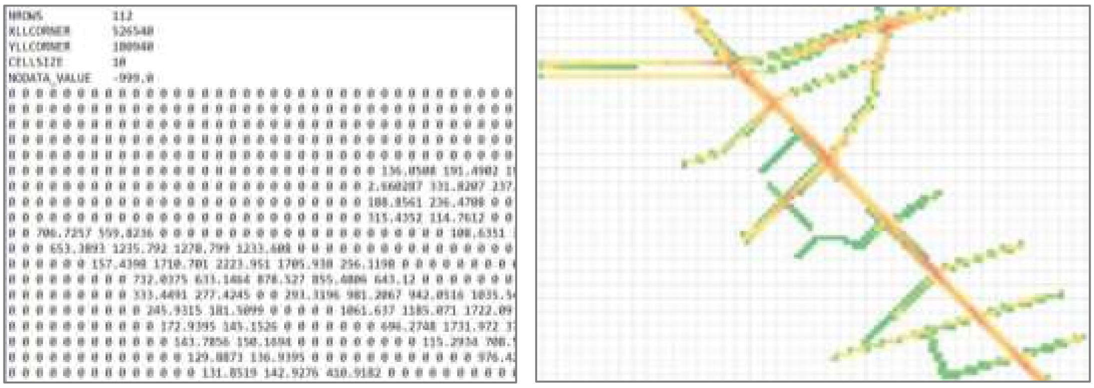


Figure 191: Excerpt from an EnViVer output file (*.asc) file and Excel plot of the output file values

4.3.2.3 Post Processing

The post processing tool in the Enterprise version of EnViVer provides functionality to:

- Calculate an average of the results of different traffic simulation runs; and
- Compare the results from different scenarios.

The tool can calculate and output results from any scenarios which have been run previously and stored using File > Export binary report. Post processing results can be viewed using the VERSIT Report Viewer, which must be installed separately to EnViVer. The resulting plots are similar in appearance to those shown above.

4.4 PHEM

PHEM (Passenger car and Heavy duty Emission Model) is an emissions modelling software package developed by Technical University of Graz (TUG) for calculating vehicle emissions. PHEM calculates the emissions of vehicles on the basis of their speed and acceleration / deceleration rates.

The model calculates the engine power output and engine speed from vehicle positions, speeds and accelerations, so any driving condition can be modelled as long as the vehicle record files are available. The simulation of different vehicle payloads in combination with road gradients, variable speeds and accelerations can be modelled replicating the different gear-shifting behaviour of drivers.

There are three versions of PHEM: STANDARD, BATCH and ADVANCE. PHEM STANDARD only requires the entry of speed curves (a vehicle's speed every second), whereas PHEM ADVANCE has the facility to configure individual vehicles if required. PHEM BATCH is a version of PHEM STANDARD with additional batch processing capability. ADVANCE mode, which allows calculations using the output of a traffic microsimulation model, should be used for the modelling work discussed here. The version of PHEM which will be used is selected on the Options tab, as shown in Figure 192.

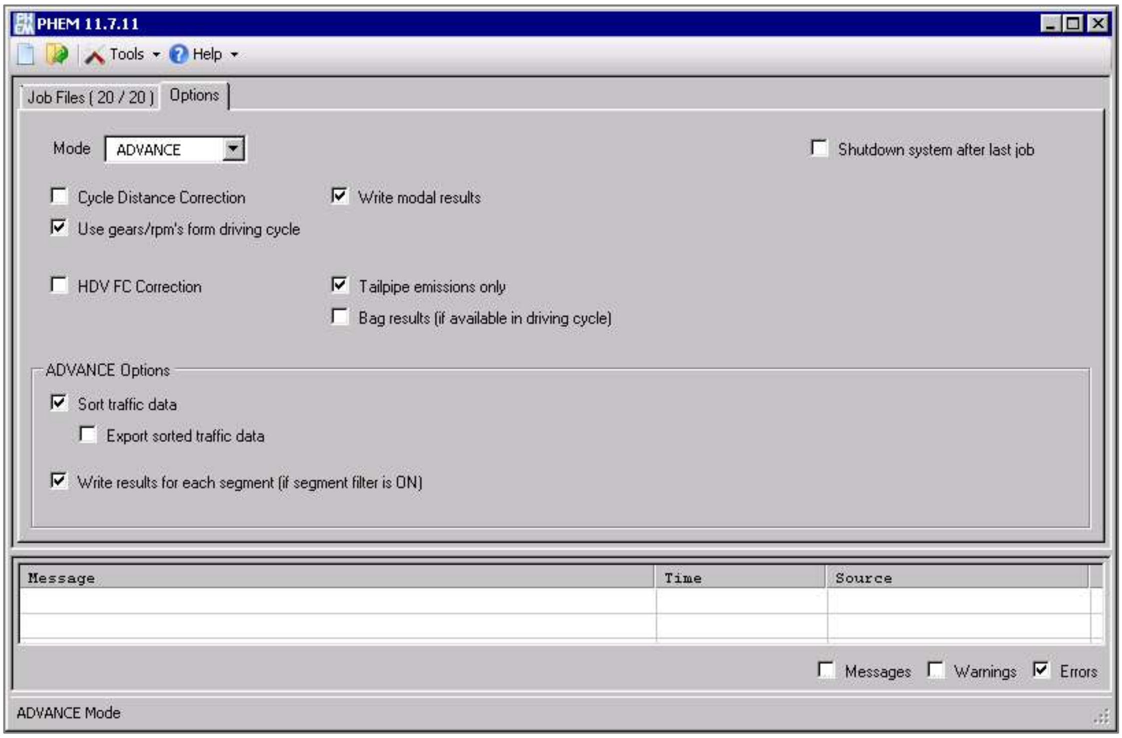


Figure 192: Options tab in the PHEM user interface

PHEM includes an extensive database of previously measured vehicles and engines for the calculation of road traffic emissions, however emissions levels can also be modelled for other types if the vehicle specifications are provided. The data is compiled as average vehicles, which illustrate the vehicle categories of passenger, light duty and heavy duty vehicles with petrol and diesel engines from Euro 0 to Euro 6 standards. The database for the average vehicles in PHEM comes from several national and international research projects.

PHEM uses the vehicle type as given in the vehicle record file and assigns the fuel type and Euro engine standard (such as Euro 5 petrol) to every individual vehicle according to the proportions given in the vehicle fleet composition file. It then calculates the emissions output for a vehicle depending on its speed at every second.

4.4.1 Inputs

PHEM uses various files (examples include vehicle specification, engine map, load and drag curve) to calculate emissions for all the vehicle categories given in the vehicle record data. It provides default files for a selection of vehicle categories based on measurements from different laboratories (TUG, EMPA – Swiss Federal Laboratories for Materials Science and Technology, and TNO). These vehicle categories differ in terms of their types, fuel types and EU engine standards. However, as driving conditions and driving behaviours differ between countries and cities, the latest files available from a TfL sponsor should be used if possible. These files will be the same in every study, unless they are updated or the study has vehicle categories which are not covered. The source of these files should be clearly identified in the report, as mentioned in section **C4.2.3**.

Besides the input data for the definition of vehicle categories, other input files that are specific to a simulation study are needed. These input files are described below.

4.4.1.1 Job File

To run PHEM, a job file (*.adv), storing information for a simulation, is needed. This includes:

- Path of the vehicle record file (*.fzp);
- Path of the fleet composition file (*.flt);
- Paths of segment data files; and
- Job Settings (defining the type of the output needed).

If all required input files are available, PHEM starts the calculation and writes the output files into the path where the job file is stored. The output files have the same file name as the job file (*.adv) with different extensions (section C4.4.2). Job files can be created by using the ADV editor within PHEM, as shown in Figure 193, or by writing directly using a text editor.

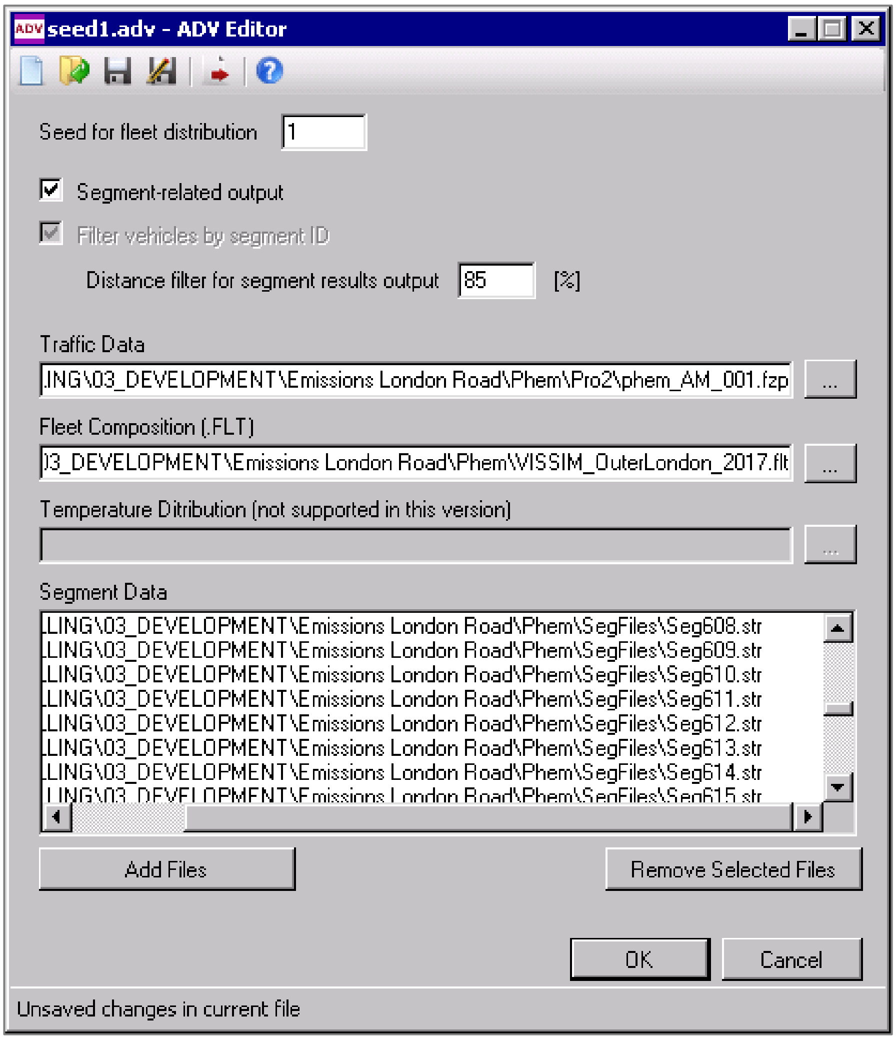


Figure 193: ADV editor which can be used to generate job files (*.adv)

The job files to be run are selected in the Job Files tab of the user interface, as shown in Figure 194. Each microsimulation run requires a separate job file.

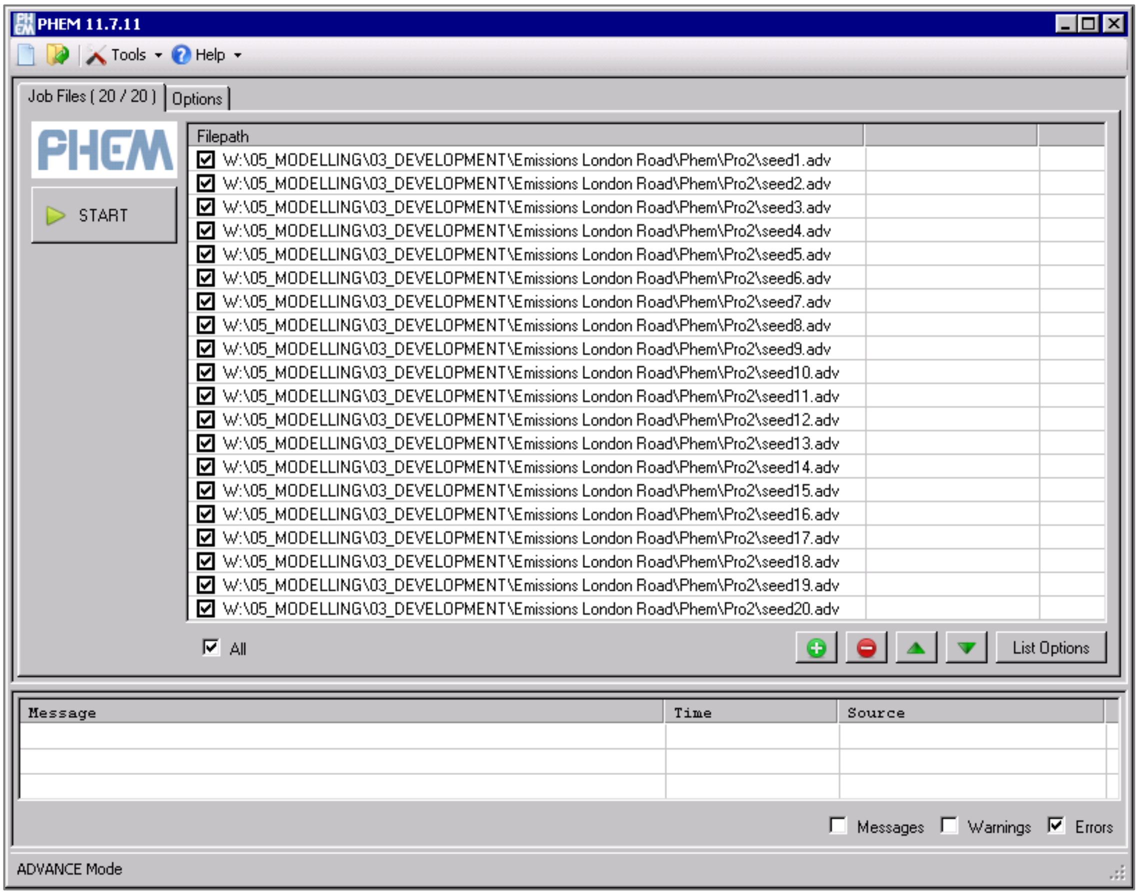


Figure 194: Screenshot of the Job Files tab in the PHEM user interface

4.4.1.2 Vehicle Record Data

PHEM has a pre-specified data structure for vehicle record data which needs to be collected with a one-second time interval from a microsimulation model. The data should be processed (if not already in the required structure) to include information as given below. The vehicle record data for PHEM should be in text format with data separated by semicolon, as shown in Figure 195:

- **Time** – A time in seconds. Needs to be an integer value in a sequence for each vehicle in the simulation (numbered after sorting the data by vehicle ID);
- **X-coordinate** – The x-coordinate of a vehicle at a simulation second;
- **Y-coordinate** – The y-coordinate of a vehicle at a simulation second;
- **Vehicle number** – The unique number of each vehicle in the network;
- **Speed** – The speed of a vehicle at a simulation time in kph (a conversion may be necessary if the output from a simulation model is in m/s);
- **Gradient** – The average gradient of a road link / section expressed as a percentage (section C4.2.1.4);
- **Vehicle type** – The type number of each vehicle category (for example Car, HGV, Bus and so on). The vehicle type numbers of all vehicle categories are predefined in PHEM and should be adopted in the vehicle record data accordingly (data processing is needed if the data from a simulation model is not same). The vehicle type numbers used in PHEM are:
    - 100=passenger vehicle
    - 200=freight vehicle
    - 300=light duty vehicle
    - 400=articulated vehicle
    - 500=city bus
    - 600=coach
    - 700=two-wheeler; and
- **Segment ID** – The unique number of each link / section / segment. Links / sections can be grouped into segments before the PHEM calculation or during the analysis of the output.

```
time;x;y;vehid;speed;gradient;vehtype;section
0;531926.312;179129.892;235;34.4559694;0;900;208
1;531933.692;179123.818;235;35.1318922;0;900;208
2;531943.882;179123.486;235;35.807815;0;900;208
0;531898.375;179167.217;250;2.6232242;0;900;262
1;531899.269;179166.162;250;7.3385904;0;900;262
2;531901.011;179164.108;250;12.0539566;0;900;4
3;531903.552;179161.062;250;16.7693228;0;900;4
4;531907.042;179157.055;250;21.484689;0;900;4
5;531911.537;179152.23;250;25.8942806;0;900;613
6;531915.627;179146.022;250;27.2300328;0;900;613
7;531919.969;179139.671;250;28.1473566;0;900;613
8;531924.451;179133.108;250;29.0646804;0;900;10607
9;531929.094;179126.561;250;28.8232794;0;900;208
10;531936.318;179123.172;250;27.8898622;0;900;208
11;531944.248;179123.569;250;26.9725384;0;900;208
0;531699.496;179387.985;259;25.8460004;0;900;264
1;531694.92;179393.441;259;25.186171;0;900;264
2;531690.495;179398.683;259;24.2044736;0;900;264
3;531686.23;179403.697;259;23.2066828;0;900;264
4;531682.107;179408.471;259;22.208892;0;900;264
5;531678.103;179413.06;259;22.0801448;0;900;10137
6;531673.543;179417.363;259;23.0618422;0;900;130
7;531669.04;179422.114;259;24.059633;0;900;130
8;531663.718;179426.363;259;25.0574238;0;900;130
0;531859.121;179206.251;263;19.6500414;0;900;167
1;531862.092;179201.778;263;18.0085146;0;900;167
2;531864.548;179197.74;263;16.6083888;0;900;167
3;531867.378;179193.289;263;20.8731398;0;900;10001
```

Figure 195: An example vehicle record data file (*.fzp) extract

4.4.1.3 Vehicle Fleet Composition File

The fleet composition file (*.flt) is an input file which contains the proportions of different vehicle categories. PHEM assigns the fuel type and Euro engine standard (such as Euro 5 petrol) to every individual vehicle according to the proportions given in the fleet composition file. For accurate emissions estimates, these proportions should be representative of the modelled traffic. Therefore, as far as possible, this information should be collected from on-street observed data. An example of a fleet composition file is shown in **Figure 196**.

```
c column 1: Vehicle Type ID ...used to assign vehicles in the .fzp file (column 7),,,,,,,
c column 2: gen file ...name of the PHEM .gen inpute file. Use <VEHDIR> for Default Vehicles.,,,,,,,
c column 3: percentage ... share percentage of vehicle category. Category sum = 100% (NOT total fleet sum!),,,,,,,
c column 4+: optional information,,,,,,,
c Vehicle Type ID,gen file,percentage,type,Fuel Type,EURO Class,Size Class,AGR/SCR (HGV)
c VISSIM vehicle categories = 100 PC + LGV (need to fuse) | 200 HGV artic |
c
c PASSENGER CAR: petrol, diesel, hybrid (petrol - rough), EV
100,<VEHDIR>\PC\PC_EU0_G.GEN,0,PC,Gasoline,0,Average,-
c includes those with Failed CAT
100,<VEHDIR>\PC\PC_EU0_G.GEN,0.00944,PC,Gasoline,0,Average,-
100,<VEHDIR>\PC\PC_EU1_G.GEN,0.00311,PC,Gasoline,1,Average,-
100,<VEHDIR>\PC\PC_EU2_G.GEN,0.01918,PC,Gasoline,2,Average,-
100,<VEHDIR>\PC\PC_EU3_G.GEN,0.08740,PC,Gasoline,3,Average,-
100,<VEHDIR>\PC\PC_EU4_G.GEN,0.12002,PC,Gasoline,4,Average,-
100,<VEHDIR>\PC\PC_EU5_G.GEN,0.09615,PC,Gasoline,5,Average,-
100,<VEHDIR>\PC\PC_EU6_G.GEN,0.09123,PC,Gasoline,6,Average,-
100,<VEHDIR>\PC\PC_EU0_HybridG.GEN,0.00018,PC,HybridGasoline,0,Average,-
100,<VEHDIR>\PC\PC_EU3_HybridG.GEN,0.00008,PC,HybridGasoline,3,Average,-
100,<VEHDIR>\PC\PC_EU4_HybridG.GEN,0.00153,PC,HybridGasoline,4,Average,-
100,<VEHDIR>\PC\PC_EU5_HybridG.GEN,0.00471,PC,HybridGasoline,5,Average,-
100,<VEHDIR>\PC\PC_EU6_HybridG.GEN,0.01056,PC,HybridGasoline,6,Average,-
100,<VEHDIR>\PC\PC_EV.GEN,0.00138,PC,EV,EV,Average,-
```

Figure 196: An example fleet composition file (*.flt) extract

4.4.1.4 Segment Data File

PHEM writes output files for each segment data file (*.str) defined, which can be used to analyse the results on an individual segment basis. These defined segments need to be included in the vehicle record file (*.fzp) and also specified in the input definition file (*.adv). An example of a typical segment file is shown in **Figure 197**.

```
Str: Segment ID
Sp: Lane nr
SegAnX: Segment start x
SegEnX: Segment end x
SegAnY: Segment start y
SegEnY: Segment end y

Str; Sp;  SegAnX;  SegEnX;  SegAnY;  SegEnY;
130;0;0;0;0;0
```

Figure 197: An example segment data file (*.str)

4.4.2 Outputs

PHEM produces two types of output file – detailed and aggregated:

- Mod File (*.mod) – stores detailed emissions results for every vehicle; and
- Vehicle Sum File (*.sum) – store average values per vehicle (vehicle.sum) and average values per segment file (segment.sum), if segment data files are provided.

Based on the analysis of the PHEM output, a report should be produced as described in section C4.2.3.

4.4.2.1 Mod File

A mod file (*.mod) provides emissions output every second for each vehicle in the network, as shown in Figure 198. One mod file is generated for each vehicle type. These files are used only when a detailed investigation is needed.

Figure 198: An example mod file (*.mod) extract

4.4.2.2 Vehicle Sum File

A vehicle sum file (*.vehicle.sum) provides an average value of emissions per vehicle for all the vehicles in the network, as shown in **Figure 199**.

```
PHEM ADVANCE Average results per vehicle
PHEM 11.7.11
27/08/2019 12:45:16
Inputfile: D:\EmissionsTest\Phem\Base\seed2.adv
VehNr,VehType,GEN,time,Prated,distance,speed,road grad,n_norm,Pe_norm,Pe_pos,Pe_neg,FC,NOx,CO,HC,PM,PN,NO,E3,Lambda,ExhTemp,Extrapolation,M
[-],[-],[-],[s],[kW],[km],[km/h],[%],[-],[-],[-],[-],[g/h],[g/h],[g/h],[g/h],[g/h],[#/h],[g/h],[?/h],[-],[°C],[-],[kg/s],[g/h],[g/h],[-],[k
238,900,HGV_CB_DOUBLE_EU5_SCR.GEN,5,228,0.04232788,30.47607,0,0.791258929252625,0.240628507733345,0.240628507733345,0,13326.73,292.8161,65.
240,900,HGV_CB_DOUBLE_EU6.GEN,4,228,0.0272202,24.49818,0,0.54984512925148,0.166438607833342,0.166438607833342,0,8922.225,27.98249,0.190486,
247,900,HGV_CB_DOUBLE_EU5_SCR.GEN,40,228,0.1653619,14.88257,0,0.296749350149184,0.145921528246254,0.149889573641121,-0.00396804539486766,71
251,100,PC_EU4_G.GEN,18,81,0.1376171,27.52342,0,0.442147872514195,0.0149520450653569,0.0683199266592662,-0.0533678807939092,2873.332,2.7520
254,100,LCV_EU5_D_I.GEN,9,67,0.07441632,29.76653,0,0.480267585979568,0.113007585207621,0.163754781087724,-0.0507471958796183,3343.591,57.320
255,100,PC_EU3_D.GEN,20,97.4,0.1590833,28.63499,0,0.302782066911459,0.0211197725569946,0.0536884487213683,-0.0325686761643738,2341.235,25.0
256,900,HGV_CB_DOUBLE_EU6.GEN,67,228,0.1976498,10.61999,0,0.239118740407389,0.104349877817362,0.110670566781243,-0.00632068896388162,5351.6
257,900,HGV_CB_DOUBLE_EU5_SCR.GEN,48,228,0.3145075,23.58806,0,0.545356809841335,0.155023391086919,0.167284740251489,-0.0122613491645704,8697
259,100,LCV_EU4_D_III.GEN,22,82,0.1764636,28.87586,0,0.447354139252142,0.0555750723248242,0.0904468897867694,-0.0348718174619452,2790.203,4
260,200,HGV_TT_32T_EU5_SCR.GEN,27,326.2,0.1746195,23.2826,0,0.366239460530104,0.123358796523125,0.144592418885278,-0.0212336223296545,10242.
262,900,HGV_CB_DOUBLE_EU5_SCR.GEN,52,228,0.3403218,23.56074,0,0.546480065313752,0.155926749253502,0.159908634825395,-0.00398108557189245,87
263,100,PC_EU4_G.GEN,31,81,0.1996063,23.18008,0,0.333434429260031,0.023888957457647,0.0514692326391777,-0.0275802751815387,2656.044,2.30238
264,100,PC_EU3_G.GEN,32,84.2,0.1934863,21.76721,0,0.392073781666113,0.0200183517606813,0.0506205347410287,-0.0290021829803474,2913.933,3.07
265,1000,LCV_EU4_D_II.GEN,24,63,0.1621097,24.31645,0,0.410546758289759,0.0711982417075584,0.0828156968733917,-0.0116174551650332,2381.864,2
```

Figure 199: An example vehicle sum file (*.vehicle.sum) extract

4.4.2.3 Segment Sum File

A segment sum file (*.sum) provides an average value of emissions per segment (for all segments with a defined segment file). An example is shown in **Figure 200**. This file also gives aggregated values of emissions per vehicle type for the whole network. This is the output file used for analysis of the emissions for different areas of the simulation model. Depending on the segments defined, aggregation may be needed when analysing the results.

```
PHEM ADVANCE Sum Results per Segment
PHEM 11.7.11
Inputfile: D:\EmissionsTest\Phem\Base\seed2.adv
Segment File: D:\EmissionsTest\Phem\SegFiles\Seg138.str
Calculated Segment Length: 0m
Minimum Travelled Distance: 0m (85%)

Vehicle Type,Vehicles,Travel Time,Travelled Distance, Average Speed,FC,NOx,CO,HC,PM,PN,NO
[-],[-],[h],[km],[km/h],[g/km],[g/km],[g/km],[g/km],[g/km],[#/km],[g/km]
100,547,1.09333333333333,33.1224718460366,30.2949437616188,76.4673930759029,0.365009404668082,0.452581362239052,0.019380
200,26,0.0569444444444444,1.58519740083814,27.8376128927673,449.509588863758,2.52795610709058,1.6582303205536,0.04945969
300,10,0.0216666666666667,0.602831938266754,27.8230125353887,221.374207877774,4.74889269606295,1.40672152028848,0.031018
900,87,0.199722222222222,5.23482578301430,26.2105324323386,244.132238095373,4.78061439402917,1.56559268364342,0.067353387
1000,44,0.0877777777777778,2.64289902567863,30.1089762419085,61.5158327974189,0.558409397590185,0.00729371081278317,0.00
1010,48,0.0958333333333333,2.88343347692490,30.0880014983467,286.937274944218,3.91686972958628,1.26525031762787,0.0785133
Sum,762,1.55527777777778,46.0716594707593,29.6227851571233,122.564206085617,1.23144035348898,0.658330944485241,0.0289054
```

Figure 200: An example segment sum file (*.sum) extract

Although PHEM does not include the capability to plot its results geographically, the segment sum file can be used to display the results in other software. For example, Vissim UDAs (section **B7.7.1.2**) can be used to display PHEM outputs or post-processed differences between scenarios, as shown in **Figure 201**.

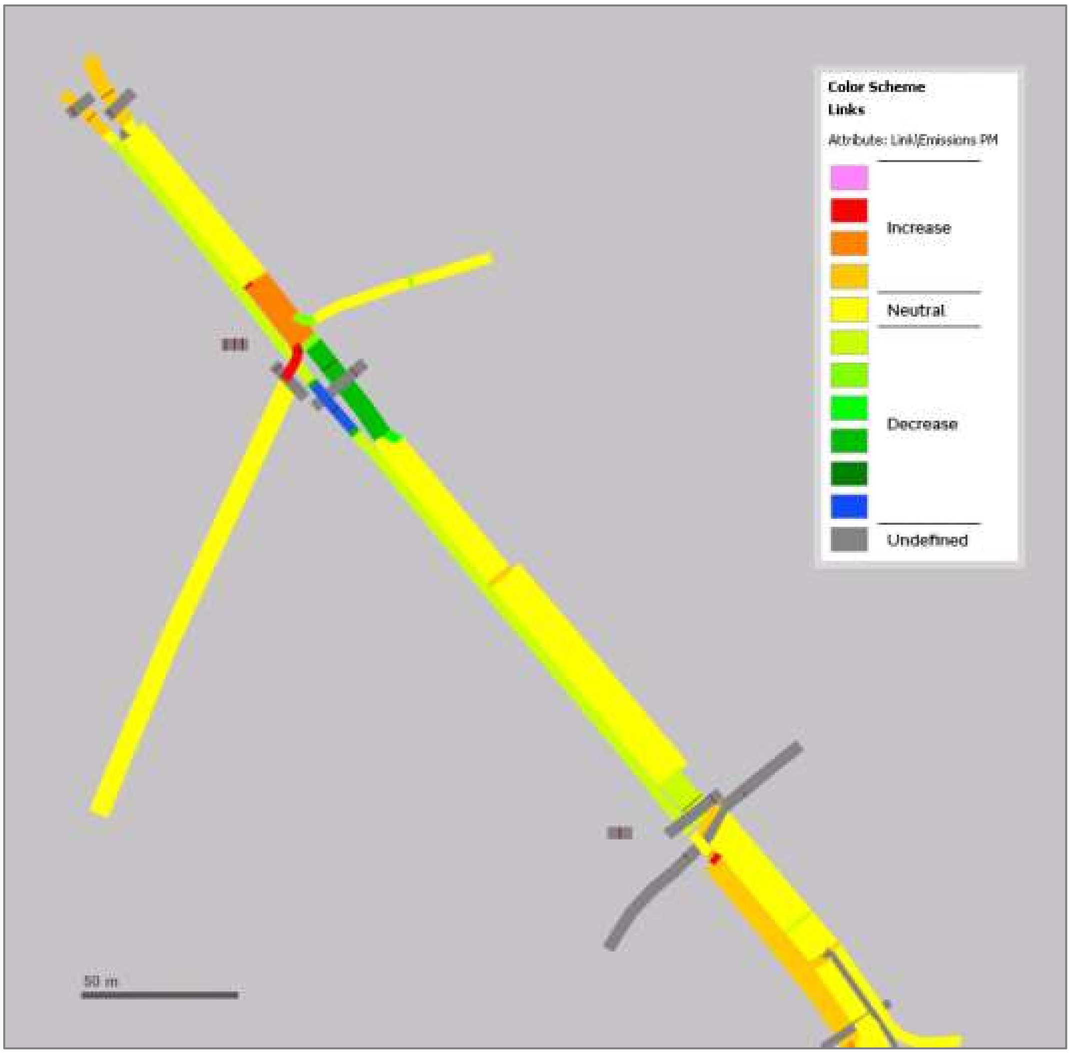


Figure 201: Difference in NO_x levels between two scenarios

Closing Summary

These Traffic Modelling Guidelines, produced by the Network Management Directorate within TfL Surface Transport, provide overarching guidance on the appropriate standards of traffic modelling required when proposing a traffic signal scheme within London.

Modelling experts within TfL and across the industry have contributed to this document. The document can be read as a whole, but can also be used as a reference for particular traffic modelling issues. **Part A** provides a high-level overview of traffic modelling for a non-technical audience, whilst **Part B** presents specific advice and standards for practitioners. **Part** C introduces techniques for modelling active travel modes in support of the Healthy Streets philosophy within the Mayor's Transport Strategy.

The content of these Guidelines is correct at the time of publishing, based on software versions currently in use within TfL. Since traffic modelling software developers frequently release new versions, this document is considered a source of evolving guidance. It continues to be updated with advice on best practice covering new products, concepts and techniques as they are developed and tested in our working environment.

All advice provided in the Traffic Modelling Guidelines is non-binding but is directly related to the way TfL operates London's traffic management systems. This document builds upon the success of the three previous versions, which have been used as guidance during the development of numerous traffic models both in the UK and overseas.

The latest version of this document is available to download from:
https://tfl.gov.uk/trafficmodelling

We encourage feedback on the advice given in this document. Please address all comments, specifying that they are related to the Traffic Modelling Guidelines Version 4.0, to:

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Transport for London
3rd Floor, Palestra
197 Blackfriars Road
LONDON
SE1 8NJ

TfLModellingGuidelines@tfl.gov.uk

Contacts

The list below provides a summary of all the email addresses that have been identified in the Traffic Modelling Guidelines and a description of their use.

AssetOperationsDataLegalRequest@tfl.gov.uk - Traffic signal information, including site reference numbers, site paperwork and demand-dependent stage frequency data (section **B2.2.1**).

Cynemon@tfl.gov.uk - Information on the Cynemon strategic cycling model (section **C2.2.3**).

ModellingData@tfl.gov.uk – Requests to access modelling data (sections **B2.3.1** and **C2.3.1**).

NMSchemeAssessment@tfl.gov.uk – Model audit submissions to Network Performance (section **B2.1.5**).

ONE@tfl.gov.uk – Information on TfL's Tactical Highway Assignment model (the ONE Model, section **B5.2.2**).

PPD3rdPartyRequests@tfl.gov.uk – Registration of schemes on to the NM Workbook (section **A3.6.1**).

StrategicModelling@tfl.gov.uk – Information on TfL's Strategic Highway Assignment suite (including MoTiON, LoHAM, Railplan and Cynemon), including accreditation for use of the ONE Model (section **B5.2.1**).

StreetsPedestrianModelling@tfl.gov.uk – Information and guidance on pedestrian modelling within Network Management (section **C3.3.1**).

TfLModellingGuidelines@tfl.gov.uk – Feedback on the contents of the Traffic Modelling Guidelines and discussion of evolving modelling techniques (section **A6**).

Glossary

Term	Description
ACC	Automated Cycle Counters – provide volume and speed data for cyclists (section B2.3.1)
Aimsun	Developer of Aimsun Next, formerly TSS (Chapter B3)
Aimsun Next	Advanced Interactive Microscopic Simulator for Urban and non-urban Networks – modelling software developed by Aimsun (Chapter B3)
AMAP	Aimsun (Next) Model Auditing Process (see MAP) (sections A3.6.1 and B2.1.5)
ANPR	Automatic Number Plate Recognition – a method of counting and classifying vehicles using their number plates (section B2.3.4.1)
ARCADY	Assessment of Roundabout Capacity And DelaY – modelling software developed by TRL (section A5.1.2)
ASL	Advanced Stop Line – area in front of the main traffic stopline so cyclists can wait in front of other vehicles (section A4.5.5 and Chapter C2)
ATC	Automated Traffic Counters – roadside infrastructure which measures the volume and speed of traffic (section B2.3.1)
CAD	Computer-Aided Design – using computer software to record or design something, in modelling it usually refers to vector drawings of the layout of a particular junction (section C3)
CE	Checking Engineer – key role identified in MAP (sections A3.6.1 and B2.1.5)
CFP	Cyclic Flow Profile – a feature of deterministic modelling that displays a graph of the arrival pattern of vehicles at a stopline (sections B4.7.2 and B6.7.2.2)
CLF	Cableless Linking Facility – method by which signal controller timings are linked together using an internal clock (section B2.3.8.4)
CPDM	Congested Platoon Dispersion Model – a traffic model used in TRANSYT that accounts for flare blocking (section B6.4.3.3)
CTM	Cell Transmission Model – a traffic model used in TRANSYT that accounts for exit-blocking (section B6.4.3.4)

CYOP	CYcle time OPtimisation – a TRANSYT feature used to select an appropriate cycle time for a modelled network (section **B6.6.4.1.4**)
DE	Design Engineer – key role identified in MAP (sections **A3.6.1** and **B2.1.5**)
DfT	The Department for Transport (section **A2.1.2**)
DMRB	Design Manual for Roads and Bridges – document containing information about the current standards on motorways and trunk roads in the United Kingdom (section **A4.5.2.1**)
DoS	Degree of saturation – measure used to determine how busy a stopline is by looking at the percentage of the capacity that is used (section **B2.3.10**)
DSD	Desired Speed Decision – used in Vissim modelling to set speed limits (section **B7.4.2.3**)
EIA	Environmental Impact Assessment – report on a scheme that should consider estimated emissions, traffic, noise and vibration, visual impact and impact on local ecology (section **A4.5.6**)
EQUISAT	A TRANSYT feature that provides an initial set of signal timings prior to optimisation, based on equal saturation of critical conflicting links (section **B6.6.4.1.1**)
FT	**Fixed time –** Traffic signal control method under UTC (see UTC) which operates via set plans which change by time of day (section **B2.3.8.2**)
FlowRound	Software for the analysis of spiral traffic lane movements at signalised and unsignalised roundabouts, developed by JCT (section **B6.4.7.1**)
Fusion	An optimisation algorithm, which is part of the RTO, and will replace SCOOT (section **B2.3.8.2**)
GIS	Geographic Information System – computer program that works with spatial data and mapping
GLA	Greater London Authority – administrative body responsible for the strategic administration of Greater London
GPS	Global Positioning System – a satellite-based navigation system that provides location and time information (section **B2.3.4.3**)
HCM	Highway Capacity Manual – publication of the Transport Research Board in the USA, containing guidelines and procedures

	for computing the capacity and quality of service of various types of highway facilities (section B3.7.1)
HGV	Heavy Goods Vehicle – vehicle classification including all goods vehicles with three or more axles (section B2.3.4.1.1)
HTA	Highway Traffic Assignment – a distribution of the travel on a set of routes among Origin-Destination pairs that estimates flows in such a way that no one vehicle can find a better generalised travel cost by switching its route (Chapter B5)
ICA	Intersection Capacity Analysis – used in Visum modelling to estimate the capacity of intersections (section B5.1)
IDP	Investment Delivery Planning, formerly Sponsorship, are the team that advocates TfL schemes.
ITN	Integrated Transport Network – a former layer from Ordnance Survey's MasterMap, now replaced by the Highways Network layer (section B2.3.6.2)
JCT	JCT Consultancy Ltd – developer of FlowRound, LinSat, LinSig and TranEd (Chapter B4)
LMAP	LinSig Model Auditing Process (see MAP) (sections A3.6.1 and B2.1.5)
LEGION	Pedestrian modelling software, developed by Bentley (section C3.3.2.1)
LGV	Light Goods Vehicle – vehicle classification including all goods vehicles up to 3,500kg gross vehicle weight (section B2.3.4.1.1)
LinSat	Freely available software developed by JCT, allowing the estimation of effective flare usage based on flow data (section B2.5.2.2)
LinSig	Deterministic modelling software developed by JCT (Chapter B4)
LTA	Local Traffic Authority – the body responsible for local roads (section A2.1)
MAE	Model Auditing Engineer – key role identified in MAP (sections A3.6.1 and B2.1.5)
MCC	Manual Classified Counts – provide traffic turning count data (section B2.3.1)
MAP	Model Auditing Process – TfL's framework which leads all interested parties through model development, submission and auditing (sections A3.6.1 and B2.1.5)

MGV	Medium Goods Vehicle – vehicle classification including all goods vehicles with 2 axles over 3,500kg gross vehicle weight
MME	Mean Modulus of Error – in TRANSYT modelling, a numerical value between zero and two, indicating how bunched a travelling platoon remains as it progresses between junctions (section **B6.7.2.2**)
MMQ	Mean Maximum Queue – the average of the maximum queue lengths in each cycle, used in deterministic modelling (sections **B4.6.4.1.2** and **B6.6.4.1.7**)
MoTiON	Model of Travel in London – TfL's strategic demand model, replacing London Transport Study, which covers all of Greater London and is built and used by TfL's City Planning Demand Forecasting and Analytics team. (section **A3.4.4**)
MOVA	Microprocessor Optimised Vehicle Actuation – an improved method of VA which is more responsive to traffic conditions (section **B2.3.8.4**)
MTS	Mayor's Transport Strategy – a document published by the Mayor of London, which sets out the Mayor's policies and proposals to reshape transport in London over the next two decades (section **A2.1**)
NAE	Network Assurance Engineer – key role identified in MAP (sections **A3.6.1** and **B2.1.5**)
NIST	Network Impact Specialist Team – team within TfL that works on behalf of the Traffic Manager to ensure that the NMD has been fully complied with in the development, design and implementation of highway scheme proposals impacting on London's major roads (section **A2.1.2**)
NMD	Network Management Duty – under the TMA, requires an authority to manage all their activities in such a way as to maximise the efficiency of movement on their road network and minimise unnecessary delay (section **A2.1**)
NP	Network Performance (within NM), formerly Urban Traffic Control (UTC) (**About the Authors**)
OD	Origin-Destination – a matrix used to input traffic flows into a model, with the origins as rows and the destinations as columns
ONE	Operational Network Evaluator – TfL's tactical model which covers Greater London and is used to assess schemes and investigate the implications of local network changes on the wider network (section **B5.2.2**)

OS	Ordnance Survey – the national mapping agency for Great Britain (section **C3.4.3**)
P	Promoter – key role identified in MAP (sections **A3.6.1** and **B2.1.5**)
PCU	Passenger Car Unit – a common unit used to represent general traffic where vehicle types are assigned a conversion factor to the equivalent number of cars based on the amount of road space they take up (section **B2.3.4.1.1**)
PDM	Platoon Dispersion Model – the traditional traffic model used in TRANSYT (section **B6.4.3.1**)
PHEM	Passenger car and Heavy duty Emission Model – an emissions modelling software package developed by Technical University of Graz for calculating vehicle emissions on the basis of their speed and acceleration / deceleration rates (section **C4.4**)
PI	Performance Index – a monetary value used in TRANSYT to assess the cost of stops and delays in a network (section **B6.1.3**)
PICADY	Priority Intersection Capacity And DelaY – modelling software developed by TRL (section **A5.1.2**)
PRC	Practical Reserve Capacity – the spare capacity of a junction, used by LinSig during optimisation (section **B4.6.4.1**)
Prior matrix	The result of the matrix building process, including the use of observed data, data cleaning and infilling methods (such as a with a gravity model). This stage of development occurs before the final matrix adjustments during calibration and validation.
PTV	Planung Transport Verkehr (PTV) AG – developer of Vissim and Visum (Chapter **B7** and section **A5.3.3**)
QueProb	TRANSYT feature allowing the estimation of effective flare usage based on flow data (section **B6.4.4.4**)
RFC	Ratio of Flow to Capacity – measure used to determine how busy an approach is at an unsignalised junction (section **B2.3.4.4**)
RR67	Research Report 67 – publication by TRL describing a methodology for the prediction of saturation flows (section **B2.3.9.1**)
RSA	Reduced Speed Area – used in Vissim modelling to implement changes in speed due to road geometry or factors that cannot be directly modelled (section **B7.4.2.3**)

RTO	Real Time Optimiser – the traffic signal control system that will replace TfL's Urban Traffic Control (UTC) system (section **B2.3.8.2**)
SAE	Signals Auditing Engineer – key role identified in MAP (sections **A3.6.1** and **B2.1.5**)
SASS	System Activated Strategy Selection – an automated method of adjusting on-street signal timings based on particular traffic flow criteria (section **B2.3.8.2**)
SATURN	Simulation and Assignment of Traffic to Urban Road Networks – modelling software suite developed by the Institute for Transport Studies, University of Leeds, and distributed by Atkins Ltd. (section **A5.3.2**)
SCOOT	Split, Cycle and Offset Optimisation Technique – technology that controls and optimises signal timings across London, developed by TRL (section **B2.3.8.2**)
SIR	Scheme Impact Report (formerly TSSR, Traffic Signal Supplementary Report) – a report on the impact of schemes which enables NIST to ensure that TfL is meeting the NMD (section **A4.6.1**)
SITS	Surface Intelligent Transport Systems – the programme within TfL that aims to respond to the future challenges that face London's road network (section **B2.3.8.2**)
SLD	Site Layout Drawing – diagram showing the layout of junctions including the locations of all street furniture and ducting (section **B2.3.1**)
SQA-0640	TfL series of documents containing Design Standards for Signal Schemes in London (formerly SQA-0064) (section **A4.5.2.1**)
SRN	Strategic Road Network – borough roads comprised of 500km of routes which are considered to have a strategic importance in terms of network operation, including major bus routes (section **A2.1**)
StratMan	Strategy Manager – the component in the RTO system which will replace TfL's current SASS (see SASS) functionality (section **B2.3.8.2**)
SVD	Selective Vehicle Detection – used in systems like iBus to give priority to specific types of vehicle (section **B2.3.8.2**)
TAG	DfT Transport Analysis Guidance (formerly WebTAG) (section **A3.6.2**)

TfL	Transport for London
TLRN	Transport for London Road Network – a network of nearly 580km of London's roads which makes up 5% of the roads but carries 30% of London's traffic and is the responsibility of TfL under the TMA (section **A2.1**)
TMA	Traffic Management Act 2004 – places a Network Management Duty (NMD) on all Local Traffic Authorities (LTAs) in England (section **A2.1**)
TMAP	TRANSYT Model Auditing Process (see MAP) (sections **A3.6.1** and **B2.1.5**)
TNO	Organisation for Applied Scientific Research – developer of EnViVer emission modelling software (section **C4.3**)
TranEd	Software developed by JCT to provide an improved graphical user interface for TRANSYT versions 12 and earlier (Chapter **B6**)
TRANSYT	TRAffic Network StudY Tool – modelling software developed by TRL (Chapter **B6**)
TRL	Transport Research Laboratory (TRL Ltd) – developer of ARCADY, PICADY, SCOOT and TRANSYT (Chapter **B6**)
TUG	Technical University of Graz – developer of PHEM emissions modelling software (section **C4.4**)
UDA	User-Defined Attribute – used to expand the functionality of Vissim and Visum modelling and can consist of data from external sources or formulae using data already in the model (section **B7.3.2**)
UGT	Underutilised Green Time – time where there are vehicles trying to cross the stopline but they are unable to do so at full speed due to queuing or other obstructions (**Appendix I**)
UTC	Urban Traffic Control – the central computer system which controls a lot of the signalised junctions in London (section **A2.2**)
VA	Vehicle Actuation – a local method of controlling signalised junctions where timings are determined by detectors (section **B2.3.8.4**)
VAP	Vehicle Actuated Programming – a method used in Vissim modelling to control signal timings (section **B7.4.5.1**)
Vissim	Verkehr In Städten – SIMulation (meaning: Traffic In Towns – SIMulation) – modelling software developed by PTV (Chapter **B7**)

Visum	Verkehr In Städten – UMlegung (meaning: Traffic In Towns – Assignment) – modelling software developed by PTV (section **A5.3.3**)
VMAP	Vissim Model Auditing Process (see MAP) (sections **A3.6.1** and **B2.1.5**)

APPENDICES

Appendix I: Underutilised Green Time Calculation

Underutilised Green Time (UGT) is the time difference between the measured time during which high demand occurs on street (G_d), and the theoretical time that it would take for the platoon to cross the stopline under normal conditions (G_n).

$$UGT = G_d - G_n - L_t$$

Where:

G_d = Measured high demand duration during green + leaving amber period

G_n = (3600/measured saturation flow) x number of PCUs during high demand period (excluding any flare contributions)

L_t = start and end lost time

L_t can typically be assumed based on the following lane-specific behaviour:

- If high demand exists at the start of green only, then L_t = one second;
- If high demand exists at the end of leaving amber only, then L_t = one second;
- If high demand exists at the beginning of green and exists at the end of leaving amber, then L_t = two seconds; and
- If high demand starts and/or finishes at any other time, then L_t = zero seconds.

When high demand exists at the beginning of green and at the end of amber, the above assumed lost time (L_t) totals two seconds. This assumes that traffic flow takes two seconds to accelerate to saturated flow and two seconds to decelerate.

If it is the case that the start or end lost time is found to be different for a surveyed lane, then this can be incorporated if required. Any modification to the default assumed values must be outlined in an accompanying modelling report and analysed to ensure accuracy.

Without flare:

$$G_n = \left(\frac{3600}{S_{FF}}\right) \times q_d$$

With flare:

$$G_n = \left(\frac{3600}{S_{FF}}\right) \times (q_d - F)$$

Where:

q_d	=	Total Flow during high demand (PCU)
F	=	Effective Flare Utilisation (PCU)
S_{FF}	=	Saturation Flow (PCU/hr)

DoS Formula by means of UGT

Without flare:

$$DoS = \frac{q \times \left(\frac{3600}{T_C}\right)}{S_{FF} \times \frac{G_t - UGT + 1}{T_C}} \times 100$$

With flare:

$$DoS = \frac{q \times \left(\frac{3600}{T_C}\right)}{\left(S_{FF} \times \frac{G_t - UGT + 1}{T_C}\right) + \left(\frac{F \times 3600}{T_C}\right)} \times 100$$

Where:

q	=	Total Sample Flow (PCU)
G_t	=	Actual Total Green Time (seconds), excluding Leaving Amber
UGT	=	Underutilised Green Time (seconds)
T_C	=	Cycle Time (seconds)
F	=	Effective Flare Utilisation (PCU)
S_{FF}	=	Saturation Flow (PCU/hr)

Appendix II: Flow Comparison (The GEH Statistic)

The GEH statistic is a standard measure of the 'goodness of fit' between observed and modelled flows. Unlike comparing flows using percentage difference, the GEH statistic places more emphasis on larger flows than on smaller flows.

The GEH statistic is calculated as follows:

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

Where:

M = Modelled flow

C = Counted (Observed) flow

Smaller GEH values indicate a better 'fit' between observed and modelled flows.

Below is a sample set of values to demonstrate the use of the GEH statistic compared with a simple percentage difference:

Table 21: Comparative analysis contrasting GEH and percentage values

M (PCU)	C (PCU)	GEH	% Difference
10,000	9,000	10.3	10%
1,000	900	3.2	10%
100	90	1.0	10%
10,000	9,520	4.9	5%
1,000	850	4.9	18%
100	57	4.9	75%

An additional method for the comparison of flows is to plot observed versus modelled flows and carry out a correlation analysis. This method provides an indication of the goodness of fit (R correlation statistic) and clearly indicates whether the model is over or under-representing flows.

Appendix III: TRANSYT 12 Node / Link Labelling Convention

TRANSYT Labelling Convention

T12 Nodes and Links are referenced by their user-assigned numbers, therefore it is recommended that a numbering convention is used during model development that is easily recognised and understood. This avoids confusion and allows clear assessment of model output during auditing and proposal optimisation. The numbering system described within this appendix is shown in **Figure 202**.

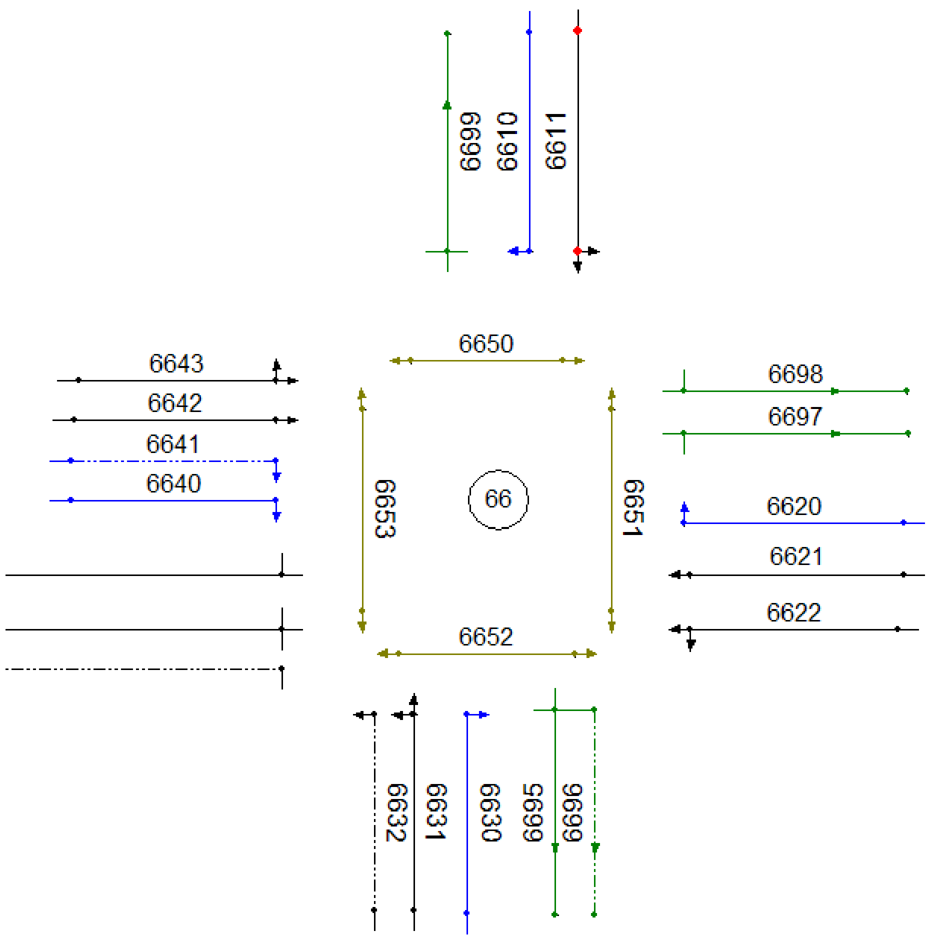

Figure 202: TRANSYT Node and Link labelling system (shown for J05/066)

TI2 Numbering Limits

TI2 has a maximum Link number of 32767. Therefore in the case where a Node number is 327 or higher, an alternative Link numbering convention should be used for the Node and described within the accompanying model report.

Node Numbering

For signalised intersections the TfL junction number short code should be used to label the Node without the group or region number, for example junction J05/000066 becomes J05/066 and hence TRANSYT Node 66. The borough code (in this example 05/xxx) should not be used to reference Nodes within TRANSYT. Unsignalised Nodes should be numbered using a unique number starting from ten and rising upwards in units of ten for additional Nodes.

Link Numbering

- **Traffic Links** -The traffic Link label should be constructed from the digits of the Node number (here it is 66) followed by a two digit number starting from ten. Link numbering for traffic Links should be applied in a clockwise direction, starting from an arbitrary reference direction that remains consistent throughout the model (for example southbound Links). As illustrated within **Figure 202**, Link numbers should begin with the offside Link of the reference direction, here 6610, and increase in units of one until the nearside Link, 6611, is reached. The next junction arm in the clockwise direction is then labelled with the Node number and a two digit number starting from 20. The same numbering process then applies, from offside (6620) to nearside (6622). This is repeated for each Link moving in a clockwise direction around the Node until all approaches have been labelled. Shared minor Links should be labelled using the same technique as the associated major Link;
- **Pedestrian Links** - Pedestrian Links should be labelled in a similar manner to signalised traffic Links, following on from the last traffic Link to be labelled. For example within **Figure 202** the last traffic label was 6643, so the pedestrian Link numbering starts from 6650. Beginning at an arbitrary reference Link (such as pedestrians crossing the southbound traffic movement), the first pedestrian phase is labelled with subsequent pedestrian Links being labelled in a clockwise manner around the node, with Link numbers incremented in units of one. The next pedestrian Link would be therefore be labelled 6651, until all pedestrian Links have been labelled;

- **Exit Links -** Exit Links from the network should be labelled with the node number suffixed by two digits starting from 99. Working clockwise, starting from the same junction reference point as used for other traffic Links, the Link numbers should descend in units of one. The first exit Link in the example illustrated by **Figure 202** is therefore 6699, followed by 6698 until 6695; and
- **Priority Links -** Give-way Links use the same methodology as signalised Links, with labelling commencing with the associated node number and then a unique two digit number starting with 10, rising in increments of one on the same arm and ten for other arms.

Appendix IV: Vissim Dynamic Assignment Convergence Methods

Two steps are outlined below which may help achieve convergence when using Dynamic Assignment (DA) in Vissim.

DA Method One – Volume Increment and Cap

If congestion is preventing the model from converging, where the iterative process cannot find a solution, it may be possible to converge the model with costs representative of a lower demand level. The initial conditions are set as follows:

- Scale total volume value to 10%, store costs and paths, and create archive files;
- Set the dynamic assignment volume increment to be 10%;
- Collect the vehicle network performance indicators, matching the evaluation period; and
- Collect the Convergence file in Direct Output.

Then run the model using the following method:

- Use multirun feature and analyse the Vehicle Network Performance results for where the performance rapidly degrades to find the 'cliff-edge.' (Ideally this is as close to 100% as possible);
- Set the volume increment to 0% and use the cost and path files from the 'cliff-edge' demand volume percentage as a starting point to converge the model at the cliff-edge demand volume; and
- Monitor model convergence criteria and converge the model.

Once the model has converged, turn off 'store costs', set the volume to 100% and run the model again with the multirun feature. The model will now assign 100% of the demand, and store these volumes in the path file, based on the costs (edge travel times) calculated for the lower demand level.

Judgement must be used as to whether the costs / travel times collected at a lower demand level are representative enough to provide a basis to distribute the full demand level. In some cases it might be useful to use smaller volume increments.

DA Method Two – Partial Dynamic Assignment

If convergence criteria cannot be achieved using the first method the following technique can improve convergence stability.

For this technique, demand is assigned partially on fixed routes and partly dynamically. The fixed routes can be thought of as the proportion of travel demand that is unaware of the full set of possible routes and rat-runs in the network, and thereby uses the main signed routes. The part that dynamically assigns can be regarded as the amount of travel demand that fully understands the network and its performance and can therefore exploit any possible route that is available.

This document does not contain formal guidance on how to divide the OD matrices into the two elements, beyond the need to use sound engineering judgement. The fixed routes for the first part of the travel demand may be chosen either through local knowledge of the network or through dynamically assigning those matrices with an artificially high value for Kirchhoff's exponent. This approach should concentrate this part of the OD matrices onto a few fast routes which can then be converted to static routes once they are assured over route choice and number of available paths. The travel demand that is dynamic should be assigned over a number of iterations to show stable convergence of the assignment. be assigned over a number of iterations to show stable convergence of assignment.

Troubleshooting

Even after trying the above two methods, it may be difficult or impossible to converge or validate the Vissim model. The following tips may be useful if this is the case:

1. Monitor the model as it runs and iterates. As part of the iteration process, models can assign unrealistic volumes of vehicles on parts of the network. Where queues become long due to over-saturated stoplines, or lack of gaps, they can block other parts of the network. Model errors should be removed and the network fine-tuned to prevent the model from 'locking up', as this can prevent, or otherwise impact the rest of, the convergence process. In this case, the requirement of a stable network for convergence must be achieved without introducing unrealistic priorities or behaviour during the fine-tuning process;
2. Use a different random seed – depending on the network some will come to convergence more easily than others;
3. VA and Dynamic Signals may make it impossible to converge certain paths where small changes in traffic lead to a large impact in journey times on certain routes. It may be necessary to create VAP routines that mimic average green times and hard-code demand-dependent stages;
4. Close edges and use route closures in order to remove unrealistic / duplicate paths within the assignment;
5. Use Path pre-selection parameters to reduce the number of paths used for OD pairs;
6. Edit the path file (*.weg) directly in a text file to remove or add paths. Preserve the path list by de-selecting 'Search New Paths' in the assignment and select 'Keep paths for OD pairs with zero volume.'; and
7. Use surcharges on links / connectors to make certain links more costly. This is not routinely recommended, as the cause of vehicle delays can normally be explicitly modelled. All surcharges and costs must be justified.

NC3

LinSig 3.1
User Guide

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Contents

1. Introduction

Welcome to the LinSig Version 3 User Guide. This User Guide aims to provide you with detailed information on learning and using the software. The User Guide is structured as follows:

1. **Introduction.** Provides an overview of the software, improvements in the latest version and information on training and software support.
2. **LinSig Basics.** Provides preliminary information on a range of LinSig issues including important definitions, a suggested sequence of working and a summary of the user interface. It is suggested that as a minimum new users read this section before using LinSig. For those users upgrading from earlier versions of LinSig, this section is recommended as a concise introduction to the features that are new to LinSig Version 3.
3. **Essential Background.** Provides more in depth background on some of the most important LinSig modelling concepts.
4. **LinSig Views Reference.** Provides detailed information on each LinSig View and how to use it. This section should be used both to gain detailed knowledge of LinSig and for quick reference to specific facts and details.
5. **Detailed Controller Background.** Provides further detail and background on some characteristics of traffic signal controllers relevant to LinSig.
6. **Reporting and Printing.** Describes how to produce reports and printed output from LinSig.
7. **Examples.** A number of examples showing how to code different junction and Arm types into LinSig.

Appendices

A. **Installation and Setup.** Provides detailed information on how to install, activate and setup LinSig, including how to setup Network Licence Servers. You do not need to read this section if LinSig has been set up for you.

1.1. What is LinSig?

LinSig is a computer software package for the assessment and design of traffic signal junctions either individually or as a network comprised of a number of junctions. It is used by traffic engineers to construct a model of the junction or network which can then be used to assess different designs and methods of operation. Apart from stand-alone junctions, it can be used for multiple traffic signal junctions, complex compound junctions such as signalled roundabouts, and road networks which may include traffic signal pedestrian crossings and priority junctions as well as traffic signal junctions.

LinSig has been available in a number of versions since 1985, and is the original software package for UK detailed traffic signal design. The software is used by the majority of UK highway authorities and consultants at several hundred locations, making it the most widely used traffic signal design and analysis software in the UK. Throughout its life it has been regularly and extensively upgraded, including several complete rewrites, as computer technology and user requirements have changed and evolved.

The idea behind LinSig is straightforward in that it models operation at traffic signal junctions in a similar way to how real traffic signal controllers at junctions actually work. This means that LinSig takes account of the features and constraints of the controlling equipment, thereby ensuring that all modelling accurately reflects how existing junctions work, and how any design proposals would operate if implemented.

LinSig is particularly appropriate for option testing and has been designed to make it easy to test large numbers of options quickly allowing unfeasible designs or scheme options to be quickly rejected or improved.

1.2. What's New in Version 3 of LinSig

LinSig for Windows Version 3 was released in 2009 and introduced a number of major new features. These include:

- **Multiple Traffic Signal Controllers.**
- **Lane based Modelling giving Improved Modelling of Short Lanes.**
- **Larger Network Modelling.**
- **Delay Based Traffic Assignment.**
- **Matrix Estimation.**
- **Pedestrian Modelling.**

These new features are explained in more detail later in this User Guide.

1.3. What's New in Version 3.1 of LinSig

LinSig 3.1 was released in May 2011 and is the first major update to LinSig since the launch of LinSig 3 in 2009. New features introduced since the launch of Version 3.0 include:

- **New traffic flow definition methods including Lane Based Flows, Layered Flows and the ability to mix different flow definition methods in different regions of a modelled Network.**
- **Improved modelling of bus traffic including Bus Zones and Bus Routes.**
- **New ways of checking input flow and count data using the new Flow Consistency Mode in the Network Layout View and a new graphical Traffic Turning Counts View.**
- **Modelling of different cycle times within the same Network model.**
- **Improved checking and auditing tools such as the new Model Audit View.**
- **Improved facilities for fine tuning network calibration such as the ability to define Bonus Green times for Lanes.**
- **SCATS™ based Terminology.**

1.4. Software Support

Full Software Support for LinSig is available free of charge for the first 12 months after purchasing a brand new site. When upgrading a site from an earlier version any existing Software Support is carried over to Version 3.

Software Support provides the following benefits:

- Free telephone/email advice on the use of LinSig.
- Basic design tips & advice for schemes being designed using LinSig. A full consultancy service is available at additional cost if more detailed advice is required.

- Free access to the LinSig Software Support Web Site. This web site includes advice on using the software, frequently asked questions (FAQs) and news of software updates.
- Free software updates which can be downloaded from the LinSig Software Support website. These include bug fixes, minor feature updates and more significant additional feature updates for a limited period after a major release. Major new versions are not included.
- Discounts off major new versions of LinSig.
- Free attendance at LinSig User Groups.

To register for your free 12 months Software Support please return the Software Support Agreement sent to you with LinSig. After this period has expired, paid Software Support is available from JCT Consultancy Ltd. Please see the Software Support Agreement or contact JCT Consultancy for more information on Software Support.

1.4.1. Accessing Software Support

Software Support can be accessed free of charge by any of the following means:

- On our Web Site at www.jctconsultancy.co.uk
- By Email at support@jctconsultancy.co.uk.
- By Telephone (09:00 to 17:00 UK Time) on (01522) 751010
- By Fax on (01522) 751188.
- By Post at: JCT Consultancy Ltd., LinSig House, Deepdale Enterprise Park, Nettleham, Lincoln, LN2 2LL.

Please have your Licence ID handy before calling Software Support so we can validate your Software Support status. If emailing please include your Licence ID, Name, Office, Company and a contact telephone number in case we need to contact you to discuss the problem. Your Licence ID is available by choosing 'About LinSig…' from the Help menu.

Please remember that LinSig is a sophisticated technical product and we aim to provide a quality support service to reflect this. Please do not hesitate to ask us if you have questions or problems. In particular we are happy to help new or inexperienced users with any questions you may be unsure about. Please remember though that software support isn't a substitute for a proper training course.

1.4.2. International Software Support

As LinSig is becoming more popular overseas particularly in Australasia we get an increasing number of software support queries from around the world.

If you are submitting a software support query from a location with a significant time difference to the UK the following will help us give you a rapid response:

- Always email us a copy of your model with your query.
- Explain your problem clearly to avoid us having to come back to you with simple questions which may have been overlooked. Remember that when you have been concentrating on a problem for some time it is easy to miss out basic facts which may be important for someone coming to the problem for the first time.
- If you are asking questions about how to model a particular traffic situation please provide a basic description of the behaviour particularly if it is custom to your location.

- If relevant please provide us with a Google Maps link to a intersection you are asking questions about as although not perfect it is a useful way of gaining a basic insight to a intersection.
- If a query is urgent please mark it as so explaining what aspects are urgent. We may be able to get back to you out of UK office hours if the query is concise enough.
- In some circumstances it may be easier to discuss an issue on the phone. If this is the case we will arrange a mutually convenient time for us to ring you.

1.5. Training

JCT Consultancy provides a wide range of training courses covering both the use of our software and general traffic signal design.

Full details of all our courses are available on our web site www.jctconsultancy.co.uk.

1.6. Model Auditing

JCT can provide a comprehensive model auditing service at a level of detail to suit needs and budgets. This can vary from a basic check of the model with a brief note on issues arising to an in depth audit with a full report. Details of our fixed cost auditing of LinSig models are available on our web site www.jctconsultancy.co.uk.

1.7. Consult-Assist

Consult-Assist is an increasingly popular option for new LinSig users especially in smaller organisation where there are no other experienced LinSig users. With Consult-Assist JCT will help you design and/or model a scheme whilst teaching you how use of LinSig 'on the job' to build a model of the scheme.

At the end of the process you will have a scheme designed by traffic signal experts which you will be fully familiar with through being intimately involved in the process. As well as having learnt how to apply LinSig to a particular scheme you will also have learnt skills which are focused to your particular use of LinSig but are also easily transferable to other schemes.

Consult-Assist can be provided in your own offices or at JCT's offices and can be tuned to match your particular needs and budgets. Please contact us if this service is of interest to you.

2. LinSig Basics

This section provides preliminary information on a range of LinSig issues including important definitions, a suggested sequence of working and a summary of the user interface. It is suggested new users read this section before using LinSig. It would also be useful for users upgrading from earlier versions of LinSig to review the section as it concisely introduces a number of topics new to LinSig 3.

2.1. Definitions

This section introduces a number of useful concepts and definitions with which it is helpful to become familiar with before starting to use LinSig.

- **LinSig Network.** The LinSig Network describes the road network being modelled in a single LinSig file. The Network size is in theory unlimited but is practically constrained by the time taken for LinSig to recalculate the traffic model and to optimise the signal timings. Depending on the complexity of the network, Networks modelled with the greatest level of detail using Matrix Based Traffic Flows can be modelled up to around 20 junctions. Networks using Lane-Based Traffic Flows or split into several Matrix Based regions can model much larger networks. The Network uses Junctions, Arms, Lanes and Pedestrian Links to describe the network being modelled.
- **Junction.** A LinSig Junction is a grouping of Arms, Lanes and other items which represent a real junction. It is used to graphically manipulate these items as a group and to structure and display results and other Junction related information. Junctions are also used to specify subsections of Network on which to carry out actions such as signal optimisation.
- **Arms.** Each Arm represents a one-way section of road forming part of the Network. Each Arm contains a number of Lanes which are used to represent how traffic uses the Arm. Arms are not themselves involved in traffic model calculations but are used purely to group and organise Lanes.
- **Lanes.** Lanes are perhaps the most important item for modelling road space in LinSig and are used to define how traffic moves, queues and interacts on an Arm. Users of earlier versions of LinSig should note that Lanes now replace and simplify Links and Lanes from earlier versions.
- **Lane Connectors.** Lane Connectors join each Lane to Lanes on other Arms that can provide or receive traffic to or from the Lane. The Lane Connectors represent how road markings dictate the way traffic should flow between Lanes. When modelling a single junction Lane Connectors are only required to define permitted turning movements from a Lane by connecting an Entry Lane to an Exit Arm’s Lanes.
- **Junction Exit Arms.** Junction Exit Arms are simply Arms carrying traffic away from a Junction and are used to graphically define the exit point of traffic from junctions. In a Network containing several junctions, Exit Arms are used to pass traffic on to the next downstream Junction using Lane Connectors to define possible lane changing or weaving movements between the two Junctions. Although Exit Arms are not strictly necessary (and may not be present in some models built in LinSig 2) they make network layout and manipulation of junctions within the network much easier and are strongly recommended. LinSig internally models Exit Arms in a lightweight manner so adding Exit Arms does not necessarily increase model run times.
- **Zones.** A Zone represents an origin and/or destination for traffic entering or leaving a Matrix Based Network region. Zones may either be External Zones which represent

traffic entering or leaving the Network at the end of an Arm, Internal Zones which represent traffic entering or leaving the Network along an Arm, for example from on-street parking, or Bus Zones which represent the starting and end points of Bus Routes through the Network.

- **Routes.** A Route represents a unique path through the Network from one Zone to another. As each Route is comprised of a sequence of individual Lanes and Lane Connectors, a number of different Routes can exist between any two Zones. Each of the Routes represents a different choice of Lanes for drivers travelling between two Zones. Routes are used both to define how traffic flow routes through Matrix Based Network regions and also to calculate journey times in both Matrix and Lane Based Network regions.
- **Pedestrian Link.** Pedestrian Links represent fixed time signal controlled pedestrian crossings. Currently non-signalled crossings cannot be modelled in LinSig.
- **Pedestrian Link Connector.** Pedestrian Link Connectors represent pedestrian movements between crossings at the same junction. Typically a pedestrian island would be represented by one or more Pedestrian Link Connectors defining the possible movements between crossings using the island.
- **Pedestrian Zone.** Pedestrian Zones represent origins or destinations for Pedestrians. Each Pedestrian Zone corresponds to a point where pedestrians step off the kerb to start walking through the junction.
- **Pedestrian Route.** A Pedestrian Route consists of a sequence of Pedestrian Links and Link Connectors and represents the path a pedestrian would take through the Junction between two Pedestrian Zones.
- **Matrix Based Network.** A Matrix Based Network is a LinSig Network in which all traffic flows are defined using an Origin-Destination Matrix assigned to Routes. This defines traffic flow information in the greatest level of detail but requires an OD Matrix to be defined for the entire Network, which may be onerous to build and lead to longer signal optimisation run times for larger Networks. This was the only option available prior to LinSig 3.1.
- **Lane Based Network.** A Lane Based Network uses Lane Based Flows throughout to specify traffic flows. A Lane Based Flows Network does not use and OD Matrix and only requires Zones and Routes to be defined if journey times on Routes are required.
- **Lane Based Traffic Flows.** Lane Based Traffic Flows are an alternative simpler way of defining traffic flows compared with Matrix Based Flows which use an OD Matrix and Routes. Flows are defined as a total traffic flow for each Lane together with incoming and outgoing turning flows. Other than the immediate previous and next Lanes for each Lane, Lane Based Flows contain no information on how traffic routes over the wider Network.
- **Flow Group.** A Flow Group represents a set of Flows for a particular period of time, for example a Morning Peak hour. Each Flow Group can contain one or more set of three different flow types: An Origin-Destination (OD) traffic flow matrix which defines traffic flows for Matrix Based Network regions; a set of Lane-Based Traffic Flows which defines traffic flows for Lane Based regions; and a Pedestrian OD Matrix.
- **Origin-Destination Matrix.** Traffic Flows through a Matrix Based Network or Matrix Based regions of a Network are represented by a matrix that specifies the traffic flow between Zones. All flows are specified in PCUs. The OD matrix does not specify which Route traffic takes between two Zones as the routing is dependent on signal timings and other issues.

- **Route Flow.** Route Flows are the flows on individual Routes between Zones and are used with an OD Matrix in Matrix Based Networks or Matrix Based regions of a Network to specify how traffic travels between Zones. A Route Flow can either be entered manually or can be estimated by LinSig using a standard traffic assignment user equilibrium algorithm to distribute traffic between Routes based on calculated delays. Different Route Flows are stored for each Scenario reflecting the fact that the same OD Matrix can be assigned to the Network in many ways depending on signal timings and other scenario specific issues.
- **Lane Based Flow Layer.** Lane Based Flow Layers can be used to separate different traffic types or movements in a Network or region of Network defined using Lane Based Flows. For example bus traffic or traffic between two points in the Network can be separated out. LinSig models each Layer separately whilst allowing for interaction between traffic in each Layer.
- **Desired Flow.** A Desired Flow is an origin-destination flow specifying the required total flow between two Zones. If the OD Matrix has been assigned correctly, the Desired Flows should equal the Actual Flows for all Scenarios.
- **Actual Flow.** An Actual Flow is an origin-destination flow that is aggregated from all Route Flows between two Zones. Actual Flows may be different for each Scenario using the Flow Group due to differences in routing patterns in each Scenario.
- **Difference Flows.** The Difference Flows are calculated as the difference between the Desired and Actual origin-destination flows. They provide a check on whether the Desired Flows Matrix has been correctly assigned to the Network with no missing or excess traffic due to Route Flow errors.
- **Turning Count.** The traffic flow counted on a turning movement at a junction. These are used to estimate a origin-destination traffic matrix for the model.
- **Controller.** A Controller represents a traffic signal controller. A LinSig Network can contain several controllers with each controller controlling one or more junctions.
- **Controller Set.** A group of Controllers all running at a common cycle time. LinSig models full coordination between junctions controlled by Controllers in the same Controller Set.
- **Phase.** A Phase in LinSig is the same definition as a traffic signal controller Phase, which is a group of Signal heads all showing the same aspects to traffic or pedestrians. This is the UK definition of a Phase not the US/Australasian definition (which confusingly is the same as a UK Stage!)
- **Stage.** A Stage in LinSig is the UK definition of a Stage – that is a group of Phases running together. A UK Stage is broadly equivalent to the US/Australasian definition of a Phase. Although the Stages are numbered, they do not have to be run in numerical order. The sequence of Stages actually run for each Controller is defined using Stage Sequences.
- **Stage Stream.** A Stage Stream is a separate set of Stages stored on a Controller which can be used to independently control a junction or portion of a junction. Each Controller may have more than one Stage Stream to allow it to control more than one junction. Each Stage Stream will have its own Stage Sequence made up of Stages from that Stream's set of Stages.
- **Stage Sequence.** A Stage Sequence is the sequence of Stages running on a single controller. If a Controller has several Stage Streams the Stage Sequence defines the order of Stages running for all Streams by providing a separate order of Stages for each Stream.

- **Network Control Plan.** A Network Control Plan specifies Stage Sequences for all Controllers in the Network. This allows the staging arrangement for the entire Network to be specified and stored in one place. Each Network Control Plan can be used in one or more Scenarios.
- **Bonus Green.** An extension or shortening of the effective green period available to traffic. Bonus Greens are often used to model underutilised green time or demand dependency.
- **Scenario.** A Scenario describes all the information needed to fully define a single LinSig model run. This includes the Traffic Flow Group, the Route Flows, the Network Control Plan, and the cycle time, stage times and offsets.

2.2. Working with LinSig Files

LinSig stores all the information relating to a Network in a single file. LinSig 3 introduces a new file format different to previous versions of LinSig which allows the large amount of extra information used in LinSig 3 to be stored. To distinguish a LinSig 3 file from files from previous versions a file extension of lsg3x is used. LinSig 3 can open files from previous versions of LinSig but can only save in LinSig 3 format due to the large number of new features. Don't forget that each LinSig 3 licence allows a copy of LinSig 2 to be installed on the same PC to provide a facility to edit files for older projects which don't require upgrading to LinSig 3 format.

2.2.1. Creating a new LinSig File

A new LinSig File is created by choosing 'New' from the LinSig File menu. This closes any current file open in LinSig before creating a new empty model. The file is not actually saved on disk until saved using 'Save As' as described below.

2.2.2. Opening an existing LinSig 3 File

An existing file can be opened by choosing 'Open' from the File menu. If a different file is already open in LinSig it will be first closed and you will be prompted to save any changes to the file as described below. LinSig provides a dialog box that can be used to locate the file you wish to open, either on the local computer, or on a network. Once the LinSig file is open, LinSig will not change the file on disk unless you explicitly choose to save it using 'Save' or 'Save As' as described below.

2.2.3. Saving LinSig Files

The LinSig File currently being edited can be saved to disk at any point by choosing 'Save' from the 'File' menu, or if you wish to change the file name, 'Save As'. Be careful not to overwrite files you wish to keep, as you cannot undo file saves from within LinSig. Due to the many changes in the data used by LinSig 3 it is not possible to save files in LinSig 1 or LinSig 2 format.

2.2.4. Loading and Converting LinSig files from Earlier Versions

LinSig 3 uses a new file format but can load & convert files from Versions 1 and 2 of LinSig which can then be saved to LinSig 3 format.

As each version of LinSig has made a number of changes, extensions and improvements to the file format it is necessary to provide LinSig with some additional information when loading a file from a previous version. This additional information is used by LinSig to convert the file into LinSig 3 format.

2.2.4.1. Loading and Converting a LinSig 1 file to LinSig 3 format

LinSig 3 can load & convert an existing LinSig 1 file simply by opening the file within LinSig 3. LinSig will detect the file is a LinSig 1 file and use the information in the old file.

Essential new information which LinSig 1 files do not contain or cannot be deduced includes:

- **Exit Arms.**
- **Lanes Connectors.**
- **Zones.**

- **Routes.**
- **Traffic Flow Origin-Destination Matrices.**

The above information must be added to a LinSig 1 file after loading into LinSig 3 before results can be obtained.

Information discarded by LinSig as there is no close equivalent in LinSig 3 includes:

- **Lane Turn Arrows.** These are derived directly from Lane Connectors in LinSig 3.
- **Geometric Saturation Flow Turn Radii.** Turn Radii are used in a more sophisticated way in LinSig 3 which is dependent on Lane Connectors and therefore should be re-entered after adding Lane Connectors.
- **LinSig 1 Link Flows.** As flows are represented in a radically more sophisticated way in LinSig 3 the conversion process cannot reliably convert the LinSig 1 flows without more information on the Network structure. It is therefore safer and nearly as quick to simply re-enter the original LinSig 1 Link Flows in the LinSig 3 Origin-Destination Matrix using the Traffic Flows View.

It is suggested the following sequence is followed after opening a LinSig 1 file. Further details on how to carry out each step are available from the Views Reference section.

- **Check Loaded LinSig 1 Model.** LinSig will indicate any LinSig 1 multi-Lane Links which require splitting into Lanes and highlights them in red or orange. This indicates:
    - **Red.** LinSig has determined the Link requires splitting but is unable to split the Link automatically. Resolve any issues with ambiguous Link structures as described below. When the issues are resolved the Link will be highlighted in orange and can be split as below.
    - **Orange.** LinSig has determined the Link requires splitting and is able to do so automatically without any additional information. Right click on each Link with the mouse and choose 'Accept Lane Structure' to split the Link into Lanes.
- **Correct Illegal Lane Structures.** If the Link is highlighted in red LinSig cannot interpret how to split the Link without further help. The two most likely reasons for this are:
    - It is ambiguous which Long Lane a Short Lane should be associated with. This can be clarified by right clicking on the Short Lane and choosing 'Feeder Lane on Left' or 'Feeder Lane on Right' as appropriate.
    - LinSig 2 could model Links containing several Short Lanes but had the restriction that all Lanes had to have the same green times and turning movements. LinSig 3's more sophisticated Short Lane blocking model can model independent control and turning movements on each Lane but currently can only model a single Short Lane attached to a single Long Lane. This caters for the majority of common cases; other cases involving multiple flares attached to a Long Lane can be modelled by making simplifying assumptions, as was the case in LinSig 1 & 2.

  When any issues have been resolved the Link will be highlighted in orange and can be split as described above.
- **Add Exit Arms in the Network Layout View.**
- **Add Lane Connectors.** Join Lanes with Lane Connectors in the Network Layout View. For a single junction from a LinSig 1 file the Lane Connectors will usually be

used just to connect Entry Lanes to Exit Lanes. This will also create Lane turn arrows.

- **Review Signalling on Lanes.** Any LinSig 3 Lanes created by splitting LinSig 1 multi-Lane Links will have the same signal control on each Lane. LinSig 3 allows different control on each Lane providing opportunities for improving the model.
- **Check Geometric Saturation Flow Settings.** Enter the geometric saturation flow turn radii on Lanes where appropriate.
- **Add Zones.** Add Zones in the Network Layout View at each point traffic enters and leaves the Network. Each Zone caters for an Entry and an Exit. LinSig will create Routes between Zones automatically as Zones are created.
- **Enter Traffic Flows as OD Matrix.** LinSig has created an empty Flow Group for each Flow Group existing in the LinSig 1 file. Enter origin destination flows into the OD Matrix for each Flow Group. If the 'Auto-Allocate' option is selected in the Traffic Flows View LinSig will attempt to automatically assign the OD Matrix to Routes as they are entered.
- **Check Route Flows.** Use the Route List View to review the Route Flows.
- **Check Lane Flows.** Use the Network Layout View to review the Lane Flows calculated from the Route Flows.
- **Save the File in LinSig Version 3 format.**

2.2.4.2. Loading and Converting a LinSig 2 file to LinSig 3 format

LinSig 3 can load & convert an existing LinSig 2 file simply by opening the file within LinSig 3. LinSig will detect that the file is a LinSig 2 file and use the information in the old file.

Essential new information which LinSig 2 files do not contain includes:

- **Junctions.** Junctions were called Arm Groups and were optional in LinSig 2. LinSig 3 will use Arm Groups if available attaching all previously unattached Arms to a new Single Junction.
- **Lane based Control Information.** Controlling traffic signal Phases were set by Link in LinSig 2.
- **Lane-by-Lane Connectors.** LinSig uses a Lane Connector for each Lane. LinSig 2 multi-lane Links will require new Lane Connectors creating for each Lane in LinSig 3.

The above information must be added to a LinSig 2 file after loading into LinSig 3 before results can be obtained.

It is suggested the following sequence is followed after opening a LinSig 2 file. Further details on how to carry out each step are available from the Views Reference section.

- **Check Loaded LinSig 2 Model.** LinSig will indicate any LinSig 2 multi-Lane Links which require splitting into Lanes and highlights them in red or orange. This indicates:
    - **Red.** LinSig has determined the Link requires splitting but is unable to split the Link automatically. Resolve any issues with ambiguous Link structures as described below. When the issues are resolved the Link will be highlighted in orange and can be split as below.
    - **Orange.** LinSig has determined the Link requires splitting and is able to do so automatically without any additional information. Right click on each Link with the mouse and choose 'Accept Lane Structure' to split the Link into Lanes.

- **Correct Illegal Lane Structures.** If the Link is highlighted in red LinSig cannot interpret how to split the Link without further help. The two most likely reasons for this are:
    - It is ambiguous which Long Lane a Short Lane should be associated with. This can be clarified by right clicking on the Short Lane and choosing 'Feeder Lane on Left' or 'Feeder Lane on Right' as appropriate.
    - LinSig 2 could model Links containing several Short Lanes but had the restriction that all Lanes had to have the same green times and turning movements. LinSig 3's more sophisticated Short Lane blocking model can model independent control and turning movements on each Lane but currently can only model a single Short Lane attached to a single Long Lane. This caters for the majority of common cases; other cases involving multiple flares attached to a Long Lane can be modelled by making simplifying assumptions, as was the case in LinSig 1 & LinSig 2.

  When any issues have been resolved the Link will be highlighted in orange and can be split as described above.
- **Review Lane Connectors.** LinSig attempts to deduce the correct Lane Connectors from LinSig 2 Link Connectors. These will usually be appropriate for LinSig 3 but should be checked.
- **Add Additional Lane Connectors.** Add Lane Connectors for any Lanes which have been created from splitting multi-Lane Links.
- **Review lengths of Short Lanes.** LinSig 3's traffic model takes into account issues which have sometimes previously been modelled by reducing the modelled Lane length using LINSAT. In LinSig 3 the physical lane length should always be used. If further fine tuning of Short Lane usage is required the Custom Occupancies can be adjusted.
- **Review Signalling on Lanes.** Any LinSig 3 Lanes created by splitting LinSig 2 multi-Lane Links will by default be created with the same signal control on each Lane. LinSig 3 allows different control on each Lane.
- **Review Movement Settings.** Any LinSig 3 Lanes created by splitting LinSig 2 multi-Lane Links will by default be created with the same movement settings for each Lane. The movement settings should be reviewed using the 'Movements' tabs of the Edit Lane dialog box to check whether each Lane would be better modelled with more specific settings.
- **Separate Streams to new Controllers.** LinSig 2 could only model a single Controller. To model multi-junction Networks in LinSig 2 multiple Stage Streams were often used as a compromise alternative to multi-Controllers. As LinSig 3 fully supports multi-Controllers Stage Streams should be moved from the LinSig 2 multi-Stream single Controller to new Controllers in LinSig 3 to reflect how the Network is signalled in reality.
- **Reassign Flows to Network.** When any Network modifications are complete, the Origin –Destination Matrix should be assigned to the Network to produce Route and Lane flows.
- **Check Route Flows.** Use the Route List View to review the Route Flows.
- **Check Lane Flows.** Use the Network Layout View to review the Lane Flows calculated from the Route Flows.

- **Save the File in LinSig Version 3 format.**

2.2.5. Importing and Merging LinSig Files

As well as allowing Networks to be built from scratch LinSig 3 allows Networks to be built up by merging together existing LinSig files into one larger Network model. This process is carried out in several stages. These are:

- Create a base model file.
- Import an existing LinSig file containing a Network region to be added to the base Network into the base model. This will be imported as a separate Network region.
- Join Network regions together either by merging Zones using the 'Zone Merge Wizard' for Matrix Based Network regions or by joining Lane Based Network regions using Lane Connectors.
- Repeat this process for any additional Network regions to be added.
- Having merged all the Network Segments together optionally refine the combined Origin-Destination Matrix for any Matrix Based regions using matrix estimation and check and refine routing in the combined Network.
- Further details are given in 'Importing & Merging LinSig Networks' in the View Reference section.

2.3. The LinSig User Interface

The LinSig model is edited using a sophisticated graphical user interface that has been developed to ensure data can be quickly entered and edited. The user interface also aims to allow the user to control the amount of information displayed at any one time, providing choice between a data display that is very dense but shows a lot of information at a glance, and a less dense display that is neater but shows less information at once.

2.3.1. Useful User Interface Concepts

When editing the LinSig model a number of standard concepts apply. These are:

- **Data Items.** A data item is a generic term for the different types of data edited in LinSig. For example, Arms, Lanes, Lane Connectors, Zones, Routes, Controllers, Phases, Stages etc are all 'Items'.
- **Selecting an Item.** Clicking on an item in a LinSig View will select it. The selected item will be shown in red. Many menu commands require you to first select an item before choosing that command. For example, before choosing the command 'Edit Lane' you must have selected a Lane. Menu commands that cannot be carried out because an Item has not been selected are shown in grey and cannot be chosen. In some instances, more than one item can be selected at once by holding the control (Ctrl) key or shift key down whilst selecting the Items. Multi-select can also be carried out in the Network Layout View by dragging a multi-select rectangle with the mouse whilst holding control (Ctrl) down. All items in the rectangle will be selected.
- **Pop-Up Context Sensitive Menus.** Clicking on a View with the right mouse button will display a 'pop-up' menu containing a choice of commands relevant to the item clicked on. All commands displayed on pop-up menus are also available on the LinSig main menu. Not all Views will have a pop-up menu.
- **Editing an Item by double clicking.** An Item can always be edited by selecting it and choosing to edit it from the main menu or pop-up menu. Alternatively, for some items, as a shortcut, you can double click the item to edit it. This does not apply where there may be more than one way to edit an item.
- **Using a wheel-mouse.** If you have a wheel mouse LinSig will use the wheel for zooming graphical views and scrolling through lists. The use of a wheel mouse is strongly recommended as they are inexpensive and make zooming graphical views very easy. If you are used to applications which zoom in the opposite direction to LinSig when using the mouse wheel its direction can be reversed in 'Program Options'.
- **Undo.** Any command can be undone by choosing 'Undo' from the edit menu. Any number of previous commands can be undone and if necessary redone. The Undo History View can also be used to display the sequence of commands Undo will undo. Undo is only available for the duration of the editing session and cannot undo past the point when a LinSig model was opened.
- **Error View.** The Error View lists any errors and warnings in the LinSig model being edited. Each error is listed together with its location and severity allowing you to get an overview of any problems which require attention. This helps to avoid issues such as inadvertently forgetting to enter the Saturation Flow for a Lane and not spotting the problem until after results have been used. Please remember though that the Error View is an aid – it is not an excuse to neglect proper scrutiny of your work and results. i.e. No errors in the Error View does not imply your model is correct.

- **Options and Preferences.** Many settings such as defaults for new Networks and graphics colours can be customised using the option dialog boxes on the File menu.
- **Always on Top.** Each of the main Views contains a pushpin button to the right of the View's title bar. Clicking the pushpin will force the View to remain on top of other Views even if one of the other Views is the active View where data is being edited. If two or more Views are set to 'Always on Top' and overlap, the most recently active View will be on top. When using this option you should be careful not to lose smaller Views behind larger Views set to 'Always on Top'.

2.3.2. New User Interface Concepts in LinSig 3 to Watch Out for

LinSig 3 makes a number of important additions and changes to the User Interface used in LinSig 2. Some of the most useful ones to watch out for include:

- **Lane Based Modelling.** In previous versions of LinSig groups of Lanes called Links were used extensively to define the Network structure. In LinSig 3 data entry has been simplified and modelling capabilities have been extended by a move to Lane based modelling. In LinSig 3 most data is entered Lane by Lane instead of some for Lanes and some for Links. As well as making data entry more straightforward many settings such as controlling signal Phase can be specified for individual Lanes rather than the Link as a whole as was required in LinSig 2. This allows a number of situations to be modelled in more detail and with fewer simplifying assumptions than in LinSig 2. This is described in more detail later in the User Guide.
- **Multiple Traffic Signal Controllers.** LinSig 3 allows multiple traffic signal Controllers to be defined and edited. Generally, Controller based views such as the Phase View or Stages View show information for one Controller at a time. The Controller being displayed can either be set to the current edited Controller or locked to a particular Controller. Changing the current edited Controller will change the Controller being displayed and edited in all Controller based views set to 'Current Controller'.
- **Multiple Traffic Flow Definition Methods.** LinSig 3.1 and above provide two different ways to define traffic flows: Using and OD Matrix and Routes as in LinSig 2 and LinSig 3.0; and Lane Based Flows. Each LinSig model can use either method across the whole Network or mix both methods in one model using different methods in different regions of the Network.

2.3.3. Important LinSig User Interface Components

The LinSig user interface consists of the main program window, which contains the following Items. More detailed explanations of many items, including each View, are included in the Views Reference section of this User Guide.

- **Main Menu.** The main menu is located along the top of the LinSig main Window and is the primary method for carrying out tasks in LinSig. Unless otherwise stated all tasks in LinSig are carried out by choosing the relevant command from this menu. If a menu command is shown in grey, this means it is not currently possible to carry out the command. For example, the 'Edit Zone' command is shown in grey if no Zone is currently selected, as LinSig does not know which Zone to edit.
- **Status Bar.** The Status Bar is shown along the bottom of the main window and displays useful information about the current LinSig model.
- **View Arrangements Manager.** The View Arrangements Manager allows arrangements of the different LinSig Views to be defined and saved. Different arrangements of views can then be recalled at any time depending on the current task being undertaken. For example, one View arrangement may be defined

positioning the Views to allow easy entering of traffic flows whilst another may arrange the signal editing Views.

- **Network Layout View.** The Network Layout View displays the overall layout of the Network's Junctions, Arms and Lanes and how they interconnect. The View can be used to carry out the following tasks:
    - Create, delete and edit Junctions
    - Create, delete and edit Arms and Lanes attached to each Junction.
    - Join Lanes on different Arms together using Lane Connectors.
    - Create, delete and edit Zones and connect them to Arms.
    - Create, delete and edit Pedestrian Links, Connectors & Zones.
    - Allow Lane Based Traffic Flows to be edited using Lane Based Flow Mode.
    - Display input data and results by Lane.
    - Display mini-graphs of flow profiles and queues.
    - Display mini stage diagrams embedded in the View.
    - Display Timing Dials which can be used to edit signal timings.
    - Examine and display Routes selected in the Route List View.
    - Allow signal times to be edited using timing dials.
    - Display flows as bandwidths.
    - Compare Scenario Route Flows using Bandwidths.
    - Display animated signal sequences and queues.
    - Annotate the Network diagram using Notes & Labels.
- **Controller List View.** The Controller List View displays all of the signal Controllers in the model and how they are grouped. The View can be used to carry out the following tasks:
    - Add, edit and delete new signal Controllers.
    - Group signal Controllers in Controller Sets.
    - Add, edit and delete Stage Streams on Controllers.
    - Set Cycle Times for Controller Sets.
- **Phase View.** The Phase View graphically displays the Phase layout for a single signal Controller. The View can be used to:
    - Select which Controller to display in this View.
    - Create, delete and edit Phases.
    - Create, delete and edit Stage Streams.
    - Define the Phases allocated to each Stage Stream.
- **Intergreen View.** The Intergreen View is used to enter and edit the Phase Intergreen Matrix for each Controller. The Intergreen Matrix's cells are colour coded to indicate cells where it may be inappropriate to have an Intergreen, for example, where two Phases are configured to run together in the same Stage. This View can be used to carry out the following tasks:
    - Select which Controller to display in this View.
    - Enter and edit Phase Intergreens.
    - View matrix cells where LinSig indicates an Intergreen would be incorrect.
    - Select which set of Intergreens to use.

- **Stage View.** The Stage View is used to construct Stages for each Controller. These are subsequently used in the Controller's Stage Sequence View to construct Stage orders for each Stream. The View can be used to carry out the following tasks:
  - Select which Controller to display in this View.
  - Define the Phases allocated to each Stage Stream.
  - Create and delete Controller Stages.
  - Renumber Stages by reordering them with the mouse.
  - Add and remove Phases from a Stage by double clicking.
  - Use colour to display Phases which cannot run together due to Intergreens etc.
- **Stage Sequence View.** The Stage Sequence View is used to create and edit Stage Sequences for each Controller. Each Stage Sequence defines the sequence of Stages being modelled for all Stage Streams on the Controller. As many Stage Sequences as desired can be created and quickly switched between. The Stage Sequence View can be used to carry out the following tasks:
  - Create and delete Staging Plans.
  - Define the Stage Sequence for each Stage Stream by dragging Stages from the Stage View.
  - Enter the Stage Sequence for each Stage Stream by typing a numerical list of Stages in the Sequence column of the Stage Sequence List.
  - Change the Stage Sequence for a Stream by reordering Stages with the mouse.
- **Network Control Plans View.** The Network Control Plans View allows Network Control Plans to be created and Stage Sequences selected for each Controller. The View can be used to carry out the following tasks:
  - Create, delete and copy Network Control Plans.
  - Edit Network Control Plans to specify a Stage Sequence for each Controller.
- **Interstage View.** The Interstage View allows a number of items relating to interstages on each Controller to be viewed and edited. The View can be used to carry out the following tasks:
  - View Prohibited Stage Changes including ones prohibited automatically by LinSig.
  - Manually prohibit Stage changes.
  - View the Interstage duration matrix.
  - View the detailed structure of an Interstage.
  - Create, edit and delete Phase Delays in the Phase Delays table.
  - Graphically add, change or delete Phase Delays by dragging the start and finish points of Phases with the mouse.
  - Automatically optimise the Interstage using a user defined critical Phase order.
- **Signal Timings View.** The Signal Timings View is an important view which shows each Controller's Stage & Phase timings and Interstage structure for each Stage Stream. The View can be used to carry out the following tasks:
  - View the Start and Finish times of Phases throughout a Signal Cycle.

  - View Stage Change Points and change them by dragging with the mouse.
  - Manage Stage Stream cycle times.
  - Optimise Stage length for individual Stage Streams.
  - View Intergreens and Interstage Structures.

- **Lane Timings View.** The Lane Timings View is similar to the Signal Timings View but displays signal green times for each Lane rather than each Signal Phase. Each Lane's start and end of green can be adjusted to allow for effects such as underutilised green and demand dependency. The Lane Timings View can be used to:
  - Show green times for each Lane at each Junction.
  - Adjust the start and end points of each Lane's green time using Bonus Greens.
- **Network Control Layout View.** The Network Control Layout View shows the signal control structure for the whole Network at once. Each Controller is shown together with its Stage Streams and Phases.
- **Traffic Flows View.** The Traffic Flows View is used to define Traffic Flow Groups and edit each group's Origin-Destination Matrix. The View can be used to carry out the following tasks:
  - Create, delete and edit Traffic Flow Groups.
  - Enter the Desired Flows OD Matrix for each Flow Group.
  - View the Actual Flow and Difference Matrices for each Flow Group.
  - View and edit Pedestrian Flow Matrices for each Junction for each Flow Group.
  - Define Formula Based Flow Groups.
- **Route List View.** The Route List View is used to view and manage Routes through the LinSig Network. Route management is an important part of LinSig Network model development as poor usage of Routes, for example modelling many unlikely weaving routes, will slow down the model substantially and possibly give less accurate results. The Route List View can be used to:
  - View edit and sort Zone-to-Zone Traffic Routes through the LinSig Network.
  - Allow and disallow routes through the Network either manually or using automatic policies.
  - View Route statistics such as travel times and delays.
  - Make manual changes to the traffic flow allocated to each Route.
  - Highlight a Route in the Network Layout View by selecting the Route in the Route List.
  - Filter the Route List to display a sub-set of Routes in the Route List and in the Network Layout View.
  - View and edit Pedestrian Routes for each Junction.
- **Matrix Estimation View.** The Matrix Estimation View lists all Traffic Turning Counts defined in the Network. These counts can be used either for estimating an OD Matrix or as a validation check that whichever method has been used flows have been entered correctly. The Turning Count View also provides a graphical view of all Turning Counts. The Matrix Estimation View can be used to:
  - View edit and delete Traffic Turning Counts.

  - View edit and delete Zone entry and exit constraints.
  - Compare Traffic Turning Counts with modelled Flows.

- **Turning Count View.** The Turning Counts View provides a graphical way of viewing and editing Turning Counts used for Matrix Estimation or validation. The Turning Counts View can be used to graphically:
  - View edit and delete Traffic Turning Counts.
  - Check Turning Counts for consistency errors.
  - View edit and delete Zone entry and exit constraints.
  - Compare Traffic Turning Counts with modelled Flows.
- **Scenario View.** The Scenario View allows Traffic Flow Groups and Network Control Plans to be associated together to define particular modelling scenarios. Each Scenario brings together all the information needed for a single LinSig run including cycle time, signal timings and Route Flows. The Scenario View can be used to :
  - Create edit and delete Scenarios.
  - Assign Route Flows for a Scenario.
  - Control how model results are updated for each Scenario.
  - Control batch signal optimisation of several Scenarios at once
- **Network Results View.** The Network Results View displays a table showing detailed model results at different levels of aggregation. The Network Results View can be used to:
  - Show aggregate model results for the whole Network.
  - Show model results aggregated by Junction.
  - Show detailed model results for each Lane or Lane Group.
  - Rows can be sorted by clicking on the header above each row.
  - Columns can be added and removed by right-clicking on the column headers. This menu can also be used to abbreviate column headers to save space.
  - Tables showing a lot of Lanes can be filtered to display just a subset of Lanes.
- **Travel Time/Delay Matrix View**. The Travel Time/Delay Matrix View displays a matrix of average travel times between Zones. It can:
  - Show average overall travel time between Zones.
  - Show excess delay over cruise time between Zones.
  - For Lane Based Networks display travel times or delays or each Lane based Flow Layer.
- **The Report Builder.** The Report Builder allows Report Templates to be built and detailed reports produced. The reports are in rich-text format that can be viewed and edited in most word processors.
- **Model Audit View.** The Model Audit View is intended to assist with model auditing by showing a subset of the most important input data and results in one place. The Model Audit View can be used to:
  - Display input data and results in a standard format for auditing.
  - Compare two LinSig files displaying Auditing information for both files and intelligently highlighting differences.

- **Audit History View.** The Audit History View allows auditors comments to be irreversibly logged in the LinSig file.
- **Cycle Time Optimisation View.** The Cycle Time Optimisation View displays the performance of the Network over a range of cycle times.
- **Time-Distance Diagrams View.** The Time-Distance Diagrams View displays time distance diagrams for selected Routes through the network. This can be used for examining coordination and progression through the Network.
- **Phase Based Design Tool.** The Phase Based Design Tool graphically implements the advanced technique of Phase Based Design which can often lead to a much more efficient Stage design. The technique involves designing a signal sequence based purely on Phases without regard to Stages. This can be carried out graphically in the Phase Based Design Tool which assists by advising of, and where necessary enforcing, constraints such as intergreens and minimums. LinSig then analyses the resulting Phase structure to determine what Stages are required to implement the signal sequence in the Controller.
- **Multiple Interstages View.** The Multiple Interstages View allows a number of Interstage diagrams to be laid out on a page and printed. This is particularly useful for preparing documentation for use in Controller Factory Acceptance Tests (FAT).
- **Stage Minimums View.** The Stage Minimums View displays the stage minimums for all possible combinations of preceding and succeeding stages. This information is useful when configuring remote monitoring and in some SCOOT applications.
- **SCOOT Data Preparation View.** The SCOOT Data Preparation View assists with the preparation of a SCOOT Database. The View allows SCOOT Stages to be defined in terms of one or more Controller Stages. LinSig then analyses all possible combinations of Controller Stages which affect SCOOT Interstage and Stage minimums, and reports the limits for Interstages and minimums for the controller which SCOOT may encounter.
- **VISSIM Interface View.** The VISSIM Interface View allows links to be set up between LinSig and a VISSIM model. This allows LinSig to import signal information from an existing LinSig model and also to update signal information in the VISSIM model after changes have been made in LinSig.
- **Error View.** The Error View Lists all current Errors and Warnings in the LinSig model together with their location. Errors indicate a fatal problem somewhere in the model whereas Warnings indicate only a possible problem which it would be wise to check.
- **Cyclic Flow Profiles View.** The Cyclic Flow Profiles View allows Lane Flow Profile graphs to be laid out on a page to be viewed or printed. Both Flow and queue profiles can be displayed and profiles can also be displayed disaggregated by Route to show the detail of different platoons passing through the Lane. An alternative to the Cyclic Flow Profiles View is to embed mini-Flow Profiles in the Network Layout View.
- **Phase Data View.** The Phase Data View simply lists the Phases currently defined in the Controller model together with input data and results for each Phase.
- **Undo History View.** The Undo History View displays all the previous editing steps and when they occurred in the current editing session. The View can be used to revert back to any point within the current editing session.
- **Lane Data Grid View.** The Lane Data Grid View displays Lane data in a spreadsheet style grid view. Where possible data items can be edited directly on the grid allowing rapid bulk data changes albeit with a less informative user interface.

2.4. International Options

LinSig includes a number of features to make it easier to use outside of the UK. These include:

- **Drive-on-the-Right Graphical Views.** When the ‘Drive-on-the-Right’ option is set LinSig displays graphical Views using Drive-on-the-Right logic.
- **SCATS™-Based Terminology.** LinSig can display Traffic Signal Controller based views using terminology and labelling consistent with the SCATS™ adaptive traffic control system developed by New South Wales Roads and Traffic Authority.

How to use these features is described in ‘General View Features’ in the View Reference Section of this User Guide.

2.5. The LinSig Modelling Process

Although LinSig models can be built up in any order it is recommended when new to LinSig to follow the editing sequences described below. This will avoid inadvertently missing out any crucial steps or becoming ‘lost’ within the modelling process. The following is intended to be a quick review of how to build a LinSig model. Much more detail on the aspects covered is found later in this User Guide.

The modelling sequences below assume the model will be built up with each step being carried out for all Junctions or Controllers. It would be equally valid to complete all steps for each Junction in turn if this is preferred.

LinSig 3.1 introduces a new way of defining traffic flows using Lane Based Flows. For models which only use Lane Based Flows this allows a significantly simpler modelling sequence to be used.

2.5.1. Modelling Sequence using Lane Based Flows

Further details of each of the steps below are available in the View Reference section of this Use Guide.

- **Network Information.** Using the Network Information dialog box (Network->Network Information) enter Project and user details for the Model.
- **Add Controllers.** Add the traffic signal Controllers to the model using the Controller List View (Controllers->Controller List View). Set the Controller type, naming information and specify whether the Controller will allow multiple Stage Streams.
- **Add Junctions.** Using the Network Layout View add a LinSig Junction for each junction within the modelled network. The choice of how Junctions are used will usually be obvious but sometimes it makes sense to create a Junction for network features which are not strictly junctions, such as mid block pedestrian crossings. Give each Junction a name and specify which Controller(s) (if any), and if appropriate Stage Stream(s), are involved in the Junction’s control.
- **Add Entry Arms.** Using the Network Layout View add Junction Entry Arms to each Junction. The Junction Entry Arms will contain the Lanes approaching the Junction’s stop lines.
- **Add Entry Arm Lanes.** On each Junction Entry Arm create additional long and Short Lanes to represent the Arm’s Lane structure. Remember that it is important to model the Lane structure as traffic uses road space which may not necessarily be the same

as lane markings. Newly created Lanes will not show Lane arrows at this point as no Lane Connectors have been added yet.

- **Add Exit Arms.** Add Junction Exit Arms at the points where traffic leaves the Junction.
- **Add Exit Arm Lanes.** On each Junction Exit Arm add any additional Lanes required. Remember that Junction Exit Lanes are always Long Lanes and are used to structure the Network not to model capacity issues such as merges immediately after a Junction.
- **Add Lane Connectors.** Lane Connectors define which traffic movements are allowed between Lanes on different Arms. If the recommended Arm structure discussed later is used, Lane Connectors within a Junction define which turning movements can take place from an Entry Lane to an Exit Lane at the same Junction. Lane Connectors between Junctions specify which Lane changes can take place between junctions. Lane Connectors are added in the Network Layout View by dragging with the mouse from one Lane to another Lane.
- **Set Cruise Speeds/Times on Lane Connectors.** For each Lane Connector set a cruise time or speed. Where multiple Lane Connectors between Arms all have the same cruise time or speed they can be edited in one step by selecting all the Lane Connectors between the Arms, right clicking on the Lane Connectors and choosing 'Edit Multiple Lane Connectors' from the pop-up menu.
- **Set Lane Lengths & Saturation Flows.** For each Lane in turn edit the Lane's length on the Lane Details tab and the saturation flow on the Sat Flow Data tab. Saturation Flows can either be manually entered or calculated from the Lane's geometry.
- **Create Traffic Flow Groups** Flow Groups can be created and managed in the Traffic Flow View. Remember that Flow Groups can be defined as a combination of other Flow Groups using a formula to specify how they are combined.
- **Add Lane Based Flows.** Use the Network Layout View's Lane Based Flow Mode and the Edit Lane dialog box to enter Lane Based Flows for the Network.
- **Add Traffic Signal Phases to each Controller.** The Phase View can be used to add Traffic Signal Phases to each LinSig Controller. Each Phase should be given an appropriate Phase Type, and Indicative Arrow and Filter Phases must have their associated Phases specified. The 'Street Minimum' specified for the Phase refers to the desired minimum observable on the street which may be different from the 'Controller minimum' given in the Controllers specification which will exclude Phase Losing Delays. As the Phases do not yet know which Lanes they are controlling the Phases will not yet show any directional arrows.
- **Edit Lanes to Connect to Phases.** Now Phases exist for each Controller each signal controlled Lane can be edited to specify its controlling Phase. The Phases will now show directional arrows based on the turning movements allowed in Lanes controlled by the Phase.
- **Edit Lanes to specify Give Way Movements.** Each Lane's give-way turning movements are specified by ticking 'This Movement Gives-Way' on the Lane's movement tabs in the Edit Lane dialog box and entering give-way settings for the movement. Further information on modelling give-way movements is provided in the Network Results View section and the Modelling Background section.
- **Add Pedestrian Network.** If pedestrian delay is being modelled Pedestrian Links, Pedestrian Link Connectors and Pedestrian Zones are added using the Network Layout View. Remember that each Junction has its own separate Pedestrian Network. If it is not required to model pedestrian delay it is not necessary to add

Pedestrian Links etc. but timing constraints such as Pedestrian Phase Minimums and Intergreens should still be modelled by including Pedestrian Phases in the Controller model.

- **Add Pedestrian Flow Information.** Pedestrian Flows are specified in the Traffic Flows View using a separate Pedestrian Origin-Destination Matrix for each Junction. Remember that even if pedestrian flow information isn't available it is still possible to partially model pedestrian delays by entering estimated relative flow weights in the Pedestrian OD Matrices.
- **Add Intergreens to each Controller.** The Phase Intergreens should now be added to each Controller using the Intergreens View.
- **Add Stages to each Controller.** Phases can now be grouped into Stages using the Stage View. Stages created in the Stage View represent Stages configured in the Controller and do not need to be in the order actually run. Phases can be added or removed from a Stage by double clicking. LinSig will prevent Phases from being added to a Stage if doing so would create a conflict between Phases. Where more than one Stage Stream is being used on a Controller Phases must first be allocated to a Stage Stream by double clicking the Phase in the Stream Box to the left of the Stage View.
- **Add Prohibited Moves for each Controller.** Using the Interstage View add any Prohibited Stage changes for each Controller by double clicking on the Stage change to be prohibited in the Prohibited Moves Matrix.
- **Add Phase Delays.** Again using the Interstage View, add any Phase Delays for each Controller.
- **Create Stage Sequences for each Controller.** A Stage Sequence represents an order of Stages to run on a Controller. Several alternative Stage Sequences can be created for each Controller with the one being used for modelling being selected in the Network Control Plan. Stages can be added to a Stage Sequence by dragging Stages from the Stage View. Stages within the Stage Sequence can also be reordered by dragging with the mouse. Alternatively (and more quickly) a numerical Stage Sequence can be entered into the sequence column of the Stage Sequence List.
- **Add Network Control Plans.** Using the Network Control Plans View create Network Control Plans to specify the Stage Sequence running on each Controller. Network Control Plans avoid the need to re-specify each Controller's Stage Sequence for every Scenario. Typically a Network Control Plan will be created for each different Network-wide signal sequencing strategy.
- **Define Modelling Scenarios.** A Scenario associates together a Traffic Flow Group, Network Control Plan, Cycle Time and signal timings providing LinSig with all the information it needs to calculate model results. Providing there are no errors in the model LinSig will always display model results for the current Scenario which can be selected from the main toolbar or in the Scenario View. LinSig will initially use arbitrary Stage Lengths but these can easily be changed for the current Scenario either manually using the Signal Timings View as detailed below, or automatically using the optimisation facilities. LinSig will then recalculate the model results for the new Stage Lengths. The Scenario View can also be used to optimise a number of Scenarios at once as a batch.
- **Changing Signal Times using the Signal Timings View and Timing Dials.** The initial results displayed by LinSig will be calculated using an initial arbitrary set of Stage Lengths for each Controller or Stage Stream. The current Stage times being used can be displayed using the Signal Timings View which also shows the duration

of Phases and details of Interstage structures. Stage Lengths can easily be changed by dragging Stage Change Points with the mouse. LinSig dynamically updates model results for the new Stage lengths as the times are changed. Alternatively Timing Dials can be used to manipulate Stage Length directly from the Network Layout View.

- **Checking for Errors using the Error View.** If Errors or Warnings exist in the Model an indicator on the Status Bar at the bottom of the LinSig main Window will indicate so. The Error View can be opened by double clicking on the Error Indicator. This View lists all Errors and Warnings and wherever possible indicates their location. Errors prevent the model from calculating results. Warnings allow results to be calculated, but indicate that LinSig thinks some data or setting **may** be dubious and needs checking. Information Warnings are LinSig bringing your attention to something you need to be aware of.
- **Signal Optimisation.** Signal Optimisation can be carried out to optimise signal timings for each Controller or Stage Stream individually or to optimise the network as a whole. LinSig can optimise the whole Network or individual Stage Streams for either best PRC or minimum delay. Whenever an optimisation is carried out the signal times are optimised for the currently modelled Scenario.
- **View Network Results.** The Network Results View displays a detailed table of performance results for each Lane or Lane Group and also for each Junction and the Network as a whole. The table can be sorted by clicking on any column header and columns can be added, removed and resized by right clicking on a column header. The amount of information shown in the Network Results View can be controlled by expanding and collapsing different Junctions using the plus and minus buttons next to each Junction in the Network Results View.
- **Check Lane Flow Profile Graphs.** As part of the Traffic Model Calculations LinSig calculates detailed traffic flow profiles of platoons passing through each Lane. The flow profiles can be displayed either using the Cyclic Flow Profiles View or embedded on the Network Layout View. The Lane Graphs are extremely useful in studying how traffic is using a Lane and can assist with identifying any areas of the model where traffic isn't being modelled correctly.

2.5.2. Modelling Sequence using Matrix Based Flows

Further details of each of the steps below are available in the View Reference section of this Use Guide.

- **Network Information.** Using the Network Information dialog box (Network->Network Information) enter Project and user details for the Model.
- **Add Controllers.** Add the traffic signal Controllers to the model using the Controller List View (Controllers->Controller List View). Set the Controller type, naming information and specify whether the Controller will allow multiple Stage Streams.
- **Add Junctions.** Using the Network Layout View add a LinSig Junction for each junction within the modelled network. The choice of how Junctions are used will usually be obvious but sometimes it makes sense to create a Junction for network features which are not strictly junctions, such as mid block pedestrian crossings. Give each Junction a name and specify which Controller(s) (if any), and if appropriate Stage Stream(s), are involved in the Junction's control.
- **Add Entry Arms.** Using the Network Layout View add Junction Entry Arms to each Junction. The Junction Entry Arms will contain the Lanes approaching the Junction's stop lines.

- **Add Entry Arm Lanes.** On each Junction Entry Arm create additional long and Short Lanes to represent the Arm's Lane structure. Remember that it is important to model the Lane structure as traffic uses road space which may not necessarily be the same as lane markings. Newly created Lanes will not show Lane arrows at this point as no Lane Connectors have been added yet.
- **Add Exit Arms.** Add Junction Exit Arms at the points where traffic leaves the Junction.
- **Add Exit Arm Lanes.** On each Junction Exit Arm add any additional Lanes required. Remember that Junction Exit Lanes are always Long Lanes and are used to structure the Network not to model capacity issues such as merges immediately after a Junction.
- **Add Lane Connectors.** Lane Connectors define which traffic movements are allowed between Lanes on different Arms. If the recommended Arm structure discussed later is used, Lane Connectors within a Junction define which turning movements can take place from an Entry Lane to an Exit Lane at the same Junction. Lane Connectors between Junctions specify which Lane changes can take place between junctions. Lane Connectors are added in the Network Layout View by dragging with the mouse from one Lane to another Lane.
- **Set Cruise Times on Lane Connectors.** For each Lane Connector set a cruise time. Where multiple Lane Connectors between Arms all have the same cruise time they can be edited in one step by selecting all the Lane Connectors between the Arms, right clicking on the Lane Connectors and choosing 'Edit Multiple Lane Connectors' from the pop-up menu.
- **Set Lane Lengths & Saturation Flows.** For each Lane in turn edit the Lane's length on the Lane Details tab and the saturation flow on the Sat Flow Data tab. Saturation Flows can either be manually entered or calculated from the Lane's geometry.
- **Add Zones.** LinSig uses Zones for routed Networks or routed regions of Network to specify how traffic will enter and exit the Network or routed region. Each Zone specifies a Network Entry Arm and a Network Exit Arm to define how traffic will enter or leave the Network from the Zone. The Zones are also used by Traffic Flow Origin-Destination (OD) matrices to specify traffic flows wishing to travel through the routed regions of the Network. Zones are added in the Network Layout View by choosing 'Add Zone…' from the Zones pop-out menu on the Network menu. Zones are not required for Lane Based Flow Network regions unless Routes are required for calculating journey times through Lane Based Flow Network regions.
- **Create Traffic Flow Groups** Flow Groups can be created and managed in the Traffic Flow View. Remember that Flow Groups can be defined as a combination of other Flow Groups using a formula to specify how they are combined.
- **Enter Traffic Flow Information into the Origin-Destination Matrix.** Traffic Flow information in LinSig is entered in Passenger Car Unit (PCU) flows between Zones. The Traffic Flow View provides a Desired Flow OD Matrix in which the Traffic Flows for each Zone-to-Zone movement are entered. The Actual and Difference Matrices are used to display assigned flow information not to enter data. This is described in more detail in Definitions above. If the OD matrix isn't known and only Junction turning counts are available LinSig's Matrix Estimation procedure can be used to estimate a Matrix which is a best fit to the counts. If used, Matrix Estimation is carried out later in the modelling sequence after Scenarios have been created.
- **Add Traffic Counts.** If traffic counts are being used either to estimate the OD matrix or just to validate the Network's assignment they can be entered using the 'Edit

Junction Turning Counts' dialog box which is opened by right clicking on a Junction and choosing 'Edit Junction Turning Counts'.

- **Add Traffic Signal Phases to each Controller.** The Phase View can be used to add Traffic Signal Phases to each LinSig Controller. Each Phase should be given an appropriate Phase Type, and Indicative Arrow and Filter Phases must have their associated Phases specified. The 'Street Minimum' specified for the Phase refers to the desired minimum observable on the street which may be different from the 'Controller minimum' given in the Controllers specification which will exclude Phase Losing Delays. As the Phases do not yet know which Lanes they are controlling the Phases will not yet show any directional arrows.
- **Edit Lanes to Connect to Phases.** Now Phases exist for each Controller each signal controlled Lane can be edited to specify its controlling Phase. The Phases will now show directional arrows based on the turning movements allowed in Lanes controlled by the Phase.
- **Edit Lanes to specify Give Way Movements.** Each Lane's give-way turning movements are specified by ticking 'This Movement Gives-Way' on the Lane's movement tabs in the Edit Lane dialog box and entering give-way settings for the movement. Further information on modelling give-way movements is provided in the Network Results View section and the Modelling Background section.
- **Add Pedestrian Network.** If pedestrian delay is being modelled Pedestrian Links, Pedestrian Link Connectors and Pedestrian Zones are added using the Network Layout View. Remember that each Junction has its own separate Pedestrian Network. If it is not required to model pedestrian delay it is not necessary to add Pedestrian Links etc. but timing constraints such as Pedestrian Phase Minimums and Intergreens should still be modelled by including Pedestrian Phases in the Controller model.
- **Add Pedestrian Flow Information.** Pedestrian Flows are specified in the Traffic Flows View using a separate Pedestrian Origin-Destination Matrix for each Junction. Remember that even if pedestrian flow information isn't available it is still possible to partially model pedestrian delays by entering estimated relative flow weights in the Pedestrian OD Matrices.
- **Review the LinSig Routes.** LinSig uses Routes to define how OD Flows are assigned to the Network. A Route in LinSig is defined as a path of Lanes between two Zones. LinSig automatically creates all possible Routes through the Network and lists them in the Route List View. The Route List View can be used to examine Routes to check for sensible routeing patterns and either automatically or manually disallow any Routes which are unfeasible or undesirable.
- **Add Intergreens to each Controller.** The Phase Intergreens should now be added to each Controller using the Intergreens View.
- **Add Stages to each Controller.** Phases can now be grouped into Stages using the Stage View. Stages created in the Stage View represent Stages configured in the Controller and do not need to be in the order actually run. Phases can be added or removed from a Stage by double clicking. LinSig will prevent Phases from being added to a Stage if doing so would create a conflict between Phases. Where more than one Stage Stream is being used on a Controller Phases must first be allocated to a Stage Stream by double clicking the Phase in the Stream Box to the left of the Stage View.
- **Add Prohibited Moves for each Controller.** Using the Interstage View add any Prohibited Stage changes for each Controller by double clicking on the Stage change to be prohibited in the Prohibited Moves Matrix.

- **Add Phase Delays.** Again using the Interstage View, add any Phase Delays for each Controller.
- **Create Stage Sequences for each Controller.** A Stage Sequence represents an order of Stages to run on a Controller. Several alternative Stage Sequences can be created for each Controller with the one being used for modelling being selected in the Network Control Plan. Stages can be added to a Stage Sequence by dragging Stages from the Stage View. Stages within the Stage Sequence can also be reordered by dragging with the mouse. Alternatively (and more quickly) a numerical Stage Sequence can be entered into the sequence column of the Stage Sequence List.
- **Add Network Control Plans.** Using the Network Control Plans View create Network Control Plans to specify the Stage Sequence running on each Controller. Network Control Plans avoid the need to re-specify each Controller's Stage Sequence for every Scenario. Typically a Network Control Plan will be created for each different Network-wide signal sequencing strategy.
- **Define Modelling Scenarios.** A Scenario associates together a Traffic Flow Group, Network Control Plan, Cycle Time, Stage lengths and Route Flows providing LinSig with all the information it needs to calculate model results. Providing there are no errors in the model LinSig will always display model results for the current Scenario which can be selected from the main toolbar or in the Scenario View. LinSig will initially use arbitrary Stage Lengths but these can easily be changed for the current Scenario either manually using the Signal Timings View as detailed below, or automatically using the optimisation facilities. LinSig will then recalculate the model results for the new Stage Lengths. The Scenario View can also be used to optimise a number of Scenarios at once as a batch and to assign OD matrices to the Scenario's Routes.
- **Changing Signal Times using the Signal Timings View.** The initial results displayed by LinSig will be calculated using an initial effectively random set of Stage Lengths for each Controller or Stage Stream. The current Stage times being used can be displayed using the Signal Timings View which also shows the duration of Phases and details of Interstage structures. Stage Lengths can easily be changed by dragging Stage Change Points with the mouse. LinSig dynamically updates model results for the new Stage lengths as the times are changed.
- **Checking for Errors using the Error View.** If Errors or Warnings exist in the Model an indicator on the Status Bar at the bottom of the LinSig main Window will indicate so. The Error View can be opened by double clicking on the Error Indicator. This View lists all Errors and Warnings and wherever possible indicates their location. Errors prevent the model from calculating results. Warnings allow results to be calculated, but indicate that LinSig thinks some data or setting **may** be dubious and needs checking. Information Warnings are LinSig bringing your attention to something you need to be aware of.
- **Estimate Matrix.** If LinSig's matrix estimation procedure is being used to estimate the OD Matrix, it can be carried out at this point in the modelling sequence as Scenarios have now been defined.
- **Assign OD Matrix to a Scenario's Routes.** Each LinSig Route is assigned a traffic flow for each Scenario. These Route Flows are then used to calculate Lane Flows and other detailed flow information required for modelling. A Scenario's OD Matrix can be assigned to the Scenario's Routes by choosing 'Assign OD Flows to Routes based on Current Scenario' from the Traffic Flows menu. This will assign the OD matrix to the Routes for this Scenario replacing existing Route Flows.

- **If necessary Fine Tune the Route Flow Distribution.** In cases where LinSig's estimate of Route Flows is not accurate enough, Route Flows can be manually changed to reflect uneven distribution of traffic between Routes. Route Flows can be edited by double clicking a Route in the Route List View. The Actual and Difference Flow Matrices in the Traffic Flow View should be used to monitor the total Route Flows between Zones for the Scenario to ensure the total amount of traffic on Routes is the same as that specified in the Desired Flows Matrix. After editing Route Flows can be locked to prevent subsequent automatic assignments changing them.
- **Signal Optimisation.** Signal Optimisation can be carried out to optimise signal timings for each Controller or Stage Stream individually or to optimise the network as a whole. LinSig can optimise the whole Network or individual Stage Streams for either best PRC or minimum delay. Whenever an optimisation is carried out the signal times are optimised for the currently modelled Scenario.
- **Investigate Reassignment.** After optimising signal timings it will often be appropriate to rerun the traffic assignment to take into account reassignment due to delay changes caused by signal timing changes.
- **View Network Results.** The Network Results View displays a detailed table of performance results for each Lane or Lane Group and also for each Junction and the Network as a whole. The table can be sorted by clicking on any column header and columns can be added, removed and resized by right clicking on a column header. The amount of information shown in the Network Results View can be controlled by expanding and collapsing different Junctions using the plus and minus buttons next to each Junction in the Network Results View.
- **Check Lane Flow Profile Graphs.** As part of the Traffic Model Calculations LinSig calculates detailed traffic flow profiles of platoons passing through each Lane. The flow profiles can be displayed either using the Cyclic Flow Profiles View or embedded on the Network Layout View. The Lane Graphs are extremely useful in studying how traffic is using a Lane and can assist with identifying any areas of the model where traffic isn't being modelled correctly.

2.5.3. Modelling Combinations of Matrix Based and Lane Based Flows

When both Matrix Based and Lane Based Flows are used in the same model each of the above two sequences should be carried out for each of the different Matrix based or Lane Based model regions. Issues such as routing etc should then be checked for the Network as a whole.

Modelling a Network with multiple regions using different flows types requires a good understanding on modelling techniques such as traffic assignment, matrix estimation, routing etc.

3. Essential Background

This section looks at some aspects of the modelling in LinSig in more detail and provides background in a number of areas.

3.1. The LinSig Traffic Model

LinSig uses Cyclic Flow Profiles (CFP) to model traffic moving through the Network. This section explains the theory underlying Cyclic Flow Profiles and how they are used to calculate queues and delays.

The concept of using Cyclic Flow profiles to model traffic behaviour is often misunderstood and assumed to be far more complex than it actually is. Although the model incorporates many details which allows it to model more complex situations with greater accuracy the underlying concept is relatively straightforward.

3.1.1.1. Model Structure

A fundamental feature of the model is to represent traffic flowing along a section of road as a Lane or Lane Group. Each Lane represents a single, independent stream of traffic travelling between two junctions. A Lane Group represents a Long and Short Lane which interact and potentially block each other and is modelled as a group of interacting Lane Segments. For a basic Lane traffic enters at its upstream end, from other Lanes, or from outside the Network, and leaves at its downstream end at a rate dependent on the Lane's control, for example whether it is a signal or give-way controlled Lane. The rate at which traffic enters or leaves the Lane varies over time with the model calculating queues and delays based on profiles of the arrival and discharge rate.

Time Slices

LinSig models the arrival and discharge profiles by splitting the profile into time slices, usually of one second. This fine resolution is necessary to model the detailed behaviour of traffic at a signal junction.

The amount of traffic arriving at a stop line during a time slice is dependent on the amount of traffic entering the Lane from upstream Lane within the time slice adjusted for the travel time on the Lane.

The amount of traffic able to leave a Lane during a time slice is dependent on how the Lane is controlled. For example, a signal controlled Lane will allow no traffic to leave during its red period but will allow traffic to leave at a maximum rate equal to the Lane's saturation flow during its green period. The rate at which traffic can leave a give-way Lane varies continuously dependent on the traffic flow in the current time slice on its opposing lanes.

Lane Groups model Long and Short Lanes which interact and potentially block each other. LinSig internally models Lane Groups using Lane Segments which behave similarly to Lanes but also models the complex interaction between Short and Long Lanes.

The application of the above rules enables LinSig to calculate the traffic entering a lane during a time slice and the traffic leaving the Lane during the time slice. If the queue length at the start of the time slice is known LinSig can then calculate the queue length at the end of the time slice.

Modelling a Longer Period

A longer time period can be modelled by chaining together a series of time slices to model the evolution of traffic flows into and out of the Lane, and the queue on the Lane over time. For each time slice the queue at the start of the time slice is assumed to be the same as the queue at the end of the previous time slice. As long as the flow profiles are known for traffic entering the network this method can be used to model a period of any duration.

3.1.1.2. Cyclic Flow Profiles

The main problem with the above methods is the amount of computation required to model a long time period, for example one hour, with a sufficiently fine time-slice. This can lead to large amounts of computation time and although computers have become much faster over the years the effort involved is still significant especially when it is necessary to rerun the model many times for optimisation purposes.

Cyclic Flow profiles have been used for many years as a way of reducing the number of computations necessary to model a junction. This method takes advantage of the fact that when all junctions in a network run at the same cycle time the pattern of traffic and queues on under capacity Lanes will be very similar during each cycle throughout the modelled period, that is, the flow and queue profiles on each Lane will repeat cyclically. In its simplest case each cycle is assumed to be identical which can then be extrapolated throughout the peak hour.

For example if the total delay on a Lane in the typical cycle is 2.3 pcuh, the cycle time is 90sec and the modelled period is one hour, then as there are 3600/90 = 40 cycles in the modelled period; the total delay for the hour is 40 x 2.3 = 92 pcuh. This also results in a reduction in the computing power required for calculating the flow profiles by 40 times.

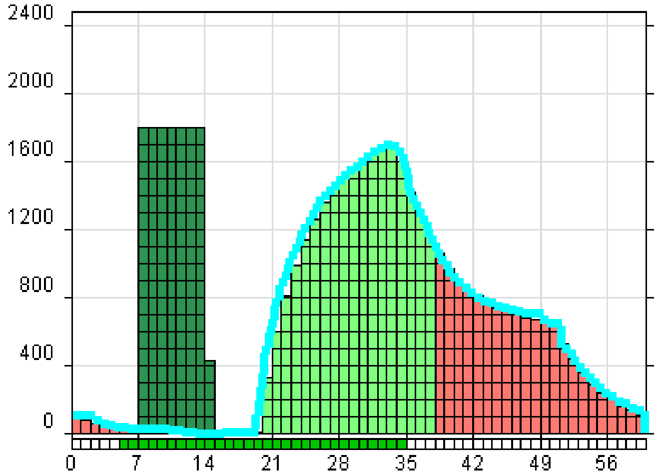
There are in fact three different cyclic flow profiles used for each Lane. These are:

- **Arrive / In Profile –** This represents the profile of traffic entering the Lane throughout the cycle.
- **Accept Profile –** This represents the profile of traffic which is allowed to leave the Lane in each time slice. The accept profile depends on the whether the Lane is opposed.
- **Leave / Out Profile**- This represents the traffic leaving the Lane in each time slice.

The Figures below show examples of each of the above profiles.

Arrive Profile

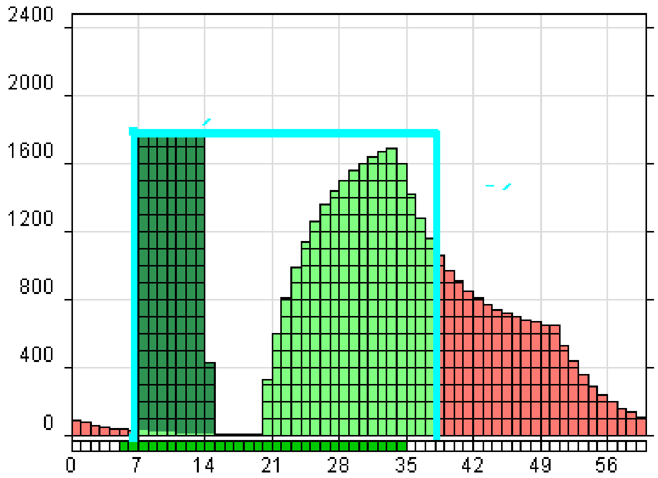
The Arrive Profile shown above shows the arrival profile of traffic at the Lane's stop line. This profile is derived from the Leave profiles from one or more upstream Lanes after they have been adjusted to allow for the time to travel between stop lines, and for the dispersion of the platoon whilst travelling along the Lane.



Arrive Profile

Accept Profile

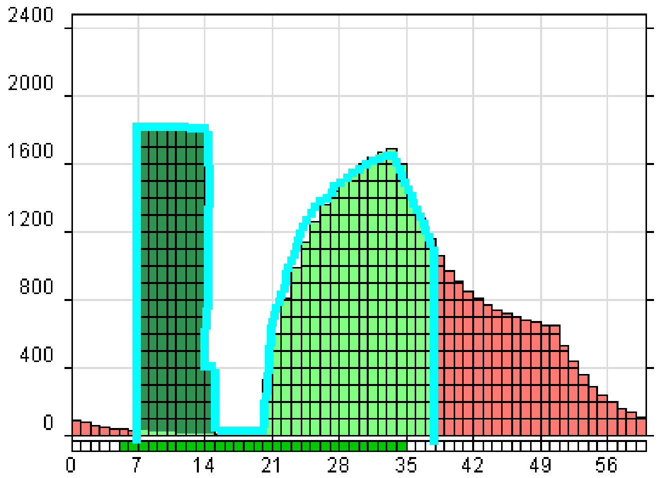
The Accept Profile shown below represents the discharge profile of a Lane controlled by traffic signals. During the period the traffic signals are on green the Lane can discharge traffic at a maximum rate equal to the Lane's saturation flow. During the red period no traffic can leave the Lane.



Accept Profile

Leave Profile

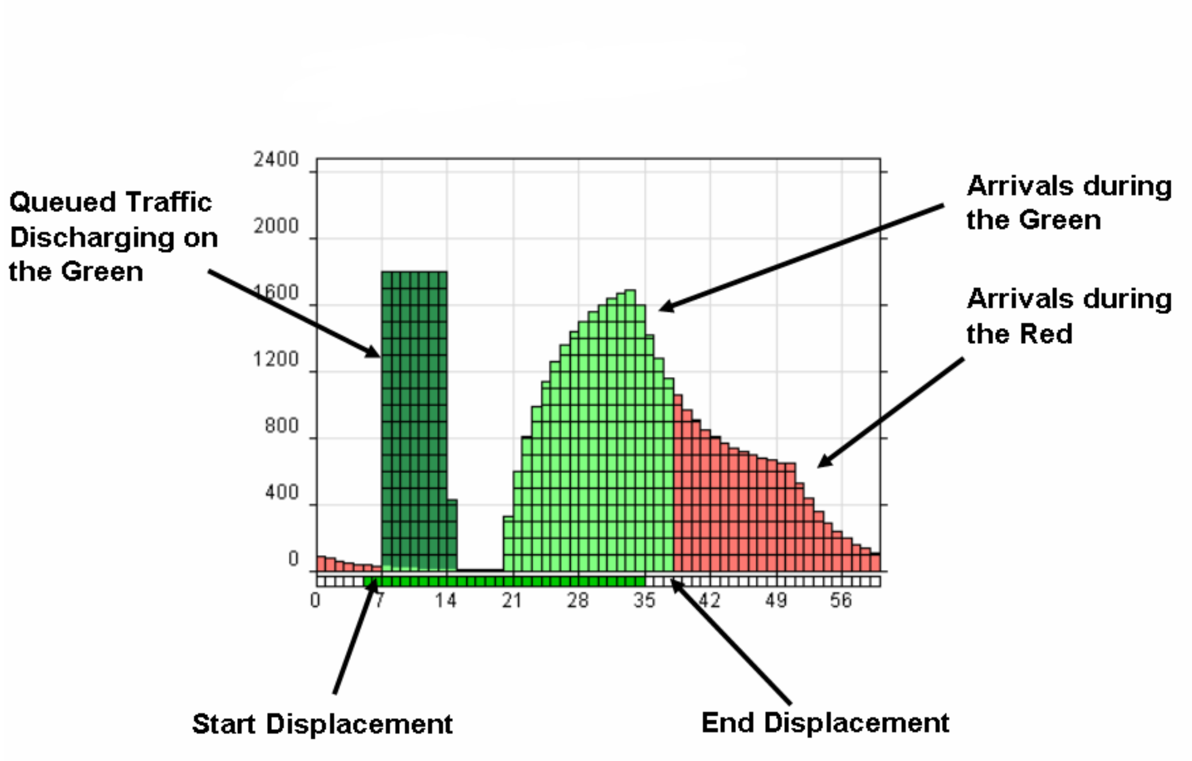
The Leave Profile shown below is calculated from the Arrive and Accept Profiles.



Leave Profile

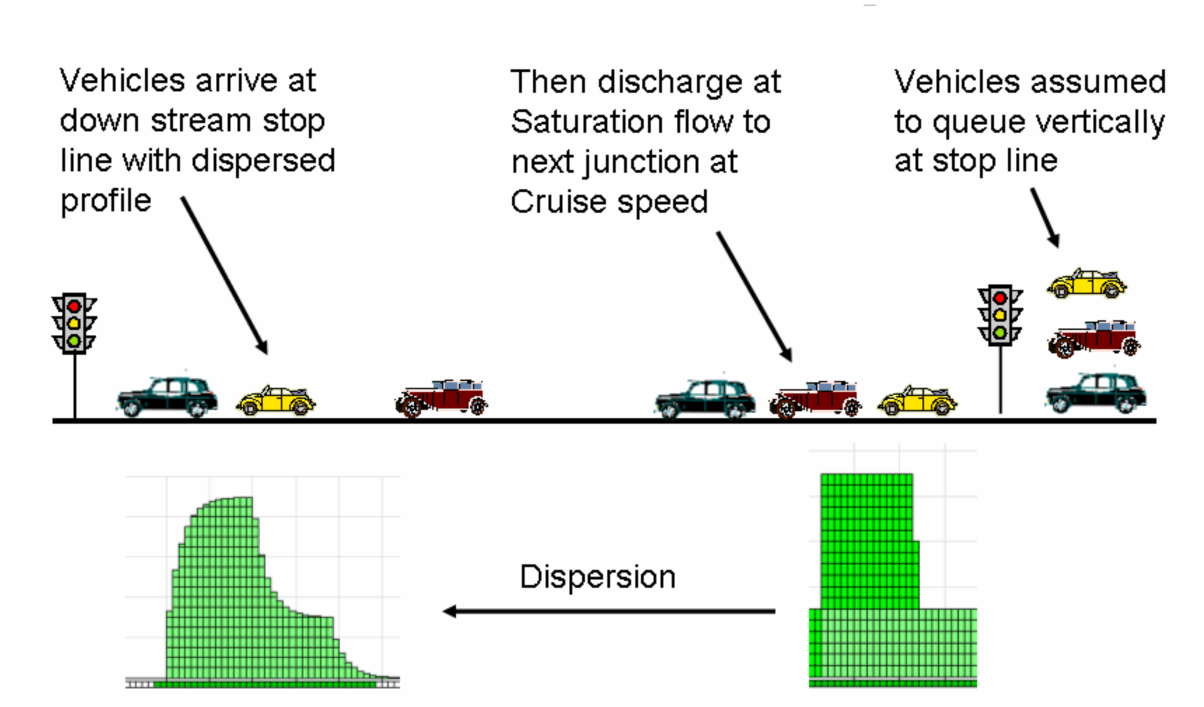
The initial peak of traffic at the beginning of the green period represents the queue formed during the red period leaving the Lane at the saturation flow rate. After the queue has discharged a short gap occurs when there is no traffic on the Lane to discharge before the next platoon of vehicles arrive and immediately leave the Lane as it is still on green. At the end of the green period the amount of leaving traffic falls to zero as the signals are now red and further traffic arriving is forced to queue and wait for the next green period.

These different periods are identified below:



3.1.1.3. Interactions between Lanes

The flow profiles for each Lane are calculated based on the traffic arriving from one or more upstream Lanes. It is important to fully understand how traffic moving between Lanes is modelled.



Queuing and Dispersion

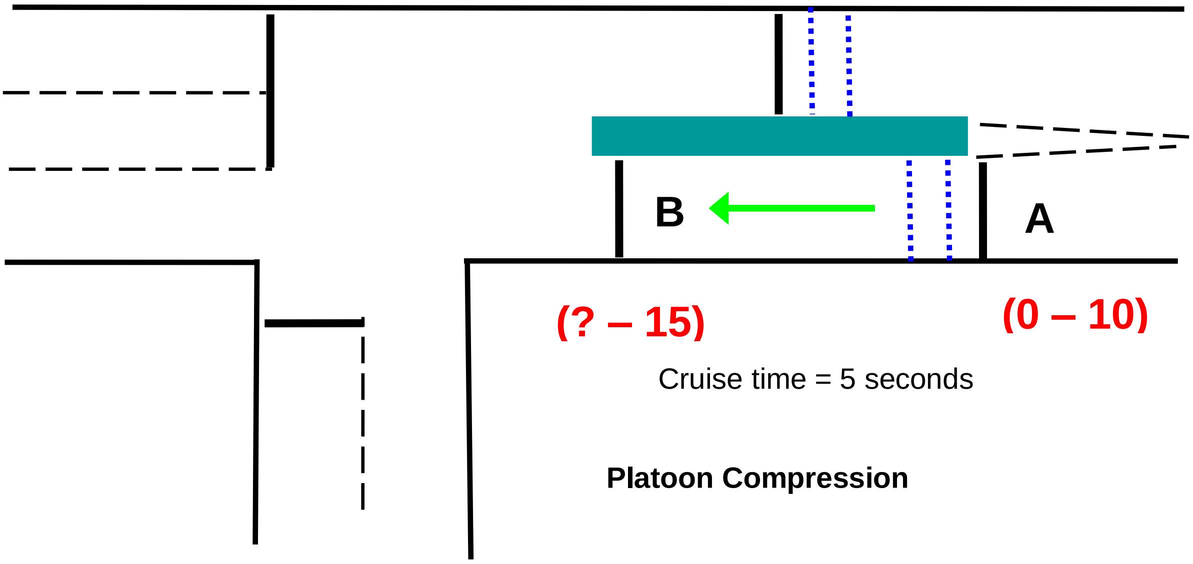
The above diagram illustrates a number of key points. These are:

- Vehicles queuing on a Lane are assumed to queue vertically at the Lane stop line. This assumption means that every vehicle travelling along a Lane takes the same cruise time to reach the stop line regardless of the length of the queue on the Lane. It also means that the modelled number of vehicles queuing at the stop line may be greater than the maximum number of vehicles that could be accommodated on the Lane.
- The profile of vehicles leaving a Lane (the Leave Profile) is used to calculate the Arrival profile at a downstream Lane's stop line. The first assumption above could allow this process to be carried out simply by assuming the Arrive Profile of a Lane is the same shape as the Leave Profile of the upstream Lane but displaced in time by the Lane's cruise time.
- In reality unless Lanes are very short, platoons of traffic spread out as they travel along a Lane. The shape of the Leave Profile is therefore smoothed as it travels along the Lane to model the effects of platoon dispersion. The level of smoothing is dependent on the Lane length.
- In the case of very Short Lanes, platoon dispersion is negligible. In reality, another effect becomes more prevalent due to the assumptions made about vehicles either being at rest or travelling at cruise speed. This is known as Platoon compression.

Platoon Compression

It is assumed that vehicles start from the stop line at the cruise speed when the signals turn green (or at least after the start displacement). This assumption is perfectly valid over Long Lanes because traffic will start to disperse. However over a Short Lane of say 40 or 50 meters, the start up time will effect when the first vehicle arrives at the second stop line. Conventional modelling techniques assume that the first vehicle starts at the cruise speed and crosses the downstream stop line after the cruise time has expired. In reality, this only happens to the last vehicle; the first vehicle will take longer because it is starting from rest. Whilst the starting displacement takes account of this at the first stop line, there will be no starting displacement at the second stop line because the vehicles are travelling at cruise speed (anticipating the green from the starting red/amber).

For example, consider the situation below where the signals at A commence green at time 0 and run until time 10. If the cruise speed from A to B is 5 seconds, then it may seem reasonable to set the green time at B to be from 5 to 15 seconds. The last vehicle through A will be travelling at the cruise speed and will therefore just clear the stop line at B. However, the first vehicle at A will be starting from rest and the time it takes to get from A to B will be one or two seconds more. This means that the signals at B could start two seconds later and run from time 8 to 15, representing only 8 seconds of green. If this is modelled in a conventional way, the stop line on B will be shown to be overloaded even though this effect can be clearly seen to happen without overloading in practice. The way to overcome this is to set the traffic at B to have no starting displacement (since the traffic will already be moving when the signals turn green).



Platoon Compression

Hence, if the traffic at A is set to run green from 0 to 10 seconds with the usual start and end displacements of 2 and 3 seconds respectively, then the signals at B will need to be set at 7 to 15 with zero start displacement and 3 seconds end displacement. The effective green at both stop lines will be 11 seconds, giving the same degree of saturation.

Generally, the rule is that if you are coordinating the signals in such a way that the first vehicle arrives on an opening green (without needing to stop), then you can remove the starting displacement.

3.1.1.4. Model Accuracy and Queue and Delay Calculations

At low and medium levels of flow on a Lane the above method is quite realistic and real life random variations in traffic do not greatly affect the overall levels of delay predicted by the model. However, it becomes increasing less accurate as flows increase as the assumption that each cycle is the same becomes less realistic. When the flow on a Lane is greater than its capacity this assumption is obviously incorrect as at the end of each cycle the queue will have permanently increased by the difference between the flow arriving in the cycle and the Lanes capacity over the cycle. Each subsequent cycle would then add a similar amount to the Lane's queue, and as the flows are assumed to be the same for each cycle throughout the modelled period the queue will never discharge during this period.

This problem is resolved by taking advantage of the fact that the additional delay per cycle due to over-saturation on a Lane can be separated from the delay caused by transient queuing within the typical cycle. The oversaturated delay component is relatively easy to calculate using a mathematical formula. This is then added to the transient delay calculated from the cyclic flow profile of the typical cycle which is termed the uniform delay.

An attempt is also made to allow for the fact that when the degree of saturation on a Lane is around 80-100% the real life randomness of traffic flows on a Lane will cause the delay to be higher than the uniform delay. A random delay component is calculated using standard formulae and is added to the uniform and oversaturated delay to give the total delay on the Lane. In reality, traffic arriving at a stop line from an approach which has no signalled junctions will have a very high random component where as arrivals from within a dense network of signals will have a much lower random component. The random delay component in the calculations is assumed to be a combination of the two situations.

3.1.1.5. Queuing

The queue lengths calculated by cyclic flow profile models are often misunderstood and it is important to understand the different queue components and how they are used to predict queue lengths.

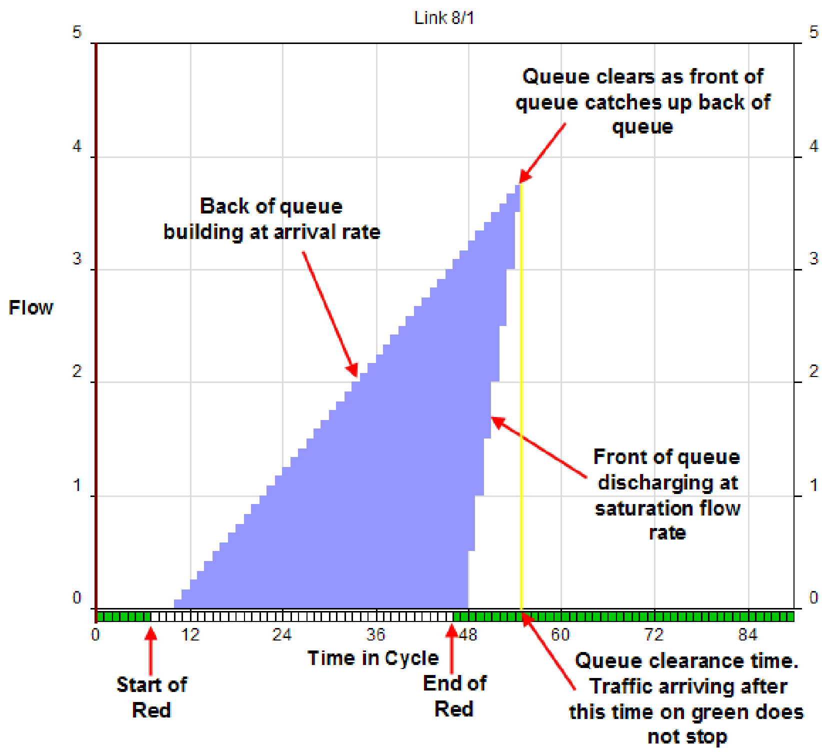
Queues are inherently difficult to model accurately regardless of the quality or level of detail used in the model. Predicted queue lengths are extremely sensitive to small changes in input data. For example looking at a typical Lane in a LinSig model with a flow of 600 PCU, its predicted queue at a degree of saturation of 90% is 19 PCU. Increasing the flow by 10% gives a degree of saturation of saturation of 100% and a queue of 29 PCU – an increase of over 50% in the queue length.

Due to the variability of queues and sensitivity to small changes in conditions both in models and in reality we recommend avoiding directly calibrating models to measured queues as unless done with extreme care and highly detailed data it has the potential for introducing significant inaccuracy into the model. It is recommended that a greater emphasis is placed on ensuring capacities are modelled correctly whilst still checking that modelled queues are acceptable.

LinSig models queue lengths in three components similar to those used to model delay.

Uniform Queuing

The Uniform queue is the cyclic queue which grows and dissipates every cycle when the Lane is below capacity. LinSig calculates the maximum queue in the modelled typical cycle and assumes this will be same for all cycles in the modelled period. The maximum Uniform queue is the maximum length of the back of the queue as LinSig allows for the fact that vehicles are still joining the back of the queue after vehicles have started leaving the front of the queue. The maximum back of queue occurs when the discharging front of the queue catches up the back of the queue which usually will be lengthening more slowly. This is illustrated in the figure below.



Oversaturated Queuing

When a Lane is oversaturated a residual queue remains at the end of the modelled typical cycle. The next cycle then adds to this residual queue by the same amount. This leads to a constantly increasing residual queue throughout the modelled period. For example, assume a Lane's arrival flow is 400 PCU/hr = 10 PCU/cycle for a 90s cycle and its capacity is 320 PCU/hr = 8 PCU/cycle and the queue is zero at the start of the modelled hour. The queue at the end of the modelled hour will be approximately (3600/90) x (10-8) = 80 PCU plus the maximum uniform queue. The mean queue will be approximately half the queue at the end of the hour, in this case 40 PCU.

Random Queuing

When a Lane has a degree of saturation less than 80% the uniform queue will be a good estimate of queuing. In cases where the degree of saturation is greater than around 110% the oversaturated case will also be fairly accurate, albeit sensitive to small changes or inaccuracies in input data. However, in most cases in traffic assessments the Lanes of most interest will be in the middle of these two zones in the 90-105% saturated range. In these cases in real life the queue will randomly clear some cycles and not clear other cycles leaving a residual queue. As the degree of saturation increases a higher proportion of cycles will result in a residual queue which will gradually accumulate over the modelled period. As LinSig only models a single typical cycle it is unable to directly model this random effect. LinSig therefore indirectly allows for this Random queuing using a standard formula to estimate the level of Random queuing on each Lane assuming random arrivals. This is then added to the Uniform and Oversaturated Queues to give the Lane's Total Queue. Although this technique allows the Lane to be modelled using a single typical cycle reducing the modelling load it can lead to inaccuracies in some cases, for example, when a Lane is in the middle of a dense network of closely spaced signal junctions arrivals will often be very tightly platooned and non-random, leading to an overestimate of Random Queuing. This is especially apparent on Short Lanes which although highly saturated are completely coordinated with upstream Lanes, for example, a circulatory Lane on a signal roundabout. Although the tight coordination allows all traffic through in the green time with no queuing the random delay predicts a queue even though the non-random behaviour of traffic in this case means no Random Queuing would occur in practice. LinSig therefore allows the Random Delay/Queue calculation to be switched off on selected Lanes. This should only be used in cases where it can be easily justified – It should not be seen as a convenient way of reducing the queue on an inconvenient Lane!

Mean Max Queue

The Mean-Max Queue is the sum of the Maximum Back of Queue in the modelled typical cycle and the calculated Random & Oversaturated Queue. The 'Mean' refers to the fact that it is the mean over a number of cycles of the maximum queue occurring each cycle.

3.2. Network Structure & Defining Traffic Flows in LinSig

This section discusses options for structuring the Network and defining traffic flows in LinSig. Further details of the techniques discussed are given in the View Reference Section.

3.2.1. Background and Version Differences

An important decision with any LinSig model, especially larger models, is how the Network should be structured and the related issue of how traffic flows will be defined.

Prior to LinSig 3.1 the only option for entering traffic flows was to use an Origin-Destination Matrix for the entire Network. Although this provided the maximum level of detail it could lead to long run times on large models, required the production of a Network wide OD Matrix which could be onerous for larger models, and required the same level of detail to be used for the entire model – not just the smaller area where detail was required.

LinSig 3.1 introduces an additional less detailed method with which to define traffic flows called Lane Based Flows and also allows LinSig Networks to be structured to use the existing Matrix Based traffic flow definition methods in areas where detail is required whilst using the simpler Lane Based Flow methods across the rest of the Network.

3.2.2. Flow Definition Methods

However traffic flows are defined the objective is to determine traffic flows on individual Lanes possibly disaggregated by traffic type, traffic movements passing through the lane, or some other criteria. The traffic flow on each Lane can then be used by LinSig to calculate results.

The two available methods of defining traffic flows are:

- **Matrix Based Flows.** Matrix Based Flows are similar to the method of defining traffic flows in LinSig prior to LinSig 3.1. The following information is used to determine traffic flows on Lanes:
    - **An Origin-Destination Matrix.** Each Traffic Flow Group defines an Origin-Destination (OD) Matrix which specifies the total traffic flow for this Flow group between pairs of Zones.
    - **Route Flows.** The OD Matrix only specifies the total traffic flow travelling between a pair of Zones not the route or routes taken. When using Matrix Based Flows each LinSig Scenario defines a set of Route Flows which specify the Routes taken by traffic travelling between each Zone pair. A Route Flow can either be entered manually or can be estimated by LinSig using a standard traffic assignment user equilibrium algorithm to distribute traffic between Routes based on calculated delays. Different Route Flows are stored for each Scenario reflecting the fact that the same OD Matrix can be assigned to the Network in many ways depending on signal timings and other scenario specific issues.

  Using Matrix Based methods LinSig can obtain a fully disaggregated breakdown of traffic passing through each Lane which is used to refine the modelling of queues, delays and capacities on each Lane.

- **Lane Based Flows.** Lane Based Traffic Flows are an alternative simpler way of defining traffic flows compared with an OD Matrix and Routes. The following information is used to determine traffic flow on Lanes:
  - **Total Lane Stop Line Traffic Flow.** The total stop line flow for the lane is specified in PCU. This is obtained externally from LinSig using traffic counts, a strategic traffic model or any alternative manual method.
  - **Incoming Turning Movements.** Turning movements entering a Lane from other Lanes. This will also be an Outgoing Turning Movement from an upstream Lane.
  - **Outgoing Turning Movements.** Turning movements leaving the Lane to other Lanes. This will also be an incoming Turning Movement from a downstream Lane.

  Lane Based Traffic Flows contain no information on how traffic routes through the Network other than the immediate upstream and downstream Lanes feeding and being fed by a Lane.

  If necessary Lane Based Flow Layers can be used to disaggregate traffic flow on a Lane by traffic type (eg buses), by movement or any other criteria.

3.2.2.1. Choosing Which Flow Definition Method to Use

Each traffic flow definition method has advantages and disadvantages. It is important to understand these when choosing how to structure a network.

The advantages of Matrix Based methods include:

- LinSig has detailed information on how traffic routes through the Network. This means that each Lane can be modelled with different traffic movements passing through the Lane being kept disaggregated throughout the modelling process. This leads to more accurate modelling of cyclic flow profile shapes which are used in the optimisation process and to calculate model results. This is particularly important on complex junctions such as signal roundabouts.
- In smaller Networks where little route choice exists the amount of data entry using an OD Matrix and delay based assignment is much less than when using Lane Based Flows.
- When changes are made to the Network, possibly as part of scheme development, LinSig can quickly reassign traffic to Routes on the changed Network based on modelled delays. This process is very quick and allows rapid assessment of the consequences of traffic rerouting due to scheme changes.
- In smaller Networks where the number of Routes is not too large very fine control over traffic routing is available by manual adjustment of Route Flows.

Disadvantages of Matrix Based Methods include:

- The greater level of detail has a cost in terms of model run times. The high level of detail being modelled can lead to longer run times especially in larger Networks.
- An Origin-Destination Matrix is required for the region of Network being modelled. For larger Networks it is unusual to have a directly counted OD Matrix although ANPR developments are making this increasingly more feasible. Although LinSig provides a facility to estimate a matrix from traffic turning counts it can be onerous for an unfamiliar user to produce a sufficiently robust OD matrix for a large Network if traffic counts are of poor quality.

- In larger Networks with significant opportunities for rerouting the number of possible Routes through the Network can be very large. Although the number of Routes can often be substantially reduced by judicious removal of unfeasible Routes a large number of valid Routes can often remain which can make fine tuning of traffic routing by manually adjusting Route Flows unfeasible.
- When traffic routes through the Network using criteria other than delay (eg signing) significant manual Route Flow changes and/or Route locking may be required when calibrating to ensure the OD Matrix and Route Flows match traffic counts.

Advantages of Lane Based Flow Methods include:

- The entry of flow information is much more direct and avoids more complex concepts such as Routes and delay based assignment.
- As the level of detail is much less than Matrix Based Methods models will run faster and larger models can be built. The speed advantage with smaller models will be much less and will be less important than other factors when choosing which method to use.
- Existing counted traffic flows or turning flows output from a strategic model can be directly entered. This avoids the need to produce an OD matrix and assign it to the Network and also avoids any calibration needed to ensure the assignment matches the original counts or flows.

Disadvantages of Lane Based Flow Method:

- Less detailed traffic flow information is available for LinSig to use for modelling a Lane's queues, delays and capacities. Although in many cases this lack of detail will only cause minor insignificant differences in results, for some more complex junctions such as signal roundabouts or closely spaced staggered T junctions the inaccuracies may be more significant.
- In simple Networks where delay based assignment is quick and accurate using Lane Based Flows will often require significantly more data entry than using Matrix Based methods.
- When changes are made to the Network (for example banning a right turn) which will lead to reassignment of traffic it is necessary to manually determine new Lane traffic flows externally from LinSig. This can involve significant effort if no established methods such as a strategic traffic model exist.

3.2.2.2. Lane Based Flow Layers

Lane Based Flow Layers can be used to separate out different traffic types or movements in a Network or region of Network defined using Lane Based Flows. For example bus traffic or traffic between two points in the Network can be separated out. LinSig models each Layer separately whilst allowing for interaction between traffic in each Layer.

Matrix Based Network regions use a similar method to separately model flows on different Routes through the Network. With Matrix Based regions all of the Layers are automatically created invisibly in the background from Routes and do not require any manual data entry or configuration.

Lane Based Flow Layers allow selective disaggregation of important movements or important traffic types (eg Buses). They should not be used to model a Network which requires extensive separation of traffic movements such as a signal roundabout as if this level of detail is required it can be achieved much more efficiently using Matrix Based Methods.

For simple Networks where it is not important to separate out different traffic types it will be sufficient to use a single Layer for the whole Network.

3.2.3. Using both Matrix Based and Lane Based Methods in the same Model

LinSig 3.1 allows Matrix Based and Lane Based Flow definition methods to be mixed in the same model. This has the advantage of allowing important areas of the Network which require detailed modelling to be defined using Matrix Based methods whilst the rest of the Network is modelled using Lane Based Flows. Lane Base Flows will usually be sufficiently accurate where flow patterns are simple, for example an arterial road with little side road traffic relative to the main road, but may not be sufficiently detailed for complex situations for example a signal roundabout.

Remember that the size of Network and other factors as discussed above may mean that it is sometimes simpler and more efficient to model the whole Network using either Matrix Based or Lane Based flow definition methods. If it is easy to model the whole Network using a Matrix this will often be the best choice as full accuracy is maintained across the Network.

3.2.3.1. Determining Regions which may Require more Detailed Modelling

Generally Lane Based Flow Methods will be sufficiently accurate when the turning proportions of flow leaving a Lane or larger section of Network do not depend significantly on the where the flow has come from.

For example this would occur if all traffic turned 30% left 70% right from a Lane regardless of where it has come from.

If the situation is more complex and traffic turning left INTO the Lane will exit 30% left/70% right, but traffic turning right INTO the Lane will exit 80% left/20% right this indicates routing is important and should be considered. This can be done using either Matrix Based methods if flows are unbalanced over a wider area (eg a signal roundabout) or Lane Based Flow Layers if only a small area is affected (eg a staggered pair of T junctions)

3.2.3.2. Defining Network Regions

Each Traffic Flow Group contains an OD Matrix, a set of Lane Based Flows or both. LinSig uses the combination of the OD Matrix and the Lane Based Flows to define Network Regions which are modelled using either method.

Creating a Matrix Based Network Region

To define a Matrix Based Region:

- Create Zones around the periphery of the region including at the boundary with the rest of the non-Matrix Based Network.
- LinSig uses a single OD Matrix for the entire Network regardless of any Network regions however only the parts of the matrix relevant to each region are used.
- Enter the section of the OD Matrix just for the Zones surrounding this region. OD Matrix cells representing traffic between Zones in different regions should be left blank.
- Use Delay Based Assignment to assign the OD Matrix to the Network region. Use the Assignment options to select only Zones surrounding the region. Only Routes between Zones around the region are used.

Creating a Lane Based Network Region

To Create a Lane Based Flow Region:

- Do not create Zones around the region which will use Lane Based Flows unless required for measuring journey times. Zones are only necessary in Lane Based Flow regions if Routes are required for calculating journey times.
- Use the Lane Based Flow Drag and Drop editing and the Edit Lane dialog box to define Lane Based Flows on all Lanes in the region.

Boundaries between Network Regions

At a boundary between two regions where either of the regions is Matrix Based use the ‘Inherit Cyclic Flow Profile from Upstream Exit Lane’ setting in the Edit Lane dialog’s Advanced tab on Lanes being fed by Zones at the region boundary to ensure traffic crossing the region boundary is correctly profiled.

It is important to ensure that Lane Based Flow regions and Matrix Based regions only overlap if this is being deliberately modelled. Where a Lane defines both Lane Based Flows and Matrix Based Flows LinSig will add these together to give a total Lane Flow. This is sometimes useful in advanced situations but can be confusing and is best avoided.

3.3. Give-Way Lanes in LinSig

LinSig models two main types of Give Way Lane. These are:

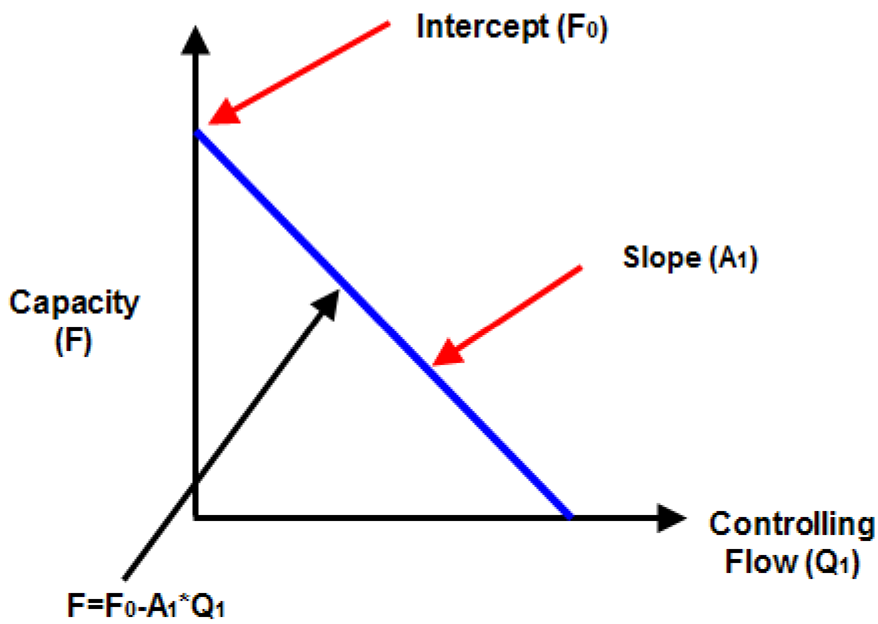
- An un-signalised Give Way Lane such as at a priority junction or a left slip.
- A Right Turn Lane which gives way to opposing traffic for part of its green period.

LinSig uses its give-way model to model the first scenario and uses the give-way model plus other Right Turn Model components to model the second scenario.

3.3.1. The LinSig Give Way Model

- The capacity of an un-signalised Give Way Lane is modelled using an assumed relationship between the capacity of the movement giving way and the rate of flow on Lanes opposing the Give Way Lane. LinSig assumes a linear relationship as shown in the graph below. The linear relationship is specified using the following parameters:
- The Intercept F_0 is the maximum flow when the Lane is potentially opposed but no opposing traffic is present.
- The Slope A_1 is a coefficient which specifies by how much the capacity is reduced by flow on the opposing Lane.

LinSig allows for any number of opposing Lanes by allowing additional A_n parameters to be specified for each opposing Lane.



The above parameters can be interpreted in traffic terms as follows:

- **Intercept (or Max Flow).** The Intercept is the maximum flow rate that could exit the give way Lane if no opposing flow was passing the give way Lane. It is important to differentiate this value from Saturation flow. Saturation flow values assume that the driver will not have to stop. The Intercept value assumes the driver may have to stop and will have to slow down to check for opposing traffic even if none is present. The Intercept value will usually be much lower than a saturation flow value for a Lane with the same geometry.

- **Slope (or Coefficient).** The Slope relates to the effect the opposing flow has on the capacity of the give way Lane. If a give way Lanes capacity drops rapidly as its opposing flow increases the slope will be higher.

LinSig uses the above relationship together with the flow on the opposing Lane in each time slice to model the capacity of the give way Lane in each time slice.

3.3.1.1. Typical Values of Give Way Parameters

Typical values of Slope and Intercept for common situations include:

	Intercept	**Slope**
Give Way Controlled Left Turn	715	0.22
Right turn at Signals (Equivalent to Webster & Cobbe)	1439	1.09

The values for the right turn as signals are designed to give as close as possible correspondence with the Webster & Cobbe give way model used in earlier versions of LinSig and generally accepted in the UK for many years.

3.3.2. The LinSig Right Turn Model

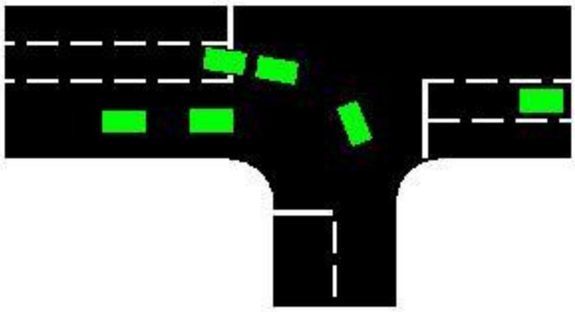
The majority of signal controlled junctions allow right turning traffic to turn in gaps across oncoming traffic when the signals are green. However, there are a number of additional issues to consider compared with a simple give way described above.

3.3.2.1. Right Turn Capacity Components

The capacity of a right turning traffic stream is comprised of a number of components. These are:

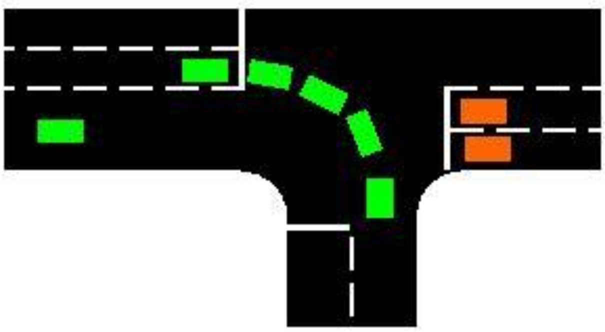
- Right turning traffic across gaps in the oncoming traffic
- Unopposed movement when opposing traffic is stopped
- Stationary traffic turning right during the intergreen.
- A bonus effect from vehicles waiting in the junction prior to the start of an indicative arrow.

Right turning traffic across gaps in the oncoming traffic



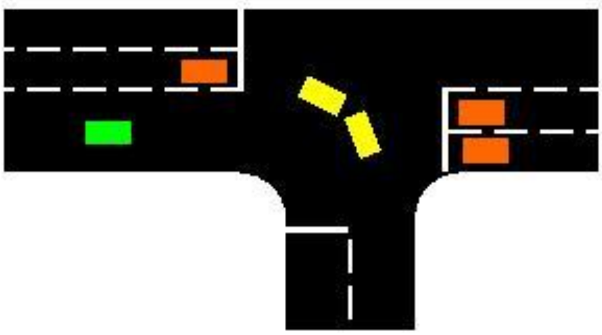
LinSig uses the give way model described above to model the capacity of the right turn during the period it is opposed by oncoming traffic. Common practice in the UK for many years has been to use Tanners formula to calculate the amount of traffic turning in gaps. This can be closely approximated in LinSig 3 by using 1440 for Intercept and 1.09 for slope in the give way model.

Unopposed movement when opposing traffic is stopped



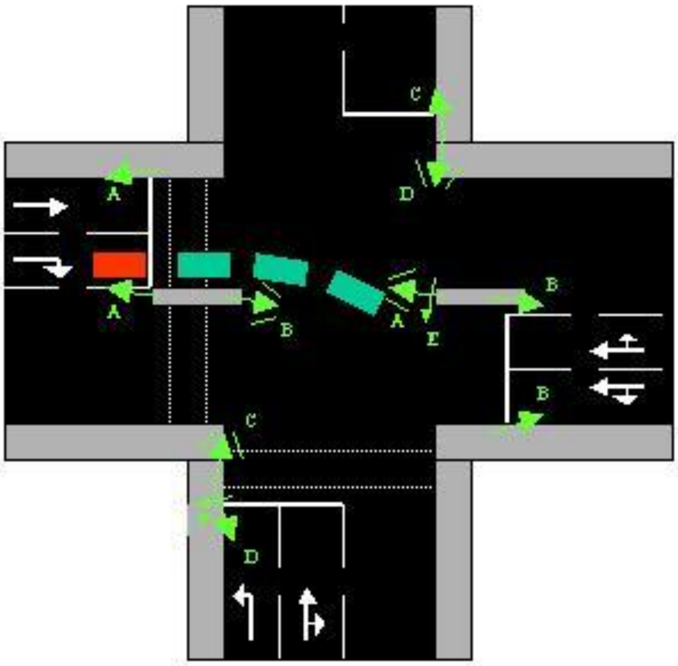
The Capacity during the time when the right turn is unopposed, possibly whilst an Indicative Green Arrow is running, is calculated using the value of 'Saturation Flow when Unopposed' defined for the give way Lane. This may be lower than the Lane's Saturation flow if the right turners share the Lane with Ahead traffic as the Lane's Saturation Flow relates to the Ahead movement.

Stationary traffic turning right during the Intergreen



Vehicles waiting in the junction at the end of the main road stage can turn right during the Intergreen. The Intergreen clearance depends upon the geometric nature of the junction. In the example above it is assumed that the two yellow vehicles stored in front of the stop line will clear during the Intergreen period. Any other vehicles waiting behind the stop line will wait for the next cycle.

Bonus effect from vehicles waiting in the junction prior to the start of an indicative arrow



This concept, which is unique to LinSig, requires careful consideration but is easily observed at any existing junction with a right turn indicative green arrow. When right turners are controlled in this way there are no stationary vehicles in front of the stop line at the end of green, which can then clear the junction in the following Intergreen period. However, an equivalent storage effect applies because of the way in which vehicles move off at the start of the arrow phase green period. This effect is controlled by the Right Turn Factor.

The above figure illustrates the concept of the Right Turn Factor.

At the start of the indicative arrow effective green (Phase E), the first car will move off to clear the junction. However, it will be about 3 seconds later when the fourth car (shown in red) is able to move over the stop line. Effectively the first 3 seconds of arrow time have discharged 3 cars after which, cars can cross the stop line at the saturation flow. Without this storage effect the first 3 seconds would only have discharged 1.5 cars. Compared with an ordinary phase, such as a fully signalled right turn, there is an additional capacity of 1.5 PCUs per cycle, which is half the number of right turners waiting in front of the stop line, corresponding to the default value of the right turn factor of 0.5.

Bonus Capacity = Junction Storage x Right Turn Factor

In extreme cases, it is possible that no movement across the stop line can take place at all during the green arrow period. If the right turn storage, for example, is 5 cars and a minimum arrow time of 4 seconds is in operation, then the end of green will have occurred before the fifth car moves off from its waiting position just in front of the stop line. In such cases there may be little point in providing a right turn indicative arrow. With LinSig it is easy to try out sequences with or without a green arrow and to examine the effect of re-locating the stop line so as to alter the number of right turners able to wait in front of it. When using other computer or manual methods of calculation the above effect is not normally recognised and the situation is treated as if no right turners were allowed to wait in front of the stop line. LinSig will therefore calculate shorter green arrow times than other methods. The validity of this can easily be confirmed by observations of traffic behaviour at existing signals in your area. The default value of Right Turn Factor is 0.5. It is unusual to have to change this value but if a change is proposed it should be carefully justified using site observations.

Right Turn Move Up

In order to ensure that right turning traffic has reached a position in the junction to accept a gap, a right turn move up parameter is specified. This is the time taken for a right turning vehicle to get from the stop line to the front position in the storage area. A rule of thumb is to estimate the move up time as 1 second for each PCU of storage space in front of the stop line.

Clear Conflict Times

The Queue Clear time is used to ensure that right turning traffic cannot clear during the Intergreen until the last opposing vehicle has travelled from the stop line to the queue clear point.

4. View Reference

LinSig maintains a detailed model of the Network being studied and the traffic signal controllers controlling Junctions within the Network. The model is displayed and edited using a series of Views. Each View displays the model in a different way or allows different aspects of the model to be worked on.

The LinSig Views were introduced briefly in 'Section 2 – LinSig Basics' where their purposes are briefly summarised. This section covers each View in more detail describing how they are used to edit the model and to interpret results.

The LinSig Network Views are:

- **Network Layout View.**
- **Traffic Flows View.**
- **Route List View.**
- **Turning Counts View.**
- **Matrix Estimation View.**
- **Lane Timings View.**

The Controller Views are:

- **Controller List View.**
- **Phase View.**
- **Intergreen View.**
- **Stage View.**
- **Stage Sequence View.**
- **Network Control Plans View.**
- **Network Control Layout View.**
- **Interstage & Phase Delays View.**
- **Signal Timings View.**
- **Multiple Interstages View.**
- **Phase Data View.**
- **Stage Minimums View.**
- **SCOOT Data Preparation View.**
- **Phase Based Design Tool.**
- **VISSIM Interface View.**

The Results and Reporting Views are:

- **Scenario View.**
- **Network Results View.**
- **Travel Time/Delay matrix View.**
- **Model Auditing View.**
- **Audit History View.**

- **Cycle Time Optimisation View.**
- **The Report Builder.**
- **Cyclic Flow Profiles View.**
- **Time Distance Diagrams View**

Other Miscellaneous Views:

- **Error View.**
- **Undo History View.**
- **Lane Data Grid View.**

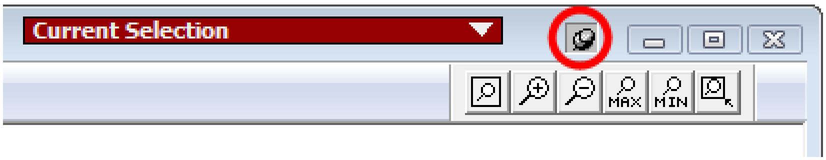
4.1. General View Features

Some features are common to a number of Views.

4.1.1. Always on Top

The ‘Always on top feature allows a View to be kept on top of all other Views. This is useful if you wish to prevent a smaller View becoming lost behind a larger View. ‘Always on Top’ can be switched on for a view by clicking the ‘pin’ icon located to the right of each View’s Title Bar.

Always On Top Off



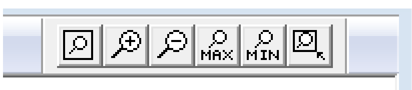
Always On Top On

If two overlapping Views are both set to always on top the most recently used View will be on top.

Tip: Avoid having a large View with ‘Always on Top’ switched on as it is very easy to lose smaller Views behind it.

4.1.2. Zoom and Pan

The main graphical layout Views can be zoomed and panned using both the toolbars and the mouse. Zooming can be carried out using the zoom toolbar located on the main toolbar of each of the zoomable Views.



Zoom Toolbar

The toolbar buttons are from left to right:

- Zoom to fit View contents to Window.
- Zoom View in.
- Zoom View out.
- Zoom to Max.
- Zoom to Min.
- Size Window to fit View Contents at current Zoom level.

If your mouse is equipped with a mouse wheel the zoomable views can be rapidly zoomed by scrolling the mouse wheel backwards and forwards. The direction of zoom can be reversed if desired using ‘Program Options’ on the File menu.

4.1.3. Defaults, Colours and Visual Settings

LinSig can use a range of default settings many of which can be changed to custom values specific to your individual usage.

Defaults and Visual settings are split into groups. These are:

- **File Specific Settings.** These settings are located on the ‘Graphical Settings’ tab of the ‘Network Settings’ dialog box. This can be opened by choosing ‘Network Settings’ from the Network menu. The tab contains settings which relate to the layout of the Network Layout View and other Views which are likely to be specific to an individual file rather than for a user. For example, a very detailed network may look better with a smaller text size or narrower lanes. These settings are therefore stored in the LinSig file so they are used whenever the file is opened by any user.
- **Default Settings for New Files.** The Default Settings for new files are located on the ‘Defaults for New Files’ and ‘Graphical Defaults for New Files’ tabs of the ‘Defaults for New Files’ dialog box. This is opened by choosing ‘Defaults for New Files’ from the File menu. These settings only apply to new files created in LinSig and once set avoid the need to setup your preferred File Specific Settings in each new file.
- **User Graphics Settings.** These settings are located on the ‘Graphics Options’ and ‘Colour Options’ tabs of the ‘Graphics Settings’ dialog box. This is opened by choosing ‘Graphics Settings…’ from the File menu. The User Graphics Settings affect display issues such as colours, line thicknesses and font sizes which do not affect the Junction Layout and can therefore be specified by personal preference rather than being tied to each file. Each LinSig file opened will be displayed using the User Graphics Settings.
- **Program Settings.** These settings are located in the ‘Program Options’ dialog box which is opened by choosing ‘Program Settings…’ from the File menu. The Program Settings affect a number of aspects regarding the way LinSig operates, such as Auto-updates and Auto-save.

The Colours, Font, Text Sizes and other visual settings can usually be altered for items displayed in Views. Generally it is recommended to retain the default colours unless a good reason to change them arises as this will avoid confusion between different users. This User Guide assumes that colours are set to default when referring to the colour of items and objects.

4.2. Using International Options

LinSig includes a number of features to make it easier to use outside of the UK. These include:

- **Drive-on-the-Right Graphical Views.** When the 'Drive-on-the-Right' option is set LinSig displays graphical Views using Drive-on-the-Right logic.
- **SCATS™-Based Terminology.** LinSig can display Traffic Signal Controller based views using terminology and labelling consistent with the SCATS™ adaptive traffic control system developed by New South Wales Roads and Traffic Authority.

4.2.1. Using Drive-on-the-Right for Graphical Views

LinSig can be set to display Graphical Views using Drive-on-the Right logic as follows:

- Choose 'Network Settings' from the LinSig Network Menu. This will open the Network Settings dialog box.
- Click the 'Graphical Settings' tab of the Network Settings dialog box.
- Choose 'Right' for the Drive Side Option.

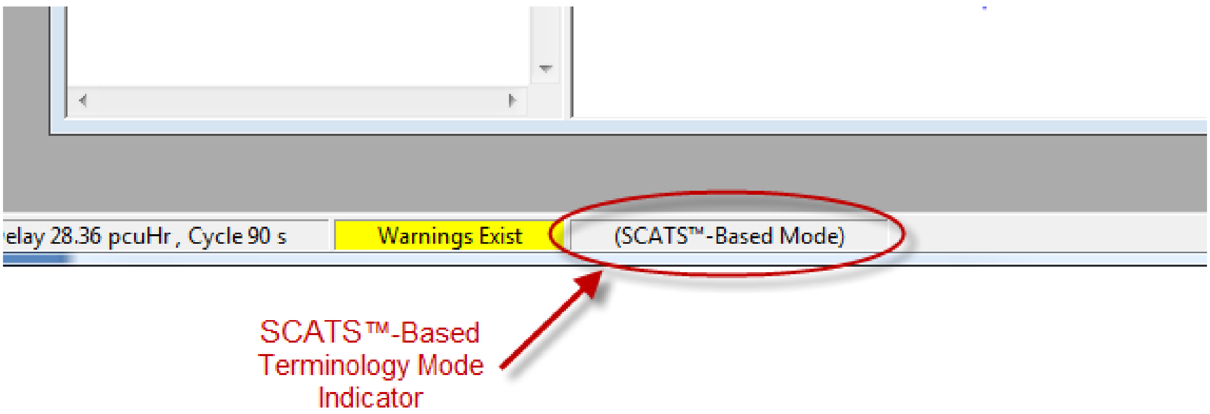
This setting should be set before beginning to build a model as LinSig cannot convert a Drive-on-the-left model to a Drive-on-the-right model or vice versa.

4.2.2. Using SCATS™-Based Terminology

LinSig can be set to use traffic signals terminology compatible with a SCATS™ controller. For example a Stage in UK terminology is referred to as a Phase in a SCATS™ controller and a UK Phase is referred to as a Signal Group.

LinSig can be set to use SCATS™-Based terminology as follows:

- Open the Program Settings dialog box by choosing 'Program Settings' from the LinSig File menu.
- Tick the Setting 'Use SCATS™-Based terminology'.
- Click 'OK' to close the Program Settings dialog box. LinSig will display a warning reminding you to restart LinSig before proceeding.
- Restart LinSig. LinSig will now use SCATS™-Based terminology. The Status bar confirms that SCATS-Based mode is in use.



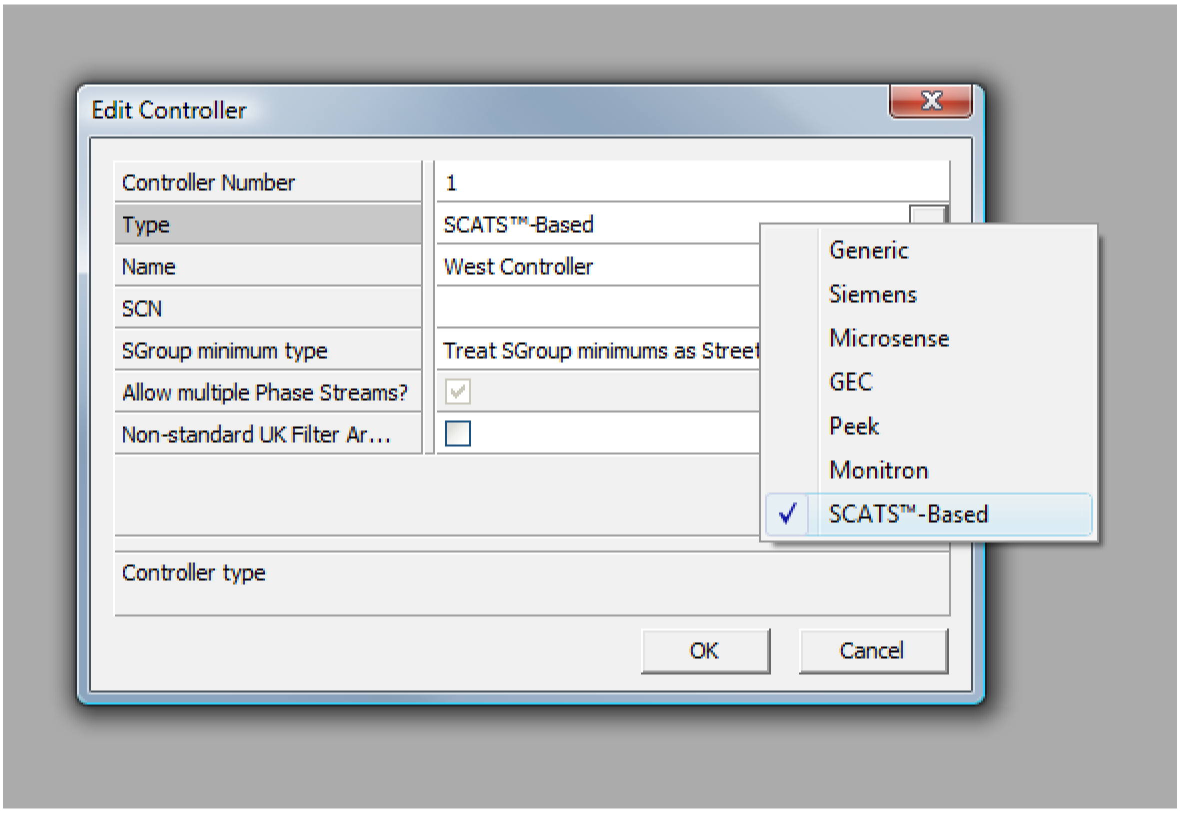
4.2.2.1. Using SCATS™-Based Controllers

When LinSig is being used in SCATS-Based Terminology mode all traffic signal controllers should be created with SCATS-Based Controller type. This will be the default when creating a new Controller when SCATS-Based Terminology mode is being used.

When an existing file created using UK mode is being converted to SCATS-Based mode Controller types should be changed to SCATS-Based using the Controller List View which can be found on the Controllers menu.

If necessary a Controllers type can be changed as follows:

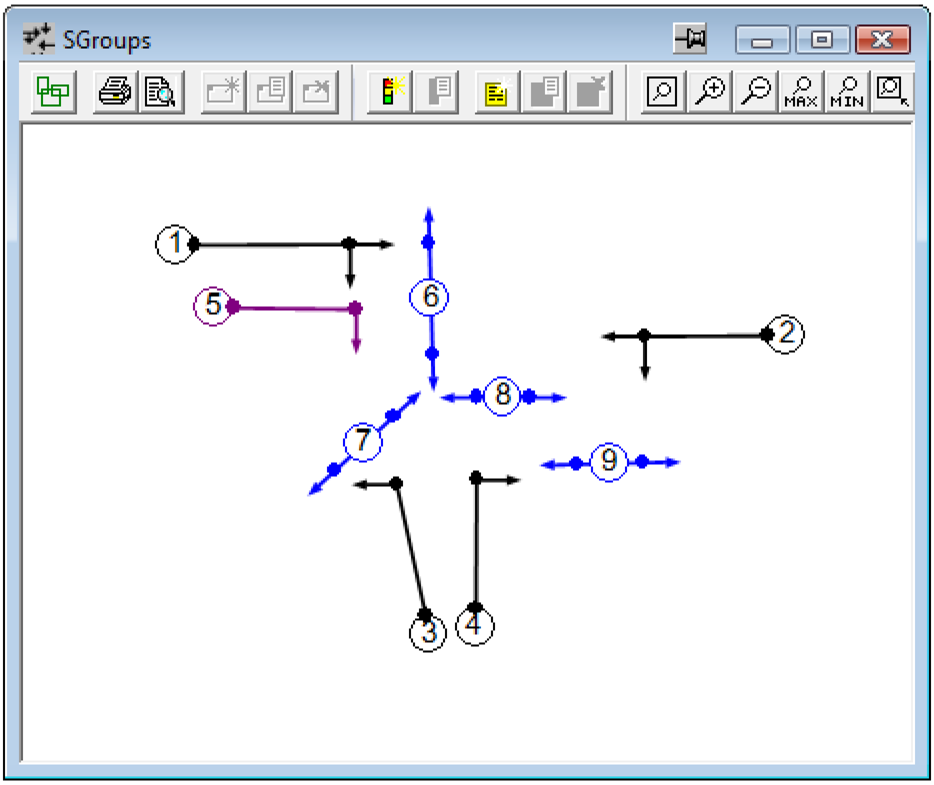
- Select a Controller in the Controller List View. The Controller List View can be opened by choosing 'Controller List View' from the Controllers menu.
- Click 'Edit' in the Controller List View to open the Edit Controller dialog box.
- Click on the Controller's type and select 'SCATS™-Based' from the list of Controller Types.



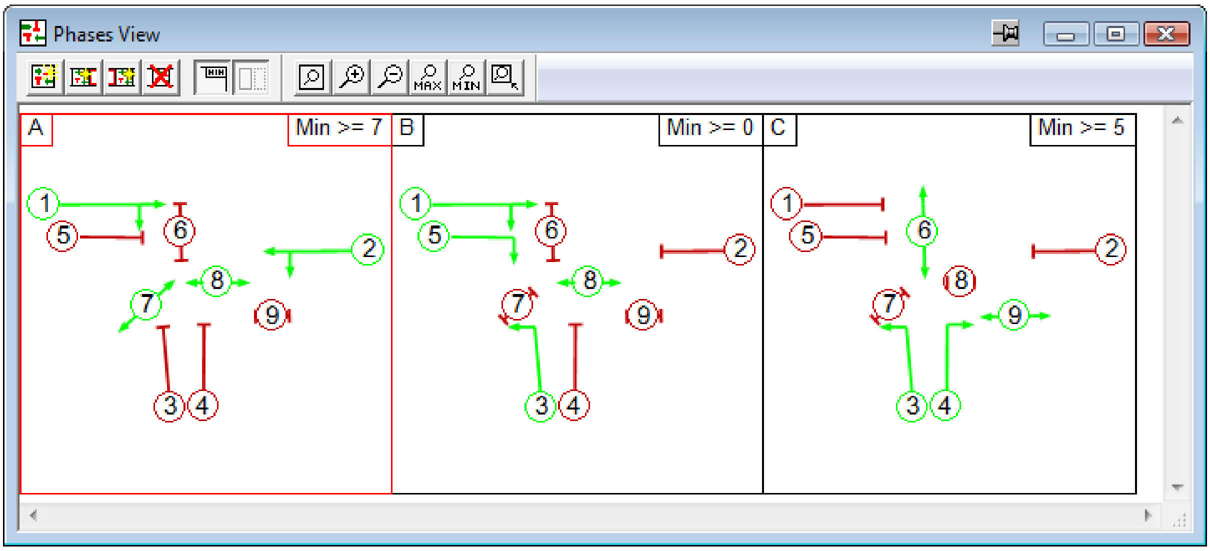
4.2.2.2. Controller Views using SCATS™-Based Terminology

When LinSig is set to use SCATS™-Based terminology mode and a Controller type is set to SCATS™-Based several Controller based views will change name and appearance to use terminology and numbering relevant to a SCATS™ Controller. These include:

- **UK Phase View becomes SGroup View.** The SGroup View shows the Signal Groups defined for a Controller. The Signal Groups are numbered.

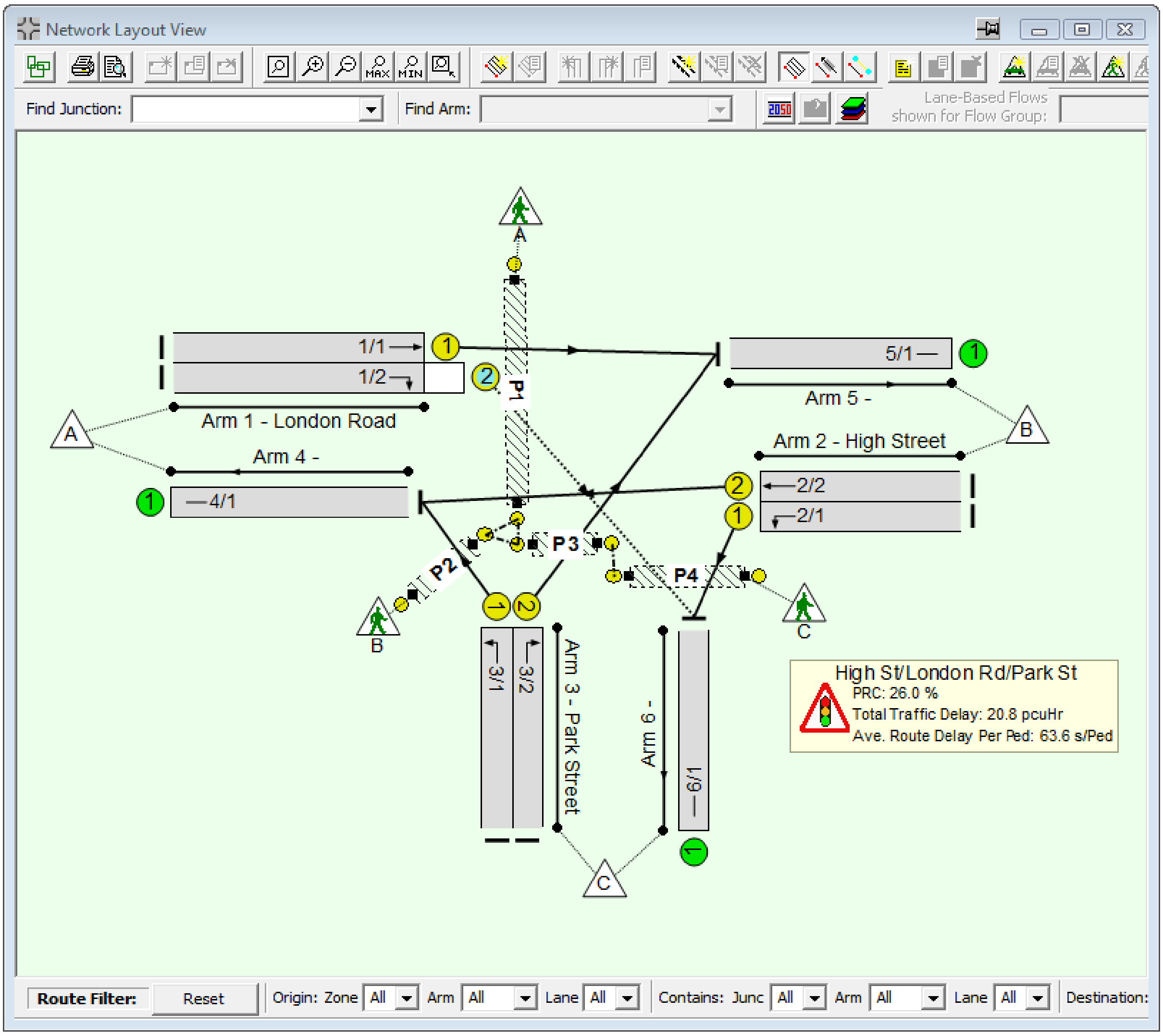


- **UK Stage View becomes Phase View.** The Phase View shows the Phases defined for each Phase Stream in a Controller. The Phases are named alphanumerically and can have alternate Phases defined.



4.3. Network Layout View

The Network Layout View is the most important View in LinSig. The View is used to build a detailed model of the Network's geometric structure and layout. This is carried out by combining components such as Junctions, Arms, Lanes and Zones to define the Junction's layout and to specify how traffic can flow through the Junction.



4.3.1. Network Building Overview

The section 'The LinSig Modelling Process' in the 'LinSig Basics' chapter describes a suggested sequence of steps for building a LinSig model. The Network Layout View is used for a number of steps in this process. The key tasks carried out in the Network Layout View are:

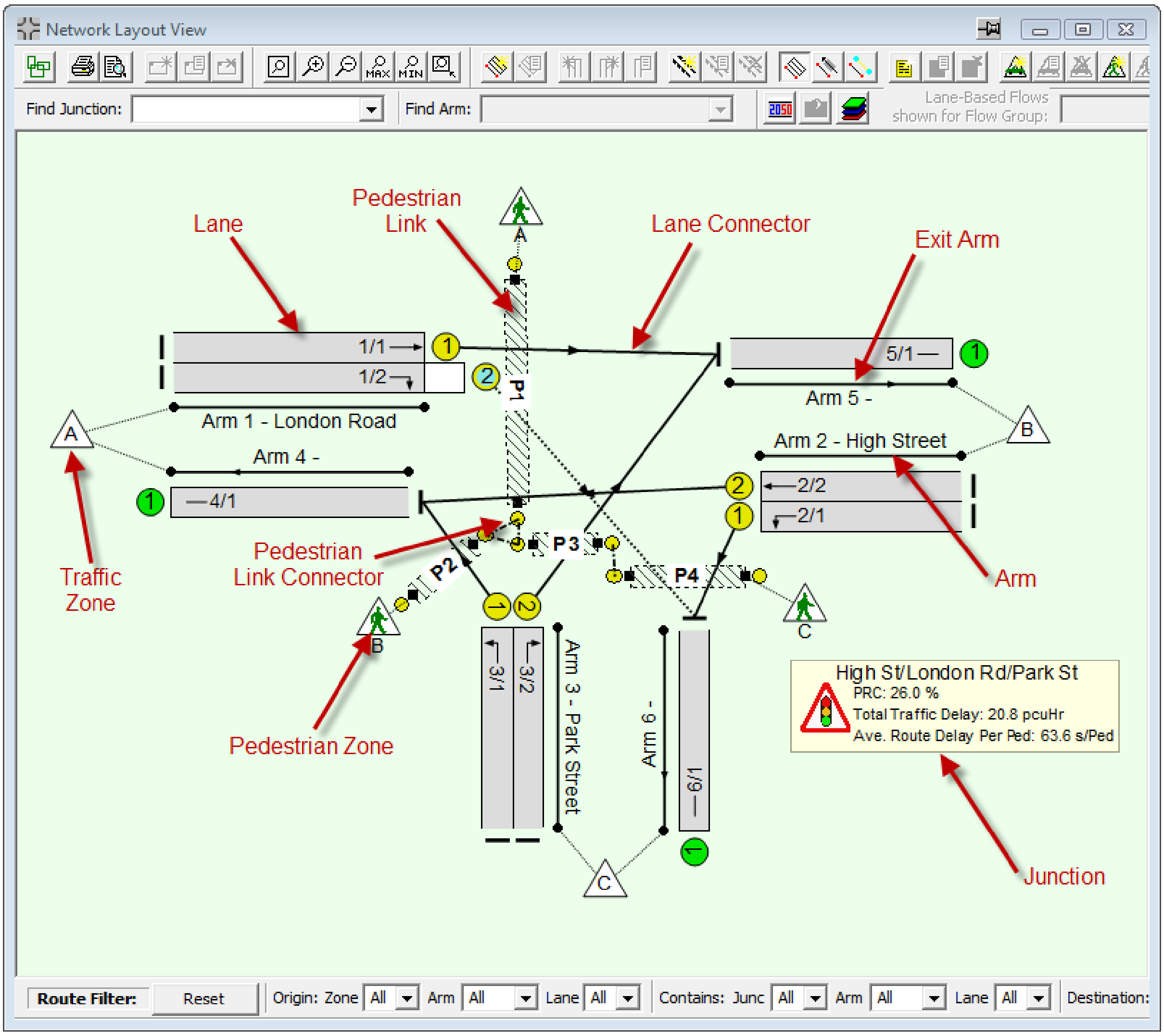
- Create LinSig Junctions for each real Junction.
- Add Arms to each Junction to reflect the Network Structure. The Network Arm Structure described below is recommended.
- Add Lanes to each Arm to reflect the Lane layout within each Junction.
- Join Lanes on different Arms using Lane Connectors.
- Edit Lanes to set Saturation Flows and give-way settings.

- If using a Matrix Based Flows add Zones to define the entry and exit points for the Network.
- If using Lane Based Flows specify flows using the drag and drop interface to drag flows around the Network.
- Create LinSig Controllers using other Views before returning to the Network Layout View to specify each Lane's controlling Phase(s).
- Create a Pedestrian Network for each Junction as desired.
- Use the Network Layout View to display results as text and profile graphs.

This section describes how to use the Network Layout View to carry out the above tasks.

4.3.2. LinSig Network Structure

LinSig uses Junctions, Arms, Lanes, Lane Connectors and Zones to describe a traffic Network. A parallel Pedestrian Network can also be modelled within the same model using Pedestrian Links, Pedestrian Link Connectors and Pedestrian Zones.



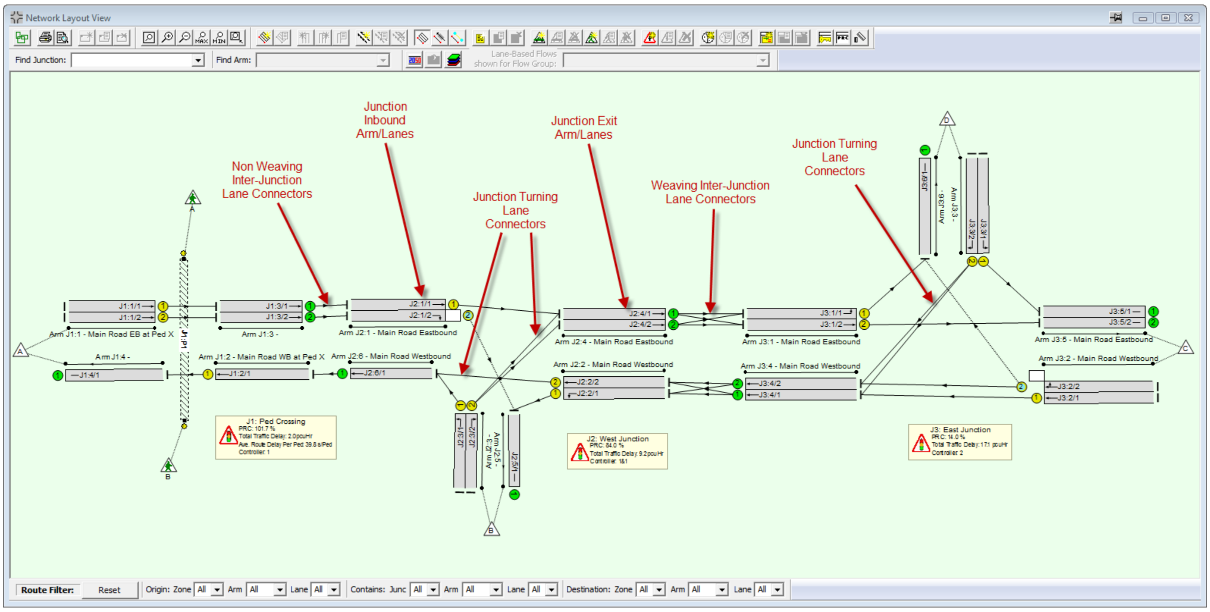
The roles of these key items are described in Definitions in section 2.1.

4.3.2.1. Recommended Network Structure

A LinSig Network's Arms and Lanes can be structured in any way desired however the following describes a recommended structure for Networks. LinSig does not require or enforce this structure but sticking to the structure will make Networks more consistent, easier to understand and visually tidier.

The key elements of this structure are:

- **Junction Inbound Arms/Lanes.** These are the Arms & Lanes on which traffic approaches a Junction's stop line and which model capacity at the stop line.
- **Junction Exit Arms/Lanes.** These Arms & Lanes are used purely to assist with Network structure and do not need to model capacity, queues or delays. The Lanes should be modelled with unconstrained (infinite saturation flow) Lanes and with a nominal length of 1 PCU.
- **Junction Turning Lane Connectors.** The Junction Turning Lane Connectors are used to represent the turning movements within the Junction. The cruise time allocated to these connectors should be the time traffic takes at turning cruise speed from the stop line of the Lane on which it enters the Junction to the point it leaves the Junction. This will usually be 2-10 seconds for a typical size of signal junction.
- **Inter-Junction Lane Connectors.** The Inter-Junction Connectors represent the road between the exit from one Junction (the exit point being the upstream Junction's Exit Arm) to the next Junction's stop line. Remember that cruise times for the whole distance are specified on the Lane Connectors not the Lanes. The cruise time allocated to these Lane Connectors should be the time traffic takes at cruise speed from the exit of the upstream junction to the stop line of the downstream junction.



Recommended Network Structure

Modelling Lane Changing (Weaving) between Junctions

In many networks of closely space signal junctions, there is little opportunity for traffic to change lanes between junctions. In fact, in many cases it is good practice to try to design the networks lane structure to minimise the need for traffic making disruptive lane changes. There is a balance to be had however, as sometimes the ability to change lanes between junctions means that traffic can distribute between lanes more evenly improving capacity.

The Inter-Junction Lane Connectors in LinSig are used to control the Lane changes allowed between Junctions.

Where no lane changing is possible, as is often the case at closely spaced junctions, Lane Connectors simply join Lanes on the previous Junction's Exit Lanes to the equivalent Lanes on the downstream Junction's Entry Lanes.

Where lane changing can take place additional diagonal weaving connectors are used to represent traffic changing lanes between junctions. In Matrix Based Network regions this will create additional Routes which provide LinSig's assignment procedure with more scope to balance traffic between Lanes.

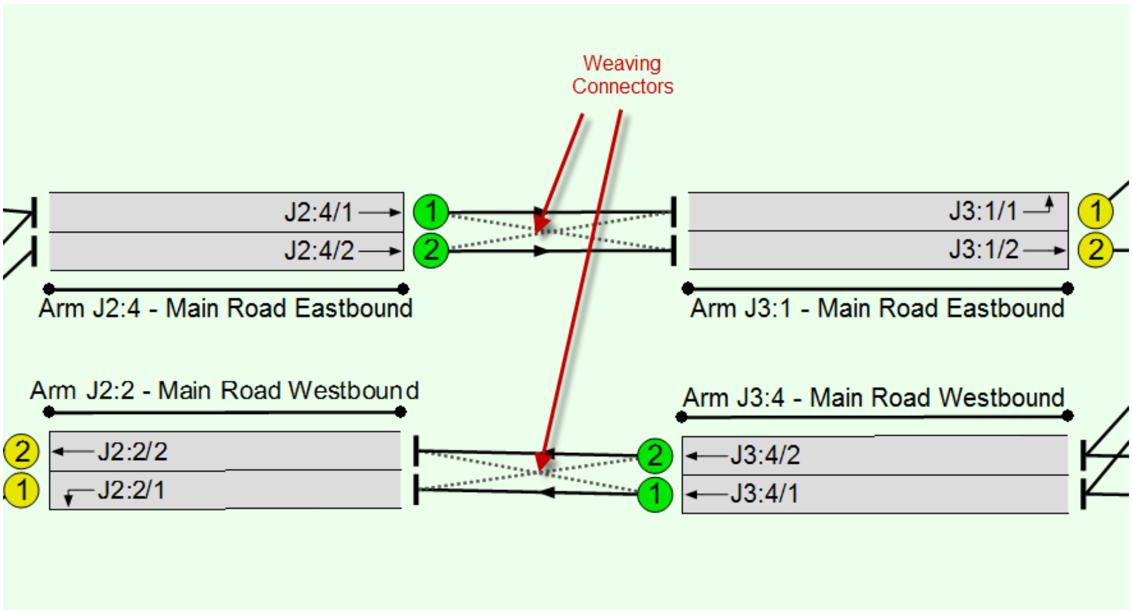
Avoiding Excessive Weaving

Care should be taken with the modelling of weaving as excessive use of weaving connectors can create very large numbers of Routes in Matrix Based Network regions many of which are not strictly necessary. These excessive Routes can significantly slow down optimisation and assignment within LinSig. Often the excessive Route numbers are due to LinSig creating Routes which weave backward and forwards between Lanes many times along a corridor. Unfeasible Routes can be quickly located and marked as non-permitted using the Route List View. This will prevent LinSig from incorrectly assigning traffic to them and also significantly speed up the model.

Automatic Identification of Excessive Weaving Routes

LinSig 3.1 introduces a new method of automatically identifying Routes which excessively weave backwards and forwards between Lanes. This can be used as follows:

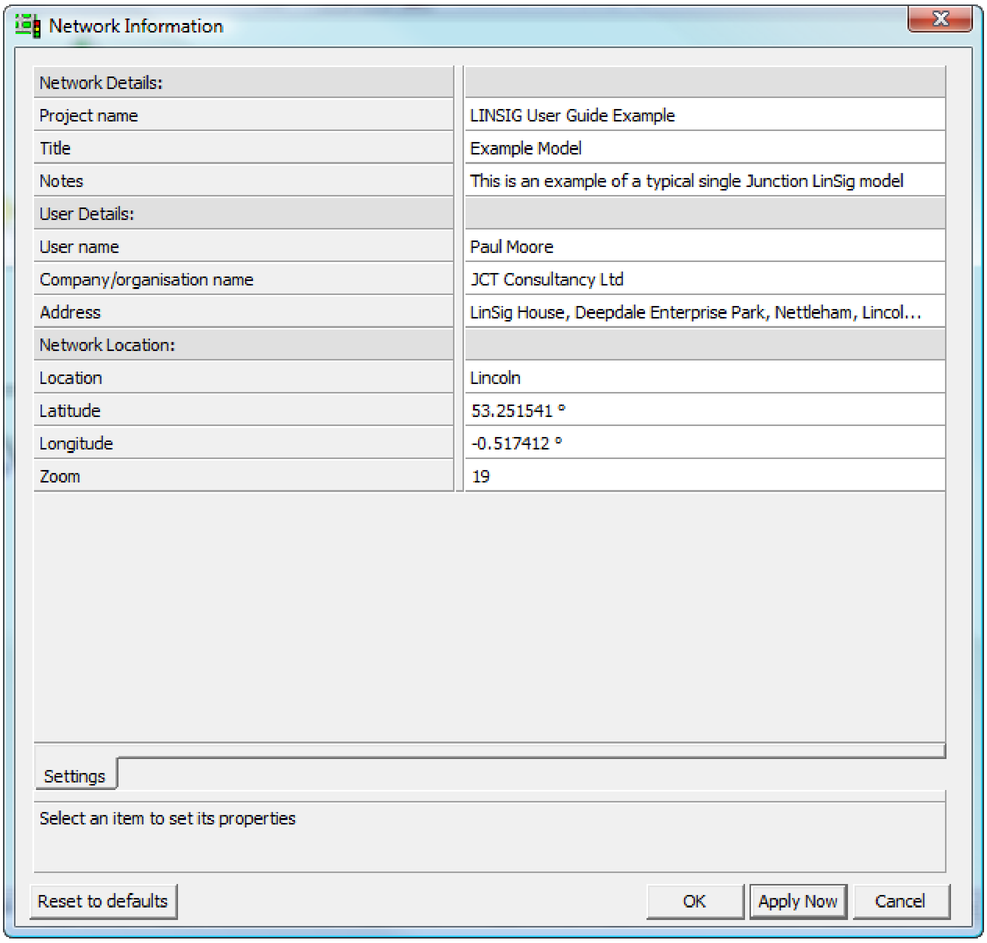
- In Network Settings check that the option 'Allow use of Weaving Connectors' is selected.
- On each Lane Connector which carries weaving traffic set the 'Mark as Weaving Connector' option in the Edit Lane Connector dialog box. Weaving Lane Connectors are shown dotted.



- Set a weaving penalty (sec per PCU) in the assignment options dialog box. This penalty is added to the assignment journey time of all traffic using this connector. This acts as a deterrent for traffic using this connector and discourages traffic from choosing Routes containing a high proportion of Weaving Lane Connectors. The weaving penalty only effects the journey time used for assignment purposes and does not affect any reported journey times or delays.

4.3.3. *Specifying Network Information*

Information regarding the Network being built can be entered using the Network Information dialog box. This is opened by choosing ‘Network Information’ from the Network menu.



The following information can be specified:

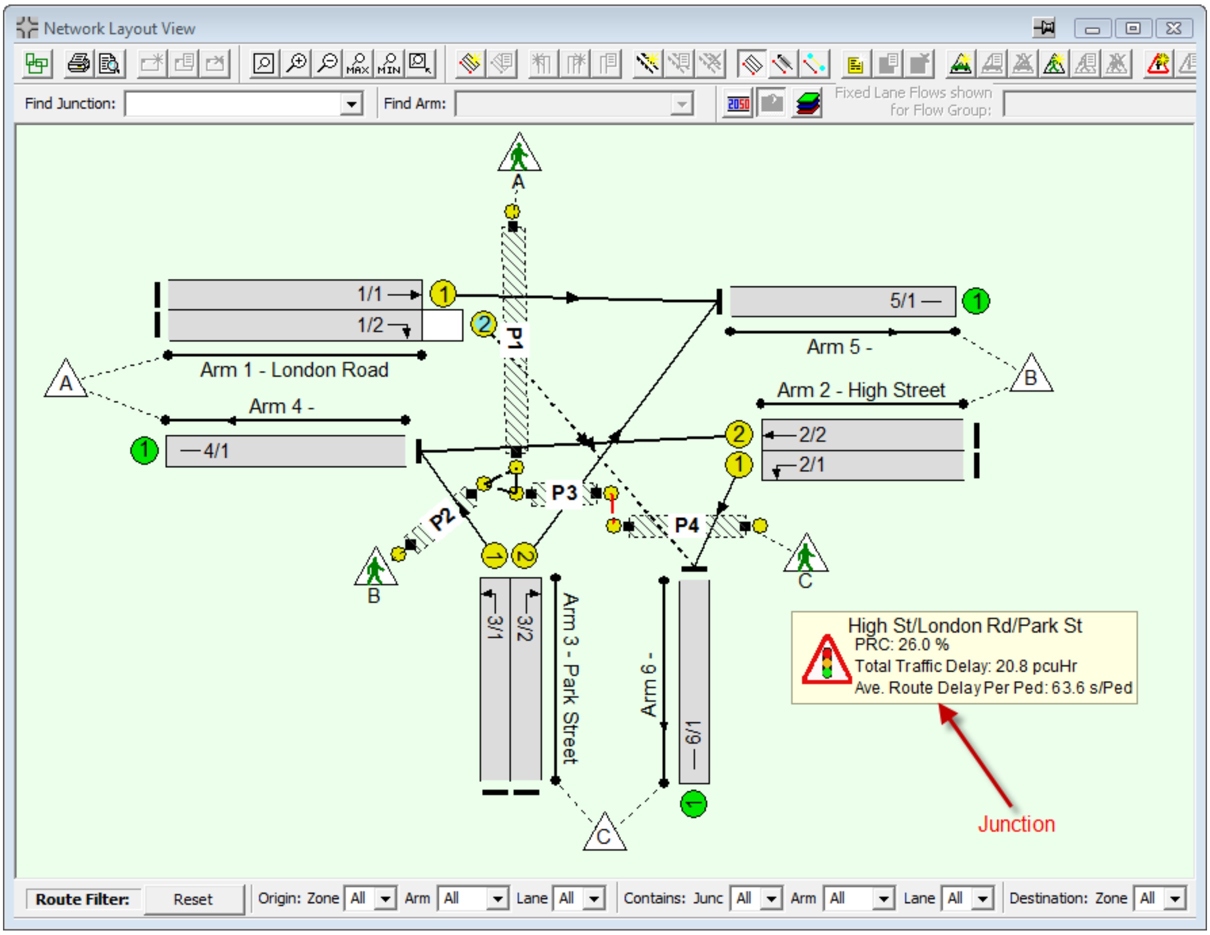
- **Project Name.** The name of the Project for which the Network is being built.
- **Title.** A title for the Network.
- **Notes.** Any general notes, for example to provide information on modelling assumptions.
- **User Details.** The Users Name, Company and Address. This can be used in reporting etc. if desired. It is recommended to set defaults for these settings using the ‘Defaults for new Files’ dialog box opened from the File menu.
- **Network Location.** The place name, Latitude and Longitude of the Networks location can be specified. This is then used by LinSig to display an aerial view of the Network’s area using Google Maps.

4.3.3.1. Displaying the Junction in Google™ Maps

If you have access to Google Maps from your computer LinSig can display Maps and/or aerial photography of the area around the Network by choosing ‘Google Maps’ from the Network menu. This will open Google Maps in your default browser and jump to the location specified in the Network Information dialog box. Please note that JCT are not responsible for the availability of this service and Google in no way endorses LinSig.

4.3.4. Working with Junctions

A LinSig Junction is a grouping of Arms, Lanes and other items which are associated with a real junction. It is used to graphically manipulate these items as a group and to structure and display results and other junction related information.



The information shown by the Junction includes:

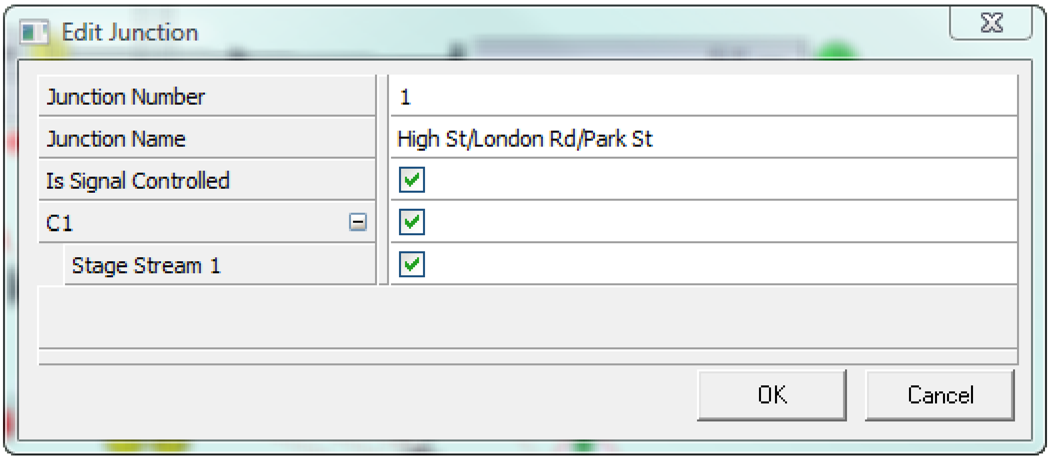
- **Junction Name.** This is a name which identifies the Junction.
- **PRC.** The Practical Reserve Capacity of the Junction.
- **Traffic Delay.** The total traffic delay on all Lanes associated with the Junction in PCUh.
- **Pedestrian Delay.** The delay per Pedestrian in secs/Ped.
- **The Junction's Controller(s).** The Controller or Controllers associated with the Junction.

4.3.4.1. Creating New Junctions

When a new LinSig file is created LinSig automatically creates a new Junction. If your model only contains a single Junction you can use this initial Junction and there is no need to create any further Junctions. Where your model contains several Junctions additional Junctions can be created as follows:

- Choose 'Add Junction' from the 'Junctions' pop-out menu on the Network menu. A new Junction will be created which can be dragged into its desired position and dropped by clicking with the mouse.

- When the Junction is dropped the Edit Junction dialog box will be displayed. This allows the Junction's settings to be entered.



- The following settings are available for the Junction:
  - **Junction Number.** The Junction Number will default to one more than the maximum Junction Number of the existing Junctions. Junctions can be numbered in any order but all Junction Numbers must be used with no gaps in the sequence. If the new Junction is allocated the same number as an existing Junction the new Junction will be inserted into the Junction numbering sequence and higher numbered Junctions renumbered.
  - **Junction Name.** A descriptive name for the Junction.
  - **Is Signal Controlled Setting.** This setting specifies whether Controller and Stage Stream associations in the next two settings can be specified for this Junction.
  - **Junction Controller.** This specifies the traffic signal controller(s) which control the Junction. Normally a Junction will only be controlled by a single Controller, however in rare cases a large or complex junction may be controlled by two or more Controllers.
  - **Junction Stage Streams.** In some cases a Junction may be operated by only one of the Stage Streams running on a Controller. In this case only the Stream(s) controlling this junction should be selected.
- Click 'OK' to finish creating the Junction.

Remember that Junctions and many other Items can also be added using right click pop-up menus as well as from the main menu. This may be quicker in some circumstances.

4.3.4.2. Moving and Repositioning Junctions

Junctions can be manipulated as follows:

- Select a Junction with the mouse. The Junction outline turns red indicating the Junction is selected and LinSig indicates which Arms belong to the selected Junction.
- The selected Junction can be dragged with the mouse to move the Junction and its associated Arms, Lanes etc.

- If the **SHIFT** key is held down whilst dragging the Junction the Junction can be moved independently of its Arms, Lanes etc.

4.3.4.3. Editing Junction Settings

A Junction's settings can be edited by selecting the Junction and choosing 'Edit Junction' from the Junction pop-out menu on the Network menu. This will open the 'Edit Junction' dialog box. Junction settings can then be edited as described above in 'Creating New Junctions'.

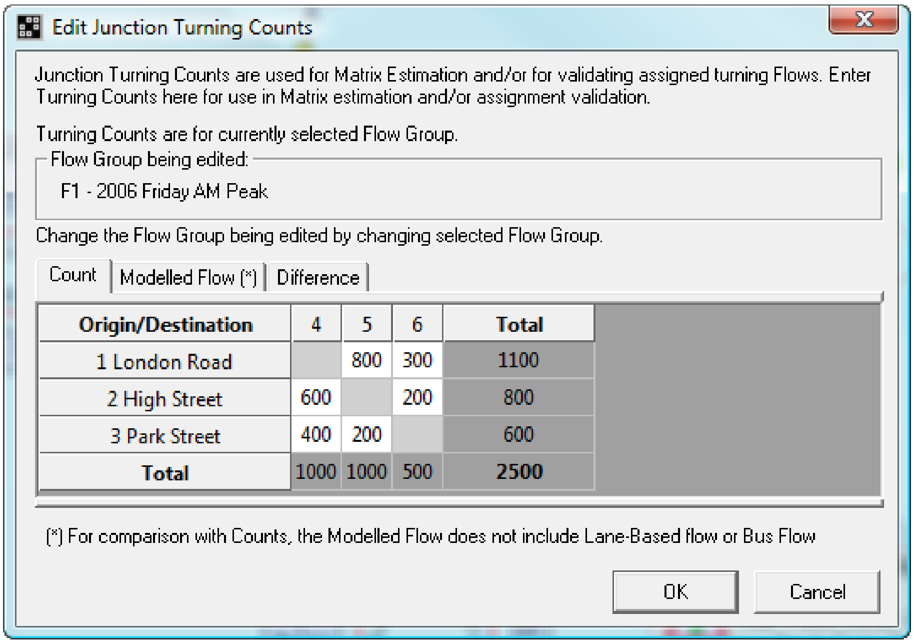
4.3.4.4. Editing Junction Turning Counts

Traffic Turning Counts in LinSig can be used for the following purposes:

- Estimating a Traffic OD Matrix.
- Validating a traffic assignment.

If neither of these processes is being carried out it is not necessary to enter Turning Counts.

Traffic Counts are entered using either a turning count matrix for a Junction or using the Matrix Estimation View.



A Junction's Turning Count Matrix can be edited as follows:

- Select a Junction with the mouse.
- Right click on the Junction and choose 'Edit the Junction's Turning Counts' from the pop-up menu. The Edit Turning Counts dialog box will open.
- In the Edit Turning Counts dialog box ensure the 'Desired' tab is selected. This tab allows the desired Turning Counts measured on site to be specified in PCU.
- As many or as few counts as desired can be entered however more counts will provide better matrix estimates and more robust validations.

The use of the 'Modelled Flow' and 'Difference' tabs to compare counts and assigned flows is described in more detail in the Matrix Estimation View section.

Inter-Junction Traffic Counts

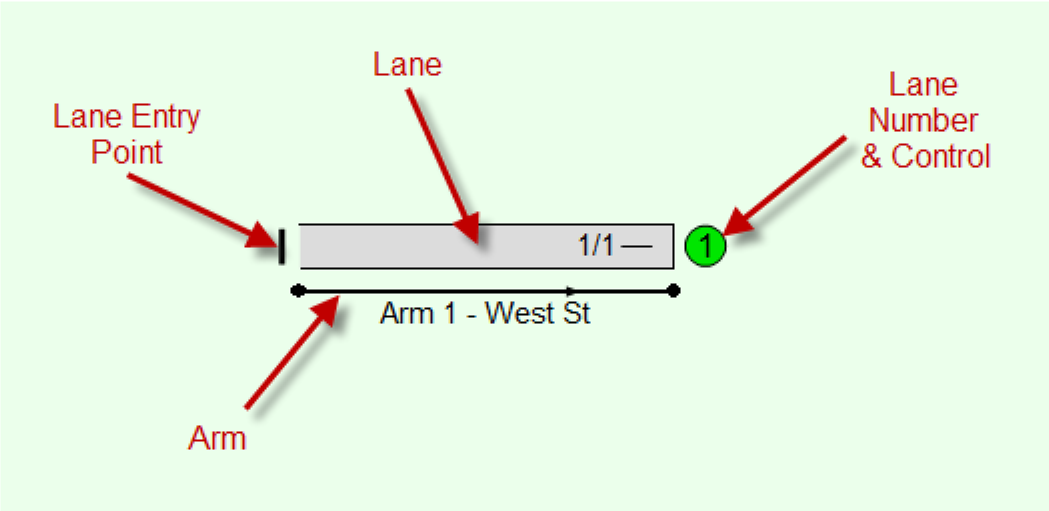
The Junction Turning Count Matrix by default only shows Turning Counts between Arms belonging to the same Junction. This is the normal recommended usage of Turning Counts where Junction Exit Arms have been specified. For Networks imported from previous versions or those with unusual geometries it may sometimes be necessary to enter a Count between two Arms at different Junctions. To display Turning Counts between different Junctions in the Junction Turning Counts Matrix the ‘Show Junction to Junction Counts’ option should be selected. This is located in the Graphic Options tab of the Graphics Settings dialog box which is opened from the File menu.

4.3.4.5. Deleting a Junction

A Junction can be deleted by selecting the Junction with the mouse and choosing ‘Delete Junction’ from the Junction pop-out menu. Deleting a Junction also deletes all items associated with the Junction such as Arms, Lanes, Lane Connectors, graphs etc.

4.3.5. Working with Arms

An Arm in LinSig is a one-way section of road forming part of the LinSig Network. Arms take no part in modelling and are principally for grouping Lanes to allow them to be graphically manipulated as a single unit. Arms always contain at least one Lane. The figure below shows a typical Arm just after it has been created and contains only a single Lane which is not yet connected to anything else. The colour of the Lane number circle shows how the lane is controlled as described in the Lanes section below.



4.3.5.1. Creating New Arms

New Arms can be created in the Network Layout View as follows:

- Choose 'Add Arm…' from the 'Arms' pop-out menu on the Network menu. A new Arm will be created which can be dragged into its desired position and dropped by clicking with the mouse. If necessary the Arm can be rotated and repositioned more accurately after it has been created as described below in 'Moving and Repositioning Arms'.
- When the Arm is dropped the Edit Arm dialog box is displayed. This allows the Arm's settings to be entered.

- The following settings are available for an Arm:
  - **Arm Number.** The Arm Number will default to one more than the maximum Arm Number of the existing Arms. Arms can be numbered in any order but all Arm Numbers must be used with no

gaps in the sequence. If the new Arm is allocated the same number as an existing Arm the new Arm will be inserted into the Arm numbering sequence and higher numbered Arms renumbered.

  - **Junction.** The Junction the Arm belongs to. The Junction is used to group Arms and other Junction related items so that they can be moved as a group rather than one by one. The Junction is also used to organise Network input data and results.
  - **Arm Name.** The Arm Name is a simple text name to describe the Arm. Usually this will be the road name of the street the Arm represents.

- Click OK to finish creating the Arm.

4.3.5.2. Moving and Repositioning Arms

Arms can be freely positioned using the mouse as follows:

- Select the Arm with the mouse. The Arm turns red indicating it is selected.
- Use the circular 'handles' at each end of the Arm to reposition the Arm. The direction of traffic on the Arm is indicated by the arrow on the Arm.
- If you have a number of Arms which you want to move together, for example all the Arms at a Junction, they can be moved by dragging the Junction rather than one by one.

Tip: To assist with positioning graphical Items LinSig can display a grid and snap the cursor to the grid when dragging. The grid is controlled from the View menu. The grid size is controlled on the 'Graphical Settings' tab of the File Settings dialog box which is opened from the File Menu.

4.3.5.3. Editing Arm Settings

An Arm can be edited by selecting the Arm with the mouse and choosing 'Edit Arm' from the 'Arms' pop-out menu on the Network Menu. This displays the Edit Arm dialog box which can be used to change the Arm's settings as described in 'Creating New Arms' above.

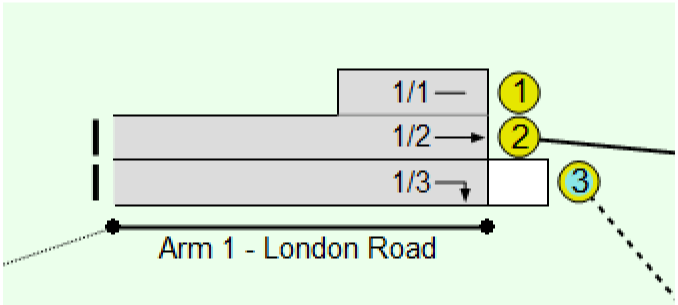
4.3.5.4. Deleting Arms

An Arm can be deleted by selecting the Arm and choosing 'Delete Arm' from 'Arms' pop-out menu on the Network menu. It is important to remember that deleting an Arm also deletes any Lanes belonging to the Arm. Undo is of course available in case of accidental deletion.

4.3.6. Working with Lanes

LinSig uses Lanes to define how road space is used on an Arm. The number of Lanes on the Arm and whether they are Long Lanes or Short Lanes is used to specify how the Arm operates.

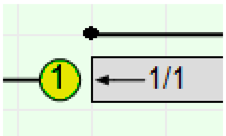
Lanes are shown in the Network Layout View as shown below.



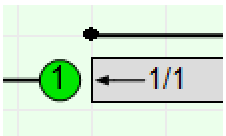
Each Lane is numbered with its number being shown in the coloured Lane number circle in front of the Lane. Lanes are always numbered from nearside to offside - that is left to right In the UK and other drive on the left regions. It is usually best to refer to a Lane as a combination of its Arm and Lane, for example Lane 1/2 refers to Lane 2 on Arm 1. Where the Network contains multiple Junctions it is necessary to also include the Junction to fully reference the Arm within the entire Network. For example Junction 3, Arm 6, Lane 2 would be referred to as J3:6/2.

Lane Type

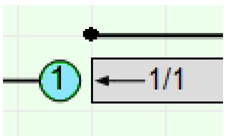
Each Lane's type is indicated by the colour of the Lane number circle. The different possible Lane types are:



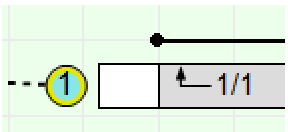
A Lane showing a yellow Lane number circle is a standard signal controlled Lane which does not give way to other traffic.



A Lane showing a green Lane number circle is an unsignalled Lane which does not give way to other traffic. They are typically used for through traffic on major roads at priority junctions and exit Lanes. This type of Lane is sometimes referred to as a 'bottleneck'. Unsignalled Lanes can either be unconstrained with effectively an infinite saturation flow or a saturation flow can be specified.



A Lane showing a blue Lane number circle is an unsignalled Lane which gives way to other traffic. They are typically used for minor arms of priority junctions and unsignalled left slips within signal junctions.



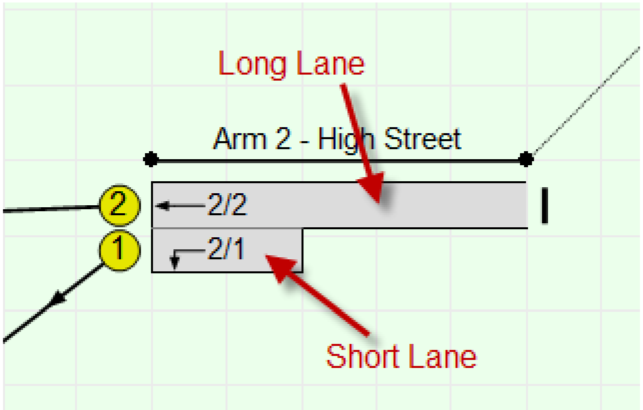
A Lane showing a yellow and blue Lane number circle is a signalled Lane which also gives way to other traffic. They are typically used for right turning lanes within a signal junction although they may also be used in more specialised situations such as signal & give-way left slips.

Each Lane also shows the possible turning movements in the Lane and also optionally display Lane input data or results as text.

Lane Length

Lanes can also be Long Lanes or Short Lanes as shown above. These are defined as follows:

- **Long Lane.** A Long Lane extends back to the previous upstream junction and can receive traffic from upstream Lanes via Lane Connectors. Long Lanes can generally supply a constant saturation flow for the full green period. As with previous versions of LinSig, and with other similar traffic models, the Cyclic Flow Profile model used in LinSig does not constrain the queue to the length of a Long Lane.
- **Short Lane.** A Short Lane only extends part of the way back to the previous upstream Junction. Short Lanes can only receive traffic from an adjacent Long Lane and cannot receive traffic directly from Lane Connectors. LinSig models the queue build up in a Short Lane constraining it to the available space. If a Short Lane fills up the queue will block back into the adjacent ahead Lane reducing its capacity.



Where signalled Short Lanes are relatively long and are unlikely to empty during a typical green period they can generally be modelled as a Long Lane which can sometimes be useful in simplifying complex Lane arrangements.

LinSig 3.1 reintroduces the ability to model simple short lanes in a similar way to LinSig 2. These are modelled in a significantly more basic way than LinSig 3 and should only be used where there is a specific reason to do so, for example compatibility with a LinSig 2 model. Further information is available in the 'Configuring Lane Settings' section.

4.3.6.1. Understanding Lanes in LinSig 3

LinSig 3 includes a range of new more detailed flare and blocking sub-models which allow LinSig to model a much wider range of standard lane arrangements, without the need for simplifying assumptions, than previous versions of LinSig or many other similar models.

The new sub-models mean that model structure is much simplified and more intuitive. For example LinSig 3 no longer uses Links to group Lanes. Generally lane geometry can be entered directly and LinSig deals internally with issues such as the interaction of short and Long Lanes, and Lanes receiving different signalling.

Whilst LinSig models a much wider range of standard lane arrangements more intuitively there are still a number of golden rules to remember when constructing a model. These are:

- Each real lane is modelled as a single LinSig Lane. Real lanes are never grouped together into a single LinSig Lane with a higher Saturation Flow as was the case with Links in earlier versions.
- A Short Lane is always associated with an adjacent Long Lane which feeds traffic into it.

- A Long Lane can only be associated with a single Short Lane. This means that situations such as a Long Lane feeding a Short Lane which in turn feeds an even shorter Lane cannot be directly modelled as such and require simplifying assumptions in a similar way to previous versions of LinSig. The need to use simplifying assumptions will be less common than in previous versions. Advice on how to model such situations is given later in this User Guide.
- A Long Lane can only have a Short Lane attached to one side. Long Lanes with a Short Lane on both sides currently also require simplifying assumptions as in previous versions of LinSig. For example, where an Arm contains a single Long Lane with a left and a right Short Lane, a lightly trafficked short right turn Lane would be modelled as a separate Long Lane allowing the left turn Lane and Long Lane to modelled with full accuracy. Alternatively if the right turn was critical the left turn Lane could be ignored, especially if very short, allowing more critical right turn issues to be accurately modelled. Advice on how to model such situations is given later in this User Guide.

Even with the above rules LinSig 3 imposes significantly less restrictions and provides more intuitive model construction than previous Link based versions of LinSig. Common situations which previously required simplifying assumptions but can now be modelled directly include:

- **Short left Lanes running on a separate Phase or filter arrow.** This common situation can now be modelled with separate signalling on the Short Lane and separate modelling of traffic on each Lane. Issues such as queuing ahead traffic preventing left turners getting to the Short Lane even though its filter arrow is running are automatically dealt with. The new models in LinSig 3 also remove the need to use LINSAT.
- **Short Opposed Right Turn Lanes.** Although LinSig 2.4 and above could model right turn bays and their effect on adjacent Lane capacity the facility was limited to a subset of special cases. LinSig 3 allows short right turn Lanes, either opposed or separately signalled unopposed, to be modelled directly and intuitively simply by defining the appropriate Lanes and specifying signalling, turning movements etc separately for the Short Lane.

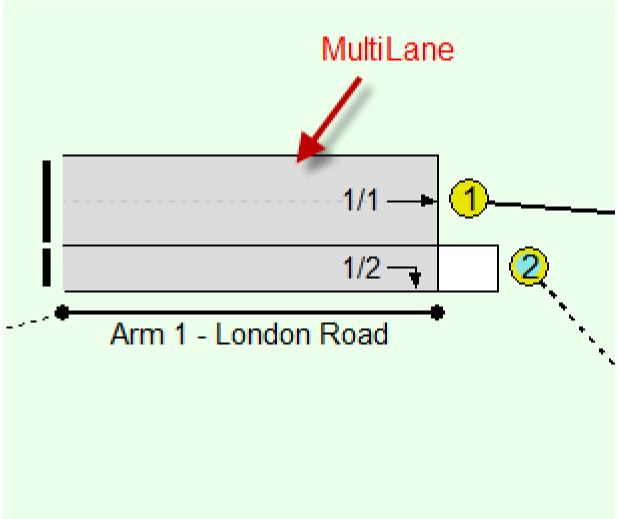
If you require any advice on how to model a particular situation please do not hesitate to contact JCT Software Support.

Short Lane Modelling and Lane Groups

LinSig 3 allows Lane arrangements to be specified in much more detail then previous versions. As described above many settings, such as Controlling Phase, which would previously have been specified for a group of Lanes via a Link can now be specified for individual Lanes. However where Short Lanes are used the Short Lane and its adjacent Long Lane will interact as traffic in one Lane may block traffic in the other Lane. For example the arrival of a large platoon of ahead traffic at the beginning of red may prevent left turners using a short left turn Lane. The interaction of the Short and Long Lanes in this way means that many results which LinSig calculates only make sense when reported for the Long and Short Lanes grouped together rather than been broken down Lane by Lane. For example it is impossible to give a capacity for a short left turn Lane alone as this will depend on the ahead Lane's characteristics and the traffic flow in the ahead Lane. LinSig will therefore report combined results for a Lane Group comprised of the Short and Long Lanes in these cases.

Modelling Short Lanes using the LinSig 2 Method

LinSig 3.1 reintroduced the ability to model short Lanes as a simple stepped saturation flow profile as was used for all short Lanes in LinSig 2. In nearly all cases the new LinSig 3 method will be superior however the old method has been included for completeness and compatibility with existing LinSig 2 models. LinSig 2 style short Lanes are edited on the 'MultiLanes' tab as detailed below. All references to short Lanes in this User Guide refer to LinSig 3 type short Lanes unless explicitly stated otherwise.



4.3.6.2. Creating and Managing Lanes

LinSig Lanes always belong to an Arm. They can be created and managed as follows:

Creating a New Long Lane

- Select a Lane adjacent to the desired position of the new Lane.
- From the 'Network…Lanes…Add Lane' menu choose 'Add Long Lane to Left' or 'Add Long Lane to Right' as appropriate.
- A new Long Lane with default settings will be created adjacent to the existing selected Lane.

Creating a New Short Lane

- Select the Long Lane which will feed traffic into the new Short Lane.
- From the 'Network…Lanes…Add Lane' menu choose 'Add Short Lane to Left' or 'Add Short Lane to Right' as appropriate.
- A new Short Lane will be created attached to the adjacent selected Long Lane. The Short Lane will have a default length which can be changed as described below.

Newly created Lanes are obviously not connected to any other Lanes yet and therefore do not show any directional arrows.

Converting a Long Lane to a Short Lane

A Long Lane can be converted to a Short Lane as follows:

- Select the Long Lane with the mouse.
- Right click on the Lane. Choose 'Convert to Short Lane with Lane on Left' or 'Convert to Short Lane with Lane on Right' as appropriate from the pop-up menu. If either menu option is unavailable it is because converting the Lane to a Short Lane would create an illegal Lane arrangement.
- LinSig converts the Lane to a Short Lane moving Lane Connectors as necessary.
- Edit the Lane to set the Short Lane length and any other settings which may be different for the Short Lane.

Converting a Short Lane to a Long Lane

A Short Lane can be converted to a Long Lane as follows:

- Select the Short Lane with the mouse.
- Right click on the Lane. Choose 'Convert to Long Lane from the pop-up menu. If this menu option is unavailable it is because converting the Lane to a Long Lane would create an illegal Lane arrangement.
- LinSig converts the Lane to a Long Lane making a intelligent guess regarding Lane Connectors. Lane Connectors should be checked and adjusted if incorrect.
- Edit the Lane to set the Lane length and any other settings which may be different for the Long Lane.

Editing Lane Settings

Each Lane has many different settings which can be edited using the Edit Lane dialog box. The Edit Lane dialog box can be opened for a Lane either by selecting the Lane and choosing 'Edit Lane' from the 'Lanes' pop-out menu on the Network menu, or by double clicking on the Lane.

A detailed explanation of Lane Settings is given below in 'Configuring Lane Settings'.

Deleting Lanes

A Lane can be deleted by selecting it and choosing 'Delete Lane' from the 'Lanes' pop-out menu on the Network Menu. If a Long Lane has an attached Short Lane the Long Lane cannot be deleted until the Short Lane has been first deleted.

Deleting a Lane also deletes the following:

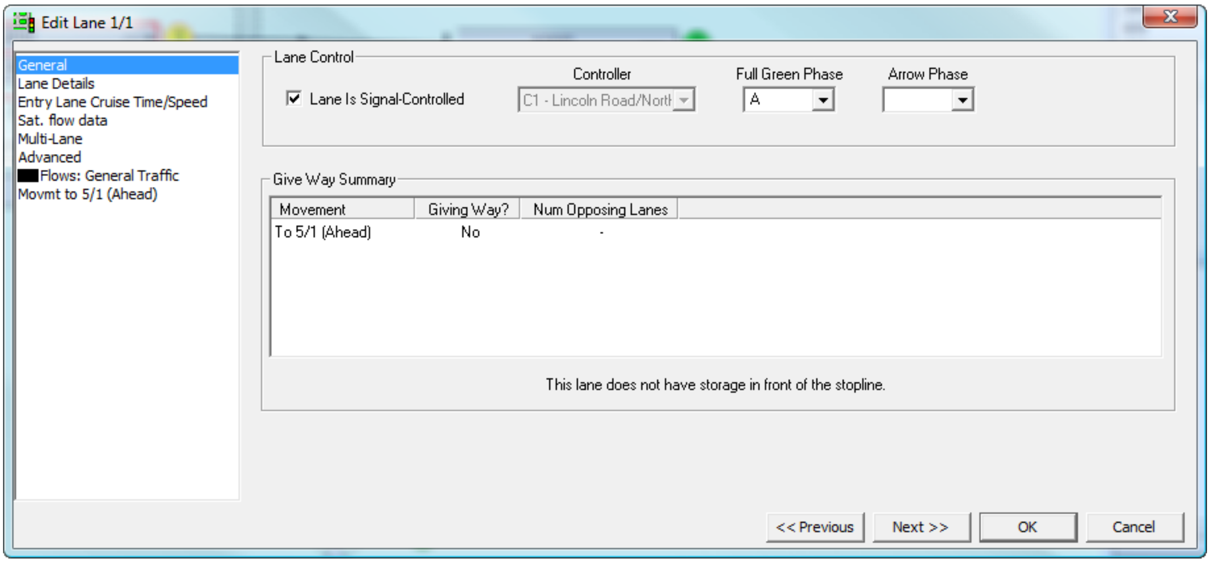
- Any Lane connectors entering or leaving the Lane.
- Any Routes passing through the Lane.
- Any Lane Based Flows defined on the Lane or its connectors.
- Any graphs or other graphical items associated with the Lane.

For a Lane in a Matrix Based Network region any traffic flow assigned to Routes through the Lane which are deleted will be lost and the Actual Flows Matrix in the Traffic Flows View will show a flow deficit reflecting this. The flow on Routes through the deleted Lane should be reassigned either to Routes through other Lanes or to Routes through any new Lanes replacing the deleted Lane. This can be done by re-running the traffic assignment by choosing 'Assign OD Flows to Routes based on current Scenario' from the modelling menu. More information is given in the section on the Traffic Flows View.

For a Lane in a Lane Based Flow Network region the flow on the Lane and its incoming and outgoing connectors will be lost. Any consequential flow inconsistencies can be viewed using the Network Layout View's Flow Consistency Mode. These can be corrected by adding flow to other Lanes to add back the lost traffic flow.

4.3.6.3. Configuring Lane Settings

Lane settings are configured using the Edit Lane dialog box. This is opened for a Lane by selecting the Lane and choosing 'Edit Lane…' from the 'Lanes' pop-out menu on the Network menu, or by double-clicking the Lane. It is advisable to specify Lane turning movements using Lane Connectors, as described below, before editing Lanes or some options such as specifying give way movements may not be available. These settings can of course always be returned to later after Lane Connectors have been added.



The Edit Lane dialog box contains a number of tabs. The available tabs for a Lane are listed on the left side of the dialog box. A tab can be selected by clicking an entry in this list.

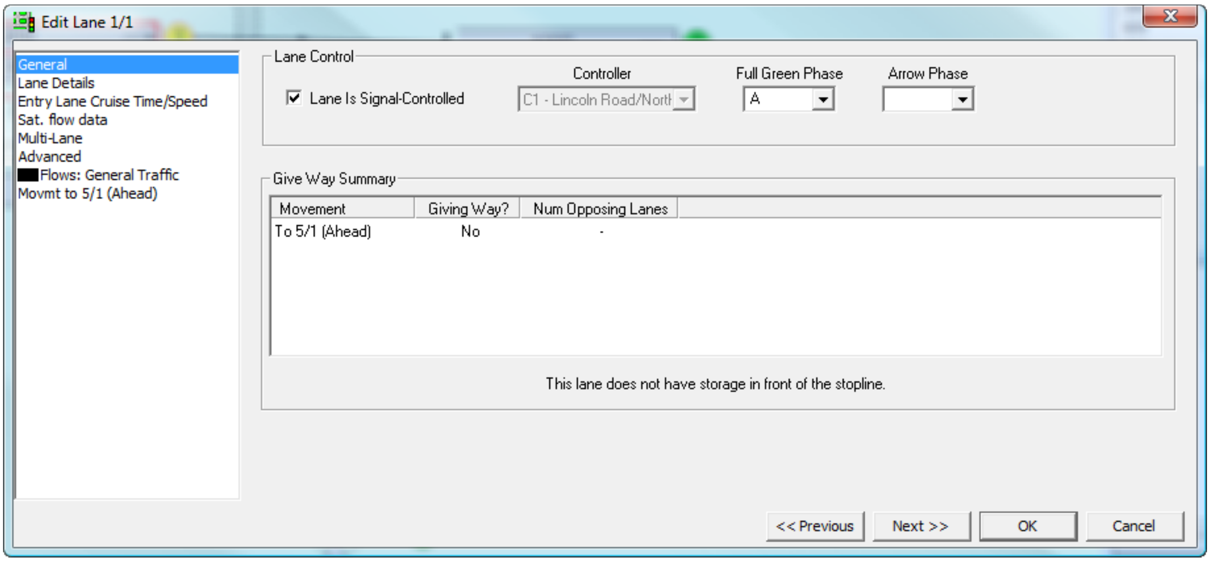
The available tabs are:

- **General.** This tab contains basic settings which apply to all Lanes.
- **Lane Details.** This tab is always available and allows more detailed settings such as Lane Length and custom Short Lane occupancies to be set.
- **Entry Lane Cruise Time/Speed.** This tab is only available for Entry Lanes at the edge of the Network. Normally cruise speeds are specified on a Lane's incoming Lane Connectors. As Entry Lanes have no incoming Lane Connectors the Entry Lane Cruise Speed/Time tab is used to specify cruise speeds/times.
- **Saturation Flow Data.** This tab is always available and allows saturation flows to be entered either directly or by estimation from lane geometry using the RR67 method.
- **MultiLane.** The MultiLane tab allows wide LinSig Lanes containing one or more identical physical Lanes to be defined. This is useful for two Lane corridors where traffic flows and lane markings mean that traffic will always share equally between the two physical lanes.
- **Advanced.** This tab is always available and includes a number of advanced settings which may not always need changing.
- **Lane Based Flow Summary.** The Lane Based Flow Summary tab is only present if Lane Based Flows are defined on a Lane with two or more Layers. This tab summarises the Lane Based Flows across all Layers and allows Layers to be managed. Details of how to use this tab are provided in the 'Working with Lane Based Flows' section below.
- **Lane Based Flow Layers.** A separate tab is shown for each Lane Based Flow Layer using the Lane. The tab allows the total flow and incoming and outgoing flows to be

specified for the layer. Note that it will normally be more convenient to use the drag and drop Lane Based Flow editing than this tab. This tab is provided principally for editing Lane Based Flow details not available through the drag and drop method. Details of how to use this tab are provided in the 'Working with Lane Based Flows' section below.

- **Movement Tabs.** A separate tab is provided for each turning movement leaving the Lane. Each tab allows settings relating to that turning movement to be set.
- **Storage in Front of Stop Line.** This tab is only available if the Lane is signal controlled and one or more movements on the Lane give-way to other Lanes. The tab includes settings relating to various bonus capacity effects applicable only to right turns at signals.
- **Non-Blocking Storage.** This tab is only available when the Lane contains a mixture of give-way and non give-way movements and is signal controlled. It is principally used for situations where an opposed right turn movement may block a non-give-way movement (usually ahead).

General Settings



The General tab contains the following settings:

- **Lane is Signalled Controlled.** Ticking the 'Lane is Signal Controlled' box specifies the Lane as a signal controlled Lane and allows the Controlling Phases to be specified.
- **Controller.** The Controller setting specifies which traffic signal controller controls this Lane. Normally this will be the Controller controlling the Junction to which the Lane belongs.
- **Full Green Phase.** The Full Green Phase is the main three-aspect phase which controls the Lane. All Lanes which are controlled by signals must have a Full Green Phase defined.
- **Arrow Phase.** The Arrow Phase applies only to Lanes that are controlled by a filter or Indicative green arrow (IGA) as well as a main three-aspect phase. The Arrow Phase can only be entered if a Full Green Phase is specified and the Full Green Phase is the associated Phase of a Filter or IGA Phase. The LinSig traffic model will take into account which Phase is controlling the Lane at each point in the cycle. Remember that LinSig only enforces the standard rules for using Filter and Indicative

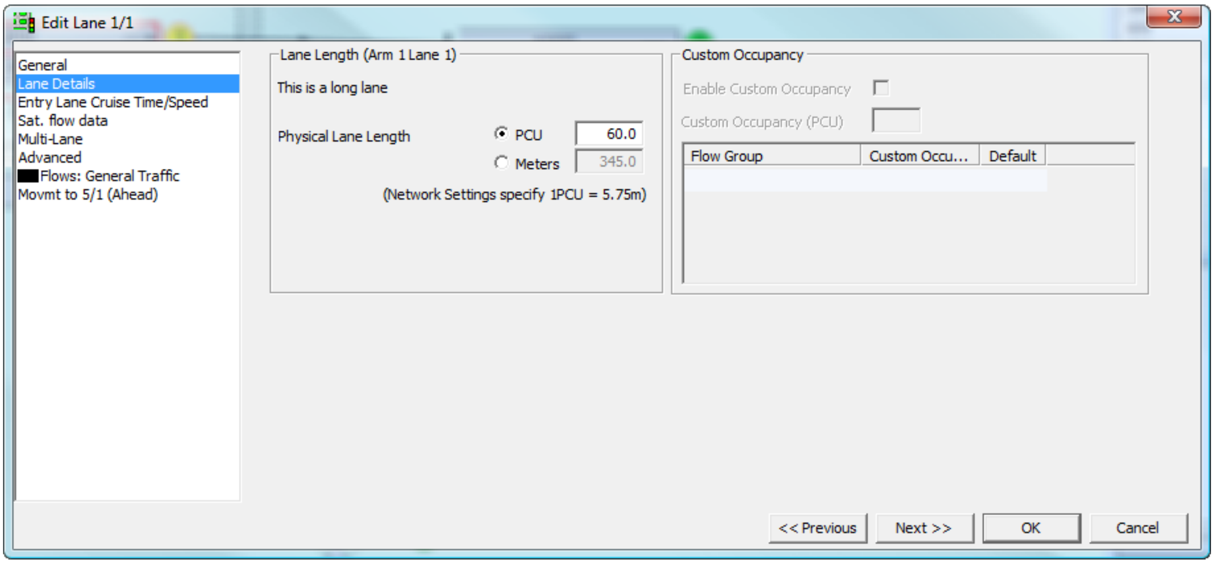
arrows. It does not prevent them being used in a technically correct but unsafe or badly designed way.

The Arrow Phase is used slightly differently when the special non-UK Filter with Closing Amber Phase is used. In this case the non-UK Filter Phases does not have an associated Phase specified therefore the Arrow Phase does not check for the Full Green Phase being associated with the Arrow Phase.

- **Give Way Summary.** The Give-Way Summary lists the different turning movements exiting the Lane and summarises which movements give way to other Lanes. Further give-way details are contained on each movement's individual tab in the Edit Lane dialog box.

Lane Details

The Lane Details tab contains a number of settings relating to detailed Lane settings such as Lane Length and custom Lane Occupancy.



Setting the Lane's Length

As discussed above in 'Working with Lanes' a Lane can be regarded as either:

- A Long Lane if it extends back to the previous junction or is long enough that it will not empty during the longest expected green period. In this case the Physical Lane Length setting is the length back to the previous Junction. If you are using Exit Arms at the previous Junction remember to allow for the length of the Lanes on the Exit Arm. Generally it is recommended that Exit Arm Lanes are given a very short nominal length with most of the length being allocated to the Junction Entry Arm.

- A Short Lane, or Flare, if it will empty during the green period and will therefore no longer run at full saturation flow. The Physical Length setting in this case is the number of PCU's able to use the Lane if it is fully occupied.

In both cases the Lane's Length can be specified in PCUs or meters. If a Lane Length is specified in meters the PCU Length specified in 'Network Settings' on the Network menu will be used to calculate the Lane's Length in PCU.

Setting Custom Lane Occupancies

Normally LinSig will always attempt to make full use of a Short Lane subject to blocking by other adjacent Lanes. This is normally sufficiently accurate, however in some more unusual situations or in cases where site conditions indicate this assumption is not correct it is possible to specify custom occupancies for each Short Lane.

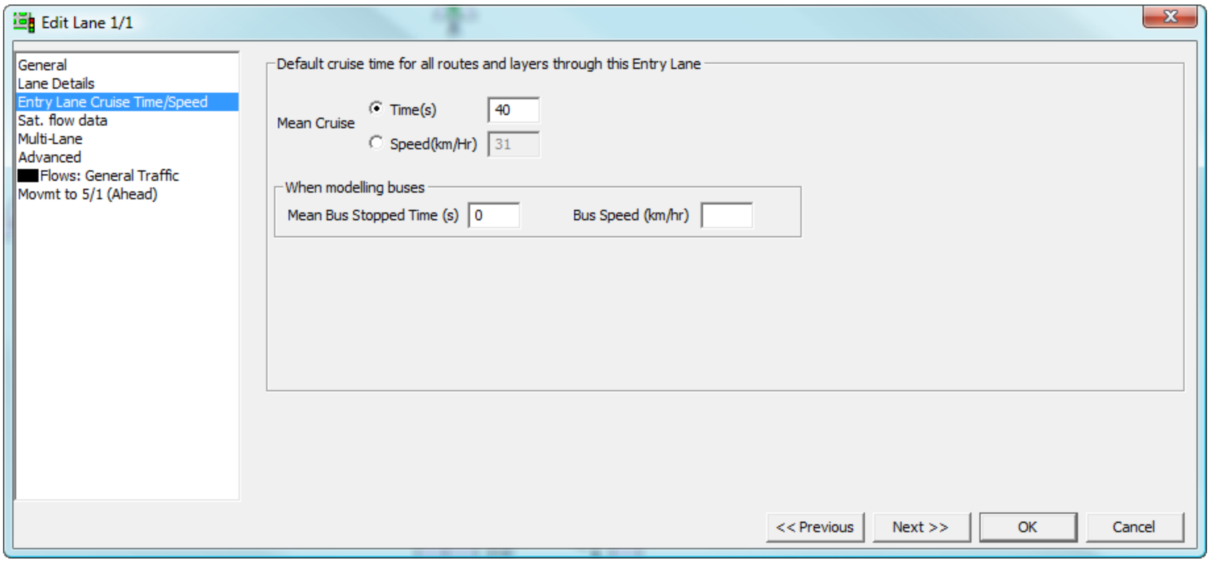
In LinSig 2 it was possible to specify Expected Usage for a Short Lane. This allowed situations such as short left turn only Lanes to be modelled more accurately by restricting the average expected usage of the Short Lane to a lower value than its physical length. This was necessary in some case to reflect the fact that traffic in the Long Lane may prevent turning traffic from filling up the flare leading to partial flow starvation. The external free tool LINSAT was often used to estimate the expected usage in many common situations.

LinSig 3's new traffic model automatically takes into account many of the issues which previously required Expected Usages to be set, however, some flare modelling situations may still arise in which it is useful to be able to override the amount of traffic using the Short Lane. LinSig 3 therefore allows custom occupancies to be set. Where a custom occupancy is specified for a Lane it will be used instead of the Lane's physical length in all modelling. **Remember custom occupancy is NOT the same as Expected Usage in LinSig 2.**

The Lane's Default Short Lane Occupancy is used for all Flow Groups unless a custom value if specified for a particular Flow Group.

Entry Lane Cruise Speed/Time

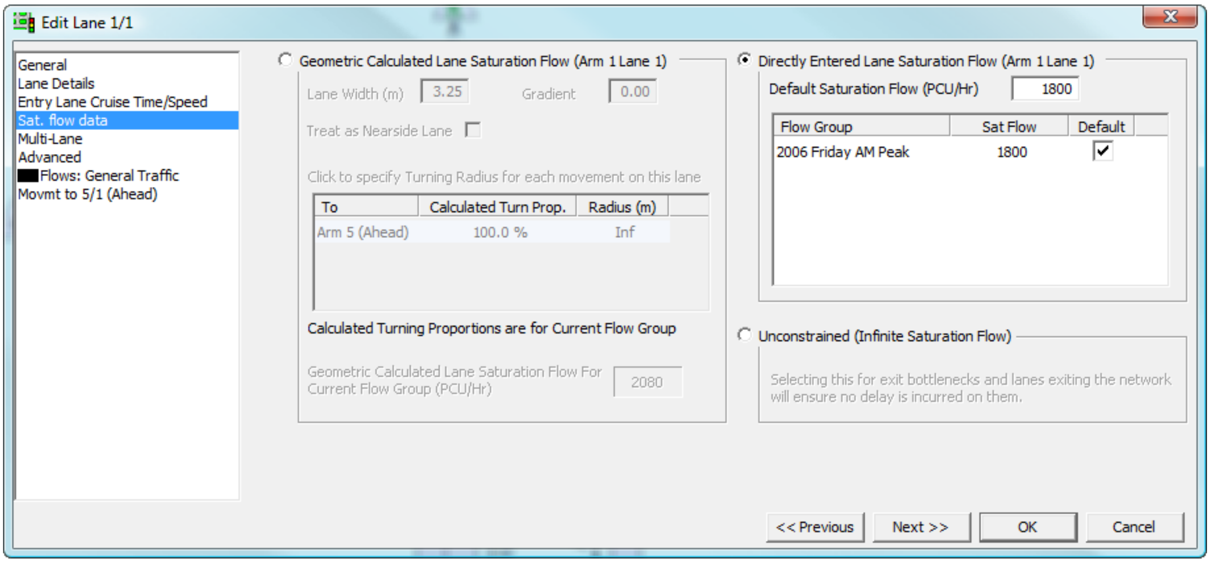
The Entry Lane Cruise Speed/Time tab allows cruise speeds/times to be specified for an Entry Lane at the edge of the Network. Normally cruise speeds are specified on a Lane's incoming Lane Connectors. As Entry Lanes have no incoming Lane Connectors the Entry Lane Cruise Speed/Time tab is used to specify cruise speeds/times.



The cruise speed/time and other settings are specified in the same way as on a Lane Connector. Further details are given in the Edit Lane Connector section.

Saturation Flow Data

The Saturation Flow Data tab allows saturations flows to be specified for the Lane.



Lane Saturation Flows can be specified manually or can be calculated from a Lane's geometry using the formulae published in the TRRL report RR67. Saturation flows are always specified in Passenger Car Units (PCU) in LinSig.

Although using saturation flows calculated from geometry may seem like an easy option, it is recommended that wherever possible at least a brief saturation flow survey is done for an existing junction. The RR67 formula, although a good starting point, does not allow for all significant factors when estimating saturation flow. For example, no allowance is made for regional variations in saturation flow leading to the same estimate for Central London and rural Lincolnshire. Additionally the data underlying RR67 was collected over 20 years ago and traffic conditions may well have changed significantly in the mean time. Before using saturation flows calculated from geometry in LinSig it is advisable to obtain and read RR67 and satisfy yourself that the methodology used is acceptable.

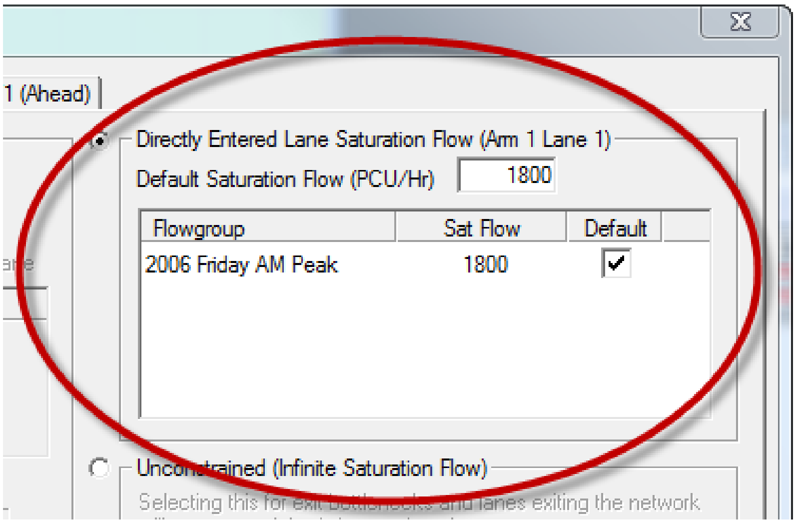
It is good practice to consult the Local Authority Traffic Signals Department for a junction's location as most will have considerable local knowledge as to what constitutes an acceptable estimate of saturation flow for similar junctions in the area.

If you choose to use RR67 saturation flows please bear in mind that as queue predictions are very sensitive to inaccurate saturation flows, the possibly small differences between estimated and true saturation flows can lead to potentially much more significant differences between modelled and surveyed queues.

It is not recommended to use RR67 for estimating saturation flows for signalled roundabout circulatory Lanes as the closely spaced entry and circulatory stop lines often affect each other's effective saturation flow. Modelling an entry saturation flow that is higher than the immediate downstream circulatory saturation flow will often lead to inaccurate modelling of queuing on the circulatory lanes. See Sliver Queues for more information.

Specifying Lane Saturation Flows Manually

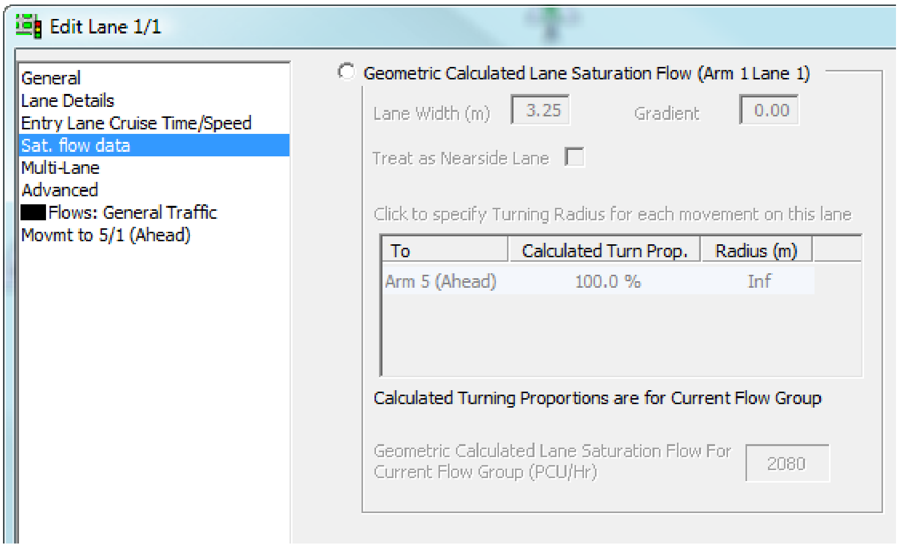
Lane Saturation Flows are entered manually by selecting 'Directly Entered Lane Saturation Flow' in the Edit Lane dialog box and entering a default saturation flow rate in PCU/Hr. If desired a different saturation flow for each Traffic Flow Group can be specified by unticking 'Default' in the Flow Group List below the Default Saturation Flow and specifying a custom Flow Group specific value.



Saturation Flows can also be edited using the Lane Grid Data View which is often faster to use when changing a number of saturation flows.

Calculating Lane Saturation Flows from Lane Geometry

As discussed above LinSig uses an extended version of the formulae from TRRL report RR67 to calculate saturation flows from Lane Geometry. Geometric parameters for the Lane and for each turning movement out of the Lane are required.



The Lane based geometric parameters are:

- **Lane Width(m)**. The Lane width.
- **Gradient(%).** The Lane's gradient. Only uphill gradients have an effect on the saturation flow. Downhill gradients do not adjust the saturation flow upwards.
- **Treat as Nearside Lane.** This setting reduces the saturation flow by 140 PCU/hr due to the 'frictional effect' of potential hazards (such as gutters or pedestrians stepping out) in the near side Lane. There is debate on whether this setting should be used for the right most lane of a multi-laned stop line where it could be argued there is also a frictional effect on traffic. RR67 gives some guidance on this but if in doubt it is conservative to apply the reduction by setting the Lane as a near-side lane.

LinSig allows turning parameters to be defined for each Lane Turning Movement which are based on Lane Connectors exiting the Lane.

The Turn based geometric parameters are:

- **Turning Proportion(%).** Where only a proportion of the total vehicles using the Lane are using a Turn, LinSig combines the saturation flows for traffic on each Turn to produce a combined saturation flow for the Lane. As the turning proportion varies according to the Traffic Flow Group used in LinSig, LinSig will automatically estimate the turning proportion for each Lane from the current Traffic Flow Group.
- **Turning Radius(m).** The minimum radius of curvature of a turning vehicles path. This should be measured very carefully for a left turn as the often small radius can have a large effect on the estimated saturation flow.

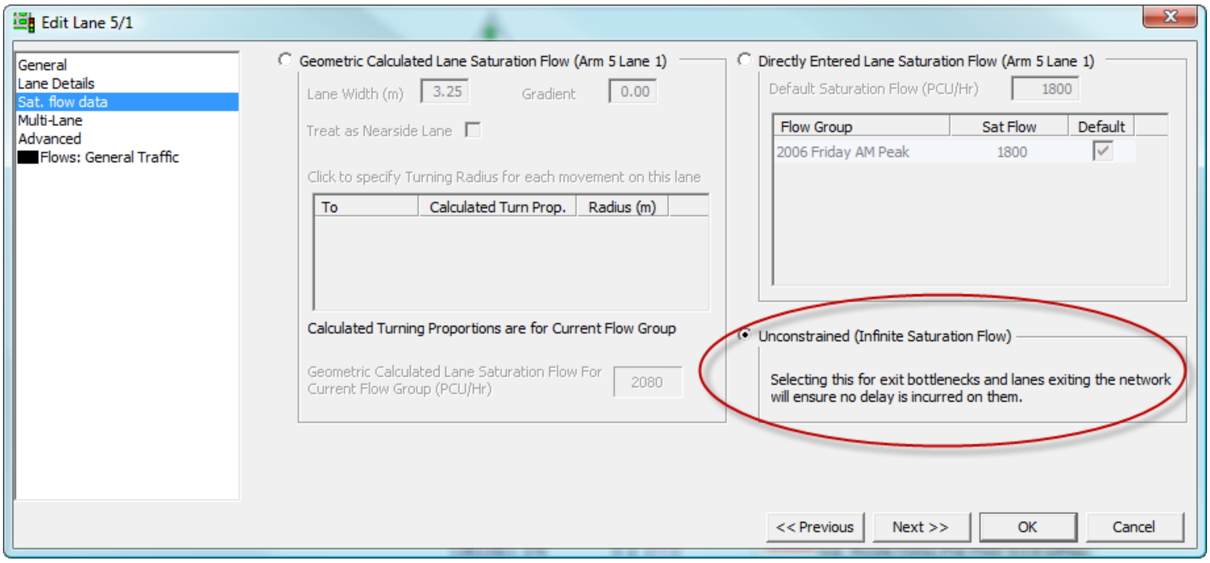
For more detail on the above methodology and parameters see the RR67 report. This can be obtained from TRL Limited.

Specifying Unconstrained Unsignalled Lanes

An unsignalled Lane in LinSig can be modelled in two ways:

- **Constrained.** A Constrained Unsignalled Lane has a Saturation flow to model a capacity constrained Lane or bottleneck.
- **Unconstrained with an infinite saturation flow.** This is used when it is unnecessary or unadvisable to model the capacity of the Lane and it is being used purely to organise good Network structure.

All Lanes are initially created as unconstrained. If it desired to model a Lane as constrained either the Geometric or Manual Saturation Flow option should be selected as described above.



To change a Lane with a saturation flow to a unconstrained Lane select the 'Unconstrained (Infinite Saturation Flow)' option on the Saturation Flow Data tab.

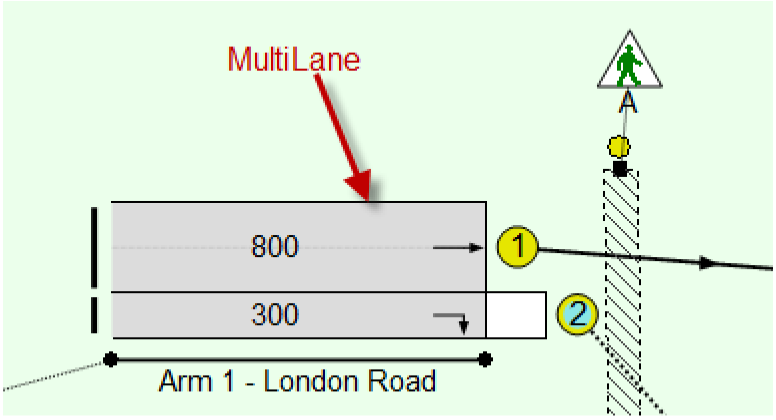
It is recommended that all Junction and Network Exit Lanes are modelled as unconstrained. Modelling a constrained exit from a Junction requires careful thought and it is not adequate just to model this with a constrained Junction exit Lane.

MultiLane

MultiLanes were introduced in LinSig 3.1 and effectively provide a mechanism similar to Links in previous versions of LinSig. A MultiLane in LinSig represents a group of Lanes which behave in an identical manner. That is:

- All physical lanes in the MultiLane receive the same green times.

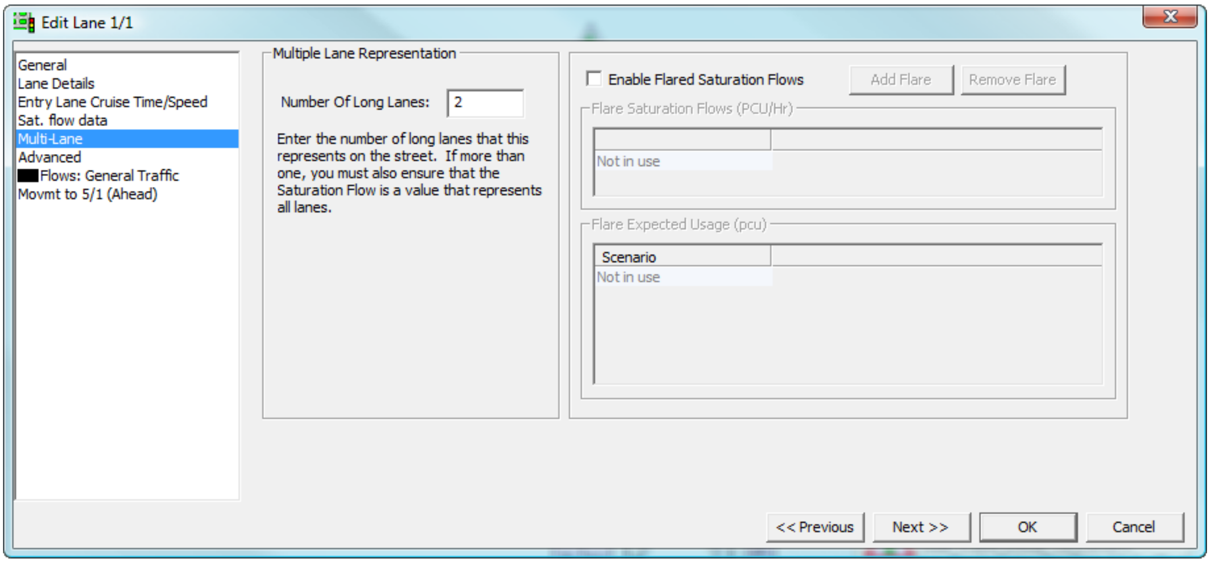
- Any give-way behaviour is identical across all lanes.
- Traffic distributes equally between each lane.



MultiLanes fulfil the following functions:

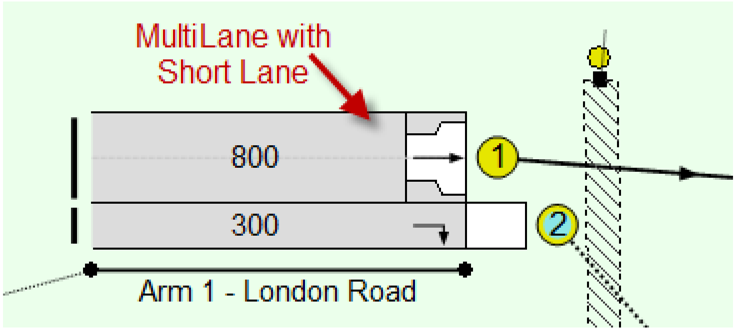
- They are directly compatible with models created in earlier versions of LinSig.
- They implicitly assume traffic equally distributes between all Lanes in the MultiLane group. This can reduce calibration effort when it is known that traffic behaves in this way as it avoids the need to calibrate separate independent Lanes to have an equal distribution of traffic.
- They make the transition from LinSig 2 to LinSig 3 more straightforward as they avoid the requirement to immediately restructure the model's Lane structure in LinSig 3. Obviously there will often be benefits in restructuring Lanes in LinSig 3 and this should be carried out for most models – MultiLanes simply allow this step to be deferred.

An important point to remember is that if a MultiLane is incorrectly used in a situation where traffic does not split equally between Lanes the model will almost always predict a better performance than reality. Wherever a MultiLane is used the above assumptions should be checked to ensure the validity of the model.



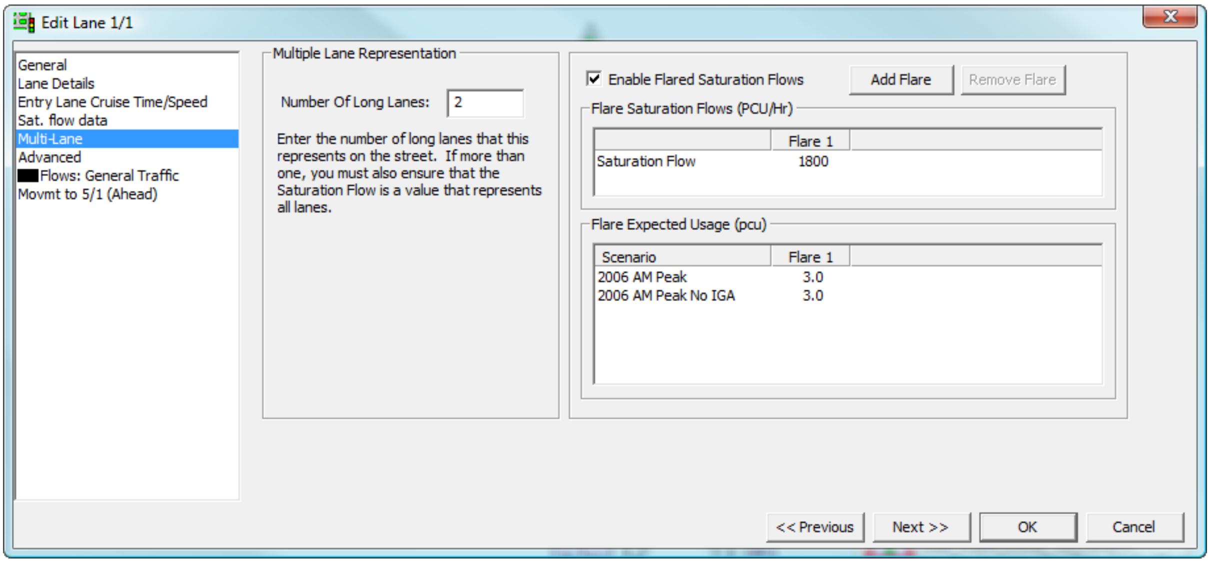
The MultiLane tab has two sections:

- **The Number of Long Lanes.** This section simply allows the number of Lanes the MultiLane represents to be entered. A saturation flow consistent with the number of lanes represented should be entered on the Saturation Flow tab as described above.
- **Short Lanes.** This section allows short lanes to be modelled as part of the MultiLane, These short lanes are modelled using a stepped saturation flow profile similar to how short lanes were modelled in LinSig 2.



The following information is required to define the short lanes within the MultiLane:

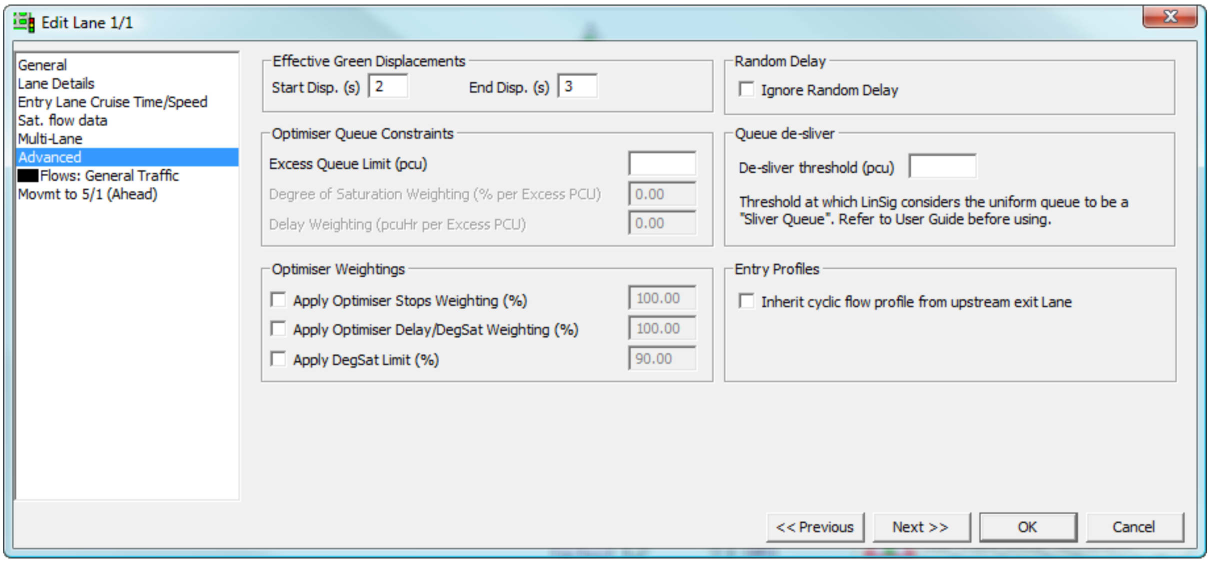
- A Saturation Flow for each short lane.
- Each short lane's expected usage in each Flow Group.



The expected usage is the average number of PCU in the short lane at the start of green rather than the physical length of the short lane. The expected usage will always be shorter than the physical usage due to effects such as traffic in an adjacent lane preventing traffic from reaching the short lane. The free utility LINSAT can be used to predict the expected usage from the physical lane length. LINSAT is currently available for free download from JCT Consultancy's web site.

Remember that the new LinSig 3 short lane model automatically allows for a number of issues such as short lane blocking which are not explicitly modelled in the MultiLane short lane model.

Advanced Settings



The Advanced tab contained the following settings:

- **Start Displacement.** The Start Displacement specifies how long it takes traffic on the Lane to achieve Saturation Flow when the Lane receives a green signal. LinSig assumes discharge across the Lanes stop line is zero for the duration of the Start Displacement before jumping to Saturation Flow after the Start Displacement has expired. The green duration adjusted for the Start and End Displacements is called the Effective Green. In the UK the Start Displacement is commonly set to 2 seconds although where justified by site or regional data, this value can be changed. Outside the UK where Red-Ambers are not used the Start Displacement can be changed to adjust for any difference in effective green. Prior to LinSig 3.1 the Start and End Displacements were sometimes used as general adjustments to Lane green times for a range of reasons. LinSig 3.1 introduced a new Bonus Green Feature which provides a more flexible way of adjusting green times allowing the Start and End Displacements to be used for their intended purpose.
- **End Displacement.** The End Displacement is similar to the Start Displacement but applies to the end of the green period. It specifies how long Saturation Flow is maintained for after the Lane's green has ended. In the UK the End Displacement is commonly set to 3 seconds although where justified by site or regional data, this value can be changed.
- **Optimiser Queue Constraints.** The Optimiser Queue Constraints can be used to help with modelling queue blocking back from one Lane to an upstream Lane. No input is required if excess queuing is not occurring. The constraints allow the LinSig Stage length optimiser to be discouraged from producing stage lengths which lead to queues on Lanes exceeding the Queue Limit. For example if a Lane between two junctions was a single lane of 100m this provides space for approximately 100/6 = 16 PCU. Because the vertical queuing model used in LinSig (more details are in the Modelling Background Section) does not model blocking back from Lanes so depending on the other Lane data LinSig may model a queue of 20PCU which obviously extends beyond the end of the Lane. Setting a queue optimiser constraint of 16 PCU encourages the optimiser to choose a longer green time reducing the queue on the Lane to below 16 PCU. The individual parameters are:
    - **Excess Queue Limit (PCU).** The queue length beyond which LinSig will try to reduce the queue. This is normally set to approximately three quarters of the queuing space on the Lane but

can also be set to less to force the optimiser to be more aggressive in reducing the queue. Beware of being too aggressive as this may prevent the optimiser from finding a meaningful answer.

- **Degree of Saturation Weighting (%).** This value is only used when optimising for Practical Reserve Capacity (PRC). LinSig will increase the degree of saturation of the Lane as seen by the optimiser when a Lane's queue exceeds the Excess Queue Limit on the Lane. When this occurs LinSig biases the optimiser to attempt to reduce the real degree of saturation on the Lane more than it otherwise would. This has the effect of reducing the queue on the Lane. LinSig increases the degree of saturation by the Degree of Saturation Weighting multiplied by the average queuing exceeding the Excess Queue Limit. A higher value will cause the optimiser to be more aggressive in reducing the queue. Too high a value however may prevent the optimiser from finding optimal signal settings. It is recommended to experiment with different values for each model.
- **Delay Weighting (pcuHr).** The delay weighting serves the same purpose as the Degree of Saturation Weighting but is used when optimising for minimum delay. Again a higher value will cause the optimiser to reduce queues more aggressively.

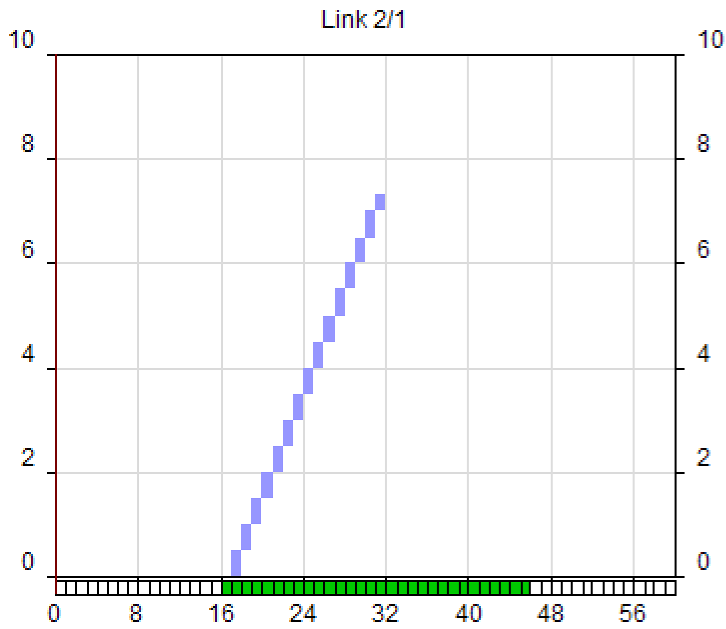
- **Optimiser Weightings.** The Optimiser weightings allow aspects of a Lane's importance to be increased or decreased causing the optimiser to find different timings. The two weights available include:
  - **Optimiser Stops Weighting (%).** This weight allows the Stops calculated by the traffic model for this Lane to be factored up or down when used by the optimiser. A value of 100 will have no effect a value greater than 100 will factor the number of Stops up and a value of less than 100 will factor the number of Stops down.
  - **Optimiser Delay/Degree of Saturation Weighting (%).** This weight allows the Delay or Degree of Saturation calculated by the traffic model for this Lane to be factored up or down when used by the optimiser. Delay is used when optimising for minimum delay and degree of saturation is used when optimising for maximum PRC. A value of 100 will have no effect a value greater than 100 will factor the Delay or Degree of Saturation up and a value of less than 100 will factor the Delay or Degree of Saturation down.
  - **Degree of Saturation Limit (%).** The Degree of Saturation Limit prevents the optimiser from finding signal timings which produce a degree of saturation on a Lane which exceeds this limit. This can be useful in prioritising the main road on an arterial corridor study.

  Whether to include the effects of Stops in the optimiser and the valuation of Stops relative to delay are set in the 'Optimisation Settings' dialog box.

- **Random Delay.** On some Lanes the assumptions used on the level of Random Delay used by LinSig may be unrealistic for the particular conditions on the Lane. The most common example is a signal roundabout circulatory Lane. As the distance between an entry and circulatory stop line is often only a short length traffic platoons arriving at the circulatory stop line are often very regular and non-random leading to an overestimation of Random Delay at higher degrees of saturation. Ticking the 'Ignore Random Delay' box omits Random delay from the Lane which may lead to a more realistic estimation of queuing and delays. Please note it is down to you as the engineer to make the judgement on whether a Lane has sufficiently non-random characteristics to make it justifiable to ignore Random Delay. If in doubt it is more conservative to leave the box unticked.

- **Queue De-Sliver Threshold (PCU).** A Sliver Queue is defined as a queue which contains a very small amount of traffic but whose back of queue extends a long way back from the stop line.

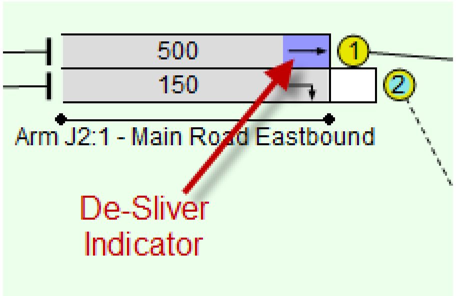
  Sliver queues are a side effect of the type of traffic model used in LinSig and often occur when the traffic flow feeding a Lane is similar to the Lane's Saturation flow. During the green period nearly as much traffic is adding to the back of the queue as is leaving the front leading to a slowly decreasing number of PCU in the queue but a rapidly extending back of queue. Where this is particularly severe, as is for example common at signal roundabout circulatory stop lines, the sliver queue may lead to reporting of unrealistically long mean-max queues and over severe application of Optimiser Queue Constraints. LinSig is in effect modelling vehicles driving up to the back of the queue at cruise speed, joining the queue for a fraction of a second before moving off again. In reality drivers would touch their brakes to avoid having to stop and join the queue. This leads to a situation where the model is 'correct' in a mathematical sense but leads to a overestimate of the practical position of the back of queue.



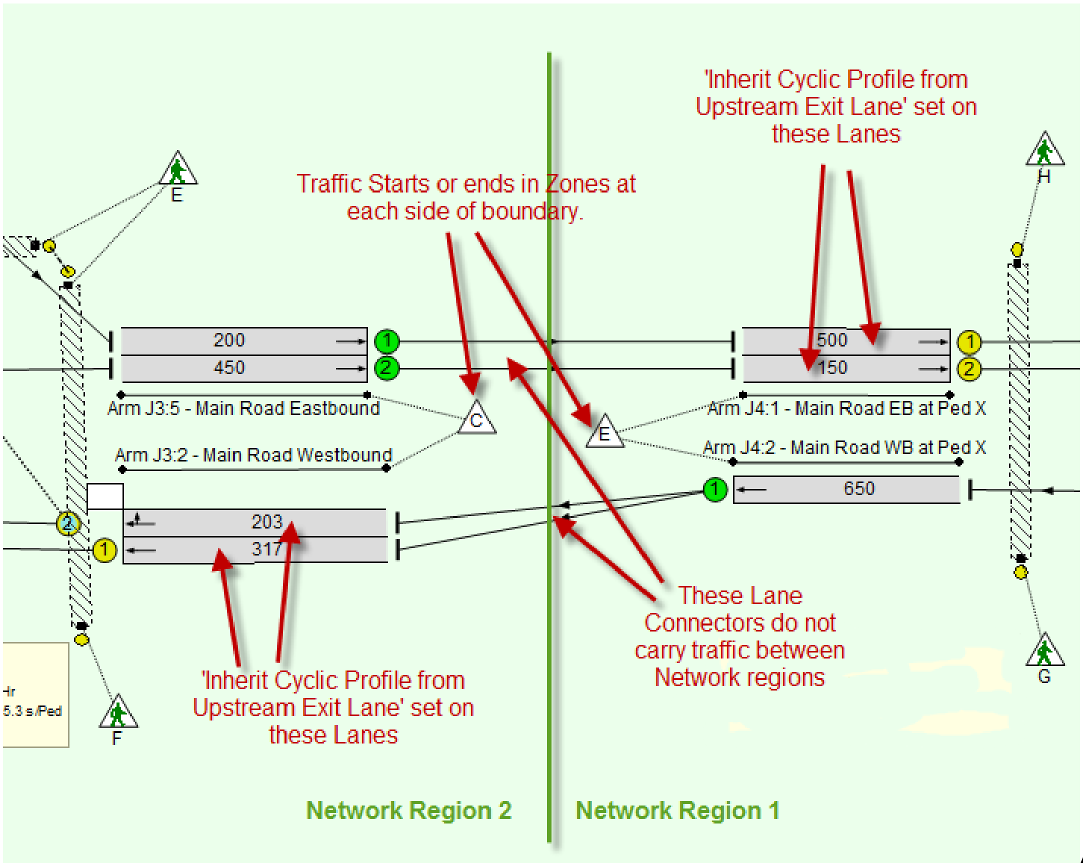
  The de-sliver mechanism detects a sliver queue which is unrealistic and prevents unrealistic back of queue values being reported. Exactly what is regarded as unrealistic is governed by the De-Sliver Threshold. The value of the De-Sliver Threshold is used by LinSig to decide when the number of PCU in the queue is unrealistically small. For example if the De-Sliver Threshold is set to 0.5 PCU LinSig will regard a potential sliver queue containing less than 0.5 PCU as unrealistic and allow traffic to exit the Lane without adding to the queue. The exact value for the De-Sliver Threshold is best determined by experimenting with its value whilst observing the Lane's Uniform Queue Graph and selecting a value which produces an intuitively sensible queue profile. If the value is set too low a sliver queue may form giving unrealistically high mean-max queues. If the value is set too high the real mean-max queue may be smoothed too much leading to an unrealistically high value of mean-max queue.

The De-Sliver mechanism is intended to allow obviously unintuitive unrealistically long queues to be corrected but the decision whether the queue profile is unrealistic rests (as it should do) with the engineer and care should be taken not to use the De-Sliver Mechanism to unjustifiably 'fiddle' queue lengths.

If a Lane has had a De-Sliver Threshold value set it will be shown in the Network Layout View with a blue indicator at the front of the Lane.



- **Entry Profiles.** The 'Inherit Cyclic Profile from Upstream Exit Lane' setting is used when joining two Network regions. The boundary between two Matrix Based Network regions is shown below. Similar principles apply when joining a Matrix Based region to a Lane Based region.



At the boundary of two Network regions where either region is Matrix Based Zones model traffic starting or terminating at the region boundary when in reality the traffic is crossing the region boundary. Zones at each side of the boundary exist only to support the splitting of the model into regions. This allows routes within each region to be modelled while avoiding having to model routes between regions. Normally traffic entering a Lane from a Zone has a flat profile over a signal cycle. Where the Zone is used to split the Network into regions the model will be more accurate if traffic leaving a Zone to enter a region uses the cyclic flow profile shape of traffic modelled as terminating on the other side of the region boundary. This setting achieves this by profiling traffic leaving a Zone based on the cyclic flow profile of traffic terminating at the Lane's previous upstream Lane. More information on splitting a Network into regions is provided in the Essential Background section.

LinSig Give Way Model

Several of the tabs in the Edit Lane Dialog refer to the LinSig Give Way model. The Give Way Model is summarised here and further information is available in 'Give Way Lanes' in LinSig in Section 3 : Essential Background.

The give way model used in LinSig is a standard linear equation model that has been used in a number of modelling packages for many years. This method has the advantage of being simple to use as well as being able to closely approximate a range of other give way models such as Tanners Formula and gap acceptance methods. The model can be used to model left turn slips at signal junctions, opposed right turns within signal junctions as well as purely priority junctions.

For right turn Lanes the give-way model is only one component of the LinSig right turn model. The right turn model is described in more detail in the modelling section.

The model is used to predict the give-way capacity of a Lane at each modelled time step based on the flow in that time step on any number of opposing Lanes or movements.

In each model time step LinSig calculates the capacity of a Give-Way Lane using the formula:

F = F0 - A1*Q1 - A2*Q2 - …. - An*Qn

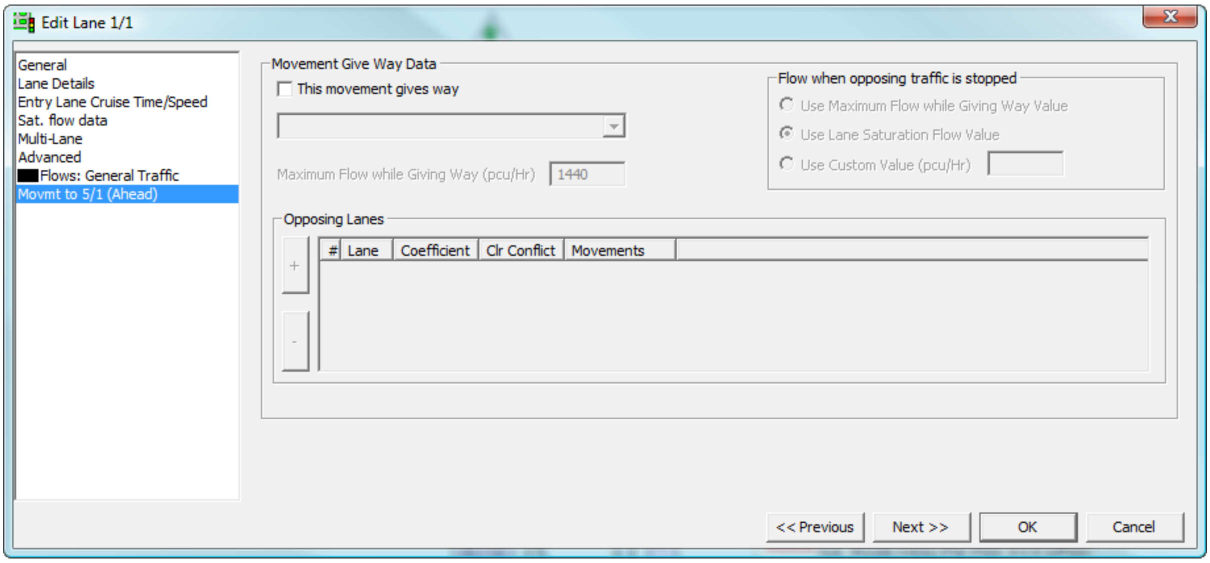
Where:

- **F** is the give-way capacity of the Lane in a time step.
- $\mathbf{F_0}$ is the maximum flow when the Lane is potentially opposed but no opposing traffic is present.
- $\mathbf{Q_1}$ is the flow in the current time slice on the first opposing Lane.
- $\mathbf{A_1}$ is a coefficient for the first opposing Lane which specifies by how much the capacity is reduced by flow on the first opposing Lane.
- $\mathbf{Q_2}$ is the flow in the current time slice on the second opposing Lane.
- $\mathbf{A_2}$ is a coefficient for the second opposing Lane which specifies by how much the capacity is reduced by flow on the second opposing Lane.
- $\mathbf{Q_n}$ is the flow in the current time slice on the second opposing Lane.
- $\mathbf{A_n}$ is a coefficient for the second opposing Lane which specifies by how much the capacity is reduced by flow on the second opposing Lane.

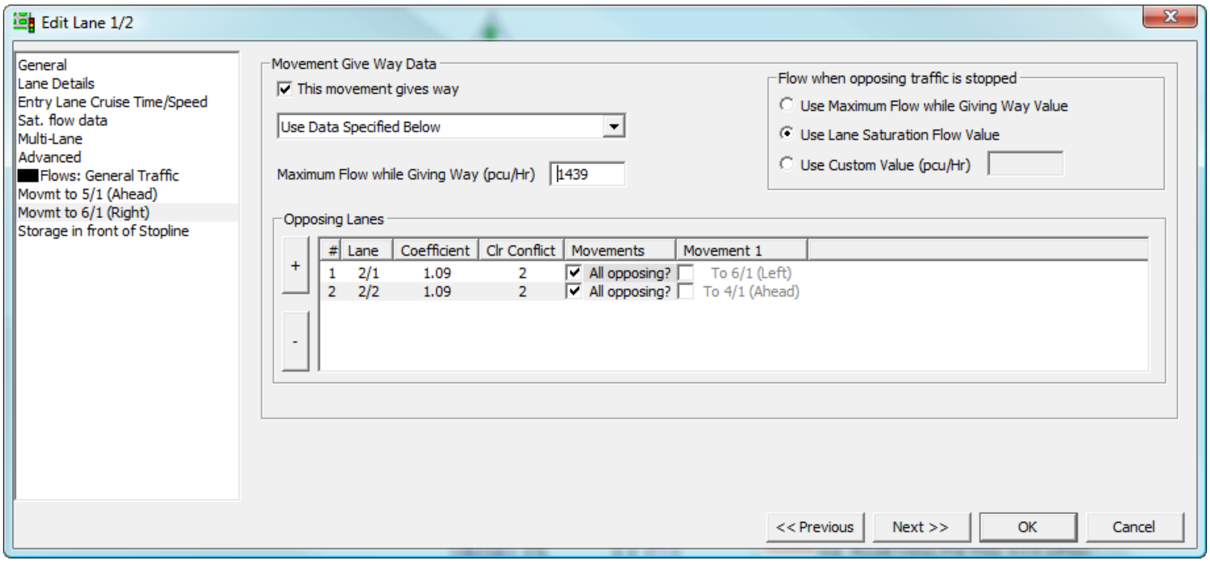
Guidance on the values to use for the above parameters is given in 'Give Way Lanes' in LinSig in Section 3 : Essential Background.

Movement Settings

The Movement tabs contain settings relating to an individual movement leaving the Lane, for example a left turn or ahead movement. The Edit Lane Dialog Box will contain a separate Movement tab for each movement.



Non-Give-Way Lane



Give-Way Lane

The settings available on each Movement tab are:

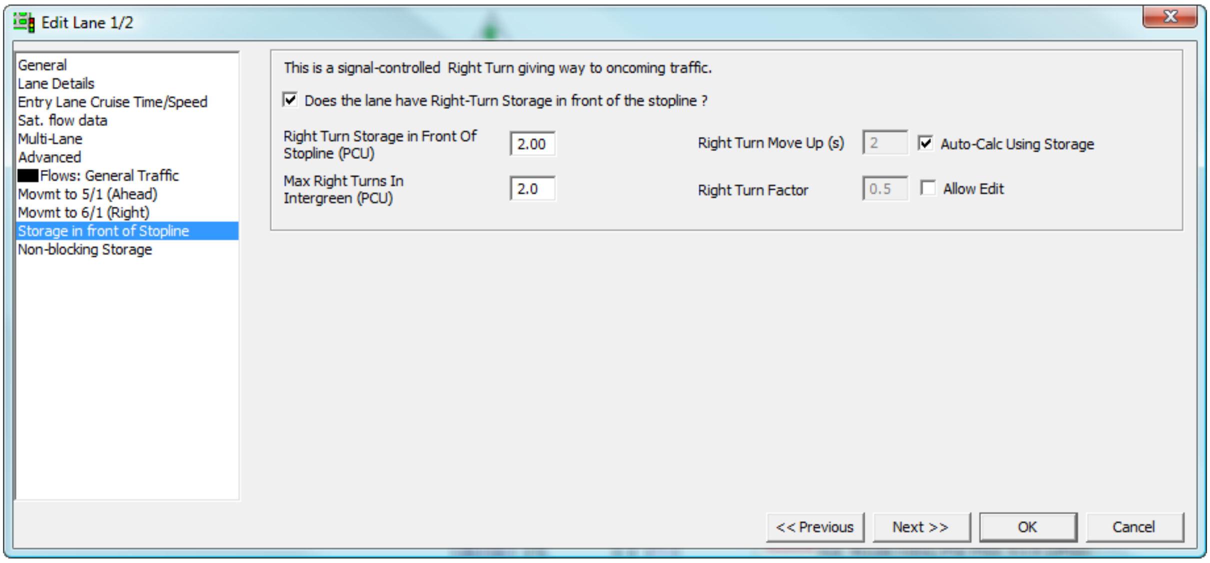
- **This Movement Gives Way.** The 'This Movement Gives Way' tick box specifies whether the movement gives way to any other movements from other Lanes or whether it is simply controlled by signals or even free flowing. If the movement gives way the box should be ticked and data entered for the rest of the fields on the tab. If the movement does not give way the box can be left unticked and no further data entry is required on this tab.
- **Maximum Flow When Giving Way (PCU/Hr).** This is the maximum capacity of the Give-Way Lane when it is giving way and therefore potentially opposed but no opposing traffic is present.
- **Flow when Opposing Traffic is Stopped (PCU/Hr).** This is the Saturation Flow for the opposed movement when the opposing traffic is stopped. When it is clear to

opposed traffic that the opposing movement is stopped, for example when a right turn's indicative arrow is running, the Lane may have a higher Saturation Flow than the Maximum Flow value as traffic may not need to check for opposing traffic which is self evidently stopped. Often this value is the same as the Lane's main saturation flow but may be different, for example if the opposed movement turns through a tight radius the saturation flow would be lower. The options available are:

  - **Use Maximum Flow when Giving Way.** Use the same value specified above in 'Maximum Flow When Giving Way'. This option should be used where it is felt that the Saturation Flow would not be different from the Maximum Flow value. Give Way Left Turns often require this option as the angle of turn often means it is not obviously apparent to opposed traffic that the opposing movements are stopped.
  - **Use Lane Saturation Flow Value.** The Lane's Saturation Flow specified on the Saturation Flow tab is used when the opposing movements are stopped.
  - **Use Custom Value (PCU/Hr).** A custom value can be specified if for any reason a value other than the other two options is required.

- **Opposing Lanes.** Any number of opposing Lanes can be used to oppose a movement. Also each movement can have different opposing Lanes. Opposing Lanes can be added to the Movement Tab by clicking the '+' button to the left of the Opposing Lanes List. Settings for each Opposing Lane can then be changed by clicking the setting to be changed in the List. The Settings are:
  - **Lane.** The Lane Reference of the Opposing Lane.
  - **Coefficient**. The A_n value as described above in 'LinSig Give Way Model'. This is used to specify by how much the traffic flow on the Opposing Lane reduces the Give Way Lane's capacity.
  - **Clear Conflict Time(sec).** The Clear Conflict Time is the time between a vehicle crossing the opposing Lane's stop line and the time it ceases to oppose traffic on the Give Way Lane. It is typically used on large junctions to allow for the fact that traffic on the opposing Lane will take a few seconds to clear before a Give Way Lane can start to discharge. Its value will depend on the size of the junction and should be measured on site where possible. The Clear Conflict Time is often ignored in some models and may be a cause of differences between model results. The Clear Conflict Time can be specified separately for each opposing Lane.
  - **Opposing Movements.** Each Opposing Lane may itself have a number of Movements each of which may or may not oppose the Give Way Lane. The Opposing Movements column allows which of the movements leaving the Opposing Lane actually oppose the Give Way Lane to be defined. If all movements oppose the 'All Opposing' box can be left ticked. If one or more movements do not oppose the 'All Opposing' box can be unticked and the boxes next to each individual opposing movement ticked or unticked as appropriate.

Storage in Front of Stop Line Settings

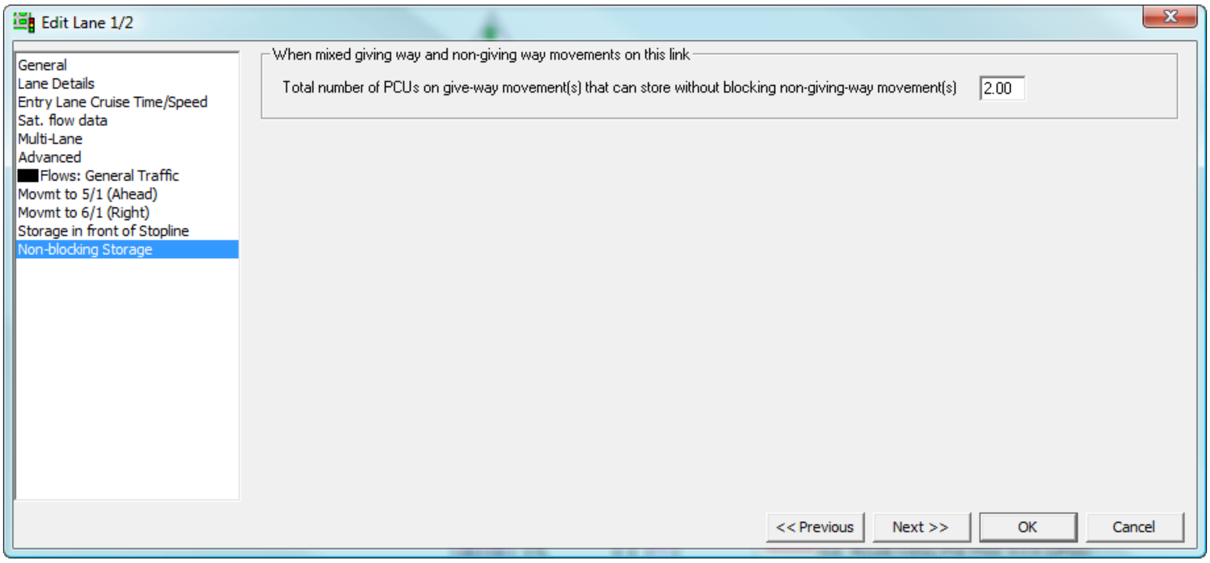


Lanes which include Right Turns that have Storage in front of the Stop Line require additional settings to model all the components of right turn capacity modelled by LinSig. These settings are contained on the 'Storage in Front of Stop Line' tab. They include:

- **Does the Lane have Right Turn Storage in Front of Stop Line?** This setting specifies whether the Lane contains Storage in front of the Stop Line and hence whether the remaining settings on the tab are required to be validly completed.
- **Right Turn Storage in Front of Stop Line.** This is the total number of PCUs which can store in front of the Stop Line whilst waiting to turn right. LinSig uses this value in calculating right turn capacity bonuses for traffic discharging with an indicative green arrow.
- **Maximum Right Turns in Intergreen (PCU).** This setting specifies how many PCUs waiting in front of the stop line can turn right during the Intergreen after a right turn Lane has terminated. It may be different from the Right Turn Storage value as it may not be possible for all vehicles in front of the stop line to turn right during the Intergreen.
- **Right Turn Move-Up Time (sec).** This specifies the time for a vehicle at the stop line to reach the point at the front of the storage area in the centre of the junction where it waits for a gap to turn right. LinSig can estimate this value by assuming the move-up time is one second for every one PCU of storage in front of the stop line.
- **Right Turn Factor.** The Right Turn Factor controls the amount of bonus capacity due to right turning traffic storing in front of the stop line. The default value is 0.5 and it is generally appropriate to retain this value unless site data suggests a different value. The Right Turn Factor is explained in more detail in the Modelling section.

Non-Blocking Storage

The Non-Blocking tab is only available when the Lane contains a mixture of give-way and non give-way movements. It is principally used for situations where an opposed right turn movement may block a non-give-way movement (usually ahead).



The only setting on this tab is:

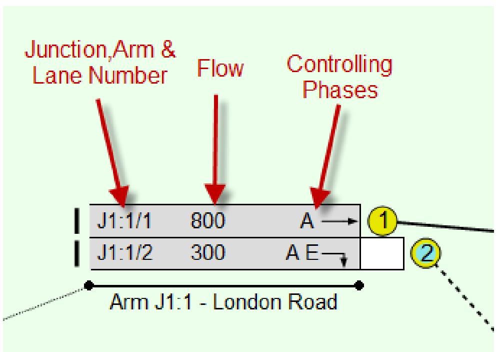
- **Total Number of PCUs on Give-Way Movements that can store without blocking Non-Giving-Way Movements.** This value is the number of PCUs on the give-way movement (usually the right turn) which can queue before blocking the non-giving way movement (usually the ahead or ahead/left movement). In LinSig 3 the Non-Blocking Storage is always less than or equal to the right turn storage.

4.3.6.4. Displaying Numerical Information on Lanes

The Network Layout View can display numerical information relating to Lanes and Lane Connectors. As LinSig uses far more input data and results than can be displayed at once different Text Display Formats are used to display different sets of information at different times. LinSig provides a range of pre-defined Text Display Formats but it is also possible to create any number of user defined Text Display Formats.

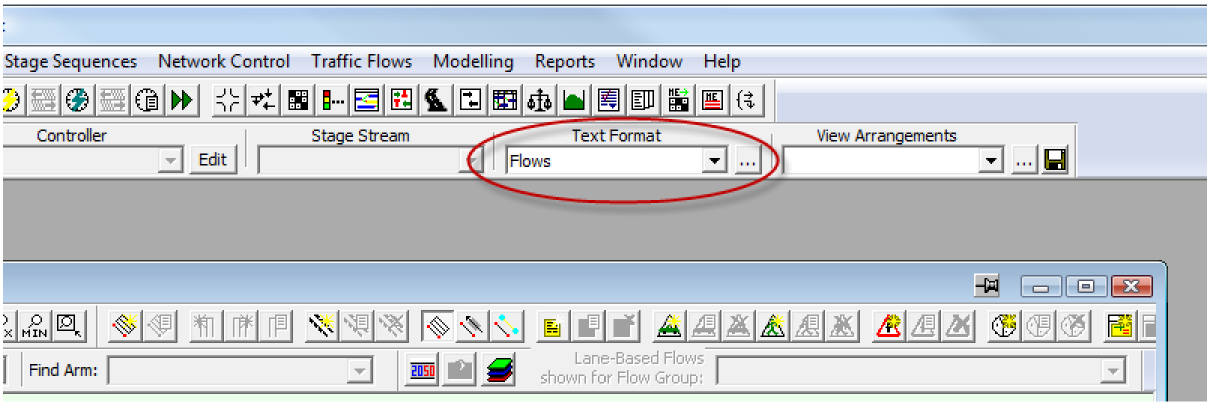
Each Lane can display up to three data or result items: one at each end and one in the middle as illustrated below. Each Text Display Format specifies which data or results appear in each position. A single data item can also be displayed on Lane Connectors. Where short Lanes are used some data and result items apply to the Lane Group consisting of the Short Lane and its adjacent Long Lane rather than individual Lanes. These values are shown on the Lane Groups Long Lane in italics.

An example of a typical display is shown below:



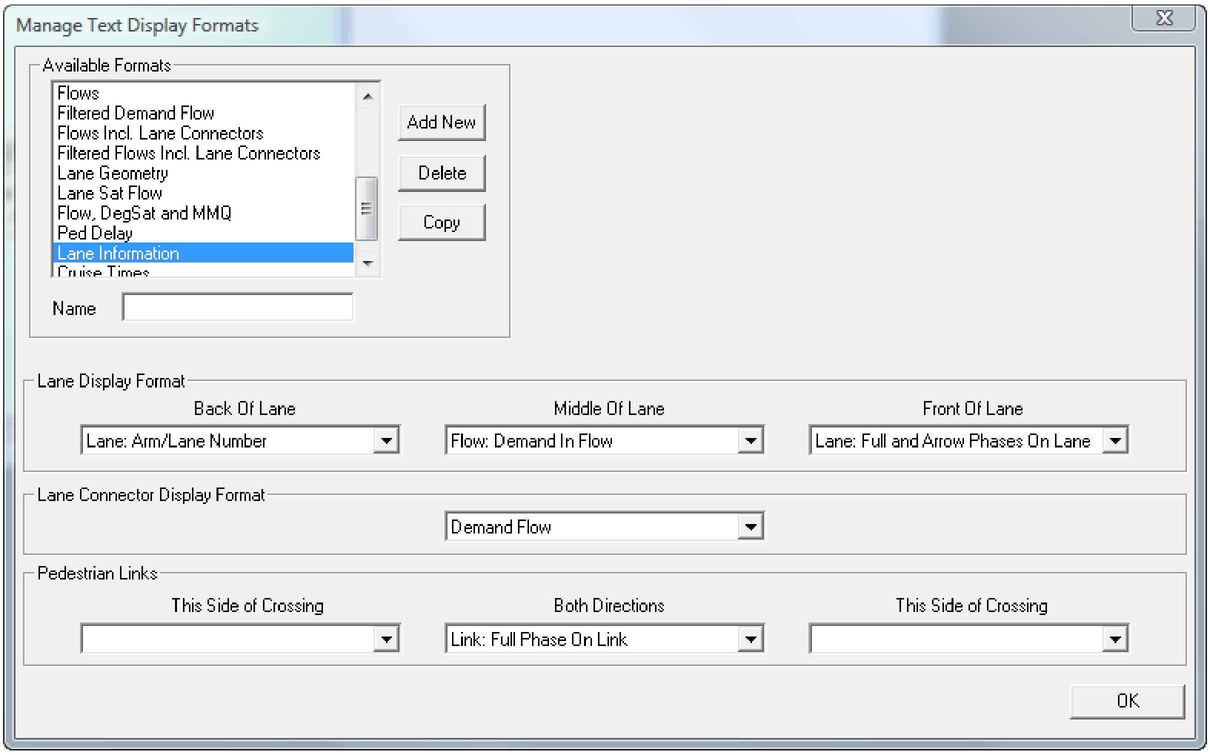
Choosing the Text Display Format

The Text Display Format can be selected using the drop down list of Text Display Formats in the toolbar.



Creating Customised Text Display Formats

New Text Display Formats can be defined using the Text Display Format Manager. This is opened by choosing 'Manage Lane Text Display' from the View Menu or by clicking the button to the right of the Text Display Format drop down list.



The Text Display Format Manager lists the available Text Display Formats, allows them to be copied or new ones created and displays the layout of data and result items on Lanes, Lane Connectors and Pedestrian Links for the Text Display Format being edited.

Creating a New Text Display Format

To create a new Text Display Format click the Add New button to the right of the 'Available Formats' list. A new Display Format initially called '(name)' will be created. This should be given a proper name by changing its name in the 'Name' box. The Text Display Format can be then be defined as described below in 'Editing a Text Display Format'.

Copying an Existing Text Display Format

An existing Text Display Format can be copied by selecting it in the 'Available Text Display Formats' list and clicking 'Copy'. A new Text Display Format called 'copy of (copied Format Name)' will be created.

Deleting a Text Display Format

A Text Display Format can be deleted by selecting it in the 'Available Text Display Formats' list and clicking 'Delete'.

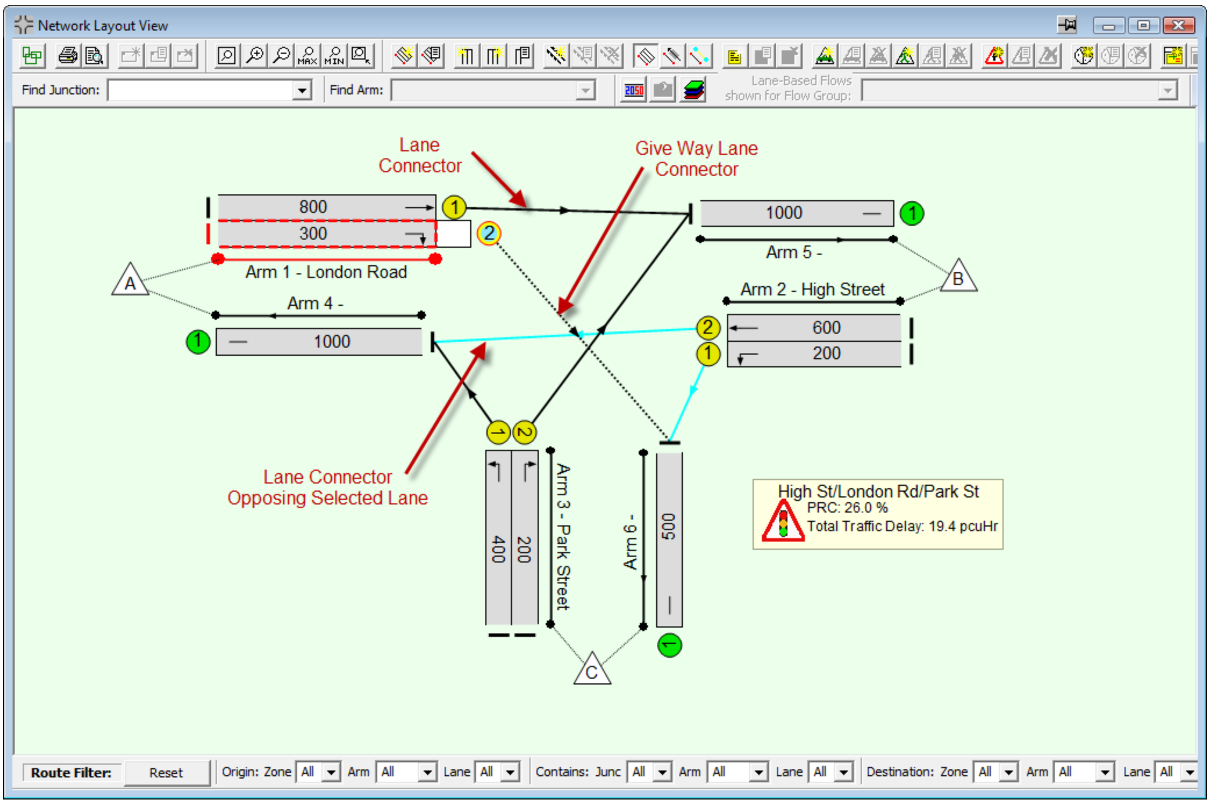
Editing a Text Display Format

A Text Display Format can be edited by selecting it in the 'Available Text Display Formats' list and using the drop down lists to set the desired data or results items for each position on Lanes, Lane Connectors and Pedestrian Links.

Lanes and Pedestrian Links can display up to three data or result items: one at each end and one in the middle. Lane Connectors can only show a single item in the middle of the connector. Any position can be left blank if desired.

4.3.7. Joining Lanes with Lane Connectors

Lane Connectors are used in LinSig to define the traffic movements which can take place between Lanes. Lane Connectors also specify the travel time or speed between stop lines and the amount of platoon dispersion present on a movement. This allows different values for travel time and platoon dispersion to be used for each movement.



The diagram above shows Lane Connectors joining Lanes to other Lanes. Lane Connectors representing traffic movements which give way to other Lanes are shown dashed. If a give-way Lane or give-way Lane Connector is selected with the mouse its opposing Lane Connectors are shown highlighted.

4.3.7.1. Creating Lane Connectors

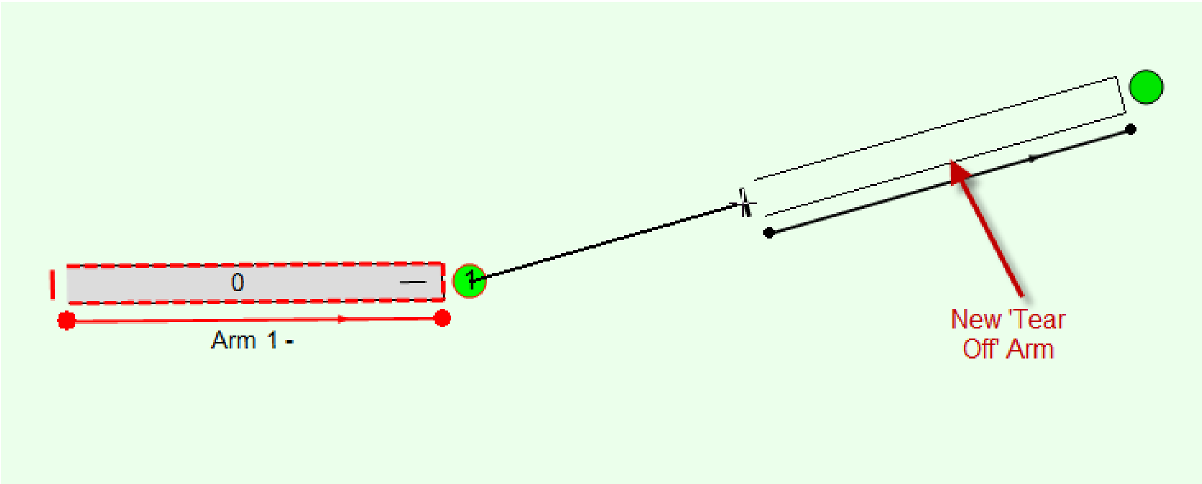
Lane Connectors can either be created between two existing Lanes or can be created between an existing Lane and a new Lane on a new Arm created at the same time as the new Lane Connector. The facility to create new Arms on the fly allows Networks to be built more speedily.

To create a Lane connector between two existing Arms:

- Select the Lane Connector's starting Lane Number Circle.
- Drag the starting Lane with the mouse. A Lane connector and new downstream Arm and Lane will 'tear off' of the starting Lane.
- Drag the mouse pointer over the Lane where the Lane Connector will end. The 'tear off' Arm will disappear indicating no new Arm will be created.
- Drop the Lane Connector on the downstream Lane by releasing the mouse. A new Lane Connector will be created between the two Lanes. The Lane Connector will be created with no mean cruise time defined and will use the default value of 10 seconds until edited to set a specific cruise time.

The ability to create a new Arm and Lane simultaneously with a Lane Connector is intended to speed the creation of Junction Exit Arms. The feature can however be used to create any Arm. To create a Lane Connector with a new Arm and Lane:

- Select the Lane Connectors starting Lane Number Circle.
- Drag the starting Lane with the mouse. A Lane connector and new downstream Arm and Lane will 'tear off' of the starting Lane.
- Drop the 'tear off' Arm and Lane anywhere other than on an existing Lane. The Edit Arm dialog box will open allowing you to enter the new Arm's Name and Junction.
- Click OK in the Edit Lane dialog box. A new Arm containing a single Lane will be created with a Lane Connector joining it to the starting Lane.
- Edit the new Arm and Lane as appropriate.



4.3.7.2. Editing Lane Connectors

Lane Connectors can be edited using the Edit Lane Connector dialog box which can be opened by:

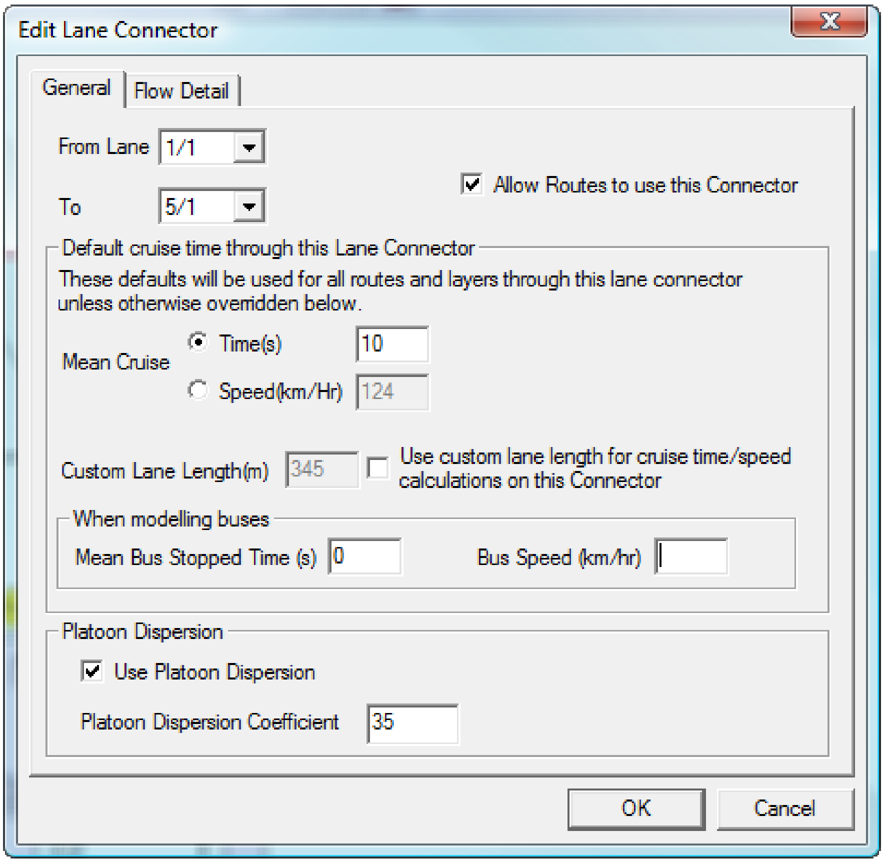
- Selecting a Lane Connector with the mouse and choosing 'Edit Lane Connector' from the 'Lane Connectors' pop-out menu on the Network Menu; or by
- Right clicking on the Lane Connector and choosing 'Edit Lane Connector...' from the pop-up menu.

The Edit Lane Connector dialog box provides two tabs for editing Lane Connector settings. These are:

- **General.** The General tab allows common Lane Connector settings to be changed.
- **Flow Detail.** The Flow Detail tab provides fine control over cruise speed/times on the Connector.

General

The General tab allows information on cruise speeds/times to be edited.



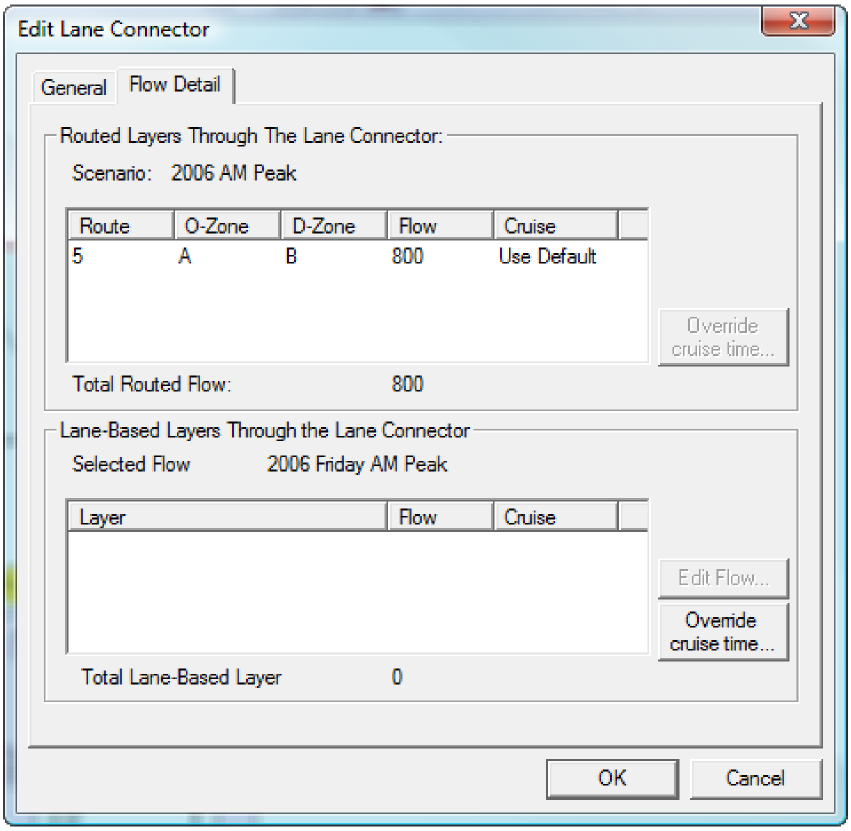
The General tab allows the following settings to be changed:

- **From Lane.** The Lane the Lane Connector starts from.
- **To Lane.** The Lane the Lane Connector ends at.
- **Allow Routes to use this Connector.** This setting governs whether LinSig will use this Lane Connector when building Routes through the Network. The setting can be used to avoid LinSig building unnecessary or undesired Routes in part of the Network.

- **Default Mean Cruise Time/Speed (sec or km/hr).** Either the mean cruise time or speed between the downstream ends of two Lanes. Whichever setting is provided LinSig will calculate the other using the Lane Connector Length as defined below. Where Junction Exit Arms are used the Lane Connector within the Junction should be used to specify the cruise time/speed from the stop line of the Lane entering the Junction to a notional point at the exit from the Junction where the Junction Exit Arm is located. The Lane Connector between a Junction Exit Arm and the next Junction should specify the Cruise Speed/Time from a notional exit point at the upstream Junction to the downstream stop line.
- **Custom Lane Length (m).** By default a Lane Connector will use the Lane Length of its downstream Lane. If necessary this setting can be used to override the Lane Length for this connector only. This will most often be necessary for Lane Connectors within Junctions.
- **Bus Modelling.** When modelling buses LinSig uses two settings instead of just a Cruise Time or Speed. These are the mean time buses are stopped whilst using the Lane Connector and the Bus Cruise Speed on this Lane Connector.
- **Platoon Dispersion.** Tick the Platoon Dispersion box to model platoon dispersion on the Lane Connector. A Platoon Dispersion Coefficient can also be entered but should be left at its default of 35 unless detailed site data suggests otherwise. For very Short Lanes, such as occur on a signal roundabout's circulatory carriageway platoon dispersion should be switched off. LinSig is unable to directly model platoon compression at this time; however it is often possible to allow for platoon compression on some movements by changing the Start/End Displacement on the Lane.

Flow Detail

The Flow Detail tab provides fine control over cruise speed/times on the Connector.



The Flow Details tab allows the following settings to be changed:

- **Routed Layers Through this Lane Connector.** The Routed Layers through this Lane Connector box lists all Routes through the Lane. Each Route is modelled as a separate Layer on the Lane. A Route can be selected using the mouse and the 'Override Cruise time' button used to specify a custom Cruise Speed/Time for this Route different from the default Speed/Time for the Connector. Custom settings for Connector Length and bus modelling parameters can also be specified.
- **Lane Based Flow Layers through this Lane Connector.** When Lane Based Flows are used on a Lane Connector this Setting allows Cruise Times to be customised for each Flow Layer in a similar manner as for Routed Layers described above. Traffic Flows on each Layer can also be edited using the 'Edit Flows...' button however care should be taken to maintain Flow Consistency.

4.3.7.3. Deleting a Lane Connector

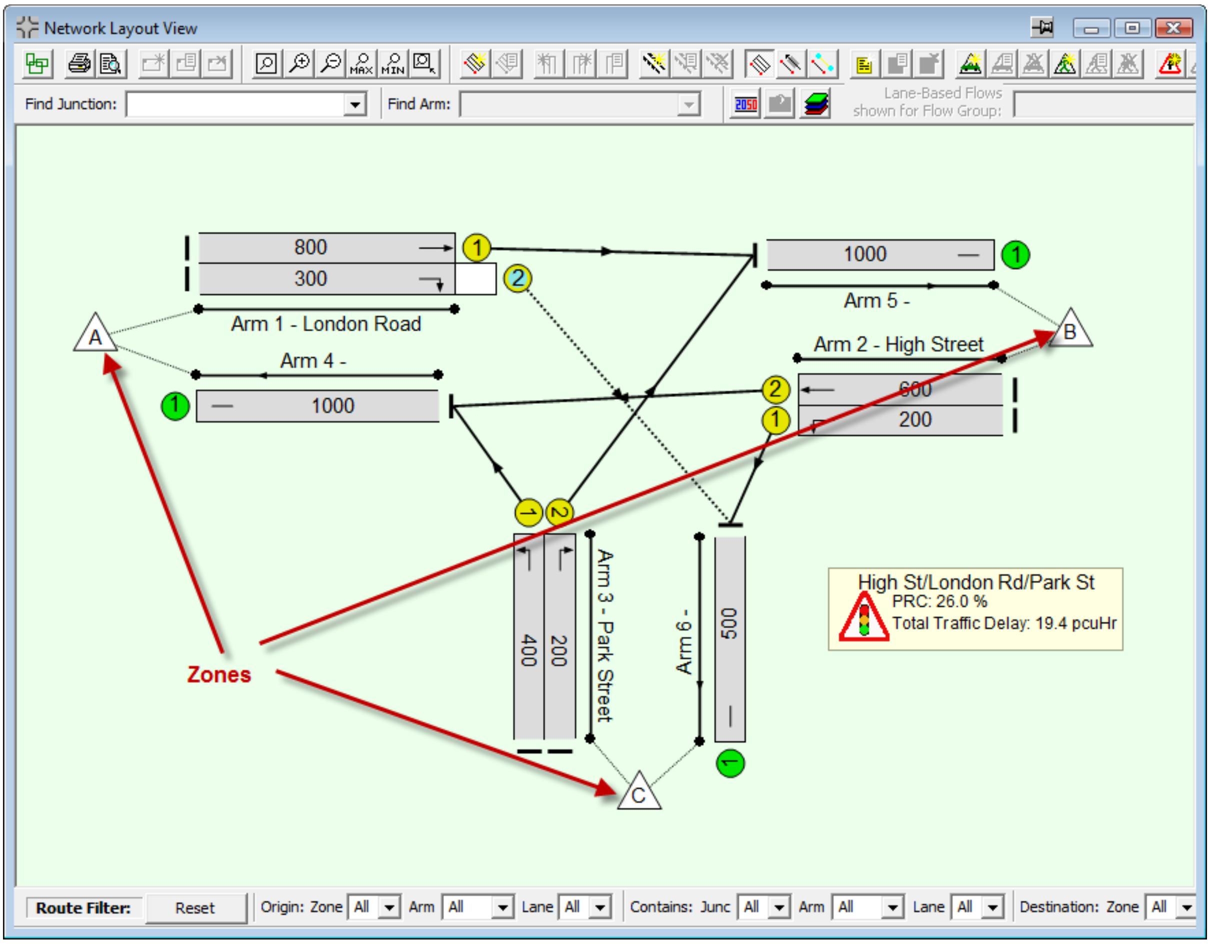
A Lane Connector can be deleted by selecting it with the mouse and choosing 'Delete Lane Connector' from the 'Lanes' pop-out menu on the Network Menu.

Deleting a Lane Connector will also delete the following:

- **Any Routes passing through the Lane Connector.** Any traffic flow allocated to Routes which are deleted will be de-allocated and the Actual Flows Matrix in the Traffic Flows View will show a flow deficit reflecting this. The flow on Routes through the deleted Lane Connector should be reassigned either to Routes through other Lanes Connectors or to any Routes through new Lane Connectors replacing the deleted Lane Connector. This can be done either manually using the Route List View or by reassigning automatically by choosing 'Assign OD Flows to Routes based on current Scenario'. More information is given in the section on the Scenarios View.
- **Any Lane Based Flows passing through the Lane Connector.** The deleted traffic flow should be added back into the model onto a different Lane Connector to reflect how traffic will use Lanes after the Lane Connector has been deleted. The Network Layout View's Flow Consistency Mode is useful for checking that all flows have been correctly added back.

4.3.8. Defining Network Entry and Exit Points using Zones

Zones are used in LinSig to define entry and exit points to and from Matrix Based regions of a LinSig Network. Zones define the start and end point of traffic movements through the Network. All Matrix Based traffic flows start from a Zone and end at a Zone. Zones are also used in the Traffic Flows View to reference the start and end points of traffic movements entered in the Traffic Flow Views Origin-Destination matrices.



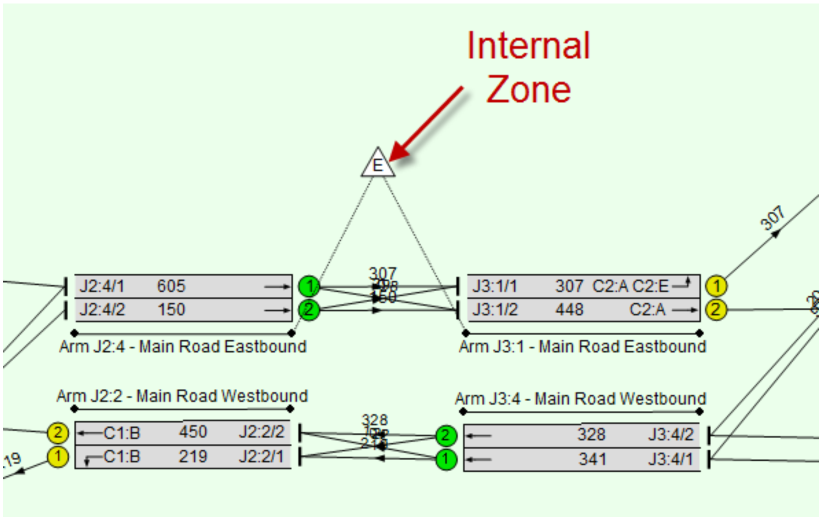
A Zone should be created for every point traffic enters or exits a Matrix Based Network or Matrix Based regions of a Network. Zones are not required for Lane Based Flow Network regions unless journey times are being calculated on Routes through the region. Further information is given on structuring a Network using Matrix Based and Lane Based Flow regions in the Essential Background section.

Three types of Zones exist in LinSig. These are:

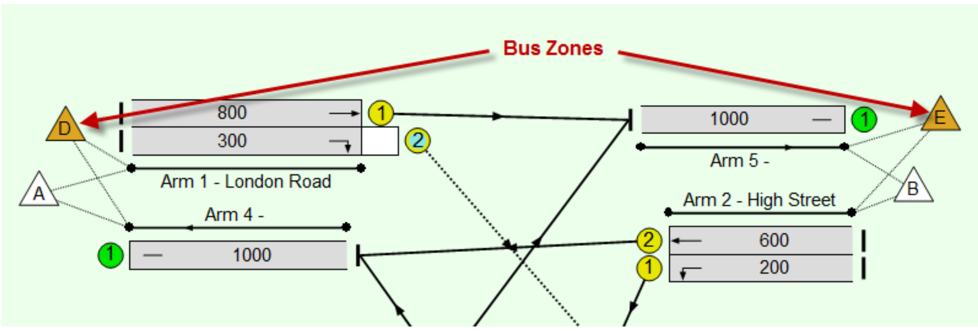
- **External Zones.** External Zones feed traffic into the end of an Arm which contains only Lanes with no incoming Lane Connectors, or receive traffic from an Arm which contains only Lanes with no outgoing Lane Connectors. They are typically used at entry and exit points around the edge of the Network. Most if not all Zones in the majority of models will be External Zones. In LinSig 3.1 and above more than one External Zone can be connected to the same Network Entry or Exit Arm.
- **Internal Zones.** Internal Zones feed traffic along an Arm which contains Lanes with incoming Lane Connectors and are used for two purposes. These are:
    - To represent traffic entering the Network from on-street parking or from a series of minor side roads which aren't important to model

explicitly. Traffic is fed uniformly across allowed Lanes and uniformly over the modelled time period. Internal Zones should be used sparingly where they are required. Overuse of unnecessary internal Zones in Networks which are wholly Matrix Based or contain large Matrix Based regions will lead to a much slower model.

- To represent the boundary between two Matrix Based Network regions or one side of the boundary between a Matrix Based region and a Lane Based Flow region. LinSig models traffic on Routes in the Matrix Based region which finish at the boundary Zone. In reality this traffic is continuing across the boundary to an adjacent Network region. Normally the cyclic flow profile shape of traffic terminating at a Zone is lost when traffic enters the Zone. In this case however the profile shape can be passed across the region boundary to an origin Zone or Lane Based Flow if the 'Inherit Cyclic Profile from Upstream Exit Lane' setting is set for Lanes immediately downstream of the region boundary. This setting can be found on the Advanced tab of the Edit Lane dialog box.



- **Bus Zones.** Bus Zones are new in LinSig 3.1 and allow start and end points of a Bus Route to be defined. Bus Zones can be set to only generate Routes to other Bus Zones which are defined as Bus Routes. Bus Routes are modelled using the Bus modelling settings set on Lane Connectors. This allows the different behaviour of Buses to normal traffic to be modelled. This includes issues such as bus stop times and increased platoon dispersion of Bus traffic. Normally Bus traffic will be specified directly on Bus Routes between Bus Zones rather than assigning an OD Matrix to Bus Routes.

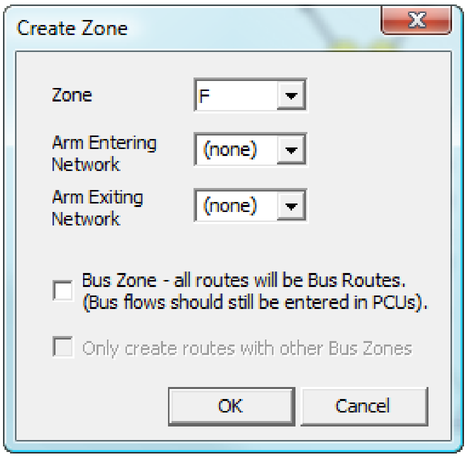


As the number of movements which LinSig needs to model increases proportional to the square of the number of Zones, excessive use of many small Zones will slow down the traffic model and optimiser considerably.

4.3.8.1. Creating Zones

To create a Zone:

- Choose 'Add Zone' from the 'Zones' pop-out menu on the Network menu.
- Position the Zone in the Network Layout View and drop it by clicking with the mouse.
- The Create Zone dialog box is displayed to configure the new Zone.



- The Create Zone dialog box allows the following settings to be specified:
  - **The Zone's Name.** Zones are always named as a letter. Zones can be named in any order but there can be no gaps in the sequence of Zone names. If a Zone is given the same name as an existing Zone the new Zone is inserted in the sequence and Zones later in the name sequence are renumbered.
  - **Arm Entering Network.** The Network Entry Arm which the Zone feeds traffic too. Currently each Zone can only feed traffic to one Arm.
  - **Arm Exiting Network.** The Network Exit Arm which the Zone receives traffic from. Currently each Zone can only receive traffic from one Arm.
  - **Bus Zone.** This setting defines the Zone as a Bus Zone. All Routes created from or too the Zone will be Bus Routes.
  - **Only Create Routes with other Bus Zones.** For Bus Zones if this setting is selected LinSig will only create Bus Routes from this Zone to other Bus Zones. In most cases selecting this setting will give the best results as allow buses are then kept separate from non-bus traffic.
- Click 'OK' to create the Zone. The Zone displays dotted Zone Feeds in the Network Layout View to indicate which Lanes it is feeding traffic to or accepting it from.

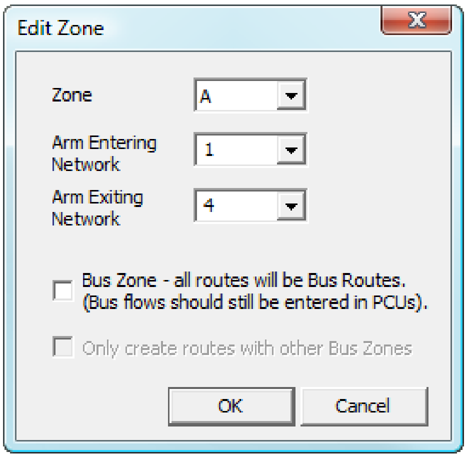
4.3.8.2. Repositioning Zones

A Zone can be repositioned by dragging it to its new position with the mouse.

4.3.8.3. Editing Zones

Zones are edited as follows:

- Select the Zone with the mouse.
- Choose ‘Edit Zone’ from the ‘Zones’ pop-out menu on the Network Menu.
- The Edit Zone dialog box is displayed which is identical to the Create Zone dialog described in ‘Creating Zones’ above.



- The Zones settings can be changed in the same way as described above in ‘Creating Zones’.

Disconnecting a Zone from its entry or exit Arm will delete all Routes starting from or ending at the Zone depending on which Arm is disconnected. Any traffic flow allocated to Routes which are deleted will be de-allocated and the Actual Flows Matrix in the Traffic Flows View will show a flow deficit reflecting this. The flow on Routes through the disconnected Zone Connector should be reallocated to the new Routes created when the Zone is reconnected possibly to a different Arm. This can be done either manually using the Route List View or by reallocating all flows to Routes by choosing ‘Allocate OD Flows to Routes’ from the Routes menu. More information is given in the section on the Traffic Flows View.

4.3.8.4. Deleting Zones

A Zone can be deleted by selecting it with the mouse and choosing ‘Delete Zone’ from the ‘Zones’ pop-out menu on the Network Menu.

Deleting a Zone also deletes any Routes originating or ending at the Zone and also deletes any traffic flows originating from or travelling to the Zone in the Traffic Flow View’s Origin-Destination Matrix. Zones should not be deleted unless you wish to delete its associated traffic flow data. When restructuring the Network instead of deleting the Zone a better option may be to disconnect the Zone from its entry and/or exit Arms and reconnect it to new Arms as appropriate. This will retain OD flow information but Route flows will need to be recreated either by automatic assignment or by manually editing route flows.

4.3.9. *Working with Lane Based Flows*

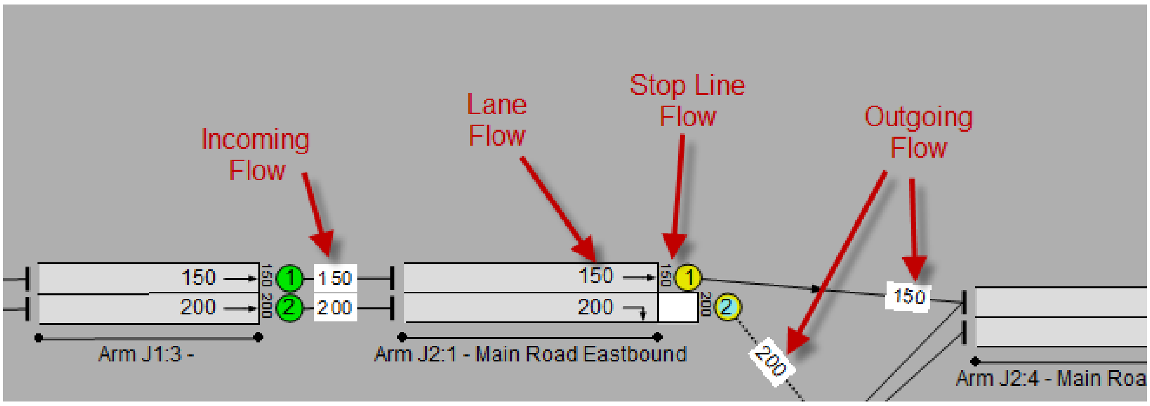
Lane Based Traffic Flows are new in LinSig 3.1 and are an alternative simpler way of defining traffic flows compared with an OD Matrix and Routes as used by Matrix Based Networks. Traffic Flows are defined as a Total Traffic Flow for each Lane together with Incoming and Outgoing Turning Flows. Other than the immediate previous and next Lanes for each Lane, Lane Based Flows contain no information on how traffic routes over the wider Network.

Further details of Lane Based Flows, including how to decide when to use them in preference to Matrix Based Flows is given in the Essential Background Section. This section describes the different ways Lane Based Flows can be entered and edited once the decision to use them has been taken.

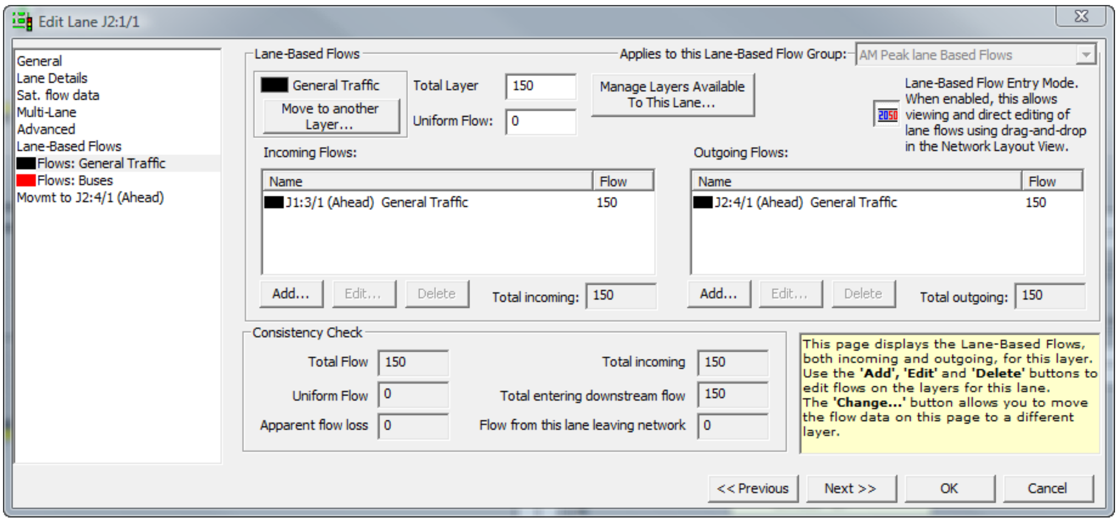
4.3.9.1. Methods for Entering and Editing Lane Based Traffic Flows

Lane Based Traffic Flows can be entered or edited in two different ways. These are:

- **Lane Based Flow Editing Mode on the Network Layout View.** This graphical drag and drop editing method is the easiest way of quickly entering Lane Based Flows.



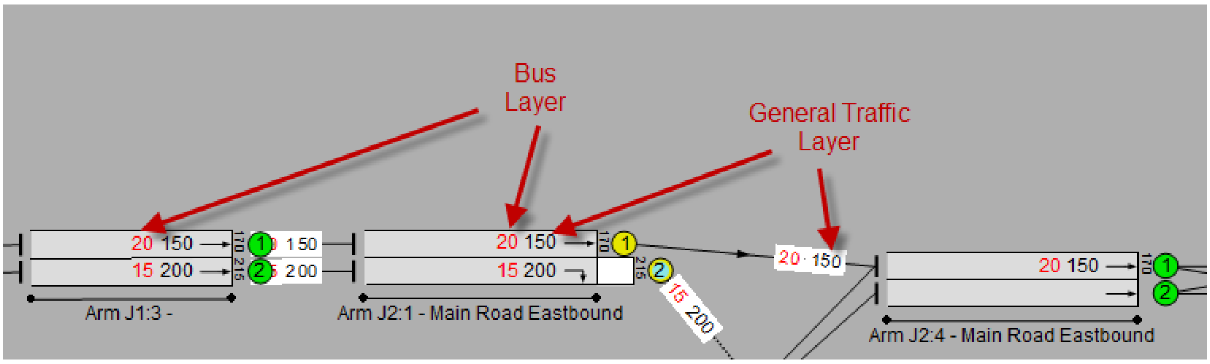
- **Lane Based Flow Tabs of the Edit Lane Dialog Box.** The Edit Lane dialog box provides one or more tabs which allow detailed editing of Lane Based Flows on a Lane. This method is simply an alternative non-graphical method of entering the same data as the graphical method.



Normally the graphical method will be used to enter the majority of traffic flow information with the Edit Lane dialog box being used to drill down and adjust detail where necessary.

4.3.9.2. Using Lane Based Flow Layers

Lane Based Flow Layers can be used to separate out different traffic types or movements in a Network or region of Network defined using Lane Based Flows. For example bus traffic or traffic between two points in the Network can be separated out. LinSig models each Layer separately whilst allowing for interaction between traffic in each Layer. If multiple Layers are used Traffic Flows are entered separated into Layers.

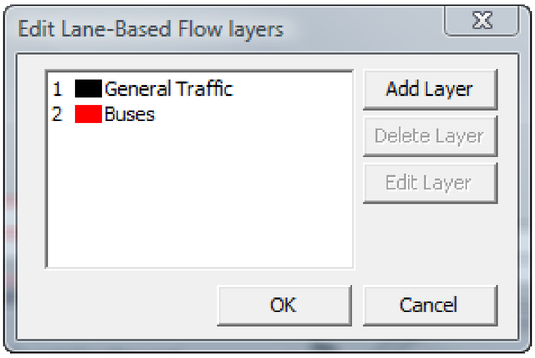


Each of the above entry methods support Lane Based Flow Layers.

If it is not required to disaggregate Lane Based traffic flows in any way it is unnecessary to use multiple Lane Based Flow Layers and the default 'General Traffic' Layer provided can be used for all traffic flows.

Managing Lane Based Flow Layers

Lane Based Flow Layers are defined using the 'Edit Lane Based Flow Layers' dialog which can be opened by choosing 'Edit Lane Based Flows' from the Traffic Flows menu or from the Network Layout View's toolbar.

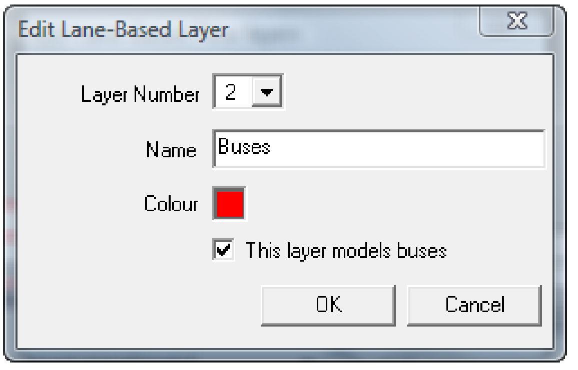


Creating a New Flow Layer

A new Flow Layer can be created by clicking 'Add layer' in the Edit Flow Layers dialog box. This creates a new Flow Layer and opens the Edit Layer dialog box which can be used to set its initial settings as described below in 'Editing Flow Layers.'

Editing a Flow Layer

A Flow Layer is editing by selecting the Layer in the Edit Flow Layers dialog and clicking on Edit Layer. This opens the Edit Flow Layer dialog box.



The Edit Flow Layer dialog box allows the following settings to be edited:

- **Flow Layer Number.** This allows a Flow Layers number to be changed reordering the list of Flow Layers.
- **Flow Layer Name.** The Flow Layer Name describes the Flow Layer with a title such as 'Buses', Traffic to Development' or 'HCV Traffic'.
- **Layer Colour.** The Colour LinSig will use when displaying Flows on the Flow Layer on the Network Layout View.
- **This Layer Models Buses.** This setting tells LinSig to model traffic on this Layer using the bus traffic sub-model. This allows bus stop times to be modelled and also uses a different platoon dispersion mode to non-bus traffic.

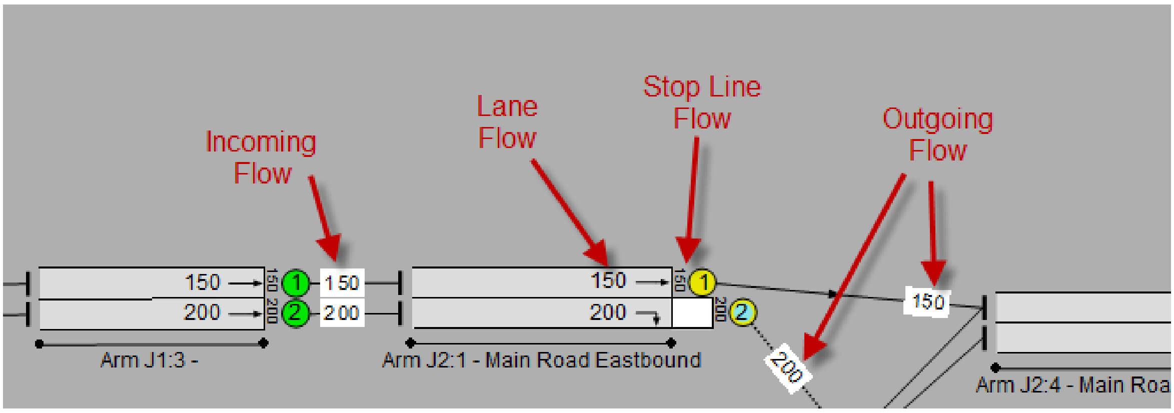
Deleting a Flow Layer

To delete a Flow Layer select the Layer and click 'Delete Layer' in the Edit Flow Layers dialog box. Any Lane Based Traffic flows present on the Layer are deleted when the Layer is deleted.

4.3.9.3. Lane Based Flow Display

Lane Based Flows are displayed in Lane Based Flow Mode using several different visual components. These include:

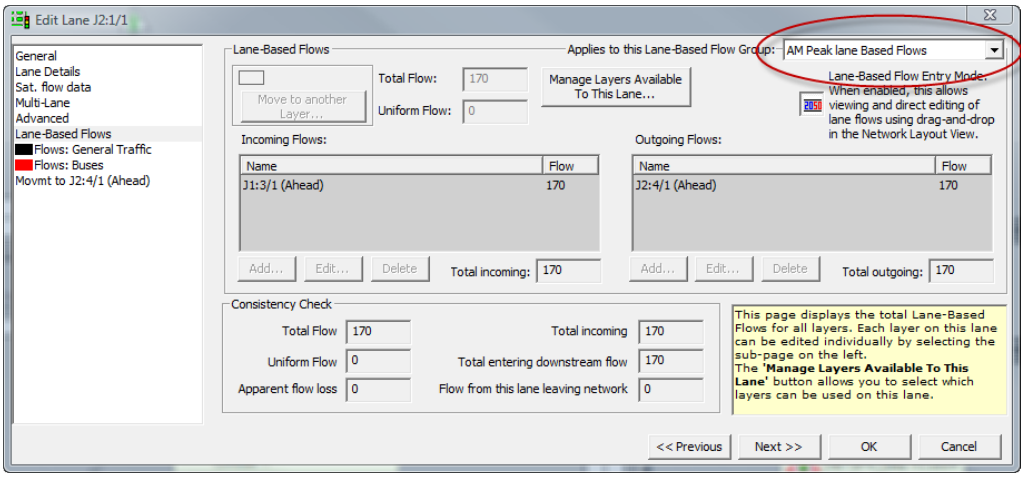
- **Lane Flow.** A Lane Flow is shown on each Lane where a Lane Based Flow is defined. It represents the traffic flow across the stop line for a Lane Based Flow Layer. One value will be displayed for each Layer used by the Lane.
- **Total Stop Line Flow.** The Total Stop Line Flow is display in front of each Lane. It is the total Lane Flow across all Layers.
- **Lane Connector Flow.** The Lane Connector Flow is displayed numerically on each Lane Connector. This represents a flow of traffic between two Lanes for a Flow Layer. An outflow from one Lane is always also an Inflow to another Lane.
- **Uniform Flow.** A Uniform Flow is shown on a Lane prefixed by 'U'. Uniform flows represent a source of traffic onto the Lane not incoming from another Lane. It feeds traffic onto the Lane at a constant rate throughout the signal cycle and is sometimes used to represent on street parking or other source of traffic along the Lane. It is relatively uncommon practice to use Uniform Flows as it is usually better to model sources of traffic explicitly in more detail.



Where Flows are displayed by Layer each Layer Flow is shown in the colour of the Layer it is on. Layer colours are defined using the Edit Layers dialog box which is opened by choosing 'Edit Lane Based Flow Layers' from the Traffic Flows menu.

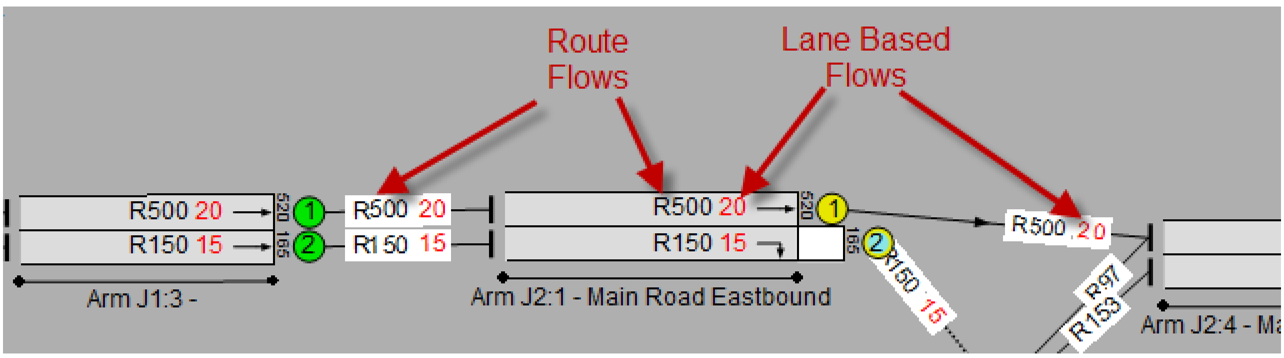
Choosing which Lane Based Flows to Show

Lane Based Flow Mode will display Lane Based Flows for the Flow Group selected in the Network Layout View toolbar. As Lane Based Flows define the assignment of flows to the Network they are defined for each Flow Group not for each Scenario as Route Flows are. This is because Route Flows could assign differently for each Scenario depending on signal settings or other Scenario specific criteria.



Showing Route Flows as well as Lane Based Flows

As each Flow Group can potentially define both Lane Based Flows and Matrix Based Flows the Network Layout View can display Route Flows as well as Lane Based Flows when in Lane Based Flow Mode.



The Route Flows can be displayed by:

- Right clicking on the Network Layout View and choosing 'Show Route Flows in Lane Based Flow Entry Mode' from the pop-up menu.
- Choosing the 'Show Route Flows' button from the Network Layout View's toolbar.

Route Flows are displayed prefix by 'R' to distinguish them from Lane Based Flows.

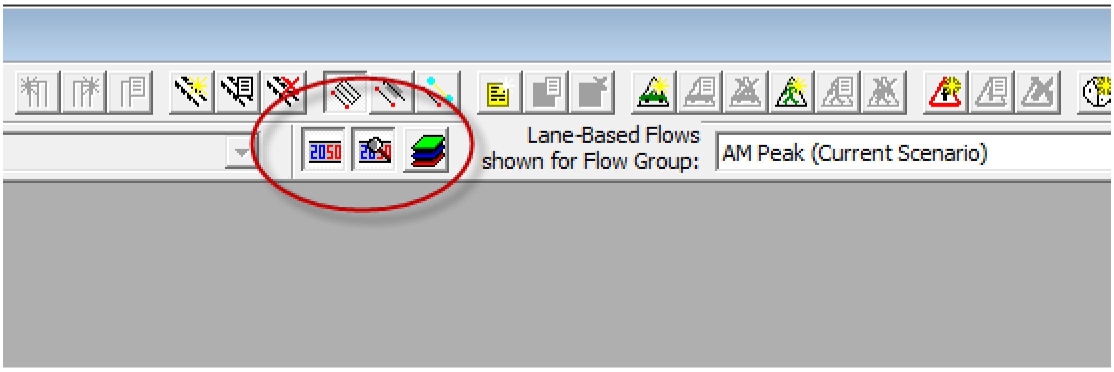
As Route Flows are defined for a Scenario not a Flow Group Route Flows are only available if the selected Flow Group is used by the currently selected Scenario. This ensures that only compatible Lane Based and Route Flows are displayed at any one time.

Displaying both Lane Based Flows and Route Based Flows is particularly useful when joining too different Network regions which define flows in different ways.

4.3.9.4. Managing Lane Based Flows using Graphical Drag and Drop

Lane Based Flows are edited graphically using Lane Based Flow Mode on the Network Layout View. Lane Based Flow Mode can be entered by one of the following methods:

- Choosing the Lane Based Flow button from the Network Layout View's toolbar.



- Right clicking on the Network Layout View and choosing 'Lane Based Flow Entry Mode' from the pop-up menu.
- Click the Lane Based Flow Entry Mode button on the Edit Lane dialog box.

When the Network Layout View is in Lane Based Flow Mode the background is shown in dark gray to distinguish it from Standard Mode.

Entering Lane Based Flows using Drag and Drop

When Lane Based Flows are edited using drag and drop a number of common cases arise. LinSig will always try to use existing flow and Layer information to intelligently anticipate what action is being carried out and attempts to minimise data entry.

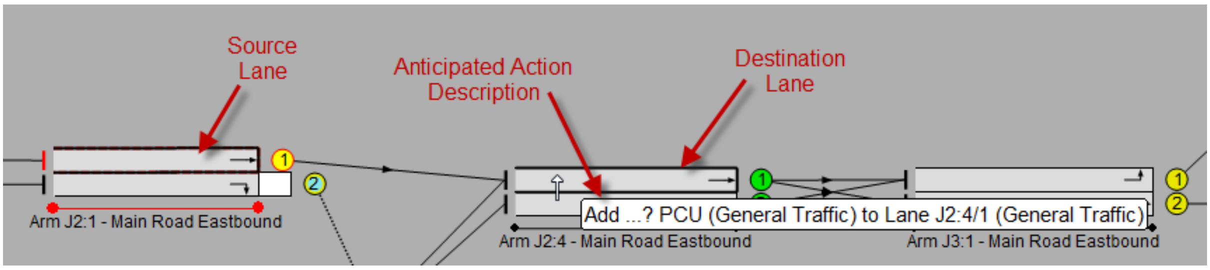
Case 1: Single Flow Layer, No existing Flows on Source and Destination Lanes

When a Lane Based Flow is added using drag and drop LinSig will add a Lane Connector Flow and also optionally add the flow to the upstream and downstream Lane's flow.

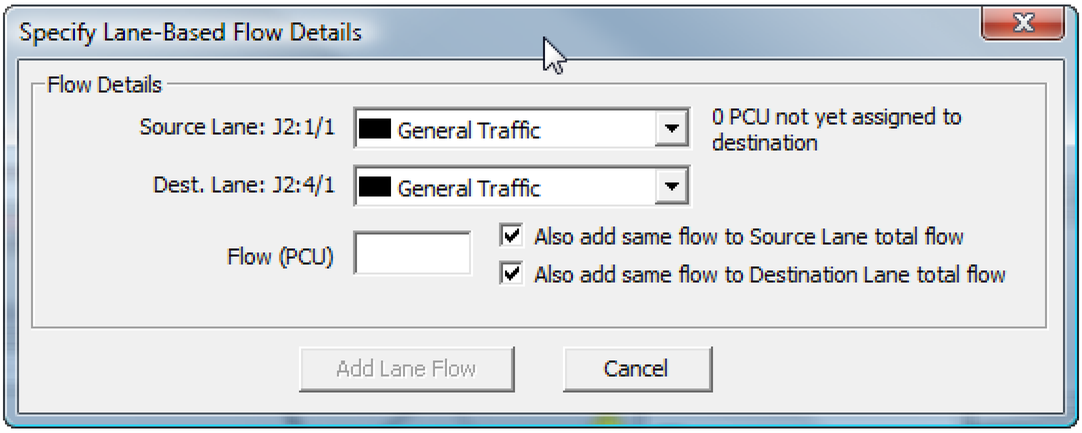
A Lane Based Flow can be added using the following procedure:

- Click on the Source Lane the traffic is leaving from.
- Drag with the mouse to the Destination Lane where traffic is moving to. This must be connected to the Source Lane with a Lane Connector. LinSig cannot chain flows over several Lanes and connectors.

- Whilst dragging LinSig will display a tooltip explaining what will be added if the mouse is released at that point. LinSig will make intelligent assumptions about what is intended in order to minimise data entry.



- Release the mouse button while pointing at the Destination Lane. LinSig will display the 'Specify Lane Based Flow Details' dialog box which allows detailed settings for the Lane Flow being entered to be specified.

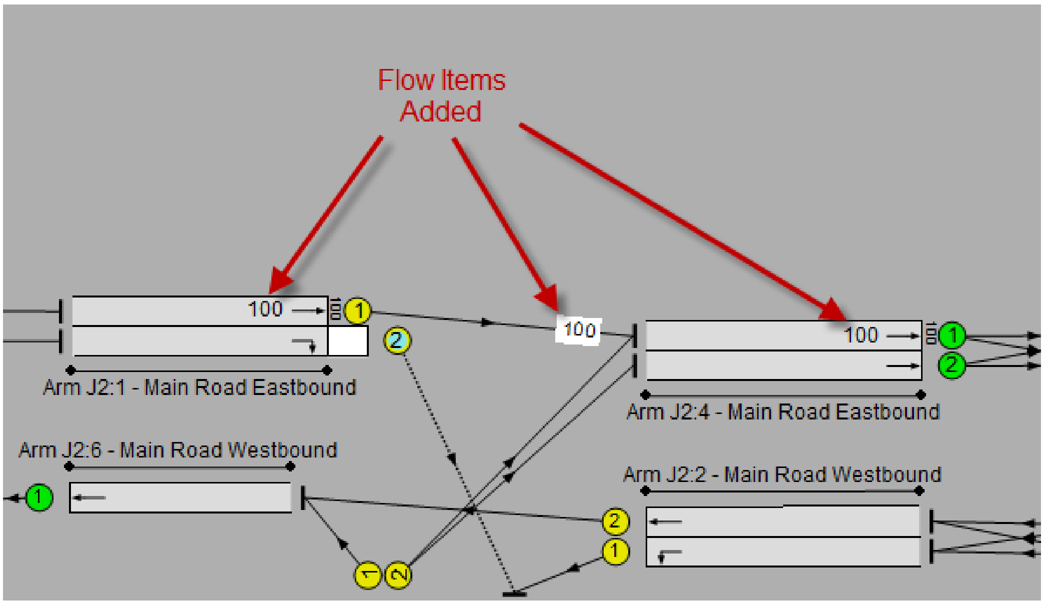


LinSig will again intelligently guess at most of the settings and for most typical situations little or no data entry will be required. In this case as only a single Layer is defined LinSig will set both Source and Destination Layers. In this case all that is required is to specify the amount of traffic travelling between the two Lanes in PCUs, for example in this case 100 PCU. The settings available are:

  - **Source Lane Layer**. The Layer on the Source Lane from which traffic is leaving.
  - **Destination Lane layer**. The Layer on the Destination Lane to which traffic is travelling. This will be the same as the Source Lane layer apart from unusual/advanced situations where multiple Layers are being merged.
  - **Also add same Flow to Source Lane Total Flow**. If this option is selected the flow being added is also added to the Source Lane's Total stop line flow for the Source Layer.
  - **Also add same Flow to Destination Lane Total Flow**. If this option is selected the flow being added is also added to the Destination Lane's Total stop line flow for the Destination Layer. This assumes that the traffic entering the Lane all reaches the downstream stop line.

- Click 'Add Lane Flow' to add the Lane Flow to the selected Flow Group.
- LinSig will add the following Flow items to Lanes:
  - As the 'Also add same flow to Source Lane Total Flow' setting was left selected 100 PCU flow crossing the stop line on the upstream Lane is added to the upstream Lane's Total Flow.

- 100 PCU flow is added to the Lane Connector between the Source and Destination Lane.
- As the 'Also add same flow to Destination Lane Total Flow' setting was left selected 100 PCU flow is assumed to reach the stop line on the downstream Lane and is added to the downstream Lane's Total Flow.



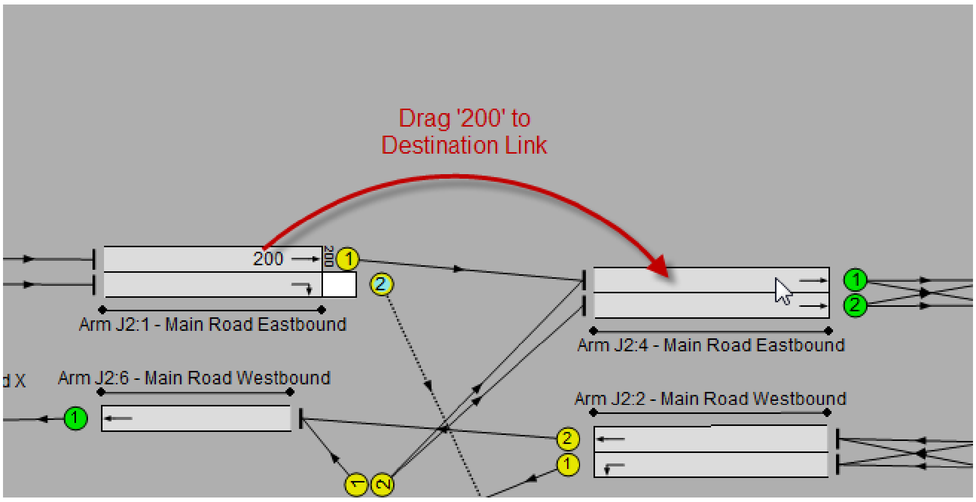
- These flow items are displayed on each of the Lanes and the Lane Connector.

Case 2: Single Flow Layer, Existing Flows on Source Lane

When existing flows exist on the Source or Destination Lane LinSig will make an intelligent guess on the most likely way they should be used whilst adding additional flows. Where these guesses are incorrect they can be overridden to specify the intended flow definition.

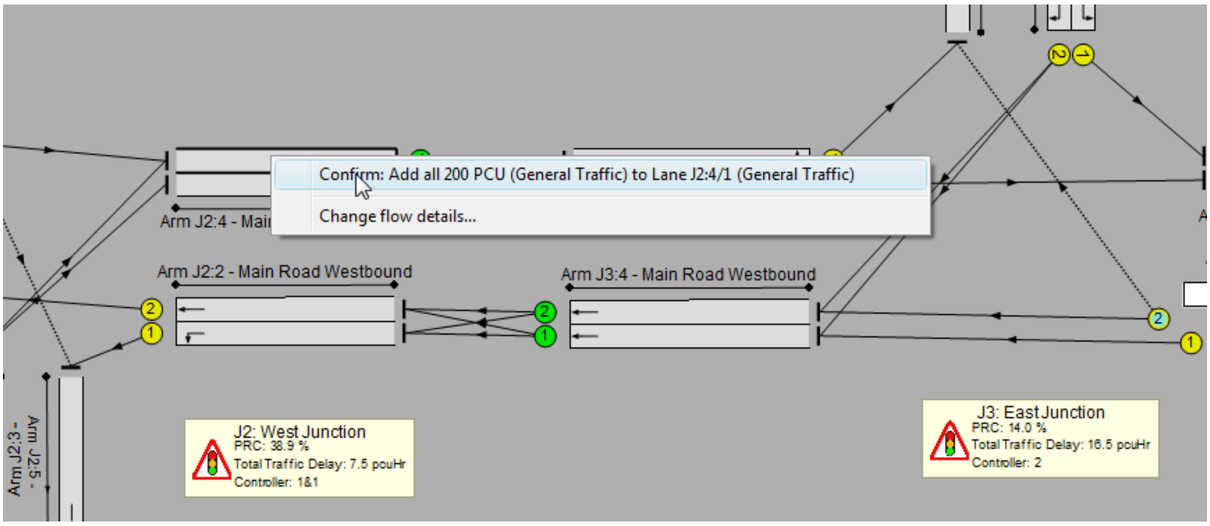
Assuming an upstream Lane contains a Total Flow of 200 PCU, Lane Based Flows can be added to downstream Lane Connectors and Lanes using the following procedure:

- Click on the '200' on Source Lane the traffic is leaving from.
- Drag with the mouse to the Destination Lane where traffic is moving to.

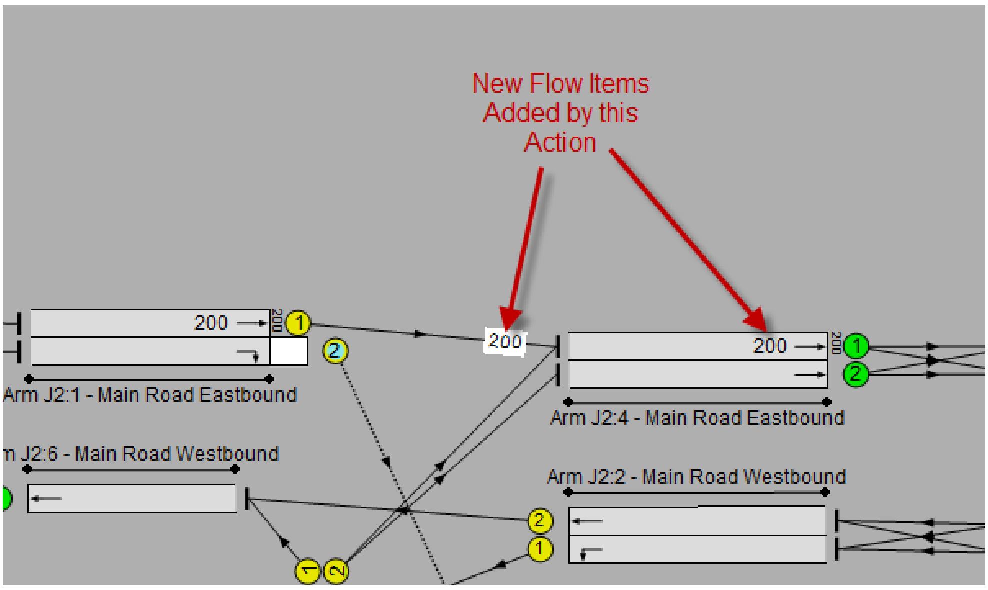


- Release the mouse button while pointing at the Destination Lane. As a Flow Value was dragged LinSig knows more information about what is happening and attempts to speed up the process by offering a guess at what action is being attempted instead of displaying the ‘Specify Lane Based Flow Details’ as happened in Case 1 above.

- The guessed action is displayed on a popup menu and if correct can be confirmed by selecting the guessed action in the menu. If the guessed action is not correct the action can be edited by choosing ‘Change Flow Details...’ from the popup menu which displays the ‘Specify Lane Based Flow Details’ dialog box which allows settings to be customised as described above in Case 1.



- If ‘Confirm: action’ is chosen from the pop-up menu LinSig adds 200 PCU to the Lane Connector and to the Destination Lane’s Total Flow. However as the 200 PCU on the Source Lane was not used on any outgoing Lane Connectors, LinSig anticipated that the desired action was to propagate the 200 PCU in the Source Lane to the Downstream Lane rather than add an additional 200 PCU and the flow is not added to the Source Lane’s Total Flow. If the ‘Specify Lane Based Flow Details’ dialog box had been opened this would have been reflected by the ‘Also add same flow to Source Lane Total Flow’ option being unticked. If this had been wrong it could of course of being changed by choosing to open the ‘Specify Lane Based Flow Details’ instead of just confirming the action and changing the option.



Case 3: Single Flow Layer, No Existing Flows on Source Lane with Multiple Outgoing Lane Connectors

Where a Source Lane has multiple outgoing Connectors LinSig will allow flows to be added to each Lane Connector in turn summing them to obtain the Total Flow on the Source Lane.

For a Lane with two outgoing Lane Connectors it is desired have a Total Flow of 300 PCU split between 200 PCU on one outgoing Connector and 100 on the other:

- Click on the Source Lane the traffic is leaving from.
- Drag with the mouse to one of the Destination Lanes where traffic is moving to.
- Release the mouse button while pointing at the Destination Lane. As in Case 1 above LinSig does not know how much flow is involved in this action and has insufficient information to make a guess. The 'Specify Lane Based Flow Details' dialog box is therefore displayed to request details of the action.
- In this case it is desired to add 200 PCU from the Source Lane to the first Destination Lane. The 200 PCU is entered into the dialog box and 'Add Lane Flow' clicked. All other options have been anticipated correctly. 200 PCU is added to the Source Lane Total Flow, the Lane Connector and the Destination Lane Total Flow.
- Drag with the mouse from the same Source Lane to the second Destination Lane.
- As the current Source Lane Total Flow is all allocated to outgoing Lane Connectors LinSig anticipates that flow is being added rather than propagated from the Source Lane as in Case 2. As new flow is being added and LinSig doesn't know how much flow is being added the 'Specify Lane Based Flow Details' dialog box is displayed to allow this to be entered. 100 PCU is entered as moving between Source and Destination Lanes.
- Additionally as LinSig has anticipated that flow is being added rather than propagated the options in the dialog box have both defaulted to adding the new flow to both Source and Destination Lanes.
- When 'Add Lane Flow' is clicked LinSig adds the 100 PCU to the Source Lane's Total Flow to give a new Total Flow of 300 PCU and adds 100 PCU to the Lane Connector and the Destination Lane's Total Flow.

Case 4: Single Flow Layer, Splitting Existing Flows on Source Lane between Multiple Outgoing Lane Connectors

Where a Source Lane has an existing Total Flow and multiple outgoing Connectors, LinSig will assist with splitting the Source Lane's Total Flow between the outgoing Lane Connectors.

For a Lane with an existing Total Flow of 400 PCU it is desired to split this flow between two outgoing Lane Connectors with 300 on the first Lane Connector and 100 on the second:

- Click on the '400' on Source Lane the traffic is leaving from.
- Drag with the mouse to one of the Destination Lanes where traffic is moving to.
- Release the mouse button while pointing at the Destination Lane. LinSig does not know how much of the flow is to be allocated to the first Lane Connector so guesses that all of the 400 PCU will be used. This is wrong in this case so instead of confirming the action 'Change Flow Details...' is chosen to open the 'Specify Lane Based Flow Details' dialog box.
- In the 'Specify Lane Based Flow Details' dialog box change the flow from 400 PCU to the 300 PCU which is to be allocated to this Lane Connector. As we are allocating

flow rather than adding flow the option to add the flow to the Source Lane's Total Flow is not required as LinSig has anticipated.

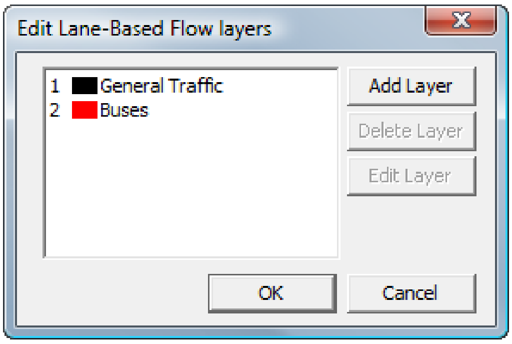
- To add the remaining 100 PCU to the second Lane Connector drag the '400' from the Source Lane to the second Destination Lane. LinSig will recognise that there are 100 PCU unallocated on the Source Lane and guess that all of these 100 PCU are to be allocated to this Lane Connector. This action can be confirmed without having to edit any options in the Specify Lane Based Flow Details' dialog box.

Case 5: Multiple Flow Layers, No existing Flows on Source and Destination Lanes

Where multiple Lane Based Flow Layers are being used, as described in 'Managing Lane Based Flow Layers' above, the drag and drop interface can also anticipate which Layers are being edited.

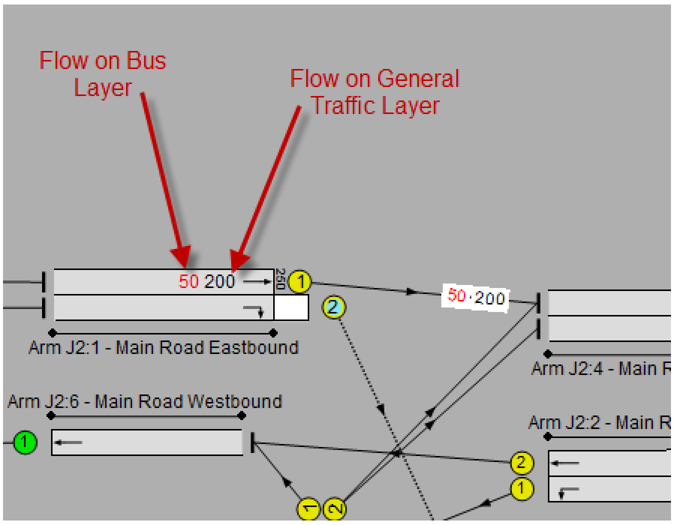
For a Lane with two Flow Layers: General Traffic; and Bus Traffic, 200 PCU are to be added to the General Traffic Layer and 50 PCU to the Bus Layer:

- Before editing Lane Flows the Flow Layers must first be set up using the 'Edit Lane Flow Layers' dialog box as described above in 'Managing Lane Based Flow Layers'. The default Layer is left unchanged as 'General Traffic' and coloured black. A new Layer is created coloured red and named 'Buses'.



- In a similar manner to Case 1 above drag from the Source Lane to the Destination Lane. As there are now multiple Layers LinSig cannot predict which Layer you are using and displays the 'Specify Lane Based Flow Details' dialog box to allow this information to be added. The Source and Destination Layers are set to 'General Traffic' and the flow is entered as 200 PCU. This is displayed in black as it is on the General Traffic Layer.

- Drag from the Source to the Destination Layer but avoid the current General Traffic numbers. LinSig will again be unable to guess which Layer is being used and show the 'Specify Lane Based Flow Details' to allow the Layer to be specified. This time select the red Bus Layer and enter 50 PCU for the flow. The flow is displayed in Red as it is on the Bus Layer.



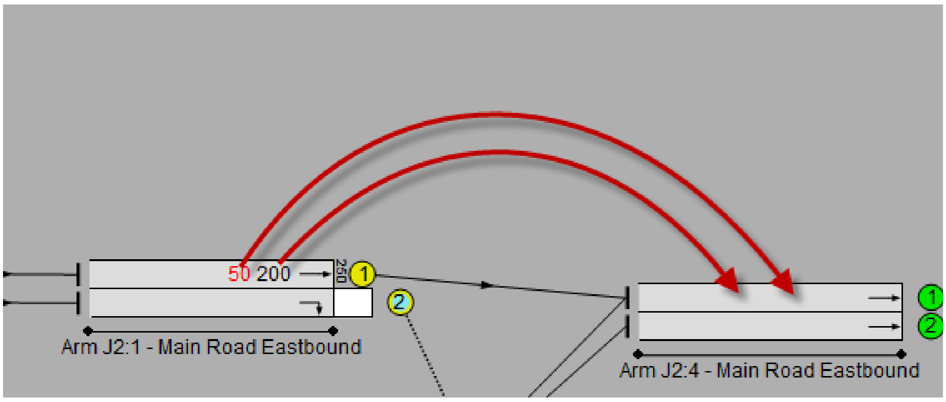
- Each Lane displays each Layers Total Flow. The Total Stop Line Flow across all Layers is displayed in front of the Lane.

Case 6: Multiple Flow Layers, Existing Flows on Source Layer

When existing flows exist on multiple Layers on the Source Lane LinSig allows each number to be dragged to another Lane to allocate traffic for that Layer to Lane Connectors. By dragging the individual numbers rather than just dragging from the Layer LinSig can guess more information and reduce the amount of data entry.

For a Lane with two Flow Layers: General Traffic; and Bus Traffic, 200 PCU Total Flow already exists on the General Traffic Layer and 50 PCU exists on the Bus Layer:

- Drag the black 200 PCU from the Source Lane to the Destination Lane.
- As traffic on the General Traffic Layer is being dragged LinSig guesses that it will be allocated to the General Traffic Layer on the Lane Connector and the Destination Lane. This allows it to make a guess at the action being carried out which can be confirmed from the pop-up menu avoiding the need to enter information in the 'Specify Lane Based Flow Details' dialog box.
- Drag the red 50 PCU from the Source Lane to the Destination Lane.
- Again LinSig can guess successfully that the 50 PCU is being added to the red Bus Layer on the Destination Lane.



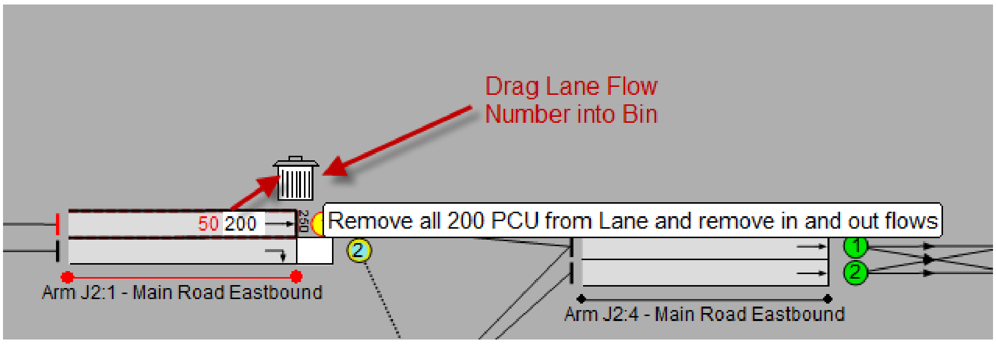
Other Cases

The above Lane Based Flow editing cases illustrate some of the main tasks which can be carried out using the drag and drop interface. The interface is very flexible and many other cases exist but most are combination or parallels of the cases described above.

Deleting Lane Based Flows using Drag and Drop

Lane Based Flows can also be deleted using drag and drop. This can be carried out as follows:

- Click on the Lane Flow number to be deleted with the mouse.
- Start dragging the Lane Flow number. A small 'bin' icon will appear next to the Lane.
- Drag over the bin and release the mouse effectively dropping the Lane Flow number into the bin.



- LinSig will delete the Lane Flow and any dependent incoming and outgoing Lane Connector Flows.

4.3.9.5. Entering Lane Based Flows using the Edit Lane Dialog Box

The Network Layout View's graphical drag and drop method is the easiest and quickest way of editing Lane Based Flows. However, this method cannot be currently used for every editing action. For example, Uniform Flows can only be currently edited using the Edit Lane dialog as described below. The Edit Lane dialog is not as automated as using the drag and drop method and is therefore not as fast to use, but allows finer control when editing Lane Based Flows.

The Edit Lane dialog is opened by selecting a Lane in the Network Layout View and choosing 'Edit Lane...' from the Lanes pop-out menu on the Network menu. Alternatively double clicking a Lane with the mouse or right clicking on a Lane and choosing 'Edit Lane...' from the pop-up menu will also open the Edit Lane dialog box.

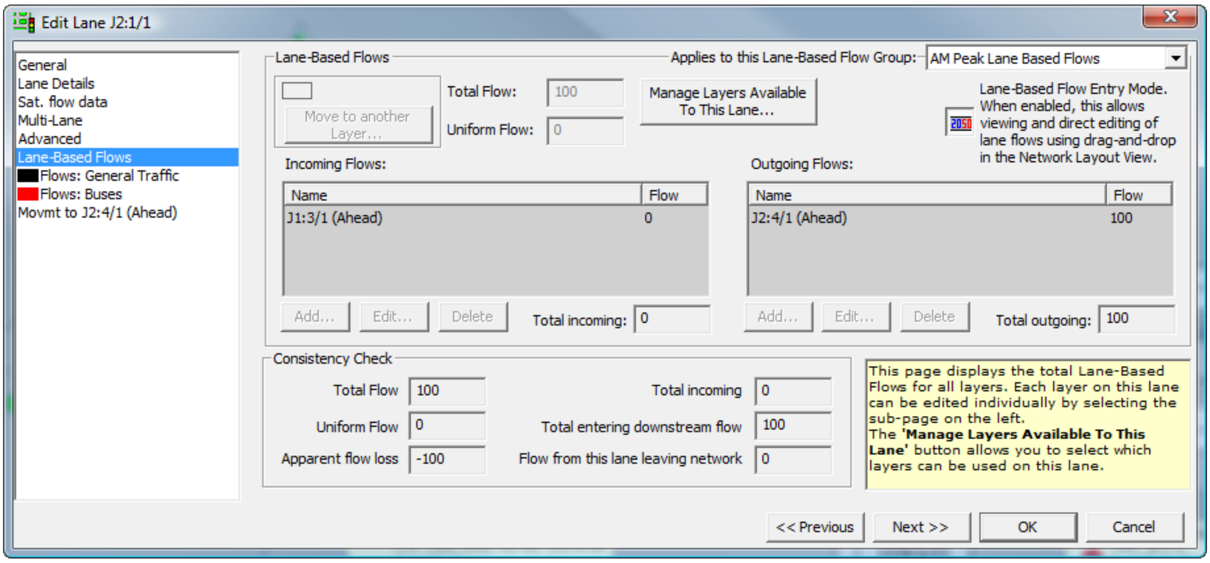
As well as being used to edit Lane Based Flows the Edit Lane dialog box can be used to edit a wide range of other settings on a Lane. Details of using the Edit Lane dialog box for editing other settings are provided in the 'Configuring Lane Settings...' section above.

Two of the tabs provided by the Lane Edit View can be used to edit Lane Based Flows. These are:

- **Lane Based Flow Summary.** The Lane Based Flow Summary tab is only present if Lane Based Flows are defined on a Lane with two or more Layers. This tab summarises the Lane Based Flows across all Layers and allows Layers to be managed.
- **Lane Based Flow Layers.** A separate tab is shown for each Lane Based Flow Layer using the Lane. The tab allows the total flow and incoming and outgoing flows to be specified for the layer.

Lane Based Flow Summary

The Lane based Flow Summary tab is only used where Lane Based Flows are being defined on a Lane and two or more Flow Layers are defined. The tab shows a summary of the total flow, incoming flows and outgoing flows across all Layers on a Lane and allows non-layer specific settings to be altered.

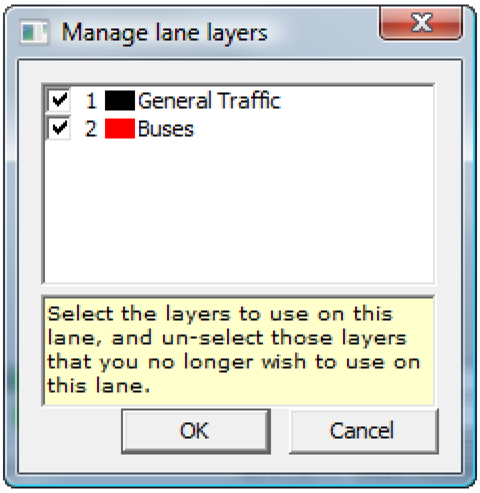


Summary Information displayed on this tab but not available for editing includes:

- **Total Flow (PCU).** The Total Flow is the total flow of traffic across the downstream stop line of this Lane summed over all Flow Layers on the Lane.
- **Uniform Flow (PCU).** The Uniform Flow displays the total Uniform Flow summed over all Flow Layers on the Lane.
- **Incoming Flows (PCU).** The Incoming Flow list lists all the Lane Connectors entering the Lane and shows the flow on each Lane Connector summed over all Flow Layers.
- **Outgoing Flows (PCU).** The Outgoing Flow list lists all the Lane Connectors leaving the Lane and shows the flow on each Lane Connector summed over all Flow Layers.
- **Consistency Check.** The consistency check table provides various totals of flows entering and leaving the Lane providing a quick check for flow consistency. The Flow Consistency Mode of the Network Layout View provides a much more comprehensive graphical check of flow consistency.

The settings available on this tab are:

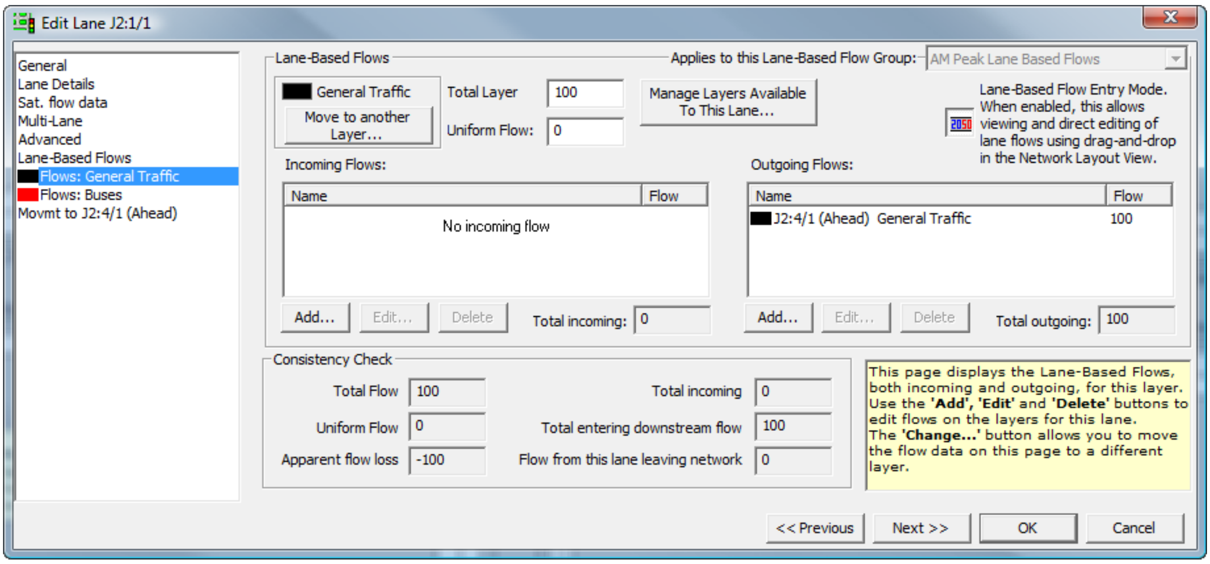
- **Selected Flow Group.** The Selected Flow Group sets which Traffic Flow Group is displayed in the Lane Edit dialog boxes Lane Based Flow tabs. This setting is the same as the Selected Flow Group Setting on the Network Layout View's toolbar. It is provided here for convenience as it allows Flow Groups to be changed without closing the dialog box.
- **Manage Layers Available to This Lane.** This setting opens a dialog box which can be used to select which Lane Based Flow Layers are used on the Lane.



The dialog lists all available Flow Layers showing the Layers available ticked. Layers can be ticked or unticked to make them available or remove them from the Lane. If a Layer is removed from a Lane all Lane Based Flows on that Layer are deleted. When editing flows using the graphical method Layers are automatically added to Lanes when flows are added. This method is only required when manual changes to Layers used by Lanes are required.

Lane Based Flow Layer

The Lane Based Flow Layer tab is used to edit traffic flows on a Lane Based Flow Layer and to manage Layers on the Lane. The drag and drop Lane based Flow editing system normally allows Lane Based Flows to be defined much more quickly and should be used in preference to this tab. This tab should only be used to edit detailed flow information not available using the drag and drop method.



In many cases where multiple Flow Layers are not required the Edit Lane dialog box will simply show a single Lane Based Flow Layer tab which can be used to edit all flows on the Lane.

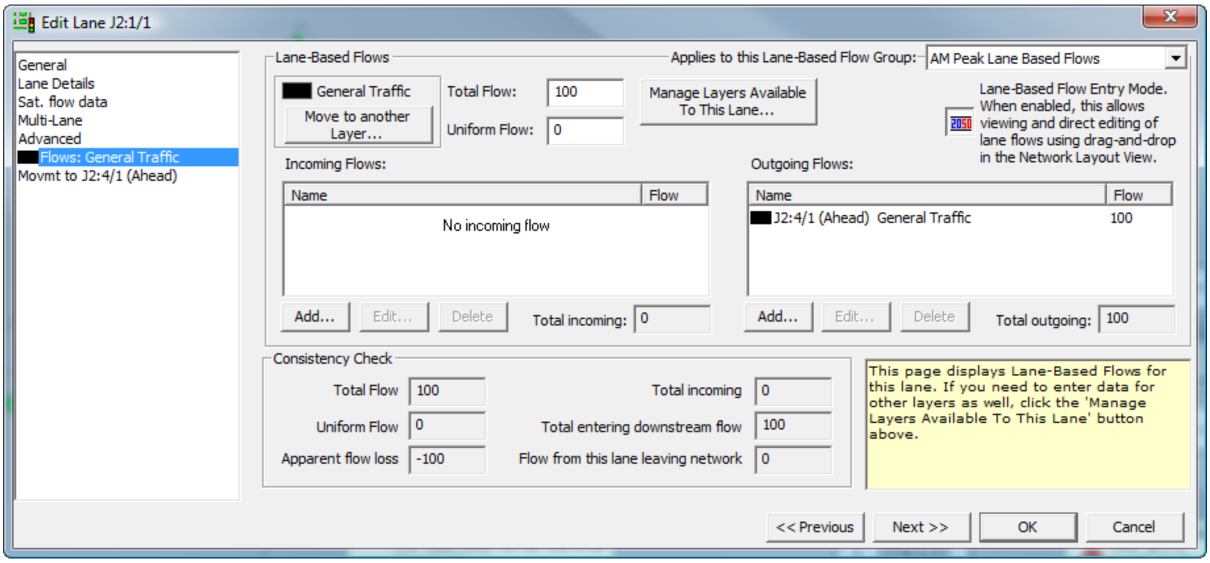
The settings available on the Lane Based Flow Layer tab are:

- **Total Flow (PCU).** The Total Flow is the total flow of traffic represented by this Flow Layer across the downstream stop line of this Lane.
- **Uniform Flow (PCU).** The Uniform Flow displays the total Uniform Flow on this Lane for this Flow Layer.

- **Incoming Flows (PCU).** The Incoming Flow list lists all the Lane Connectors entering the Lane and shows the flow on each Lane Connector on this Flow Layer.
- **Outgoing Flows (PCU).** The Outgoing Flow list lists all the Lane Connectors leaving the Lane and shows the flow on each Lane Connector on this Flow Layer.
- **Consistency Check.** The consistency check table provides various totals of flows entering and leaving the Lane using this Flow Layer and provides a quick check for flow consistency. The Flow Consistency Mode of the Network Layout View provides a much more comprehensive graphical check of flow consistency.
- **Change Layer.** The Change Layer button allows the traffic Flows defined on this Layer to be moved onto a different Flow Layer.
- **Manage Layers Available to This Lane.** This works the same way as on the Lane Based Flow Summary tab.
- **Lane Based Flow Entry Mode.** This button switches the Network Layout View into Lane Based Flow Entry Mode. This allows the Lane Based Flow drag and drop method of editing Lane Based Flows to be used.

Adding Lane Based Flows when using a Single Flow Layer

When using a single Flow Layer the Lane Based Flow Summary tab is not shown and a single Lane Based Flow Layer tab for the default Layer.



Lane Based Flows can be added using the Edit Lane dialog box as follows:

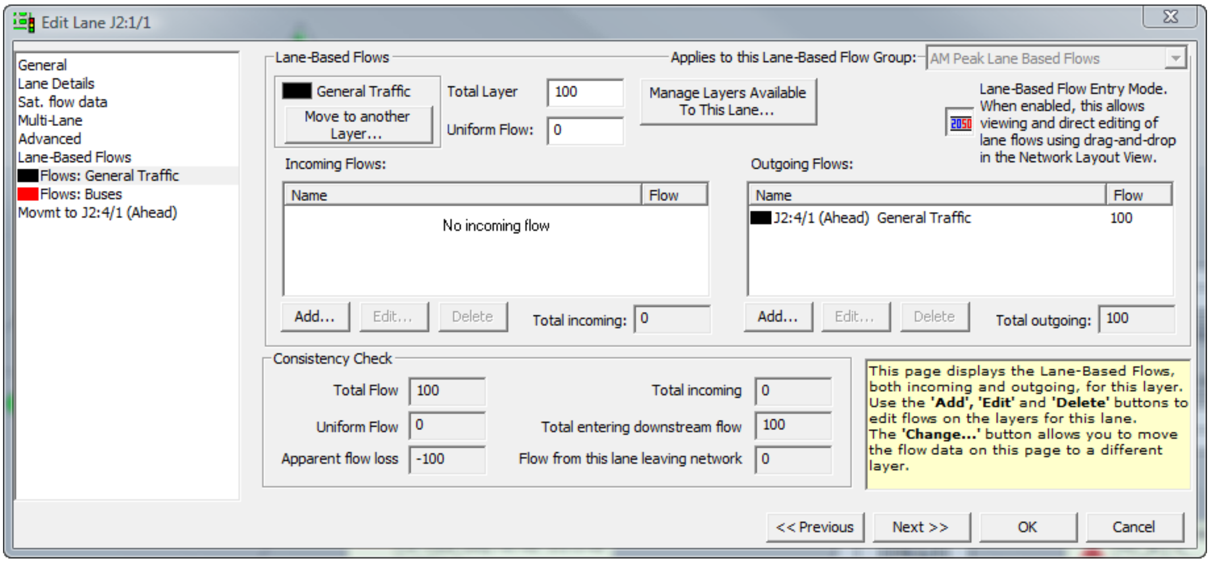
- Double Click a Lane which requires flows to be added. This will open the Edit Lane dialog box for this Lane.
- As only a single Flow Layer is being used LinSig automatically enables this Layer on a Lane when it is first edited.
- Select the Flow tab for the single Flow Layer.
- Enter the Total stop line flow on the Lane in Total Flow.
- Check the Incoming Flows and Outgoing Flows lists. As every Incoming Flow is also an Outgoing Flow for another Lane some entries may already exist in either list that were entered earlier when editing other Lanes.
- Click on ‘Add...’ for Incoming or Outgoing Flows as appropriate. This opens the ‘Specify Incoming Flow’ dialog box allowing either an incoming or outgoing turning

movement to be added. As only a single Flow Layer is being used LinSig presets the Source and Destination Layers for the incoming movement to the default Layer.

- Assuming that an Incoming Flow is being added the 'Specify Incoming Flow' dialog box allows the Source Lane for the Incoming Flow and the amount of flow in PCU to be entered.
- The new Lane Based Flow movement is displayed on the Network Layout View if it is set to Lane Based Flow entry mode.

Adding Lane Based Flows when using Multiple Flow Layers

When using multiple Flow Layers a Lane Based Flow Summary tab is shown as well as a separate Lane Based Flow Layer tab for each Flow Layer.



Lane Based Flows can be added using the Edit Lane dialog box as follows:

- Double Click a Lane which requires flows to be added. This will open the Edit Lane dialog box for this Lane.
- As multiple Flow Layers exist within the model LinSig does not know which ones are used by this Lane so the 'Manage Layers Available to this Lane' button must be used to specify which Layers are used. A new Lane Based Flow Layer tab will be created for each Layer.
- Select the Flow Layer tab for the Flow Layer on which traffic is to be added.
- Enter the Total stop line flow on the Lane on this Layer in Total Flow.
- Check the Incoming Flows and Outgoing Flows lists. As every Incoming Flow is also an Outgoing Flow for another Lane some entries may already exist in either list that were entered earlier when editing other Lanes.
- Click on 'Add...' for Incoming or Outgoing Flows as appropriate. This opens the 'Specify Incoming Flow' dialog box allowing either an incoming or outgoing turning movement to be added. The Layers in the 'Specify Incoming Flow' dialog box will be defaulted to the Layer currently being edited.
- Assuming that an Incoming Flow is being added the 'Specify Incoming Flow' dialog box allows the Source Lane for the Incoming Flow and the amount of flow in PCU to be entered.
- The new Lane Based Flow movement is displayed on the Network Layout View if it is set to Lane Based Flow entry mode.

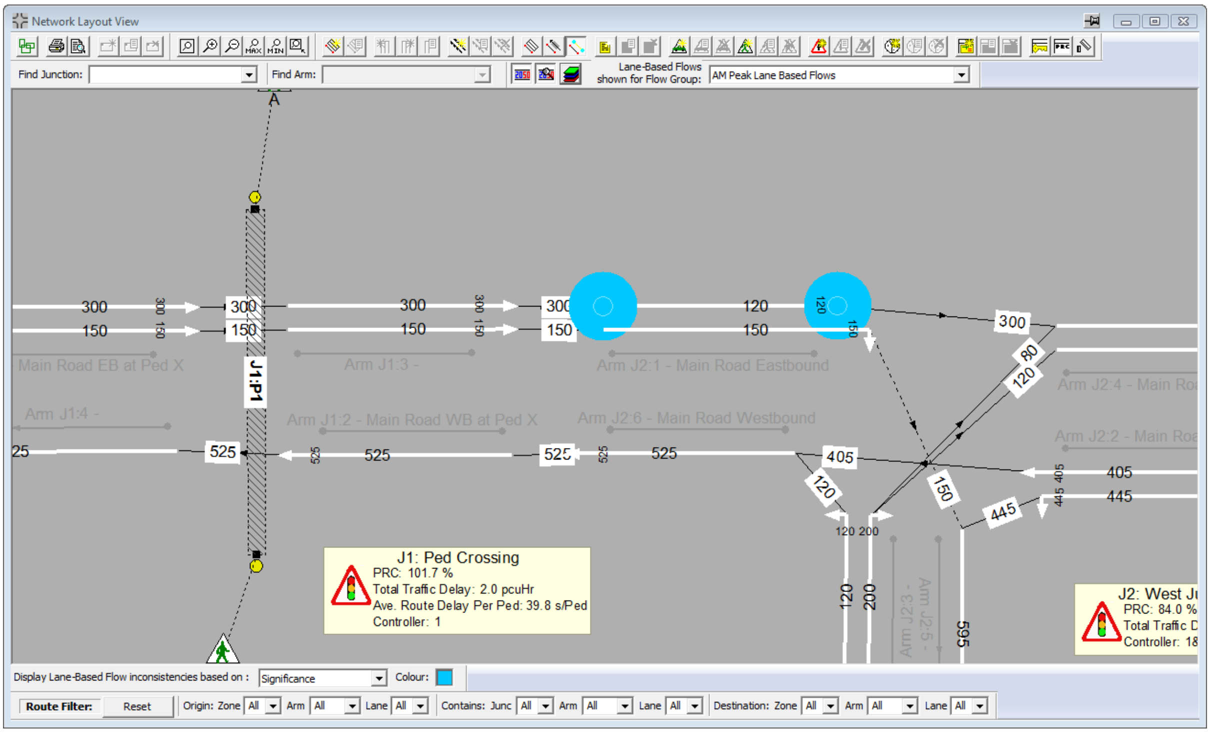
When using the graphical Lane Based editing LinSig updates several dependent flow items at once when adding flows. However, when using the Edit Lane dialog box each flow item must be edited separately.

4.3.9.6. Checking Lane Based Flows for Consistency Errors

Although Lane Based Flows provide a lot of flexibility it is very easy to introduce flow errors into the Network. The Network Layout View provides a Flow Consistency Check Mode which allows flow errors to be quickly located and corrected.

Flow Consistency Mode can be switched on in the Network Layout View by choosing 'Flow Consistency Mode' from the main View menu.

When Flow Consistency Mode is switched on the Network Layout View changes to show Lane arrows instead of normal Lanes. Lane Based Flows are also shown for the currently selected Flow Group.



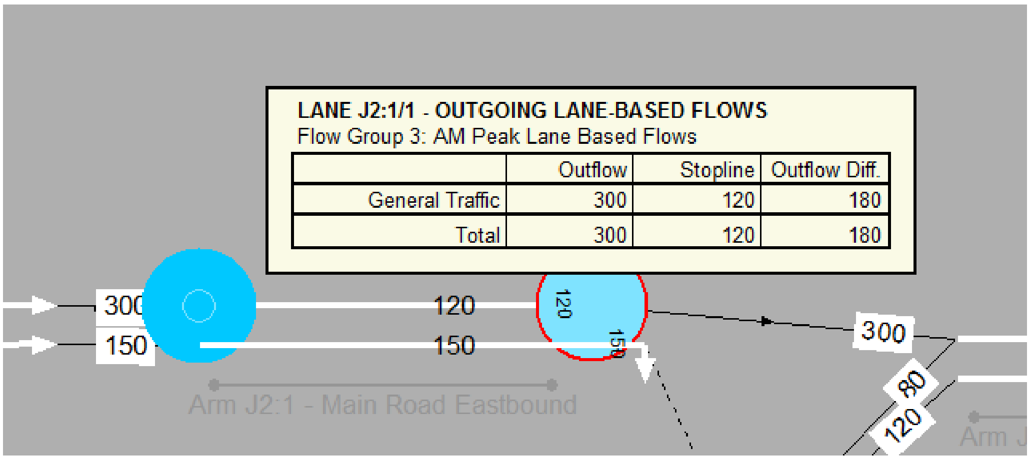
Flow Consistency errors are highlighted at the upstream and downstream end of each Lane. Where a consistency error occurs LinSig displays a coloured circle the size of which depends on the size of the consistency error.

The size of the circle can be changed using the 'Display Lane Based Flow Inconsistencies based on:' option on the Network Layout View's bottom toolbar. The options available are:

- **Absolute Difference.** The circles are scaled by the absolute level of flow inconsistency.
- **Percentage Difference.** The circles are scaled by the percentage difference of flow inconsistency.
- **Significance.** A combined measure of absolute and percentage error similar to the GEH statistic for comparing flows is used. This is the recommended setting. The setting in effect scales the circles non-linearly so small errors are not missed and large errors do not create large circle obscuring the background.

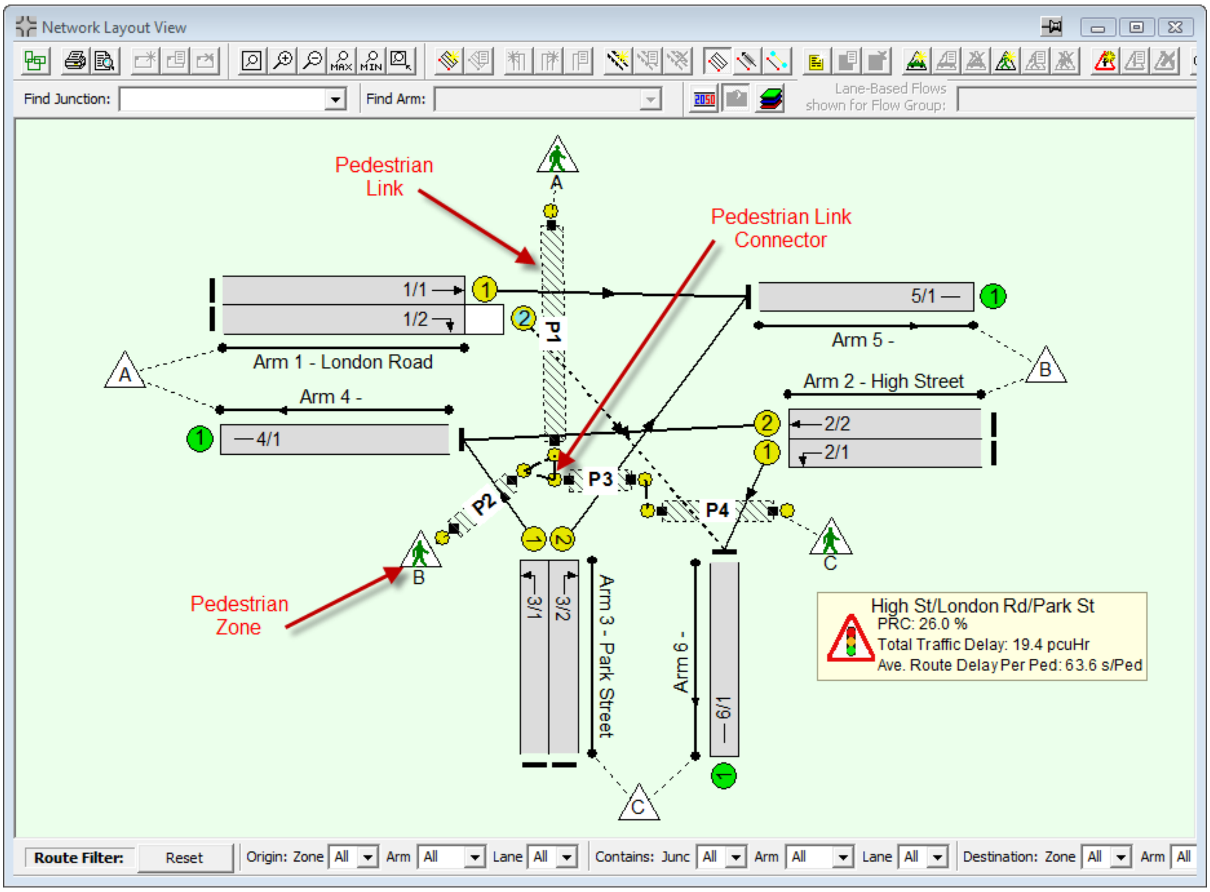
Flow Inconsistency Details

Additional details of Flow Consistency errors can be obtained by hovering over the consistency error warning indicator with the mouse. This displays a pop-up table providing details of traffic flows at the point of the inconsistency warning.

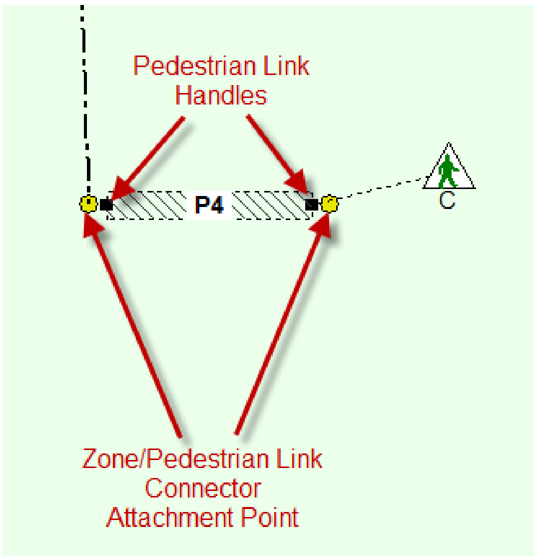


4.3.10. Working with Pedestrian Links

Pedestrian Links are used in LinSig to represent and model pedestrian crossings. Typically a Pedestrian Link is used to model each crossing in the Junctions being modelled.



Pedestrian Links are displayed as follows:



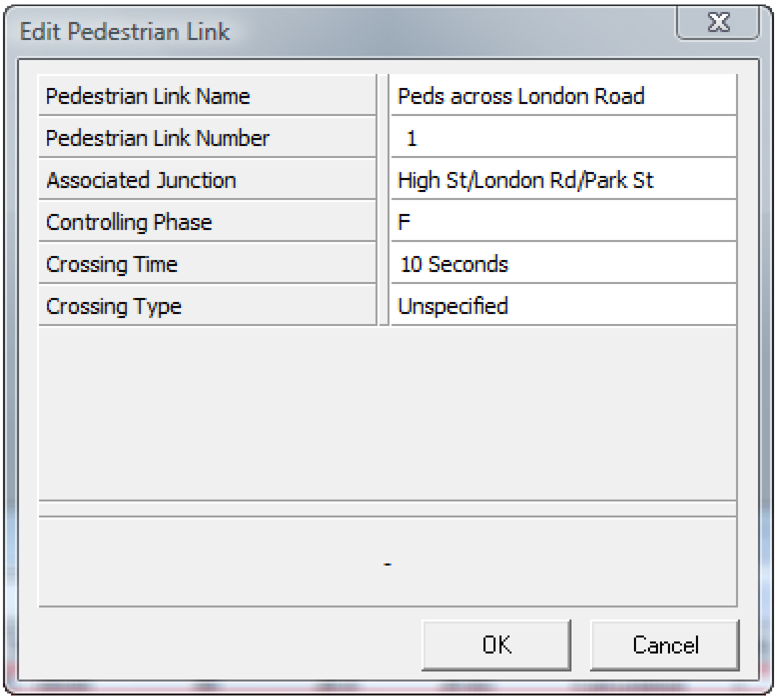
Pedestrian Links together with Pedestrian Link Connectors form a Pedestrian Network for each LinSig Junction. Pedestrian movements between junctions are not modelled. Due to issues such as pedestrian dispersion, crossing at places other than a controlled crossing and leaving the Network between Junctions modelling pedestrians over a wider area is complex and beyond what LinSig is intended to model.

LinSig uses each Junction's Pedestrian Network to model Pedestrian walk and delay times from one side of the Junction to another. If this involves several crossings LinSig takes account of Pedestrian coordination when modelling delays.

4.3.10.1. Creating New Pedestrian Links

New Pedestrian Links can be created in the Network Layout View as follows:

- Choose 'Add Pedestrian Link…' from the 'Pedestrian Links' pop-out menu on the Network menu. A new Pedestrian Link will be created which can be dragged into its desired position and dropped by clicking with the mouse. If necessary the Pedestrian Link can be rotated and repositioned more accurately after it has been created as described below in 'Moving and Repositioning Pedestrian Links'.
- When the Pedestrian Link is dropped the Edit Pedestrian Link dialog box is displayed. This allows the Pedestrian Link's settings to be entered.



- The following settings are available for an Pedestrian Link:
    - **Pedestrian Link Number.** The Pedestrian Link Number will default to one more than the maximum Pedestrian Link Number of the existing Pedestrian Links. Pedestrian Links can be numbered in any order but all Pedestrian Link Numbers must be used with no gaps in the sequence. If the new Pedestrian Link is allocated the same number as an existing Pedestrian Link the new Pedestrian Link will be inserted into the Pedestrian Link numbering sequence and higher numbered Pedestrian Links renumbered.
    - **Pedestrian Link Name.** The Pedestrian Link Name is a simple text name to describe the Pedestrian Link.

- **Associated Junction.** The Junction the Pedestrian Link belongs to. All Pedestrian Links must belong to a Junction.
- **Controlling Phase.** The Phase controlling the Pedestrian Link. Only Pedestrian Phases on the Controllers and Streams attached to the Pedestrian Links Junction are available.
- **Crossing Time.** The time it takes an average pedestrian to cross the crossing from kerb to kerb. This is used for delay calculations and is not currently used for any intergreen calculations.
- **Crossing Type.** The Crossing type is for reference and future use only and is not currently used in any modelling.

- Click OK to finish creating the Pedestrian Link.

4.3.10.2. Moving and Repositioning Pedestrian Links

Pedestrian Links can be freely positioned using the mouse as follows:

- Select the Pedestrian Link's handles with the mouse. The Pedestrian Link turns red indicating it is selected.
- Use the square handles at each end of the Pedestrian Link to reposition the Pedestrian Link. Remember to use the square handles for dragging rather than the circular connection points.
- If you have a number of Pedestrian Links which you want to move together, for example all the Pedestrian Links at a Junction, they can be moved by dragging the Junction rather than one by one.

4.3.10.3. Editing Pedestrian Link Settings

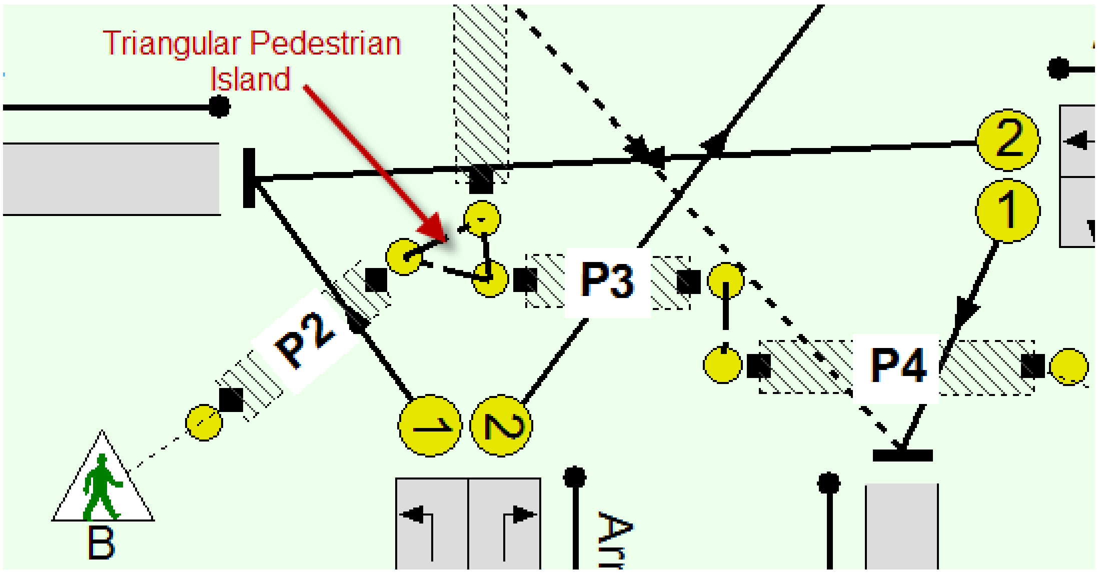
An Pedestrian Link can be edited by selecting the Pedestrian Link with the mouse and choosing 'Edit Pedestrian Link' from the 'Pedestrian Links' pop-out menu on the Network Menu. This displays the Edit Pedestrian Link dialog box which can be used to change the Pedestrian Link's settings as described in 'Creating New Pedestrian Links' above.

4.3.10.4. Deleting Pedestrian Links

A Pedestrian Link can be deleted by selecting the Pedestrian Link and choosing 'Delete Pedestrian Link' from 'Pedestrian Links' pop-out menu on the Network menu. It is important to remember that deleting a Pedestrian Link also deletes any Pedestrian Link Connectors and Pedestrian Routes associated with the Pedestrian Link. Undo is of course available in case of accidental deletion.

4.3.11. Joining Pedestrian Links with Link Connectors

Pedestrian Link Connectors are used in LinSig to define possible movements between Pedestrian Links when Pedestrian need to use more than one crossing to cross from one side of a junction to another. For example Pedestrian Link Connectors are used as shown below to define the movements possible through a pedestrian island.



The diagram above shows three Pedestrian Link Connectors joining three Pedestrian Links to define which pedestrian movements can be carried out on the island.

4.3.11.1. Creating Pedestrian Link Connectors

Pedestrian Link Connectors can either be created between two existing Pedestrian Links or can be created between an existing Pedestrian Link and a new Pedestrian Link created at the same time as the new Pedestrian Link Connector. The facility to create new Pedestrian Link Connectors on the fly allows Pedestrian Networks to be built more speedily.

To create a Pedestrian Link Connector between two existing Pedestrian Links:

- Drag the starting Pedestrian Link's Connection Point with the mouse. A Pedestrian Link Connector and new downstream Pedestrian Link will 'tear off' of the starting Pedestrian Link Connector.
- Drag the mouse pointer over the Connection Point on the Pedestrian Link where the Pedestrian Link Connector will end. The 'tear off' Pedestrian Link will disappear indicating no new Pedestrian Link will be created.
- Drop the Pedestrian Link Connector on the downstream Pedestrian Link by releasing the mouse. A new Pedestrian Link Connector will be created between the two Pedestrian Links. The Pedestrian Link Connector will be created with a default walk time which can be edited if desired as described below.

The ability to create a new Pedestrian Link simultaneously with a Pedestrian Link Connector is intended to speed the creation of Pedestrian Networks. To create a Pedestrian Link Connector with a new Pedestrian Link:

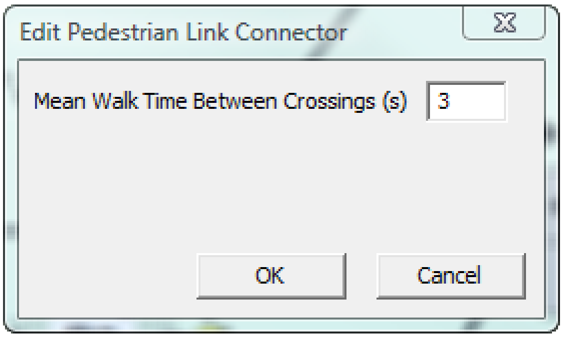
- Drag the starting Pedestrian Link's Connection Point with the mouse. A Pedestrian Link Connector and new downstream Pedestrian Link will 'tear off' of the starting Pedestrian Link Connector.

- Drop the 'tear off' Pedestrian Link anywhere other than on an existing Pedestrian Link. The Edit Pedestrian Link dialog box will open allowing you to enter the new Pedestrian Link's Name, Junction, Controlling Phase and crossing time as described above.
- Click OK in the Edit Pedestrian Link dialog box. A new Pedestrian Link will be created with a Pedestrian Link Connector joining it to the starting Pedestrian Link.
- Edit the new Pedestrian Link and Link Connector as appropriate.

4.3.11.2. Editing Pedestrian Link Connectors

Pedestrian Link Connectors are edited as follows:

- Select a Pedestrian Link Connector by clicking it with the mouse.
- Choose 'Edit Pedestrian Link Connector' from the 'Pedestrian Link Connectors' pop-out menu on the Network Menu. This opens the Edit Pedestrian Link Connector dialog box.



- The Edit Pedestrian Link Connector dialog box allows the Pedestrian Link Connector's only setting to be edited:
    - **Mean Walk Time Between Crossings.** The walk time between crossings is the time for a Pedestrian to walk across a pedestrian island or section of footway from the end of one pedestrian crossing to the start of another.

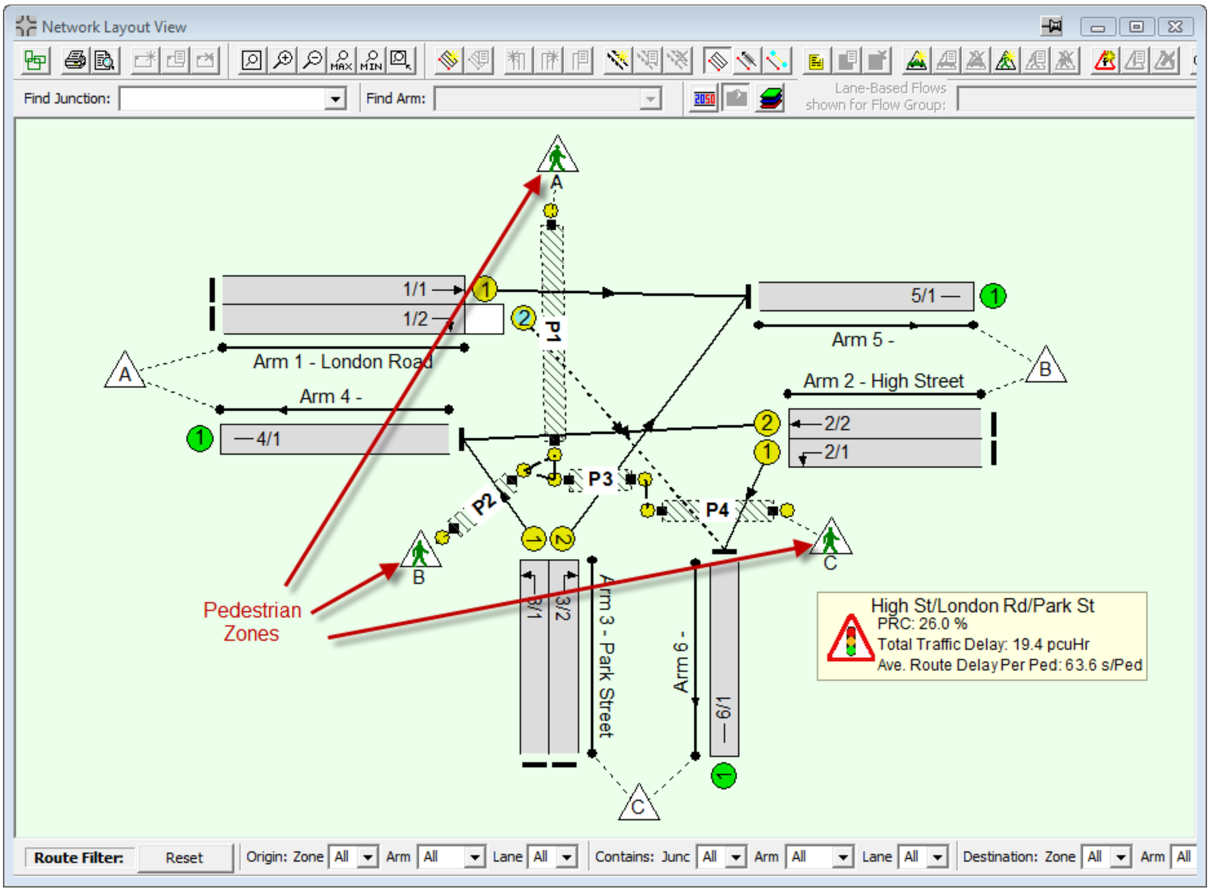
4.3.11.3. Deleting a Pedestrian Link Connector

A Pedestrian Link Connector can be deleted by selecting it with the mouse and choosing 'Delete Pedestrian Link Connector' from the 'Lanes' pop-out menu on the Network Menu.

Deleting a Pedestrian Link Connector also deletes any Pedestrian Routes passing through the Pedestrian Link Connector. Any Pedestrian flow allocated to Pedestrian Routes which are deleted will be de-allocated and Junction's Pedestrian Flow Matrix in the Traffic Flows View will show a flow deficit. Pedestrian Route Flows should be edited to reassign the lost Pedestrian Flow either to other existing Routes or to new Routes when the Junction's Pedestrian Network is complete.

4.3.12. Defining Pedestrian Start and End Points using Pedestrian Zones

Pedestrian Zones are used in LinSig to define points where Pedestrians start and end their walk through a LinSig Junction. All Pedestrian movements start from a Pedestrian Zone and end at a Pedestrian Zone. Pedestrian Zones are also used in the Traffic Flows View to reference the start and end points of Pedestrian movements entered in the Traffic Flow View's Pedestrian Junction Origin-Destination matrices.

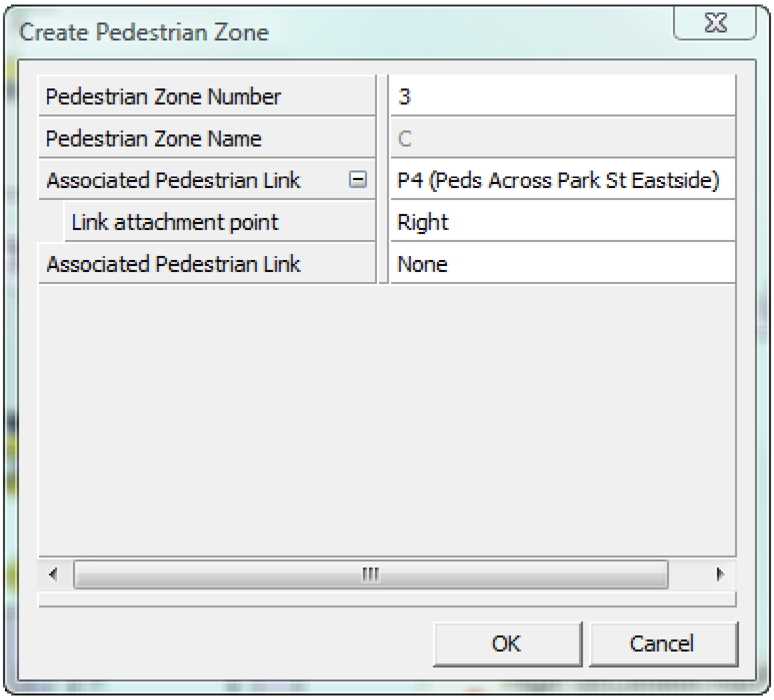


A Pedestrian Zone should be created for each point a pedestrian may start or finish a walk through a Junction.

4.3.12.1. Creating Pedestrian Zones

To create a Pedestrian Zone:

- Choose 'Create Pedestrian Zone' from the 'Pedestrian Zones' pop-out menu on the Network menu.
- Position the Pedestrian Zone in the Network Layout View and drop it by clicking with the mouse.
- The Create Pedestrian Zone dialog box is displayed to configure the new Pedestrian Zone.



- The Create Pedestrian Zone dialog box allows the following settings to be specified:
  - **The Zone's Name/Number.** Pedestrian Zones are always named as a letter. Pedestrian Zones can be named in any order but there can be no gaps in the sequence of Pedestrian Zone names. If a Pedestrian Zone is given the same name as an existing Pedestrian Zone the new Pedestrian Zone is inserted in the sequence and Pedestrian Zones later in the name sequence are renumbered.
  - **Associated Pedestrian Link.** The Pedestrian Link into which the Pedestrian Zone feeds Pedestrian traffic.
  - **Pedestrian Link Attachment Point.** Specifies which end of the Pedestrian Link the Zones attaches to.
- Click 'OK' to create the Pedestrian Zone. The Pedestrian Zone displays dotted Zone Feeds in the Network Layout View to indicate which Pedestrian Links it is feeding traffic to or accepting it from.

4.3.12.2. Repositioning Pedestrian Zones

A Pedestrian Zone can be repositioned by dragging it to its new position with the mouse.

4.3.12.3. Editing Pedestrian Zones

Pedestrian Zones are edited as follows:

- Select the Pedestrian Zone with the mouse.
- Choose 'Edit Pedestrian Zone' from the 'Pedestrian Zones' pop-out menu on the Network Menu.
- The Edit Pedestrian Zone dialog box is displayed which is similar to the Create Pedestrian Zone dialog described in 'Creating Pedestrian Zones' above.
- The Pedestrian Zones settings can be changed in the same way as described above in 'Creating Pedestrian Zones'.

Disconnecting a Pedestrian Zone from its associated Pedestrian Links will delete all Pedestrian Routes starting from or ending at the Pedestrian Zone. Any Pedestrian flow allocated to Pedestrian Routes which are deleted will be de-allocated and the Actual Pedestrian Flows Matrix in the Traffic Flows View will show a flow deficit reflecting this. The flow on Pedestrian Routes through the disconnected Pedestrian Zone Connector should be reallocated to the new Pedestrian Routes created when the Pedestrian Zone is reconnected possibly to a different Pedestrian Link. This can be done using the Pedestrian Route List in the Route List View. More information is given in the sections on the Traffic Flows and Route List Views.

4.3.12.4. Deleting Pedestrian Zones

A Pedestrian Zone can be deleted by selecting it with the mouse and choosing 'Delete Pedestrian Zone' from the 'Pedestrian Zones' pop-out menu on the Network Menu.

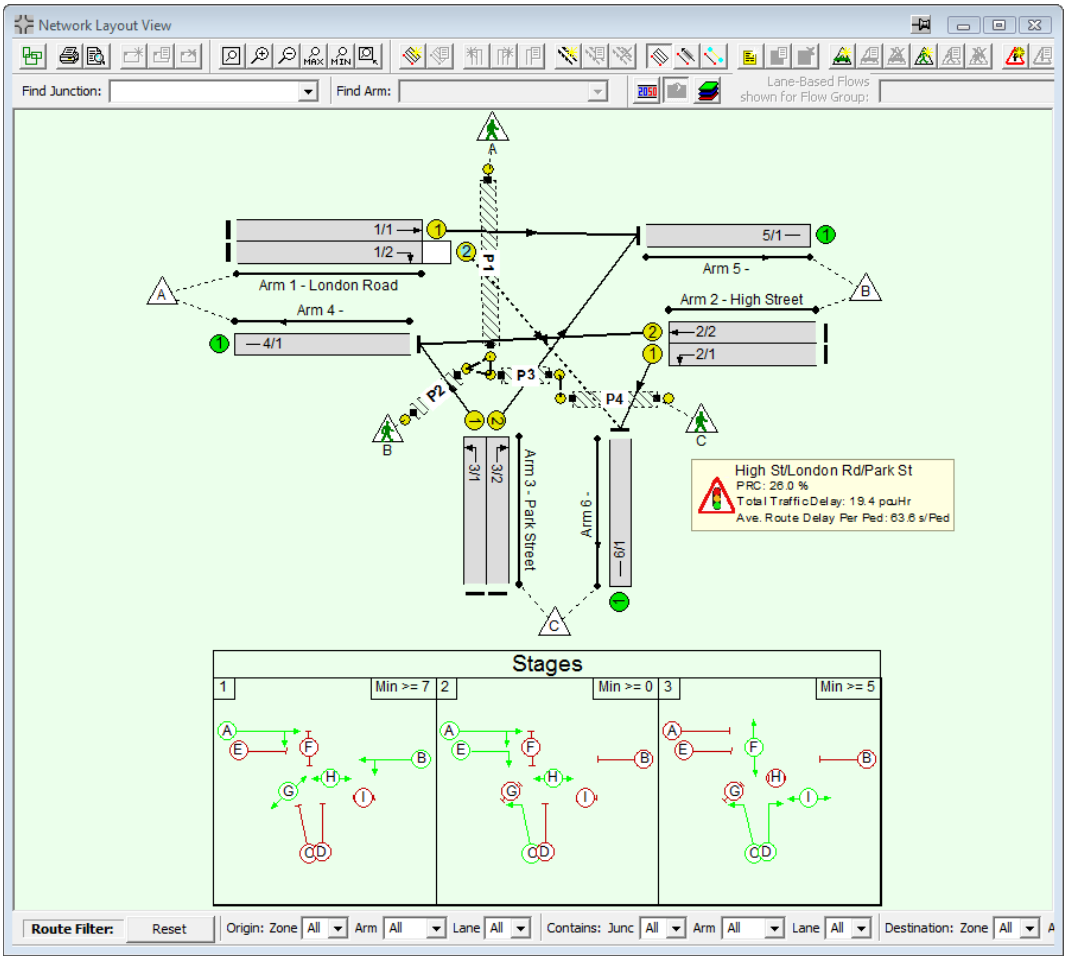
Deleting a Zone also deletes any Pedestrian Routes originating or ending at the Pedestrian Zone and also deletes any Pedestrian flows originating from or travelling to the Zone in the Traffic Flow View's Junction Pedestrian Origin-Destination Matrices. Pedestrian Zones should not be deleted unless you wish to delete its associated Pedestrian flow data. When restructuring the Network instead of deleting a Pedestrian Zone a better option may be to disconnect the Pedestrian Zone from its associated Pedestrian Links and reconnect it to new Pedestrian Links as appropriate. This will retain Pedestrian OD flow information but Pedestrian Route flows will need to be recreated using the Route List View.

4.3.13. Displaying Signal Staging on the Network Layout View

LinSig can display a copy of the Stage View or Stage Sequence View on the Network Layout View. This is extremely useful when printing the network – especially larger networks as it allows the staging of a Junction to be concisely included on the main network diagram. Each Network Layout View Stage Sequence displays one of the following:

- The available Stages from the Stage View for a single Stage Stream on a Controller.
- The Stage order for a Stage Sequence from the Stage Sequence View for a single Stage Stream.

If desired multiple Stage Diagrams can be used for more than one Controller or Stage Stream.



4.3.13.1. Adding a Stage Diagram to the Network Layout View

A Stage Diagram can be added to the Network Layout View as follows:

- Choose ‘Add Stage Diagram’ from the ‘Stage Diagram’ pop-out menu on the Network menu.
- Click on the Network Layout View where you wish to create the Stage Diagram. The ‘Edit Stage Diagram’ dialog box appears to allow you to set the diagram’s options.
- Select the mode of the Stage Diagram. The mode governs what the Stage Diagram shows. The options are:

  - **Show Available Stages.** This option displays all the Stages defined in the Stage View and represents all the available Stages configured in the Controller for one Stage Stream. The Stages are ordered by Stage number and are therefore not necessarily in the order in which the Stages are run.
  - **Show Stage Sequence.** This option shows the Stage Sequence for the Stage Sequence associated with the current Scenario. As the current Scenario changes the Stage Diagram changes to reflect the Stage Sequence for the new current Scenario.
- Select the Layout of the Stage Diagram. This setting governs how the different Stage boxes are laid out within the overall Stage Diagram. This setting can usually be set to 'Auto' but where this does not provide a sensible layout the Layout option can be used to provide several alternative layouts.
- Click OK to create the Staging Diagram.

4.3.13.2. Repositioning and Resizing a Stage Diagram

A Stage Diagram can be repositioned by dragging the diagram with the mouse. It can also be resized by dragging any or the diagram's borders or corners with the mouse.

4.3.13.3. Editing a Stage Diagram

A Stage Diagram can be edited by double clicking with the mouse. This will open the 'Edit Stage Diagram' dialog box which can be used to edit the Stage Diagram's settings as described in 'Adding a Stage Diagram to the Network Layout View' above.

4.3.13.4. Changing the Appearance of the Stage Diagram

The graphical appearance of the Stage Diagram is inherited from either the appearance of the Stage View or the Stage Sequence View.

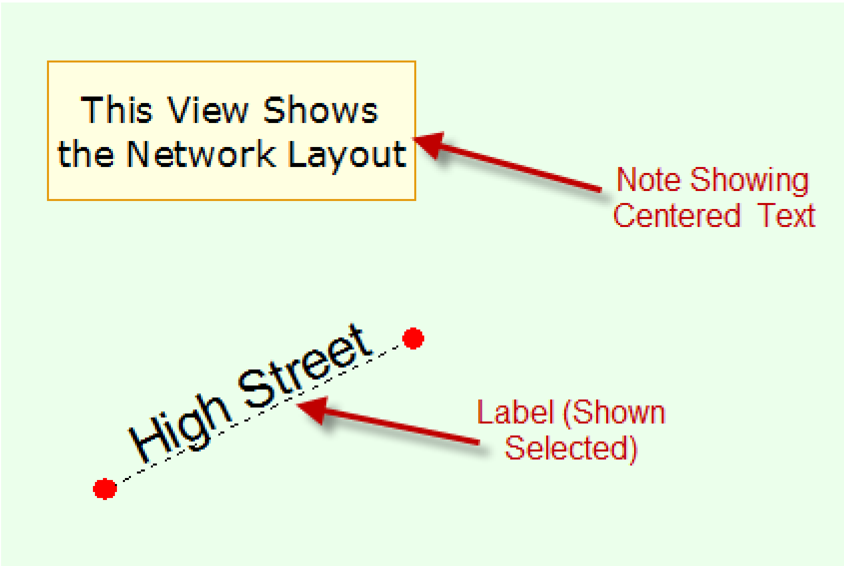
4.3.13.5. Deleting a Stage Diagram

A Stage Diagram can be deleted by selecting it with the mouse and choosing 'Delete Stage Diagram' from the 'Stage Diagram' pop-out on the Network Menu.

4.3.14. Annotating the Network Layout View

The Network Layout View can be annotated using Notes and Labels. These are used as follows:

- Notes are used to place paragraphs of formatted text on the Network Layout View. They can be formatted in any font, size or colour and justification and are displayed in a coloured background rectangle. They can be thought of as similar to Post-It notes. Notes can also be used on the Phase View. As well as static text Notes can contain dynamic fields which show current data from the model updating as the model changes.
- Labels are used to position single lines of text on the View at any angle. They can also be displayed with any font size and colour.



4.3.14.1. Working with Notes on the Network Layout View and Phase View

Notes can be used anywhere on the Network Layout View or Phase View as described below.

Adding Notes to the Junction Layout and Phase View

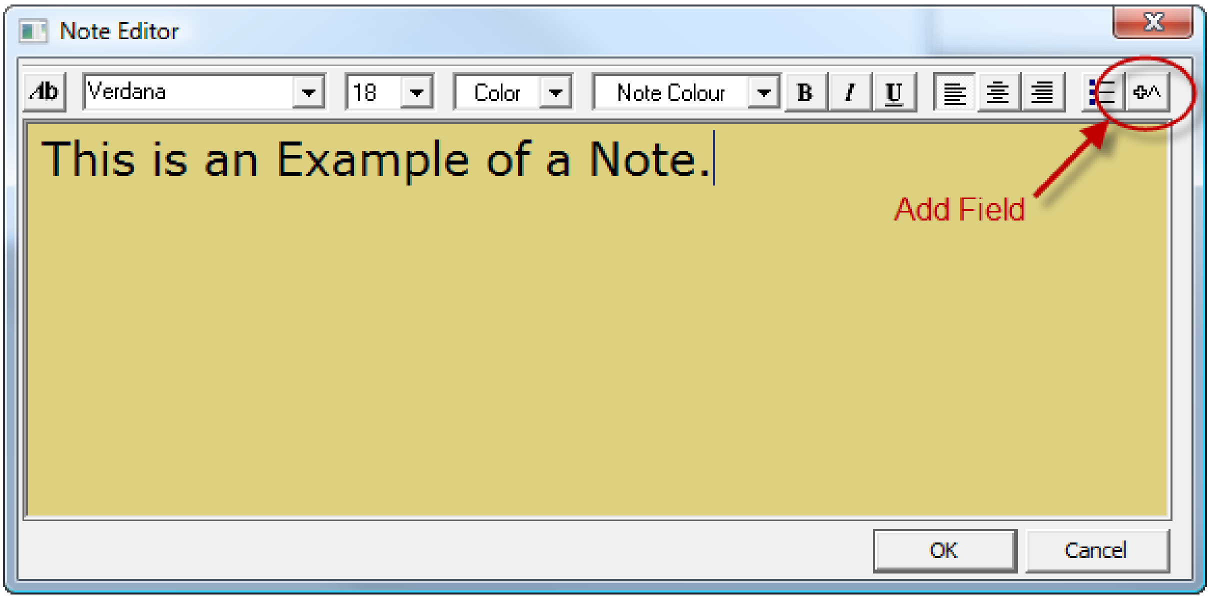
A Note is added to the Network Layout View as follows:

- Choose ‘Add Note’ from the ‘Notes’ pop-out on the Network Menu.
- Click anywhere on the Network Layout View to drop the new empty Note.
- Edit the Note’s text as described below in ‘Editing a Note’.

Editing a Note

The text of a Note can be edited as follows:

- Double click on a Note to open the Note Editor. The Note Editor displays the Note’s text (if any) and formatting options for the Note.

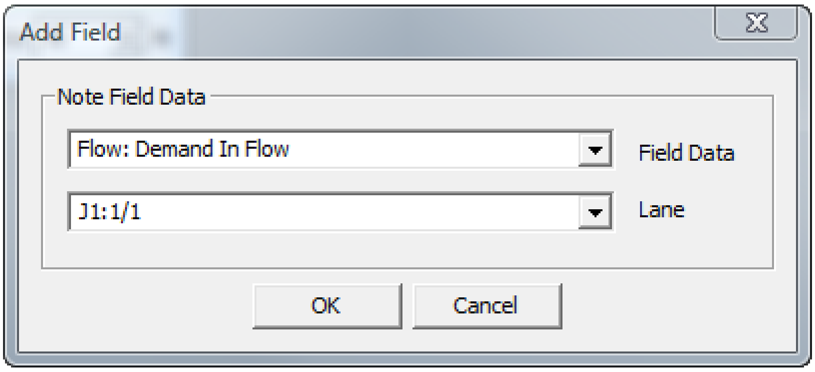


- Enter the Note's text.
- Click OK to save the Note's text.

Inserting a Dynamic Field in a Note

A dynamic field can be inserted in a Note as follows:

- Open the Note for editing as described above.
- Click on the 'Add Field' toolbar button. This opens the Add Field dialog box as shown below.



- Select the data type and Lane for the field. Currently only Lane based data can be shown. Also results for a combined long and Short Lane Group are shown on the Long Lane.
- Click OK. This will insert a field code into the Note.
- Continue editing the Note or click OK to save the Note.
- LinSig will replace the field code with the appropriate data.
- If desired field codes can be typed directly into the Note.

Formatting a Note

The Note Editor allows the font, colour and size of text to be set for individual paragraphs, words and characters as well as the Note as a whole. To change the formatting of all or part of the Note:

- Select the text you wish to change the formatting for. The current format for the selected text is shown in the settings boxes on the Note Editor's main toolbar.
- Choose a new font, font size, colour and other options such as bold and underline.
- Some settings such as justification, centring and bullet point only apply to a whole paragraph. A background colour can also be selected which applies to the whole Note.
- When all formatting changes have been made click OK to apply the changes to the Note.

Repositioning and Resizing a Note

Each Note can be moved by dragging with the mouse and resized by dragging the Note's borders or corners with the mouse. Each paragraph within the Note will be wrapped to fit within the Note's borders.

4.3.14.2. Adding a QuickNote to the Network Layout View

A QuickNote is a preconfigured Note containing dynamic fields which can be quickly added to the Network Layout View to display dynamic information regarding a Lane.

To add a QuickNote:

- Right Mouse click on the Lane for which the QuickNote is to be added.
- Choose a QuickNote type from the QuickNotes pop-out on the pop-up menu.
- Drag the QuickNote to its desired position and drop it by clicking with the mouse.

The QuickNote will update to reflect changes in the model's data.

4.3.14.3. Working with Labels on the Network Layout View

Labels can be used as an alternative to Notes on the Network Layout View.

Adding Labels to the Network Layout View

A Label is added to the Network Layout View as follows:

- Choose 'Add Label' from the 'Labels' pop-out on the Network menu.
- Click anywhere on the Network Layout View to drop the Label. The 'Create Label' dialog box will appear.
- Set the Label's text, colour and Font.
- Click OK to create the Label.

Editing a Label

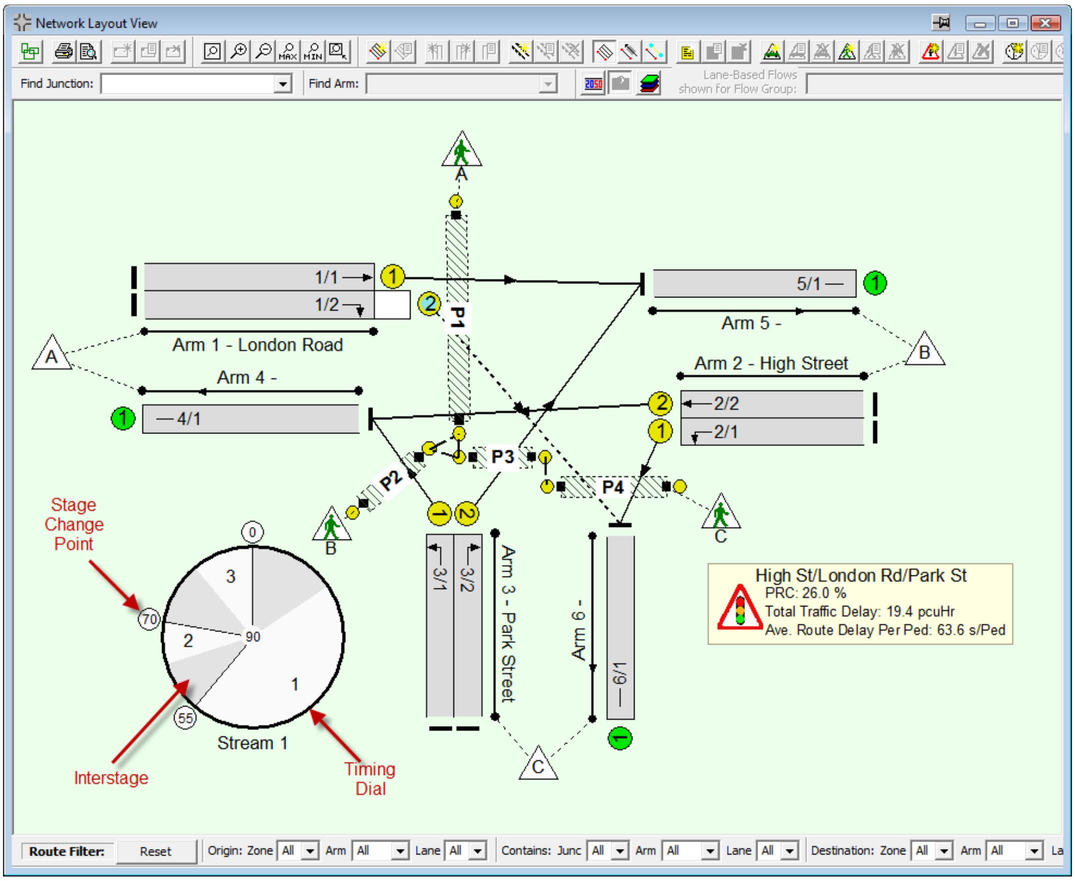
A Label can be edited by double clicking with the mouse and changing its settings as described in 'Adding Labels to the Network Layout View' above. Currently dynamic data fields cannot be used in labels.

Repositioning a Label

A Label can be repositioned by selecting it with the mouse and then dragging either the centre of the Label move the whole Label, or one of the red handles at the end of the Label to change the Labels orientation.

4.3.15. Displaying and Using Timing Dials

Timing Dials allow the signal timings for a Stage Stream to be displayed and changed directly on the Network Layout View. This is useful with larger Networks when there is insufficient screen space to view both the Network Layout View and the Signal Timings View at the same time. It also provides a concise overview of signal times for all Stage Streams when printed on the Network Layout View.



4.3.15.1. Adding a Timing Dial to the Network Layout View

To add a Timing Dial to the Network Layout View:

- Choose 'Add Timing Dial' from the 'Timing Dials' pop-out on the LinSig Network Menu.
- Position the Timing Dial on the Network Layout View and click to drop the Dial. The 'Create Timing Dial' dialog box opens allowing options to be set.
- Set the options for the new Timing Dial. Available options include:
    - **Controller.** The Controller for which the Timing Dial displays timing information.
    - **Stage Stream.** The Stage Stream on the specified Controller for which the Timing Dial shows information.
    - **Show Title.** Select whether to display the Controller and Stream name next to the Timing Dial.
    - **Show Timings in Grab Handles.** If the Timing Dial is large enough this option can be used to display the stage change point values in each of the stage change point handles.
    - **Set Timing Dial Size.** Sets the size of the Timing Dial.

- Click OK to close the 'Create Timing Dial' dialog box and display the new Timing Dial.
- The Timing Dial will always show the Stage lengths for the current Scenario. If the current Scenario is changed the Timing Dials will change to reflect the Stage lengths in the new current Scenario.

4.3.15.2. Editing the Settings for a Timing Dial

An existing Timing Dial's settings can be edited at any time by double clicking the Timing Dial. This will open the 'Edit Timing Dial' dialog box which can be used to change its settings as described above in 'Adding a Timing Dial to the Network Layout View'.

4.3.15.3. Deleting a Timing Dial

To delete a Timing Dial select the Dial with the mouse and choose 'Delete Timing Dial' from the 'Timing Dials' pop-out on the Network Menu. Alternatively right click on the Dial and choose 'Delete Timing Dial' from the pop-up menu.

4.3.15.4. Adjusting Signal Settings using a Timing Dial

As well as displaying the Stage lengths for the current Scenario the Timing Dial can be used to adjust the Stage Lengths as follows:

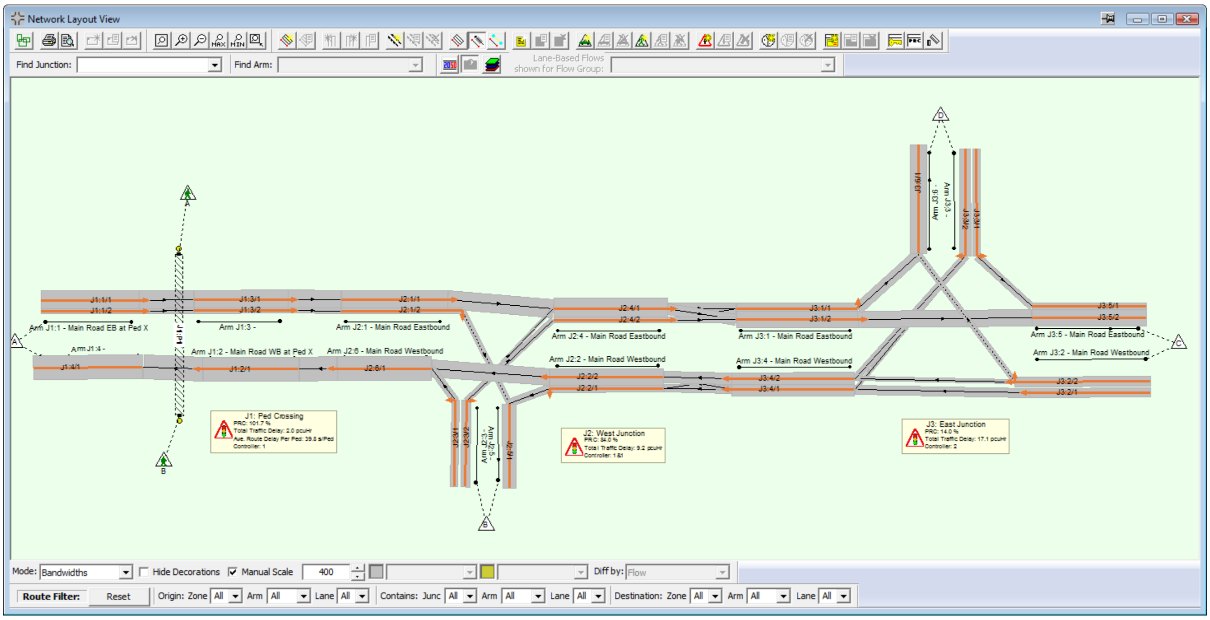
- Click on any Timing Dial stage change point handle and drag with the mouse. LinSig will update the other views with the new stage times. Alternatively the arrow keys on the keyboard can be used to incrementally change a Stage Change Point.
- All minimums, intergreens etc. are complied with as part of the dragging process.
- If Flow Profile and Queue Graphs are also displayed on the Network Layout View they are dynamically updated as the stage change points are changed. This makes the combination of Timing Dials and embedded graphs very powerful for manually adjusting signal timings to achieve a specific result. For example using the Timing Dials and graphs it is easy to manually coordinate Lanes to achieve front end or back end coordination and to monitor/limit queues on specific Lanes.

Signal Offsets for a Stage Stream can be changed as follows:

- Click on any Timing Dial stage change point handle and whilst holding the Shift key down drag with the mouse. The Offset of the Stage Stream relative to other Stage Streams will be changed without changing any Stage Lengths. LinSig will update the other views with the new signal times.

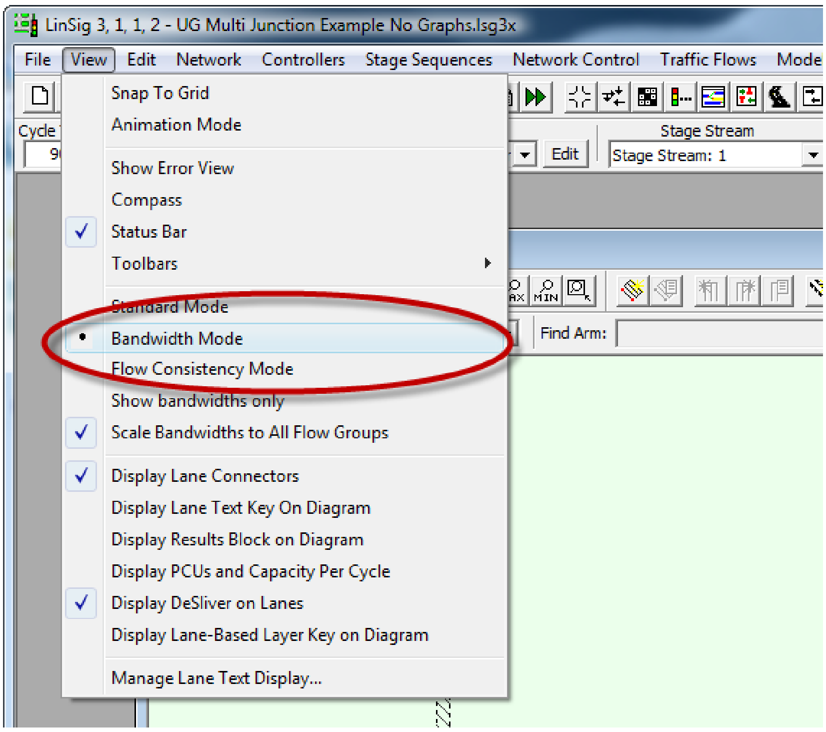
4.3.16. Displaying Lane Bandwidths on the Network Layout View

Lane Bandwidths display the Traffic Flows passing through a Network by using variable width bands on each Lane and Lane Connector where the width of the band is proportional to the traffic flow on the Lane or Connector. Although useful in any size of Network the Bandwidths are particularly useful for larger networks with more complex flow patterns.



4.3.16.1. Displaying Bandwidths

Bandwidths can be displayed by choosing 'Bandwidth Mode' from the View Menu. The Network Layout View will change its appearance to display the Bandwidths, with a simplified display of Lanes to avoid obscuring the Bandwidths. The Bandwidths can be removed by choosing 'Standard Mode' from the Network Menu.



4.3.16.2. Bandwidth Options

A number of options are available to control the display of Bandwidths. These include:

- **Show Bandwidths Only/Hide Decorations.** Choosing 'Show Bandwidths Only' from the View Menu or ticking 'Hide Decorations' on the Network Layout View's toolbar hides the display of Lanes in Bandwidth Mode. This sometimes useful in displaying a cleaner less cluttered view.
- **Scale Bandwidths to All Flow Groups.** If 'Scale Bandwidths to All Flow Groups' is selected on the Network Menu LinSig will scale all Bandwidths so as to ensure Bandwidth scales for different Flow Groups are comparable. If this option is set the Bandwidth scale is set so the highest Lane flow in all Flow Groups will sensibly fit on the Bandwidth diagram. If this option is not set the diagram will be scaled to the highest flow in the current Scenario's Flow Group.
- **Manual Scale.** If the Manual Scale option is selected on the Network Layout View Toolbar the Bandwidth scale can be set manually. This scale will apply to all Flow Groups.

4.3.16.3. Scenario Comparison

As well as illustrating the absolute level of flow on each Lane the bandwidths can be used to compare two Scenarios. The bandwidths displayed represent the difference in flow or delay between two different Scenarios.

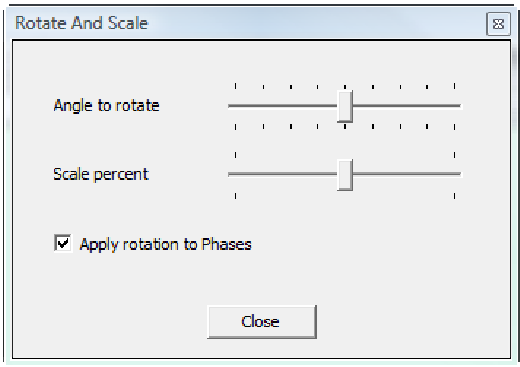
A pair of Scenarios can be compared as follows:

- Switch the Network Results View into Bandwidth Mode as detailed above.
- On the Bandwidths toolbar displayed in the Network Results View change the Bandwidths mode setting to 'Scenario Compare'.
- On the Bandwidths Toolbar select two Scenarios to compare using the drop down lists.
- Select whether to compare Flows or Delays using the 'Diff by' drop down list.

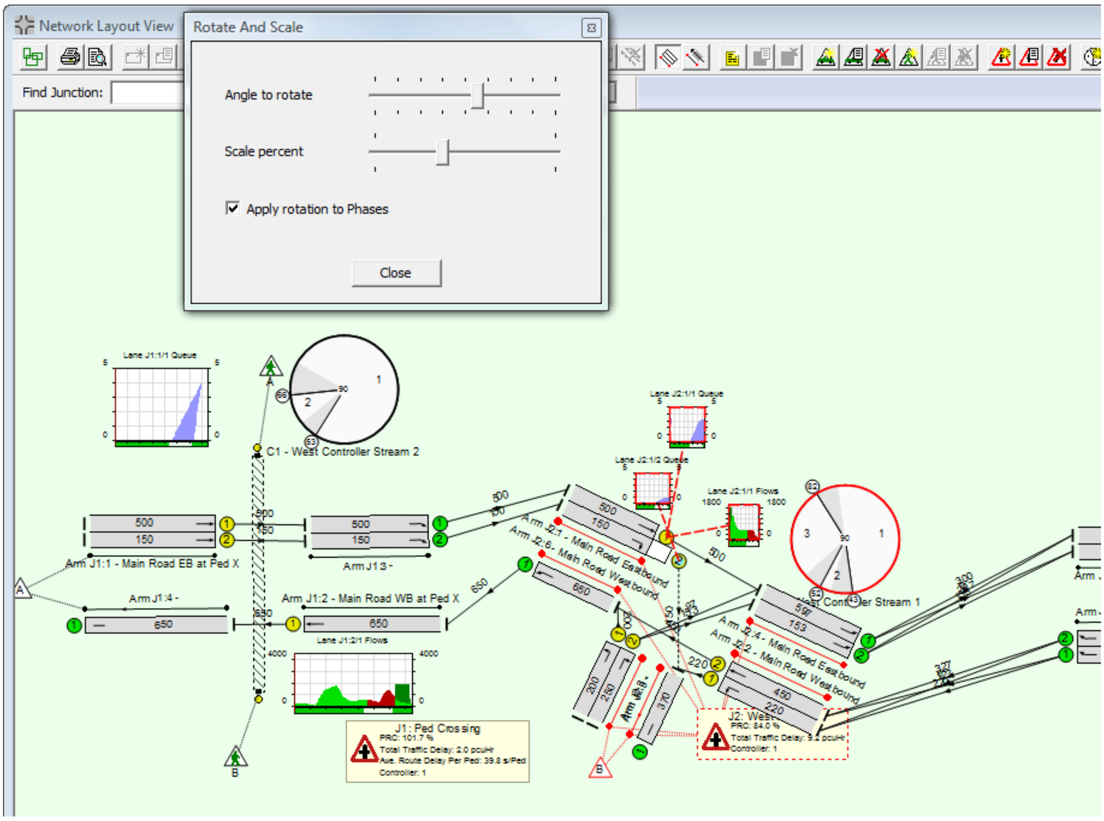
4.3.17. Rotating and Scaling Network Items

Segments of the LinSig Network Layout View can be quickly scaled and/or rotated as follows:

- Select the Network Items to be scaled whilst holding down the CTRL key on the keyboard. This will select multiple Network Items. Many Items can be selected at once by selecting a Junction.
- Choose 'Scale and Rotate Selected Items' from the Network menu. This will open the 'Rotate & Scale' dialog box.



- The selected items can be rotated or scaled dynamically by dragging the 'Angle to rotate' and 'Scale Percent' sliders.



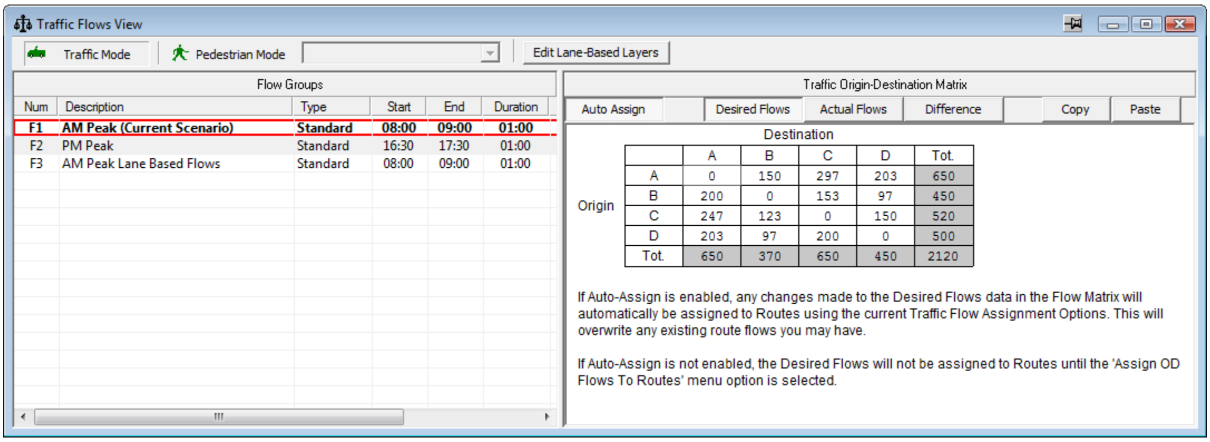
- The Rotate and Scale is particularly useful to align several separately imported Junctions prior to merging connecting Zones.
- If the 'Apply Rotation to Phases' option is ticked LinSig will also rotate and scale any Phases associated with the selected Items.

4.4. Traffic Flows View

The Traffic Flows View is used to carry out the following tasks:

- Create and manage Traffic Flow Groups.
- Specify traffic flows by entering origin-destination matrices for each Flow Group.
- Specify pedestrian flows by entering an OD matrix for each Junction for each Flow Group.

The View can be opened by choosing 'Show Traffic Flows View' on the Traffic Flows menu.



The Traffic Flows View is split into two panels. These are:

- **The Traffic Flow Group List.** The Traffic Flow Group List shows the different Traffic Flow Groups defined in the LinSig model. The list also shows Flow Group currently being displayed and edited in rest of the Traffic Flow View and the Flow Group currently being used by the current Scenario for traffic model calculations.
- **The Origin-Destination (OD) Matrices.** The matrix displays the traffic or Pedestrian OD flow matrices for the currently selected Flow Group. As explained below only the Desired Flows matrix can be edited, the other matrices being used to display information calculated from the Network's Route Flows.

4.4.1. Defining Traffic Flows in LinSig

LinSig 3.1 provides a new alternative method of defining traffic flows as well as the existing Matrix based method. Detailed information on both methods including their relative advantages and disadvantages is given in 'Flow Definition Methods' in the Essential Background section.

4.4.2. Defining Pedestrian Flows in LinSig

The use of pedestrian flows in LinSig is optional. LinSig can still model pedestrian delays without pedestrian flow data however flow data is required if estimates of overall aggregate level of delay is required.

Pedestrian flows in LinSig are entered and managed in a similar way to traffic flows. The main difference is that pedestrian flows are entered as an OD matrix for each Junction as opposed to a single OD matrix for the entire Network as with Traffic. This is because:

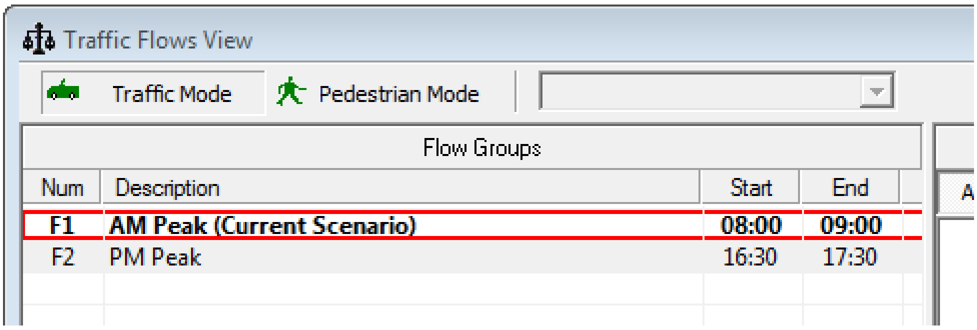
- It simplifies the specification of pedestrian flow data.
- Counting a pedestrian OD matrix for a large network is very difficult and expensive.

- The benefits of modelling pedestrians moving between junctions is not great as pedestrian platoons tend to disperse rapidly as pedestrians cross the road between junctions, walk at different speeds, stop between junctions etc.
- Where detailed pedestrian modelling is important other more complex (and significantly more expensive) specialist modelling tools exist.

As well as using pedestrian OD matrices in a similar way to traffic OD matrices, LinSig also uses Pedestrian Routes in a similar manner to traffic Routes. A Pedestrian Route is defined as a single path between two Pedestrian Zones. Pedestrian OD Flows are manually assigned to Pedestrian Routes using local knowledge of Pedestrian movements at each Junction. This is not usually an onerous task as each Junctions Pedestrian Network is usually quite small.

4.4.3. Managing Flow Groups using the Traffic Flow Group List

The Traffic Flow Group List displays the currently defined Flow Groups and allows new Flow Groups to be created and edited. A new LinSig model is always created with an empty Flow Group already defined.



The Flow Group List shows the following information for each Flow Group:

- **Flow Group Number.** A unique reference number for the Flow Group.
- **Description.** A text description of the Flow Group.
- **Type.** Whether the Flow Group is a Standard or Formula Flow Group
- **Start Time.** The time of day the Flow Group starts.
- **End Time.** The time of day the Flow Group ends.
- **Duration.** The duration of the Flow Group.
- **The Selected Flow Group.** The Selected Flow Group is highlighted in red. The Selected Flow Group is the Flow Group which for which the OD matrices are displayed in the right panel of the Traffic Flows View. It is not necessarily the Flow Group being used for model calculations. The Selected Flow Group can be changed by clicking a Flow Group in the Flow Group List.
- **The Current Scenario Flow Group.** The Flow Group currently being used for model calculations is inferred from the current Scenario selected in the Scenario View and is shown in bold and labelled '(current Scenario)' in the Traffic Flow Groups List. It is changed by selecting a new current Scenario in the Scenario View. When the Current Scenario is changed LinSig will recalculate model results using the Flow Group and other settings from the new Current Scenario.

Creating a New Flow Group

A new Flow Group can be created as follows:

- Choose 'Add Flow Group' from the Flow Groups pop-out menu on Traffic Flows menu.
- Select the type of Flow Group to create. A Flow Group can be a Standard Flow Group or a Formula Flow Group which is calculated from one or more component Flow Groups.
- A new Flow Group with a default name and time period is created at the end of the Flow Group List. The new Flow Group can be edited as described in 'Editing Flow Groups' below.

Inserting a Flow Group into the Flow Group List

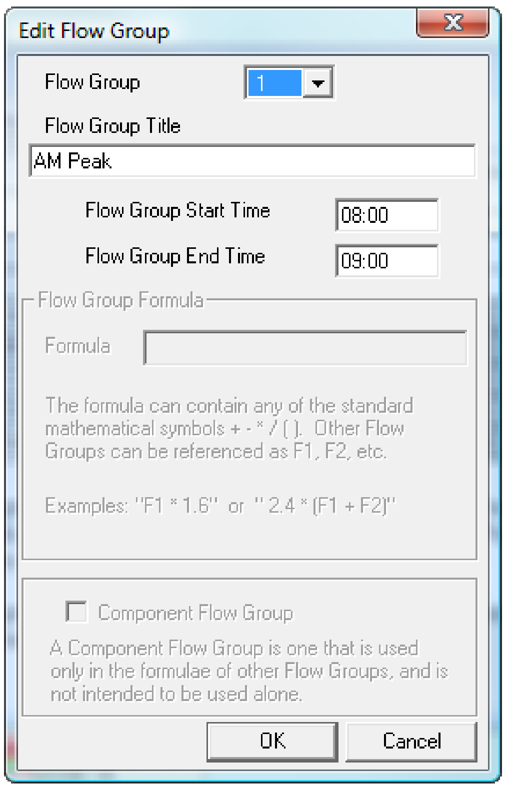
A new Flow Group can be inserted at any position in the Flow Group List as follows:

- Select a Flow Group next to where the new Flow Group is needed.
- Choose 'Insert Flow Group After Selected Flow Group' or 'Insert Flow Group Before Selected Flow Group' from the Traffic Flows menu as appropriate. A new Flow Group is created and inserted into the Flow Group List.
- The new Flow Group can be edited as described in 'Editing Flow Groups' below.

Editing a Flow Group's Details

Editing a Flow Group's traffic flow information is covered below in the section 'Origin-Destination Matrices'. A Flow Group's general details, other than traffic flow information, can be edited as follows:

- Select the Flow Group in the Flow Group List.
- Choose 'Edit Flow Group' from the Traffic Flows menu.
- The Edit Flow Group dialog box is displayed.



- The Edit Flow Group dialog box allows the following Flow Group settings to be edited:
    - **Flow Group Number.** A Flow Group can be renumbered by changing its Flow Group Number. Flow Group numbers must be sequential with no gaps in the sequence. If the Flow Group is given the same number as an existing Flow Group the Flow Group will be inserted into the sequence and the existing and higher number Flow Groups will be renumbered.
    - **Flow Group Title.** Each Flow Group should be given a meaningful title.
    - **Flow Group Start Time.** The Flow Group Start Time should be specified using the 24 hour clock in the format hh:mm.
    - **Flow Group End Time.** The Flow Group End Time should be specified using the 24 hour clock in the format hh:mm.
    - **Component Flow Group.** A Component Flow Group is a Flow Group which is used **only** as a component of another Flow Group in a Flow Group Formula. Typically running or reporting a model using just a single Flow Group Component would not be correct. Marking a Flow Group as a Component Flow Group prevents the Flow Group from being selected as the Flow Group for analysis and also omits them where relevant from reports. Setting a Flow Group to be a component Flow Group has no affect on calculations
    - **Flow Group Formula.** This is covered below in 'Defining Flow Groups using Formulae'.
- Click OK to finish editing the Flow Group.

Deleting a Flow Group

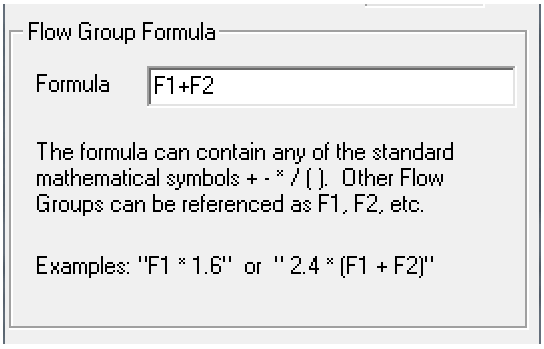
A Flow Group can be deleted by selecting it in the Flow Groups List and choosing 'Delete Flow Group' from the Traffic Flows menu.

Deleting a Flow Group also deletes all associated traffic information such as Origin-Destination matrices and Lane based Flows. Items using the Flow Group such as Scenarios will not be deleted but will show an error until a new Flow Group is set.

Defining Flow Groups using Formulae

Traffic Flow Groups are often built up by combining a number of component sets of traffic data to form a new composite set of traffic flows. For example in a development context a Flow Group may be defined as a set of base traffic flows plus development generated traffic flows. A more complex example may involve growthing the base traffic to a future year before combining it with development flows from a number of different (and usually ever changing) development scenarios.

LinSig allows Traffic Flow Groups to be defined as combinations of other previously defined Flow Groups. Formulae are used to combine Flow Groups in any combination. For example if the base traffic is Flow Group 1 (F1) and Development scenario A is Flow Group 2 (F2), a new combined Flow Group 3 (F3) could be defined using the Formula F3 = 1.06*F1+F2. This will factor up the base traffic by 6% before adding the development traffic. A Flow Group does not have to be defined as a Component Flow Group to be used in a formula. Component Flow Groups are Flow Groups which are used only in formulae.

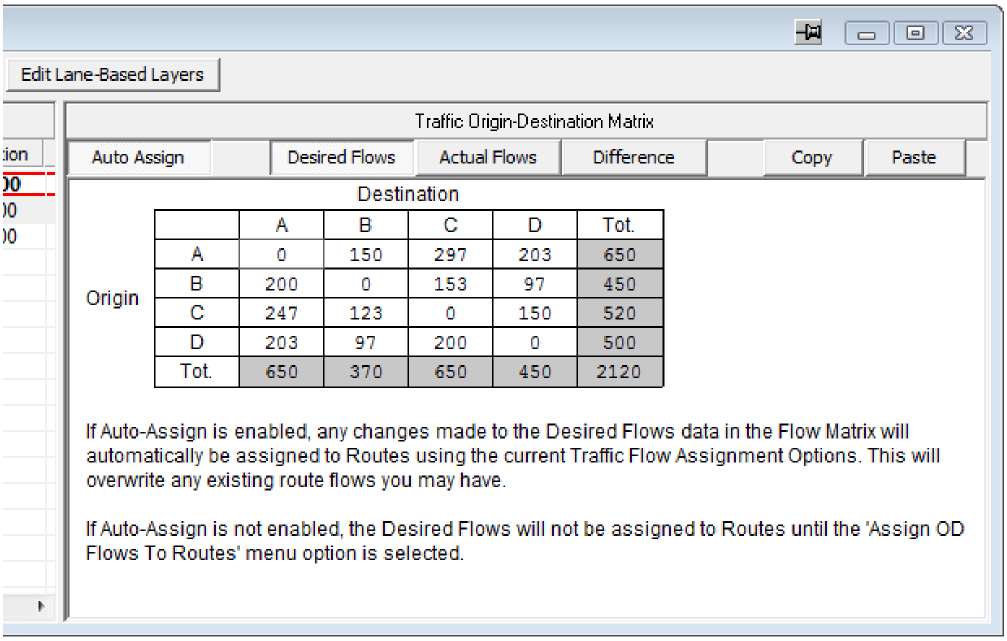


A Formula based Flow Group can be defined choosing ‘Formula Flow Group’ when creating the Flow Group, and specifying a formula in the Edit Flow group dialog box. Any common mathematical operators such as +,-,* and / can be used as can brackets () to specify precedence.

4.4.4. Working with the Origin-Destination Matrices

LinSig uses Origin-Destination (OD) matrices to display and edit the following for the Flow Group selected in the Flow Group List on the left side of the Traffic Flows View:

- Total Zone-to-Zone traffic movements through the Network.
- Total Zone-to-Zone Pedestrian movements through each Junction.



Traffic OD movements are specified using a single OD matrix for the entire network, however it is less meaningful to model pedestrians over such a large area therefore pedestrian OD matrices are specified using one OD matrix for each LinSig Junction. This makes the specification of pedestrian flows simpler.

4.4.4.1. Traffic Origin-Destination Matrices

Each Traffic Flow Group OD matrix shows traffic flows in PCU between Traffic Zones for the duration of the Flow Group's modelled time period. For example a Flow Group of duration 15 minutes would have 15 minutes flows entered.

The Traffic OD Matrices are displayed in the Traffic Flows View as follows:

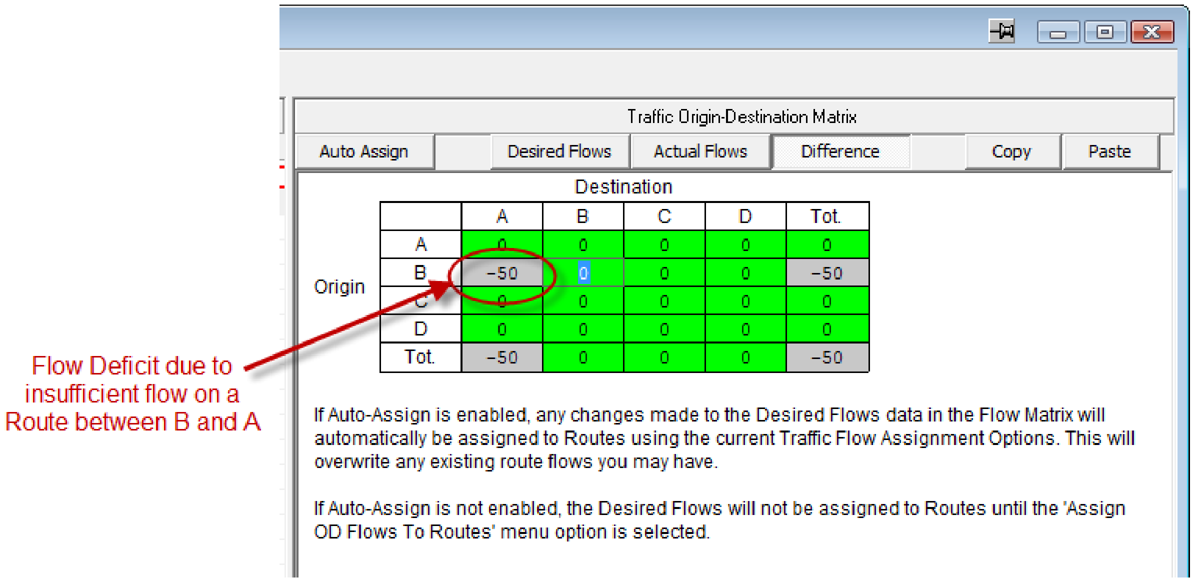
- Click the 'Traffic Mode' button on the Traffic Flow View's toolbar to ensure Traffic Flows are being shown.
- Choose either 'Desired Flows', 'Actual Flows' or 'Difference' to display one of the three OD matrices described below.
- Only the Desired Flows Matrix can be edited, the Actual Flows and difference matrices are for error checking/output only.

The three types of LinSig Matrices are:

- **Desired Flows Matrix.** This matrix displays and allows editing of the desired Zone-to-Zone traffic flows for the entire network. As is customary with origin-destination (OD) matrices Origin Zones are shown to the left of the matrix and Destination Zones above. Each cell contains the desired total traffic flow by any Route from the Origin

Zone to the Destination Zone. The Desired Flows Matrix is the traffic data used by LinSig when automatically assigning traffic flows to Routes.

- **Actual Flows Matrix.** The Actual Flows Matrix is derived from the traffic flows actually assigned to each Route as described in the Route List View section. Each Zone-to-Zone total is calculated by summing the Route traffic flows for all Routes connecting an Origin and Destination Zone. It represents the total Zone-to-Zone flow actually assigned to Routes rather than the flow that we are aiming to assign to Routes as is shown in the Desired Flows Matrix. As the traffic routing pattern in the Network may be different for each Scenario the Actual Flow Matrix will be dependent on the Current Scenario being shown. The aim should still be for each Scenario's Actual Flow Matrix to match the Flow Group's Desired Flow Matrix but any differences may vary by Scenario.
- **The Difference Matrix.** The Difference Matrix shows the numerical differences between a cell in the selected Flow Groups Desired Flows Matrix and the same cell in the Current Scenario's Actual Flows Matrix. As with the Actual Flow matrix it is only shown when the Current Modelled Scenario's Flow Group matches the Flow Group being displayed in the Traffic Flows View. The Difference Matrix represents Zone-to-Zone movements for which too little or too much flow has been allocated to Routes. Where the Difference Matrix is non-zero, this should be investigated and corrections made to Route Flows using the Route List View. This will ensure the total Zone-to-Zone route flows for a Scenario equal the Flow Group's desired Zone-to-Zone traffic movements.



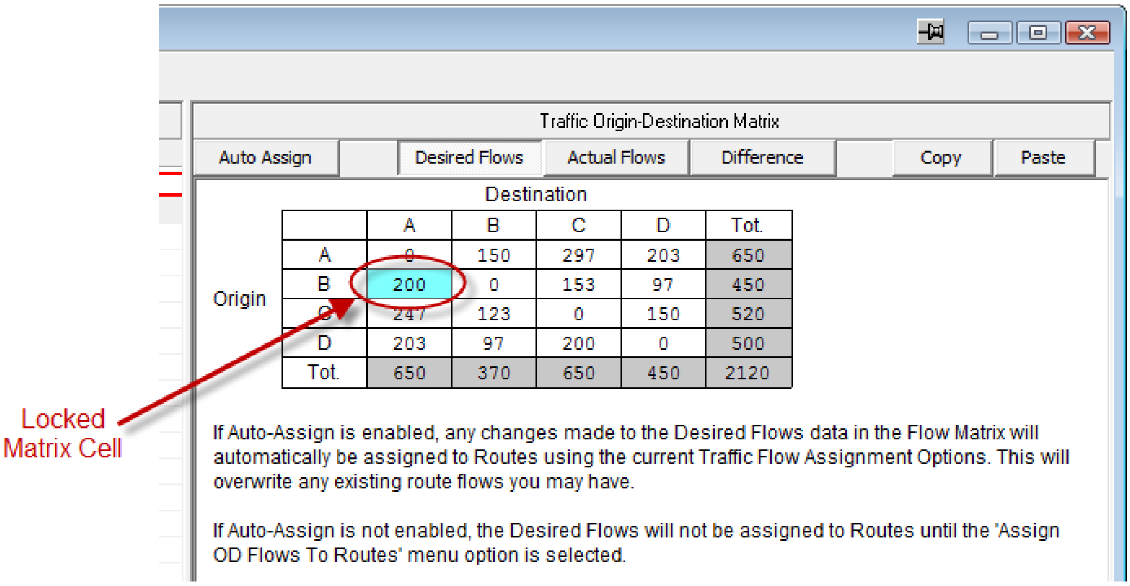
Auto-Assignment of OD Matrix to Routes when OD Matrix Changes

When traffic data in the Desired Flows OD Matrix changes it is necessary to re-assign the new OD flows to the Routes. The assignment process is described in detail in the Scenario View section. If 'Auto-Assign' is selected using the button on the Traffic Flow View toolbar LinSig will automatically reassign the matrix to the Routes for all Scenarios using this Flow Group whenever the Desired Flows Matrix changes. This will of course replace the flows on all affected Routes losing any custom Route Flows. This option should only be used with a small model as reassigning a large model after every minor change to the matrix will be very slow.

Locking Matrix Cells for Matrix Estimation

An OD matrix cell can be locked preventing matrix estimation from changing its value. To lock a cell:

- Right click on the matrix cell and choose 'Lock this value during Matrix Estimation'.
- Only cells in the Traffic Matrix can be locked.



4.4.4.2. Pedestrian Origin-Destination Matrices

Pedestrian Origin-Destination matrices are similar to Traffic OD matrices but are specified as a separate matrix for each LinSig Junction. Each Junction OD Matrix specifies Pedestrian movements from each Origin Pedestrian Zone to each Destination Pedestrian Zone in Pedestrians per modelled time period, where the modelled time period is specified by the Flow Group.

The Pedestrian OD Matrices are displayed as follows:

- Click the 'Pedestrian Mode' button on the Traffic Flow View's toolbar to ensure Pedestrian Flows are being shown.
- Select the Junction for which the Pedestrian OD matrices are to be displayed in the Junction drop down list on the Traffic Flow View's toolbar.
- Choose either 'Desired Flows', 'Actual Flows' or 'Difference' to display one of the three OD matrices described below.
- Only the Desired Flows Matrix can be edited, the Actual Flows and difference matrices are for error checking/output only.

The basis of the Desired Flows, Actual Flows and Difference Matrix are the same as described above but obviously applying to pedestrians rather than traffic.

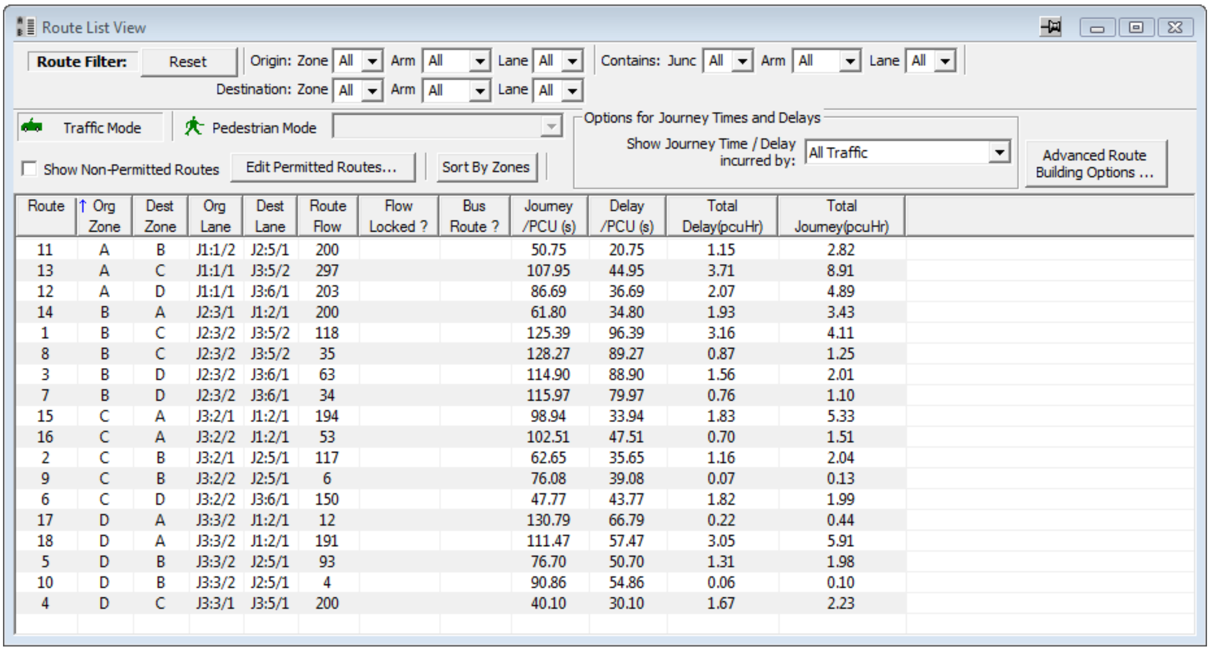
Modelling Pedestrians when No Pedestrian Flow Data is Available

In many cases pedestrian flow data will not be available for one or more Junctions being modelled. This is not necessarily a major problem as it is still possible to model pedestrian delay at junctions even when no pedestrian data is available. The main points to consider are:

- If no pedestrian flow data is available pedestrian flows should be entered as 1 (or any other nominal value) in the Pedestrian Desired Flows Matrix and on Pedestrian Routes.
- Only delay per pedestrian results will be meaningful. Aggregate pedestrian delay statistics will obviously not be valid as LinSig does not know how many pedestrians are using the junction.
- The lack of aggregate pedestrian delay statistics means that when no pedestrian flows are specified it is not possible to compare overall levels of traffic and pedestrian delay.
- The best comparison where no pedestrian flow data is available is to compare relative delays per pedestrian on important Pedestrian Routes using the Route List View.

4.5. The Route List View

The Route List View is used to work with routing patterns within the LinSig Network and lists information on Routes for the currently modelled Scenario.



Route	Org Zone	Dest Zone	Org Lane	Dest Lane	Route Flow	Flow Locked ?	Bus Route ?	Journey /PCU (s)	Delay /PCU (s)	Total Delay(pcuHr)	Total Journey(pcuHr)
11	A	B	J1:1/2	J2:5/1	200			50.75	20.75	1.15	2.82
13	A	C	J1:1/1	J3:5/2	297			107.95	44.95	3.71	8.91
12	A	D	J1:1/1	J3:6/1	203			86.69	36.69	2.07	4.89
14	B	A	J2:3/1	J1:2/1	200			61.80	34.80	1.93	3.43
1	B	C	J2:3/2	J3:5/2	118			125.39	96.39	3.16	4.11
8	B	C	J2:3/2	J3:5/2	35			128.27	89.27	0.87	1.25
3	B	D	J2:3/2	J3:6/1	63			114.90	88.90	1.56	2.01
7	B	D	J2:3/2	J3:6/1	34			115.97	79.97	0.76	1.10
15	C	A	J3:2/1	J1:2/1	194			98.94	33.94	1.83	5.33
16	C	A	J3:2/2	J1:2/1	53			102.51	47.51	0.70	1.51
2	C	B	J3:2/1	J2:5/1	117			62.65	35.65	1.16	2.04
9	C	B	J3:2/2	J2:5/1	6			76.08	39.08	0.07	0.13
6	C	D	J3:2/2	J3:6/1	150			47.77	43.77	1.82	1.99
17	D	A	J3:3/2	J1:2/1	12			130.79	66.79	0.22	0.44
18	D	A	J3:3/2	J1:2/1	191			111.47	57.47	3.05	5.91
5	D	B	J3:3/2	J2:5/1	93			76.70	50.70	1.31	1.98
10	D	B	J3:3/2	J2:5/1	4			90.86	54.86	0.06	0.10
4	D	C	J3:3/1	J3:5/1	200			40.10	30.10	1.67	2.23

The following tasks can be carried out using the Route List View.

- Reviewing Traffic Routes through the Network and viewing delay and journey times along Routes.
- Specifying whether a Route is permitted or not. Sometimes LinSig will discover Routes which although logically valid Routes through the Network wouldn't in practice be used by traffic. LinSig allows Routes to be defined as non-permitted meaning that LinSig will never allow any traffic to be allocated to the Route.
- Manually editing Route Flows where it is preferred to set a Route Flow rather than allow LinSig to automatically assign it.
- Lock a Route Flow to prevent the LinSig assigning it a different flow during automatic assignment.

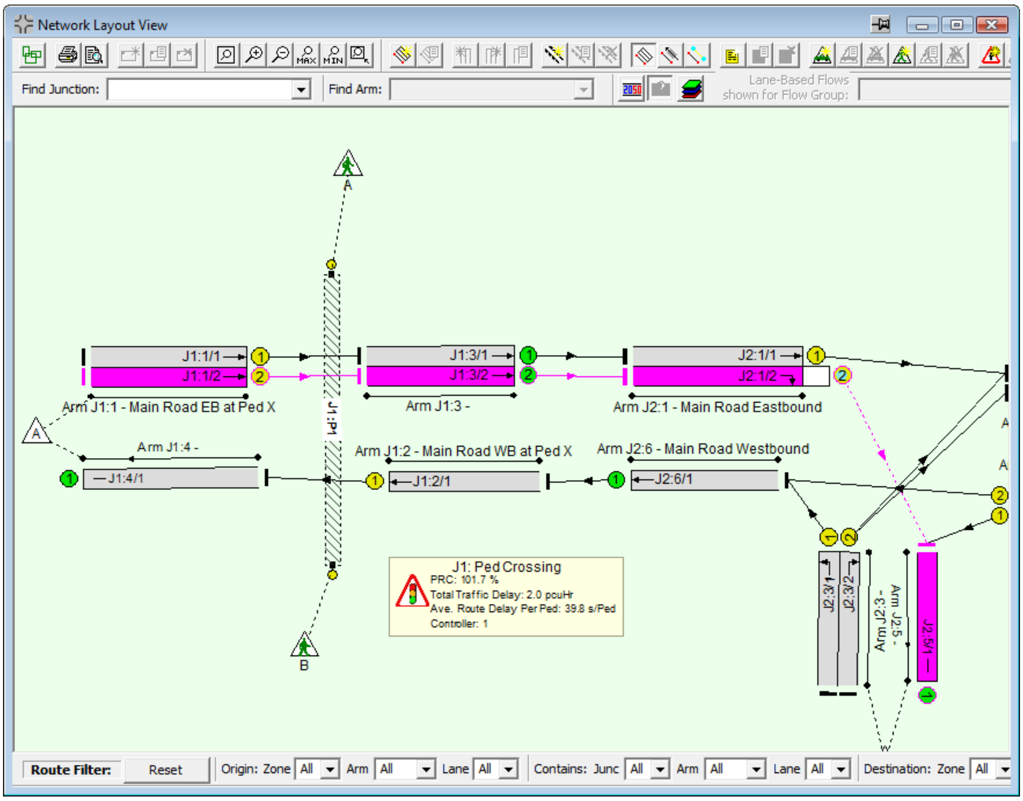
4.5.1. Working with Routes in LinSig

A Route in LinSig represents a unique path through the Network from one Zone to another. Depending on the size and complexity of the Network one or more Routes may exist between two Zones. Each of the Routes represents a different choice of Lanes for drivers or Links for Pedestrians travelling or walking between two Zones.

Routes can be one of two types:

- **Traffic Routes.** Traffic Routes are comprised of a sequence of individual Lanes and Lane Connectors from one Traffic Zone to another.
- **Pedestrian Routes.** Pedestrian Routes are comprised of a sequence of Pedestrian Links and Pedestrian Link Connectors from one Pedestrian Zone to another.

The main purpose of Routes is to specify traffic or Pedestrian flows through the Network at a very detailed level. Each Route is allocated a flow either manually or automatically. LinSig then aggregates the Route flows to calculate Lane flows and any other traffic flow information required.



The Route List View lists all the Traffic or Pedestrian Routes through the Network. LinSig scans the Network whenever its structure changes and discovers any new Routes created, adding them to the Route List.

4.5.1.1. Traffic Route List

The Traffic Route List is displayed by clicking on 'Traffic Mode' in the Route List View's toolbar. The Route List View displays the following information for each Traffic Route:

- **Route Number.** Each Route is given a unique Index number which identifies it.
- **Origin Zone.** The Zone the Route starts from.
- **Destination Zone.** The Zone where the Route ends.
- **Origin Lane.** The Lane the Route starts from in the format Junction:Arm/Lane.
- **Destination Lane.** The Lane where the Route Ends in the format Junction:Arm/Lane.
- **Route Flow.** The traffic flow on the Route in PCU.
- **Flow Locked?** Whether the Route Flow can be modified by the automatic flow assignment.
- **Bus Route?** Indicates that the Route is a Bus Route.
- **Journey Time (sec).** The average time it takes traffic to travel from Zone to Zone along this Route. This value is used extensively in the delay based assignment algorithm.
- **Delay (sec/PCU).** The average delay per PCU to traffic on the Route caused by queuing.

- **Total Delay (PCUHr).** The aggregate delay to all traffic on the Route caused by queuing.
- **Total Journey Time (PCUHr).** The aggregate time taken by traffic travelling on this Route.

The List can be sorted by any of the above criteria by clicking on a column header.

4.5.1.2. Pedestrian Route List

The Pedestrian Route List is displayed by clicking on 'Pedestrian Mode' in the Route List View's toolbar. The Route List displays the following information for each Pedestrian Route:

- **Pedestrian Route Number.** Each Pedestrian Route is given a unique Index number which identifies it.
- **Origin Pedestrian Zone.** The Pedestrian Zone the Route starts from.
- **Destination Pedestrian Zone.** The Pedestrian Zone where the Route ends.
- **Flow.** The traffic flow on the Route in Pedestrian per Modelled Time Period.
- **Flow Locked?** Whether the Pedestrian Route Flow can be modified by the automatic flow assignment.
- **Journey Time (sec).** The average time it takes pedestrians to travel from Zone to Zone along this Route.
- **Delay (sec/Ped).** The average delay to pedestrians on the Route caused by waiting for a green signal**.**
- **Total Delay (PedHr).** The aggregate delay to all pedestrians on the Route caused by waiting for a green signal.
- **Total Journey Time (PedHr).** The aggregate time taken by pedestrians using this Route.

4.5.1.3. Managing the Route List

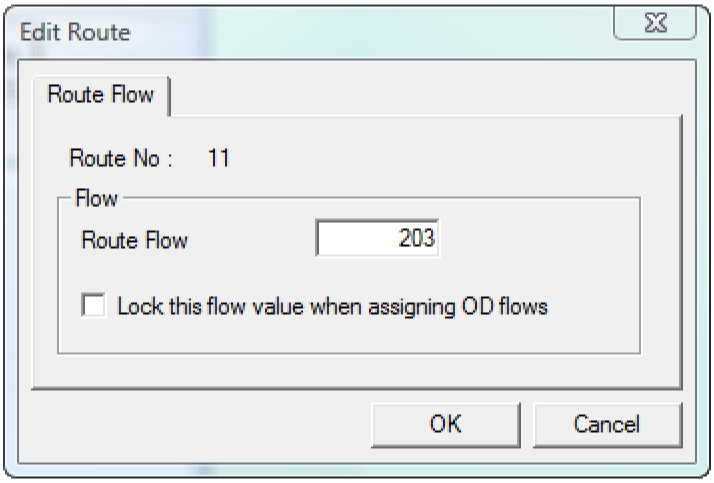
Routes in both the Traffic Routes List and the Pedestrian Routes List can be managed in similar ways as follows:

Selecting a Route

A Route is selected by clicking on it with the mouse in the Route List. The Route is highlighted in Route List indicating it is selected. The Route is also highlighted in the Network Layout View.

Editing a Route Flow

The traffic flow allocated to a Route can be manually edited by selecting the Route in the Route List and choosing 'Edit Route Flow' from the Routes pop-out menu on the Traffic Flows menu. The Edit Route Flow dialog box appears which allows the Route Flow in PCU to be specified.



Lane Flows in the Network Layout View and Network Results View, and the Actual Flows matrix in the Traffic Flows View are updated to reflect the new Route Flow. The traffic model also calculates new results based on the new Route Flow.

Locking a Route Flow

When editing a Route ticking the 'Lock this Flow value when balancing' box prevents the Route's flow from being changed when carrying out automatic flow assignment as described below. This is typically used for Traffic Routes to manually specify and Lock the traffic flow on some Routes on an Arm and balance the remaining flow between the remaining non-locked Routes. More information is provided in 'Allocating the Traffic Flow Matrices to Routes using the Route List' below.

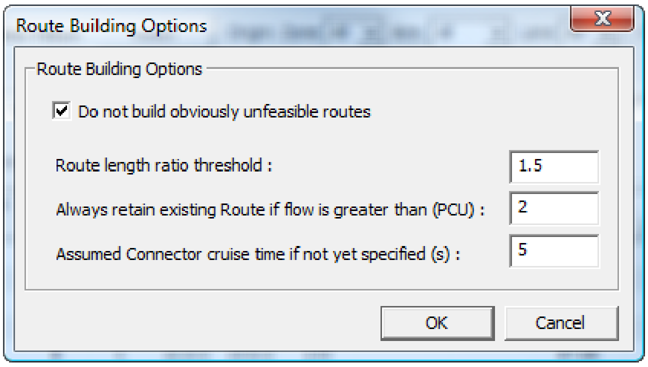
Suppressing Unfeasible Routes

In larger LinSig Networks the number of possible Routes through the Network is very large and increases exponentially as Network size increases. This is particularly so when many route options are available due to the Network Topology.

Whilst building Routes LinSig monitors how good a Route is and how likely a Route is of having traffic assigned to it and suppresses obviously unfeasible Routes from being built and consuming computing resources.

Unfeasible routes can be suppressed as follows:

- Click the 'Advanced Route Building Options…' button in the Route List View.



- Select the 'Don't Build Obviously Unfeasible Routes' option.
- The 'Route Length Ratio Threshold' setting controls how severely LinSig will suppress unfeasible Routes. This can be increased to make LinSig build more routes or decreased to suppress further Routes from being built.
- If an existing Route has a flow greater than the 'Always retain existing Route is Flow is greater than:' setting LinSig will never suppress this Route even if it meets the criterion for suppression due to changes in Network data or the suppression criteria.

Setting Non-Permitted Traffic Routes

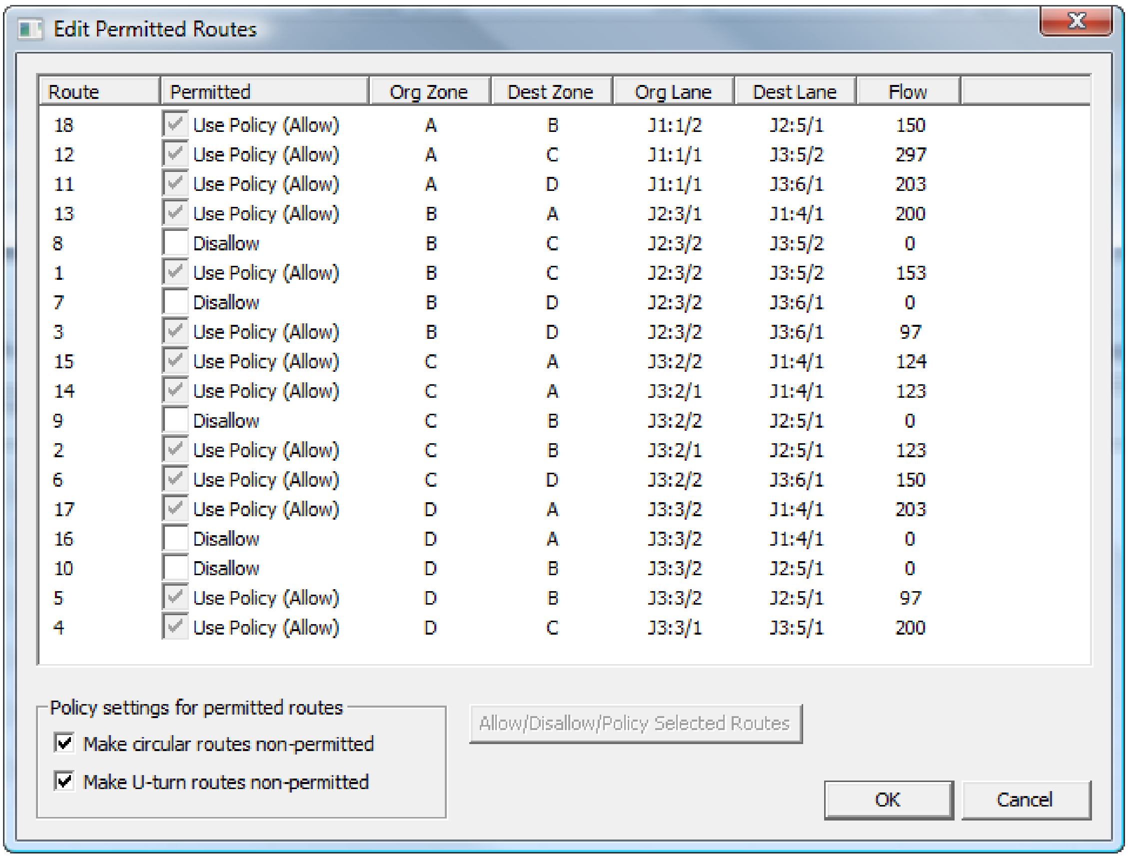
Even if LinSig is set to suppress unfeasible routes as described above some Routes are deemed feasible are undesirable and wouldn't in practice be used by traffic. LinSig allows Routes to be defined as non-permitted meaning that LinSig will never allow any traffic to be assigned to the Route. Setting non-permitted Routes currently applies to Traffic Routes only.

Routes can be specified as non-permitted in two ways:

- Manually by explicitly setting the Route as non-permitted as described below.
- By Permitted Route Policy which allows Routes conforming to one of several polices such as U turning and spiral Routes to be automatically set to non-permitted. These policies will filter out many Routes avoiding the need to manually set large numbers of Routes to non-permitted manually. Policies can always be overridden

The Edit Permitted Routes dialog box is used for both methods:

- In the Route List View click 'Edit Permitted Routes'. The Edit Permitted Routes dialog box opens. This lists all Traffic Routes in the Network, a copy of key Route identification information and the Route's permitted status.



Route	Permitted	Org Zone	Dest Zone	Org Lane	Dest Lane	Flow
18	Use Policy (Allow)	A	B	J1:1/2	J2:5/1	150
12	Use Policy (Allow)	A	C	J1:1/1	J3:5/2	297
11	Use Policy (Allow)	A	D	J1:1/1	J3:6/1	203
13	Use Policy (Allow)	B	A	J2:3/1	J1:4/1	200
8	Disallow	B	C	J2:3/2	J3:5/2	0
1	Use Policy (Allow)	B	C	J2:3/2	J3:5/2	153
7	Disallow	B	D	J2:3/2	J3:6/1	0
3	Use Policy (Allow)	B	D	J2:3/2	J3:6/1	97
15	Use Policy (Allow)	C	A	J3:2/2	J1:4/1	124
14	Use Policy (Allow)	C	A	J3:2/1	J1:4/1	123
9	Disallow	C	B	J3:2/2	J2:5/1	0
2	Use Policy (Allow)	C	B	J3:2/1	J2:5/1	123
6	Use Policy (Allow)	C	D	J3:2/2	J3:6/1	150
17	Use Policy (Allow)	D	A	J3:3/2	J1:4/1	203
16	Disallow	D	A	J3:3/2	J1:4/1	0
10	Disallow	D	B	J3:3/2	J2:5/1	0
5	Use Policy (Allow)	D	B	J3:3/2	J2:5/1	97
4	Use Policy (Allow)	D	C	J3:3/1	J3:5/1	200

- The permitted status is the only column that can be changed. It can be set to one of three settings. These are:

  - **Allow.** The Route can be used by LinSig regardless of the policies.
  - **Disallow.** The Route cannot be used regardless of the policies.
  - **Use Policy.** Whether the Route is allowed is governed by the Policies selected in the 'Policy Settings for Permitted Routes' box at the bottom of the Edit Permitted Routes dialog box. The result of applying the policy to a Route is shown in the Permitted Status column as either 'Use Policy (Allow)' or 'Use Policy (Disallow)' as appropriate.
  - Currently two policies are available. These are: Make Circular Routes non-Permitted; and Make U-turn Routes non-permitted. It is recommended that both policies are kept switched on unless problems are encountered with a particular Network. Remember the explicit Allow or Disallow can always be used to override the policies.
- Click OK to save the permitted status for the Routes.

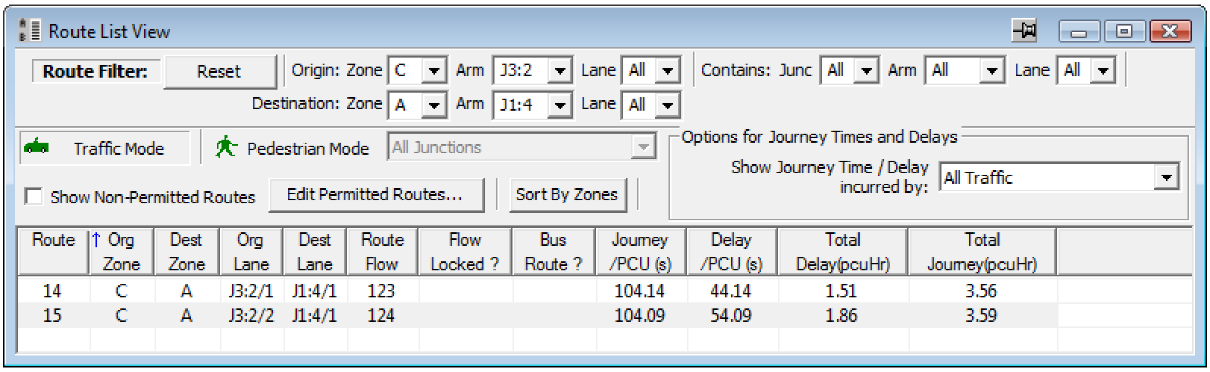
Any Route which is disallowed will have its Route Flow set to zero. This will cause a flow deficit between the total Route flows in the Actual Flows OD matrix and the Desired Flows OD matrix. This should be checked and remedied either by reassigning the OD matrix or by manually editing Route flows.

Multiple Routes can have their permitted status changed at once as follows:

- Select several Routes whilst holding down the Shift or Ctrl key.
- Click 'Allow/Disallow/Policy Selected Routes' button to set the status of the selected Routes.
- Click OK to save the permitted status for the Routes.

The Route Filter

The Route Filter allows the Route List to be filtered to show only Routes matching a filter criterion defined in the Route Filter. This is useful with larger Networks which contain many Routes. As well as showing only filtered Routes in the Route List the Network Layout View also highlights the currently filtered Routes.



A Route Filter can contain any or all of the following criteria:

- Route Origin Zone, Arm or Lane.
- The Route Destination Zone, Arm or Lane,
- An Arm or Lane which a Route passes through.

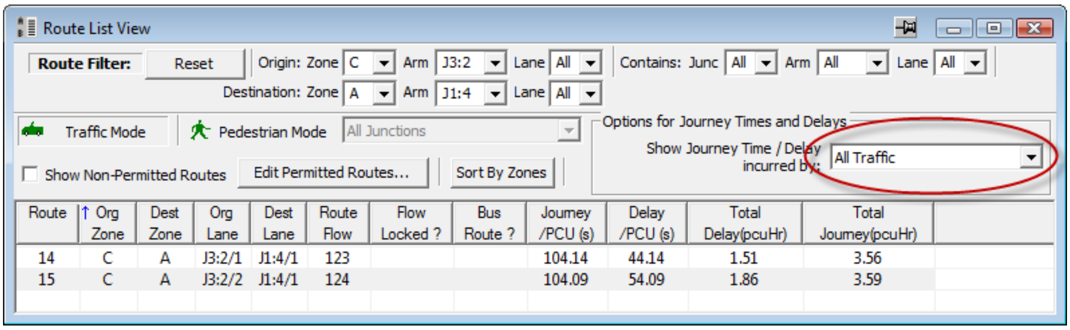
Only Traffic Routes which match all three criteria will be included in the Filtered Route List. Pedestrian cannot currently be filtered.

The Route Filter can be set using either the toolbar in the Route List View or the toolbar in the Network Layout View. If a Route Filter has been set it can be removed by clicking the 'Reset' button in the Route Filter toolbar.

Refining the Route Journey Times

The journey time shown on the Routes can be further refined by choosing one of the following options:

- **All Traffic.** Displays the travel times experienced by all traffic travelling on the Route.
- **Routed Traffic Only.** Displays the journey times experienced by routed traffic travelling along the Route. Delays experienced by any Lane Based Traffic encountered along the Route are not included. This option is useful for displaying delays to buses on Bus Routes where general traffic is specified using Lane based Flows.
- **Lane Based Flow Traffic Only.** Displays the journey times experienced by Lane Based Traffic. If multiple Lane Based Flow Layers are used this option aggregates delays over all Layers.
- **Layer: 'Layer Name'.** One option will be available for each Lane Based Flow Layer in the model. Each option will display only delay incurred by traffic on the individual Layer. This is useful for displaying journey times for a specific class of Lane Based traffic.



4.5.2. Assigning the Desired Traffic Flow Matrices to Routes using the Route List

The Desired Flows Matrix as displayed in the Traffic Flows View defines the total desired movements between Zones. The process of assignment to Routes specifies which Routes through the Network traffic will use to travel between two Zones.

The Route List View is used to display the Routes through the Network and allows the Routes to be assigned traffic flows and managed in other ways.

Assigning the Origin-Destination Matrix to Routes

Traffic flows can be assigned to Routes in two ways. These are:

- **Manually assigning a Traffic Flow to each Route.** This method provides more flexibility and control as the flow patterns can be refined to a high level of detail. It can however be time consuming with larger Networks.
- **Automatically assigning Traffic Flows to each Route based on the Desired Origin-Destination Matrix.** This method is significantly faster than manually assigning flows but is by its nature more systematic and assumes acceptance of standard traffic routing algorithms.

It is of course possible to use a combination of the above methods, using automatic assignment initially and refining manually where desired.

The Traffic Flows View monitors the total aggregate amounts of traffic allocated to Routes in the Actual Flows Matrix and provides a check that the flows allocated to Routes match the Desired Origin-Destination matrix.

Manually assigning Traffic Flows to Routes

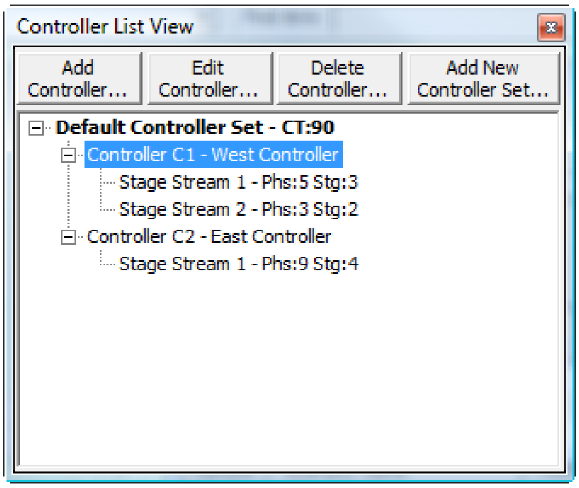
Traffic flows can be assigned to each Route independently by editing the traffic flow on each Route as described in 'Editing a Route Flow' above. It is your responsibility to ensure that the sum of Route Flows between any two Zones equals the total desired Zone to Zone flows specified in the Traffic Flow View's Desired Flows Matrix. The Difference Matrix in the Traffic Flows View is useful in checking for any mismatches between the Desired Flows Matrix and total Route Flows between Zones.

Automatically Assigning the Desired Flows OD Matrix to Routes

Traffic from a Desired OD Matrix can be assigned to each Scenario's Routes automatically using LinSig's equilibrium assignment algorithm. As the assignment is carried out for each Scenario this is described in more detail in the Scenario View section.

4.6. Controller List View

The Controller List View lists all the traffic signal controllers in the Network together with the Stage Streams running on each Controller. It is opened by choosing 'Controller List View' from the Controllers menu. The View is used to edit Controller settings, to group Controllers into Controller Sets and to move Stage Streams between Controllers.



4.6.1. Definitions

The Controller List View can be used to manage three different signal control items. These are:

- **Controller Sets.** Controller Sets allow Controllers using a common cycle time to be grouped together for easier management.
- **Controller.** Each Controller represents a real life signal controller.
- **Stage Stream.** Each Controller can control one or more Stage Streams. Stage Streams can best be thought of as splitting a physical Controller into several 'virtual' Controllers, each of which can independently control a Junction or part of a Junction.

4.6.2. Working with Controller Sets

Each LinSig Model is created with a single default Controller Set containing a Single Stage Stream Controller. Multiple Controller Sets are only required if multiple traffic signal cycle times are required in a single LinSig Network. If all Junctions share the same cycle time the default Controller Set will be sufficient.

4.6.2.1. Creating a New Controller Set

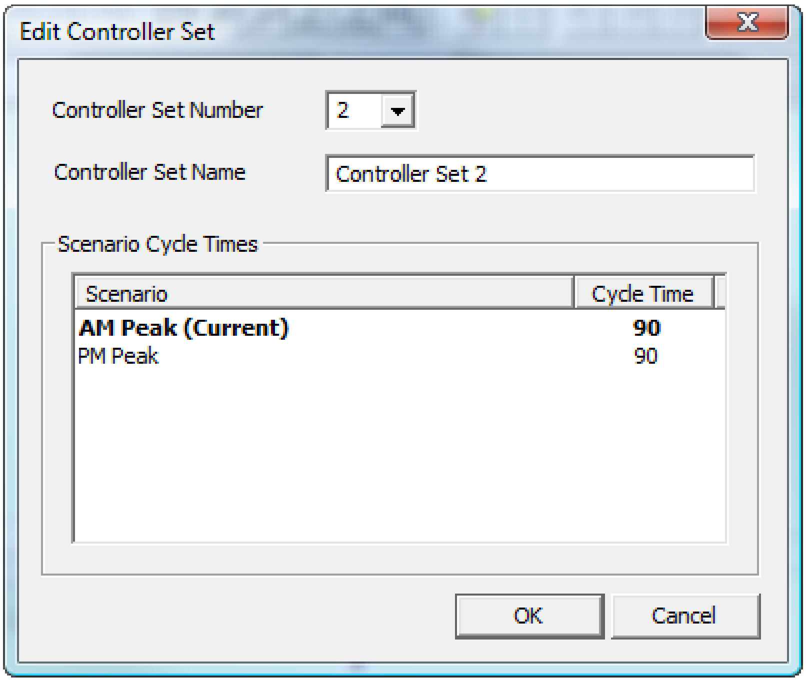
A new Controller Set can be created as follows:

- Choose 'Add New Controller Set...' from the Controller Set pop-out menu on the Controllers menu or alternatively use the 'Add New Controller Set' button on the Controller List View's toolbar.
- The 'Edit Controller Set' dialog box is shown allowing the new Controller Set's initial settings to be changed as described below in 'Editing Controller Sets'.
- When all settings have been set click 'OK' to create the new Controller Set.

4.6.2.2. Editing a Controller Set

A Controller Set is edited as follows:

- Right Click on the Controller Set to be edited in the Controller List View and choose 'Edit Controller Set'. This will open the 'Edit Controller Set' dialog box.



- The Edit Controller Set dialog box allows the following settings to be changed:
  - **Controller Set Number.** The Controller Set Number defines the order Controller Sets are listed in the Controller List View.
  - **Controller Set Name.** The Controller Set Name allows the Controller Set to be given a name for reference and reporting purposes.
  - **Scenario Cycle Times.** The Controller Set's cycle time can be set independently for each Model Scenario. The cycle time will be used for all Controllers in the Controller Set. If different cycle times are required the Controller Set should be split into two or more Controller Sets. Cycle times can also be managed from the Scenario View and on the main toolbar.
- Click OK to update the Controller Set with the new settings.

4.6.2.3. Deleting a Controller Set

A Controller Set can only be deleted when all Controllers in the Controller Set have been deleted or moved into other Controller Sets.

A Controller Set can be deleted by right clicking on the Controller Set in the Controller List View and choosing 'Delete Controller Set' from the pop-up menu.

4.6.2.4. Moving Controllers between Controller Sets

A Controller can be moved to a different Controller Set by dragging it to a new Controller Set in the Controller List View. The Controller will adopt the cycle time of its new Controller Set.

4.6.3. Working with Controllers

LinSig can model one or more Controllers each of which can contain one or more Stage Stream. Controllers can also be grouped into Controller Sets as described above to allow multiple cycle times to be used within the same Network. Each Controller adopts the cycle time of its parent Controller Set.

4.6.3.1. Selecting the Current Controller

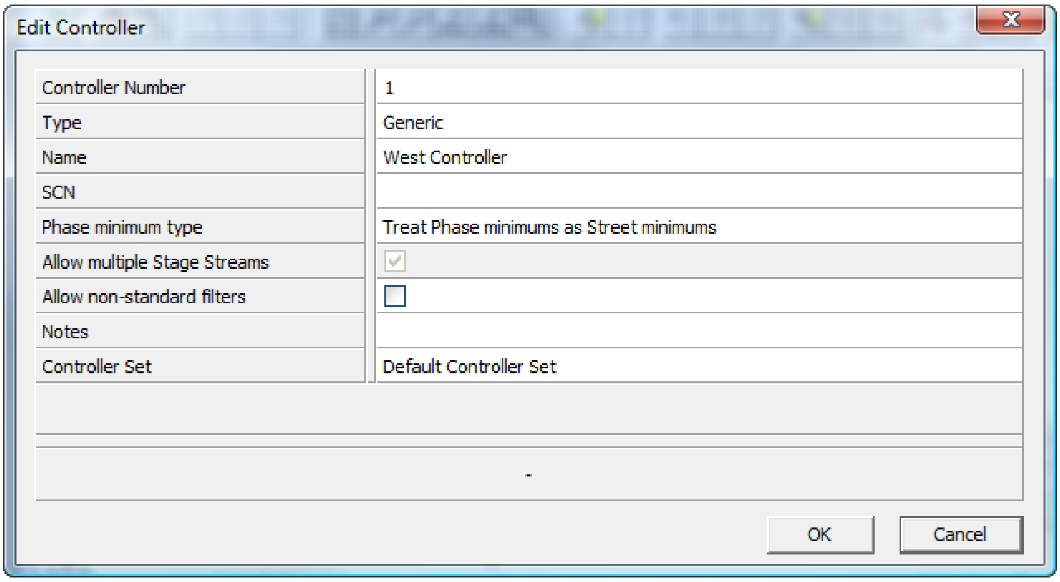
LinSig will use the Current Controller in a number of Views to determine which Controller to display information for. The Current Controller can be selected in either of the following ways.

- Select the Current Controller from the Controller drop down list in the main LinSig toolbar.
- Select the Current Controller by clicking on a Controller in the Controller List View.
- Right clicking on a Junction in the Network Layout View and choosing 'Make this Junctions Controller the Current Controller'.

4.6.3.2. Creating New Controllers

A new LinSig Network always includes an initial single Stage Stream Controller in the default Controller Set. Additional Controllers can be created as follows:

- Right Click the Controller Set where the new Controller is to be added and choose 'Add New Controller to this Controller Set' from the pop-up menu.
- A new Controller will be created and the Edit Controller dialog box opens allowing the Controllers initial settings to be made.



- Controller Settings which can be changed are:
    - **Controller Number.** The Controller Number is LinSig's reference number for the Controller. Controllers can be numbered in any order but all Controller numbers must be used with no gaps in the sequence. If a new Controller is given the same number as an existing Controller the new Controller will be inserted into the Controller numbering sequence and higher numbered Controllers will be renumbered.

- **Controller Type.** The Controller Type setting allows the Controller to be set to follow traits of a particular controller manufacturer.
- **Controller Name.** A descriptive name for the Controller.
- **SCN (System Code Number).** A standard code number identifying the Controller in the UTC system.
- **Phase Minimum Type.** The Phase Minimum Type can be set to Street Minimums or Controller Minimums. Street minimums are usually used when designing the controller to achieve a particular set of observed minimum values on the street. Controller Minimums are usually used when inputting minimum vales from a Controller specification sheet. This is covered further in the Controller Background section.
- **Allow Multiple Stage Streams.** This setting specifies whether LinSig will allow multiple Stage Streams to be edited on this Controller. If a Controller will contain only a single Stage Stream the user interface can be simplified by leaving this box unticked. LinSig will then hide user interface elements for this Controller related to editing multiple Stage Streams.
- **Allow Non-Standard Filters.** This setting specifies whether LinSig will allow non-standard filters to be specified on this controller. If this box is ticked LinSig allows the termination type to be set on a Filter Phase allowing it to be terminated either on the start of its associated Phase as normal, or when the associated Phase terminates as is sometimes used.
- **Notes.** A note which allows any information relevant to this Controller to be added.
- **Controller Set.** This setting allows the Controller's Controller Set to be changed. The Controller Set can also be changed by dragging the Controller into a new Controller Set in the Controller List View.

- Click OK to finish creating the Controller.

4.6.3.3. Editing Controller Settings

A Controller's settings can be edited by selecting the Controller in the Controller List View and clicking the 'Edit' button on the Controller List View's toolbar. This opens the 'Edit Controller' dialog box allowing settings to be edited as described in 'Creating a New Controller' above.

4.6.3.4. Deleting Controllers

A Controller can be deleted by selecting the Controller in the Controller List View and clicking delete on the Controller List View's toolbar. Remember that deleting a Controller will also delete all of its Phases, Phase Intergreens, Stages, Stage Sequences, etc. and also leave any Lanes controlled by the Controller as uncontrolled Lanes.

4.6.4. Managing Stage Streams in the Controller List View

The Controller List View can also be used to create and manage Stage Streams belonging to Controllers.

4.6.4.1. Adding a Stage Stream to a Controller

A new Stage Stream can be created on a Controller by right clicking the Controller in the Controller List View and choosing 'Add New Stage Stream'. The new Stage Stream will always be added to the end of the Stage Stream list but can be subsequently moved within the list as described below.

4.6.4.2. Reordering Stage Streams on a Controller

Stage Streams on a Controller can be reordered as follows:

- Select the Stage Stream in the Controller List View.
- Right click on the Stage Stream and choose 'Renumber Stage Stream' from the pop-up menu. This opens the Renumber Stage Stream dialog box.
- Select the new Stage Stream number in the dialog box.
- The Stage Stream is renumbered.
- Phases are not automatically renumbered to reflect the new Stage Stream order but can be done so manually using the Phase View if desired.

4.6.4.3. Moving a Stage Stream to another Controller

A Stage Stream can be moved to another Controller as follows:

- Select the Stage Stream in the Controller List View.
- Using the mouse drag the Stage Stream over its new Controller in the Controller List View.
- Drop the Stage Stream on its new Controller. This will remove the Stage Stream and associated items such as Phases, Stages etc. from their previous Controller and add them to their new one. Phases etc are renumbered to be compatible with their new Controller.
- The Stage Stream is always added at the end of the Stage Stream List in the new Controller but can be reordered as described above.

4.6.4.4. Deleting a Stage Stream

A Stage Stream can be deleted as follows:

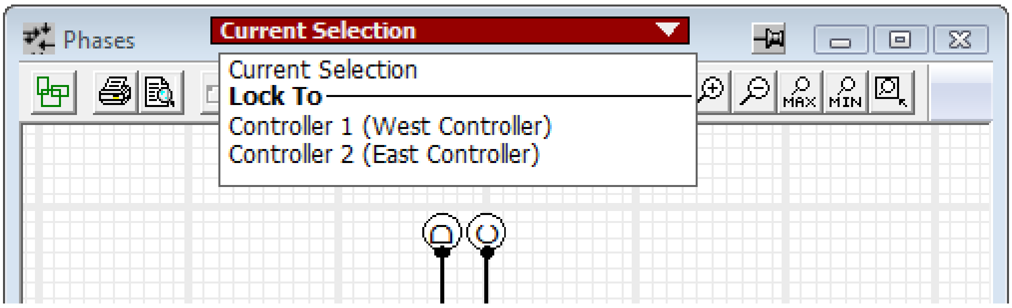
- Select the Stage Stream in the Controller List View.
- Choose 'Delete Stage Stream' from the Stage Streams pop-out menu on the Controllers menu.
- The Stage Stream together with its Stages and Stage Sequences are deleted. Phases allocated to the Stage Stream are not deleted but are unallocated making them available for inclusion in other Stage Streams.

4.7. Phase View

The Phase View is used to display and edit each Controller's traffic signal Phases. It is opened by choosing 'Phase View' from the LinSig Controllers menu. Each Phase View shows the Phases for a single Controller and works slightly differently depending on whether the Controller being displayed contains more than one Stage Stream.

4.7.1. Selecting which Controller to View

It is possible to have one or more Phase Views open in a LinSig model at any one time. Each Phase View shows the Phases for a single LinSig traffic Signal Controller.

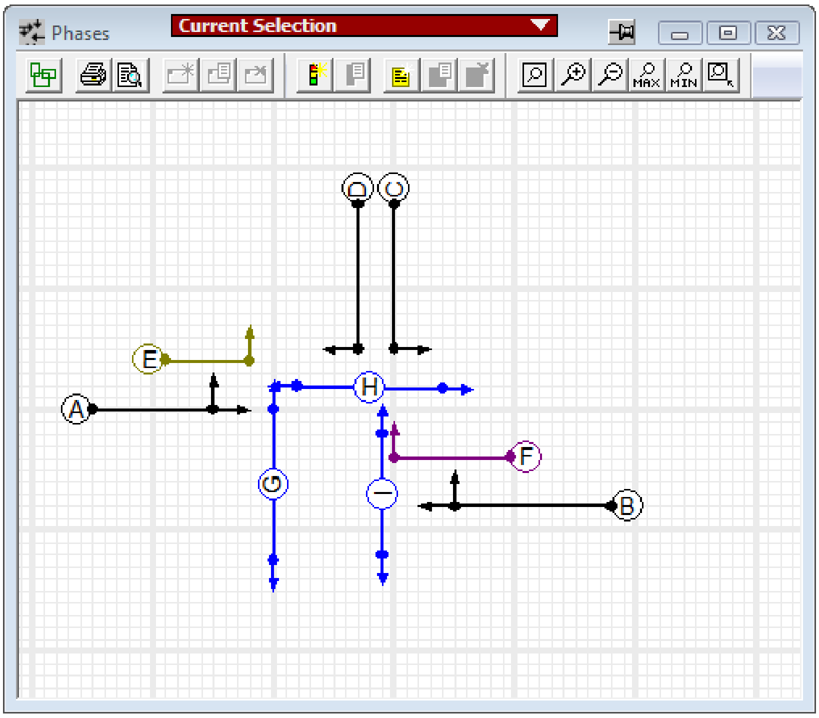


The Controller being displayed is set using each View's Controller Selector drop list as follows:

- LinSig always has a 'Current Controller' which is used by several Views to ensure they are all displaying information for the same Controller. The Current Controller is selected using the Controller List View or using the Controller drop down list on the main LinSig toolbar. If the Controller drop down list on the Phases View's title bar is set to 'Current Selection' the Phase View will display the Phases for the Current Controller as selected in the Controller List View. If the Current Controller changes the Controller displayed in this View will also change to reflect the new Current Controller.
- In some instances you may wish to view the Phases for several controllers at the same time. To allow this each Phase View may be locked to a particular Controller so its display does not change when the Current Controller is changed. To lock a Phase View to a Controller drop down the Controller Selector drop list in the Phase Views title bar and choose which Controller to lock the Phase View too.

4.7.2. Single Stage Stream Use

The Phase View shows the current layout of Phases defined in the Controller. Each Phase is colour coded to indicate its phase type. Phases show directional arrows based on the Lanes they control and therefore arrows are only shown when a Phase controls one or more Lanes.



4.7.2.1. Using the Phase View

The Phase View can be zoomed and panned as described above in 'General View Features'. This section also describes how to change other visual settings, how to print the Phase View and how to export its layout to other graphics software.

The Phase View shows the following:

- Each Phase is displayed as an arrow indicating the traffic movements controlled by the Phase.
- Phases are colour coded depending on Phase type.
- Phases can be rotated, lengthened, shortened by dragging the circular handles at each end of a Phase. The whole phase can also be relocated by selecting it and dragging.
- Directional arrows are shown on the Phase only after one or more Lanes have been defined as being controlled by the Phase. It should be remembered that Phases may control several Lanes and that Lanes may be controlled by more than one Phase so that there will not always be a one-to-one correspondence between the arrows shown on Phases and Lanes. For example Phase B in the diagram above is a Three Aspect Phase controlling both ahead and right turn Lanes – hence it shows both ahead and right turn arrows. Phase F is an Indicative Right Turn Arrow controlling just the right turn and shows only the right turn arrow.

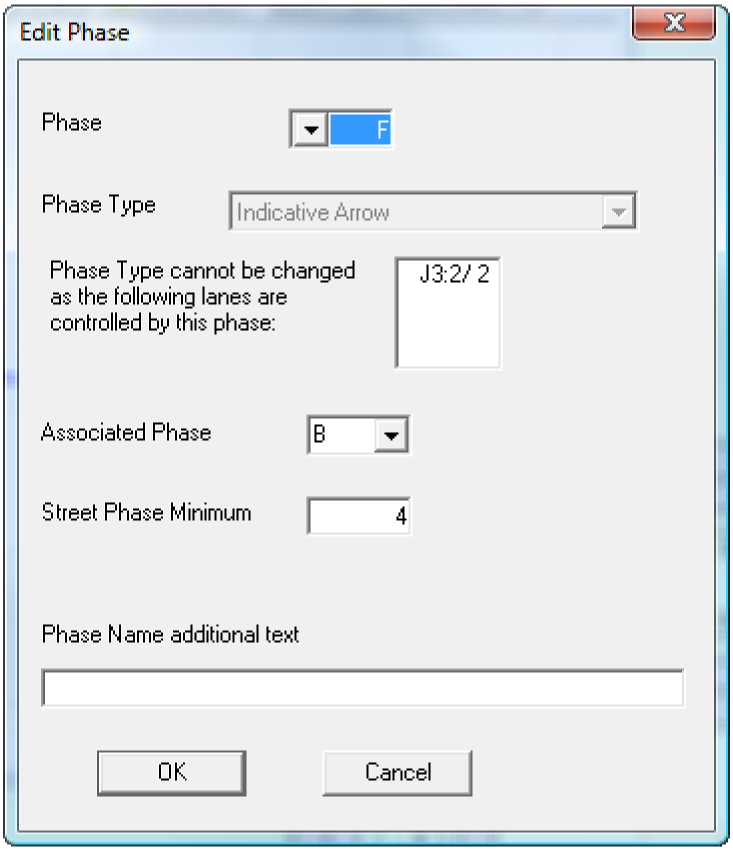
4.7.2.2. Creating New Phases

A new Phase can be created as follows:

- Choose 'Add Phase…' from the Phases pop out menu on the Controllers menu or right click in the Phase View with the mouse and choose 'Add Phase…' from the pop-up menu.
- A new Phase is created and can be dropped in an appropriate position using the mouse.
- The Edit Phase Dialog box is shown and can be used to configure the Phase's properties as described below in 'Editing Phases'.
- The Phase can be repositioned if necessary by dragging the centre of, or circular handles at each end of the Phase with the mouse.

4.7.2.3. Editing Phases

Phases can be edited by selecting the Phase and choosing 'Edit Phase…' from the Phases pop-out menu on the Controllers menu, or by double clicking with the mouse. The Edit Phase Dialog Box shown below is used to edit the Phase's settings.



A Phase has the following parameters:

- **Phase Letter.** The letter used to reference the Phase in the Controller. The Phase can be relabelled by changing the Phase letter in the drop down List. Other Phases will be renumbered accordingly. Phases must be contiguous with no gaps in the Phase sequence.
- **Phase Type.** A phase can exist as one of eight different types. These are:
  - **Three Aspect Traffic Phase.** This is a 'standard' phase used for most normal traffic movements. Although the signals will in reality

show periods of amber and red/amber LinSig models the signals as green or not green.

  - **Indicative Arrow Phase.** Generally used to provide an unopposed period for right turning traffic which turns in gaps in the opposing traffic for part of its cycle. IGA phases are often mistakenly called 'Right Filters'. True Right Filters are relatively uncommon in the UK.
  - **Filter Phase.** Usually used to control left turning traffic which starts before the main movement. Also very infrequently used to control right turning traffic as a true Right Filter.
  - **Pedestrian Phase.** Used to control Pedestrians. Again LinSig models the signals as green or not-green with any blackout periods being subsumed into the not-green period.
  - **Dummy Phase.** Dummy Phases are phases which exist only in the signal controller's software and do not control any lights or other equipment.
  - **Dummy with Red/Amber.** The same as a Dummy Phase but operates as though the Phase has a dummy Red/Amber period.
  - **Cycle Phase.** Identical to a Traffic Phase but with a green lamp with a cycle symbol.
  - **Bus Phase.** Identical to a Traffic Phase but with a green lamp with a bus symbol.
  - **LRT (Tram) Phase.** Same as a Traffic Phase but with no starting red/amber period and controls LRT signals rather than normal traffic signal lights.
  - **Filter with Closing Amber.** This Phase type is for use in the Republic of Ireland and other locations which allow similar signalling. This Phase should not be used in the UK as its behaviour does not conform to the Traffic Signs Regulations. This type of Filter Phase can be set as a Lane's Arrow Phase but may start and end independently of the Lanes's Full Green Phase due to its Closing Amber, and therefore does not require an associated Phase. The Lane will run if either its Filter or Full Green Phase is at Green. This type of Phase is usually configured in the Controller as a normal Three Aspect Phase.

- **Controlled Lanes.** If the Phase controls any Lanes the phase type cannot be altered. LinSig shows the controlled Lanes which must be disconnected from this Phase before the Phase Type can be altered.
- **Associated Phase.** If this Phase is a Filter or Indicative Green Arrow enter the associated Three Aspect Phase. If the Associated Phase does not yet exist you will need to return to this Phase, after creating the Associated Phase, to set this Phase's Associated Phase.
- **Phase Minimum.** Enter the Phase Minimum value. This value may be either a Street Minimum or a Controller Minimum depending on the Phase Minimum type setting in the Controller Settings. More detailed information on Phase minimums is located in the Controller Background Section.
- **Phase Name Additional Text.** Phase names are generated automatically by LinSig. To provide more flexibility in naming Phases you may enter some additional text that will be appended to the generated Phase name. This is particularly important for pedestrian Phases as LinSig cannot usually generate a detailed phase name for a pedestrian Phase.

4.7.2.4. Using a Phase to Control Lanes

Each Traffic Phase may control one or more Traffic Lanes. A Traffic Phase will display directional arrows in the Phase View based on the turning movements allowed on the Lanes it controls. No arrows will be shown if the Phase does not control any Lanes. The Phases controlling each Lane are specified whilst editing Lanes in the Network Layout View.

4.7.2.5. Deleting Phases

To delete a Phase select it with the mouse and choose ‘Delete Phase’ from the Phases pop-out menu on the Controllers Menu, or right click on the Phase with the mouse and choose ‘Delete Phase’ from the pop-up menu. Any Intergreens or Phase Delays which are dependent on the Phase will also be deleted.

4.7.3. Using Multiple Stage Streams with the Phase View

Multiple Parallel Stage Streams are a feature of traffic signal controllers which allow more than one junction, or independent parts of a single Junction, to be operated in parallel by a single traffic signal controller. As it is used in only a small proportion of junction designs LinSig allows the feature to be switched off simplifying the interface. By default Multiple Stage Streams are switched off.

Every valid LinSig Controller must contain at least one Stage Stream. The maximum number of Stage Streams allowed depends on the controller type being used but is typically in the range four to eight with some newer controllers potentially allowing more. Remember that using multiple Stage Streams is usually associated with complex designs and the stream structure requires careful thought.

4.7.3.1. Switching on Multiple Stage Streams

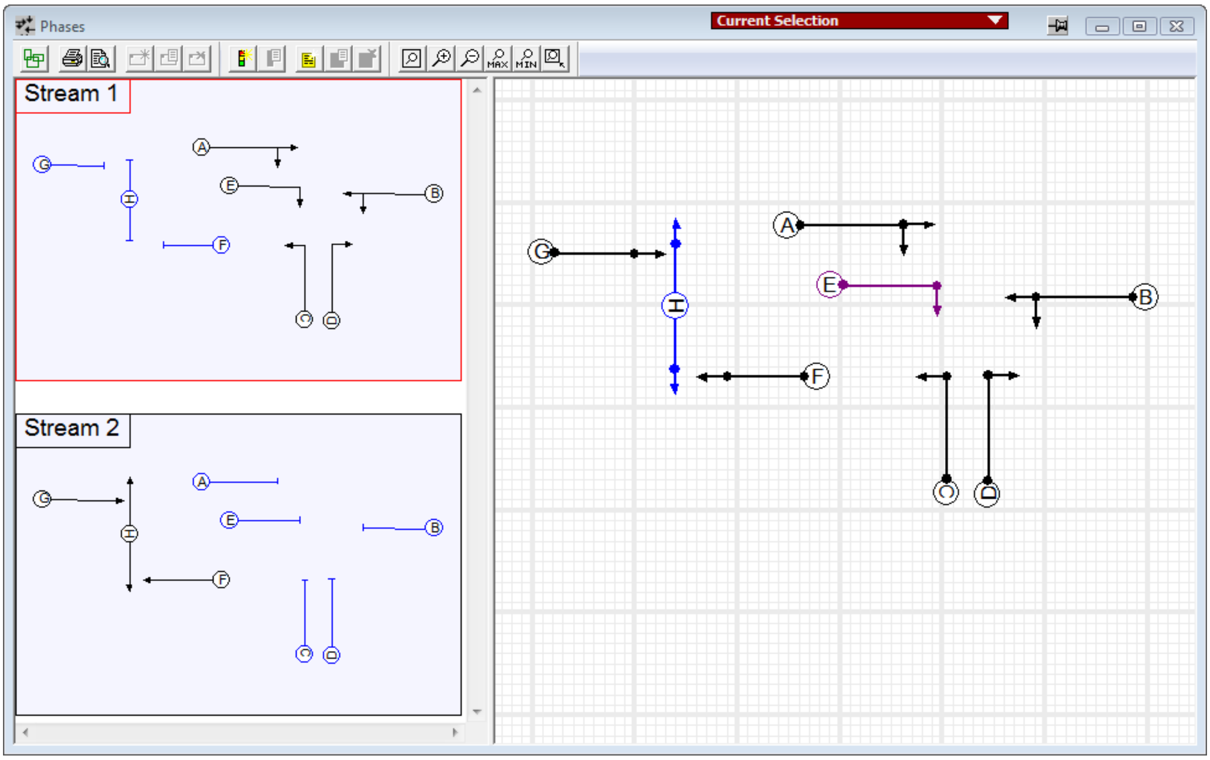
Multiple Stage Streams are switched on as follows:

- Select the Controller in the Controller List View.
- Click Edit in the Controller List View to edit the Controller’s settings.
- Tick ‘Allow Multiple Stage Streams’ in the Controller Settings. This enables this Controller to support multiple Stage Streams.

The Phase View will now be displayed as shown in the next section below.

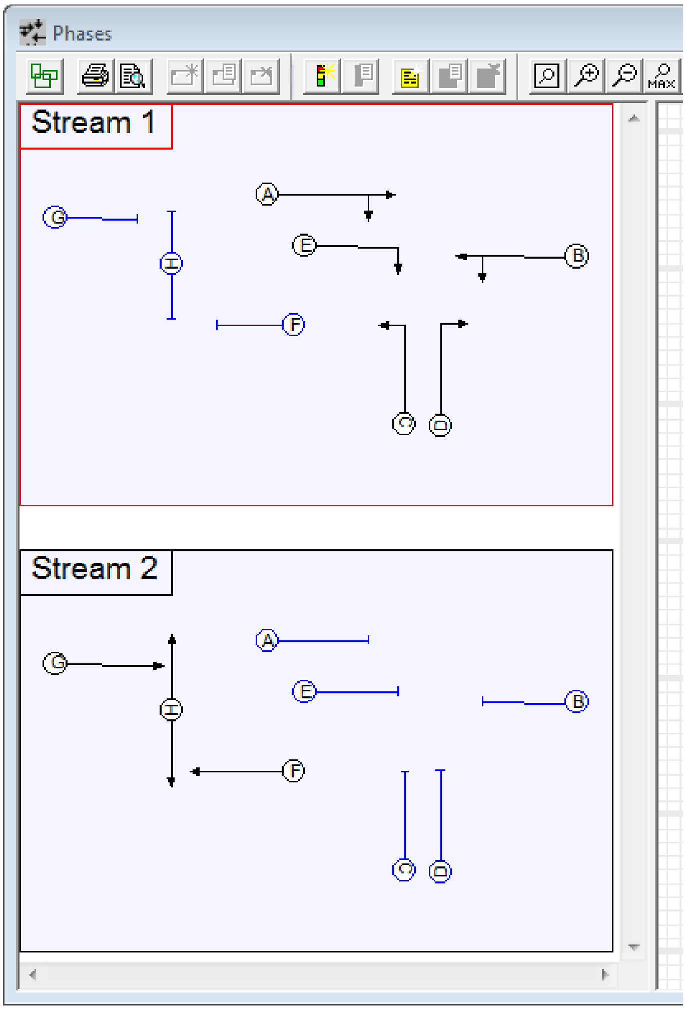
4.7.3.2. The Multiple Stage Stream Phase View

When Multiple Stage Streams are switched on the Phase View displays an additional panel to the left of the main Phase layout showing Stage Streams and the Phases allocated to each Stage Stream. This panel is similar to that shown in the Stage View when multiple Stage Streams are in use. As well as using the Controller List View the Stage Stream panel of either View can be used to add and delete Stage Streams and to allocate Phases to Streams.



4.7.3.3. The Stage Stream Panel

Each Stage Stream shows a reduced size copy of the Phase layout on the Controller. Phases are colour coded to show whether they are allocated to the current Stage Stream, or are unallocated or allocated to a different Stage Stream.



Phases are displayed as follows:

- Phases allocated to a Stage Stream are shown in black and have directional arrows.
- Phases not allocated to any Stage Stream are shown in grey with no arrows.
- Phases allocated to a different Stage Stream are shown in blue with no arrows.

When more than one Stage Stream is defined:

- The set of Phases defined for the Controller are shared across all the Stage Streams.
- Each Phase can only be allocated to a single stage stream.
- A Phase can only run in a Stage in the Stage Stream to which it is allocated.
- A Phase cannot be removed from a Stage Stream if it is running in a Stage in that Stream.

It is recommended to allocate Phases to Stage Streams as soon as possible in the design as this will assist LinSig with error checking when working in other Views, particularly when defining which Phases run in which Stages in the Stage View.

4.7.3.4. Managing Stage Streams using the Phase View

Although the Controller List View is the main place to manage Stage Streams the Phase View can also be used as follows:

Selecting Stage Streams and the Current Stage Stream

When carrying out an action on a Stream LinSig needs to know which Stream to use. The Stage Stream panel allows a Stage Stream to be selected, highlighting it in red. This selected Stage Stream will be used in all situations where an action is performed on a Stage Stream, for example when adding a Stage in the Stage View it will be added to the Current Stage Stream. The current Stage Stream can also be set using the Stage Stream dropdown list on the main LinSig toolbar.

Creating a new Stage Stream

To create a new Stage Stream choose 'Add a Stage Stream…' from the Stages Menu. A new Stage Stream will be shown in the Stage Stream panel. This will initially have no Phases allocated to it.

Deleting Stage Streams

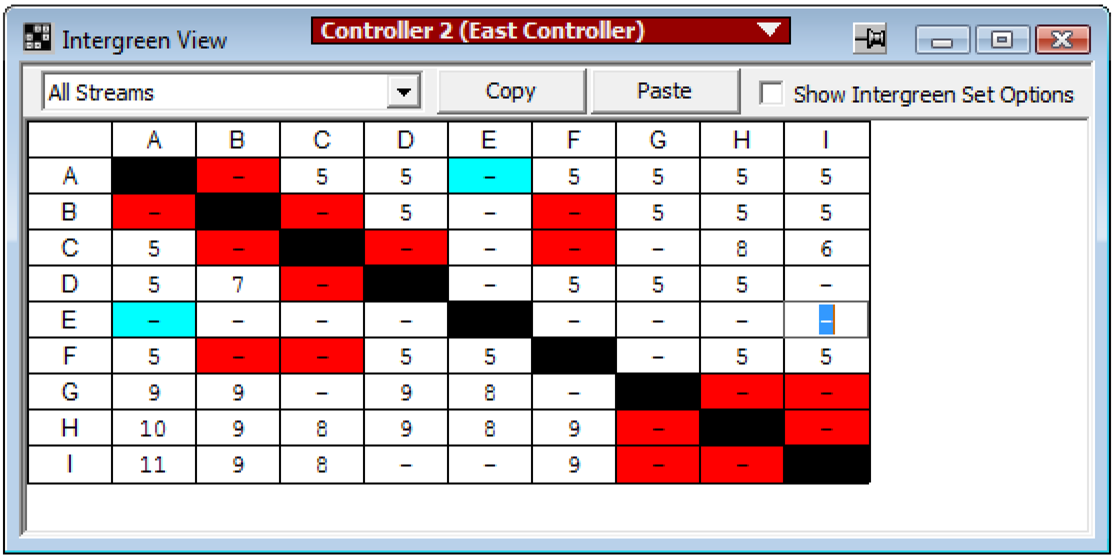
To delete a Stage Stream select the Stream you wish to delete and choose 'Delete Stage Stream' from the Stages Menu or right-click pop-up menu.

Allocating Phases to a Stage Stream

Phases are allocated to a Stage Stream (or de-allocated if already allocated) by double clicking with the mouse. If the Phase is already allocated to a different Stage Stream LinSig will not allow it to be allocated to another Stage Stream without first removing it from its current Stream.

4.8. Intergreen View

The Intergreen View is used to display and edit each Controller's Phase Intergreens. It is opened by choosing 'Intergreen View' from the LinSig Controllers menu. Each Intergreen View shows the Intergreens for a single Controller. The View displays Intergreens as a matrix with the terminating Phase on the Rows and the starting Phase on the columns.



	A	B	C	D	E	F	G	H	I
A		–	5	5	–	5	5	5	5
B	–		–	5	–	–	5	5	5
C	5	–		–	–	–	–	8	6
D	5	7	–		–	5	5	5	–
E	–	–	–	–		–	–	–	–
F	5	–	–	5	5		–	5	5
G	9	9	–	9	8	–		–	–
H	10	9	8	9	8	9	–		–
I	11	9	8	–	–	9	–	–	

The Intergreens represent the safe clearance interval in seconds between the time a phase terminates and the time another phase starts. Advice on calculating Intergreens can be obtained in the DfT Advisory Leaflet TAL 1/06.

4.8.1. Selecting which Controller to View

It is possible to have one or more Intergreen Views open in a LinSig model at any one time. Each Intergreen View shows the Intergreens for a single LinSig traffic Signal Controller. The Controller being displayed is set using each View's Controller Selector drop list as follows:

- LinSig always has a 'Current Controller' which is used by several Views to ensure they are all displaying information for the same Controller. The Current Controller is selected using the Controller List View or using the Controller drop down list on the main LinSig toolbar. If the Controller drop down list on the Intergreen View's title bar is set to 'Current Selection' the Intergreen View will display the Intergreens for the Current Controller as selected in the Controller List View. If the Current Controller changes the Controller displayed in this View will also change to reflect the new Current Controller.

- In some instances you may wish to view the Intergreens for several controllers at the same time. To allow this each Intergreen View may be locked to a particular Controller so its display does not change when the Current Controller is changed. To lock a Intergreen View to a Controller drop down the Controller Selector drop list in the Intergreen View's title bar and choose which Controller to lock the Intergreen View too.

4.8.2. Managing Intergreens

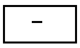
4.8.2.1. Displaying Intergreens for Individual Stage Streams

If multiple Stage Streams are enabled in the Controller being edited the Intergreen View can show the Intergreens just for Phases within a Stage Stream rather than for all Phases. This allows the Intergreen View to be more concise.

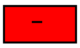
The drop-down list in the Intergreen View's toolbar can be used to choose a Stage Stream for which to display Intergreens or to choose the normal Intergreen View showing all Phases.

4.8.2.2. Intergreen Error Checking

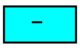
LinSig checks whether an Intergreen is appropriate for each phase-to-phase movement taking into account which Phases run together in Stages and other relationships between Phases such as Filters and their Associated Phases.



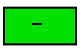
A cell containing a dash indicates that there is currently no conflict between the phase pairs. You should enter an Intergreen value if you wish to define the phases as conflicting, or leave the cell blank if the phases do not conflict. Remember that an Intergreen of zero is not the same as having no Intergreen.



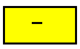
A cell with a red background indicates that the phases currently run together in a stage and can therefore have no conflicting value. You cannot enter a value in this cell.



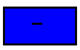
A cell with a light blue background indicates that the phases are currently associated and can therefore have no conflicting value. You cannot enter a value in this cell.



A cell with a green background indicates that the intergreen matrix is currently asymmetrical and it is probable that an intergreen is required in this cell. Note that it is unusual to have an intergreen from a filter phase to another phase. LinSig therefore does not indicate a symmetry problem in this case.



A cell with a yellow background indicates that the phases are both pedestrian types and therefore are unlikely to have a conflicting value. You may enter a value in this cell but are unlikely to need to do so.



A cell with a blue background indicates that the phases are in different Stage Streams. As LinSig does not allow intergreens between Phases in different Streams you cannot enter a value in this cell.

4.8.2.3. To Change an Intergreen

To change an Intergreen click on the Intergreen Matrix cell you wish to change and enter the new value. The Intergreen will be updated when you move away from the cell.

4.8.2.4. To Delete an Intergreen

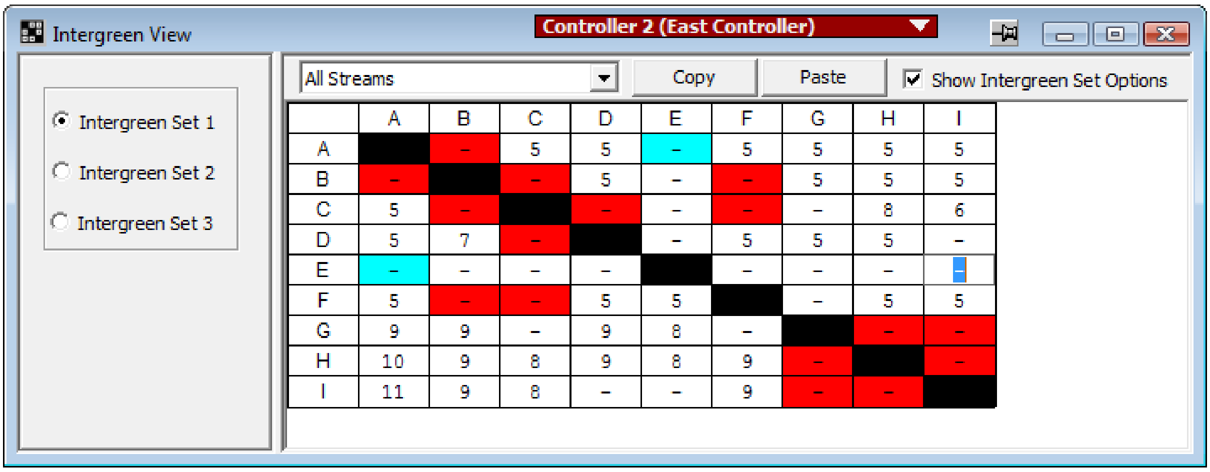
To delete an Intergreen select the appropriate cell and delete the value using the delete key. The Intergreen will be updated when you move away from the cell.

Tip: Remember that a zero length Intergreen is NOT the same as having no Intergreen. If no Intergreen exists between two Phases they can overlap. If a zero Intergreen exists they do not require any clearance time but they cannot overlap.

4.8.3. Using Multiple Intergreen Sets

LinSig 3.1 and later allows up to three different Intergreen sets to be defined. These can be switched between at any time and are useful when modelling situations with variable intergreens the most common being Puffin pedestrian crossings.

Multiple Intergreen sets are enabled by selecting the 'Show Intergreen Set Options' option in the Intergreen toolbar. The Intergreen View will allow three different sets of intergreens to be used. The currently used set is selected in the Intergreen sets section of the Intergreen View.



	A	B	C	D	E	F	G	H	I
A		–	5	5	–	5	5	5	5
B	–		–	5	–	–	5	5	5
C	5	–		–	–	–	–	8	6
D	5	7	–		–	5	5	5	–
E	–	–	–	–		–	–	–	–
F	5	–	–	5	5		–	5	5
G	9	9	–	9	8	–		–	–
H	10	9	8	9	8	9	–		–
I	11	9	8	–	–	9	–	–	

4.9. Stage View

The Stage View is used to create Traffic Signal Stages for each Controller, and to display and edit the Phases running in each of the Controllers Stages. Each Stage represents a Stage configured in the controller and available for use in Stage Sequences.

The Stage View is opened by choosing 'Stage View' from the LinSig Controllers menu. Each Stage View shows the Stages for a single Controller and works slightly differently depending on whether the Controller being displayed contains more than one Stage Stream.

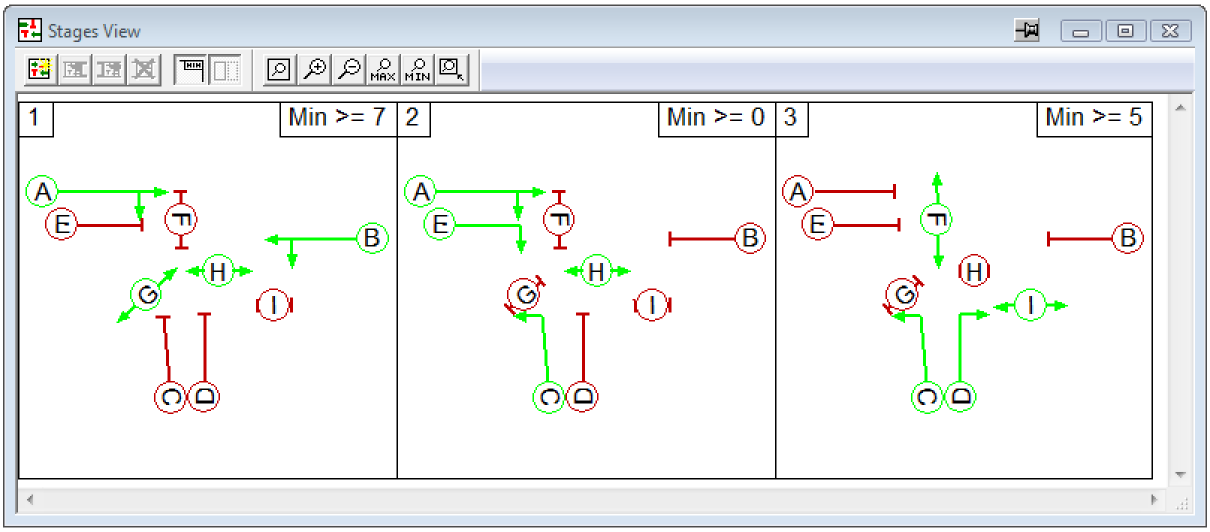
4.9.1. Selecting which Controller to View

It is possible to have one or more Phase Views open in a LinSig model at any one time. Each Phase View shows the Phases for a single LinSig traffic Signal Controller. The Controller being displayed is set using each View's Controller Selector drop list as follows:

- LinSig always has a 'Current Controller' which is used by several Views to ensure they are all displaying information for the same Controller. The Current Controller is selected using the Controller List View or using the Controller drop down list on the main LinSig toolbar. If the Controller drop down list on the Phases View's title bar is set to 'Current Selection' the Phase View will display the Phases for the Current Controller as selected in the Controller List View. If the Current Controller changes the Controller displayed in this View will also change to reflect the new Current Controller.
- In some instances you may wish to view the Phases for several controllers at the same time. To allow this each Phase View may be locked to a particular Controller so its display does not change when the Current Controller is changed. To lock a Phase View to a Controller drop down the Controller Selector drop list in the Phase Views title bar and choose which Controller to lock the Phase View too.

4.9.2. Single Stage Stream Use

The Stage View displays the Stages defined for the Controller currently being viewed in the Stage View. Each Stage shows which Phases run in that Stage.



4.9.2.1. Stage View Layout

Phase Display

Phases are colour coded to indicate which are running and also to indicate any Phases which cannot be run for any reason. The layout of Phases in each Stage is provided by the Phase View so the position of Phases can be changed if necessary using the Phase View.

Phases are displayed as follows:

- **Green showing directional arrows –** The Phase runs in the Stage with the directional arrows indicating which movements the Phase controls.
- **Red with no Arrows** - The Phase cannot run in the Stage due to either a conflict with a Phase already running or with a phase delay already defined. The conflict is usually due to a Phase intergreen between this Phase and a Phase already running in the Stage. No arrows are shown indicating the phase is not running.
- **Blue with no Arrows** - The Phase cannot run in this stage as it would violate rules relating to the use of filter and indicative green arrow phases. No arrows are shown indicating that the Phase is not running.
- **Grey with no Arrows** - The Phase could run in this stage but is not currently selected to do so. No arrows are shown indicating that the phase is not running.

Stage Minimums

LinSig can optionally show the minimum possible Stage Minimum for each Stage. In many cases Stages can run in a variety of orders and a Stage could have a different effective minimum for each possible Stage Sequence. LinSig therefore calculates Stage minimums for all possible sequences of three stages and displays the lowest Stage Minimum found for the middle Stage. The minimum Stage Minimums are useful for specifying Stage Length limits in UTC or monitoring systems.

The Stage View shows only a summary of the minimum Stage Minimums. The Stage Minimum View shows more detail on how Stage Minimums vary for different Stage orders.

4.9.2.2. Selecting Stages and the Current Stage

When carrying out an action on a Stage LinSig needs to know which Stage to use. The Stage View allows a Stage to be selected by clicking on it, the selected Stage being highlighted in red. This selected Stage will be used in all situations where an action is performed on a Stage, for example when deleting a Stage.

4.9.2.3. Creating a New Stage

To create a new Stage choose 'Add Stage' from the Stages Menu or Right-Click at the end of the current Stages and choose 'Add Stage' from the pop-up menu. The Stage will be created with no Phases running.

4.9.2.4. Inserting a Stage

To insert a Stage between two existing Stages select one of the Stages and choose 'Insert Stage before Selected Stage' or 'Insert Stage after Selected Stage' as appropriate from the Stages Menu. As Stages must always be in numerical order with no gaps in the sequence existing Stages will be renumbered when a Stage is inserted. Remember that the numerical order of Stages in the Controller does not imply that they must be run in this order in LinSig Stage Sequences.

4.9.2.5. Renumbering a Stage

To renumber a Stage, select it with the mouse and drag it to its new position in the Stage View. The other Stages in the Stream will be renumbered accordingly.

4.9.2.6. Changing a SCATS-Based Phase Name

When using SCATS-Based Terminology mode each SCATS™ Phase (equivalent to a UK Stage) can be renamed as follows:

- Click on the Phase to be renamed with the right mouse button and choose 'Edit Phase Name' from the pop-up menu. The Edit Phase dialog will open.
- Either choose a new Phase Name for the Phase or the Phase for which this Phase is an alternate Phase. If the new Phase Name already exists LinSig will rename subsequent Phases.

4.9.2.7. Deleting a Stage

To Delete a Stage select it with the mouse and choose 'Delete Stage' from the Stages Menu or Right-Click on the Stage and choose 'Delete Stage' from the pop-up menu. The other Stages in the Stream will be renumbered to close the gap in the Stage order created by deleting the Stage.

Deleting a Stage has the following consequences:

- If the Stage is used in any Stage Sequences it will be deleted from the Stage Sequence.
- If any Phase Delays exist which are dependent on the Stage they will be deleted.

Tip: Remember that if you accidentally delete a Stage using Undo will completely restore any Staging Plans or Phase Delays affected by deleting the Stage.

4.9.2.8. Running or Removing a Phase from a Stage

A Phase can be added to or removed from a Stage by double clicking the Phase in the relevant Stage in the Stage View with the mouse. This will add a previously non-running Phase to the Stage or remove a running Phase. A Phase which has a conflict with Phases already running or is subject to some other constraint cannot be run in the Stage and will be shown colour coded as described above to indicate why it cannot be run. Double clicking on a Phase which cannot run will display more detail on the reason the Phase cannot run.

4.9.3. Using Multiple Stage Streams with the Stage View

Multiple Parallel Stage Streams are a feature of traffic signal controllers which allow more than one junction, or independent parts of a single Junction, to be operated in parallel by a single traffic signal controller. As it is used in only a small proportion of junction designs LinSig allows the feature to be switched off simplifying the interface. By default Multiple Stage Streams are switched off.

Every valid LinSig Controller must contain at least one Stage Stream. The maximum number of Stage Streams allowed depends on the controller type being used but is typically in the range four to eight with some newer controllers potentially allowing more. Remember that using multiple Stage Streams is usually associated with complex designs and the stream structure requires careful thought.

4.9.3.1. Switching on Multiple Stage Streams

Multiple Stage Streams are switched on as follows:

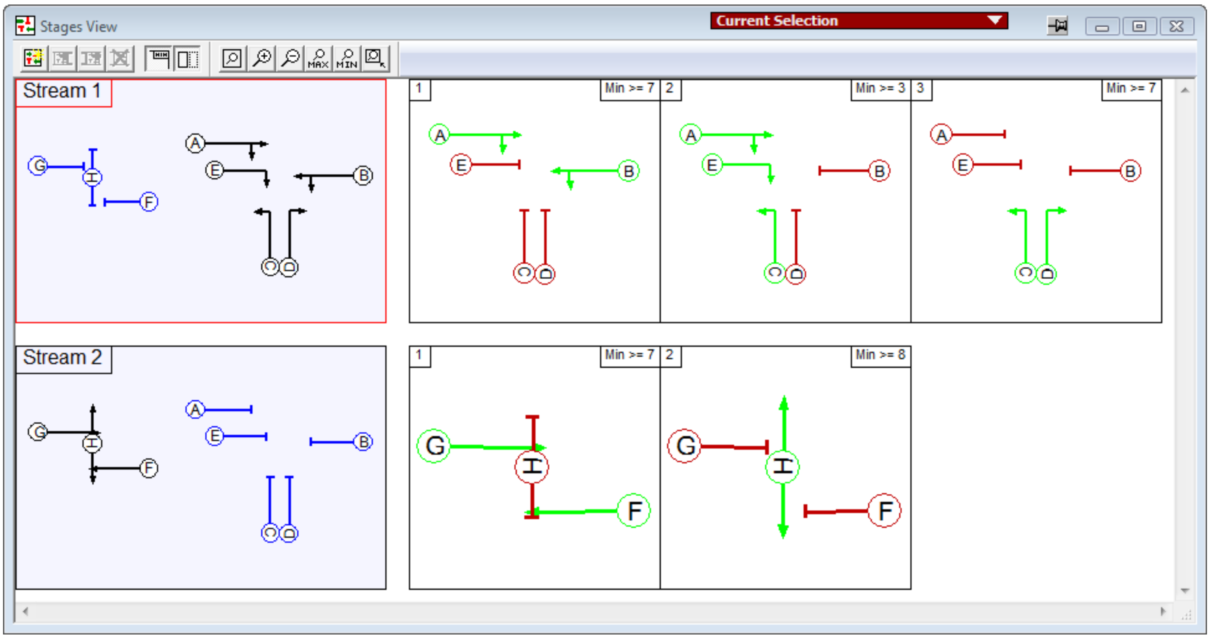
- Select the Controller in the Controller List View.
- Click Edit in the Controller List View to edit the Controller's settings.
- Tick 'Allow Multiple Stage Streams' in the Controller Settings. This enables this Controller to support multiple Stage Streams.

The Stage View will now be displayed as shown in the figure below.

4.9.3.2. The Multiple Stage Stream Stage View

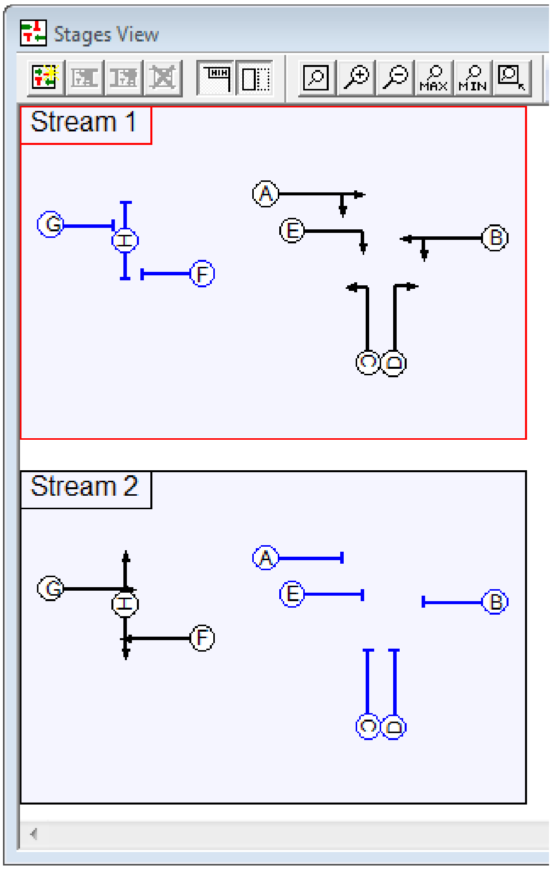
When Multiple Stage Streams are switched on the Stage View displays an additional panel to the left of the main Stage panel showing Stage Streams and the Phases allocated to each Stage Stream. This panel is similar to that shown in the Phase View when multiple Stage Streams are in use. As well as using the Controller List View the Stage Stream panel of either View can be used to add and delete Stage Streams and to allocate Phases to Streams.

With Multiple Stage Streams switched on LinSig allows a separate set of Stages to be defined for each Stream, with Stages in different Streams being made up of different sets of Phases.



4.9.3.3. The Stage Stream Panel

Each Stage Stream shows a reduced size copy of the Phase layout on the Controller. Phases are colour coded to show whether they are allocated to the current Stage Stream, are unallocated or allocated to a different Stage Stream.



Phases are displayed as follows:

- Phases allocated to a Stage Stream are shown in black and have directional arrows.
- Phases not allocated to any Stage Stream are shown in grey with no arrows.
- Phases allocated to a different Stage Stream are shown in blue with no arrows.

When Multiple Stage Streams are being used:

- The set of Phases defined for the Controller are shared across the Stage Streams.
- Each Phase can only be allocated to a single stage stream.
- A Phase can only run in a Stage in the Stage Stream to which it is allocated.
- A Phase cannot be removed from a Stage Stream if it is running in a Stage in that Stream.

It is recommended to allocate Phases to Stage Streams as soon as possible in the design as this will assist LinSig with error checking when working in other Views, particularly when defining which Phases run in which Stages in the Stage View.

4.9.3.4. Managing Stage Streams using the Stage View

Although the Controller List View is the main place to manage Stage Streams the Stage View can also be used as follows:

Selecting Stage Streams and the Current Stage Stream

When carrying out an action on a Stream LinSig needs to know which Stream to use. The Stage Stream panel allows a Stage Stream to be selected, highlighting it in red. This selected Stage Stream will be used in all situations where an action is performed on a Stage Stream, for example when adding a Stage in the Stage View it will be added to the Current Stage Stream.

Creating a new Stage Stream

To create a new Stage Stream choose 'Add a Stage Stream…' from the Stages Menu. A new Stage Stream will be shown in the Stage Stream panel. This will initially have no Phases allocated to it.

Deleting Stage Streams

To delete a Stage Stream select the Stream you wish to delete and choose 'Delete Stage Stream' from the Stages Menu or right-click pop-up menu.

Allocating Phases to a Stage Stream

Phases are allocated to a Stage Stream (or de-allocated if already allocated) by double clicking with the mouse. If the Phase is already allocated to a different Stage Stream LinSig will not allow it to be allocated to another Stage Stream without first removing it from its current Stream.

4.9.3.5. Working with the Multiple Stage Stream Stage View

Stages can be created, deleted, renumbered and their Phases changed in an almost identical manner as the single Stream View. The main differences are:

- Each Stream has a separate set of Stages and inserting or deleting Stages in one Stream does not affect the Stages in another Stream.
- Each Stage box by default shows only the Phases allocated to the Stream to which the Stage belongs. The stage boxes can be set to scale to fit to all Phases or just the Phases in the Stream by clicking the 'Toggle Fitting of Stage Display to Stream' button on the Stage View's toolbar.

4.10. Stage Sequence View

A LinSig Stage Sequence consists of a running order of Stages for each Stage Stream. Stages can run in any order in a Stage Sequence and if necessary can run more than once or not at all. This differs from the Stage View which shows the Stages in the order they are configured in the Controller. For example, typical Stage Sequences may include sequences such as 'All Stages', 'Early Cut Off', or 'Including Pedestrian All Red'.

The Stage Sequence View is used to create and edit Stage Sequences, and to display and edit the Stages running in each Sequence. The View is opened by choosing 'Stage Sequence View' from the Stage Sequences Menu.

The Stage Sequence View is used slightly differently depending on whether multiple stage streams are enabled with LinSig.

4.10.1. Selecting which Controller to View

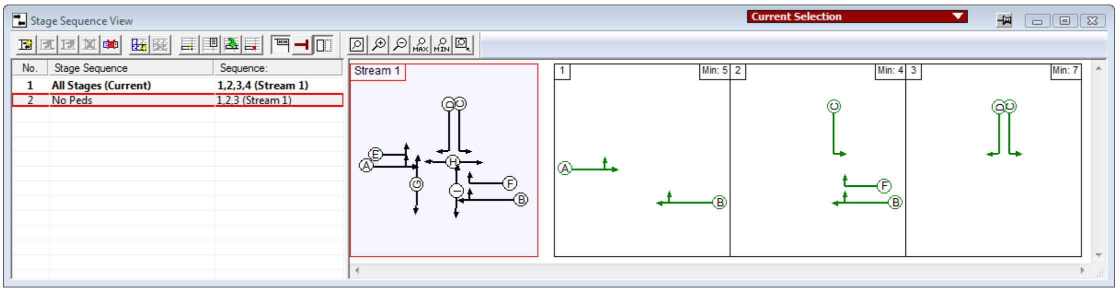
It is possible to have one or more Stage Sequence Views open in a LinSig model at any one time. Each Stage Sequence View shows the Phases for a single LinSig traffic Signal Controller. The Controller being displayed is set using each View's Controller Selector drop list as follows:

- LinSig always has a 'Current Controller' which is used by several Views to ensure they are all displaying information for the same Controller. The Current Controller is selected using the Controller List View or using the Controller drop down list on the main LinSig toolbar. If the Controller drop down list on the Phases View's title bar is set to 'Current Selection' the Stage Sequence View will display the Phases for the Current Controller as selected in the Controller List View. If the Current Controller changes the Controller displayed in this View will also change to reflect the new Current Controller.
- In some instances you may wish to view the Phases for several controllers at the same time. To allow this each Stage Sequence View may be locked to a particular Controller so its display does not change when the Current Controller is changed. To lock a Stage Sequence View to a Controller drop down the Controller Selector drop list in the Stage Sequence Views title bar and choose which Controller to lock the Stage Sequence View too.

4.10.2. Single Stage Stream Use

The Stage Sequence View is comprised of two panels:

- The Stage Sequence List down the left hand side of the View lists all the stored Stage Sequences for the Controller.
- The Stage Sequence panel on the right shows the Stage order of the currently selected Stage Sequence and also displays timing information for the Stage Sequence such as Stage durations and minimums.



4.10.2.1. The Stage Sequence List

The Stage Sequence List lists all of the Stage Sequences defined in the Controller currently being viewed in the Stage Sequence View. The following information is shown for each Stage Sequence:

- **The Stage Sequence Number.** A unique reference number for each Stage Sequence.
- **The Stage Sequence Name.** A descriptive name for the Stage Sequence such as 'All Stages' or 'With IGA'.
- **Sequence.** The Stage order for the Stage Sequence as a numerical list.
- **The Selected Stage Sequence.** The Selected Stage Sequence is highlighted in red. The Selected Stage Sequence is the Stage Sequence which is shown and edited in the other panel of the Stage Sequence View. It is not necessarily the Stage Sequence being used for model calculations. The Selected Stage Sequence can be changed by clicking a Stage Sequence in the Stage Sequence List.
- **The Currently Modelled Stage Sequence.** The Stage Sequence currently being used for model calculations is inferred from the Network Control Plan being used by the Current Scenario selected in the Scenario View and is shown in bold and labelled '(current)' in the Stage Sequence List. It is changed either by changing the Current Scenario's Network Control Plan or by selecting a new Current Scenario in the Scenario View. When the Current Scenario is changed LinSig will recalculate model results using the Stage Sequence and other settings from the new Current Scenario**.**

Creating a New Stage Sequence

A new Stage Sequence can be created by choosing 'Create Stage Sequence' from the Stage Sequences Menu or by right-clicking on the Stage Sequence List and choosing 'Create Stage Sequence' from the pop-up menu. The Stage Sequence will be created with a default name but with an empty Stage Sequence.

Editing a Stage Sequence

A Stage Sequence can be edited by selecting it in the Stage Sequence List and choosing 'Edit Stage Sequence' from the Stage Sequences menu. This will open the Edit Stage Sequence dialog box which can be used to renumber the Stage Sequence and to change its name. Alternatively the Stage Sequence Name can be edited directly by clicking on a Sequence name in the Stage Sequence List.

Deleting a Stage Sequence

A Stage Sequence can be deleted by selecting the Stage Sequence in the Stage Sequence List and choosing 'Delete Stage Sequence' from the Stage Sequences Menu. After deleting a Stage Sequence the next Sequence is automatically selected. When a Stage Sequence is deleted any Network Control Plans using the deleted Stage Sequence will become invalid. Additionally any Scenarios using invalidated Network Control Plans will become invalid and will no longer be available for modelling until their Network Control Plans are corrected or a new Network Control Plan chosen.

4.10.2.2. The Stage Sequence Display

The Stage Sequence Display shows the Stage order configured for the current Stage Sequence. Stages can run in any order and can if necessary be repeated.

The Stage Sequence shows a Stage diagram for each time a Stage runs in the Stage Sequence. Each Stage diagram shows the Phases running in the Stage and other information about the Stage. This includes:

- The Phases running in the Stage are displayed. The Stage Sequence View toolbar provides options on how Phases are displayed.
- The Interstage duration between a Stage and its preceding Stage is shown in the bottom-left corner of the Stage. This is only shown for the Stage Sequence associated with the Current Scenario as other Stage Sequences do not store signal timings.
- The duration of the Stage in this Stage Sequence is shown in the bottom-centre of the Stage. This is for display only – the Stage duration can be changed in the Signal Timings View. This is only shown for the Stage Sequence associated with the Current Scenario as other Stage Sequences do not store signal timings.
- The Stage Minimum of the Stage is shown in the top-right corner of the Stage. The Stage Minimum shown is the particular Minimum for the Sequence of Stages in the Stage Sequence. Other Sequences of Stages may result in different Stage Minimums. See the Stage Minimums View for more information.

Some of the above data items are only available when the Stage Sequence is valid. If the Sequence is invalid as described below some items may not be shown.

Changing the Way the Stage Sequence is displayed

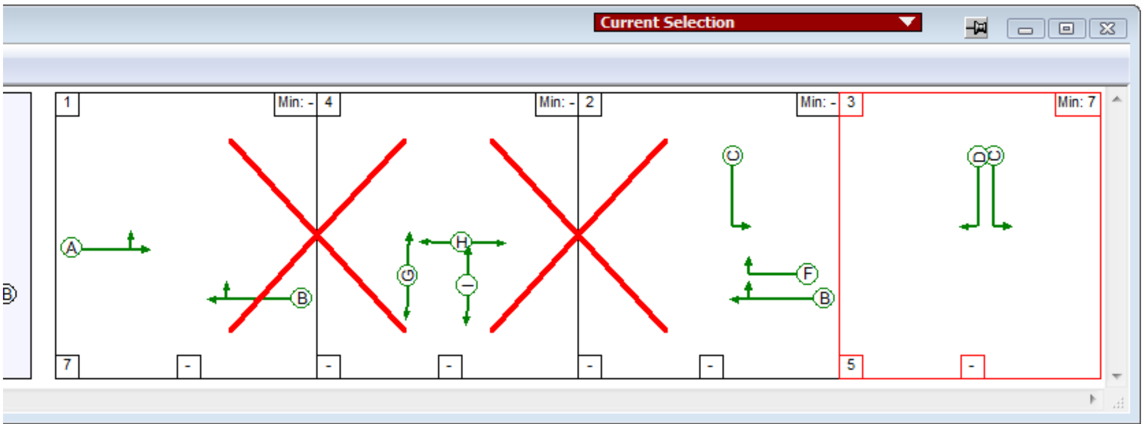
The Stage Sequence View toolbar includes a number of buttons which control the way the Stage Sequence is displayed. Options include:

- Non-Running Phases can be omitted.
- The display of Stage durations, minimums and Interstages can be omitted.

Stage Sequence Validation

LinSig checks Stage Sequences to ensure they are valid. A Stage Sequence is valid if the Stage order does not contain any Prohibited Stage Changes, all Stages containing filters or indicative arrows are terminated correctly, and no other problems exist in the sequence. An invalid Sequence is indicated in two ways. These are:

- A large red cross over a Stage Change. This indicates that the Stage Change has been prohibited. If you wish to use this Stage Change in a Stage Sequence first use the Interstage View to investigate why the Stage Change is prohibited, and remove the prohibition if appropriate.
- A large blue cross over a stage change. This indicates that although the Stage Change has not been explicitly prohibited, it cannot take place due to a problem - typically a Filter or Indicative Arrow Phase is not being terminated correctly. If you wish to use this Stage Change in a Stage Sequence first use the Phase View and Interstage View to investigate the relationship between associated phases and amend as necessary to make the Stage Change legal.



As you build up a Stage Sequence the unfinished sequence will usually show a number of sequence errors. This is quite normal and reflects the fact that the Stage Sequence is not valid until it is complete.

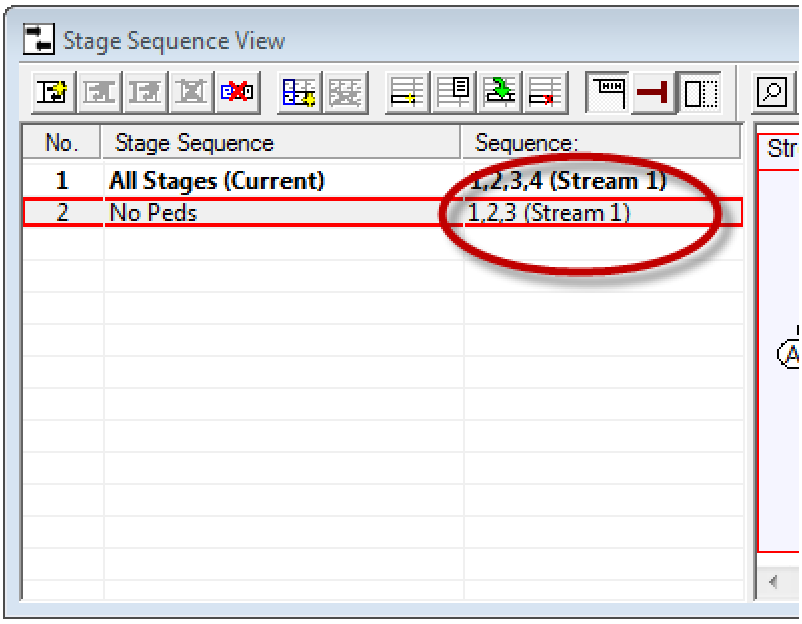
All of the traffic model calculations in LinSig depend on the Stage Sequence associated with the Current Scenario's Network Control Plan, containing a valid Stage Sequence. If a valid Stage Sequence is not defined many of the results views will be unable to show any results. In this case error messages are shown indicating the possible cause of the problem. As soon as a Scenario with a valid Stage Sequence is selected or the current Scenario's associated Stage Sequence is changed to define a valid Stage Sequence the result Views will be automatically refreshed with results for the new or corrected Stage Sequence.

4.10.2.3. Defining a Stage Sequence's Stage Order

A Stage Sequences Stage order is defined by adding, inserting and removing Stages into and from the Stage Sequence.

Quick Stage Sequence Creation

The Stage Sequence can be edited graphically as described below or can be created quickly by typing a sequence of Stage numbers into the Stage Sequence column of the Stage Sequence List. To enter or edit the sequence for a Stage Sequence double click the Stage Sequence's 'Sequence' column in the Stage Sequence List. A new sequence can be entered as a series of Stage numbers, for example, '123' or '134'. If Stage numbers greater than 9 are used they must be separated by commas.



Adding or Inserting Stages into the Stage Sequence

Stages can be added to the Stage Sequence in several ways. The most important include:

- Choose 'Add Stage to End of Sequence' from the Stage Sequences Menu. LinSig will display the Select Stage dialog box allowing you to pick which Stage to add to the end of the Stage Sequence.
- If a Sequence already contains some Stages additional Stages can be inserted around them. To Insert a Stage select an existing Stage in the Stage Sequence and choose 'Insert Stage before/after selected Stage' from the Stage Sequences Menu. The Select Stage dialog box will again ask which Stage to insert.

- Arrange the Views so that both the Stage View and Stage Sequence Views are visible. Stages can be dragged from the Stage View and dropped at any position within the Stage Sequence View's Stage Sequence. The Stage Sequence View will display an insertion point where the Stage will be inserted.

Providing the new Stage Sequence is valid LinSig will update model results for Scenarios using this Network Control Plans containing this Stage Sequence to reflect the new sequence. LinSig will adjust the signal timings in each Scenario using the changed Stage Sequence to ensure legal signal timings are used but these timings will not necessarily be sensible or optimal.

Moving a Stage within the Stage Sequence

A Stage can be moved within the Stage Sequence by dragging the Stage to its new position with the mouse. Provided the Stage's new position creates a valid Stage Sequence LinSig will update the model calculations for Scenarios using Network Control Plans containing the changed Stage Sequence.

Removing a Stage from the Stage Sequence

A Stage can be removed from the Stage Sequence by selecting it with the mouse and choosing 'Remove Selected Stage from Stage Sequence' from the Stage Sequence menu, or by right clicking on the Stage and choosing 'Remove Selected Stage from Stage Sequence' from the pop-up menu. Removing a Stage from a Stage Sequence does not delete the Stage itself.

4.10.3. Using Multiple Stage Streams with the Stage Sequence View

Multiple Parallel Stage Streams are a feature of traffic signal controllers which allow more than one junction, or independent parts of a single Junction, to be operated in parallel by a single traffic signal controller. As it is used in only a small proportion of junction designs LinSig allows the feature to be switched off simplifying the interface. By default Multiple Stage Streams are switched off.

Every valid LinSig Controller must contain at least one Stage Stream. The maximum number of Stage Streams allowed depends on the controller type being used but is typically in the range four to eight with some newer controllers potentially allowing more. Remember that using multiple Stage Streams is usually associated with complex designs and the stream structure requires careful thought.

4.10.3.1. Switching on Multiple Stage Streams

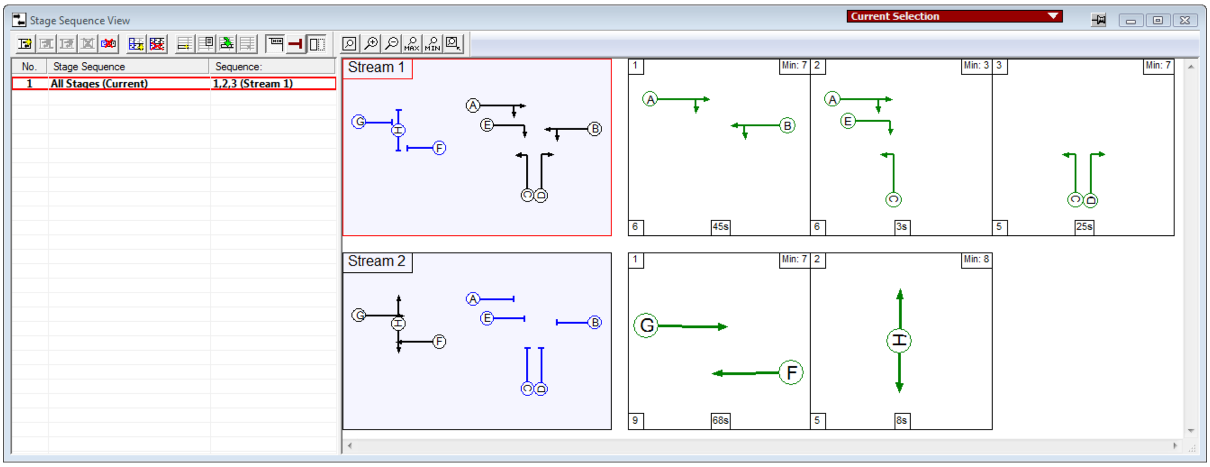
Multiple Stage Streams are switched on as follows:

- Select the Controller in the Controller List View.
- Click Edit in the Controller List View to edit the Controller's settings.
- Tick 'Allow Multiple Stage Streams' in the Controller Settings. This enables this Controller to support multiple Stage Streams.

The Stage Sequence View will now be displayed as shown in the figure below.

4.10.3.2. The Multiple Stage Stream Stage Sequence View

When Multiple Stage Streams are switched on the Stage Sequence View displays an additional panel to the left of the main Stage Sequence panel showing Stage Streams and the Phases allocated to each Stage Stream. This panel is similar to that shown in the Phase View and Stage View when multiple Stage Streams are in use, however the Stage Sequence View's Stage Stream display cannot be used to change the Phases allocated to the Stage Stream. As well as using the Controller List View the Stage Stream panel of either View can be used to add and delete Stage Streams.



With Multiple Stage Streams are switched on LinSig requires a separate Stage Sequence to be defined for each Stage Stream. The Stage Sequence for each Stream is made up of Stages defined for that Stage Stream. Stages defined for a Stage Stream cannot be used in the Stage Sequences of different Stage Streams.

4.10.3.3. The Stage Stream Panel

Each Stage Stream shows a reduced size copy of the Phase layout on the Controller. Phases are colour coded to show whether they are allocated to the current Stage Stream, are unallocated or allocated to a different Stage Stream.

Phases are displayed as follows:

- Phases allocated to a Stage Stream are shown in black and have directional arrows.
- Phases not allocated to any Stage Stream are shown in grey with no arrows.
- Phases allocated to a different Stage Stream are shown in blue with no arrows.

The Stage Stream Panel in the Stage Sequence View cannot be used to change the Stage Stream.

4.10.3.4. Managing Stage Streams using the Stage Sequence View

Although the Controller List View is the main place to manage Stage Streams the Stage Sequence View can also be used as follows:

Selecting Stage Streams and the Current Stage Stream

When carrying out an action on a Stream LinSig needs to know which Stream to use. The Stage Stream panel allows a Stage Stream to be selected, highlighting it in red. This selected Stage Stream will be used in all situations where an action is performed on a Stage Stream, for example when adding a Stage in the Stage View it will be added to the Current Stage Stream.

Creating a new Stage Stream

To create a new Stage Stream choose 'Add a Stage Stream…' from the Stages Menu. A new Stage Stream will be shown in the Stage Stream panel. This will initially have no Phases allocated to it. Phases can be allocated to Streams using the Phase or Stage Views.

Deleting Stage Streams

To delete a Stage Stream select the Stream you wish to delete and choose 'Delete Stage Stream' from the Stages Menu or right-click pop-up menu.

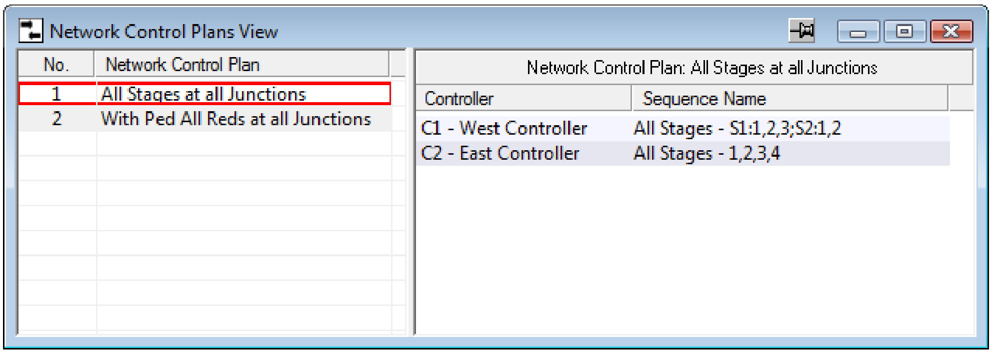
4.10.3.5. Working with the Multiple Stage Stream Stage Sequence View

Stage Sequences are created and edited for multiple Stage Stream models in an almost identical manner to single Stage Stream models as described above. The main differences are:

- Each Stage Sequence requires a Stage Sequence to be defined for each Stage Stream. Each Stage Sequence is created and edited in the same manner as single Stage Stream Stage Sequences.
- When viewing or entering a Stage Sequence in the 'Sequence' column of the Stage Sequence List the current Stream is viewed or edited. To view or edit the Stage Sequence for a different Stage Stream change the current Stage Stream as described above before making changes the same as in the single Stream case also described above.
- When adding Stages to a Stage Sequence they will be added to the end of the Sequence for the currently selected Stream.
- When inserting Stages into a Stage Sequence the new Stage will be inserted into the same sequence as the currently selected Stage.
- When dragging Stages from the Stage view they can only be dropped into the same Stream's Stage Sequence in the Stage Sequence View.
- An Invalid Stage Sequence for any Stream will prevent LinSig from calculating traffic model results for any Scenarios using Network Control Plans containing the Stage Sequence.

4.11. Network Control Plan View

A Network Control Plan is new to Version 3 of LinSig and is used to assist with specifying the signal staging for larger more complex Networks. Each Network Control Plan specifies a Stage Sequence for each Controller in the Network and is used to build up a set of compatible signal sequences for all Junctions. This means that each Scenario can specify the signal staging for the entire Network simply by specifying a single Network Control Plan. The alternative would be to specify a Stage Sequence for each Controller in every Scenario which would become time consuming and error prone as Networks become larger.



The Network Control Plan View allows Network Control Plans to be viewed and edited. The View consists of the following panels:

- **The Network Control Plans List.** The Network Control Plans List is located to the left of the Network Control Plans View and lists all the Network Control Plans defined in the LinSig model.
- **The Network Control Plan Stage Sequence Selection List.** This section is located in the right panel of the Network Control Plans View and for the Network Control Plan selected in the Control Plans List allows a Stage Sequence to be selected for each Controller. For each Controller the following information is displayed:
    - **Controller Name.** The name of a traffic signal Controller in the LinSig model.
    - **Sequence.** The Stage Sequence selected for this Controller in this Network Control Plan. The Stage Sequences are created and edited in the Stage Sequence View.

4.11.1. Managing Network Control Plans

Network Control Plans can be created, selected and deleted using the Network Control Plans List.

4.11.1.1. Creating a New Network Control Plan

A Network Control Plan can be created as follows:

- Right click in the Network Control Plans List and choose 'Create New Network Control Plan' from the pop-up menu.
- A new Network Control Plan is created with the first defined Stage Sequence selected for each Controller as default.
- Each Controllers Stage Sequence can be changed from the default as described below.

Alternatively a new Network Control Plan can be created by copying as existing Network Control Plan as follows:

- Select the Network Control Plan to be copied in the Network Control Plans List.
- Right click on the Network Control Plan.
- Choose 'Copy Network Control Plan' from the pop-up menu.
- A new Network Control Plan is created with a default name. It can be renamed by clicking on the default name in the Network Control Plans List.

4.11.1.2. Deleting Network Control Plans

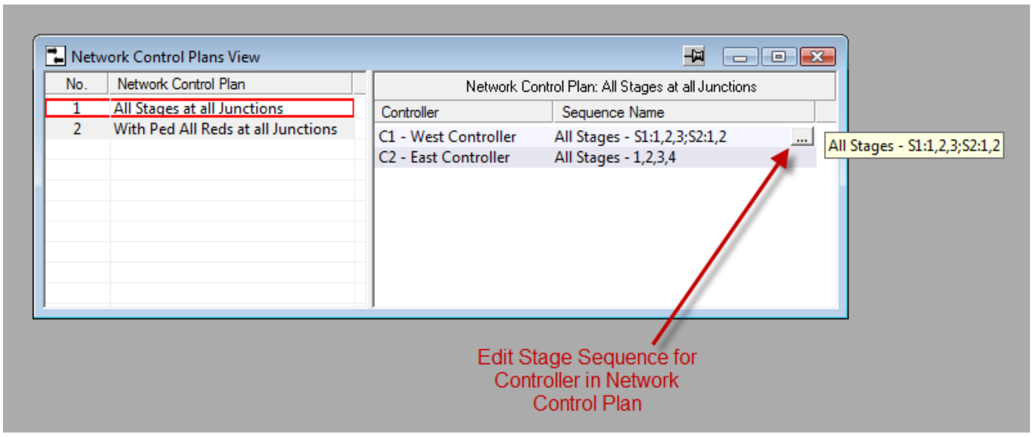
A Network Control Plan can be deleted as follows:

- Select the Network Control Plan in the Network Control Plan List.
- Right click on the Network Control Plan.
- Choose 'Delete Network Control Plan' from the pop-up menu.
- The Network Control Plan is deleted but Stage Sequences referenced by the Network Control Plan are not. Any Scenario using the Network Control Plan will be invalid until a new Network Control Plan is selected for it.

4.11.2. Editing Network Control Plans

Each Network Control Plan specifies a Stage Sequence for each Controller in the Network. Each Stage Sequence is specified as follows:

- In the Stage Sequence List on the right of the Network Control Plans View click on the Stage Sequence name for any Controller.
- Click on the edit button which appears to the right of the Stage Sequence name. This drops down a Stage Sequence List which lists all available Stage Sequences for this Controller.



- Select a Stage Sequence from the drop down list. This is the Stage Sequence which LinSig will run for this Controller when this Network Control Plan is used in a Scenario.

4.12. Scenario View

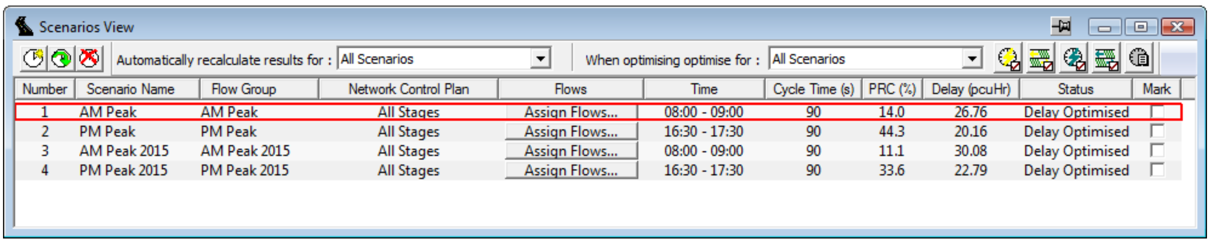
The Scenario View allows Traffic Flow Groups and Network Control Plans to be associated together to define particular modelling scenarios. Each Scenario brings together all the information needed for a single LinSig run. This includes:

- **Traffic Flow Group.** Specifies the traffic wishing to pass through the Network during the modelled period.
- **Network Control Plan.** Specifies the signal stage order for each Controller in the Network.
- **Cycle Times.** Specifies the cycle times at which Controllers will run. Cycle times are managed using Controller Sets. All Controllers in each Controller Set run at the same cycle time.
- **Signal Stage Times.** The signal timings for each Controller as manually defined or as calculated by the signal optimiser.
- **Traffic Route Flows.** The Route Flow pattern for models using Matrix Based Flows. These are based on the assignment of the Scenario Traffic Flow Group's Origin-Destination Matrix to Routes. These are defined either by manually assigning traffic flows to Routes or by using delay based assignment or lane flow balancing to automatically assign traffic to Routes. The Route Flows can be different for each Scenario as different signal settings in each Scenario will often lead to different delays and therefore different routing patterns within the Network. When Lane Based Flows are used the flow pattern is by definition fixed and therefore cannot change between Scenarios.

Typically a number of Scenarios will be set up with each Scenario representing a different combination of the above information for which LinSig model results are required. Using Scenarios makes changing between different model runs very easy as the current Scenario can simply be changed rather than having to remember to change each of the above individual settings.

4.12.1. Working with Scenarios

The Scenario View is used to create, select, edit and delete Scenarios. It can be opened by choosing 'Scenario View' from the Scenario Menu.



The Scenario View lists all the Scenarios displaying the following for each Scenario:

- **The Scenario Name.** This should be a descriptive name for the Scenario. For example 'AM Peak with Right Turn Stage'.
- **The Scenario Flow Group.** The Traffic Flow Group used by the Scenario.
- **The Scenario Network Control Plan.** The Network Control Plan used by the Scenario.

- **The Scenario Time Period.** The Time Period covered by the Scenario. This is inherited from the Scenario's Flow Group and is edited in the Traffic Flow Group View.
- **The Scenario Cycle Time.** The cycle time or cycle times used by this Scenario. This is described in more detail below in 'Managing Cycle Times'.
- **The Scenario Results Summary.** Summary results including the Practical Reserve Capacity (PRC) and Delay are shown for the Scenario. These are based on the Scenarios current signal times and traffic routing.
- **The Scenario Status.** Displays the status for the Scenario. This includes whether model results have been calculated since the last change to the model and whether the Scenarios green times have been optimised.
- **Mark.** Allows a Scenario to be selected as requiring calculation or optimising when the Scenario View is set to only calculate or optimise selected Scenarios.

4.12.1.1. Creating a New Scenario

To create a new Scenario choose 'New Scenario' from the Scenarios pop-out on the Modelling menu or click the 'New Scenario' button in the Scenario View's toolbar. This creates a new Scenario with a default name, a default Flow Group and Network Control Plan, arbitrary signal times and flows unassigned to Routes.

The Scenario Name, Flow Group or Network Control Plan can be changed by clicking on the item you wish to change in the Scenario View and entering a new name or choosing a new setting from the resulting drop down list.

Scenarios can also be created by copying an existing Scenario. To copy an existing Scenario, select it in the Scenario View and choose 'Copy this Scenario' from the Scenarios pop-out on the Modelling menu.

4.12.1.2. Selecting a Scenario for Editing

A Scenario can be selected for editing either by:

- Clicking on the Scenario in the Scenario View. The selected Scenario will be shown highlighted in red.
- Choosing a new current Scenario from the drop down list in the LinSig main toolbar.

When a new Scenario is selected all other Views are updated to display, and allow editing of, information relating to the new Scenario. For example the Signal Timings View will always show the Stage green times relating to the currently selected Scenario.

4.12.1.3. Editing a Scenario

The following items can be edited on a Scenario:

- **The Scenario's Name.** The Scenario's name can be changed by clicking on existing name and entering a new one.
- **The Flow Group.** The Scenario's Flow Group can changed by clicking on a Scenario's existing Flow Group and selecting a new Flow Group from the drop down list.
- **The Network Control Plan.** The Scenario's Network Control Plan can changed by clicking on a Scenario's existing Network Control Plan and selecting a new Network Control Plan from the drop down list.
- **Cycle Time.** This is described in more detail below in 'Managing Cycle Times'.

The Scenario Time Period cannot be changed as it is inherited from the Scenario's Flow Group. If necessary the time period can be changed for the Flow Group using the Traffic Flows View.

4.12.1.4. Deleting a Scenario

A Scenario can be deleted by selecting the Scenario and choosing 'Delete Scenario' from the Scenarios pop-out on the Modelling menu. Deleting a Scenario does not delete the Scenario's associated Flow Group or Network Control Plan, however the Signal Timings and Traffic Routing contained within the Scenario are lost.

4.12.1.5. Copying a Scenario's Traffic Flows to Turning Counts

If a Matrix Based model contains Route Flows but no Turning Counts the Route Flows can be used to calculate new Turning Counts. This can be useful when merging simple Networks which contain no Tuning Counts into a larger Network as it is useful for the larger merged Network to contain Turning Counts. These can be used in the merged Network to estimate a combined matrix. More detail is provided in 'Re-Estimating a Combined Matrix for Merged Matrix Based Networks' in the 'Importing& Merging LinSig Networks' section.

4.12.1.6. Managing Cycle Times

Cycle times are managed slightly differently depending on whether multiple Controller Sets exist within the model.

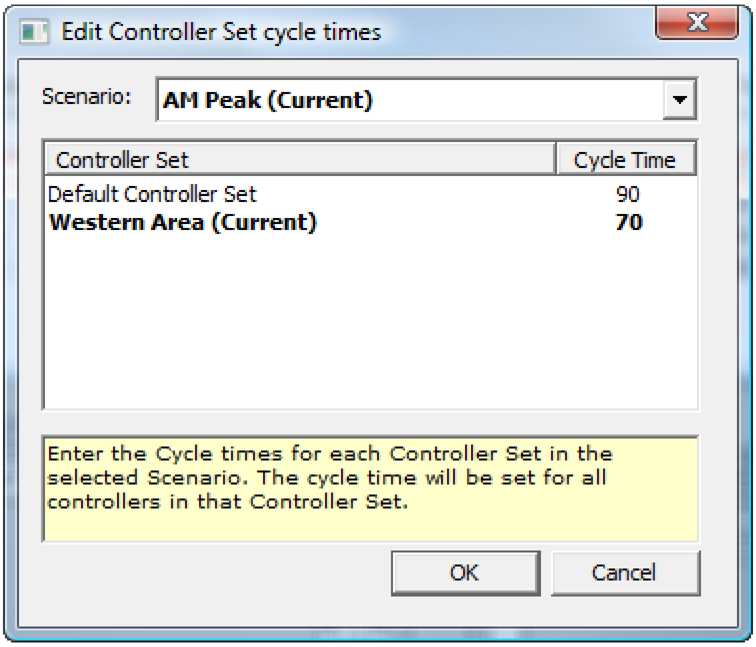
Managing Cycle Times for a Single Controller Set Model

The Scenario's cycle time can be changed by either clicking on a Scenario's existing cycle time and entering a new one or by selecting the Scenario and entering a new Network cycle time in the main LinSig toolbar.

Managing Cycle Times for a Multiple Controller Set Model

Where multiple Controller Sets exist the cycle times can be managed as follows:

- Click on either a Scenario's existing cycle time or the cycle time on the main LinSig toolbar. This will open the 'Controller Set Cycle Time Management' dialog box.



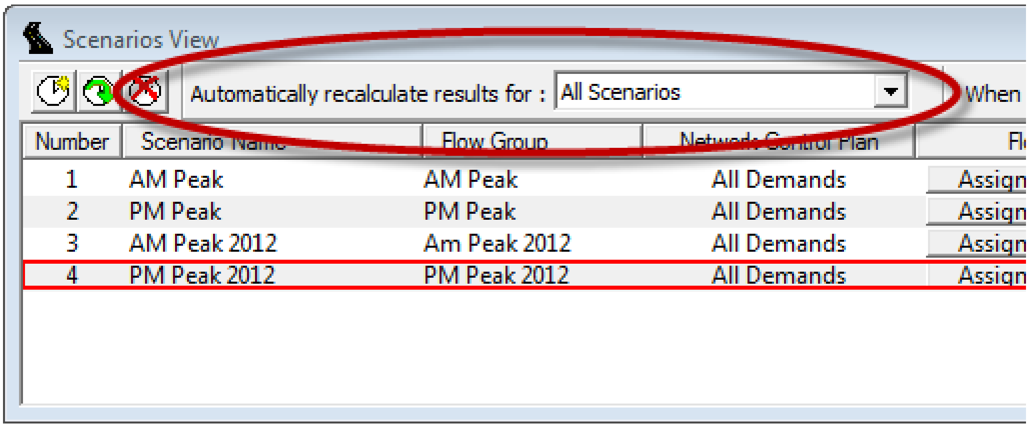
- The 'Controller Set Cycle Time Management' dialog box allows the cycle time of each Controller Set for each Scenario to be changed.

More information is provided on cycle time management in the Signal Timings View section.

4.12.1.7. Controlling Recalculation of Model Results

When an item of data affecting model results is changed, for example a Saturation Flow being altered, LinSig will need to recalculate model results for each Scenario affected. The Scenario View can be used to control when this recalculation takes place.

Recalculation is controlled using the 'Automatically Recalculate Results for:' drop down list in the Scenario View's toolbar.



The options available are:

- **Automatically Recalculate Results for all Scenarios.** LinSig will immediately recalculate results for all Scenarios listed in the Scenarios View when model input data changes. This should be the normal setting and should only be changed if a large number of Scenarios, or a large modelled Network, is causing unacceptably long recalculation times.
- **Automatically Recalculate Results for Current and Marked Scenarios.** LinSig will immediately recalculate results for the current Scenario and any Scenarios with the 'Mark' column in the Scenarios View ticked. This allows recalculation of any superseded or redundant Scenarios to be avoided. Obviously results will not be displayed in the Scenarios View for any non-calculated Scenarios, which will show a status of 'Not Calculated' in the Status column. Selecting a Scenario as the Current Scenario will immediately recalculate model results for that Scenario.
- **Automatically Recalculate Results for Current Scenario only.** LinSig will immediately recalculate results for the Current Scenario. All other Scenarios will be given the Status 'Not Calculated' and will not show results in the Scenario View. This setting provides the quickest recalculation time but each Scenario will only be recalculated if it is selected as the Current Scenario.
- **Do not Automatically Recalculate Results.** This setting prevents LinSig from automatically carrying out model recalculation as soon as model input data changes. This can be useful when making a large number of minor input data edits to a very large model which can take a second or two to recalculate. All Scenarios will be given the status 'Not Calculated' and will not show any results in the Scenario view. When the model editing is complete the recalculation status should be changed to one of the above settings to trigger recalculation of model results.

Any Scenario which has been successfully recalculated since the last change to any input data affecting model results will show a status of 'calculated' in the Scenario View. If for any reason a Scenario cannot be recalculated a status of 'Error' will be displayed. The details of what may have caused the error can be found in the Error View.

4.12.1.8. Controlling Batch Signal Time Optimisation in the Scenario View

The Scenario View can be used to optimise signal times for a number of Scenarios at once. This avoids having to optimise each Scenario individually by selecting each Scenario in turn before clicking the ‘Optimise’ button on the main toolbar. If desired each Scenario can still be optimised individually using ‘Optimise Current Scenario for Delay/PRC’ on the Optimiser menu.

Further details on Batch Optimisation are given in the ‘Signal Optimisation using Scenarios’ section below.

4.12.2. Traffic Assignment using Scenarios

The Desired Flows Matrix as displayed in the Traffic Flows View defines the total desired movements between Zones. The process of assignment to Routes specifies which Routes through the Network traffic will use to travel between two Zones. Each Scenario contains its own distinct set of Route Flows, as a Flow Group’s OD matrix may potentially be assigned to the same Network with a number of different routing patterns depending on Scenario settings such as signal timings and cycle time.

4.12.2.1. Assignment Overview

Traffic flows can be assigned to Routes in two ways. These are:

- **Manually assigning a traffic flow to each Route.** This method provides more flexibility and control as the flow patterns can be refined to a high level of detail. It can however be time consuming with larger Networks. This method is described in more detail in the Route List View section.
- **Automatically assigning traffic flows to each Route based on the Desired Origin-Destination matrix.** LinSig uses standard traffic routing algorithms to automatically assign the OD Matrix to Routes based on delays calculated by the traffic model.

It is of course possible to use a combination of the above methods, using automatic assignment initially and refining manually where desired.

4.12.2.2. Automatic Assignment Methods

LinSig can assign traffic using two different methods. These are:

- **Delay Based Assignment.** Delay based assignment is new to Version 3 and is the now the preferred method for assigning flows to Routes in most cases. LinSig uses delays calculated from the LinSig network model to assign traffic to Routes using a standard equilibrium assignment method. In basic terms LinSig distributes traffic between competing Routes such that no traffic can achieve a quicker travel time between two Zones by transferring to a different Route. This method is widely used in large area transport modelling software packages such as SATURN or TRIPS, however LinSig is the only small area model of its type which assigns traffic in this way whilst modelling delays due to traffic signals in such a high level of detail.
- **Network Entry Arm Lane Flow Balancing.** LinSig assigns traffic to Routes by attempting to achieve equal Lane flows on Network Entry Arms. No account is taken of flow distribution on arms other than the first Arm on a Route. This method is an alternative method to delay based assignment and may be useful in some cases for single Junction models and signal roundabouts.

It is recommended to use delay based assignment unless good specific reasons exist to use entry Lane flow balancing.

4.12.2.3. Principles of Delay Based Equilibrium Assignment

When Delay based Assignment is selected LinSig uses the long established technique of equilibrium assignment to distribute zone to zone traffic volumes as defined in the OD Matrix between Routes.

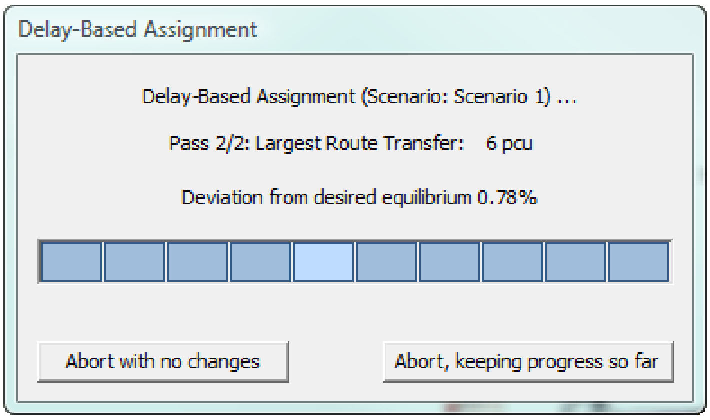
During the assignment process LinSig shifts traffic from Routes with longer travel times to Routes with shorter travel times. LinSig then recalculates Route travel times for the changed Route flows before repeating the process many times. When no traffic can be moved to a Route with a shorter travel time the assignment has 'converged' and is complete. In practice for medium and large networks it is impractical to attempt to achieve perfect convergence as LinSig will spend substantial time shuffling small amounts of traffic between routes which in practical engineering terms will be inconsequential.

It is important to remember that LinSig (or any other equilibrium based assignment model) is assigning traffic on the assumption that delay is the main determinant of route choice. In some networks this may not be true, for example where traffic signs direct traffic to take illogical longer routes. In these cases local knowledge of routing behaviour, manual adjustment of Route flows and Route flow locking should be used to achieve a more appropriate assignment.

4.12.2.4. Carrying out a Traffic Assignment in the Scenario View

Traffic flows can be assigned for any Scenario as follows:

- Select the Scenario you wish to use to assign flows to be the Current Scenario by clicking on it in the Scenario View. The Current Scenario is shown outlined in red and is also shown in LinSig's main toolbar drop down Scenario list.
- Choose 'Assign OD Flows to Routes based on Current Scenario' from the Traffic Flows menu. The 'Traffic Flow Assignment Options' dialog box is displayed. This allows various options relating to how the assignment is carried out to be specified. The different options are described below.
- After setting the required options (if any) click OK. LinSig will carry out a full delay based assignment of the entire network. The time taken to assign flows will vary from instantaneous to several minutes depending on the size of Network, number of Routes, level of traffic and level of Route choice in the Network. LinSig will display a progress dialog box which monitors the assignment's progress.

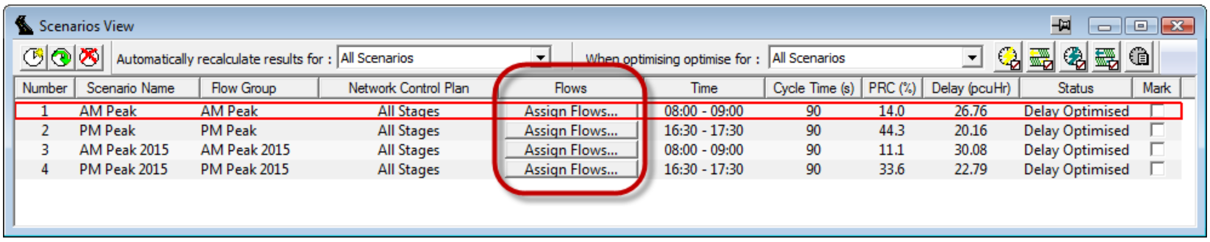


- The two progress indicators displayed are:
    - **Largest Route Transfer.** This shows the largest amount of traffic the assignment process has moved between Routes on the last iteration. This will diminish as the assignment converges. If you feel that the amount of traffic being moved is insignificant for your

purposes it is possible to terminate the assignment early by clicking 'Abort, keeping progress so far'.

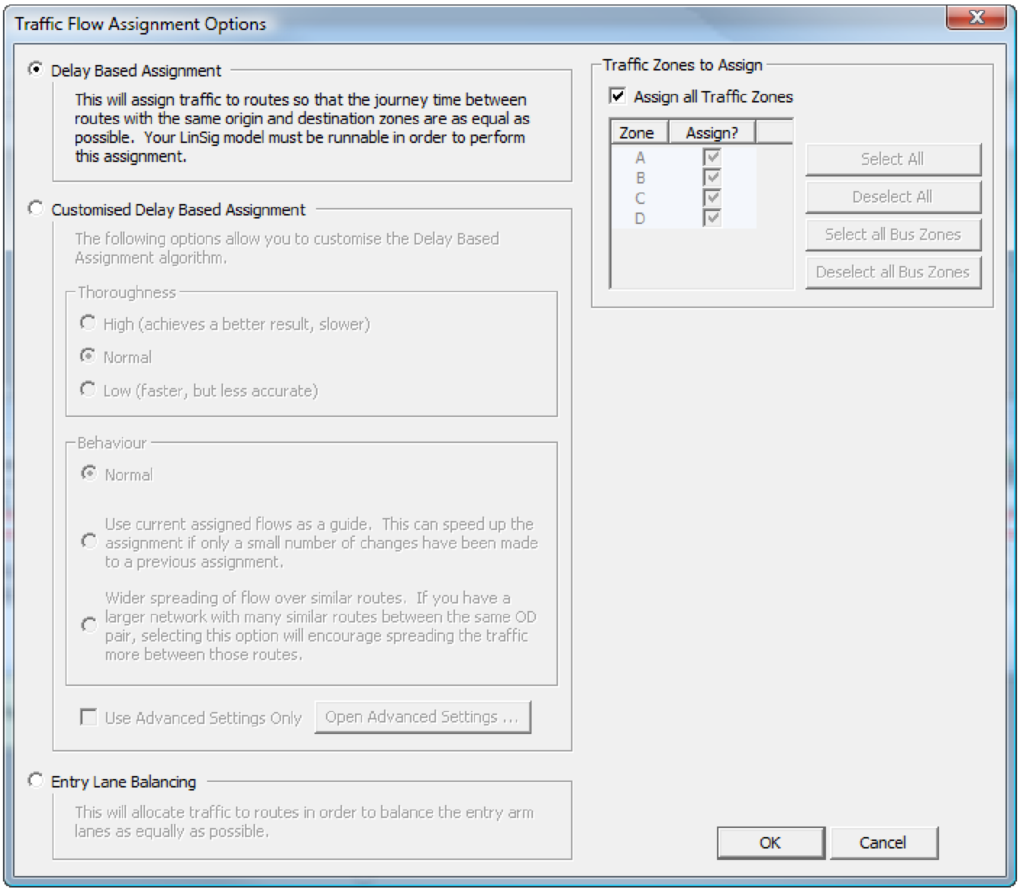
- ○ **Deviation from Equilibrium.** This measures the closeness of the assignment to perfect user equilibrium route flows. Generally a value of 1% is considered a good fit for a larger network however it is often possible to achieve 0.25% or lower for a smaller network.

- Alternatively the assignment can be run for a Scenario by clicking the 'Assign Flows' button for a Scenario in the Scenario View.



4.12.2.5. Traffic Flow Assignment Options

The Traffic Flow Assignment Options dialog box is opened by selecting a Scenario and choosing 'Assign OD Flows to Routes based on Current Scenario'.



The options available are:

- **Delay Based Assignment.** This is the default selection which will be appropriate for most Networks. This option uses a standard set of options for the assignment which will achieve an acceptable combination of assignment speed and accuracy for most Networks.

- **Customised Delay Based Assignment.** This allows various options controlling the assignment process to be customised. This is not usually necessary but may be useful for larger networks or networks with unusual characteristics to achieve a faster or more precise assignment. The available options are:
  - **Thoroughness.** Allows a choice to be made between a slower more precise assignment and a faster less precise one. The faster assignment may be useful when doing initial testing of a larger model.
  - **Behaviour.** The Behaviour setting governs the initial route flows LinSig uses to start the assignment process.
    - **Normal.** Normal simply starts each assignment run with zero route flows. The first assignment iteration will then carry out an all-or-nothing assignment which will provide the initial Route Flows.
    - **Use Current Flows.** This option starts the assignment using the current assigned flows for this Scenario. This is very useful for speeding up the assignment process for larger Networks when only minor changes have been made to the Network, for example revising signal timings. As the final assigned flows are likely to be similar to the previous assigned flows the assignment process starts with route flows near to the final route flows potentially leading to a big reduction in assignment run time.
    - **Wider Flow Spreading.** This option spreads traffic between two Zones equally between all allowed routes between the Zones. This option will sometimes give a more realistic assignment when many similar routes exist between Zones but will slow down the assignment process.
  - Advanced Settings. The advanced settings affect the speed, precision and realism of the assignment and are intended to be used for 'difficult networks' under guidance from JCT Software Support. It is recommended that the advanced settings are not changed unless instructed to do so by JCT.
- **Entry Lane Balancing.** LinSig assigns traffic to Routes by attempting to achieve equal Lane flows on Network Entry Arms. No account is taken of flow distribution on arms other than the first Arm on a Route. This method is an alternative method to delay based assignment and may be useful in some cases for single Junction models and signal roundabouts.
- **Traffic Zones to Assign.** This option allows only traffic from a subset of Zones to be assigned. Generally Zones are assigned in mutually connected sets each set being associated with a Matrix based Network region.

4.12.2.6. Improving Assignment Run Times in Larger Networks

In larger networks the delay-based assignment may take from several seconds to a few minutes to run. The following factors are worth considering:

- Assignment run time is heavily influenced by the level of Route choice in the Network. If many weaving movements have been allowed and permitted routes have not been checked properly LinSig may have many choices of unlikely Routes on which to place traffic when assigning. This can significantly extend run times and also lead to overly complex routing in some cases. The best approach is to only allow weaving movements where they are likely to happen rather than allowing weaving to occur in all situations.

- Excessive use of Internal Zones will also lead to longer assignment run times as LinSig will need to balance many more competing traffic movements on Routes. Generally Internal Zones should be used judiciously where obvious significant traffic generation is occurring within the Network, for example on street parking.
- Remember that the delay based assignment on larger Networks will always be significantly quicker then working out Lane flows on a spreadsheet or piece of paper as has usually been necessary case previously.

4.12.3. Signal Optimisation using Scenarios

Signal Timings can be optimised for the current Scenario in the following ways:

- To minimise delay in the whole Network by adjusting stage lengths and offsets for all Stage Streams.
- To maximise PRC in the whole Network by adjusting stage lengths and offsets for all Stage Streams.
- To minimise delay in the whole Network by adjusting offsets only between all Stage Streams.
- To maximise PRC in the whole Network by adjusting offsets only between all Stage Streams.
- To minimise delay for a single Junction by adjusting the stage lengths and offset for just the Stage Stream(s) controlling that Junction.
- To maximise PRC for a single Junction by adjusting the stage lengths and offset for just the Stage Stream(s) controlling that Junction.
- To minimise delay for Lanes controlled by a single Stage Stream by adjusting the stage lengths and offset for the Stage Stream.
- To maximise PRC for Lanes controlled by a single Stage Stream by adjusting the stage lengths and offset for the Stage Stream.

4.12.3.1. Optimising Signal Timings for the Whole Network

Either stage lengths and offsets or offsets only can be optimised over the whole Network.

Optimising Stage Lengths and Offsets for the Whole Network

To optimise stage lengths and offsets for the whole Network choose ‘Optimise Stage Lengths and Offsets for Delay’ or ‘Optimise Stage Lengths and Offsets for PRC’ from the Optimiser pop-out menu on the Modelling menu. LinSig will adjust the Stage Lengths and Offsets of the current Scenario to minimise total traffic delay or maximise PRC for the Network.

Optimising Offsets Only for the Whole Network

To optimise offsets only for the whole Network choose ‘Optimise Offsets only for Delay’ or ‘Optimise Offsets only for PRC’ from the Optimiser pop-out menu on the Modelling menu. LinSig will adjust the Offsets of the current Scenario to minimise total traffic delay or maximise PRC for the Network.

4.12.3.2. Optimising Signal Timings for a Single Junction

To optimise signal timings for a single Junction right click on the Junction and choose ‘Optimise this Junction for PRC’ or ‘Optimise this Junction for delay’ as appropriate. LinSig will adjust the Stage Lengths and offset of just the Stage Stream or Streams controlling the

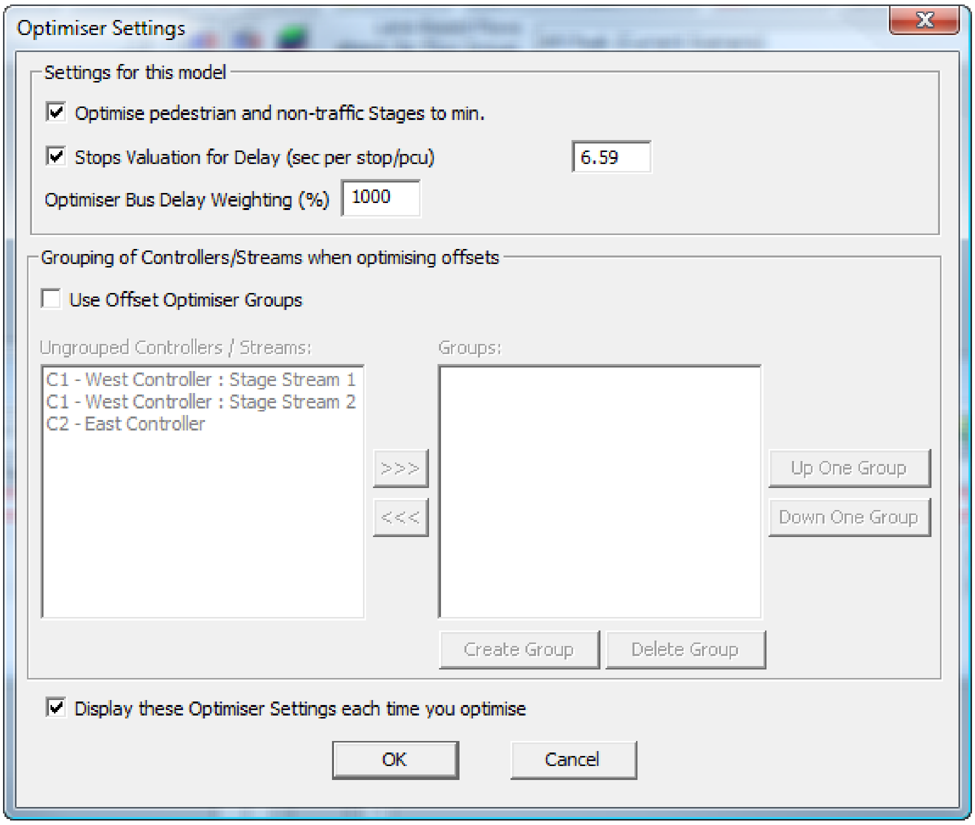
Junction to minimise traffic delay or maximise PRC over all the Lanes contained by the Junction.

4.12.3.3. Optimising Signal Timings for a Single Stream

To optimise signal timings for a single Stage Stream click ‘Optimise for Delay’ or ‘Optimise for PRC’ in the Stage Stream List in the Signal Timings View. LinSig will adjust the Stage Lengths and offset of just the individual Stage Stream to minimise traffic delay or maximise PRC.

4.12.3.4. Controlling the Signal Optimiser using Optimiser Settings

The optimisation process can be controlled using optimiser settings which are changed using the Optimiser Settings dialog box.



The Optimiser Settings dialog box by default opens every time the optimiser is run. This can easily be switched off if optimiser settings are only being used infrequently. Alternatively the optimiser settings dialog can be displayed by choosing ‘Optimiser Settings’ from the Optimiser pop-out menu on the Modelling menu.

The Optimiser Settings available include:

- **Optimise Pedestrian and non-traffic Stages to minimum.** Setting this option tells LinSig’s optimiser to assume all Pedestrian and non-traffic Phases always run to minimum and should therefore always be locked at their minimums throughout the optimisation process. This option is provided for compatibility with future facilities and should currently always be selected.
- **Stops Valuation for Delay.** Ticking ‘Stops Valuation for Delay’ includes the effects of vehicle stops within the optimisation process. This will have the effect of producing signal times which trade off small increases in overall traffic delay for larger decreases in the number of PCUs having to stop at signals.

The stops valuation for delay specifies an assumed cost of a stop in delay terms. When optimising LinSig uses this value to determine how much increase in delay to accept for a decrease in stops. The higher the value the more important stops become relative to overall network delay. The default value is derived from regularly used values for the monetary cost of delay and stops used in many other models. This should only be changed if a good reason exists to do so.

The importance of Stops on an individual Lane can also be weighted using the Stops and delay/degree of saturation weights on the Advanced tab of the Edit Lane dialog box.

- **Grouping of Controllers and/or Stage Streams when Optimising Offsets.** This setting allows Controllers and/or Stage Streams to be grouped together when optimising signal offsets. This allows the offsets between Stage Streams or Controllers to be locked together and optimised against other Stage Streams as a group as detailed below.
- **Display These Optimiser Settings Each Time you Optimise.** This setting is selected by default causing the optimiser settings dialog to be shown every time the optimiser is run, partly to highlight the available settings and partly to confirm the current optimiser settings. If this dialog becomes annoying it can be prevented from appearing at every optimisation by deselecting this option. It can however still be displayed by choosing 'Optimiser Settings…' from the Optimiser pop-out menu on the Modelling menu if settings require changing.

Managing Offset Optimiser Groups

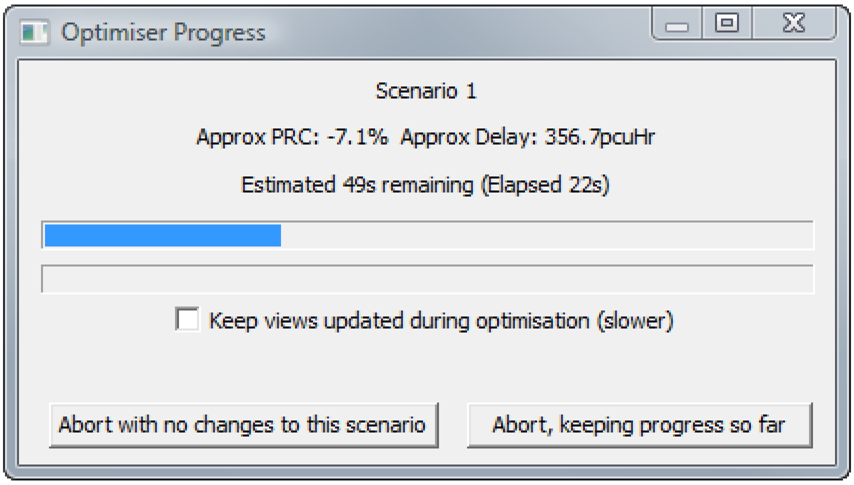
Controllers and/or Stage Streams can be managed into Offset Optimiser Groups as follows:

- Controllers and/or Stage Streams can be added to Offset Optimiser Groups by selecting the Controller or Stream in the 'Ungrouped Controllers/Streams' list and clicking the right arrow to move the Controller across to the right 'Groups' list.
- New Offset Optimiser Groups can be created by clicking 'Create Group'. This will create a new empty Offset Optimiser Group.
- Controllers can be moved between Groups by clicking 'Up One Group' or 'Down One Group' as appropriate.
- Controllers can be removed from a Group by selecting the Controller in the right 'Groups List' and clicking the left arrow.

4.12.3.5. Monitoring the Optimisers Progress

For a small model the Optimiser runs almost instantaneously but for a larger or more complex model the optimiser may take from several seconds up to several tens of seconds to run with very large models taking up to a few minutes.

The progress of the optimiser can be monitored using the Optimiser Progress dialog box:



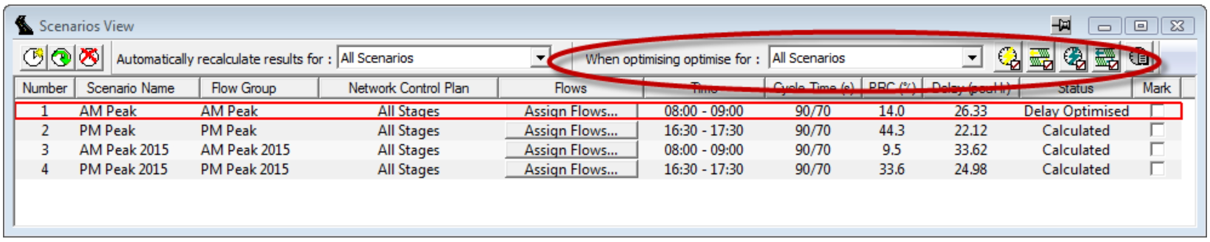
The Optimiser Progress dialog shows the following:

- **The Scenario Being Optimised.**
- The Best Results So Far. The PRC and Network Delay for the best signal timings found so far within this optimisation.
- **Run Time Estimate.** LinSig provides an estimate of how long the optimisation will take to complete. LinSig reviews this estimate as the optimisation runs so the remaining time estimate can go up or down during the optimisation.
- **Keep Views Updated.** This setting causes LinSig Views to be updated during the optimisation process. This provides feedback on what the optimiser is doing but will substantially slow down the optimiser.
- **Abort with No Changes to this Scenario.** Clicking this button aborts the optimisation process with no changes to the Scenario's signal settings.
- **Abort, Keeping Progress so far.** Clicking this button aborts the optimisation process and sets the Scenario's signal settings to the best signal settings found so far during the optimisation process. This option is useful if you feel the optimiser has achieved sufficient accuracy for your purposes and you don't wish it to run to completion.

4.12.3.6. Controlling Batch Signal Time Optimisation in the Scenario View

The Scenario View can be used to optimise signal times for a number of Scenarios at once. This avoids having to optimise each Scenario individually by selecting each Scenario in turn before clicking the 'Optimise' button on the main toolbar. If desired each Scenario can still be optimised individually using 'Optimise Current Scenario for Delay/PRC' on the Optimiser menu.

The batch optimisation in the Scenario View is controlled using the 'When optimising optimise for:' drop down list in the Scenario View's toolbar.



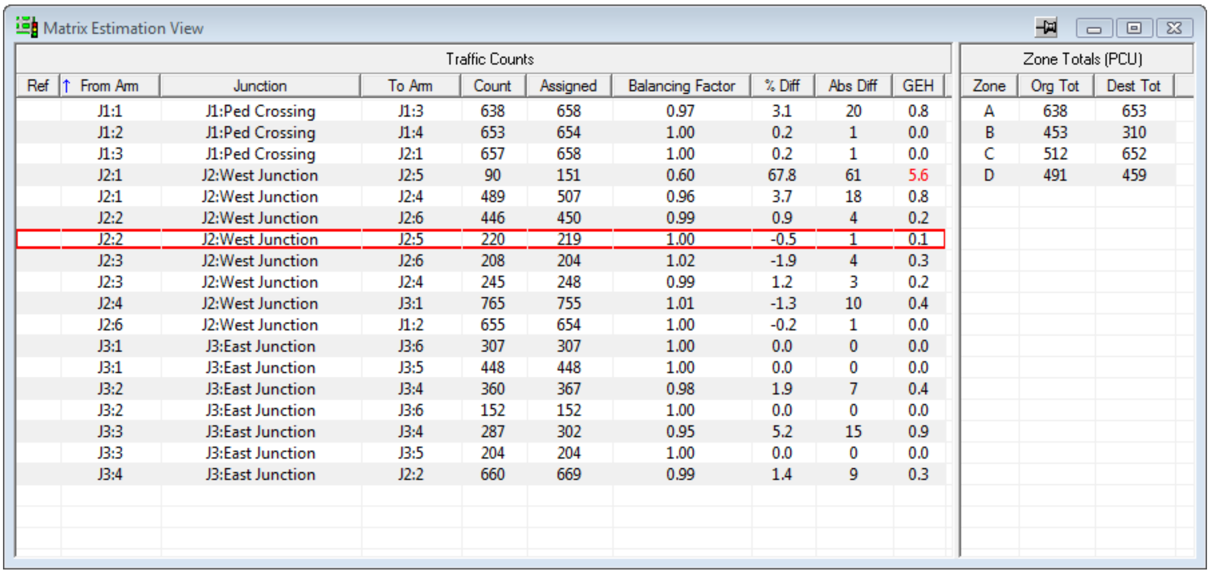
The options available are:

- **Optimise All Scenarios.** When either the 'Optimise Scenarios for Delay' or 'Optimise Scenarios for PRC' button on the Scenario View's toolbar is clicked LinSig will optimise the signal times for all Scenarios. For complex models or large numbers of Scenarios this may take a few seconds or even some minutes in extreme cases.
- **Optimise Current and Marked Scenarios.** When either of the optimise buttons on the Scenario View's toolbar are clicked LinSig will optimise the signal times for both the currently selected Scenario and any Scenarios ticked in the Scenario View's 'Marked' column. This allows a subset of Scenarios to be batch optimised which can be useful when optimising larger models or when a large number of Scenarios exist.
- **Optimise Current Scenario.** When either of the optimise buttons on the Scenario View's toolbar are clicked LinSig will optimise the signal times for the currently selected Scenario only. This is equivalent to choosing 'Optimise Current Scenario…' from the Optimiser menu.

Regardless of the above option chosen LinSig will give any optimised Scenario a status of either 'delay optimised or 'PRC Optimised' indicating the results shown are optimal. If any model data is changed which means one or more Scenarios may no longer be optimal LinSig will change their status to 'Calculated' reflecting the fact they need to be re-optimised.

4.13. Matrix Estimation View

The Matrix Estimation View is used as an integral part of LinSig's procedure for estimating traffic Origin Destination matrices from traffic counts. It can also be used for validating either a manual or automatic traffic flow assignment against traffic counts. The View is opened by choosing 'Matrix Estimation View' from the Traffic Flows menu.



Traffic Counts									
Ref	↑ From Arm	Junction	To Arm	Count	Assigned	Balancing Factor	% Diff	Abs Diff	GEH
	J1:1	J1:Ped Crossing	J1:3	638	658	0.97	3.1	20	0.8
	J1:2	J1:Ped Crossing	J1:4	653	654	1.00	0.2	1	0.0
	J1:3	J1:Ped Crossing	J2:1	657	658	1.00	0.2	1	0.0
	J2:1	J2:West Junction	J2:5	90	151	0.60	67.8	61	5.6
	J2:1	J2:West Junction	J2:4	489	507	0.96	3.7	18	0.8
	J2:2	J2:West Junction	J2:6	446	450	0.99	0.9	4	0.2
	J2:2	J2:West Junction	J2:5	220	219	1.00	-0.5	1	0.1
	J2:3	J2:West Junction	J2:6	208	204	1.02	-1.9	4	0.3
	J2:3	J2:West Junction	J2:4	245	248	0.99	1.2	3	0.2
	J2:4	J2:West Junction	J3:1	765	755	1.01	-1.3	10	0.4
	J2:6	J2:West Junction	J1:2	655	654	1.00	-0.2	1	0.0
	J3:1	J3:East Junction	J3:6	307	307	1.00	0.0	0	0.0
	J3:1	J3:East Junction	J3:5	448	448	1.00	0.0	0	0.0
	J3:2	J3:East Junction	J3:4	360	367	0.98	1.9	7	0.4
	J3:2	J3:East Junction	J3:6	152	152	1.00	0.0	0	0.0
	J3:3	J3:East Junction	J3:4	287	302	0.95	5.2	15	0.9
	J3:3	J3:East Junction	J3:5	204	204	1.00	0.0	0	0.0
	J3:4	J3:East Junction	J2:2	660	669	0.99	1.4	9	0.3

Zone Totals (PCU)		
Zone	Org Tot	Dest Tot
A	638	653
B	453	310
C	512	652
D	491	459

For single Junctions and very simple Networks it will often be unnecessary to use matrix estimation as it will usually be possible to work out and enter an OD matrix by taking values directly from Junction Turning Counts. This becomes increasingly complex for larger networks and is unfeasible for networks with 4 or more Junctions.

4.13.1. Obtaining an Origin-Destination Matrix

The Origin-Destination Matrix specified in each Traffic Flow Group when using Matrix Based Flows is a critical part of a Matrix Based LinSig model or Matrix Based region of a larger model. LinSig uses the detailed information contained in an OD matrix to model queues, delays and capacities with significantly more accuracy than is possible with just Lane or turning flows. The use of an OD matrix also means that techniques such as automatic delay based assignment is possible which can dramatically speed up the specification and entry of Network Traffic flows when changes and made to the Network.

More in depth discussion of the benefits and costs of using Matrix Based Flows in LinSig is provided in the Essential Background section.

The main drawback with using an OD matrix is how to count or otherwise derive a sufficiently detailed and accurate flow matrix. For a typical LinSig sized network the two main techniques are:

- **Direct Measurement of OD movements.** Direct measurement using video or increasingly Automatic Number Plate Recognition (ANPR) is the most accurate but also the most expensive technique. As ANPR becomes more widespread and reduces in cost direct measurement will become increasingly more feasible. It is recommended that for complex junctions such as signal roundabouts OD matrices are directly measured whenever possible.
- **Estimation of the Matrix from Junction Turning Counts.** Matrix Estimation uses relatively less expensive junction turning counts to estimate the most likely OD matrix consistent with a set of measured traffic counts. Many different techniques have been

used in large transportation models for many years to estimate OD matrices and LinSig uses one of the most common and tried and tested methods based on a mathematical method called entropy maximisation. In simple terms where a set of traffic counts could be reproduced by many different OD matrices the entropy maximisation technique aims to estimate the most probable OD matrix which will fit the traffic counts. This does not mean that this is necessarily the correct matrix only that the estimated matrix is the best possible estimate from the information contained within the traffic turning counts.

However the OD matrix is obtained it should be remembered that accurate traffic flow information is a fundamental first step to any Junction or Network modelling project. The correct pattern of OD movements is also crucial when modelling Networks of closely spaced coordinated signal junctions.

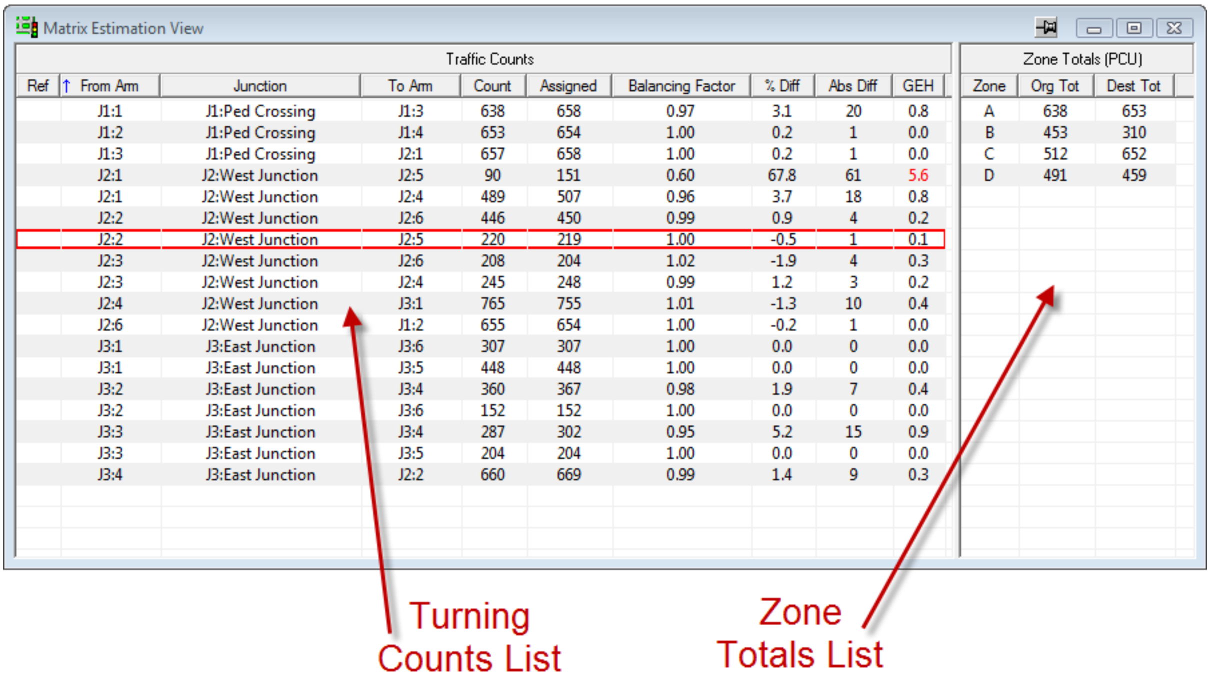
4.13.2. Golden Rules of Matrix Estimation

Matrix Estimation has been used for many years in larger transportation based models and in some quarters has gained a reputation as being a ‘black art’. For anyone who has not encountered matrix estimation before the following golden rules will hopefully put the method in context:

- Matrix estimation is the classic ‘garbage in – garbage out’ method. Carefully checked and used good quality traffic flows covering a large proportion of the Network will generally produce an acceptably accurate cost effective matrix. Poor quality counts which are sparse, out of date, inconsistent, don’t allow for all sources or sinks of traffic are unlikely to produce an acceptable matrix.
- Matrix estimation is not a ‘point and shoot’ method. Careful checking of count data is required before using the technique in LinSig.
- Keep refining the matrix until it is sufficiently accurate. The first run of matrix estimation should not just be accepted and used. Often careful examination of the estimated matrix will suggest adjustments which can be made to the counts or Network to produce a better matrix.
- As LinSig Networks tend to be smaller with less route choice than larger transportation models on which matrix estimation has traditionally been used, and given that for most LinSig Networks all or a very high proportion of junctions will be counted, LinSig has a much better chance of estimating a ‘good’ matrix than much larger models where there are many more ‘unknowns’ within the model.

4.13.3. Working with the Matrix Estimation View

The Matrix Estimation View displays information relating to traffic counts used for matrix estimation and also statistics which can be used for validating assigned flows against counts.



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	J2:1	J2:West Junction	J2:5	90	151	0.60	67.8	61	5.6
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	J2:4	J2:West Junction	J3:1	765	755	1.01	-1.3	10	0.4
	J2:6	J2:West Junction	J1:2	655	654	1.00	-0.2	1	0.0
	J3:1	J3:East Junction	J3:6	307	307	1.00	0.0	0	0.0
	J3:1	J3:East Junction	J3:5	448	448	1.00	0.0	0	0.0
	J3:2	J3:East Junction	J3:4	360	367	0.98	1.9	7	0.4
	J3:2	J3:East Junction	J3:6	152	152	1.00	0.0	0	0.0
	J3:3	J3:East Junction	J3:4	287	302	0.95	5.2	15	0.9
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Zone	Org Tot	Dest Tot
A	638	653
B	453	310
C	512	652
D	491	459

Controlling the Traffic Counts Displayed

The Matrix Estimation View displays traffic count information for a single Traffic Flow Group at any time. The Traffic Flow Group used can be selected in the Matrix Estimation View's toolbar. The toolbar also allows the graphical Turning Counts View to be opened.

The Turning Count List

The Turning Count List is located on the left side of the Matrix Estimation View and lists Turning Counts for the selected Traffic Flow Group. The List also displays statistics comparing the goodness of fit between the counts and the assigned flows in the Current Scenario. The Turning Count List displays the following columns:

- **From Arm.** The Arm at which the counted turning traffic starts from.
- **Junction.** The Junction the counted traffic is passing through.
- **To Arm.** The Arm at which the counted turning traffic turns into.
- **Count.** The amount of counted traffic on this movement in PCU.
- **Assigned.** The total assigned flow on this turning movement in the Current Scenario.
- **Balancing Factor.** A measure of how much the matrix estimation process has changed OD matrix movements through this count.
- **% Diff.** The percentage difference between the count and the total assigned flow on this turning movement in the Current Scenario.
- **Abs Diff.** The absolute difference between the count and the total assigned flow on this turning movement in the Current Scenario in PCU.

- **GEH.** The GEH or Geoffrey E. Havers (GLC transport planner who invented the statistic in the 1970s) Statistic. The GEH statistic measures a combination of relative and absolute error between a traffic count and a modelled flow and is commonly used to test the goodness of fit of modelled flows to observed counts. This is explained in more detail below.

The Zone Totals List

The Zone Totals List shows selected Traffic Flow Group's Zone origin and destination totals implied from the turning counts and allows unspecified Zone totals to be entered. Zones should always have totals, either implied or explicitly entered, specified before running matrix estimation. If Zone totals are not specified the matrix estimation process will use the Zone to indiscriminately allocate traffic into to better match traffic counts, regardless of whether this is sensible. This process is often referred to as 'Zone Dumping' and is usually undesirable.

All traffic flow or count values displayed in the Matrix Estimation View are in PCUs.

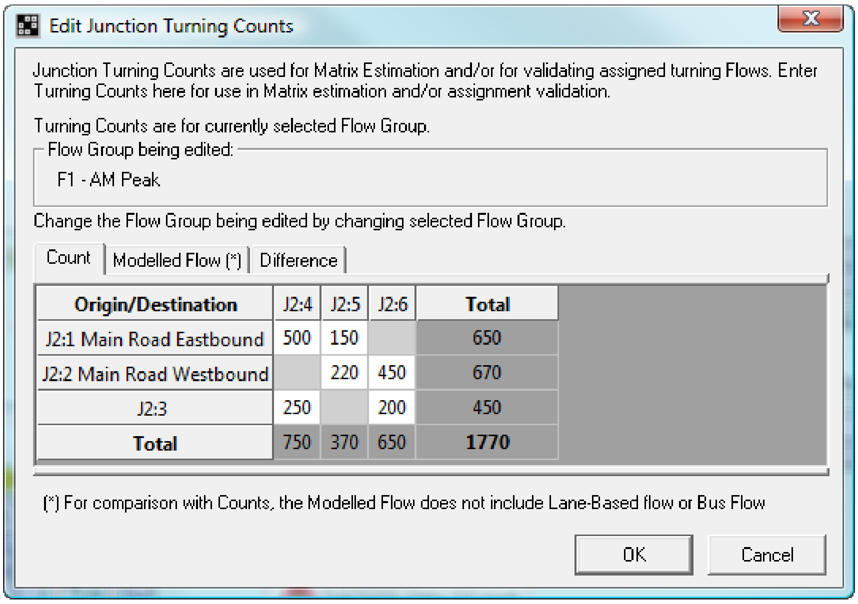
4.13.4. Working with Traffic Counts

The starting point for matrix estimation or Network validation is a robust set of traffic counts. LinSig allows a set of turning counts for each Traffic Flow Group to be entered for each Junction or for the Network as a whole.

A Traffic Turning Count in LinSig is defined as a measured amount of traffic moving from one Arm (from Arm) to another Arm (to Arm). Usually both Arms will be at the same Junction but they do not have to be as long as Lanes on both Arms are directly connected with Lane Connectors. Currently it is not possible to specify Lane to Lane counts in LinSig.

Traffic Counts can be entered in three ways. These are:

- **Using a Turning Count Matrix in the Network Layout View.** Counts can be entered using the Edit Junction Turning Count Dialog box which can be opened by right clicking on a Junction in the Network Layout View and choosing 'Edit Junction Turning Counts'. This is described in more detail in the Network Layout View section.



- **Using the Turning Count List in the Matrix Estimation View.** Counts can be entered as a list of counts in the Matrix Estimation View as described in the next section.

- **Using the graphical Turning Counts View.** The Turning Counts View is new in LinSig 3.1 and displays the Turning Counts graphically. Consistency checking information is also provided allowing 'rogue' counts to be quickly located. This is described in more detail in the Turning Count View section below.

For all methods counts are entered as PCUs.

4.13.4.1. Managing Counts using the Matrix Estimation View Count List

The Count List can be used to enter and delete counts for the Current Scenario's Traffic Flow Group. Movements for which no Count is defined are still shown in the Count list but obviously have no count value. A value of zero should not be used for non-existent Counts as this would imply the Count has been observed to have zero PCU rather than not observed at all.

Entering or Editing a Count

A Count can be edited in the Count List by clicking on the Count's value and entering a new value in PCUs.

Deleting a Count

A Count's value can be deleted by right clicking with the mouse and choosing 'Delete Count'. Any implied Zone totals which are no longer fully specified will be removed from the Zone totals panel. If new Counts which are to be added will not re-specify the Zone total a Zone total should be manually entered as detailed below.

4.13.4.2. Managing Zone Totals using the Matrix Estimation View

Zone totals define the total amount of traffic which has been counted leaving or entering each Zone. Zone totals can be specified as follows:

- As an implied total calculated from turning counts on the Arm feeding or being fed by the Zone.
- As an explicit Zone origin or destination total which has been counted or at least estimated.

It is important when using matrix estimation that all Zone totals are specified. If any Zones do not have both origin and destination totals specified the matrix estimation process will tend to add an excess of short trips to and from the Zone as this will allow other turning counts to be matched more closely. This can result in unrealistic Zone totals and OD patterns. This effect can occur regularly in large transportation models with many uncounted zones and is sometimes referred to as 'Zone Dumping'.

4.13.4.3. Count Consistency

When preparing counts for use in LinSig (or any other matrix estimation process) it is very important to check for count consistency between counts. If inconsistent counts are used large errors can be introduced into the estimated matrix. Where counts are inconsistent LinSig will generally try to produce a matrix which will reproduce counts as well as possible when assigned to the network but by definition it will not be able to match all counts. The following types of inconsistency can occur:

- **Junction In-Out Inconsistency.** The total of counted traffic entering a Junction is different from the counted traffic leaving a Junction. Where only turning counts are entered this cannot occur in LinSig but where counts between Junctions are used Junction Inconsistency is possible.

- **Inter-Junction Inconsistency.** The total counted traffic entering a road between two Junctions is different from the counted traffic entering the next downstream junction. This can be caused by a number of issues including:
    - Counts at each Junction being carried out at different times or even on different days.
    - Count inaccuracies and miscounting.
    - Traffic turning off or entering the network between the Junctions.
    - On-street parking between the two Junctions.

  The first two issues should be corrected by careful examination of counts and selection of the most accurate ones omitting the least accurate of inconsistent counts.

  The second two issues if significant can be explicitly modelled using internal Zones as described below.

If inconsistent counts are used in LinSig for matrix estimation LinSig will attempt to produce the best matrix possible but it is always better to use local knowledge of the network and judgement to resolve count consistency problems rather than just relying on LinSig 'doing its best' with a poor set of counts.

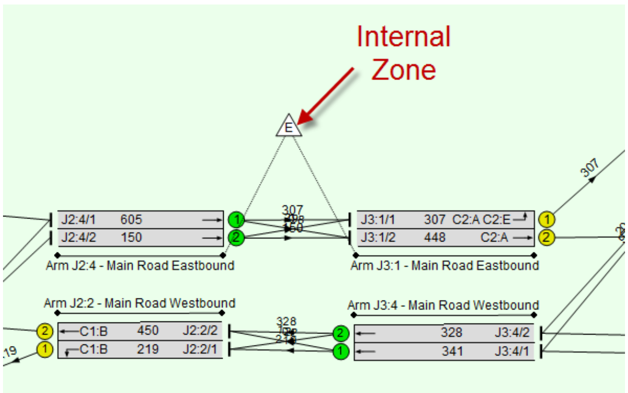
4.13.4.4. Using Internal Zones to Resolve Consistency Issues

Where it is identified by inspecting counts that an inconsistency between two counts is due to traffic entering or leaving the Network between Junctions it can be resolved in one of three ways:

- Ignoring the inconsistency if it is small and is unlikely to cause problems.
- Adding a new Junction and Zone(s) to explicitly model traffic entering from a distinct and significant side road.
- Adding an Internal Zone when it is unnecessary or undesirable to explicitly model the traffic entry point as a new Junction. The Internal Zone will provide a new source and sink for traffic entering or leaving the Network between two Junctions. Internal Zones should not be used unnecessarily just to 'mop up' minor differences in counts as this will lead to significantly longer run times.

The first method is self explanatory and is the preferred option where flow inconsistencies are minor. The second method is carried out using standard Network modelling techniques. The third method using an Internal Zone is used as followed:

- Add an Internal Zone with the previous Junction's Exit Arm as the Zone's 'Arm Exiting Network' and the Arm at the downstream Junction as the Zone's 'Arm Entering Network'.



- Enter Zone origin and destination totals in the Matrix Estimation View. These should be estimated from the counted loss or gain of traffic between Junctions. This step is very important as if not carried out the matrix estimation process will tend to terminate or start and excessive number of OD movements in the Zone.

4.13.5. Estimating an Origin-Destination Matrix

4.13.5.1. Matrix Estimation Prerequisites

LinSig can only estimate an origin-destination matrix when the following prerequisites have been satisfied:

- A Traffic Flow Group has been created which will hold the new estimated matrix. It will be necessary to create a Flow Group for each period for which a matrix is to be estimated. For example the AM and PM Peak periods.
- Traffic Turning Counts have been entered in each Traffic Flow Group to be estimated for preferably all Junctions in the Network. If any Junctions are omitted LinSig may be unable to estimate some movements in the matrix.
- Zone origin and destination totals have been specified for ALL Zones using the Matrix Estimation View.
- A Scenario has been created based on the Traffic Flow Group containing the counts and a Network Control Plan which contains Signal Sequences for each Junction which are as near as possible to the Signal Sequences running when counts were made. This can be difficult as signal information is not often recorded at the time of a count but a best estimate should be made.
- Signal timings in the Scenario should be set to typical stage lengths and offsets at the time the Counts were carried out. Again this information is not usually available so a best guess should be made. The signal timings are only important to the matrix estimation process when significant route choice occurs within the modelled network.
- Any matrix cells which are accurately known prior to estimation should be specified in the Traffic Flows View and locked as described in the Traffic Flow Views section.

4.13.5.2. Estimating the Matrix

When the above prerequisites are satisfied the matrix can be estimated as follows:

- Choose 'Estimate Flow Matrix from Turning Counts based on Current Scenario' from the Traffic Flows menu.
- LinSig displays the Matrix Estimation Settings dialog box. Make any necessary changes to settings. Further details on the settings available are described below.
- LinSig will carry out the matrix estimation followed by an assignment of the new matrix to the Network.
- The length of time taken for the matrix estimation process is dependent on the size of Network, the number of Zones, the amount of multiple route choice and loops in the network, the level of weaving allowed between Junctions and the general traffic level in the Network. A simple example with 2 staggered 'T' Junctions, 4 Zones, no street route choice, and full weaving typically takes less than 10 seconds on a modern office PC. A larger more complex network may take substantially longer. It should be remembered though that doing the process by hand would take substantially longer and the use of an OD matrix leads to time savings when specifying network flows later in the modelling process. Please report any models which appear to be taking an excessive amount of time to JCT Software Support

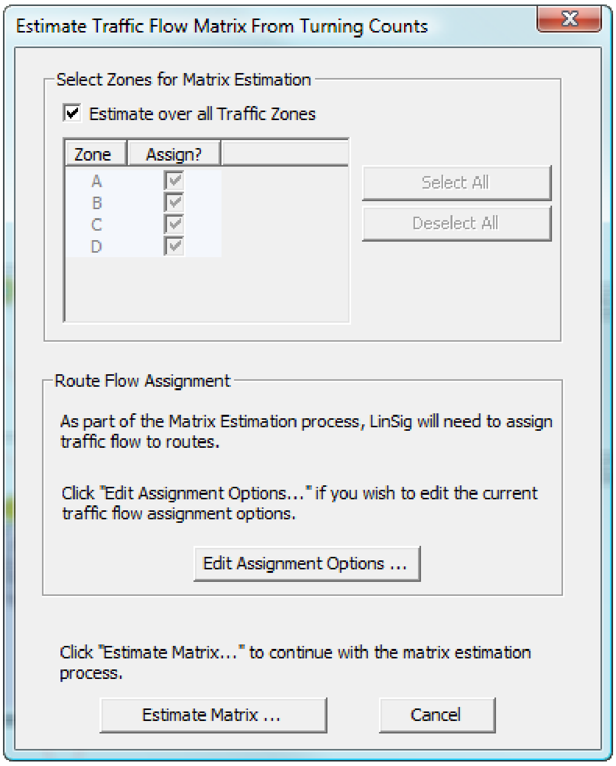
(support@jctconsultancy.co.uk) as this will assist us in improving the matrix estimation process.

- Check the quality of the estimated matrix and its assignment using the techniques described below.

4.13.5.3. Matrix Estimation Options

The Matrix Estimation options serve two purposes. These are:

- Select an area of the Matrix to estimate. This allows an area of the OD Matrix corresponding to a Matrix Based Network region to be estimated.
- Control Assignment options for the assignment part of the matrix estimation process. The Routes which traffic uses through the Network and the amount of traffic predicted to use them are a crucial part of the matrix estimation process. The assignment options allow this process to be controlled. Further details of assignment options are provided in the assignment section.



4.13.6. Validating an Estimated Matrix or Assignment

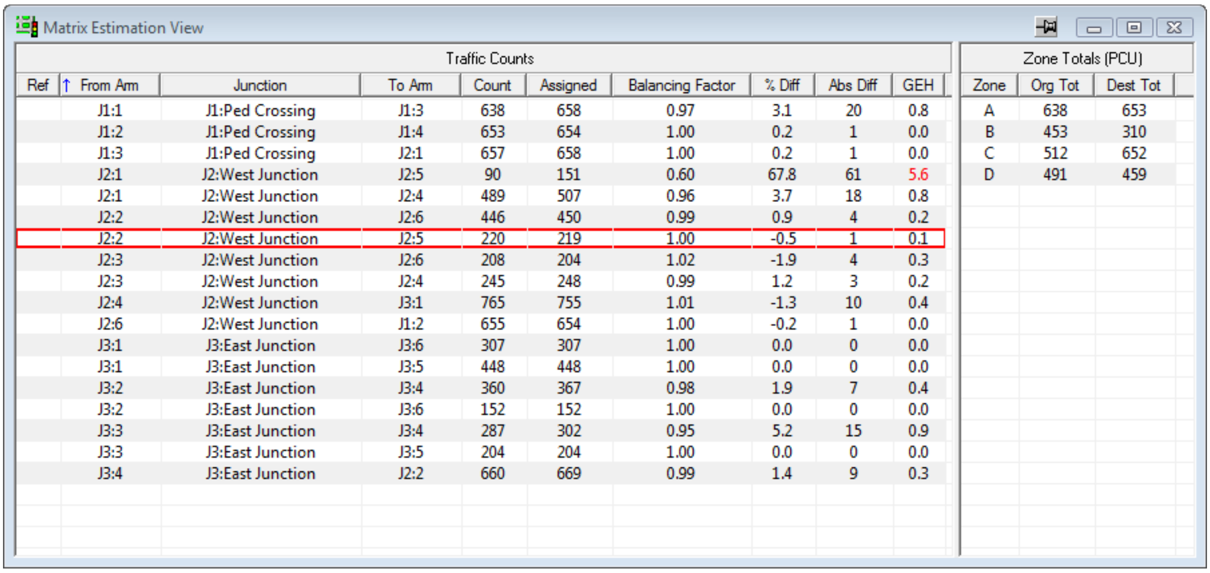
The Matrix Estimation View can be used to validate a Matrix Based model by comparing Traffic Counts to assigned flows. This can be based on either an estimated or manually entered OD Matrix which is assigned either automatically or manually to the Network. The Matrix Estimation View is simply comparing counted and modelled flows, regardless of how they are modelled, and providing goodness of fit statistics.

Counts and assigned Flows can be compared in two ways. These are:

- **Using the Matrix Estimation View.** This provides the most comprehensive way of comparing Counts and modelled flows across the whole Network.
- **Using the Traffic Count Matrix in the Network Layout View.** This provides less detail than the Matrix Estimation View but allows Counts and modelled flows to be quickly compared using a Junction Turning Count Matrix.

4.13.6.1. Model Validation using the Matrix Estimation View

As described above the Matrix Estimation View displays a list of Turning Counts together with a range of statistics comparing the Counts with the modelled flows from the Current Scenario.



Ref	From Arm	Junction	To Arm	Count	Assigned	Balancing Factor	% Diff	Abs Diff	GEH
	J1:1	J1:Ped Crossing	J1:3	638	658	0.97	3.1	20	0.8
	J1:2	J1:Ped Crossing	J1:4	653	654	1.00	0.2	1	0.0
	J1:3	J1:Ped Crossing	J2:1	657	658	1.00	0.2	1	0.0
	J2:1	J2:West Junction	J2:5	90	151	0.60	67.8	61	5.6
	J2:1	J2:West Junction	J2:4	489	507	0.96	3.7	18	0.8
	J2:2	J2:West Junction	J2:6	446	450	0.99	0.9	4	0.2
	J2:2	J2:West Junction	J2:5	220	219	1.00	-0.5	1	0.1
	J2:3	J2:West Junction	J2:6	208	204	1.02	-1.9	4	0.3
	J2:3	J2:West Junction	J2:4	245	248	0.99	1.2	3	0.2
	J2:4	J2:West Junction	J3:1	765	755	1.01	-1.3	10	0.4
	J2:6	J2:West Junction	J1:2	655	654	1.00	-0.2	1	0.0
	J3:1	J3:East Junction	J3:6	307	307	1.00	0.0	0	0.0
	J3:1	J3:East Junction	J3:5	448	448	1.00	0.0	0	0.0
	J3:2	J3:East Junction	J3:4	360	367	0.98	1.9	7	0.4
	J3:2	J3:East Junction	J3:6	152	152	1.00	0.0	0	0.0
	J3:3	J3:East Junction	J3:4	287	302	0.95	5.2	15	0.9
	J3:3	J3:East Junction	J3:5	204	204	1.00	0.0	0	0.0
	J3:4	J3:East Junction	J2:2	660	669	0.99	1.4	9	0.3

Zone	Org Tot	Dest Tot
A	638	653
B	453	310
C	512	652
D	491	459

The statistics available for each Count are:

- **The Percentage Difference.** This compares the count and modelled flow in relative terms and is defined as the percentage of the Count by which the modelled flow exceeds it. This is useful for comparing larger flows, for example, checking that all significant flows are within x% of the Count.
- **The Absolute Difference.** For Counts where flows are small the percentage difference between Counts and modelled flows can often be very large even though the flows in absolute terms are very close. For example a comparison of a count of 25 and an assigned flow of 20 would be regarded as reasonably good but the percentage difference of 20% appears very poor. In these cases it is important to also consider the absolute difference between Counts and modelled flows.
- **The GEH Statistic.** The GEH statistic (named after Geoffrey E. Havers the GLC transport planner who invented the statistic in the 1970s) combines the above two measures of relative and absolute difference to provide a single statistic measuring the fit between Counts and modelled flows. The value of GEH indicates how 'different' the Count and modelled flow would generally be regarded by a traffic engineer. GEH levels in practical terms are:
    - A GEH < 1 indicates an excellent match between Count and modelled flow.
    - A GEH < 5 is generally acceptable in a larger network but should be checked in a smaller network to see if improvements can be made.
    - A GEH > 5 and <10 would be unacceptable in a small network but may be acceptable in a larger network if carefully checked and the difference explained.
    - A GEH > 10 would rarely be acceptable and indicates something is wrong somewhere. The most likely cause is poorly matching and inconsistent counts.

The criteria usually used for the overall acceptability of larger network validation are 85% of Counts being matched with GEH < 5. It should be easier to meet this criterion with smaller more densely counted Networks and a more rigid criterion may be justified in many cases.

4.13.6.2. Validating Counts using the Junction Turning Counts Matrix

As described in the Network Layout View section the Junction Turning Counts Matrix can be used to validate Counts and modelled flows at a Junction as well as enter Turning Counts. The Junction Turning Counts Dialog displays the following matrices:

- **Desired Counts Matrix.** The Desired Counts Matrix displays and allows editing of Turning Counts at a Junction. This is described in more detail in The Network Layout View section.
- **Actual Flows Matrix.** The Actual Flows Matrix shows the modelled flows for the Current Scenario corresponding to each Count. These are calculated from Route flows through each Count position.
- **Difference Matrix.** The Difference Matrix shows the difference between the Desired Counts Matrix and Actual Flows Matrix. Only the absolute difference between Counts and modelled flows is given.

4.13.6.3. Resolving Validation Problems

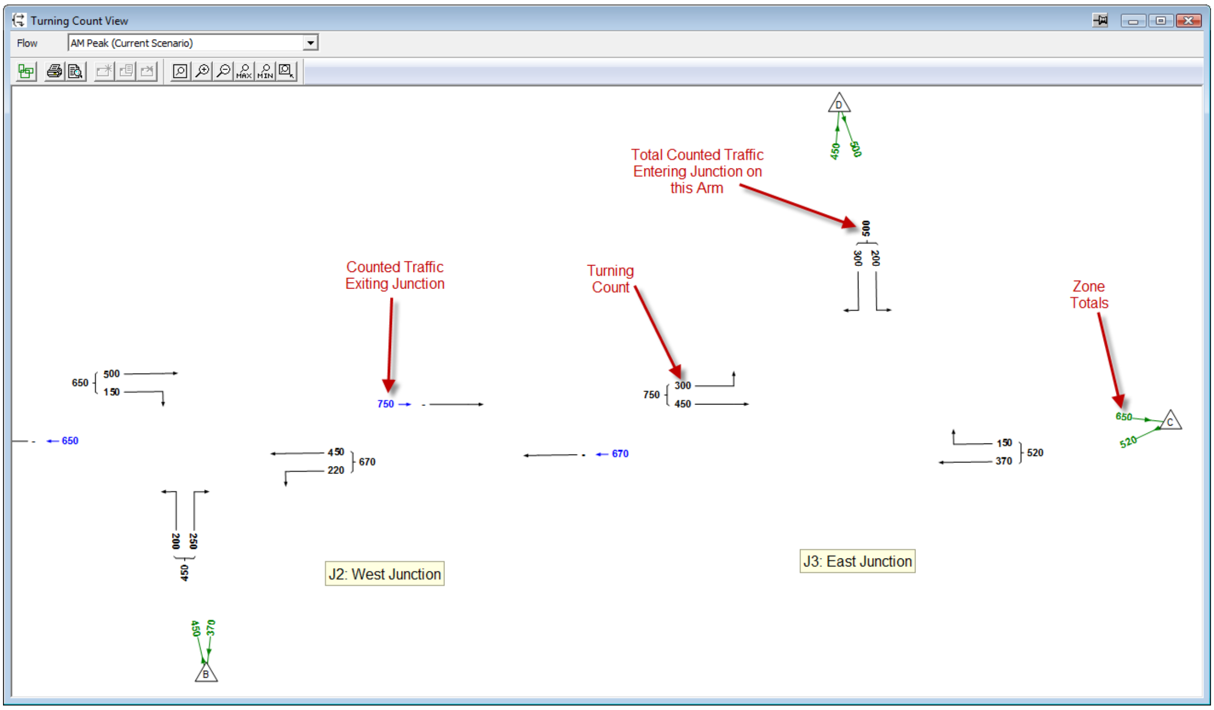
The following provides suggestions on how to improve a Networks Validation. It is not intended to be exhaustive but provides some starting points to consider:

- Check cruise times are realistic as incorrect Route times will lead to LinSig assigning traffic to incorrect Routes. Route travel times provide a good check on assignment routing decisions.
- Check Lane Connectors allow traffic Routes which exist in reality. Missing Lane Connecters can lead to LinSig assigning traffic incorrectly.
- Check missing Counts haven't forced LinSig into estimating uncounted matrix cells as zero. Although this won't lead to a direct validation problem (as there is no Count to validate against) it may lead to incorrect delays being calculated which distort the routing pattern in the Network.
- Check that capacities and delays are being correctly calculated especially where they affect route choice. Incorrect saturation flows which imply incorrect capacity calculation can easily lead to quite large errors in delay which can distort Routing within the Network.
- Check that signal timings in the Scenario being validated are representative of the timings used for the time period being validated. Incorrect signal timings may bias traffic onto different Routes than those used in reality when traffic was counted leading to poor validation. Where signal timings are unknown it is worth experimenting to see how signal settings affect the validation.

4.14. Turning Counts View

The Turning Counts View graphically displays the Turning Counts used for estimating an OD Matrix or validating a traffic assignment in LinSig. The information displayed is the same as that shown in the Matrix Estimation View and more detail is given in the Matrix Estimation View section on how Turning Counts are used and managed. As Lane Based Flows do not use Turning Counts this View is only relevant when Matrix Based Flows are being used for all or part of the Network.

The View can be opened by choosing 'Turning Counts View' from the Traffic Flows menu.



The Flow Group for which Turning Counts are displayed can be selected in the Turning Counts View toolbar. The selected Flow Group is linked with the selected Flow Group used by the Matrix Estimation View so both Views always show traffic flow information for the same Flow Group.

4.14.1.1. Turning Counts

The Turning Counts View displays each Junction's Turning Counts. The information displayed includes:

- **Turning Counts for each Junction.** Turning Counts for each Junction are displayed showing counts values in PCU.
- **Junction Arm Inflow Totals.** The total incoming counted flow is displayed for each Arm entering the Junction. This helps with locating poor quality or inconsistent counts.
- **Junction Arm Outflow Totals.** The total outgoing counted flows is displayed for each Arm leaving the Junction. These values can be compared with Inflow totals to assist with detecting inconsistent counts.

4.14.1.2. Zone Totals

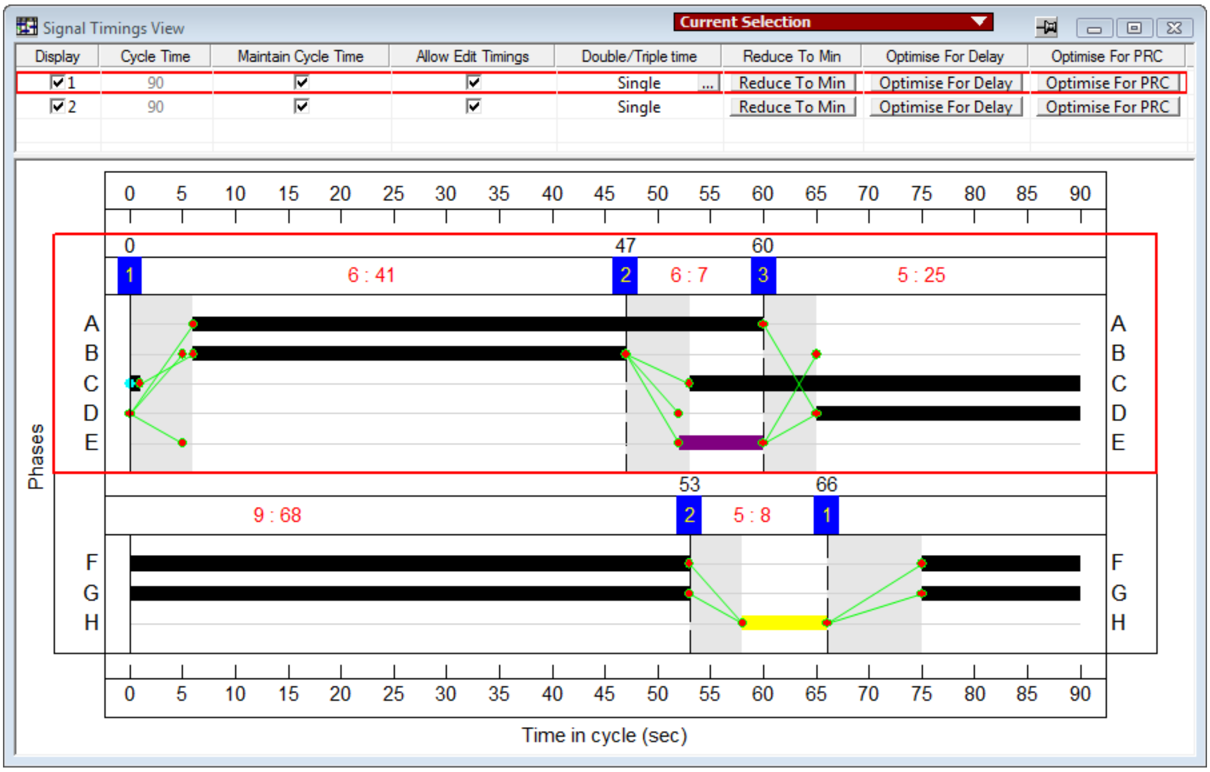
Each Zone in the Network graphically displays the total counted Origins and Destinations. As in the Matrix Estimation View the Zone Totals can be implied by adding nearby Turning Counts or can be explicitly entered values.

4.14.1.3. Editing Turning Counts and Zone Totals

Turning Counts and Zone Totals can be edited in the Turning Counts View by double clicking with the mouse and entering the new count value in PCU. This will update the Count which will also be reflected in the Matrix Estimation View and the Junction Turning Counts Matrix. Further information on using Counts is provided in the Matrix Estimation View section.

4.15. Signal Timings View

Each Signal Timings View is used to display and adjust the Stage and Phase timings for the Current Scenario. The View is opened by choosing 'Signal Timings View' from the Stage Sequences menu.



As well as viewing Stage and Phase timings, the Signal Timings View also shows detailed Interstage structure, Stage Minimums and allows signal timing optimisation of individual Controllers or Stage Streams to be carried out.

The Signal Timings View is comprised of two panels:

- **The Stage Stream List.** This allows timing and display settings for each Stage Stream to be controlled. When multiple Stage Streams are disabled a single line showing the only Stage Stream is displayed.
- **The Signal Timings Panel.** This shows the Stage and Phase Times for the current Scenario over the Network Cycle Time. A wide range of other information such as Intergreens are also shown as described below.

4.15.1. Selecting which Controller to View

It is possible to have one or more Signal Timings Views open in a LinSig model at any one time. Each Signal Timings View shows the signal timings for a single LinSig traffic Signal Controller. The Controller being displayed is set using each View's Controller Selector drop list as follows:

- LinSig always has a 'Current Controller' which is used by several Views to ensure they are all displaying information for the same Controller. The Current Controller is selected using the Controller List View or using the Controller drop down list on the main LinSig toolbar. If the Controller drop down list on the Signal Timings View's title bar is set to 'Current Selection' the Signal Timings View will display the signal timings for the Current Controller as selected in the Controller List View. If the Current

Controller changes the Controller displayed in this View will also change to reflect the new Current Controller.

- In some instances you may wish to view the signal timings for several controllers at the same time. To allow this each Signal Timings View may be locked to a particular Controller so its display does not change when the Current Controller is changed. To lock a Signal Timings View to a Controller drop down the Controller Selector drop list in the Signal Timings View's title bar and choose which Controller to lock the Signal Timings View too.

4.15.2. The Stage Stream List

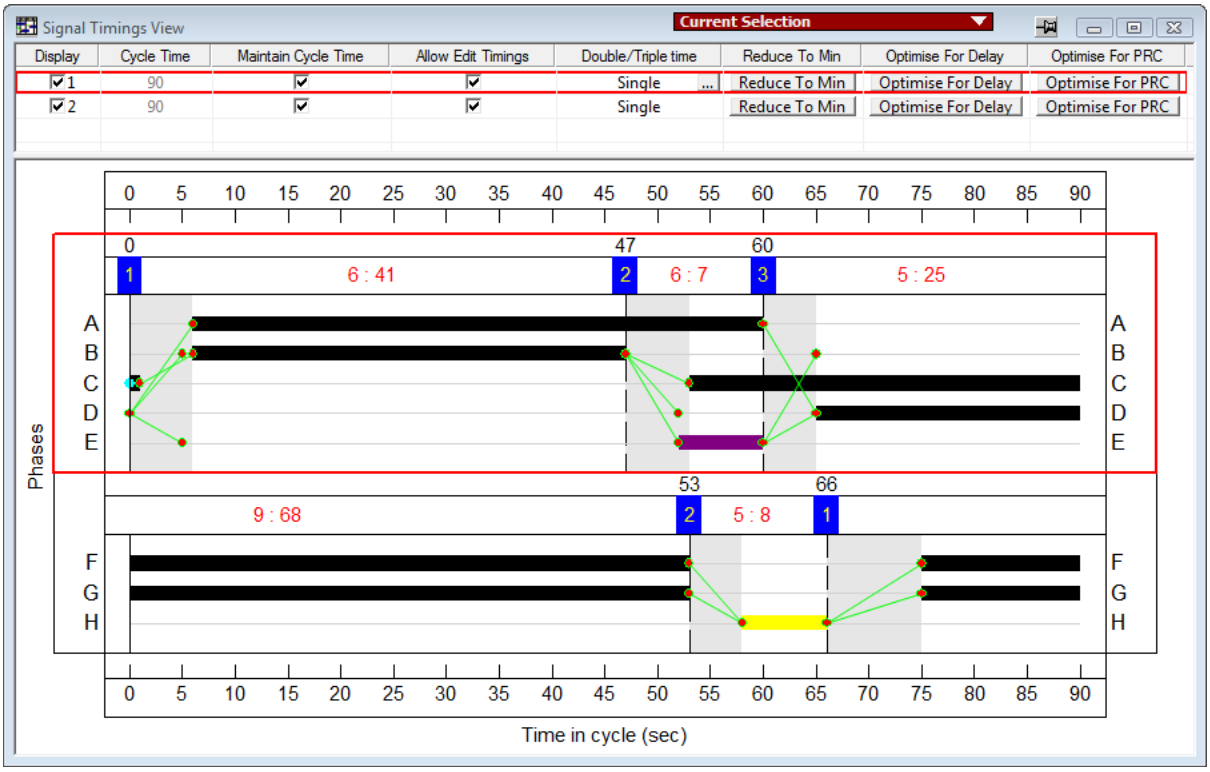
The Stage Stream List allows the following options and settings to be controlled for the Stage Stream:

- **Display.** This controls whether the Signal Timings are shown for this Stage Stream. This is permanently on when Multiple Stage Streams are disabled.
- **Cycle Time.** This displays the current Cycle Time for a Stage Stream using the current Scenario. This will usually be the same as the Network Cycle Time set on the main toolbar or the Stage Stream's parent Controller Set's cycle time where multiple Controller Sets are being used. It may however be different from its parent Controller Set's cycle time when:
    - Constraints such as the Stage Stream's minimum Cycle Time would be violated if the Controller Set's Cycle Time was applied to the Stage Stream.
    - A Stage Sequence with a different Cycle Time to the Controller Set's Cycle Time has been created or imported into the Scenario.
- **Attempt to Maintain Cycle Time.** When 'Attempt to Maintain Cycle Time' is ticked LinSig will attempt to maintain the Stream's Cycle Time equal to its parent Controller Set's Cycle time when making changes to traffic signal related data in LinSig. For example, if an Intergreen is changed which lengthens an Interstage, LinSig will, if possible, reduce one of the Stage lengths to maintain the Cycle Time.
- **Allow Edit Timings.** When 'Allow Edit Timings' is un-ticked LinSig does not allow Stage Timings to be changed in the Stage. This is useful to prevent making inadvertent changes to signal timings.
- **Multi-cycling.** The Multi-Cycling setting provides a quick way of implementing simple equal length double and triple cycling. It allows a Stage Sequence to be repeated twice or three times within the Stream's overall Cycle Time. Each half or third cycle will be of equal length. This option is not suitable for implementing unequal length double cycling which should be implemented by repeating Stages in the Stage Sequence.
- **Reduce to Minimum.** Click the 'Reduce to Minimum' button to reduce the Stage Streams Cycle Time to its minimum length. This will automatically untick 'Maintain Cycle Time' as the link with the parent Controller Set's Cycle Time is broken. The parent Controller Set's Cycle Time can be re-implemented by re-ticking 'Maintain Cycle Time'.
- **Optimise Delay.** Clicking the 'Optimise Delay' button optimises the Stage lengths for the Stage Stream to minimise aggregate traffic delay for Lanes controlled by the Stage Stream. All other Stage Streams are unchanged. More information on optimisation is available in the Scenario View section.

- **Optimise PRC.** Clicking the 'Optimise PRC' button optimises the Stage lengths for the Stage Stream to maximise Practical Reserve Capacity (PRC) for Lanes controlled by the Stage Stream. All other Stage Streams are unchanged. More information on optimisation is available in the Scenario View section.

4.15.3. The Signal Timings Panel

The Signal Timings Panel is located below the Stage Stream List in the Signal Timings View. When a junction contains more than one Stage Stream a Signal Timings panel is displayed for each Stage Stream as shown below.



Each Signal Timings Panel shows the following:

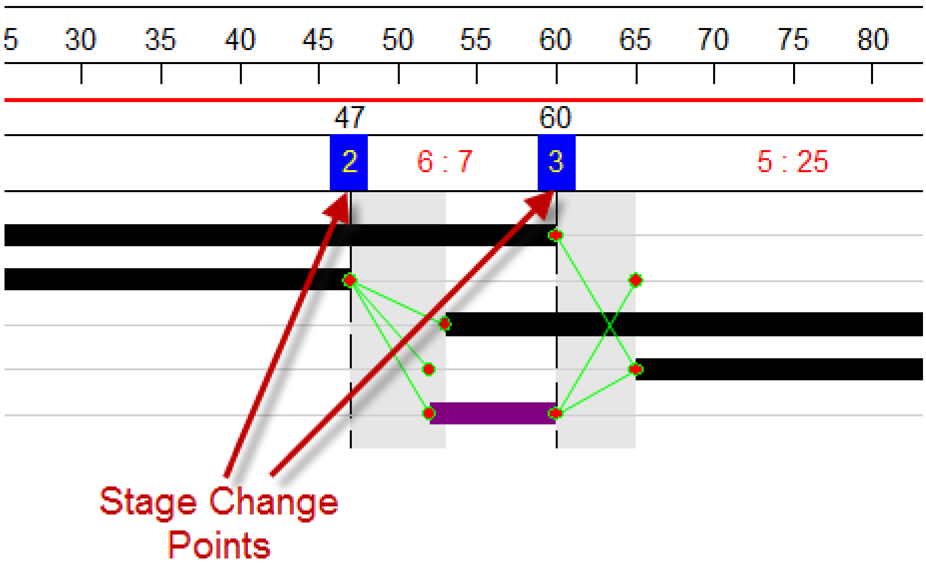
- **Phase Bars.** Each traffic signal Phase is represented as a bar showing the times when the Phase is running. Phase Bars are displayed as follows:
    - Coloured by Phase Type using the same colours as the Phase View.
    - Displayed in yellow if the Phase is running to minimum.
    - Displayed in red if abnormally the Phase Minimum is being violated. LinSig will normally prevent this but some obscure uncommon scenarios can cause a Phase Minimum to be violated. LinSig will also include an error message in the Error View and traffic model results will not be available.
    - Shaded by intensity of Outflow controlled by the Phase. Right Click on the Signal Timings Panel and choose 'Show Out Flow' to select this Phase bar display mode. LinSig will shade the Phase bar in proportion to the level of traffic flow crossing the stop line. If the most saturated Lane controlled by the Phase is at Saturation the Phase bar will be 100% shaded. If however no flow is crossing the stop line the Phase bar will be shown transparent. This display

allows a rapid assessment to be made of the efficiency of green time use.

- **Stages.** Each Traffic Signal Stage is displayed using a blue cursor above the main Phase Bars area to show each Stage Change point. The exact time of the Stage Change Point is shown above the Stage Change Point Cursor. Stage Change points can be dragged with the mouse to change Stage lengths. LinSig will ensure constraints such as Intergreens and Phase minimums are not violated.
- **Interstages.** Interstages between Stages are shaded grey.
- **Phase Intergreens.** Phase Intergreens are displayed as green ‘struts’ between Phases. LinSig will normally ensure that all Intergreens are not violated however some uncommon or obscure scenarios (for example very long intergreens stretching across several Stages) can sometimes be violated. If an Intergreen is violated LinSig will display it in red, place an error in the error view, and will not produce any traffic model results.
- **Interstage and Stage Lengths.** LinSig displays the Interstage and Stage Lengths numerically in the area between Stage Change Point cursors. The times are shown in the format: ‘Interstage : Stage Length’.

4.15.3.1. Changing Stage Change Points & Stage Lengths

Stage Change Points and Stage Lengths can all be changed graphically by dragging the blue Stage Change Point Cursors with the mouse. This will change the Stage Change Points in the current Scenario whilst keeping the Cycle Time the same.

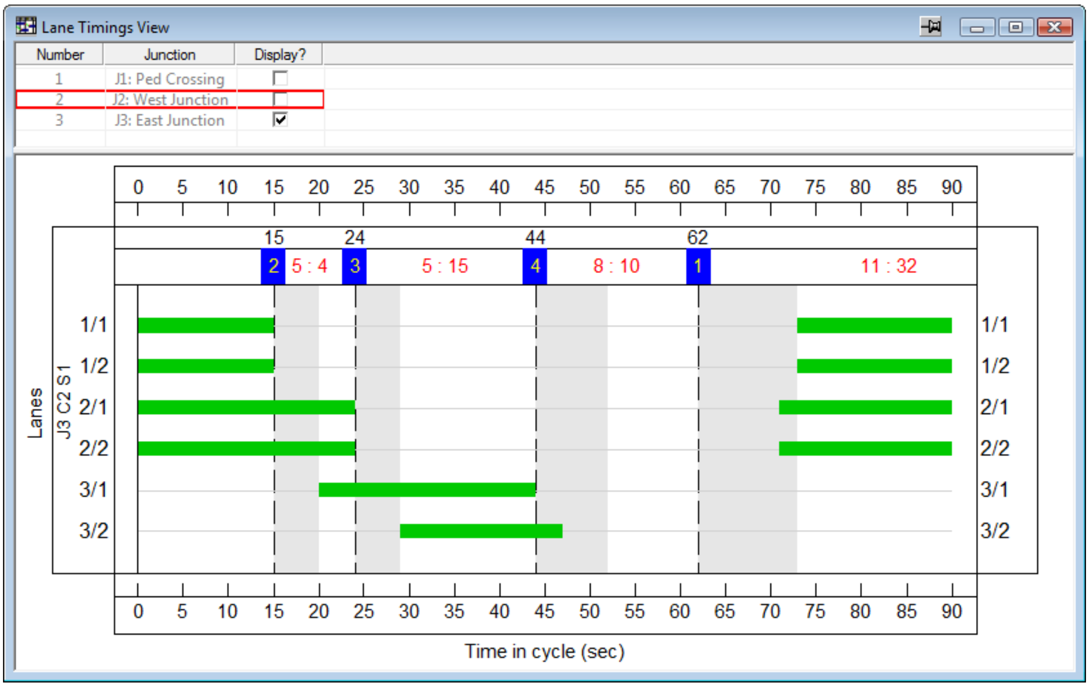


4.15.3.2. Changing Stage Stream Offsets

A Stage Stream’s Offset can be changed by dragging a Stage Change Point whilst holding the SHIFT key down.

4.16. Lane Timings View

The Lane Timings View displays the period each Lane receives a green signal within the cycle. It can be opened by choosing 'Lane Timings View' from the Stage Sequences menu.



Its principal purpose is to allow the effective green times of individual Lanes to be adjusted using Bonus Greens to allow for effects such as underutilised green time and demand dependency.

The Lane Timings View is comprised of two panels:

- **Junction List.** The Junction List lists all Junctions in the Network and allows the Junctions to be displayed in the Lane Timings View to be selected by ticking the 'Display?' column.
- **Lane Timings Panel.** This shows the Stage and Lane Green periods for the current Scenario over the cycle time. Bonus Greens can also be set for each Lane's green periods.

4.16.1.1. Lane Timings Panel

The Lane Timings Panel shows the following information.

- **Lane Green Bars.** Each Lane's green period is represented as a bar showing the times when the Lane is running.
- **Stages**. Each Traffic Signal Stage is displayed using a blue cursor above the main Lane Greens area to show each Stage Change point. The exact time of the Stage Change Point is shown above the Stage Change Point Cursor. Stage Change points can be dragged with the mouse to change Stage lengths. LinSig will ensure constraints such as Intergreens and Phase minimums are not violated.
- **Interstages.** Interstages between Stages are shaded grey.
- **Interstage and Stage Lengths.** LinSig displays the Interstage and Stage Lengths numerically in the area between Stage Change Point cursors. The times are shown in the format: 'Interstage : Stage Length'.

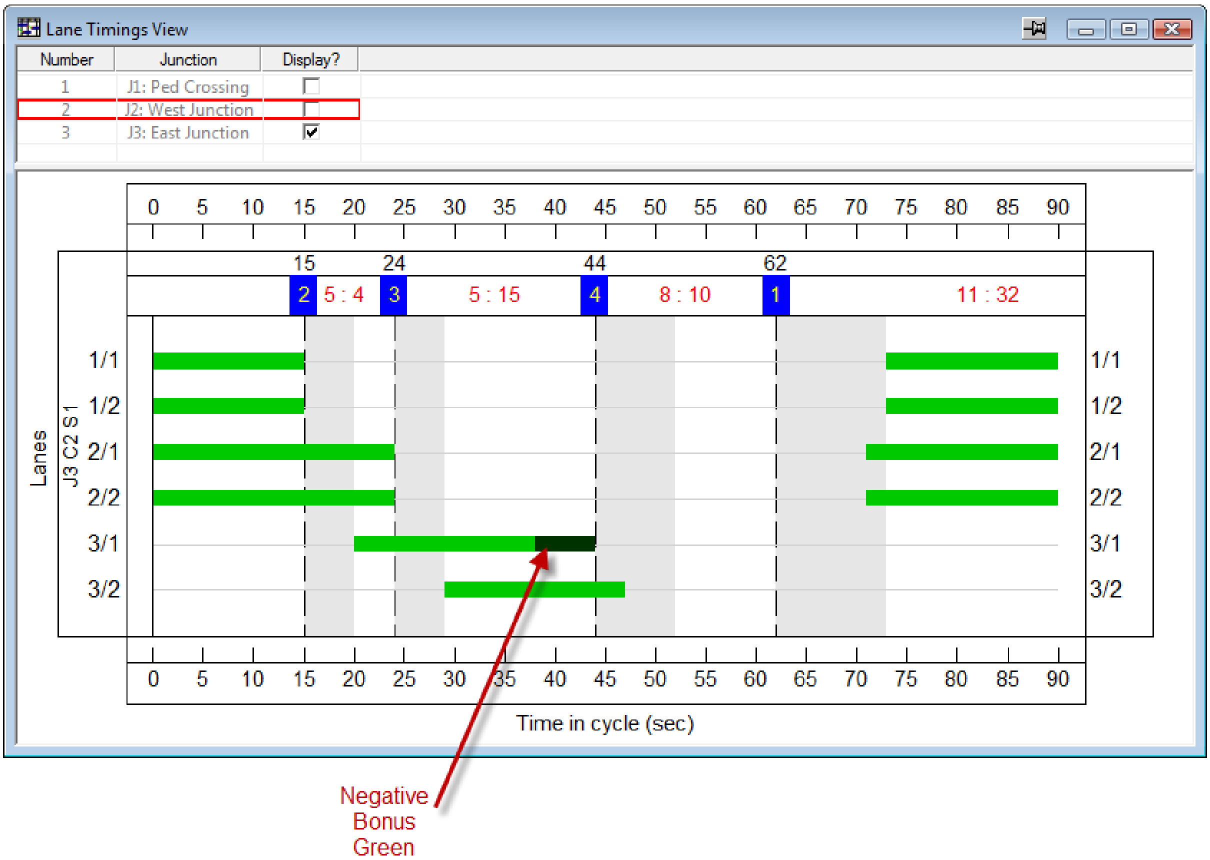
4.16.1.2. Changing Stage Timings using the Lane Timings View

Although the Signal Timings View is more appropriate for making changes to Stage times it is also possible to change Stage times in the Lane Timings View by dragging Stage Change Points with the mouse in a similar way to the Signal Timings View.

4.16.1.3. Adding Bonus Greens to Lane Green Periods

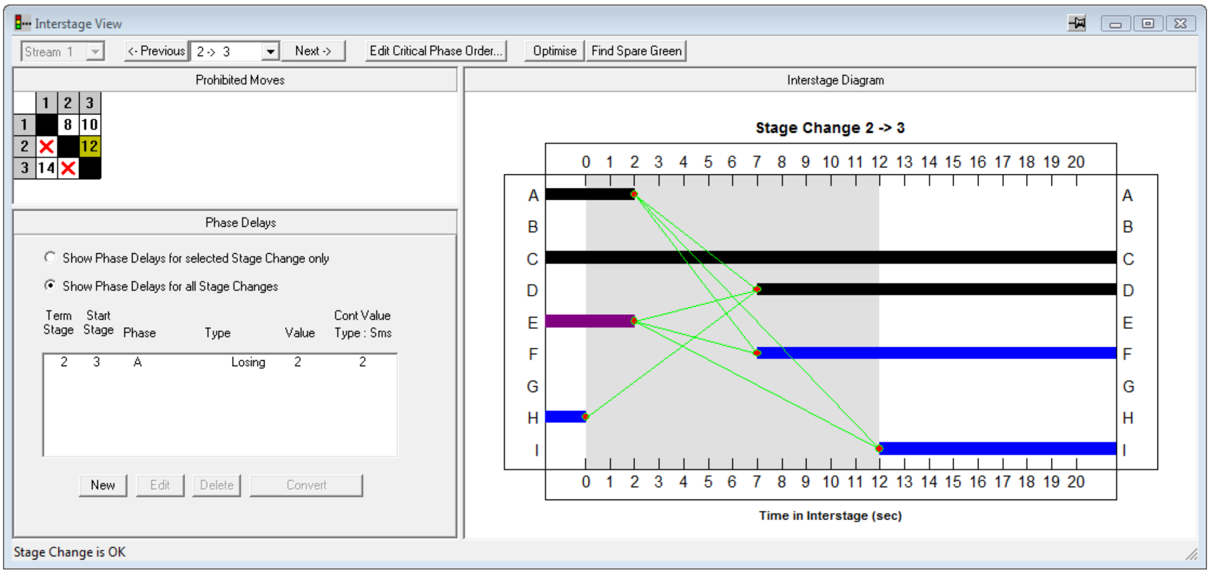
Bonus Greens can be added to a Lane Green Period as follows:

- Right click anywhere on the Lane Green Period's bar in the Lane Timings Panel.
- Choose 'Edit Start Bonus Green' or 'Edit End Bonus Green' from the pop-up menu. This will open the 'Edit Bonus Greens' dialog box.
- In the 'Edit Bonus Greens' dialog box double click the value next to the Bonus Green Type and enter a value for the Bonus Green. Positive Bonus Greens always result in more green time and negative Bonus Greens less green time.
- If more than one Bonus Green Type is added they are summed together to give the total Bonus Green.



4.17. Interstage & Phase Delays View

The Interstage & Phase Delays View is used to display and edit Interstage structures in LinSig. The Interstages can have a significant effect on junction performance and safety and it is important they are correctly designed. The Interstage & Phase Delays View can be used to optimise Interstage structures by automatically adjusting Phase Delays. The View can also be used to manually adjust Phase Delays where necessary.



The Interstage & Phase Delays View show Interstages and Phase Delays for a single Controller at once, in a similar manner to other Controller related Views, and is used the same way regardless of whether Multiple Stage Streams are being used for the Controller being viewed. For more information on using Multiple Stage Streams see the Phase View section.

The View is opened by choosing 'Interstage & Phase Delays View' from the Controllers Menu.

4.17.1. Selecting which Controller to View

It is possible to have one or more Interstage Views open in a LinSig model at any one time. Each Interstage View shows the Interstage details for a single LinSig traffic Signal Controller. The Controller being displayed is set using each View's Controller Selector drop list as follows:

- LinSig always has a 'Current Controller' which is used by several Views to ensure they are all displaying information for the same Controller. The Current Controller is selected using the Controller List View or using the Controller drop down list on the main LinSig toolbar. If the Controller drop down list on the Interstage View's title bar is set to 'Current Selection' the Interstage View will display the Interstages for the Current Controller as selected in the Controller List View. If the Current Controller changes the Controller displayed in this View will also change to reflect the new Current Controller.
- In some instances you may wish to view the Interstages for several controllers at the same time. To allow this each Interstage View may be locked to a particular Controller so its display does not change when the Current Controller is changed. To lock an Interstage View to a Controller, drop down the Controller Selector drop list in

the Interstage View's title bar and choose which Controller to lock the Interstage View too.

4.17.2. Working with the Interstage & Phase Delays View

The Interstage & Phase Delays View is comprised of several panels. These include:

- **The Prohibited Stage Change and Interstage Length Matrix.** The Prohibited Stage Change Matrix indicates Stage Changes which are prohibited either automatically by LinSig or manually by the user. The matrix also shows Interstage lengths calculated by LinSig for all allowed Stage Changes. When Multiple Stage Changes are being used the matrix is shown for the Current Stage Stream as selected in the Interstage View's toolbar or the main LinSig toolbar.
- **The Phase Delays List.** The Phase Delays List displays a list of Phase Delays configured in the Controller.
- **The Interstage Structure Panel.** The Interstage Structure Panel shows the Interstage Structure for the Interstage selected in the Prohibited Stage Change Matrix. The panel shows terminating and starting Phases, Intergreens and Phase Delays which make up the Interstage. The Panel can also be used to automatically optimise the Interstage structure.

4.17.2.1. The Prohibited Stage Change and Interstage Length Matrix

The Prohibited Stage Change and Interstage Length Matrix displays an Interstage matrix for the current Stage Stream.

The matrix displays the following:

- The currently Selected Interstage is shown with a yellow background and corresponds to the Interstage shown in the Interstage Structure panel.
- Interstages which are prohibited are marked with a cross. Interstages which are automatically prohibited by LinSig, for example to avoid violating rules regarding terminating Filter Phases, are shown in blue. Interstages which have been explicitly banned by the user are shown in red.
- Permitted Interstages display the Interstage duration calculated by LinSig. This is calculated from the Phase Intergreens and Phase Delays involved in the Interstage.

4.17.2.2. The Current Interstage and Selecting an Interstage

When LinSig needs to display or perform an action on an Interstage it needs to know which one to use. The Interstage View allows an Interstage to be selected by either:

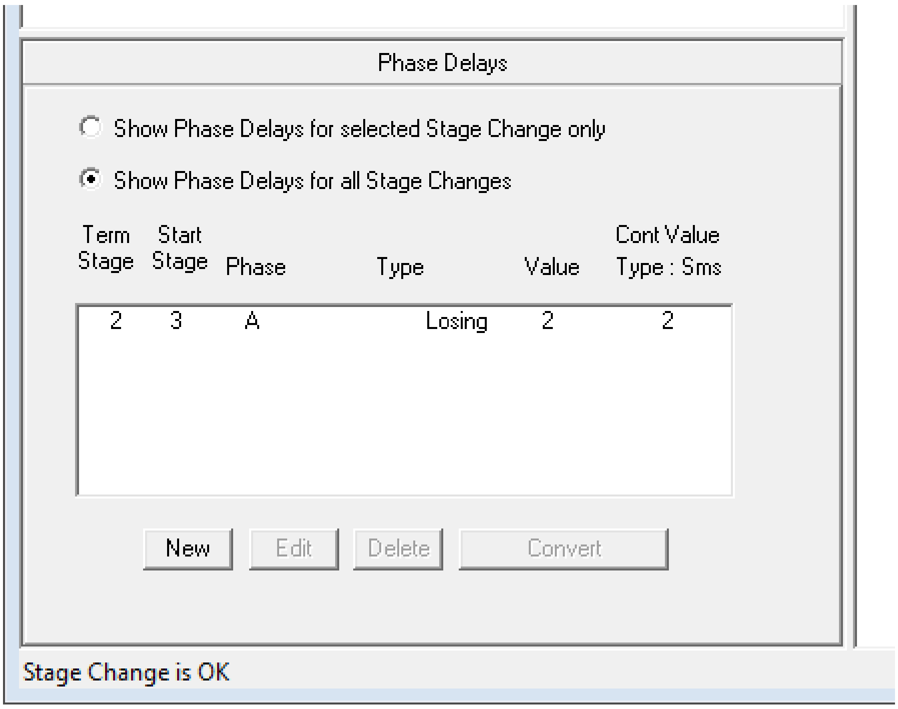
- Clicking an Interstage in the Prohibited Stage Change Matrix. The selected Interstage is highlighted with a yellow background.
- Selecting an Interstage from the drop down list in the Interstage View toolbar.
- Using the ‘Previous’ and ‘Next’ buttons in the toolbar to cycle through Interstages in sequence.

The Interstage Structure Diagram will always show the detailed structure of the current Interstage.

When multiple Stage Streams are in use on the Controller being displayed Interstages are shown for the current Stage Stream only. The current Stage Stream can be changed using the drop down list in the Interstage View’s toolbar or on the Stage Stream drop down list on the main toolbar. Using multiple Stage Streams is covered in more depth in the Phase View section.

4.17.2.3. The Phase Delays List

The Phase Delays List displays a list of Phase Delays configured on the controller and is also used to create, edit and delete Phase Delays. For more information on Phase Delays and how they are used see the information on Phase Delays in the ‘Background’ section.



The information shown for each Phase Delay is as follows.

- The terminating and starting stages for which the phase delay is active.
- The Phase associated with the phase delay.
- The type of the Phase Delay. Phase Delay Types are described below.
- The Phase Delay value (seconds) in the LinSig model.
- The Phase Delay value (seconds) for the current controller type. The current controller type is shown at the top of the column.

Controlling the Phase Delay List

The Phase Delay List shows the Phase Delays currently configured on the Controller. If Multiple Stage Streams are being used only Phase delays for the Current Stage Stream are listed. The Phase Delay List can be very long for complex models and can be further filtered by choosing to show Phase Delays for the currently selected Stage Change only.

Phase Delay Types

Phase Delays can be of two basic types. These are:

- **Phase Losing Delays**. These are Phase Delays associated with Phases which lose right of way in the Phase Delay's associated Stage Change. These are the most commonly used Phase Delay and are often used to assist with optimising Interstages. The Phase Delay's value defines how long the Phase will continue to run for after the terminating Stage ends.
- **Phase Gaining Delays**. These are Phase Delays associated with Phases which gain right of way in the Phase Delay's associated Stage Change. These are much less common than Phase Losing Delays and are typically used to align the starting point of Phases in an Interstage. This is sometimes desirable when different Intergreen values would cause Phases to start at different times in a potentially unsafe manner. A Phase Gaining Delay delays the start of a Phase after the point it would start – normally when all intergreens to the Phase have completed. Phase Gaining Delays can be specified in two different ways in LinSig as described below.

LinSig will automatically determine the type of a Phase Delay based on its associated Phase and Stage Change.

As signal controllers supplied by different manufacturers define a Phase Gaining Delay's value in different ways, LinSig has introduced two variants of Phase Gaining Delay to allow all controller types to be accommodated. These are:

- **Absolute Phase Gaining Delay.** An Absolute Phase Gaining Delay delays the start of a Phase by the Phase Delay's value timed from the end of the terminating Stage.
- **Relative Phase Gaining Delays.** A Relative Phase Gaining Delay delays the start of a Phase by the Phase Delay's value timed from the point the Phase would have started if the Phase Delay did not exist.

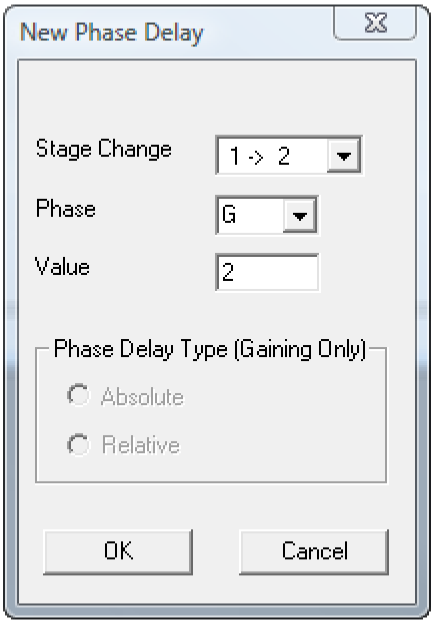
Each Phase Gaining Delay can be entered in either form in LinSig. As well as displaying the value of a Phase Gaining Delay as it is defined LinSig will also calculate its value in the native form used by the current Controller Type.

Controller Manufacturers specify phase gaining delays as follows:

- **Siemens/Plessey** - Absolute but deduct red/amber time on traffic phases.
- **GEC** - Absolute.
- **Peek/Ferranti** - Relative.
- **Microsense/Telent** - Relative.
- **Monitron** - Relative.

Creating a New Phase Delay

A new Phase Delay is created by clicking ‘New” in the Phase Delay List panel. This will create a new Phase Delay and display the ‘New Phase Delay’ dialog box.

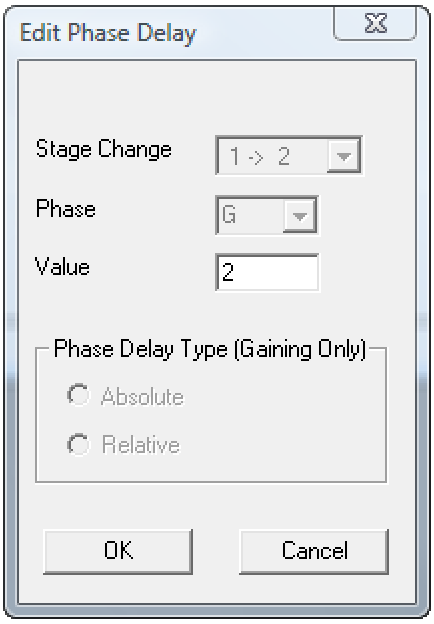


The following information is required for a new Phase Delay:

- **The Phase Delay's Stage Change.** Select the Stage Change associated with this Phase Delay from the drop down list. If a Phase has already been selected only Stage Changes compatible with this Phase are displayed.
- **The Phase Delay's Phase.** Select the Phase associated with this Phase Delay from the drop down list. If a stage change has already been entered only the Phases compatible with this Stage Change are shown.
- **The Phase Delay Value**. Enter the length of the Phase Delay in seconds.
- **The Phase Delay Type.** The Phase Delay type is only required for Phase Gaining Delays. LinSig will use the Stage Change and Phase to determine whether the Phase Delay being entered is a Phase Gaining Delay. More information on Phase Delay Types is given in ‘Phase Delay Types’ above.

Editing a Phase Delay

Phase Delays are edited by selecting the Phase Delay in the Phase Delay List and clicking 'Edit'. This opens the 'Edit Phase Delay' dialog box.



The following information can be edited for Phase Delays:

- **The Phase Delay Value.** Enter the length of the Phase Delay in seconds.
- **The Phase Delay Type.** The Phase Delay Type is only required for Phase Gaining Delays. LinSig will use the existing Stage Change and Phase to determine whether the Phase Delay being entered is a Phase Gaining Delay. More information on Phase Delay Types is given in 'Phase Delay Types' above.

When Editing a Phase Delay the Stage Change and Phase cannot be changed. If necessary the Phase Delay should be deleted and a new Phase Delay created with the correct Stage Change and Phase.

Deleting Phase Delays

A Phase Delay can be deleted by selecting it in the Phase Delay List and clicking 'Delete'.

Converting Phase Gaining Delays

Phase Gaining Delays are entered either as Absolute Phase Gaining Delays or Relative Phase Gaining Delays as detailed above. A Phase Delay can be permanently converted from one type to the other as follows:

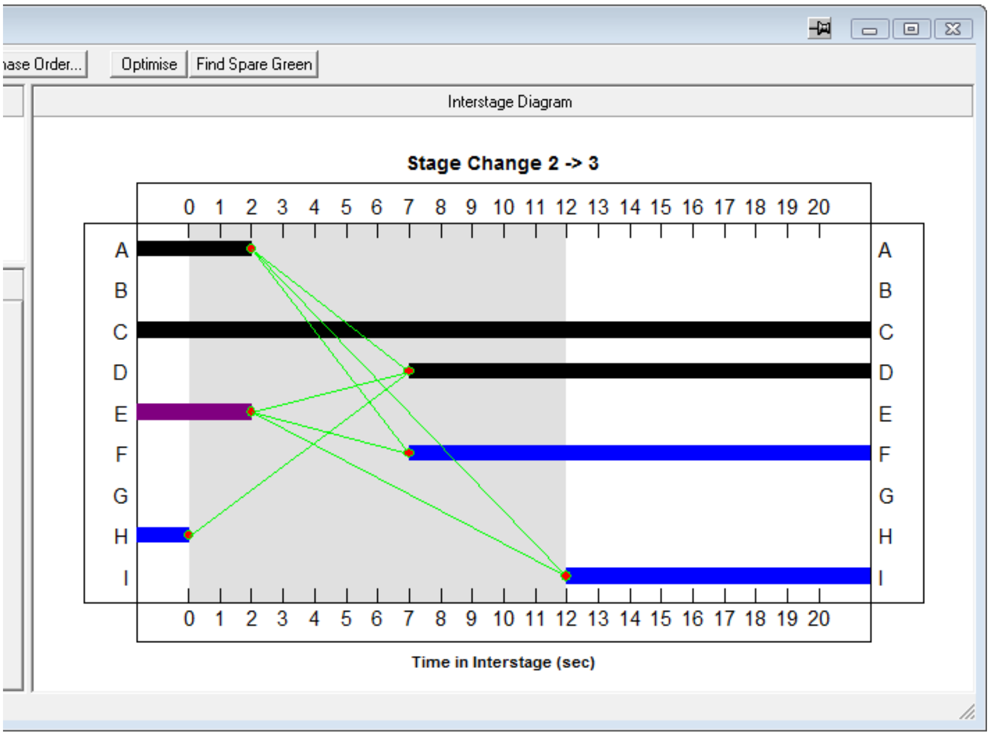
- Select the Phase Delay in the Phase Delay List.
- Click the 'Convert to Relative' or Convert to Absolute' button as appropriate. LinSig will change the type of the Phase Gaining Delay and recalculate its value to reflect its new type.

4.17.2.4. The Interstage Structure Diagram

The Interstage Structure Diagram shows the following:

- **Terminating Phases.** The Phases terminating in this Interstage are shown to the left of the panel. Each Phase is coloured according to its Phase type as defined in the Phase View. Phases may terminate within the Interstage when they have Phase Losing Delays defined.

- **Starting Phases.** The Phases starting in this Interstage are shown to the right of the panel. The Phases start when Intergreens from other Phases or Phase Gaining delays terminate.
- **Phase Intergreens.** The Phase Intergreens are shown as green 'struts' separating Phases.



The Interstage Diagram initially accommodates Interstages up to 20 seconds and marks the time axis every two seconds. This can be changed if necessary by double clicking on the time axis and entering a new size and scale as appropriate. If necessary LinSig will adjust the time axis markings to avoid overlapping.

Using Phase Delays to Adjust Phase Termination and Start Times

The Interstage View can be used to adjust the start and end times of Phases within the Interstage. LinSig implements these adjustments using Phase Delays.

The termination point of a Phase can be delayed by dragging the end of the Phase with the mouse to set a new end time. LinSig will create a Phase Losing Delay to implement the new Phase end time. This Phase delay will also appear in the Phase Delay List. If the Phase end time is dragged back to the start of the Interstage the Phase Delay is no longer necessary and is removed by LinSig.

The start time of a Phase will initially be determined using the end times of terminating Phases, and Intergreens from the terminating Phases to the starting Phases. The start time of a starting Phase can be delayed by dragging to the right with the mouse. LinSig implements this as a Phase Gaining Delay which will be shown in the Phase Delay List. As for Phase Losing Delays, if the Phase start time is dragged so that the Phase Delay is no longer necessary LinSig will delete the Phase Gaining Delay.

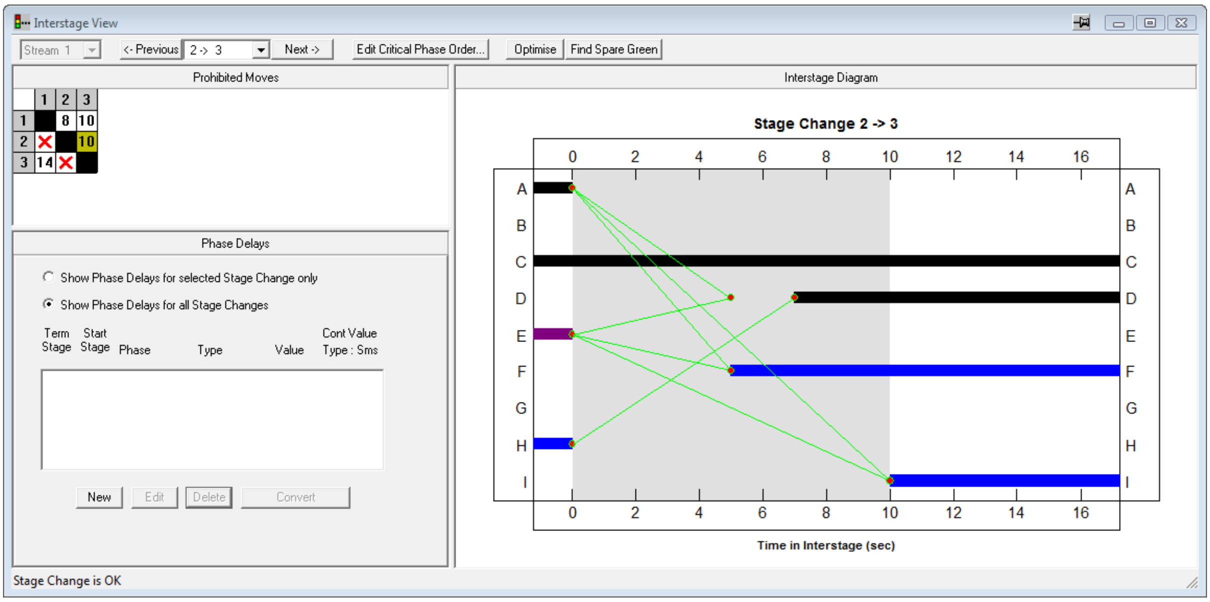
Optimising Interstages

LinSig provides two mechanisms for determining the optimum set of Phase Delays for an Interstage. These are:

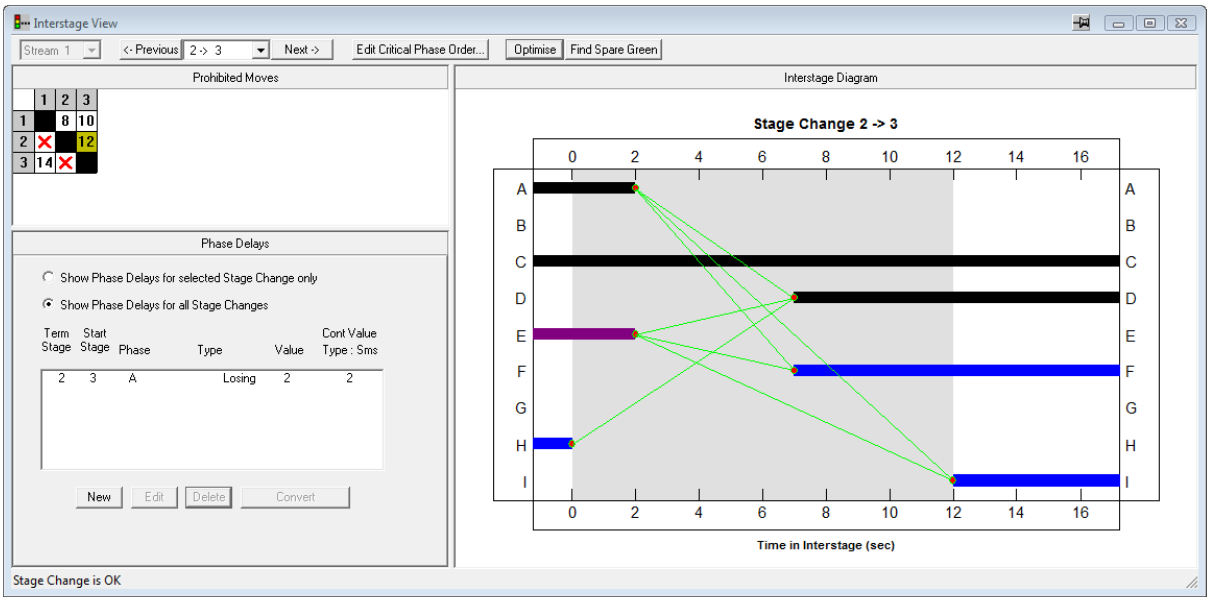
- **Find Spare Green**. This is a basic method which simply extends terminating Phases without causing any starting Phases to start later. This optimisation is carried out by clicking 'Find Spare Green' in the Interstage View toolbar.
- **Full Optimisation**. This much more sophisticated method optimises the Interstage to ensure critical terminating and starting Phases have the minimum separation, usually equal to their Intergreen, between them.

Interstage Optimisation

Interstage optimisation is run by clicking 'Optimise' in the Interstage View's toolbar. It is important to setup a Critical Phase order before running the optimiser. The diagrams below shows the same Interstage before and after it has been optimised by adding a two second Phase Delay to Phase A. Even though the Interstage is longer it is more efficient as the separation of Phases A and D has been reduced to the minimum possible. In this case the IGA Phase E is also extended as it terminates when it's associated Phase A terminates.



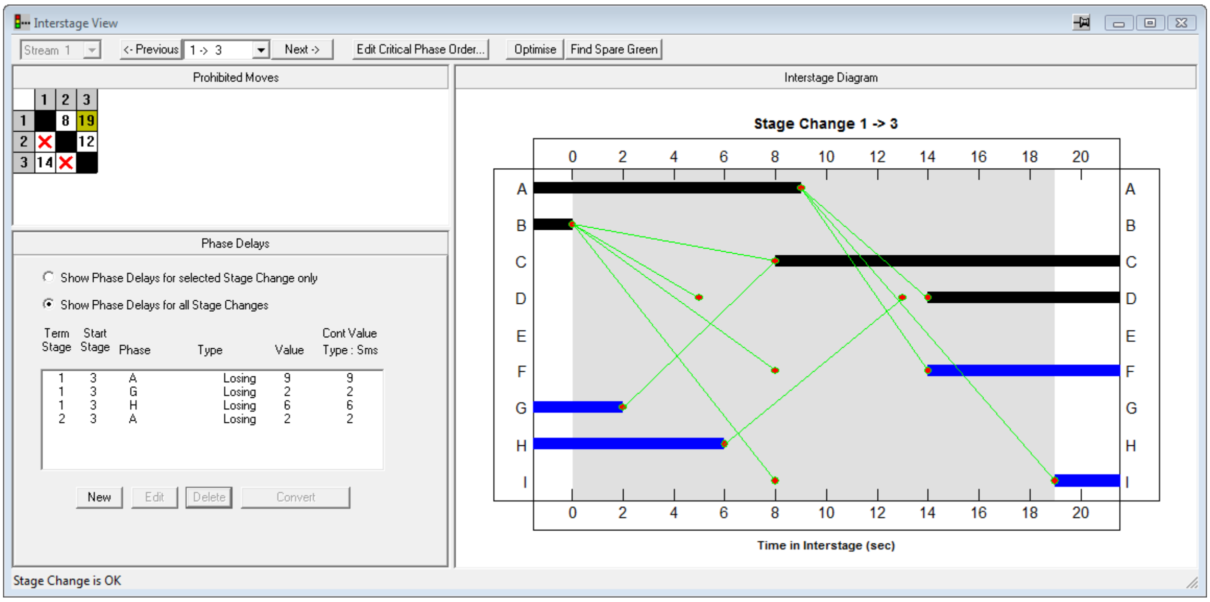
Before Interstage Optimisation



After Interstage Optimisation

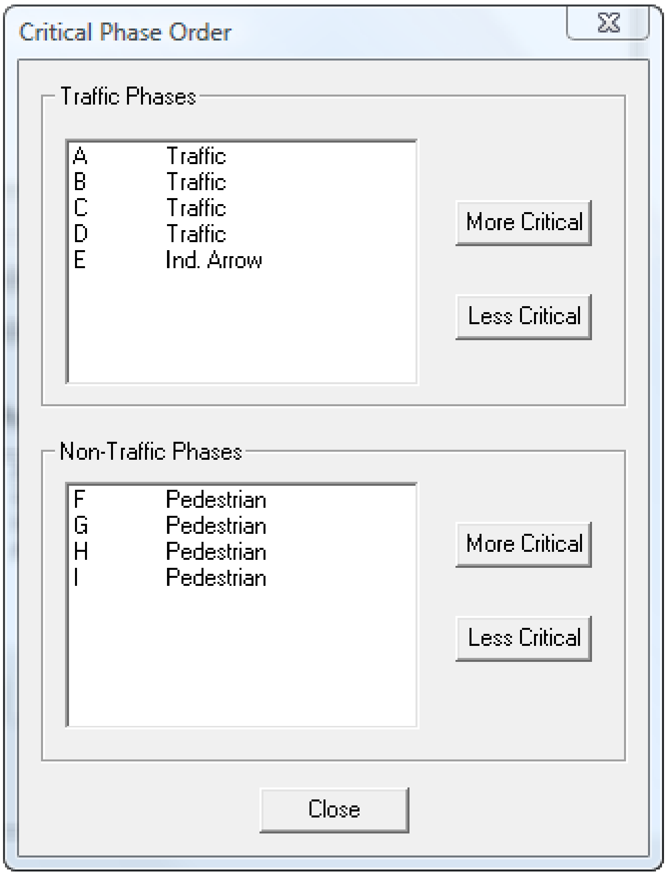
Overlapping Phases in Interstage

Where Interstages allow terminating and starting Phases to overlap LinSig will only optimise the Interstage up to the point the Phases would overlap. A design decision is required whether to overlap the Phases in the Interstage or whether to create a new Stage based on the overlapping Phases. The diagram below shows a different Interstage with Phases A and C overlapping.



Setting the Critical Phase Order for Interstage Optimisation

The Critical Phase Order for Interstage Optimisation is set using the Critical Phase Order dialog box which is opened by clicking 'Edit Critical Phase Order…' on the Interstage View toolbar. The Critical Phase order governs the priority with which LinSig optimises the separation of terminating and starting Phases.



Phases are ordered in two separate lists: Traffic Phases and non-traffic Phases. Traffic Phases are always treated as higher priority than all non-traffic Phases.

To change the order of Phases select a Phase in either list, and use the 'More Critical' and 'Less Critical' buttons to adjust its position.

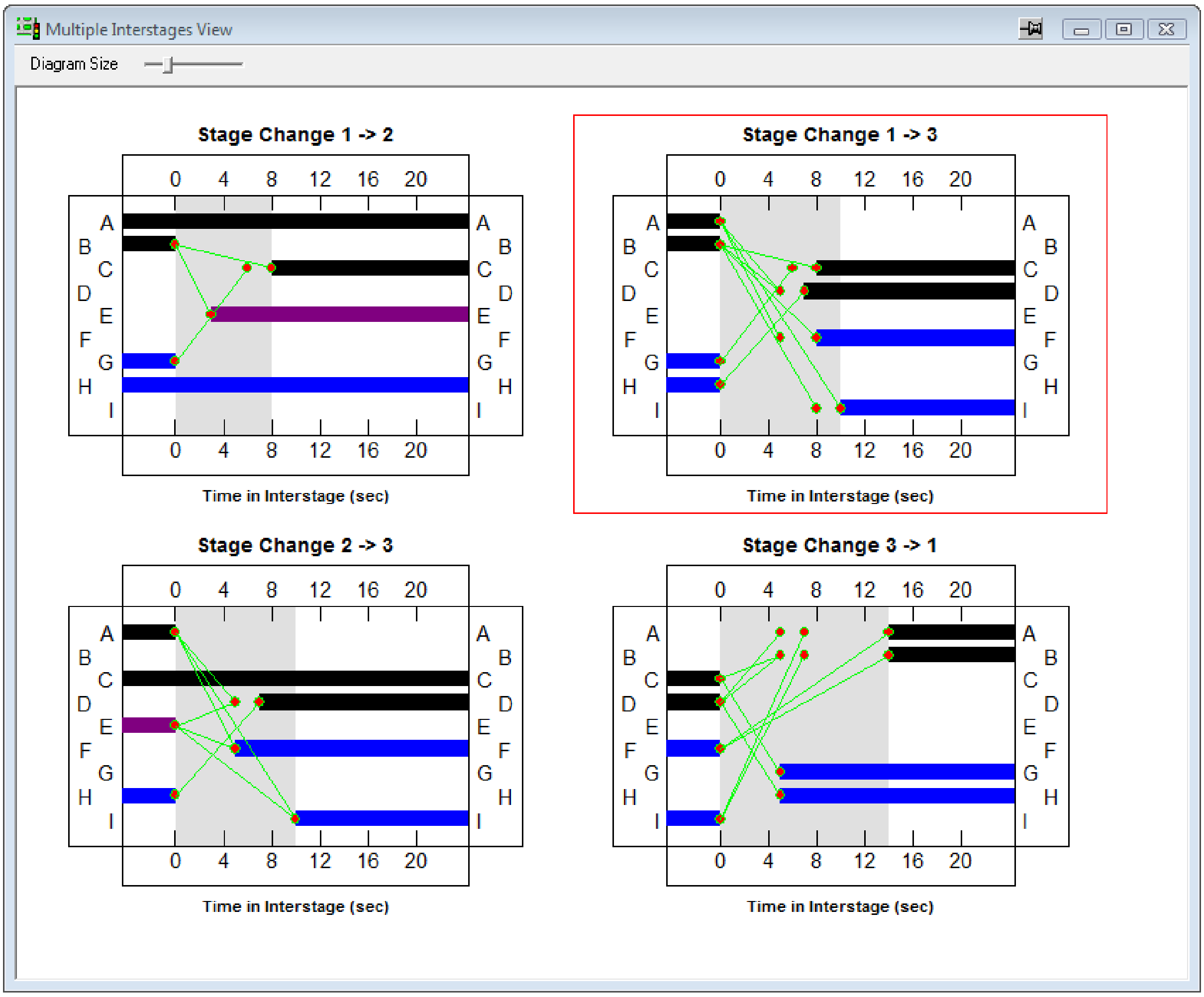
4.17.2.5. Checking of Interstages for Safety Issues

Interstages should always be checked by a competent engineer as badly designed Interstages can have safety implications. LinSig optimises Interstages solely from the point of view of efficiency. The subjective assessment of whether an Interstage is safe should always be done by an engineer. That is why there is deliberately no 'Optimise All Interstages' button in LinSig – It is far better practice to optimise each Interstage in turn reviewing its safety as you proceed.

4.18. Multiple Interstages View

The Multiple Interstages View is similar to the Interstage Structure Diagram displayed in the Interstage & Phase Delays View. The key difference is that the Multiple Interstage View displays a number of Interstage Diagrams. This allows the Interstages be printed as a set which is useful for reference when undertaking signal controller Factory Acceptance Tests (FAT).

Although the Multiple Interstage View is primarily intended for printing purposes many of the Interstage Views features such as Phase Delay adjustment and Interstage optimisation can also be carried out in the Multiple Interstage View.



4.18.1.1. Adding Interstage Diagrams

Interstage Diagrams are added to the Multiple Interstage View by right-clicking on the View and choosing ‘Add Interstage Diagram…’ from the pop-up menu. LinSig will ask which Interstage to add before displaying the Interstage Diagram in the View.

Choosing ‘Show all Allowed Interstage Diagrams’, adds all non-prohibited Interstages in one step.

4.18.1.2. Deleting an Interstage Diagram

To delete an Interstage Diagram, right-click the diagram with the mouse and choose ‘Delete Interstage Diagram’ from the pop-up menu.

4.18.1.3. Repositioning Interstage Diagrams

Interstage Diagrams can be repositioned in the View by selecting a Diagram with the mouse and dragging it to a new position. The new position will be indicated by a red insertion line.

4.18.1.4. Adjusting the size of Interstage Diagrams

The ‘Diagram Size’ slider on the Multiple Interstage View toolbar can be used to adjust the screen display size of Interstage Diagrams.

4.18.1.5. Adjusting the Interstage Diagrams Time Axis Scaling

The scaling of the Interstage Diagrams’ time axis can be changed by double clicking on the time axis of any Interstage Diagram. This allows the time axis width and tick interval to be adjusted.

4.18.1.6. Printing the Interstage Diagrams

The Interstage Diagrams can be printed by choosing ‘Print’ or ‘Print Preview’ from the File menu. This will display the Print Options dialog box which allows the layout of Interstage Diagrams on the printed page to be set. LinSig will then use the order of Interstage Diagrams in the Multiple Interstage View to determine the position of each Diagram on the printed page.

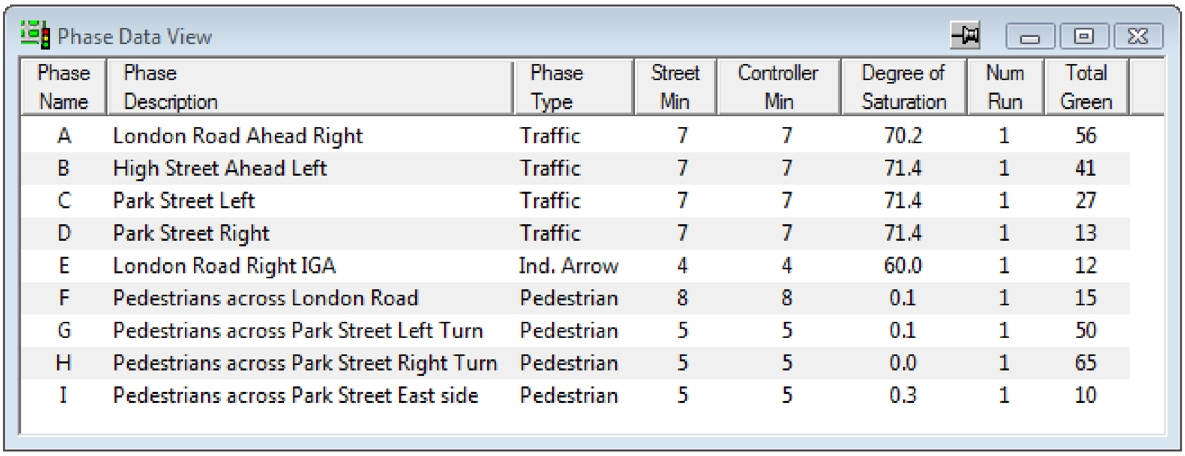
More information on Printing and setting general Print options is available in the ‘General View Features’ section.

4.18.1.7. Exporting the Interstage Diagrams to Graphics Software

The Interstage Diagrams can be exported to other graphics software either as a Windows Metafile or in DXF format which can be imported into most Cad software. Further details are given in the ‘General View Features’ section.

4.19. Phase Data View

The Phase Data View shows information for each Phase on a single LinSig Controller in a tabular format. The View can be opened by choosing ‘Phase Data View’ from the Controllers menu.



Phase Name	Phase Description	Phase Type	Street Min	Controller Min	Degree of Saturation	Num Run	Total Green
A	London Road Ahead Right	Traffic	7	7	70.2	1	56
B	High Street Ahead Left	Traffic	7	7	71.4	1	41
C	Park Street Left	Traffic	7	7	71.4	1	27
D	Park Street Right	Traffic	7	7	71.4	1	13
E	London Road Right IGA	Ind. Arrow	4	4	60.0	1	12
F	Pedestrians across London Road	Pedestrian	8	8	0.1	1	15
G	Pedestrians across Park Street Left Turn	Pedestrian	5	5	0.1	1	50
H	Pedestrians across Park Street Right Turn	Pedestrian	5	5	0.0	1	65
I	Pedestrians across Park Street East side	Pedestrian	5	5	0.3	1	10

The Phase Data View shows information on all of the Phases on a single Controller. Which Controller is displayed is selected using the Controller Selector drop down list on the View’s title bar as described in the Phase View section.

The Phase Data View shows the following information for each Phase:

- **The Phase Letter.**
- **The Phase Description.** This is automatically generated by LinSig using information from the Lanes controlled by this Phase.
- **The Phase Type.** The different Phase Types are explained in the Phase View section.
- **The Street Minimum.** This shows the Street Minimum value for this Phase. This is only applicable if the 'Treat Phase Minimums as Street Minimums' option is chosen in the Controller Information Dialog. If not LinSig only uses Controller Minimums and Streets Minimums are not relevant.
- **The Controller Minimum.** This Shows the Controller Minimum value for this Phase. See 'Phase Minimums' in the Technical Reference for more detailed information on Phase Minimums. The Controller Minimum can be derived in two ways:
    - If the 'Treat Phase Minimums as Controller Minimums' option is chosen in the Edit Controller Dialog the Controller Minimum is taken as the Phase Minimum Value set for the Phase.
    - If the 'Treat Phase Minimums as Street Minimums' option is chosen the Controller Minimum is calculated from the supplied Street Minimum.
- **The Degree of Saturation.** The Degree of Saturation of the worst Lane controlled by the Phase.
- **The Number of Run**s. This shows the number of times this Phase runs each cycle in the current Network Control Plan’s Stage Sequence for this Controller.
- **The Total Green Time.** This shows the total time this Phase is green each cycle.

The Phase Data View is for display purposes only and is not used to edit Phases. All Phase Editing is carried out in the Phase View.

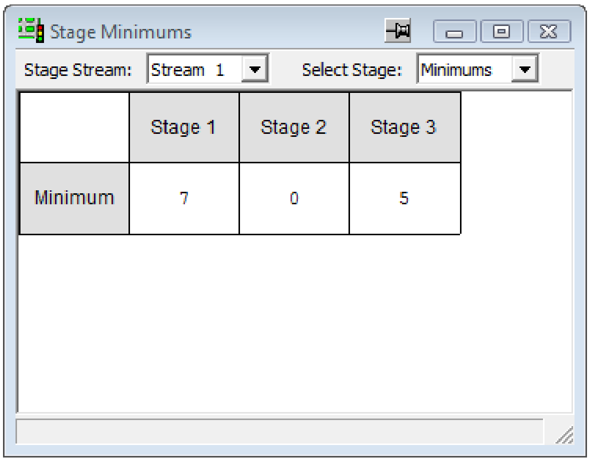
4.20. Stage Minimums View

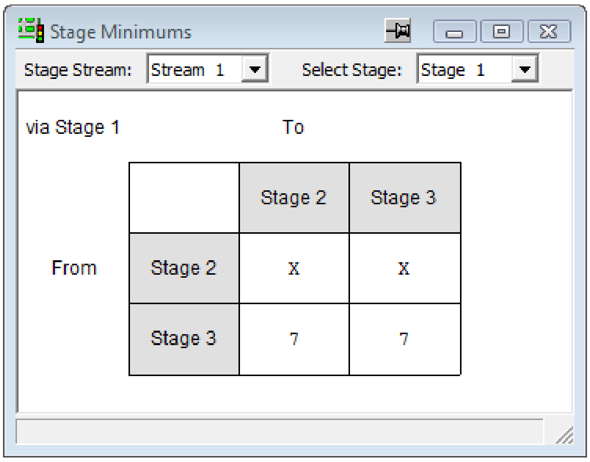
The Stage Minimums View provides a detailed analysis of the Stage Minimum times for all possible Stage orders on a Controller. The way Stage minimums differ for different stage orders, especially the minimum possible value of Stage Minimum for all stage orders, is important when configuring parameters for fault monitoring and UTC systems.

The Stage Minimums View can be opened by choosing ‘Stage Minimums View’ from the Controllers menu. The Controller for which the Stage Minimums View displays information can be selected using the Controller Selector drop down list on the View’s title bar, as described in the Phase View section. The information shown is for the current Stage Stream which can be changed if necessary in the View’s toolbar.

The Stage Minimums View has two main displays as shown below. These are:

- **The Stage Minimum Matrix.** This shows the Stage minimums for a Stage for all possible 3-Stage sequences of preceding and succeeding Stages.
- **The Minimum Stage Minimums Summary.** This shows a summary of the Minimum possible Stage Minimum when considering all possible Stage orders.





4.20.1.1. The Stage Minimum Matrix

LinSig shows a Stage Minimum Matrix for each Stage in the Current Stage Stream. As Stage Minimums are calculated from Phase Minimums a Stage’s minimum may be different depending on the Stages running before and after it. The Stage Minimum Matrix shows the Stage Minimum for the subject Stage for all combinations of preceding and succeeding Stages, allowing the spread of minimums to be ascertained.

For example, for Stage 1 LinSig will calculate the Stage Minimums for Stage 1 in the sequences 3-1-2 and 3-1-3. Normally sequences 2-1-2 and 2-1-3 would also be considered but the Stage change 2-1 is prohibited in this example.

4.20.1.2. The Minimum Stage Minimums Summary

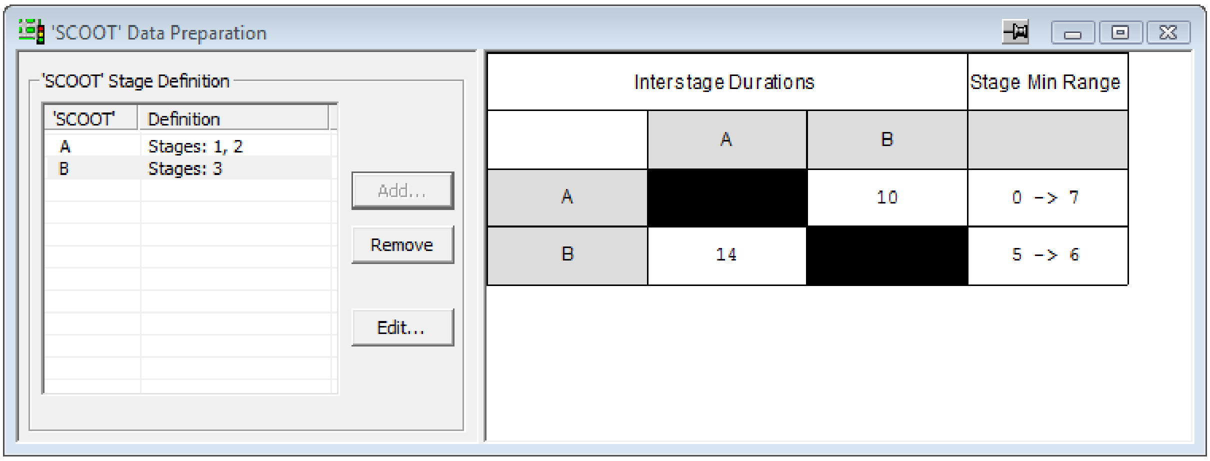
The Minimum Stage Minimums Summary summarises the different Stage Minimum Matrices by showing the Minimum Stage Minimum for each Stage. This is useful when configuring fault monitoring and UTC systems.

4.21. SCOOT Data Preparation View

The SCOOT Data Preparation View assists with calculating a range of data useful in preparing SCOOT and UTC databases.

The View can be opened by choosing ‘SCOOT Data Preparation View’ from the Controllers menu. The Controller for which the View displays information can be selected using the Controller Selector drop down list on the SCOOT Data Preparation View’s title bar, as described in the Phase View section.

If multiple Stage Streams are being used the View displays information for the current Stage Stream. This can be changed either by selecting a new Stage Stream in the main toolbar or by changing the current Stage Stream in the Phase, Stage or Signal Timings View.



The SCOOT Data Preparation View consists of two main components. These are:

- **The SCOOT Stage Definition List.** This allows SCOOT Stages to be defined as either sets of alternative Controller Stages or as Controller Phases.
- **The Interstage and Minimums Results Matrix.** This displays a SCOOT Interstage matrix and SCOOT Stage Minimum matrix.

4.21.1.1. The SCOOT Stage Definition List

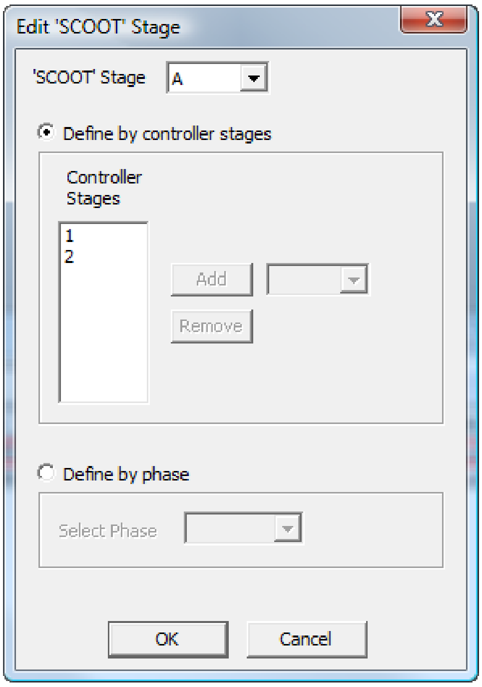
The SCOOT Stage Definition List lists currently defined SCOOT Stages.

Adding a new SCOOT Stage

To add a new SCOOT Stage click ‘Add…’ to the right of the SCOOT Stage Definition List. This will create a new SCOOT Stage and display the Edit SCOOT Stage dialog box for the Stage. This can then be used as described below to set up the SCOOT Stage.

Editing SCOOT Stages

To Edit a SCOOT Stage, select it in the SCOOT Stage Definition List and click 'Edit…' to the right of the List. This will open the Edit SCOOT Stage dialog box as shown below.



The Edit SCOOT Dialog box allows the following settings to be edited:

- **The SCOOT Stage Name**. The name of the SCOOT Stage being added or edited. Generally SCOOT Stages are represented by letters unlike controller Stages which are numbered.
- **The Controller Stages defining the SCOOT Stage.** SCOOT Stages can have one or more alternative Controller Stages allocated to them. For example, although SCOOT will always run Stage A the Controller may be running either Stage 1 or 2 during this period. To add a Controller Stage to the SCOOT Stage select a Controller Stage from the drop down list and click 'Add'.
- **The Phase defining the SCOOT Stage.** Some SCOOT systems allow SCOOT Stages to be defined in terms of Controller Phases rather than Controller Stages, the SCOOT Stage being deemed to run from the start to the end of the Phase. To define a SCOOT Stage as a Controller Phase, choose 'Define by Phase' and select the Controller Phase from the drop-down list.

When the SCOOT Stage is correctly defined click OK to close the Edit SCOOT Stage dialog box and apply any changes to the SCOOT Stage. Clicking Cancel will discard any changes made in the Edit SCOOT dialog box, or if adding a new SCOOT Stage discards the Stage.

4.21.1.2. The Interstage and Minimums Results Matrix

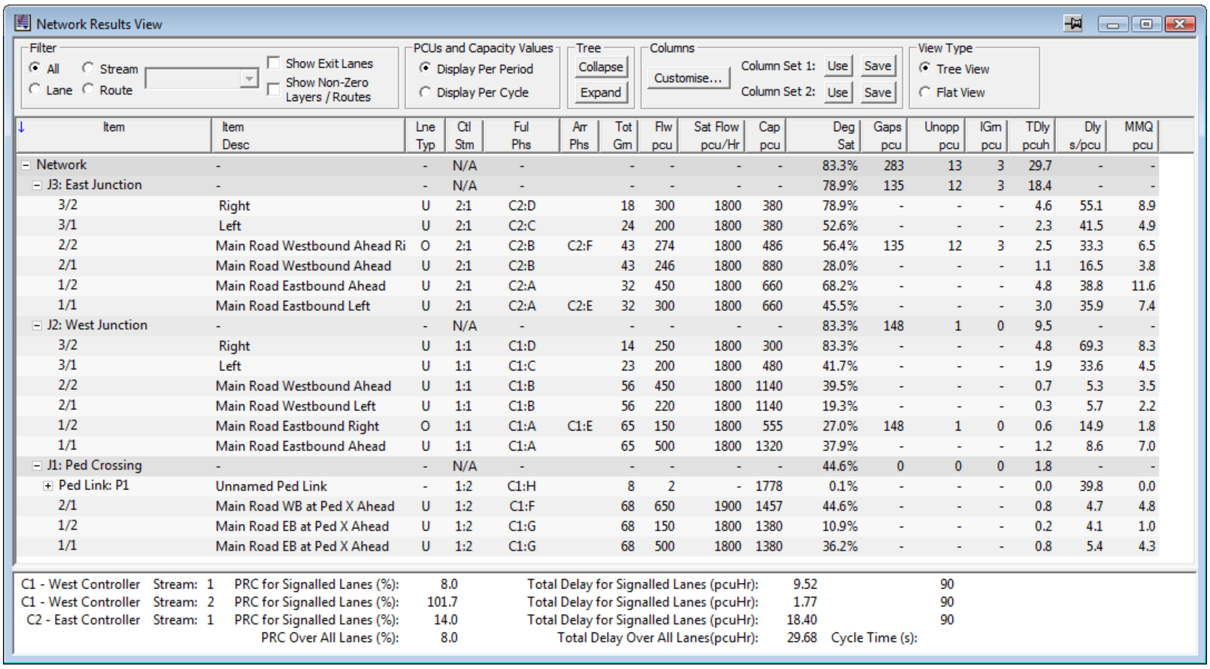
The Interstage and Minimums Results Matrix displays the following:

- **A SCOOT Interstage Matrix.** This shows the range of values the Interstage between two SCOOT Stages may take. This is calculated from the range of Controller Interstages occurring when different alternative Controller Stages or Phases are used for the SCOOT Stage.
- **A SCOOT Stage Minimums Table.** This shows the range of SCOOT Stage minimums which can occur for a SCOOT Stage taking into account the different Controller Stages or Phases which can be represented by the SCOOT Stage.

4.22. Network Results View

The Network Results View displays a range of detailed performance statistics and data for the Network and Network items such as Junctions, Lanes, and Pedestrian Links. The View can be opened by choosing ‘Network Results View’ from the Modelling menu.

The figure below shows an example of the Network Results View showing a selection of data items. Results are always shown for the currently selected Scenario as shown in the Scenario View or main toolbar.



Item	Item Desc	Lne Typ	Ctl Stm	Ful Phs	Arr Phs	Tot Grn	Flw pcu	Sat Flow pcu/Hr	Cap pcu	Deg Sat	Gaps pcu	Unopp pcu	IGrn pcu	TDly pcuh	Dly s/pcu	MMQ pcu
Network	-	-	N/A	-		-	-	-	-	83.3%	283	13	3	29.7	-	-
J3: East Junction	-	-	N/A	-		-	-	-	-	78.9%	135	12	3	18.4	-	-
3/2	Right	U	2:1	C2:D		18	300	1800	380	78.9%	-	-	-	4.6	55.1	8.9
3/1	Left	U	2:1	C2:C		24	200	1800	380	52.6%	-	-	-	2.3	41.5	4.9
2/2	Main Road Westbound Ahead Ri	O	2:1	C2:B	C2:F	43	274	1800	486	56.4%	135	12	3	2.5	33.3	6.5
2/1	Main Road Westbound Ahead	U	2:1	C2:B		43	246	1800	880	28.0%	-	-	-	1.1	16.5	3.8
1/2	Main Road Eastbound Ahead	U	2:1	C2:A		32	450	1800	660	68.2%	-	-	-	4.8	38.8	11.6
1/1	Main Road Eastbound Left	U	2:1	C2:A	C2:E	32	300	1800	660	45.5%	-	-	-	3.0	35.9	7.4
J2: West Junction	-	-	N/A	-		-	-	-	-	83.3%	148	1	0	9.5	-	-
3/2	Right	U	1:1	C1:D		14	250	1800	300	83.3%	-	-	-	4.8	69.3	8.3
3/1	Left	U	1:1	C1:C		23	200	1800	480	41.7%	-	-	-	1.9	33.6	4.5
2/2	Main Road Westbound Ahead	U	1:1	C1:B		56	450	1800	1140	39.5%	-	-	-	0.7	5.3	3.5
2/1	Main Road Westbound Left	U	1:1	C1:B		56	220	1800	1140	19.3%	-	-	-	0.3	5.7	2.2
1/2	Main Road Eastbound Right	O	1:1	C1:A	C1:E	65	150	1800	555	27.0%	148	1	0	0.6	14.9	1.8
1/1	Main Road Eastbound Ahead	U	1:1	C1:A		65	500	1800	1320	37.9%	-	-	-	1.2	8.6	7.0
J1: Ped Crossing	-	-	N/A	-		-	-	-	-	44.6%	0	0	0	1.8	-	-
Ped Link: P1	Unnamed Ped Link	-	1:2	C1:H		8	2	-	1778	0.1%	-	-	-	0.0	39.8	0.0
2/1	Main Road WB at Ped X Ahead	U	1:2	C1:F		68	650	1900	1457	44.6%	-	-	-	0.8	4.7	4.8
1/2	Main Road EB at Ped X Ahead	U	1:2	C1:G		68	150	1800	1380	10.9%	-	-	-	0.2	4.1	1.0
1/1	Main Road EB at Ped X Ahead	U	1:2	C1:G		68	500	1800	1380	36.2%	-	-	-	0.8	5.4	4.3

C1 - West Controller	Stream: 1	PRC for Signalled Lanes (%):	8.0	Total Delay for Signalled Lanes (pcuHr):	9.52	90
C1 - West Controller	Stream: 2	PRC for Signalled Lanes (%):	101.7	Total Delay for Signalled Lanes (pcuHr):	1.77	90
C2 - East Controller	Stream: 1	PRC for Signalled Lanes (%):	14.0	Total Delay for Signalled Lanes (pcuHr):	18.40	90
		PRC Over All Lanes (%):	8.0	Total Delay Over All Lanes(pcuHr):	29.68	Cycle Time (s):

The Network Results View is divided into three main areas. These are:

- **Display Settings.** This allows settings to be made governing the way the Network Results View displays the results.
- **The Results List.** This lists each Item for which data can be displayed showing a range of relevant data columns for each Item. The list is a hierarchal list allowing which Items are to be displayed and the level of detail to show to be easily controlled. The following Items can be shown in the list:
  - **Network.** Aggregate performance statistics for the entire Network.
  - **Junctions.** Aggregate Performance statistics for each Junction.
  - **Lanes.** Performance statistics for individual signal or give-way controlled traffic Lanes. Short Lanes are shown grouped with their associated Long Lane. Lanes can be further broken down to show Route Layers.
  - **Pedestrian Links.** Performance statistics for individual Pedestrian Links. Pedestrian Links can be further broken down by direction of movement.

  Each item can be expanded and collapsed as appropriate to manage the amount of information shown. How many and which data columns are displayed are also fully customisable.
- **The Network Summary.** This includes a summary of the performance of each Stage Stream and of the Network as a whole.

4.22.1.1. Display Settings

The Network Results View Display Settings control which results are shown and how they are displayed.

Results Filter

The Results Filter allows the Results List to be filtered by a range of criteria to reduce the amount of information shown. The filter criteria are:

- **All.** Shows all the available Lanes or other Items.
- **Stream.** Shows all the Lanes or other Items controlled by a specified Stage Stream.
- **Lane.** Shows all the Routes passing through a specified Lane.
- **Route.** Shows all the Lanes along a specified Route.
- **Show Exit Lanes.** If 'Show Exit Lanes' is un-ticked the Network Results View omits Exit Lanes from the Results List.
- **Show Non-Zero Layers/Routes.** Routes/Layers break down the results on each Lane to give the delays or other statistics for each individual Route or Lane based Flow Layer passing through a Lane. Often this level of detail isn't required and the 'Show Non-Zero Layers/Routes' option can be un-ticked simplifying the Network Results View.

PCU and Capacity Values

The 'PCU and Capacity Values' setting controls whether results are shown for the whole modelled time period or for a typical cycle within the modelled time period. The columns affected by this setting are:

- **Demand Flow**
- **Capacity**
- **Flow Entering Lane**
- **Flow Leaving Lane**
- **Right Turners in Gaps**
- **Right Turners in Interstage**
- **Right Turners When Unopposed**
- **Uniform Stops**

Results which are expressed as a *rate*, for example flow or delay per hour, are not affected by this setting.

Column Sets

The Network Results View provides many columns of results of which only a proportion need to be displayed at any one time depending on the level of detail required. As it is common to need to view different levels of detail in the Network at different times the Network Results View allows two standard sets of displayed columns to be defined. These can then be recalled at any time without having to reselect each individual column to be displayed or hidden.

Defining a Column Set

A column set can be defined by selecting the columns for display as detailed below and clicking 'save' next to one of the column sets.

Displaying a Column Set

A Column Set can be displayed by clicking on ‘Use’ next to one of the Column Sets.

View Type

The View Type allows the Network Results View to be displayed as a hierarchal Tree View (the default) or as a Flat View showing all Lanes at one level. The Flat View is primarily to allow all Lanes to be sorted by one column, for example Degree of Saturation, irrespective of its parent Junction.

4.22.1.2. The Results List

The Results List displays numerical data and results for the items selected using the Route Filter. The Results List is hierarchal allowing the amount of information displayed to be managed by expanding or collapsing sections of the list to display more or less information.

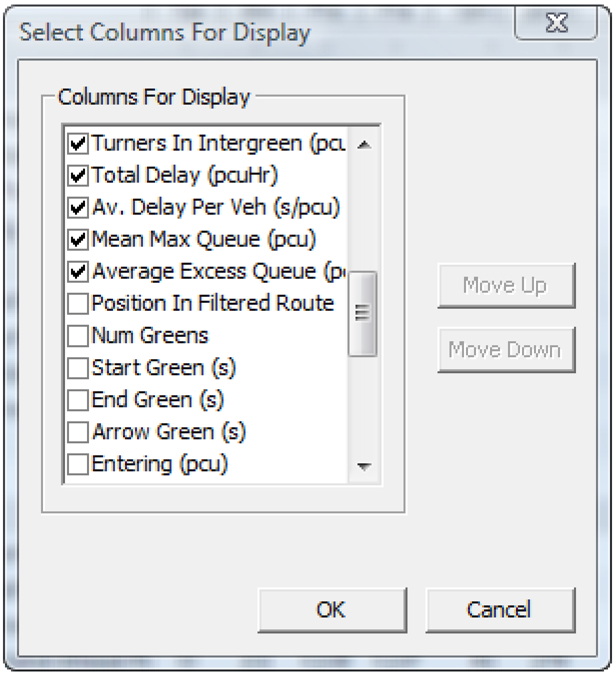
Expanding and Collapsing the Results List

Items on the results list can be expanded or collapsed by clicking on the + or – adjacent to each item. The List adjusts the number of columns displayed so that only relevant columns are displayed when the list is fully or partially collapsed.

Customising the Data Columns Displayed

The Results List can be customised by adding or removing columns from the Results List. The columns shown can be changed as follows:

- Right Click on the Results List column headings and choose ‘Customise’ from the pop-up menu. The Select Columns dialog box will be opened.



- Tick or Un-tick columns in the Select Columns dialog box as appropriate.
- Select a column and click ‘Move Up’ or ‘Move Down’ to change the order of columns.
- Click OK to finish customising the columns.

After the columns have been customised the set of columns can be saved as described above so they can be quickly redisplayed if any changes are made to columns.

If necessary columns can be reset to default selection and order by right clicking on the column headers and choosing ‘Reset to Default’.

Show Full or Abbreviated Columns Heading

LinSig can show either full or abbreviated headings for each column show in the Results List. The full headings provide a clearer explanation of what each column shows but take up a lot of space. The abbreviated headings are much more concise but can also be a little cryptic for new users. It is suggested that abbreviated headings are used most of the time switching to full headings if you aren't sure what a column is.

To switch between full and abbreviated headings Right Click on the Results List column headings and choose 'Show Full Headings' or 'Show Abbreviated Headings' from the pop-up menu.

Available Data Columns in the Network Results View

The Data Columns available are:

- **Item.** The number or name of the Lane or other Item for which results are being shown.
- **Item Description.** A longer name or description of the Item.
- **Lane Type.** The Type of the Lane. Lane Types are 'U' for unopposed Lanes and 'O' for a Give-Way Lane which is opposed.
- **Controller/Stream.** The number of the Controller & Stage Stream controlling this Lane in the format 'Controller : Stage Stream'.
- **Route Position.** The sequential position of a Lane along a Route when Lane Results are filtered to display Lanes along a single Route. Shown as 'N/A' when Lanes are not filtered by Route.
- **Full Phase.** The Full Green Traffic Phase Controlling a Lane. All signal-controlled Lanes will have a Full Green Phase.
- **Arrow Phase.** The Arrow Phase Controlling a Lane. Arrow Phases will only ever be Filter or Indicative Arrow Phases.
- **Number of Greens.** The number of green periods for the Lane per cycle.
- **Total Green (sec).** The total time the Lane receives a green signal per cycle.
- **Start Green (sec).** The time within the cycle when the Lane receives a green signal.
- **End Green (sec).** The time within the cycle when the Lane loses its green signal.
- **Arrow Green (sec).** The time an opposed Lane receives a green arrow signal per cycle. This is only applicable for Lanes controlled by an Indicative Green Arrow or Filter Phase.
- **Bonus Green.** Indicates whether Bonus Greens are present on the Lane.
- **Demand Flow (PCU).** The total Traffic Flow in the current Flow Group wishing to travel on the Lane. The Demand Flow assumes all traffic reaches the Lane and does not reduce the Flow on the Lane where upstream Lanes are overcapacity and hold back traffic.
- **Saturation Flow (PCU/hr).** The Saturation Flow on the Lane.
- **Capacity (PCU).** The Capacity of the Lane is the amount of traffic which can exit the Lane assuming infinite arriving traffic flows in the same turning proportions as the arriving demand traffic flows.
- **Degree of Saturation (%).** The Degree of Saturation of the Lane. This is defined as the ratio of Flow to Capacity for the Lane.

- **Entering Flow (PCU).** The total traffic flow entering the Lane from upstream Lanes. This may be lower than the Demand Flow if traffic is held up on upstream oversaturated Lanes.
- **Leaving Flow (PCU).** The total traffic flow leaving the Lane. This may be lower than the Entering Flow if the Lane is oversaturated.
- **Turners in Gaps (PCU).** The total flow exiting a Give-Way Lane during gaps in the opposing traffic.
- **Turners When Unopposed (PCU).** The total turning flow turning during a Give-Way-Lane's unopposed period, normally when an indicative green arrow is controlling the Lane.
- **Turners in Intergreen (PCU).** The flow leaving a Give-Way Lane during the Intergreen.
- **Uniform Delay (PCUHr).** The total Uniform Delay suffered by traffic over the modelled time period. A more detailed description of Uniform Delay is provided in the Modelling Section.
- **Random & Oversaturation Delay (PCUHr).** The total combined Random & Oversaturation Delay suffered by traffic over the modelled time period. A more detailed description of Random & Oversaturation Delay is provided in the Modelling Section.
- **Storage Area Uniform Delay (PCUHr).** The Uniform Delay suffered by traffic in the Right Turn Storage Area in front of the stop line. This is only applicable for right turn give way Lanes.
- **Total Delay (PCUHr).** The sum of Uniform, Uniform Storage and Random & Oversaturation Delay. This is the total aggregate delay suffered by traffic using the modelled Network.
- **Average Delay per PCU (sec).** The Average Delay for each PCU on the Lane averaged over the modelled time period.
- **Uniform Stops (Stops).** The Total Uniform Stops over the modelled time period.
- **Average Stops Per PCU (Stops/PCU).** The Average number of Stops per PCU averaged over the modelled time period.
- **Back of Uniform Queue at the end of Red (PCU)**. The extent of the Uniform Queue on a Lane at the time of the end of the Lane's controlling Phase's red period. Traffic may continue to add to the back of the queue whilst the queue is clearing leading to a Maximum Back of Uniform Queue greater than the queue at the end of red. The 'Back of Uniform Queue at the end of Red' allows only for the variation of the queue within a typical cycle and does not include Random and Oversaturation queues.
- **Maximum Back of Uniform Queue (PCU).** The maximum extent of the Uniform Queue on a Lane, taking into account the effect of traffic continuing to add to the back of the queue whilst traffic is discharging from the front. The Maximum Back of Uniform Queue allows only for the variation of the queue within a typical cycle and does not include Random and Oversaturation queues.
- **Random & Oversaturation Queue (PCU).** The Random & Oversaturation Queue due to non-cyclical effects (i.e. effects which last longer than a typical cycle) over the modelled time periods. The Random & Oversaturation Queue estimates the queue which will form due to (a) some cycles randomly having more or less arrivals than the typical cycle leading to an overall net increase in queue length; and (b) the steadily

building queue over the modelled time period when the Lane is oversaturated. Further details on this topic are provided in the modelling section.

- **Mean Maximum Queue (PCU).** The Mean Maximum Queue is the sum of the Maximum Back of Uniform Queue and the Random & Oversaturation Queue. It represents the maximum queue within a typical cycle averaged over all the cycles within the modelled time period. When a Lane is oversaturated the Maximum Queue within each cycle will grow progressively over the modelled time period. This means that the Mean Maximum Queue will be approximately half the final queue at the end of the modelled time period. Please read the Modelling Section before attempting to interpret queue predictions.
- **Queue De-Sliver Threshold (PCU).** The De-Sliver Threshold displays the value entered for the Queue De-Sliver Threshold on the 'Edit Lane' dialog box's 'Advanced' tab. This is useful for indentifying Lanes on which the De-Sliver mechanism has been used. More details is given in the 'Network Layout View' Section but briefly the De-Sliver Mechanism automatically avoid long spurious queues being reported on Lanes when certain conditions occur.
- **Average Excess Queue (PCU).** The Average Excess Queue is the average amount the queue exceeds the stacking space on the Lane defined on the 'Edit Lane' dialog box's 'Advanced' tab. This is useful for monitoring how Excess Queue weightings are being applied.
- **Weighted Deg Sat (%).** The degree of saturation for the Lane after weighting for any excess queues or Lane weighting factors. This is used mainly for monitoring the optimiser.
- **Weighted Delay (PCUHr).** The total delay on the Lane after weighting for any excess queues, Lane weighting factors or use of Stops valuation. This is used mainly for monitoring the optimiser.
- **Ignoring Random Delay?** The Ignoring Random Delay column indicates if Random Delay is being ignored for the Lane.

4.22.1.3. Network Summary

The Network Summary shows summary results for the entire Network broken down by Controller and Stage Stream. The following information is shown for each Controller and/or Stage Stream:

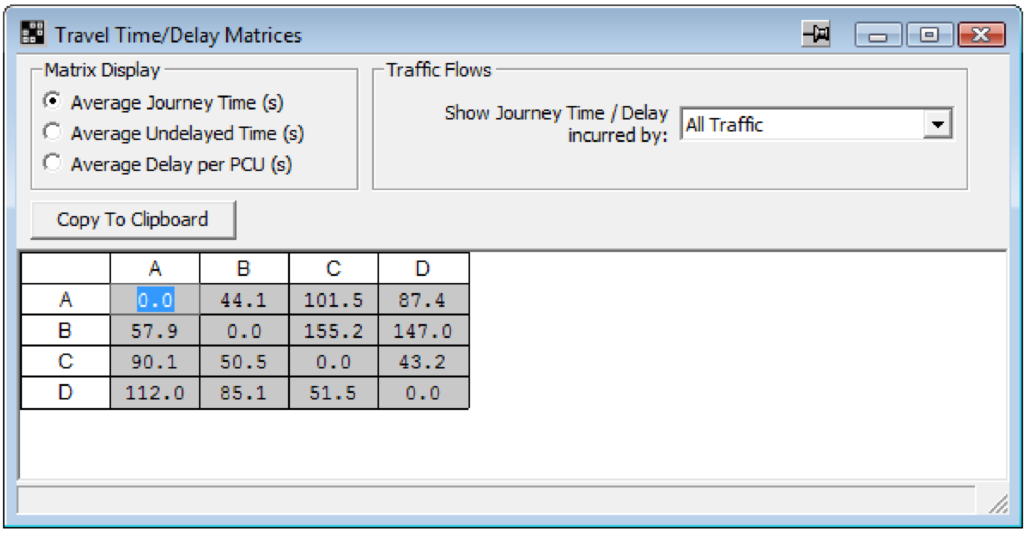
- **Practical Reserve Capacity (%).** This shows the Practical Reserve Capacity (PRC) for each Stage Stream. The PRC is calculated from the maximum degree of saturation on a Lane controlled by the Stage Stream and is a measure of how much additional traffic could pass through a junction controlled by the Stage Stream whilst maintaining a maximum degree of saturation of 90% on all Lanes.
- **Total Delay (PCUHr).** This shows the total aggregate delay on all Lanes controlled by each Stage Stream.

The following information is shown for the whole Network:

- **Total Delay for all Lanes (PCUHr).** This is the total delay for all Lanes in the Network including Exit Lanes. This may differ from the sum of the total delay for each Stream if the Exit Lane's saturation flow is set too low and leads to delay on the Exit Lanes.
- **Practical Reserve Capacity (PRC) over All Lanes.** This is the PRC calculated from the Lane with the worst Degree of Saturation in the entire Network.

4.23. Travel Time/Delay Matrix View

The Travel Time/Delay Matrix View displays a matrix of average travel time between Zones in the model. The View can be opened by choosing 'Travel Time/Delay Matrix View' from the Modelling menu.



The Travel Time Matrix shows journey times between Zones based on one of the following critera:

- **Overall Average Journey Time (s).** The average time for traffic to travel between Zones. Where more than one Route exists between the Zone LinSig weights the delay based on the traffic using each Route.
- **Average Undelayed Time (s).** The average travel time between Zones based on cruise times with no queuing delay.
- **Average Delay (s).** The average queuing delay encountered by traffic travelling between the two Zones.

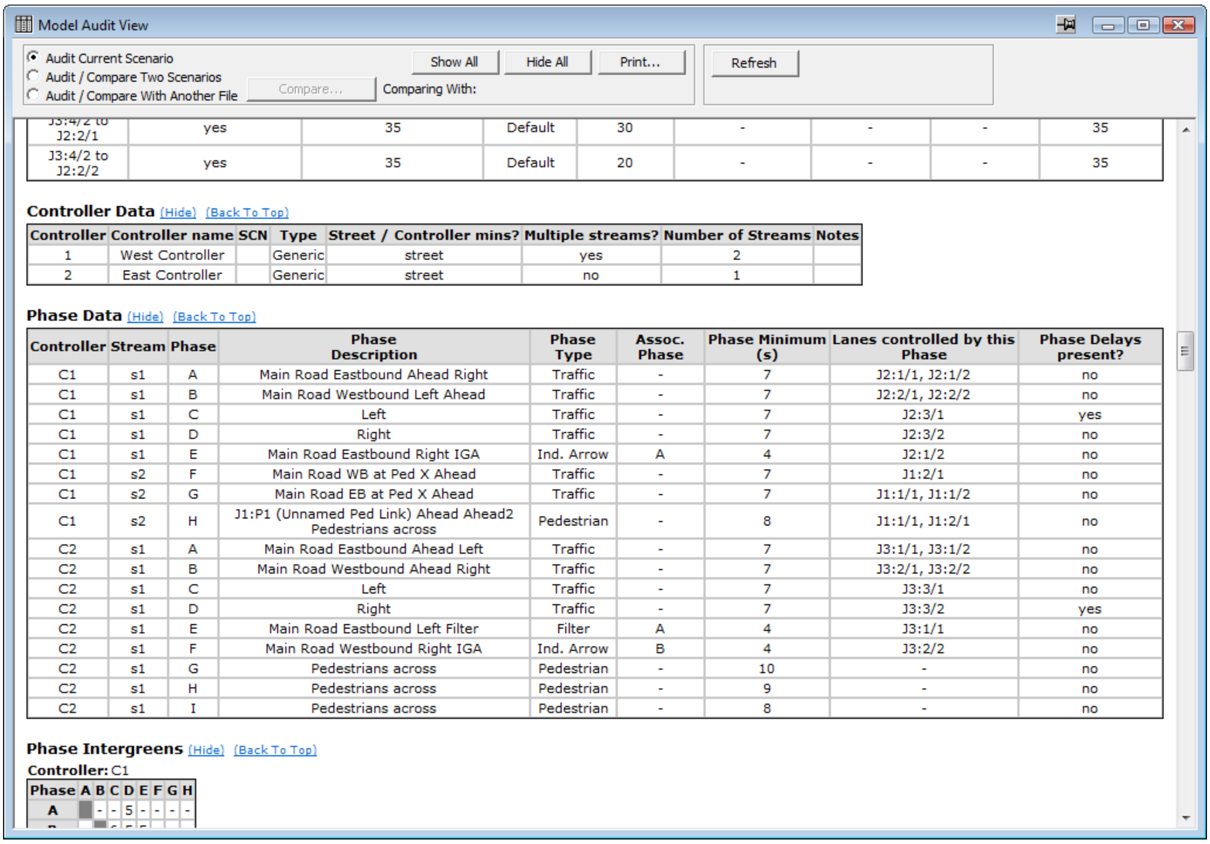
4.23.1.1. Refining the Travel Time Matrix

The time shown in the Travel Time Matrix can be further refined by choosing one of the following options:

- **All Traffic.** Displays the travel times experienced by all traffic travelling between the Zones.
- **Routed Traffic Only.** Displays the travel times experienced by traffic travelling between Zones on Routes. Delays experienced by any Lane Based Traffic are not included. This option is useful for displaying delays to buses on Bus Routes where general traffic is specified using Lane based Flows.
- **Lane Based Flow Traffic Only.** Displays the travel times experienced by Lane Based Traffic. If multiple Lane Based Flow Layers are used this option aggregates delays over all Layers.
- **Layer : 'Layer Name'.** One option will be available for each Lane Based Flow Layer in the model. Each option will display only delay on the individual Layer. This is useful for displaying travel times for a specific class of Lane Based traffic.

4.24. Model Audit View

The Model Audit View is designed to assist with checking or auditing a LinSig model. It brings together all of the important input data and results for a LinSig model and presents it in an easy to check standard format. It can also be used to compare two models by highlighting differences between two Models. The Model Audit View can be opened by choosing 'Model Audit View' from the File menu.



The Model Audit View displays:

- A toolbar which allows options to be set for the View.
- The main section showing Model input data and results tables for a single LinSig Scenario. A Contents List at the top of the Model Audit lists all of the tables displayed. Clicking on a table title in the Contents List jumps to the relevant table in the Model Audit View.

4.24.1.1. Creating a Model Audit

To create a standard Model Audit of the currently open LinSig model:

- Ensure 'Audit Current Scenario' is selected in the Model Audit View's toolbar.
- Select the Scenario which you wish to Audit in the main LinSig toolbar.
- The Model Audit View will display auditing information for the selected Scenario.

4.24.1.2. Refreshing the Model Audit View

If the LinSig model is changed in any way the Model Audit View will be out of date. The Audit View is not automatically updated each time the model changes but can be refreshed at any point by clicking ‘Refresh’ on the Model Audit View toolbar. A warning will be displayed in the Audit View toolbar whenever the View requires refreshing.

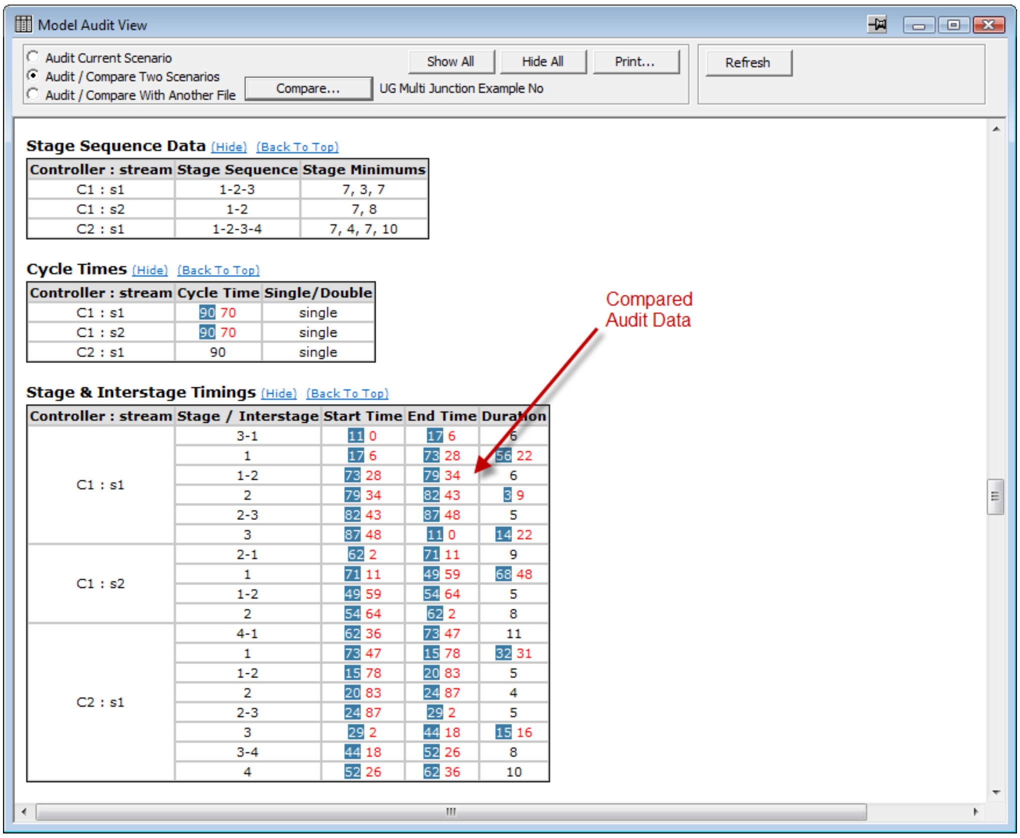
4.24.1.3. Comparing Two Scenarios

The Model Audit View can compare two LinSig Scenarios highlighting the differences between the two models. This is done intelligently rather than just comparing the text of two Model Audit Views.

To compare two Scenarios:

- Ensure the ‘Audit/Compare Two Scenarios’ option is selected in the Model Audit View toolbar.
- Click the ‘Compare’ button on the Model Audit View toolbar and select the Scenarios you are comparing.
- LinSig will display the comparison of the Scenarios in the Model Audit View. Differences between the two models will be highlighted.

Remember that the comparison is of the Model Audit information which includes all important engineering data. It does not include minor settings such as assignment or optimisation settings so an identical Model Audit Comparison means the traffic engineering behind Scenarios is the same but does not necessarily mean that they are identical.



4.24.1.4. Comparing Two LinSig Models

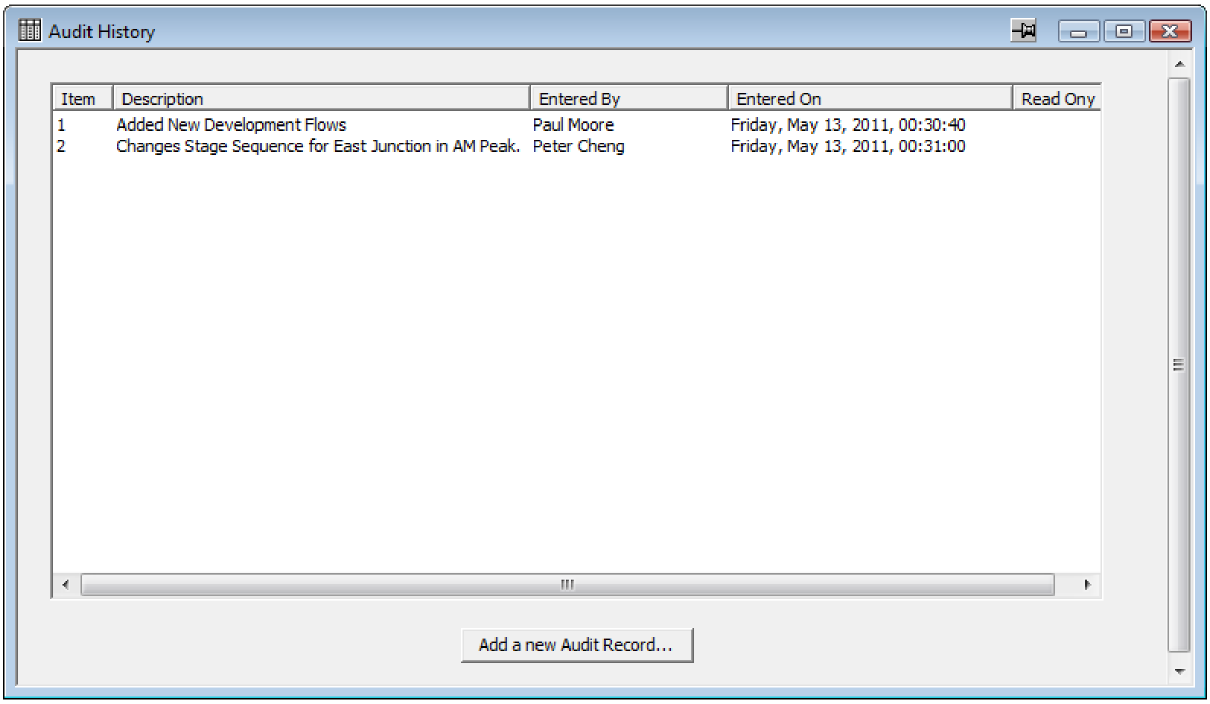
The Model Audit View can compare two LinSig models highlighting the differences between the two models. This is done intelligently rather than just comparing the text of two Model Audit Views.

To compare two LinSig Models:

- Ensure the 'Audit/Compare with another File' option is selected in the Model Audit View toolbar.
- Click the 'Compare' button on the Model Audit View toolbar and locate the LinSig file you are comparing the current model with.
- Select the Scenarios you wish to compare in the Current Model and the Comparison Model.
- LinSig will display the comparison of the Scenarios from the two files in the Model Audit View. Differences between the two models will be highlighted.
- Remember that the comparison is of the Model Audit information which includes all important engineering data. It does not include minor settings such as assignment or optimisation settings so an identical Model Audit Comparison means the traffic engineering behind Scenarios is the same but does not necessarily mean that the files are identical.

4.25. Audit History View

The Audit History View allows comments and notes to be logged in the LinSig file as a permanent record of changes to the model. The Audit History View is opened by choosing 'Audit History' on the File menu.

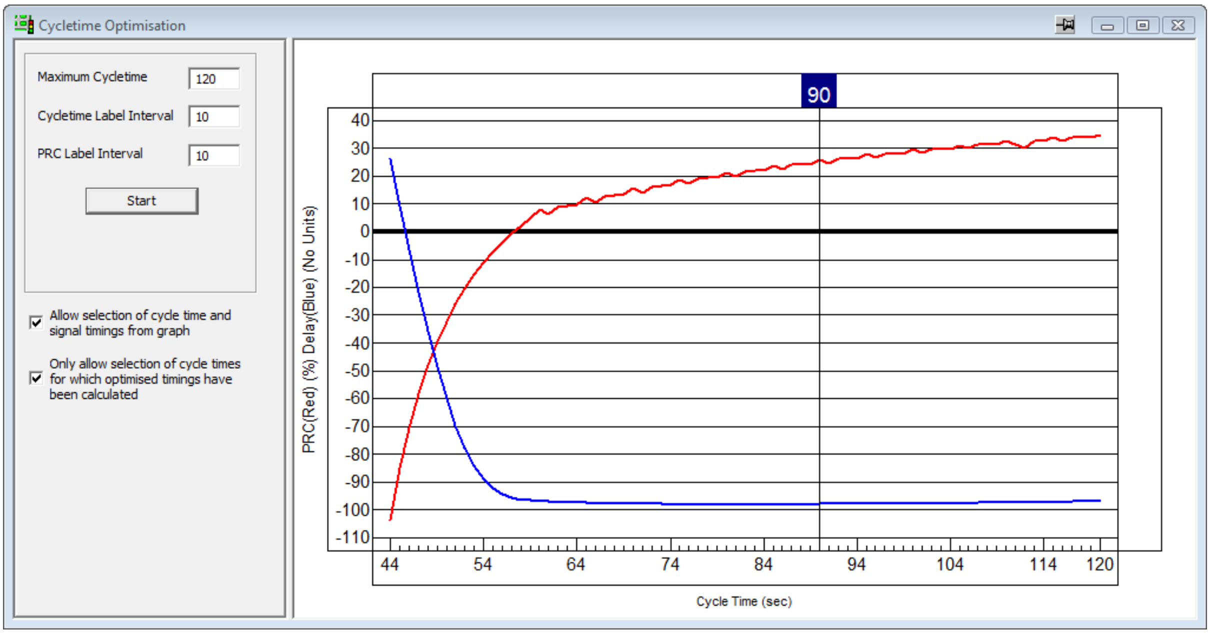


The Audit History shows a list of log entries with each log entry containing:

- **Log Item number.**
- **Log Item Description.** A text description of the log item.
- **Entered By.** The name of the person entering the log item. If a User Name has been entered in 'Network Information' on the Network menu it will be used as a default.
- **Entered On.** The date and time the log entry was made. This is automatically set from the system time when the log entry is made.
- **Read Only.** After the file has been saved Audit History Log Items are read only and cannot be deleted or changed.

4.26. Cycle Time Optimisation View

The Cycle Time Optimisation View displays a graph of Practical Reserve Capacity and Delay against the Network's cycle time. This allows the effect of cycle time on the Network to be assessed and an appropriate cycle time chosen.



4.26.1.1. Using the Cycle time Optimisation View

The Cycle Time Optimisation View displays a graph of Practical Reserve Capacity (PRC) and Network Delay for the current Scenario with optimal Stage Lengths, over a range of cycle times.

LinSig deliberately does not pick and suggest an optimal cycle time as it is far more appropriate for the engineer to decide the cycle time taking into account issues such as pedestrian safety, UTC requirements and adjacent junctions as well as the cycle time graph in the Cycle Time Optimisation View.

LinSig 3 only builds the cycle time graph when the 'Start' button is clicked. This is because the more sophisticated traffic model, the more thorough signal optimiser and the larger potential model size means that LinSig takes longer to build the cycle time curves.

The Cycle Time Optimisation View displays the following:

- **The Graph Settings.** The Graph Settings are shown in the left panel and allow the maximum cycle time to be graphed and the axis labelling to be set. The maximum cycle time should be selected carefully as having too long a cycle time can slow LinSig's calculations down significantly.
- **The Cycle time Range.** The range of cycle times is shown on the bottom axis. This range extends from the minimum cycle time for the current Staging Plan to a user defined maximum cycle time.
- **The Practical Reserve Capacity Range.** The range of Practical Reserve Capacity (PRC) is shown on the left hand axis. This range is automatically adjusted to show the full range of PRCs for the junction over the cycle time range.
- **The PRC Curve.** The red curve shows the PRC for each cycle time within the cycle time range.

- **The Total Delay Curve.** The blue curve shows the Total Delay for each cycle time in the cycle time range. The curve is shown without units as only the shape of the curve is significant in this view not the absolute values of delay. If you would like to know the absolute values of Total Delay refer to the 'Network Results View'. There is no significance to the crossing point of the PRC and delay curves.
- **The Current Cycle Time Indicator.** If the option ‘Allow Selection of Cycle Time and Signal Timings from Graph‘ is ticked a Current Cycle Time Indicator is shown at the top of the view as a dark blue rectangle containing the current cycle time. The Cycle Time Indicator can be dragged with the mouse to change the cycle time for the current Scenario.

4.26.1.2. Settings and Options

The Cycle Time Optimisation View has the following Settings and Options which control how the View works:

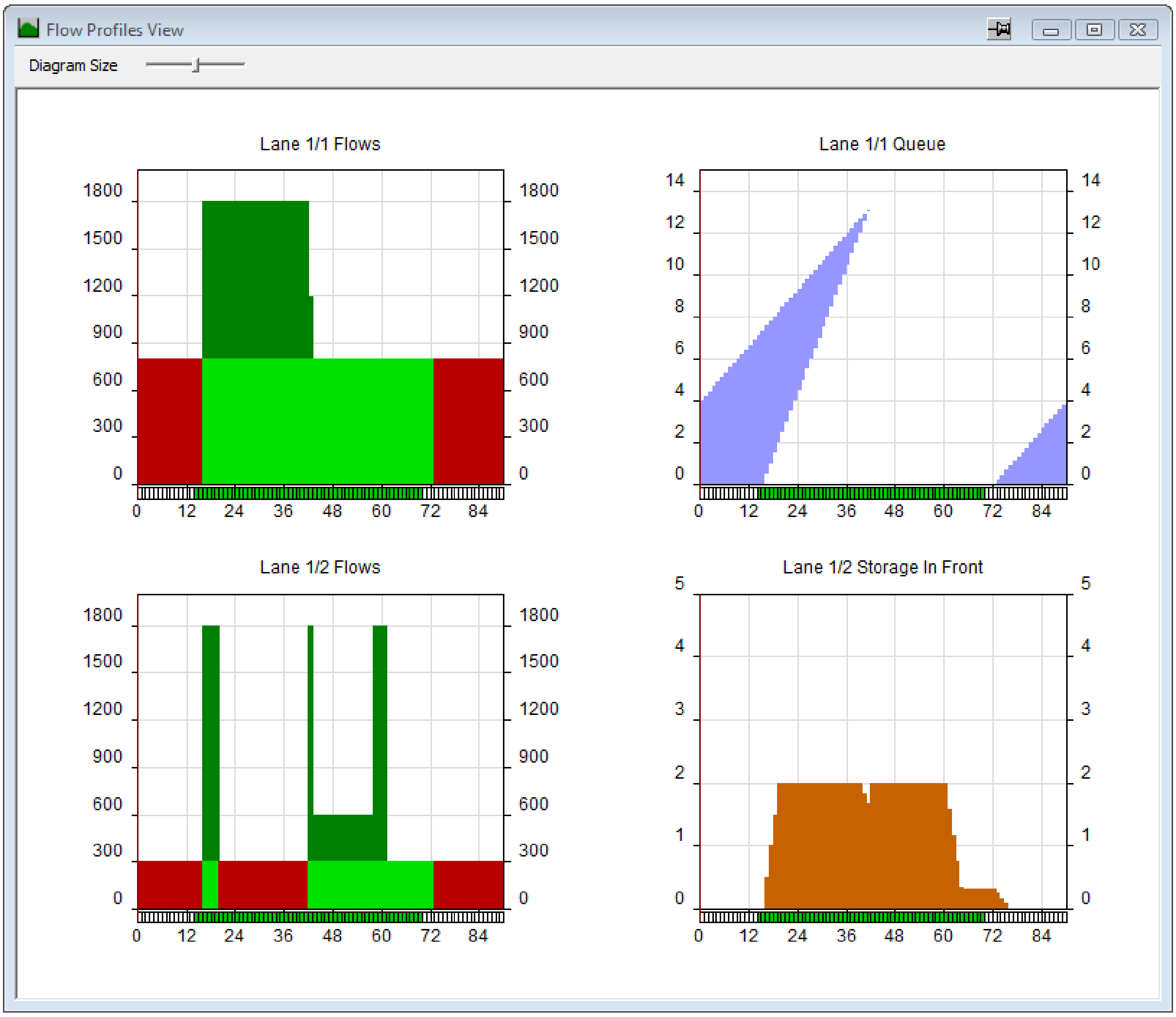
- **Allow Selection of Cycle Time and Signal Timings from Graph.** If this box is ticked the Cycle Time Optimisation View displays a cursor which can be dragged with the mouse to set the Cycle Time for the current Scenario. The Stage lengths in the current Scenario will be reset to the optimal settings for the Cycle Time if they have been calculated. If the Stage Lengths are subsequently changed in the Signal Timings View to non-optimal settings the cursor will disappear and this box will be unchecked indicating that the Scenario’s timings do not match the optimal ones for the cycle time as represented in the Cycle Time Optimisation View.
- **Only Allow Selection of Cycle Times for which Optimised Timings have been calculated.** If the calculation of the Cycle Time Optimisation View has been aborted part way through some cycle times will have been optimised and some will not. If this box is ticked LinSig will only allow the cycle time cursor to select timings which have been optimised. If the box is un-ticked all cycle times can be selected with the cursor but un-optimised cycle times will use estimated Stage Lengths instead of true optimums.

4.26.1.3. Cycle Time Optimisation for Larger Networks

The Cycle Time Optimisation View does a considerable amount of optimisation work and for a large or complex Network may take some time to run. In this case we recommend assessing Cycle Time options using several Scenarios using the same Traffic Flow Group and Network Control Plan but different cycle times. This allows better control of the number of cycle times assessed and hence optimisation time.

4.27. Cyclic Flow Profiles View

The Cyclic Flow Profiles View displays detailed Flow Profile graphs for Lanes or Lane Groups showing flow profiles calculated by the traffic model. The graphs are the same graphs as can be shown on the Network Layout View, but the Flow Profile View allows them to be laid out on a page for printing at a larger size. The Cyclic Flow Profiles View can be opened by choosing 'Show Cyclic Flow Profiles View' from the Cyclic Flow Profiles pop-out menu on the Modelling menu.



4.27.1. *Creating Graphs and Controlling their Layout*

The Flow Profile View allows graphs to be laid out in a rectangular grid. This creates flexibility in setting graphs out in sequence horizontally or vertically, for example to follow a Route or corridor.

Creating Flow Profile Graphs

Flow Profile Graphs can be added to the Flow Profile View as follows:

- Right click on the Flow Profile View with the mouse.
- Choose 'Add Graph for Lane' from the pop-up menu and select the Lane to be graphed and the Graph Type as described below.

- The new graph will be added to the Cyclic Flow Profiles View and can be repositioned as desired as described below.
- Alternatively choosing 'Add Graphs for Route' from the pop-up menu adds a series of graphs in sequence for the Lanes along a LinSig Route.

Selecting a Graph

A graph can be selected by clicking it with the mouse. The graph will be highlighted with a red border indicating it is selected.

Repositioning Graphs

A graph can be repositioned in the Flow Profile View by selecting it with the mouse and dragging it into a new position. A solid red line will indicate the new position where the graph will be move to. If the graph is inserted between existing graphs the existing graphs will be moved to accommodate the new graph.

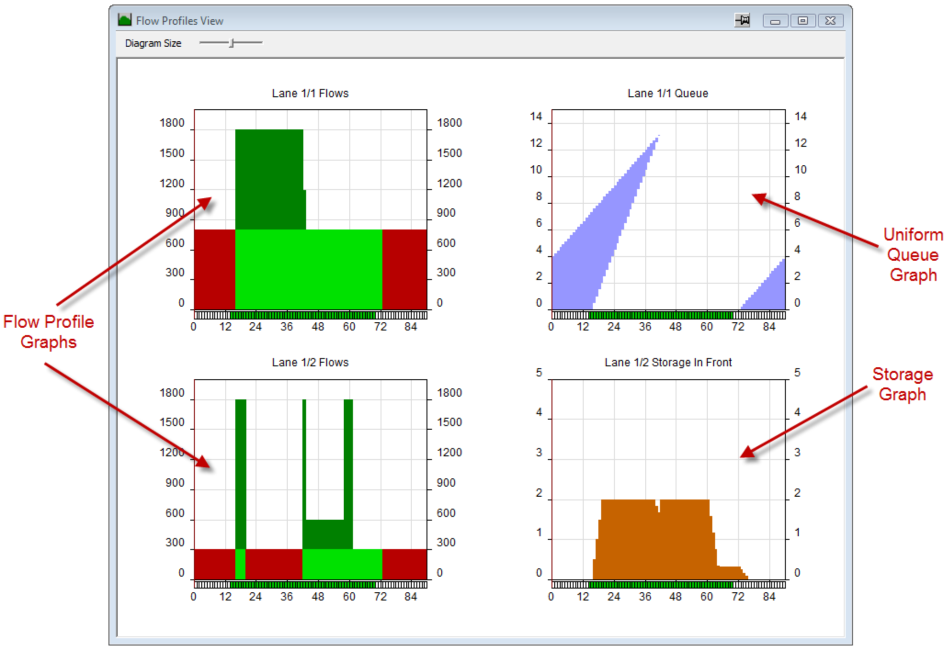
Deleting a Graph

To delete a Flow Profile Graph select it with the mouse and choose 'Delete Graph' from the Flow Profiles menu.

4.27.2. Graph Types

The Flow Profile View can display three types of graph. These are:

- **Flow Profile Graphs.** These show the profile of traffic flow into and out of a Lane or Lane Group during a typical signal cycle.
- **Uniform Queue Graph.** These show the position of the front and back of the Uniform Queue on a Long Lane or Lane Group.
- **Storage Graph.** Storage Graphs show the amount of traffic currently in a Short Lane or Right Turn Storage Area.



Graphs can only be viewed if traffic model results are available. If any errors exist preventing the traffic model from calculating results the Graphs will display an error message.

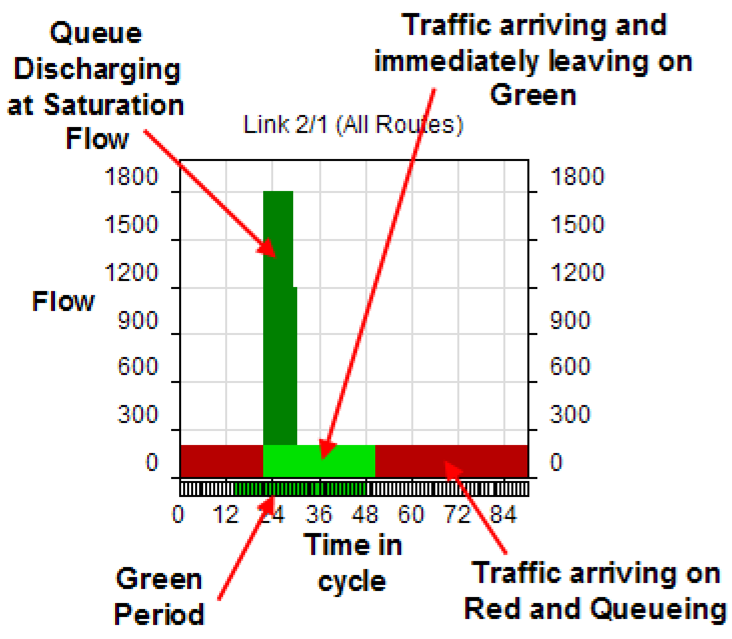
Further details of how the Graphs are calculated and their interpretation is given in the modelling section.

4.27.3. Flow Profile Graphs

The Flow Profile Graphs show the traffic flow into and out of a Lane over a typical signal cycle. As LinSig assumes all traffic queues vertically at the stop line, rather than spread out along the Lane, all flows relate to traffic crossing the stop line as opposed to joining or leaving the queue somewhere along the Lane. Flow Profile Graphs can be shown for the following items:

- **Long Lane.** A Flow Profile Graph for a simple Long Lane with no associated Short Lane shows traffic entering and leaving the Lane over the stop line.
- **Combined Lane Group.** When a Long Lane has an associated Short Lane the two Lanes are modelled as a combined pair to allow all the blocking and interaction between the two Lanes to be modelled. The Combined Lane Group graph shows the inflow and outflow of traffic over the stop line for the combined pair of Lanes. If necessary individual OD movements can be shown as described below.
- **Long Lane within a Long Lane/Short Lane Group.** This graph shows the traffic entering and leaving the Long Lane of a Lane Group in front of the point where traffic splits into the Short Lane. This graph takes into account whether traffic queuing in the Short Lane prevents traffic from entering the section of the Long Lane in front of the split point.
- **Short Lane.** This graph shows the traffic entering and leaving the Short Lane in a Lane Group. Similar to above this graph takes into account whether traffic queuing in the Long Lane prevents traffic from entering the Short Lane.
- **Right Turn Storage Area.** The Right Turn Storage Area is the space within the centre of a junction where right turning traffic can wait in front of the stop line to turn in gaps in the oncoming traffic. This graph shows the traffic entering and leaving the Storage Area.

Each of the above graphs is presented in the same way. A typical LinSig Flow Profile graph shows the following information. This example is for a constant arrival rate although more complex examples follow exactly the same principles.



4.27.3.1. Creating Flow Profile Graphs

Flow Profile Graphs are created as described above and selecting ‘Flow Graph’ as the Graph Type.

4.27.3.2. Controlling the Display of Flow Profile Graphs

The display of Flow Profile Graphs can be customised in a number of ways. These include:

- **Graph Scaling and Sizing.**
- **Showing Inflows and Outflows on separate graphs.**
- **Showing separate graphs for each Route through a Lane.**
- **Showing the individual Route Flow Components on one aggregate graph.**

Scaling Graphs

Each graph is displayed at the same size but the flow axis can be scaled separately. To change a graph’s scale:

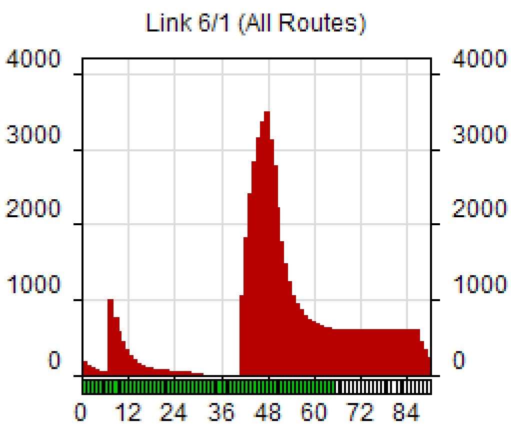
- Right-click on the graph and choose ‘Set Scale’ from the pop-up menu.
- Either enter a maximum value for the graph’s flow axis or tick ‘Autoscale’ for LinSig to calculate a flow axis scale that will accommodate the graph. Autoscale is less useful when presenting a number of graphs as scales may all be different making the graphs difficult to compare.

Sizing Graphs

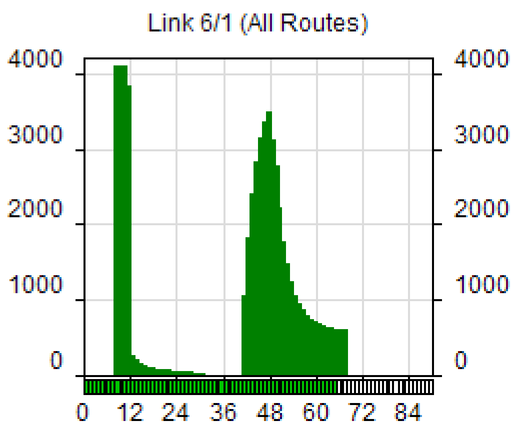
All graphs are shown at the same size. The size of the graphs can be adjusted using the slider on the Cyclic Flow Profiles View toolbar.

Showing Inflows and Outflows Separately

For complex graphs it is possible to show just the Inflows or Outflows for a Lane. For example:



Inflows Only



Outflows Only

A graph can be set to show either inflows or outflows as follows:

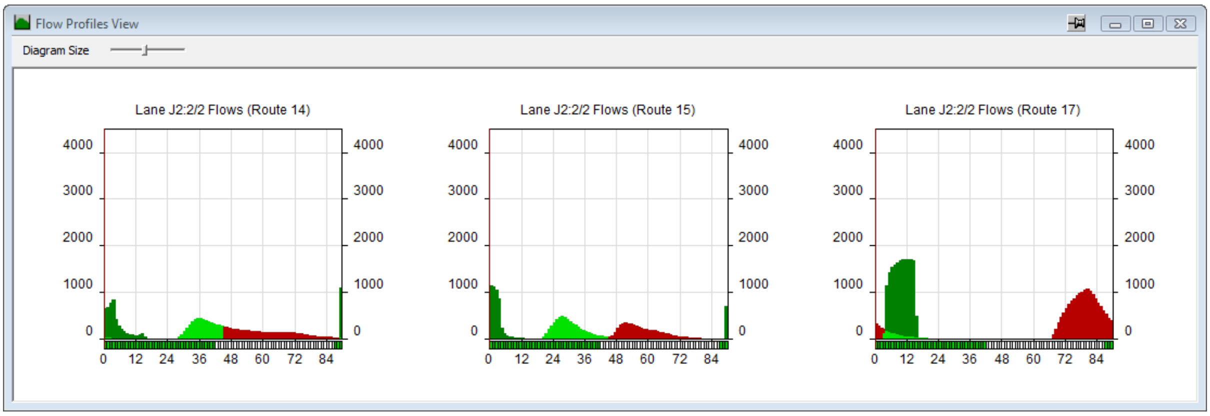
- Select the graph using the mouse.

- Either Right Click the graph with the mouse and choose from the pop-up menu or use the Flow Profiles menu to choose 'Show In Profile' or 'Show Out Profile' as appropriate.

Showing Separate Graphs for each Route through a Lane

Whilst LinSig is modelling a Lane it keeps Traffic Flows on the Routes passing through the Lane separate. This allows LinSig to display the flow profiles on a Lane not just for the whole Lane but also for individual Route components on the Lane.

For example the Flow Profiles shown above could be split into their component profiles as shown below.



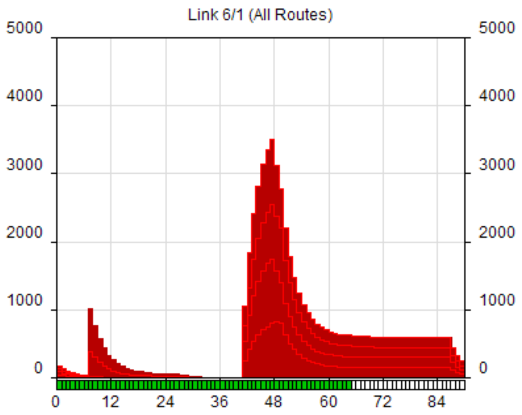
Viewing separate profiles is sometimes useful when analysing a complex model and trying to identify the effects of different signalling arrangements on different traffic movements rather than on the Lane as a whole.

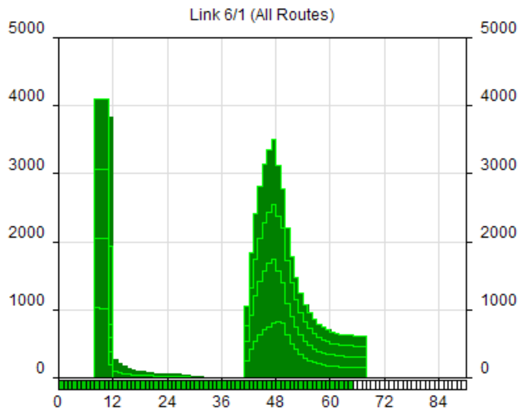
A Flow Profile graph for a single Route through a Lane can be displayed as follows:

- Select the graph for the Lane in question.
- Right-Click on the graph with the mouse. A pop-up menu will appear.
- Choose 'Show Route x Only' where x is the Route number of one of the Routes through the Lane.
- The graph will show the Flow Profile for the individual Route through the Lane.
- Add additional graphs for the Lane changing each of them to show a different Route as desired.

Showing the Individual Route Flow Components on a Single Graph

As well as splitting a Flow Profile graph into separate graphs for each Route the Flow Profile View can also show a single graph for the Lane or Lane Group, as described above in 'Showing Inflows and Outflows Separately', displayed disaggregated by Route.





Each Route Flow Profile is shown as a separate 'layer' in the graph. The layered Route Flow Profiles cannot be shown on a combined inflow/outflow graph as the display becomes extremely complex and difficult to understand.

Displaying a Graph Showing Route Flows as Route Layers

A graph can be displayed with Route Layers as follows:

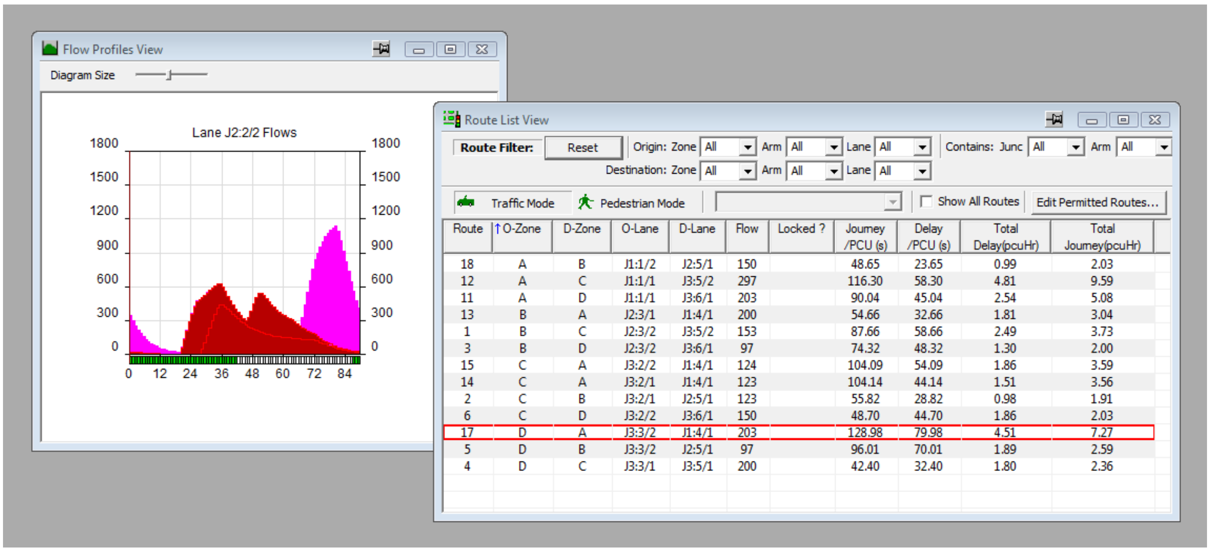
- Right click on a graph and choose to display either Inflows or outflows from the pop-up menu.
- Ensure 'Aggregate all Routes' on the 'Show Routes' pop-out menu is selected on the same pop-up menu and that the graph isn't showing a single Route Profile.
- Choose 'Show Route Components when Aggregated' from the pop-up menu.
- The graph will be shown with each Route Component as a separate layer.

Highlighting a Single Route Layer

When a Lane has many Routes it is sometimes difficult to determine which Route Layer is which in the graph. A Route Layer can be identified as follows:

- Ensure the Route List View, the Network Layout View and the Flow Profile View are all visible.
- Select a Route passing through the Lane in the Route List.
- The Route will be highlighted in the Network Layout View and the Route Layer will be highlighted in each of the Flow Profile Graphs.

Highlighting Route Layers is very useful when examining the effects of platooning and working out which movements queue and which get good green progression.



4.27.4. Uniform Queue Graphs

Uniform Queue Graphs show the Uniform Queue on a Lane over a typical signal cycle. It is important to understand that the graphs show only the Uniform Queue and do not include the random and oversaturated queue components which are calculated separately, not by the flow profiles. More information on the different queues and delays types is given in the modelling section.

Uniform Queue Graphs can be shown for the following items:

- **Long Lane.** A Uniform Queue Graph for a simple Long Lane with no associated Short Lane shows how traffic queues on the Lane.
- **Combined Lane Group.** When a Long Lane has an associated Short Lane the two Lanes are modelled as a combined pair to allow all the blocking and interaction between the two Lanes to be modelled. The Combined Lane Group Uniform Queue graph shows how traffic queues on the combined Lane Group as a whole.

Uniform Queue Graphs cannot be shown for Short Lanes or Long Lanes within a Lane Group. Storage Graphs as described below serve a similar purpose.

Uniform queue graphs show the following information:

4.27.4.1. Creating Uniform Queue Graphs

Uniform Queue Graphs are created as described above and selecting ‘Queue Graph’ as the Graph Type.

4.27.4.2. Controlling the Display of Uniform Queue Graphs

The display of Queue Graphs can be customised by displaying the Random & Oversaturated Queue on the Graph as well as the Uniform Queue.

Displaying the Random & Oversaturated Queue

The Random & Oversaturated Queue can be displayed on a Queue Graph by right clicking on the Graph and choosing ‘Show Random & Oversat Component‘.

Remember that the queue graph is for a typical cycle therefore the level of random & overstaturated queue is an average value. This is discussed in more detail in the Modelling Background section.

Disaggregating Queue Graphs by Route

Uniform Queue graphs cannot currently show the queue layered for different Route Flow Components on the Lane as Flow Profile Graphs can do.

4.27.5. Storage Graphs

Storage Graphs are new in LinSig 3 and show the amount of traffic in Lane segments such as Short Lanes or Right Turn Storage Areas. They can be used to assess when Short Lanes or other Storage Areas begin to influence or block traffic in adjacent Long Lanes.

Storage is similar but not the same as a queue. It is generally only used for Short Lane segments where traffic within the Lane segment is preventing traffic from entering from upstream but may not be forming a queue with a distinct front and back as modelled on a normal Long Lane. For most purposes, especially for Short Lane segments such as occurring when flared Lanes or Right Turn Storage is modelled it is usually sufficiently accurate to think of storage as the same as a queue.

Storage Graphs can be shown for the following Items:

- **A Long Lane within a Long Lane/Short Lane Group.** This graph shows traffic storing within the Long Lane of a Lane Group in front of the point where traffic splits into the Short Lane. It is useful for assessing whether and when traffic in the Long Lane blocks traffic in its adjacent Short Lane.
- **A Short Lane within a Lane Group.** This graph shows traffic storing within the Short Lane in a Lane Group. Similar to above this graph is useful for assessing whether and when traffic in the Short Lane blocks traffic in its adjacent Long Lane.
- **A Right Turn Storage Area.** The Right Turn Storage Area is the space within the centre of a junction where right turning traffic can wait in front of the stop line to turn in gaps in the oncoming traffic. This graph shows traffic storing within the Storage Area and is useful for assessing how right turning traffic blocks ahead traffic in an adjacent Long Lane.

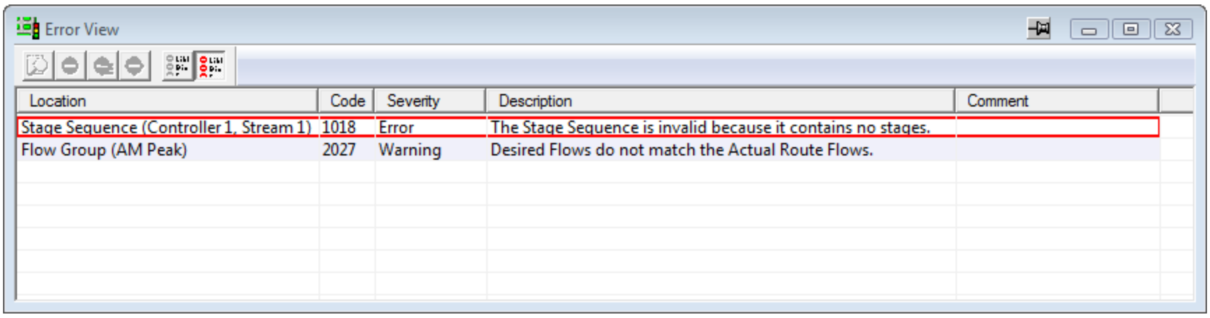
4.27.5.1. Creating Storage Graphs

Uniform Queue Graphs are created as described above and selecting ‘Storage Graph’ as the Graph Type.

4.28. Error View

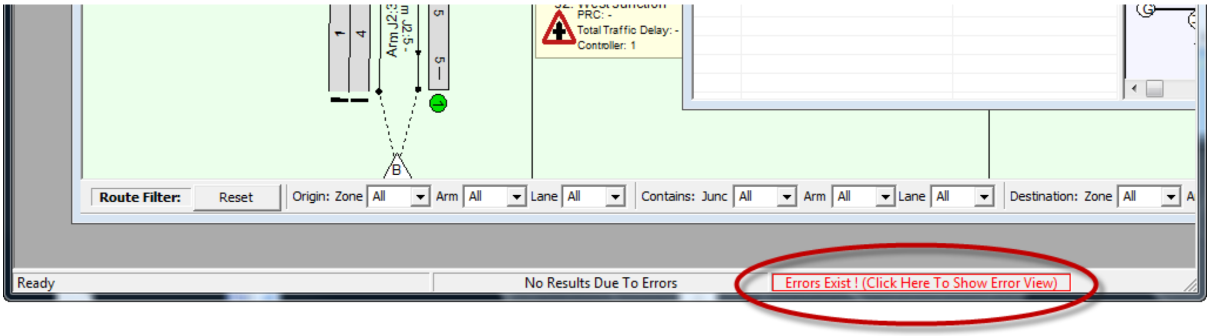
The Error View brings together all error and warning messages for the whole LinSig model. It acts like a checklist of errors requiring fixing avoiding the need to trawl the model looking for errors and reducing the likelihood of accidentally missing a problem which could be causing results to be incorrect.

The Error View can be opened by choosing 'Show Error View' from the View Menu or by double clicking the Error Warning on the Status Bar at the bottom of the Main Window.



The Error View shows three main pieces of information:

- **The Error's Location.** This describes where in the LinSig model the error occurs.
- **Code.** A numeric code identifying the error type.
- **The Error's Severity.** This describes the consequences of the error. The two levels of severity are:
    - **Error.** An Error prevents results from being calculated until the error is fixed.
    - **Report Generator Error.** This indicates a serious error in a report. Model results can still be obtained but reports cannot be run.
    - **Warning.** A Warning does not prevent results from being calculated but indicates something that LinSig thinks is suspicious and requires investigating. It is completely acceptable for a LinSig model to have warnings provided they have been checked and you have satisfied yourself that they do not affect the validity of results.
    - **Information.** An Information entry in the Error List indicates something which LinSig wishes to bring to your attention about an aspect of the Network or Network Item. The information entry does not necessarily imply that anything is wrong with the model but is just LinSig prompting with reminders of issues to consider.
- **The Error's Description.** This provides a detailed description of the error or warning.
- **A User Comment on a Warning or Information Entry.** This allows a comment to be added to a warning or Information Entry when it is hidden as described below.



When Errors or Warnings exist in the Error View LinSig will highlight this by displaying a red or amber Error Indicator in the Status Bar at the bottom of the Main Window. The Error View can be opened by double clicking the Error Indicator.

4.28.1.1. Correcting Model Errors

LinSig assists with correcting Errors by guiding you to the source of the Error whenever possible. Double clicking on an error will jump to the View or Dialog Box which LinSig thinks is the best place to fix the error. As some errors have complex causes, LinSig can not always work out the best location to fix the error for all errors, but can usually do so for the most common ones.

4.28.1.2. Hiding Warnings and Information Entries

In a larger model a number of warnings and Information Entries may accumulate which after investigation are determined to be irrelevant or inconsequential to a model. These warnings can be hidden to keep the Error List tidy and avoid missing other more important errors. Full Errors always indicate that something serious is wrong and cannot be hidden.

Hiding an Individual Warning

An individual Warning or Information Entry can be hidden by selecting the Warning in the Error List and clicking the ‘Hide this Item’ in the Error View’s toolbar. If desired a comment can be added to the Warning to record why the warning was hidden.

Hiding all Warnings of a Type

All Warnings of a particular type can be hidden by selecting a Warning of the type to be hidden in the Error List and clicking the ‘Hide this type of Warning’ button on the Error View’s toolbar.

Showing Hidden Warnings

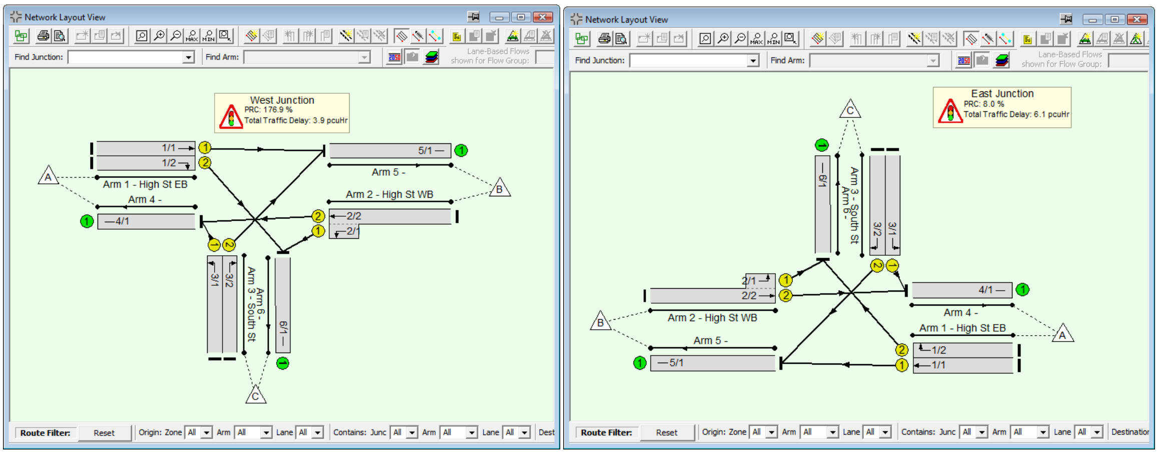
Warnings which have been previously hidden can be shown by clicking on the ‘Show Suppressed Warnings’ button in the Error View’s toolbar.

Un-Hiding a Previously Hidden Warning

A Warning which has previously hidden can be unhidden by displaying hidden warnings in the Error List, selecting the warning and clicking the ‘Do not Hide this Item’ button in the Error View’s toolbar.

4.29. Importing & Merging LinSig Networks

Many users will have large numbers of existing LinSig models of single Junctions or small Networks. LinSig allows Networks to be merged together to create new larger Networks to allow the modelling of larger areas.



Two Separate LinSig Models before Importing

Importing refers to the process of adding a LinSig network to another Network. It does not refer to the process of loading and converting LinSig files from earlier versions.

4.29.1. Points to Consider before Merging Networks

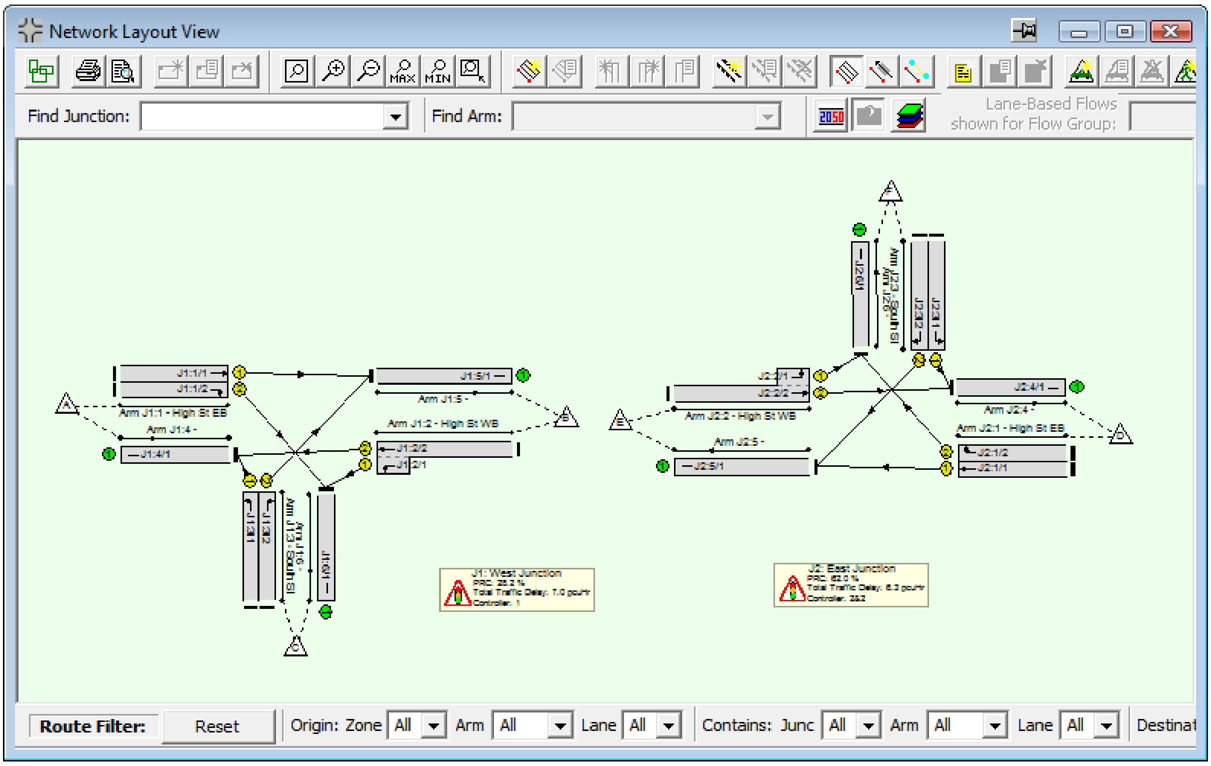
Whilst planning whether and how to merge Networks the following (sometimes contradictory) points need to be considered:

- With LinSig 3.1 and above different Junctions within the model can now operate at different cycle times.
- Merging two Networks into a larger Network will increase the run time of optimisation and assignment. Merging two Matrix Based Networks will generally increase run times by a larger factor than merging two Lane Based Networks as the number of routing options increases disproportionately.
- Merging Matrix Based Networks may be desirable as it allows rerouting due to signal timing or Network changes to be modelled. Remember LinSig isn't intended to be a large area model though like SATURN or VISUM.
- Merging Networks reduces the number of model files and assists with version control.
- For complex models which take some time to run it is often possible to structure the model into separate semi-independent Network regions which will provide large improvements in run time without a great loss of accuracy. This is particularly beneficial for Matrix Based Networks as routing is then only modelled within each region as opposed to between regions as well. This dramatically reduces the number of Routes without necessarily reducing accuracy.
- If merging an existing LinSig 2 model it is recommended to first convert the existing model to LinSig 3. Although this is not absolutely necessary it simplifies the merging process by avoiding having to convert the model from LinSig 2 to LinSig 3 and merge all in the same step.

- Where Networks being merged contain different Scenario's it is recommended that before importing each Network is first set up so that any Scenarios required in the merged model are present in all imported files and are given the same name.
- If a number of Matrix Based component Networks are being merged together by merging Zones as described below it is useful for all models to contain Turning Counts prior to merging. This allows matrix estimation to be run on the combined model to estimate an improved matrix for the whole merged model. If any component Networks do not include Turning Counts these can be calculated from Route Flows in the component model as detailed below in Re-Estimating a Combined Matrix for Merged Matrix Based Networks

4.29.2. Importing a LinSig Network into an existing Model

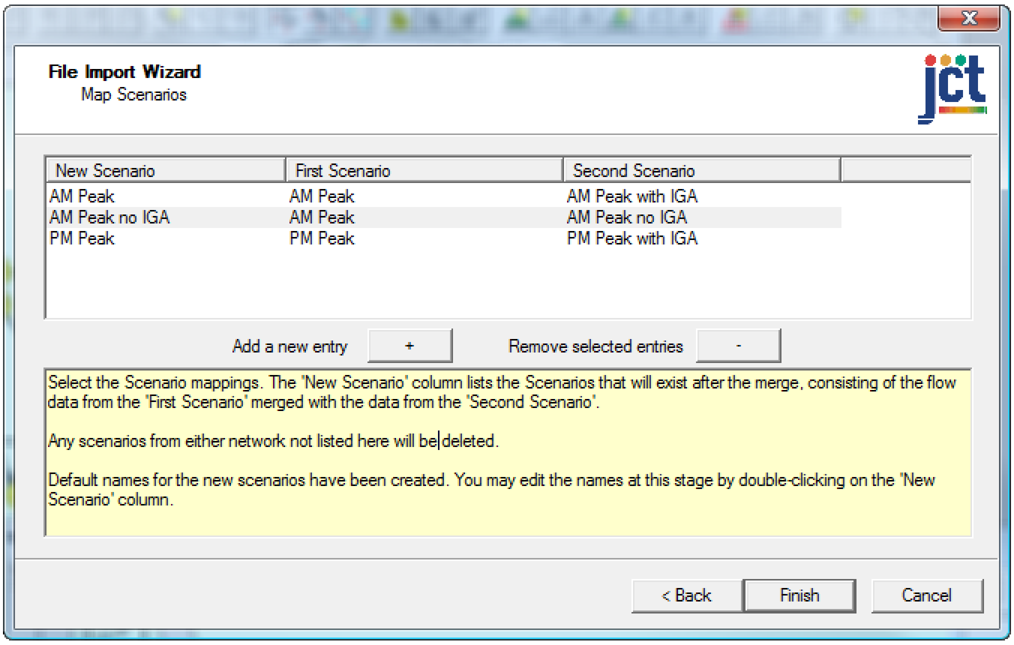
The process of importing a LinSig Network adds the new Network to the old Network as an isolated piece of Network. It does not join the two Networks together. This is carried separately as described below.



Separate LinSig Models after Importing Right Network into Left Network

A separate Network can be imported into another Network as follows:

- Open the base Network in LinSig.
- Choose 'Import File into Current Model' from the Network menu.
- Click 'Next' to start the File Import Wizard.
- Select the File to import.
- Map Scenarios in the existing and imported model to define new combined Scenarios. Where Scenario names match in the base and imported models LinSig will automatically create new Scenarios matching these.



- Click Finish to complete the import process.

The Import process carries out the following:

- Adds all the Junctions, Arms, Lanes and other Network Items from the imported Network to the existing model's Network.
    - Junctions are renumbered to append to the existing Network's Junctions.
    - Zones are renumbered to append to the existing Network's Zones.
    - Pedestrian Zones are renumbered to append to the existing Network's Pedestrian Zones.
    - Arms and Lanes belong to each Junction and do not need renumbering.
- Adds the Controllers and all the Controller items belonging to the Controllers to the existing Network.
    - Controllers from each imported model are added in a new Controller Set.
    - Controllers are renumbered to append to the existing Network's Controller List.
    - Phases, Stages etc belong to each new Controller and therefore do not need renumbering.
- Creates merged Scenarios in the existing model based on matched Scenarios in the existing and imported models. Any non-matched Scenarios are deleted.
- Creates merged Network Control Plans in the existing model based on the matched Scenarios. Any non-matched Network Control Plans are deleted.
- Creates merged Traffic Flow Groups in the existing model. Any Traffic Flow Groups not used by new merged Scenarios are still imported but are prefixed as 'Imported:'

The model now contains two disconnected Networks which can be joined together as described below.

4.29.3. Joining Imported Network Regions

When a Network is imported into an existing LinSig model it is imported as a separate disconnected Network region. After importing the separate Network regions, they can be joined together to form a single larger Network. How they are joined together depends on the different Network region types being joined.

4.29.3.1. Joining Two Matrix Based Regions

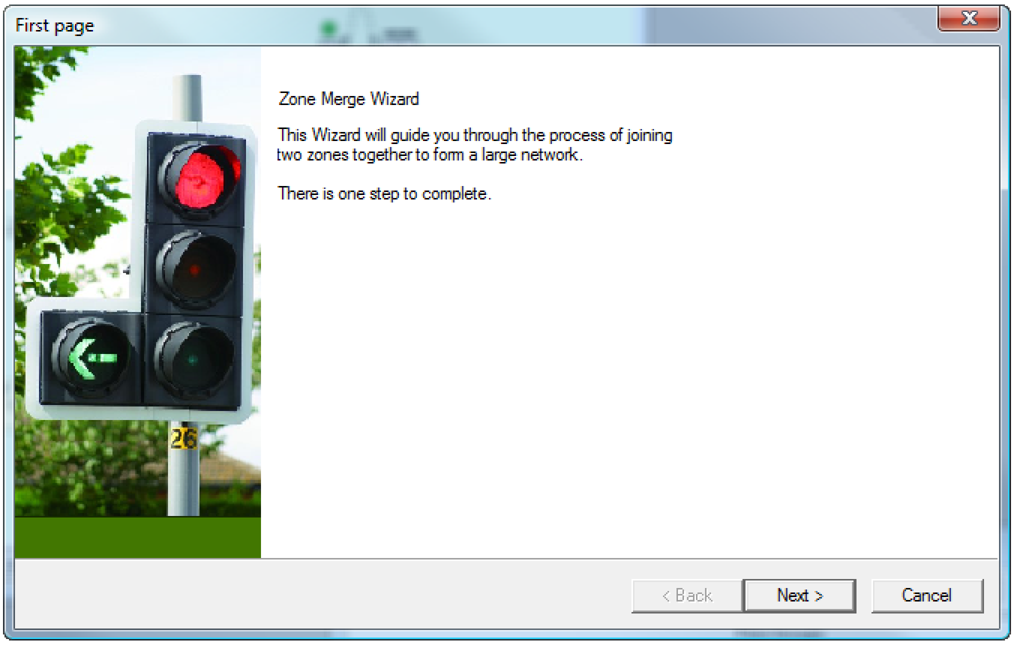
Two Matrix Based Regions can be joined in two different ways. These are:

- **Merging two Zones at the join point of the two regions.** This method is the most detailed and provides greatest modelling accuracy but may involve more work. LinSig eliminates the two Zones at the join point creating one large Network with Routes between all remaining Zones in the new joined Network. Only one Zone from each Network region can be merged at once. In larger Networks where two or more Zones require merging with the existing Network, each Zone pair should be merged sequentially.
- **Connecting the Network Regions but retaining the boundary Zones.** This method will create a faster running model and will often involve less work calibrating traffic flows within the model as Routes are only considered within each Network region not between them. This means that each Network region can be calibrated in isolation which may be easier than calibrating one larger Network. This method retains the Zones at the region boundary and does not create any new Routes between Zones on different sides of the boundary. The Lanes downstream of the boundary should be set to inherit the cyclic flow profile of traffic entering the Zone upstream of the boundary. This is achieved using the ‘Inherit Cyclic Flow Profile from Upstream Exit Lane’ option in the Lane Edit dialog box’s Advanced tab.

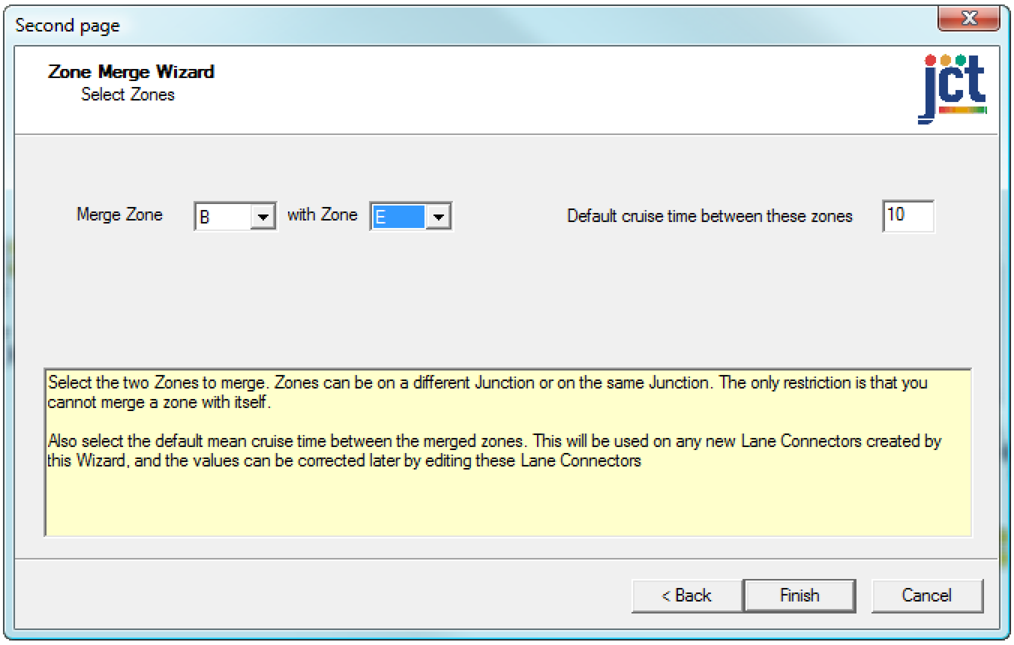
Merging Zones

Zones at the boundary of two Matrix Based Network regions are merged using the Zone Merge Wizard as follows:

- Open the Zone Merge Wizard by choosing ‘Merge Zone/Networks’ from the Network menu.

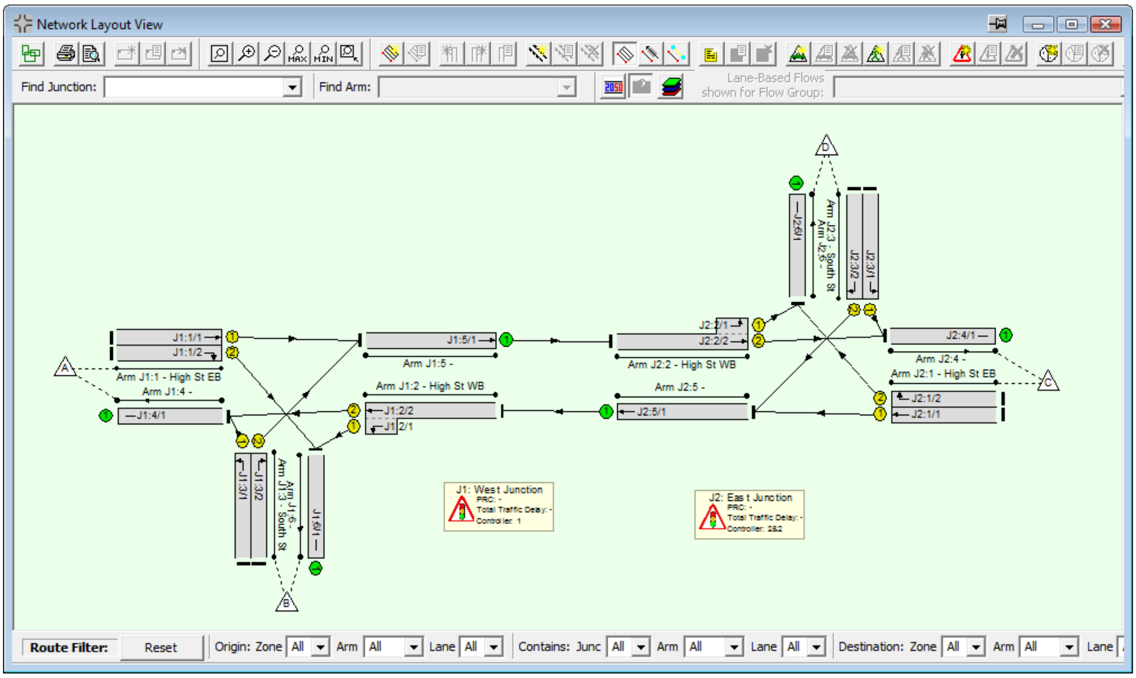


- Click Next to move to step 1 of the Wizard.



- Enter the two Merge Zones. Each Zone must be from a separate unconnected part Network.
- Enter a default cruise time for the new Lane Connectors which will replace the existing pair of Zones. This can be adjusted later if required.
- Click ‘Finish’ to complete the Zone Merge.
- LinSig will carry out the merge generating new Routes based on combining Routes in each of the existing part Networks at the merge point. This can lead to large numbers of new Routes in some cases. If feasible the Routes in the new merged Network should be examined using the Route List View and any unlikely or undesirable Routes marked non-permitted.

After the Zone Merge Wizard is complete further Networks can be imported and merged into the new Network if desired.



Re-Estimating a Combined Matrix for Merged Matrix Based Networks

After importing and merging Networks, an improved matrix can sometimes be obtained by using matrix estimation to re-estimate a combined matrix for the whole of the merged Network.

If the imported Networks all contain Turning Counts this is relatively easy to carry out. If however the original component Networks were all simple, possibly just single Junctions, they may not contain Turning Counts. This would require Turning Counts to be entered for all Junctions in the merged Network before matrix estimation could be carried out.

LinSig 3.1 and above avoids having to enter Turning Counts by providing a method to create Turning Counts from an existing Scenario's traffic flows. These Turning Counts can then be used to re-estimate the matrix for the merged model.

For each of the component Networks prior to importing into the merged model carry out the following:

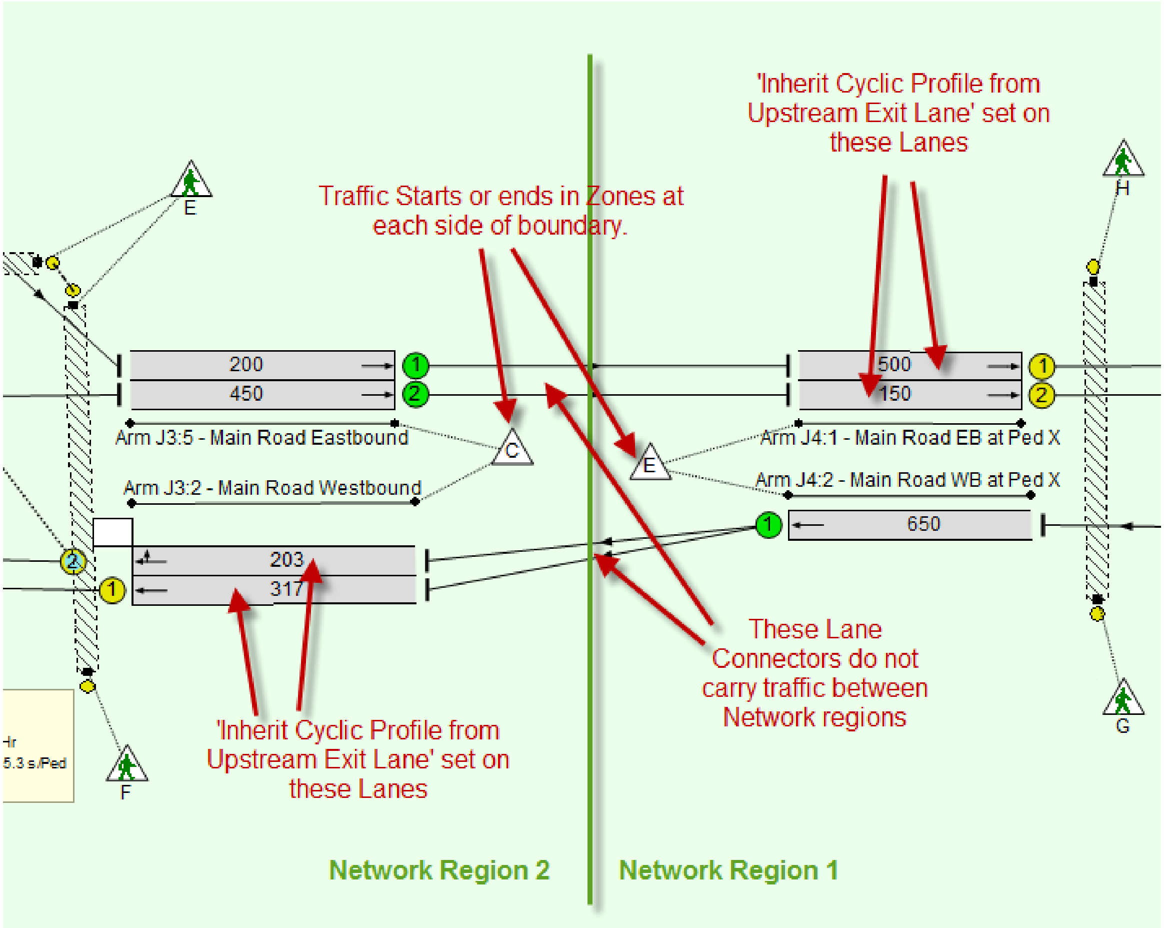
- Right click on the Scenario in the Scenario View and choose 'Copy this Scenario into Turning Counts.
- LinSig will produce a copy of the Scenario and a copy of the Flow Group used by the Scenario. The new copy Scenario will also be set to use the copy Flow Group.
- The new copy flow Group will contain Turning Counts calculated from the Route Flows in the original Scenario.
- Choose whether tidy up the model by deleting any of the old Scenarios and/or Flow Groups.
- When the models are combined together by importing and Zone merging the component networks as described above the new combined Network will contain a full set of Turning Counts.
- Matrix estimation can be run on the combined network to produce an improved combined matrix.

Connecting Two Matrix Based Regions without Merging Zones

Two Matrix Based Network regions can also be joined without merging the Zones at the region boundary. This has advantages and disadvantages as discussed above.

The two regions can be joined as follows:

- Create Lane Connectors joining Lanes immediately upstream and downstream of the region boundary.
- By default the Lanes immediately downstream of the Network region boundary are fed with traffic from the Zone immediately downstream of the boundary using a flat cyclic flow profile. This is because instead of traffic crossing the boundary on the Lane Connectors just created traffic will have exited the Network at the Zone immediately upstream of the Network boundary. This is potentially inaccurate as traffic entering the Zone upstream of the Network boundary should really reappear on the downstream Lanes with the same cyclic flow profile. This can be rectified using the 'Inherit Cyclic Flow Profile from Upstream Exit Lane' setting on Lanes which are fed by the Zones just downstream of the region boundary. This setting, which can be found on the Advanced tab of the Edit Lane dialog box, causes LinSig to take the cyclic flow profile of traffic exiting the Network into the Zone just upstream of the region boundary and apply the profile shape to the traffic exiting the Zone downstream of the boundary.



- The use of the this method maintains cyclic flow profiles and coordination across the Network region boundary but greatly limits the number of Routes in the model by only modelling Routes within each Network Region and not modelling Routes between each Network region. The lack of Routes crossing the region boundary means that cyclic flow profiles of traffic crossing the region boundary would be lost if the above setting was not used.

4.29.3.2. Joining Two Lane Based Network Regions

Two Lane Based regions are much simpler to join as there are no Routing issues to resolve. The Network regions can be joined as follows:

- Create Lane Connectors joining Lanes immediately upstream and downstream of the region boundary.
- Add Lane Based Flows on the new Lane Connectors using the Network Layout View's Lane Based Flow Edit Mode

4.29.3.3. Joining a Matrix Based and a Lane Based Network Region

Where the two Network regions being joined are of different types they can be joined using a combination of the above techniques. This involves:

- Create Lane Connectors joining Lanes immediately upstream and downstream of the region boundary.
- Where traffic leaving the Matrix Based region terminates at the Zone upstream of the Network region boundary its cyclic flow profile must be passed on to the first Lane downstream of the region boundary which has a Lane Based Flow defined on it. This

is achieved using the ‘Inherit Cyclic Flow Profile from Upstream Exit Lane’ setting on the Advanced tab of the Edit Lane dialog box.

4.30. Importing TranEd 2 Files

LinSig 3.1 and above can import files from TranEd 2 JCT Consultancy's graphical editor for TRANSYT models. TranEd 2 files contain all or most of the information required to construct a basic LinSig model and in many cases numerically identical results to running the TranEd 2 file in TRANSYT will be obtained in LinSig.

4.30.1.1. Importing a TranEd 2 File

A TranEd 2 file can be imported as follows:

- Choose 'Import TranEd 2 File...' from the File menu.
- Locate the TranEd file using the dialog box and click 'Open'.
- LinSig will close the current LinSig model and import the TranEd file.
- If any features used in the TranEd 2 model require modelling differently in LinSig a 'Import Messages' dialog box will be shown detailing any import issues.

4.30.1.2. Issues to Resolve after Importing

After importing a TranEd file the following issues may require additional changes in LinSig:

- **Mixed Give Way and ahead Lanes.** In TranEd/TRANSYT lanes containing a mix of ahead traffic and give way traffic (usually opposed right turners) are modelled using the 'Opposed by First Opposing Link Only' parameter. In LinSig mixed movements in Lanes are modelled automatically and this parameter value is calculated from traffic flows on different turns leaving the Lane. In order to model this situation correctly in LinSig turning movements leaving the Lane should be checked and non give way Connectors set correctly as non give way in LinSig. The total give way flow and total non-give way flow on the Lane should also be checked to ensure they are consistent with the 'Opposed by First Opposing Link Only' which is discarded as it is now calculated from turning flows.
- **Multi-Lane Arms.** As a TranEd file defines Lanes indirectly as Links it has no information on how Lanes may be grouped together as Arms in LinSig. Lanes will be graphically positioned based on Link positions in TranEd but each is created with its own Arm. In cases where a better representation is two Lanes on a single Arm, Arms can be merged as follows:
    - Select two adjacent Arms whilst holding the control key (Ctrl) down.
    - Right click on one of the Arms with the mouse and choose 'Join Arms' from the pop-up menu.
    - LinSig will merge the Lanes on the two Arms into a single Arm.
- **Pedestrian Modelling.** As LinSig currently does not allow Pedestrian Links to be modelled without using a Pedestrian Matrix for each Junction, Link Based Pedestrian Flows from TranEd cannot be used and are discarded.

4.31. Importing TRANSYT Files

4.31.1. Importing Version 12 and earlier Files into LinSig

Currently TRANSYT files cannot be imported directly into LinSig however TRANSYT 12 models and earlier can be imported into TranEd 2 and the resulting TranEd 2 file imported into LinSig as described above.

If you would like to use TranEd 2 to load TRANSYT files into LinSig and do not have access to TranEd 2 contact JCT Consultancy Support.

4.31.2. Importing TRANSYT 13 Files into LinSig

As TRANSYT 13 files are a closed file format LinSig cannot import them directly. TRANSYT 13 can however export TRANSYT 12 format files which can be imported into LinSig via TranEd 2 as described above.

4.32. VISSIM Interface View

LinSig 3.1 and above provides an interface between LinSig and VISSIM models. This interface can be used in two different ways. These are:

- LinSig can Import traffic signal information from a VISSIM model and generate a new LinSig Controller model from the imported timings.
- A LinSig Controller model which has been generated from a VISSIM model or built within LinSig can be linked to a VISSIM model and used to update signal information within the VISSIM model.

The VISSIM Interface requires a licensed copy of VISSIM on your PC.

4.32.1. VISSIM Version Compatibility

Currently the LinSig-VISSIM Interface works with versions of VISSIM up to and including Version 5.10. Later versions of VISSIM which introduced VISSIG are not compatible with LinSig 3.1 at the time of release. An update to LinSig will be issued shortly to provide compatibility with the latest version of VISSIM (VISSIM 5.3. at the time of LinSig 3.1 release).

4.32.2. Importing Traffic Signal Information from VISSIM

The signal control aspects of a VISSIM model can be imported into LinSig as follows:

- Create an empty LinSig Model.
- Open the VISSIM model you wish to import into LinSig in VISSIM.
- In LinSig in the VISSIM Interface View click ‘Import from VISSIM’.
- LinSig will display a dialog box listing all the signal controllers in the VISSIM model which LinSig can import. Select the Controllers to be imported and click ‘OK’.
- LinSig will import the VISSIM controller data and construct a LinSig Controller Model from this data.
- Using LinSig Controller Views check the imported model to ensure it correctly represents the VISSIM control logic.
- Save the LinSig Model.

The LinSig Model now contains one or more Controllers which replicate the control logic in the VISSIM model. The model also contains mappings between LinSig Controllers and VISSIM controllers and LinSig Phases and VISSIM Signal Groups.

4.32.3. Mapping an Existing LinSig Model to a VISSIM Model

If a LinSig Model already exists it is possible to manually map the LinSig Signal Control items to VISSIM signal control items. This is carried out as follows:

- Check the LinSig model to ensure there is a one-to-one mapping between LinSig Controllers and VISSIM controllers.
- In the VISSIM Interface View select each LinSig Controller in turn and enter the mapping between LinSig Phases and VISSIM Signal Groups.

4.32.4. Injecting Signal Timings into VISSIM

A LinSig Controller Model imported from VISSIM or mapped manually with VISSIM from an existing LinSig Model can be used to edit signal timings and inject these timings back into VISSIM. This can be carried out as follows:

- Signal timings can be edited in the LinSig model using standard techniques described elsewhere in this User Guide. The only restriction is to avoid changing LinSig Phases in a way which would invalidate the mapping with VISSIM Signal Groups.
- When the desired timings have been set up in LinSig these can be injected into the VISSIM model by clicking 'Inject VISSIM with Current Timings' button in LinSig's VISSIM Interface View. If the matching VISSIM model is not already open in VISSIM the model name will be requested.
- LinSig will inject the timings into the VISSIM model which can then be re-run using the new signal timings.

4.33. Animating LinSig Views

Several of the LinSig Views can be animated to dynamically show how signal timings change and coordinate throughout a typical cycle. LinSig steps through a typical cycle showing the situation for each time step in a number of views.

The Views which can be animated include:

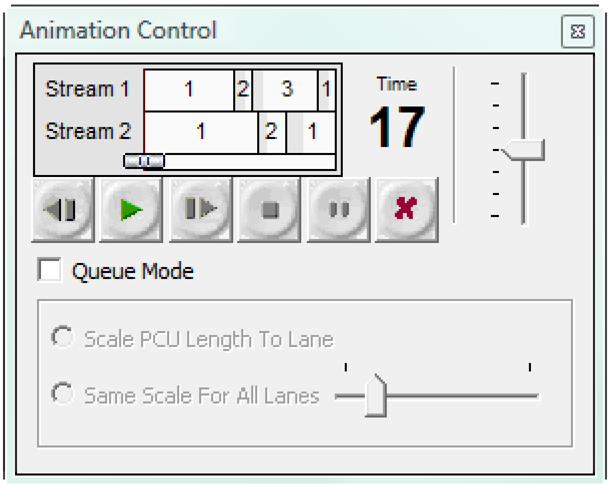
- The Network Layout View animates the display of turning movements on green and queue build up and decay on Lanes.
- The Phase View animates the display of running and non-running Phases.
- The Staging Plan View shows the running Stage at the current animation time.
- The Signal Timings View shows the current animation time within the cycle.
- The Flow Profile Graphs show the current animation time within the cycle.

The purpose of the animation is twofold:

- Provide an easy way for the engineer to visually check aspects of the model such as coordination.
- Provide a way of presenting a scheme to semi-technical users. Although the animation is obviously not as effective as some software packages capable of 3D photo-realistic visualisation it does provide a resource free method of demonstrating exactly how schemes will work to semi technical colleagues.

4.33.1. Controlling the Animation

The Animation is controlled using the Animation Toolbar. This is opened by choosing 'Animation Mode' from the LinSig 'View' menu.



The different sections of the Animation Control Toolbar are:

- **The Start/Stop/Pause buttons.** These respectively start the animation running, stop the animation, pause the animation and close the animation Control Toolbar.
- **The Step Buttons.** These allow the animation to be stepped forwards and backwards one second at a time.
- **The 'Time in Cycle' Display'.** The central section displays the Stage Sequence for each Stage Stream and the animation's current time within the cycle. The time in cycle slider can be used to manually change the current animation time. Each Stage

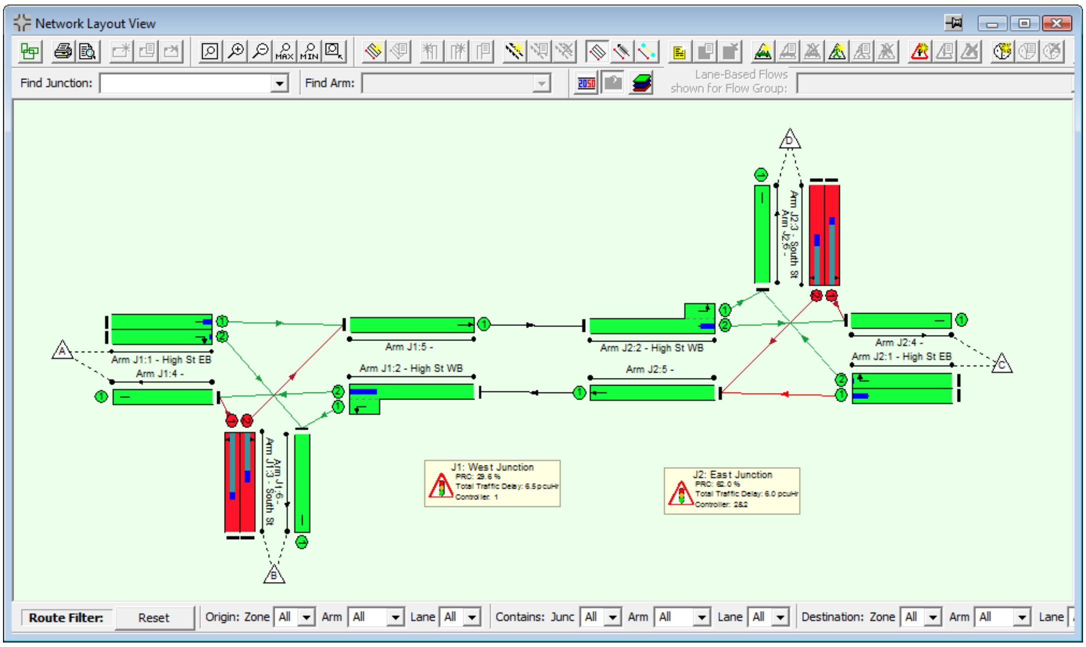
is shown in white with its Interstage in grey. If the Network contains more than one Controller the currently selected Controller is displayed in the Animation Control.

- **The Animation Speed Slider.** The animation speed is controlled by the vertical slider to the right of the Animation Control Toolbar. The animation speed can be increased by slider the slider down or decreased by sliding the slider up. The animation speed can be varied between real time and 40x real time.
- **Queue Display Settings.** This section controls whether to display animated queues in the Network Layout View and queue scaling settings.

4.33.2. Viewing Animation in the Network Layout View

The Network Layout View displays the animation in several ways. These are:

- The Lanes are coloured red or green depending on whether the Lane's Controlling Phase is running at the current point in the cycle.



- The Lane Connectors are coloured red or green depending on whether a movement is allowed at the current point in the cycle.
- Any graphs appearing on the Network Layout View display a time cursor at the current point in the cycle.
- Queues at the current point of the cycle are shown as a bar overlaid on the Lanes. The length of the bar is scaled in one of two ways:
    - The queue is scaled so that when the queue is 100% of the Lanes true length it is shown as 100% of the Lane's graphical length.
    - The queue is scaled so that queues on all Lanes are scaled the same but queue length shown does correspond to the Lanes graphical length.

4.33.3. Viewing Animation in the Phase View

The Phase View displays the Phases configured in the Controller. When animation is active the Phases are shown as red or green depending on whether they are running or not at the current point in the cycle shown on the Animation Control Toolbar.

4.33.4. Viewing Animation in the Stage Sequence View

The Staging Plan View highlights the Stage running for each Stage Stream at the current animation time displayed in the Animation Control Toolbar .If the current animation time falls in the interstage between two Stages both stages will be highlighted.

4.33.5. Viewing Animation in the Signal Timings View

The Signal Timings View shows the current animation time within the cycle. This makes it very easy to see where in the cycle the animation is, which Stage or Interstage is running and which Phases are about to start or terminate.

5. Detailed Controller Background

This section provides additional information on various traffic signal controller issues. It is intended to assist with understanding controller issues affecting LinSig modelling and is not intended to replace a thorough knowledge of controllers and their configuration.

5.1.1. Phase Minimums

LinSig uses two types of Phase Minimum. This section explains how the minimums are defined and how they are used in LinSig.

The Phase Minimum types are:

- **Street Minimum.** The Street Minimum is the minimum time that a phase must be observed to run for on the street to comply with relevant standards. For a traffic phase the Street Minimum is usually 7 seconds.
- **Controller Minimum.** The Controller Minimum is the Phase Minimum stored in and used by the controller, and the LinSig controller model. Controller Phase Minimums are often the same as Street Phase Minimums but where phase delays are used they can be different. Controller minimums must always be greater than or equal to the Street Minimum.

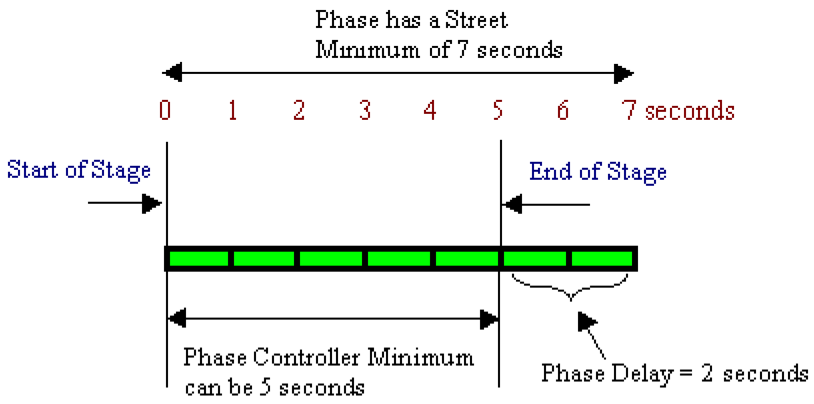
5.1.1.1. Why are two types of Phase Minimum Required?

The two types of Phase Minimum are required because of the way traffic signal controllers use Phase Minimums and Phase Delays. Phase Minimums entered into the controller are always controller minimums. The controller will continue running a Phase and will not consider terminating it until its controller minimum has expired. The controller does not however take into account any Phase Losing Delays, so if a Phase has a Phase Losing Delay it will continue to run into the Interstage for the duration of the Phase Losing Delay after the controller minimum has expired. This means that for the stage changes involving a Phase losing delay the effective minimum will in fact be the controller minimum plus the phase losing delay. If the minimum used in the controller is the desired Street Minimum the effective minimum will be too long potentially causing inefficiencies.

5.1.1.2. Compensating for Phase Delays

Where it can be guaranteed that the Phase Delay will occur on all possible stage changes it is possible to reduce the controller minimum below the Street Minimum to compensate for the Phase Delay.

In the example below, a Phase is required to have a Street Minimum (design value) of 7 seconds. The Phase however has the benefit of a 2 second Phase losing delay at the end of the stage. Hence, if the Controller Minimum is set to 5 seconds, the phase will run for at least 7 seconds on street. If the phase is given a 7 second controller minimum, then it will run for at least 9 seconds.



5.1.1.3. Calculating Controller Minimums

Like a real controller the LinSig Controller Model only uses controller minimums internally. LinSig will, however, allow you to specify the Street Minimums, converting them to controller minimums before they are used in the controller model. This allows you to use the street minimums from your design directly with no manual adjustments.

Whether the entered Phase Minimums are directly entered Controller Minimums or are Street Minimums which require conversion is specified in the Controller Information dialog which can be opened from the Network Menu.

If you choose to specify street minimums, LinSig will compute the lowest possible controller minimum that each phase could have such that the street minimum is not violated when running.

In the example above, the phase delay enables LinSig to suggest that a Phase Controller minimum of 5 seconds is adequate. However, if we consider the situation on a change to a different Stage, upon which there are no phase delays, then a controller minimum of 5 seconds would be unsuitable. LinSig therefore computes the controller minimum with regard to all permitted stage changes, hence adding or deleting prohibited stage changes may well cause controller minimums to be changed.

5.1.2. Phase Intergreens

A Phase Intergreen is the period of time between the termination of the green signals for one phase and the beginning of the green on another phase. Intergreens should be calculated by locating conflict points on a plan and using the procedure detailed in TAL 1/06 to determine Intergreen durations. This is available from the DFT's web site. (Currently http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_611509.pdf)

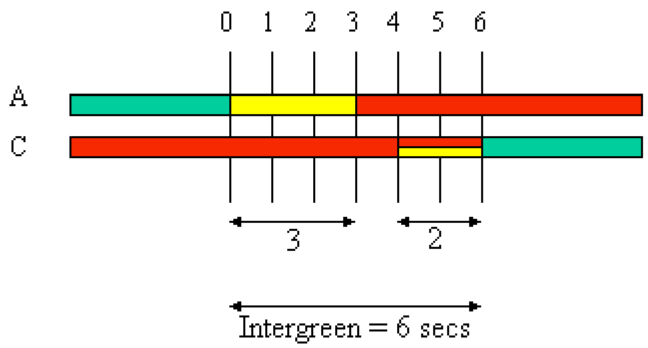
The following good practice points should be observed when using Intergreens:

- It is never normally appropriate to simply guess Intergreens as 5 seconds as sometimes occurs in preliminary junction designs. As well as being very bad practice it can lead to unexpected falls in capacity when Intergreens are calculated properly later in the design process.
- It is important to carefully calculate pedestrian to traffic and traffic to pedestrian intergreens as they can often have a significant impact on junction capacity.

- Normally intergreens from a Filter Phase to other Phases should not be entered as the intergreen of the Filter's associated Full Green Phase is used instead. Specifying intergreens between a back-to-back right Filter and its opposite opposing ahead movements can cause problems in the controllers design. This is due to the two Right Filters and associated Ahead Phases all waiting for each other to finish before completing the interstage, causing infinite loops in the interstage logic.

5.1.2.1. Intergreen Traffic Phase Aspect Sequence

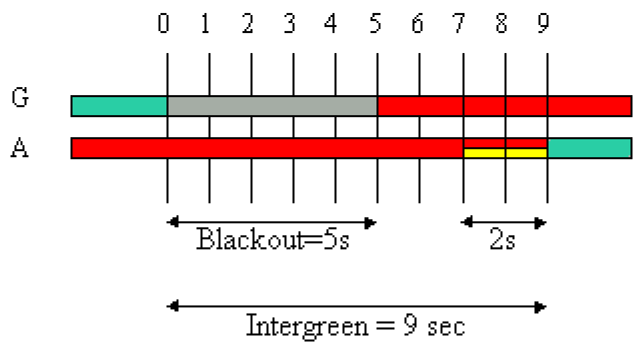
The signal sequence during a typical Intergreen is shown below. In this example the Intergreen A to C is 6 seconds.



5.1.2.2. Intergreen Pedestrian Phase Aspect Sequence

Blackouts are part of the intergreen between a pedestrian phase terminating and a traffic phase starting. They have no effect on the intergreen other than to replace part of the red man with no indication. Blackouts are not explicitly modelled in LinSig for Windows.

The signal sequence for a typical pedestrian intergreen is shown below. In this example the Intergreen between pedestrian Phase G and traffic Phase A is 9 seconds with a 5 second blackout period.



6. Reporting and Printing

LinSig can print information in three ways. These are:

- Directly printing the Network Layout, Network Control Layout View and Phase Views to a printer.
- Directly printing groups of Interstage and Flow Profile diagrams to a printer.
- Building a Report using the Report Builder. This can include both tables and graphics.

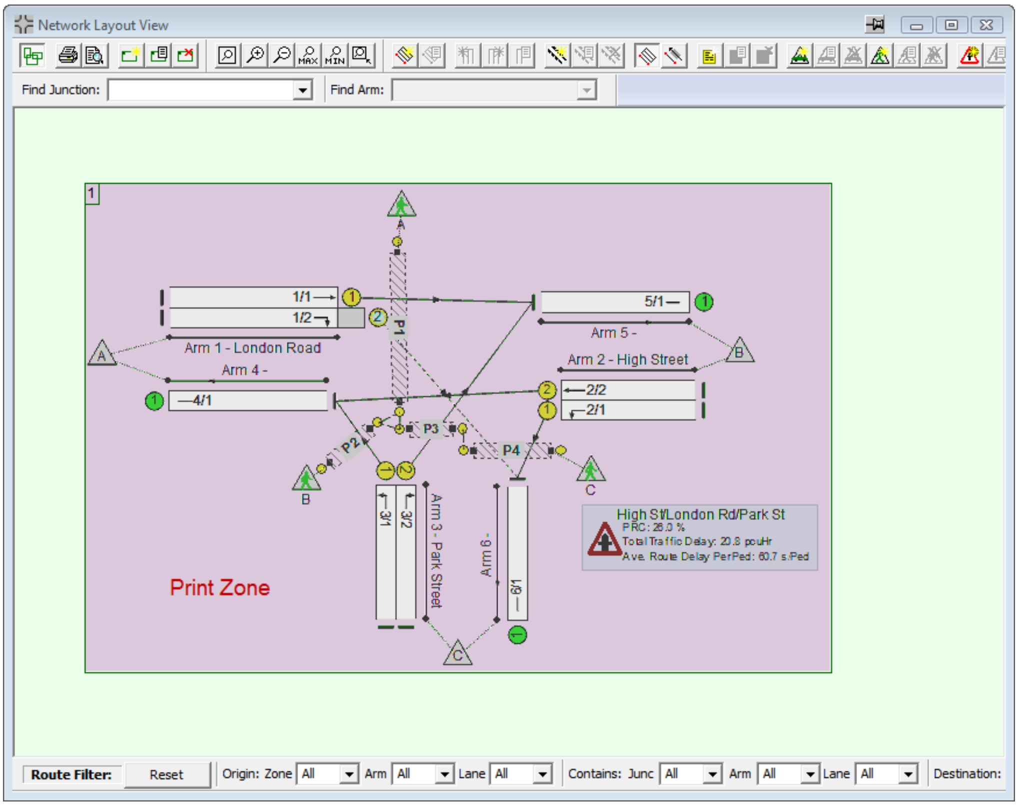
6.1. Printing Graphical Layout Views

The Network Layout View, Network Control Layout View and Phase View show the graphical layout of the Network, the Network-wide control and each Controller's Phases. As these diagrams can often be larger than an A4 page LinSig allows them to be printed directly to a printer, possibly a large format printer, as well as being included in a LinSig Report.

LinSig includes a sophisticated multi-page printing system that allows Print Zones to be defined to specify which part of the View is printed on each page. Each Print Zone can have scaling defined independently and pre-defined title blocks can be added to each page.

Most Views can of course also be embedded in a LinSig Report and printed with the rest of the report via a word processor. This is covered in the Reporting section.

LinSig allows multi-page print layouts to be set up and stored enabling consistent layout and scaling between print sessions. Print Zones are used to set up the scaling and other settings for each printed page, each Zone corresponding to one page.



As shown in above a Print Zone is a rectangular area of a View and defines the content that will be included on the printed page corresponding to the Print Zone. Any number of Print Zones can be defined, with each Print Zone corresponding to a Printed Page.

6.1.1.1. Creating Print Zones

All creation and editing of Print Zones is carried out with the View in Print Layout Mode. This special mode allows Print Zones to be created and edited but does not allow changes to be made to the Network.

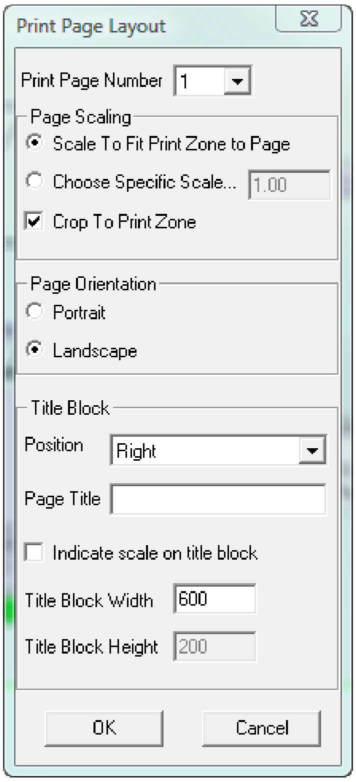
- To switch a View into Print Layout Mode choose 'Print Layout' from the File menu and choose 'Print Layout Mode' from the pop-out menu. Print Layout Mode can be switched off at any point by choosing 'Print Layout Mode' again. Alternatively the Print Layout button on the View's toolbar can be used.

A new Print Zone/Printable Page can be created as follows:

- On the File menu pop out the Print Layout menu and choose 'Create a new Print Page…' from the pop-out menu.
- The Print Page Settings dialog box will appear. This allows settings relating to scaling and layout of the print page to be changed. These can be changed at any point so for now click 'OK' to accept the defaults.
- A light grey rectangle is displayed indicating the current extents of the Print Zone corresponding to the new page. The Print Zone can be repositioned and resized using the mouse.

6.1.1.2. Editing Print Zones

Print Zone Settings are edited using the Print Page Layout dialog box. This can be opened by selecting a Print Zone and choosing 'Edit Print Zone' from the Print Layout pop-out menu. The settings for each page are independent of the settings for other pages.



The main settings are:

- **Page Number.** When more than one page is defined, pages can be renumbered by choosing a new page number in the drop down list. Other pages will be renumbered to create a gap in the numbering sequence if required.

- **Page Scaling.** Each Page either can scale the section of the View within its Print Zone to fit onto the current printer's default paper size, or can specify an absolute scale. Absolute scales are less flexible than scale-to-fit but are useful in ensuring each page's text and detail sizes are identical.
- **Page Orientation.** Allows each page's orientation to be set independently. The shape of the Print Zone has no bearing on its page orientation.
- **Title Block.** Optionally inserts a title block onto each page populating it with the project information defined in 'File Settings' which can be found on the File Menu. Each page can also have a separate Page Title defined.

6.1.1.3. Printing the View

Having defined the desired number of Print Zones, the View can be printed as follows:

- Choose 'Print…' from the LinSig File menu. LinSig will display the Print dialog box.
- If necessary, select the desired printer from the drop down list.
- If necessary, specify which pages are to be printed.
- If necessary, click on 'Properties' to display and change any printer specific settings such as paper size, colour or print quality.
- Click 'OK' to send to the printer.

6.2. Printing Multiple Interstage and Flow Profile Diagrams

The Multiple Interstage View and Flow Profile View allow multiple diagrams to be laid out and printed direct to a printer. They can also be included in a Report but direct printing allows a set of diagrams to be printed quickly without having to set up a specific Report.

Either View can be printed as follows:

- Open the View and create the diagrams required as described in the View's section in the View Reference.
- Choose 'Print…' from the LinSig File menu. LinSig will display the Print dialog box.
- If necessary, select the desired printer from the drop down list.
- Select the desired layout of diagrams on the printed page. LinSig will fit the layout of diagrams to the printer's current paper size.
- If necessary, click on 'Properties' to display and change any printer-specific settings such as paper size, colour or print quality.
- Click 'OK' to send to the printer.

6.3. The LinSig Report Builder

The LinSig Report Builder allows detailed reports to be designed and generated as Rich Text Format (RTF) files. The RTF format is supported by most modern word processors including Microsoft Word, Corel WordPerfect and the free to download OpenOffice. Reports can then be edited and enhanced, for example with company logos, before being printed from within the word processor. The Rich Text Format is particularly suited to this task as it allows graphics and tables to be easily integrated into reports as well as providing comprehensive support for different page sizes and orientations. LinSig no longer generates HTML reports due to the lack of flexibility of modifying and customising HTML based reports using standard word processing software.

6.3.1. Report Definitions and Templates

A LinSig Report is defined using a Report Definition. A Report Definition specifies information such as a Report's title, page size, and most importantly the layout of the Report. The Report's layout is specified as a sequence of Report Fragments. Each Report Fragment represents a Report item such as a table or diagram. LinSig includes over 30 different Report Fragments representing items such as Network Layout Diagrams, Lane input data tables, intergreen matrices, Stage diagrams and Network Results tables. A Report Definition can be as complex or as simple as desired and any number of different Report Definitions can be defined in each LinSig file. Any Report can be rerun at any point and will be completely regenerated using the current state of the LinSig model. This allows Reports to be defined once and quickly updated as a LinSig model evolves.

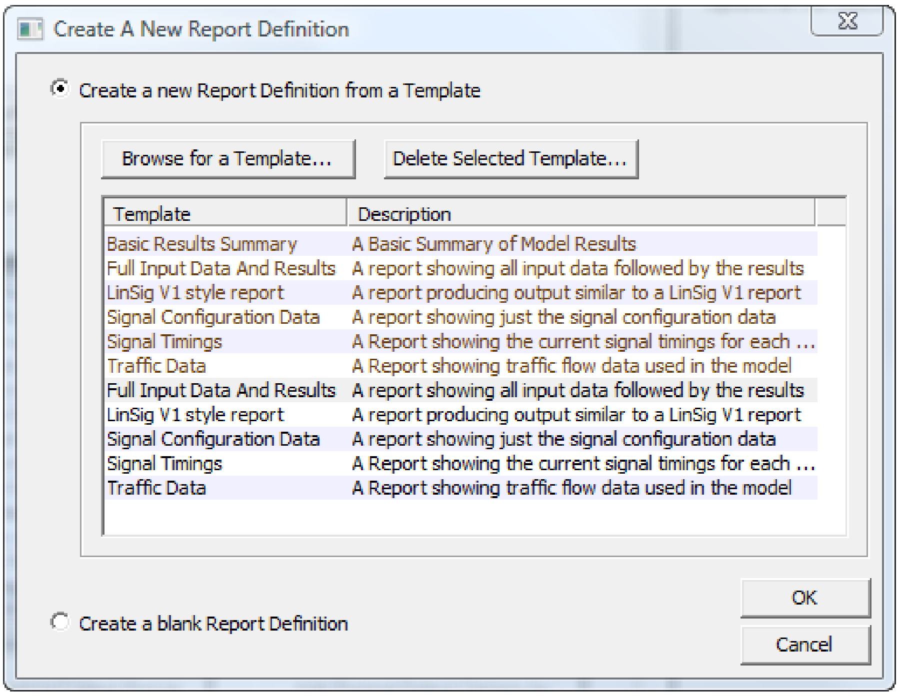
In many cases a Report Definition developed as part of one LinSig file could be useful for a number of LinSig files. LinSig therefore allows Report Definitions to be exported using Report Templates. Each Report Template is a file containing a detailed definition of the Report. This file can be imported into any LinSig model by any user to allow the Report to be reproduced based on the LinSig file it is imported into. LinSig is supplied with a number of default templates to get you started, however you may find it useful to develop a series of standard Report Definitions which can be distributed within your organisation to ensure a consistent Report design by all users.

6.3.2. Quickly Printing a Default Report

LinSig comes with a number of pre-built Report Templates which can be used to quickly run a report if you haven't yet had chance to develop your own Report templates.

To create a report based on a default template:

- Open the Report Builder by choosing 'Report Builder' from the LinSig Reports menu.
- Click the 'Add New Report Definition' button. The 'Create a New Report Definition Dialog Box will open as shown below. The Standard Report Templates supplied with LinSig are shown in brown. Any User-Defined Report Templates are listed in black.

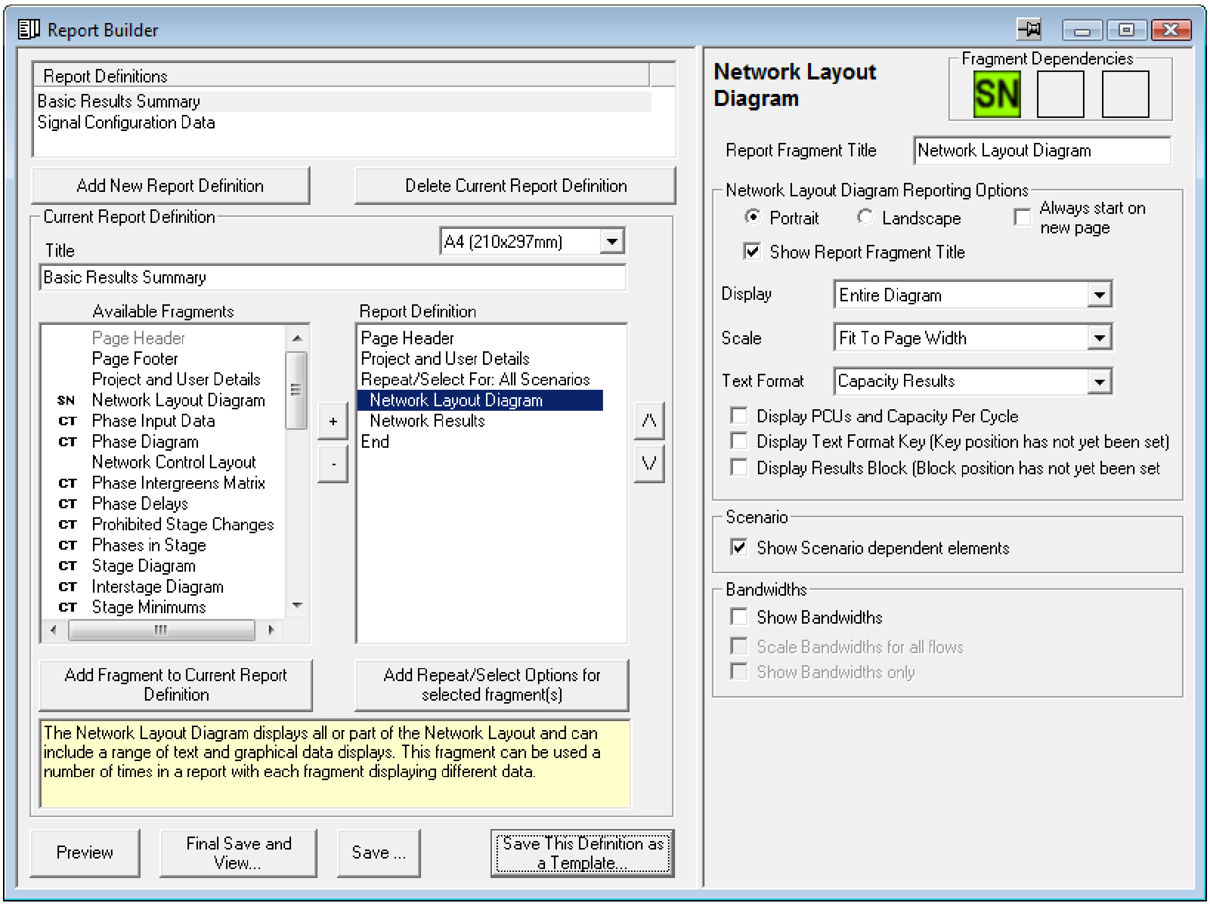


- Check that the 'Create a new Report Definition from a Template' option is selected.

- Select a Report Template from the list as desired and click the OK button.
- The Report Definition defined in the Template is loaded into the LinSig file and added to the file's Report Definition List. The Report's contents are shown in the Report Builder. Further information on changing the standard reports and working in the Report Builder is given later in this section.
- Click 'Preview…' at the bottom of the Report Builder. To avoid polluting your main data folders with lots of preview files LinSig saves a copy of the Report in the Windows temporary files folder and opens the Report in your default word processor.
- If desired the Report can be edited in the word processor before printing. As you previewed the Report you will need to specify where you wish to save the Report when saving it from your word processor.
- Alternatively you can click 'Final Save and View…' which allows you to save the file straight to the current LinSig data file's folder before opening the file in your default word processor.
- If you wish to rebuild the report at any stage you do not need to re-import the template. Simply select the Report Definition in the Report Definitions List and click 'Save and View This Report…'

6.3.3. Using the Report Builder

The Report Builder shown below is used to design and work with reports. Each Report consists of a sequence of Report Fragments, each Fragment representing a component of the Report, such as a diagram or table.



The Report Builder consists of two main panels:

- **The Report Building Panel.** The left panel of the Report Builder provides tools to create new Report Definitions, manage Report Definitions and to define the content of the current Report Definition. The panel contains the following items:
    - **The Report Definitions List.** The Report Definitions List at the top of the panel lists the Reports defined in the current LinSig data file. The list allows a current Report to be selected. The current Report can then be run or edited using the rest of the Report Builder.
    - **The Report Page Size.** The Page size the Report's layout will be designed for.
    - **The Report Title.** The title of the current Report.
    - **The Available Fragment List.** The Available Fragment List lists all the fragments which can be added to the current Report Definition. Clicking on any Fragment in the list displays a description of the Fragment and its use in the yellow hint box immediately below the list. Fragments which can be repeated using Repeat/Select options are shown with an icon to their left describing the type of Repeat/Select options available. Any Fragments which cannot be added to the report for any reason are shown grey.
    - **The Report Definition.** The Report Definition lists the Report Fragments contained in the current Report Definition.
- **The Fragment Options Panel.** The right panel of the Report Builder displays options for the Report Fragment currently selected in Report Definition in the left panel. Each fragment has a different set of options with the number of options available reflecting the complexity of the fragment.

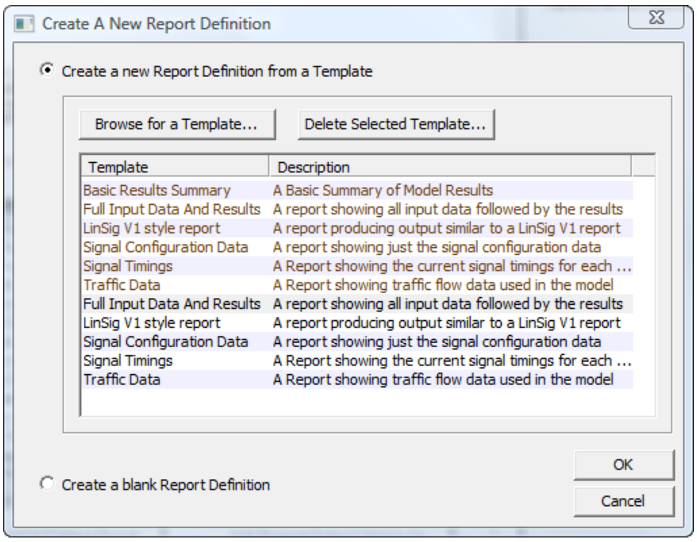
6.3.3.1. Managing Report Definitions

Each LinSig file can contains several Report Definitions each of which is used to define the layout of a LinSig Report. A Report can be produced or rerun at any time based on any of the Report Definitions.

Creating a new Report Definition

A new Report Definition can be created as follows:

- Click the 'Add New Report Definition' in the Report Builder. The 'Create a New Report Definition Dialog Box will open as shown below.



- A new Report Definition can be based either on a previously defined Report Template or can be created as a blank Report Definition.
- To create a new Report based on a Template, select the 'Create a new Report Definition from a Template' option. The Template List lists all of the Templates currently installed in either:
    - **The System Templates Folder.** The Templates in this folder are listed in brown. The folder is located at '[LinSig Install Folder]\Report Templates'. This is usually 'C:\Program Files\JCT Consultancy\LinSig 3\Report Templates'. This folder contains all the pre-defined Templates supplied with LinSig. Although there is no reason not to save your own Templates here you may find that your system's permissions have made the 'program files' folder read only.
    - **Custom Templates Folder.** The Templates in this folder are listed in black. The folder is located at '[My Documents]\LinSig Report Templates'. If desired the folder can be changed using the LinSig Program Options to a shared network drive to allow users to share Templates.

  Select the desired template and click OK to create the new Report Definition from the selected Template and return to the main Report Builder.
- Alternatively select the 'Create a blank Report Definition' option and click OK to create the Report Definition and return to the Report Builder.
- The new Report Definition is listed in the Report Definitions List in the Report Builder.

Deleting a Report Definition

A Report Definition can be deleted at any time by selecting the Report Definition in the Report Definitions List and clicking 'Delete current Report Definition'. This will only delete the Report Definition from the current LinSig file and will not affect any template files from which the Report Definition may have been created.

Saving a Report Definition as a Template

A Report Definition can be saved as a LinSig Report Template at any point. This Template can then be used to add the Report Definition to any other LinSig file.

To save a Report as a Template:

- Click 'Save this Definition as a Template' in the Report Builder.
- Specify a description for the Template.
- The Template is saved as a .RPX file which can be saved in any location but it is recommended to save most Report Templates in the Custom Report Templates Folder so LinSig can easily find them.

6.3.3.2. Editing a Basic Report Definition

Any Report Definition can be edited at any point to add or remove Report Fragments, to control how repeating fragments operate and to set display options for each fragment.

Adding Fragments to a Report Definition

A Fragment can be added to a Report Definition as follows:

- Select the Report Definition you wish to add the Fragment to in the Report Definitions List.

- Select the Fragment to be added from the Available Fragments List.
- Select the position where the Fragment is to be inserted in the Report Definition by selecting the Fragment in the Report Definition immediately before the desired insertion position.
- Click 'Add Fragment to current Report Definition' button or the '+' button between the Available Fragment List and the Report Definition. The Fragment will be inserted into the Report Definition.
- If the Fragment is shown in Red indicating the Fragment requires Repeat/Select options to be set, or the Fragment is inserted into the wrong place these problems can be corrected by moving the Fragment up or down the list as described below.

Removing a Fragment from a Report Definition

A Fragment can be removed from a Report Definition as follows:

- Select the Fragment to be removed in the Report Definition.
- Click the '-' button between the Available Fragment List and the Report Definition. The Fragment will be removed from the Report Definition.
- Once the Fragment has been removed all custom options for that Fragment are lost and would need to be reset if the fragment was reinserted into the Report Definition.

Changing the Order of Fragments in a Report Definition

The Fragments in a Report Definition can be reordered to customise the layout of tables and graphics in the Report. The Fragments are reordered as follows:

- Select the Fragment to be moved in the Report Definition. Several Fragments can be selected and moved together by holding control or shift down whilst selecting.
- Click either the up or down arrow buttons to the right of the Report Definition to move the selected Fragment up or down relative to other Fragments in the report.
- As the Fragment is moved it may turn red indicating in its current position it has Repeat/Select errors. This can be ignored unless occurring when the Fragment is in its final position in which case the Repeat/Select options should be corrected as described below.

6.3.3.3. More Advanced Report Editing using Repeat/Select Options

The Repeat/Select facility allows sophisticated control over how a LinSig Report handles repeating Fragments, for example, a table of traffic flows which is required to be repeated for a number of different Flow Groups. As well as allowing individual Fragments to be repeated the Report Builder also allows groups of Fragments to be repeated making the design of Reports very flexible.

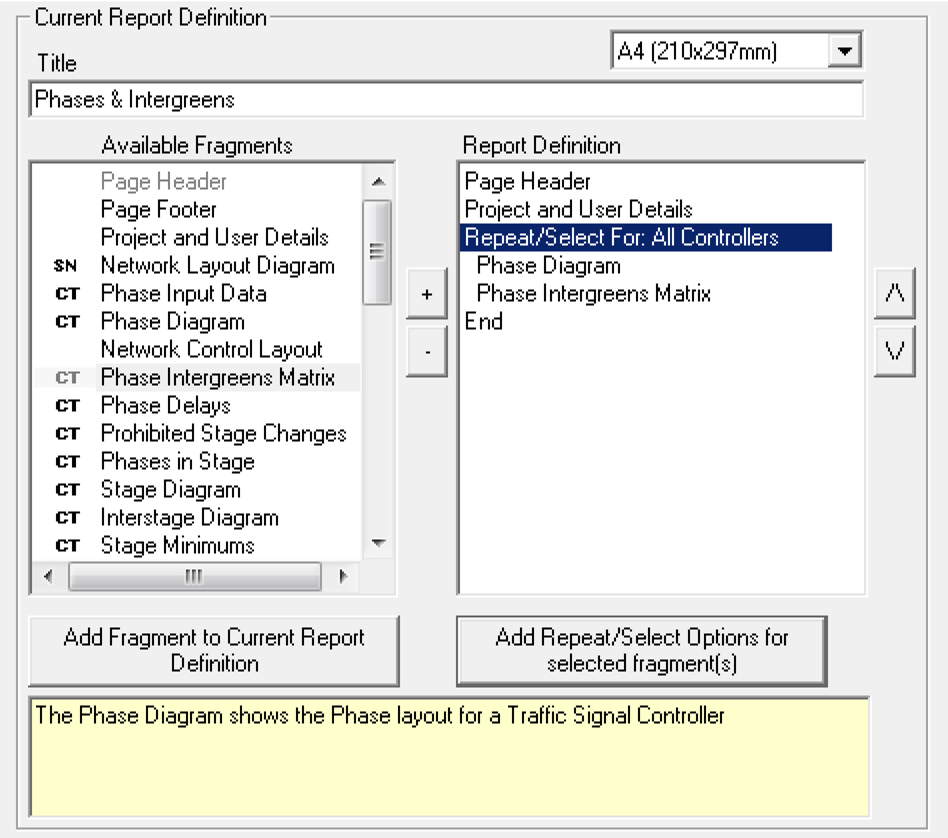
The repeating of Fragments or groups of Fragments are controlled using Repeat/Select blocks. A Repeat/Select Block encloses one or more Fragments in the Report Definition. The Report Builder then repeats these Fragments multiple times for a chosen criterion such as Controller or Scenario.

The following example illustrates the principle of Repeat/Select Blocks. In the example it is desired to have the following report layout:

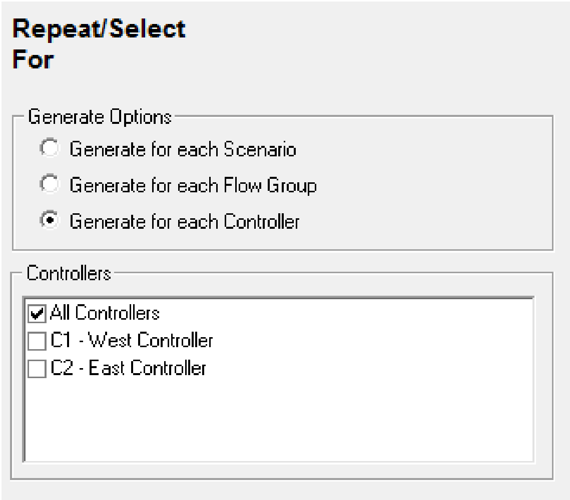
- Project and User Details Table.
- Phase Diagram – Controller 1
- Phase Intergreen Matrix – Controller 1

- Phase Diagram – Controller 2
- Phase Intergreen Matrix – Controller 2
- Phase Diagram – Controller 3
- Phase Intergreen Matrix – Controller 3
- …
- … Repeat for all Controllers.

The following shows how this Report layout is defined in the Report Builder.



As the above example shows, the Report Definition includes a Phase Diagram Fragment and a Phase Intergreen Matrix Fragment enclosed by a Controller Repeat/Select Block. The Repeat/Select Block's options are shown below and indicate that the Fragments enclosed by the block will be repeated for All Controllers.



Repeating a Block of Report Fragments

A block of Report Fragments can be repeated as follows:

- In the Report Builder's Report Definition List click the fragments you wish to repeat whilst holding the control (CTRL) key down. This will select multiple Report Fragments from the list.
- Click the 'Add Repeat/Select Options for selected fragment(s)' button below the Report Definition List. The Report Builder will try to determine what criterion to repeat the fragments for based on the fragment types being repeated. The repeating fragments are shown indented in the Report Definition List emphasising that they are part of the Repeat/Select Block.
- To review the Repeat/Select Options for the block select the Repeat/Select Fragment in the Report Definition List. The right pane in the Report Builder shows the Repeat/Select Options. If desired these options can be changed either to repeat the block based on a different criterion or to select only a subset of items, for example Controllers, for which to repeat the block for.

If necessary a Report Fragment can be nested within two or more Repeat/Select Blocks to repeat the fragment for combinations of two different criteria. For example the Stage Timings fragment needs to know both which Controller and which Scenario to use and would therefore be enclosed in two Repeat/Select Blocks one repeating for Controller and one for Scenario.

Report Fragment Repeat/Select Criteria

Some Fragments which are based around a particular Flow Group, Controller or Scenario must be located in a Repeat/Select Block so that the Report Builder knows which Flow Group etc. to base the Fragment on. Fragments which are required to be within a Repeat/Select block within the report definition indicate this by showing an icon to the left of the Fragment in the 'Available Fragments' list.

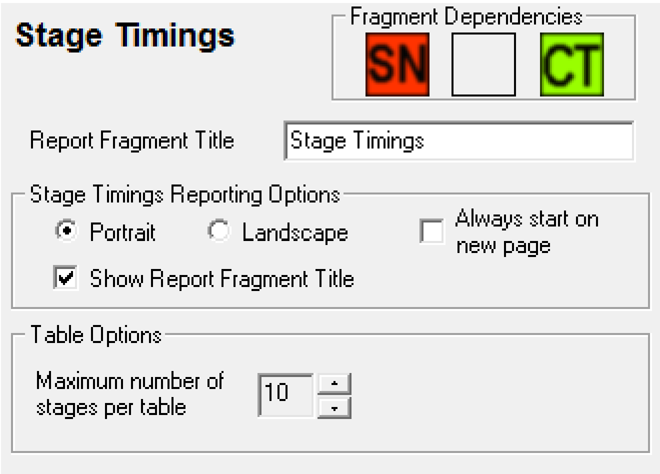
The icons have the following meanings:

SN	The Fragment must normally be within a Repeat/Select Block using Scenario as its Repeat criterion.
FG	The Fragment must normally be within a Repeat/Select Block using Flow Group as its Repeat criterion.

CT	The Fragment must normally be within a Repeat/Select Block using Controller as its Repeat criterion.
CT-SN	The Fragment must normally be within two nested Repeat/Select Blocks one using Scenarios and the other Controllers as their Repeat criteria.

When a LinSig model contains only a single Flow Group, Controller, or Scenario a Repeat/Select Block is NOT strictly required for that criterion as the Report Builder knows that only one item e.g. Flow Group is available to use with the Fragment. It is however recommended to include a Repeat/Select Block around the Fragment to avoid having to change the Reports if further items e.g. Flow Groups are added at a later time, or the Report Definition is saved as a Template.

Each Fragment which is dependent on any Repeat/Select options being specified indicates whether these requirements have been fulfilled using the Fragment Dependencies section at the top of each Fragment. This is illustrated below for the Stage Timings Fragment.



The dependency indicators show which dependencies apply to this fragment and which have currently been fulfilled. In this case the Stage Timings Fragment requires a Scenario (SN) and a Controller (CT) to be specified. The Controller has been satisfied by including the Fragment within a Controller Repeat/Select Block (or only a single Controller exists) but the Scenario has not been satisfied indicating that a further Scenario Repeat/Select Block is required before the Fragment will work correctly.

When a LinSig model contains only a single Flow Group, Controller or Scenario the dependency indicator will automatically be shown as green without the need to use a Repeat/Select Block for that criterion.

6.3.4. Viewing and Printing a Report

As LinSig Reports are created in RTF format, they are viewed, edited and printed using an external RTF compatible Word Processor or viewer. It is anticipated that almost all users will have a modern word processor available to them on their PC, however for users who do not have such software available a free Microsoft Word Viewer can be downloaded from Microsoft's web site www.microsoft.com. You may need to consult your IT department before downloading or installing the viewer. Although JCT will always try to assist with any Word Processor or Viewer related problems, it may sometimes be quicker to contact your Word Processor Vendor or Helpdesk to assist with purely Word Processor related problems.

You should ensure the software you wish to use to view LinSig Reports is set up as the default application for opening *.RTF files. Sometimes other applications can 'hijack' the *.RTF extension leading to Reports inadvertently opening in an incorrect application. To correct this use your Word Processor, or Windows, settings to re-associate the *.RTF extension with your Word Processor of choice.

Once a Report has been defined, the Report can be viewed in several ways using the buttons at the bottom of the Report Builder's left pane. These are:

- **Preview.** This creates the report file in a temporary location avoiding polluting the main data folder with a large number of report files as the Report is refined. If desired the Report can be edited in the word processor but if so it should be saved to a folder other than the temporary folder.
- **Final Save and View.** When you are happy with your Report use 'Final Save and View' to specify where the file will be saved before opening the file in your word processor. This allows you to ensure the file is saved in your preferred location.
- **Save.** This saves the Report file without viewing and is intended for the quick preparation of a number of reports for later checking.

6.4. Exporting Graphics

Several LinSig Views can be exported to a number of graphics file formats to allow them to be used in engineering drawings or Desk Top Publishing (DTP) applications.

6.4.1. Exporting a View to CAD

A View is exported to CAD using the universal DXF (Drawing Interchange Format) file format. This file can then be imported to any CAD software that supports DXF import.

6.4.2. Exporting Views to DTP and Word Processors

Many DTP packages support DXF and this can be used in this case. As a quicker alternative LinSig allows a View to be copied to the Windows Clipboard as a scalable metafile. This can then be pasted into many Desktop Publishing and Word Processing packages using standard Windows cut and paste techniques. As the format used is a scalable metafile, the pasted diagram can be resized within the DTP software with no loss of quality.

7. Examples

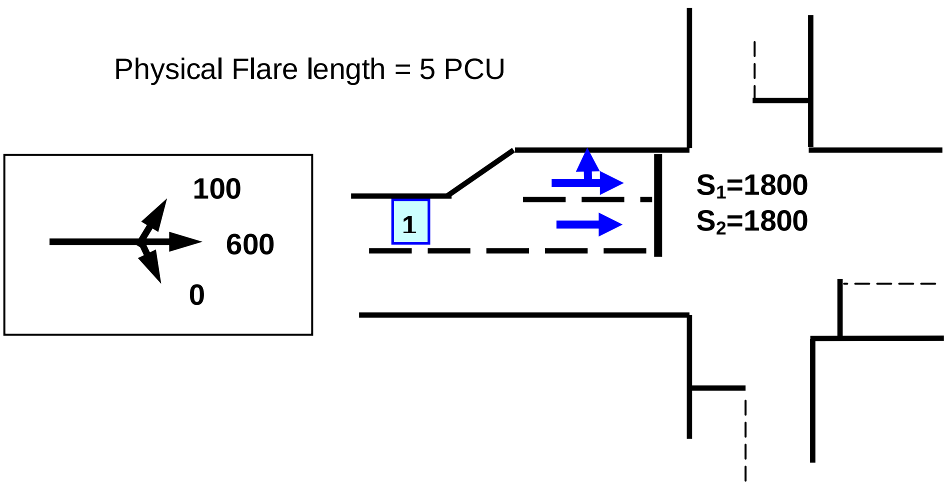
7.1. Arm Structure Examples

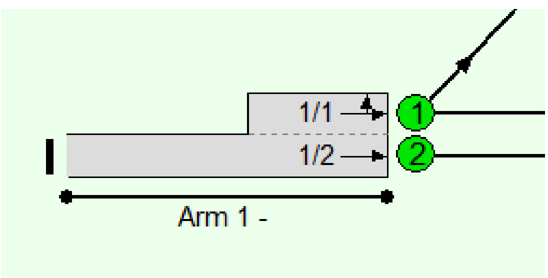
This section provides a series of examples to illustrate how different junction geometries and traffic scenarios are coded into LinSig Arm Structures.

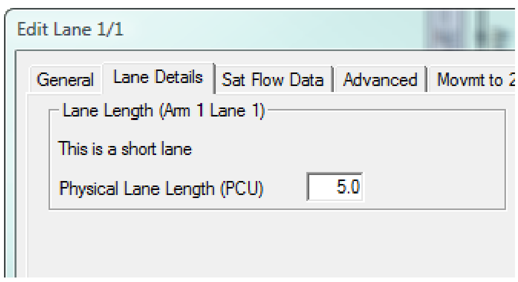
7.1.1. Example 1 – Flared Entry

In the example below the Approach on Arm 1 is configured as having one long offside lane and one short nearside lane. The inside lane can hold 5 PCUs (this represents approximately 30 meters).

- The Short Lane is created by selecting the Long Lane, right clicking and choosing ‘Create Short Lane to Left’ from the pop-up menu.
- The length of the Short Lane is set as 5 on the Lane Details tab of the Short Lane’s ‘Edit Lane’ dialog box.



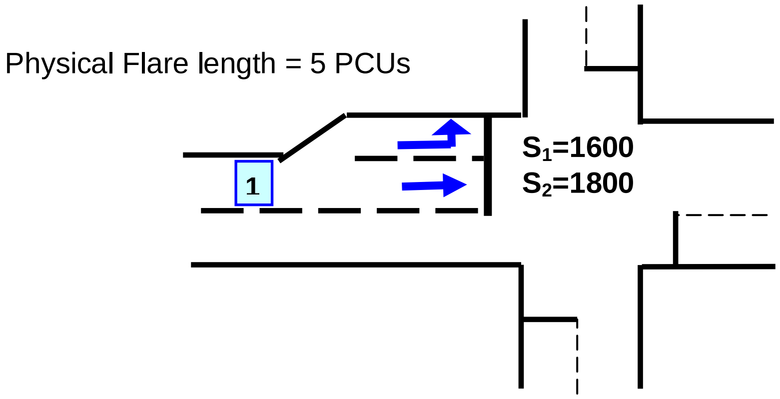


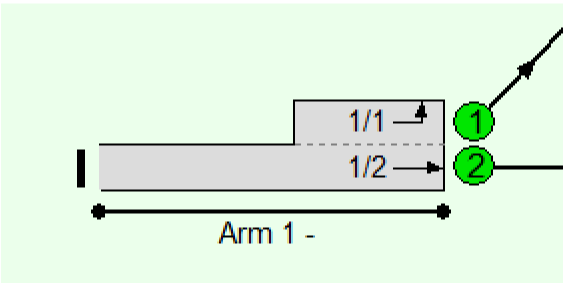


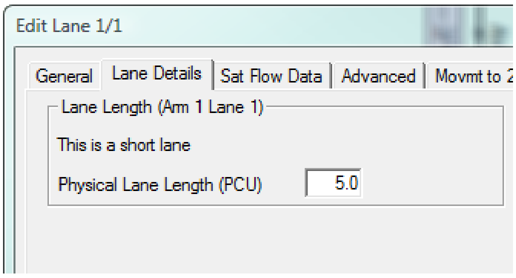
7.1.2. Example 2 – Left Turn Bay

The figure below shows an example where the inside Lane is flared and is designated as an exclusive left turn Lane.

- The Short Lane is created by selecting the Long Lane, right clicking and choosing 'Create Short Lane to Left' from the pop-up menu.
- The length of the Short Lane is set as 5 on the Lane Details tab of the Short Lane's 'Edit Lane' dialog box.
- Unlike earlier versions of LinSig LINSAT does not need to be used to calculate an expected usage of the Short Lane. LinSig 3's traffic model deals with this internally.

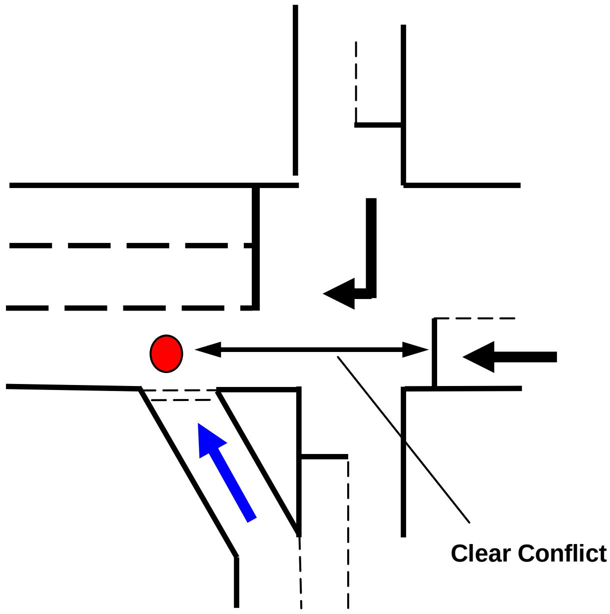


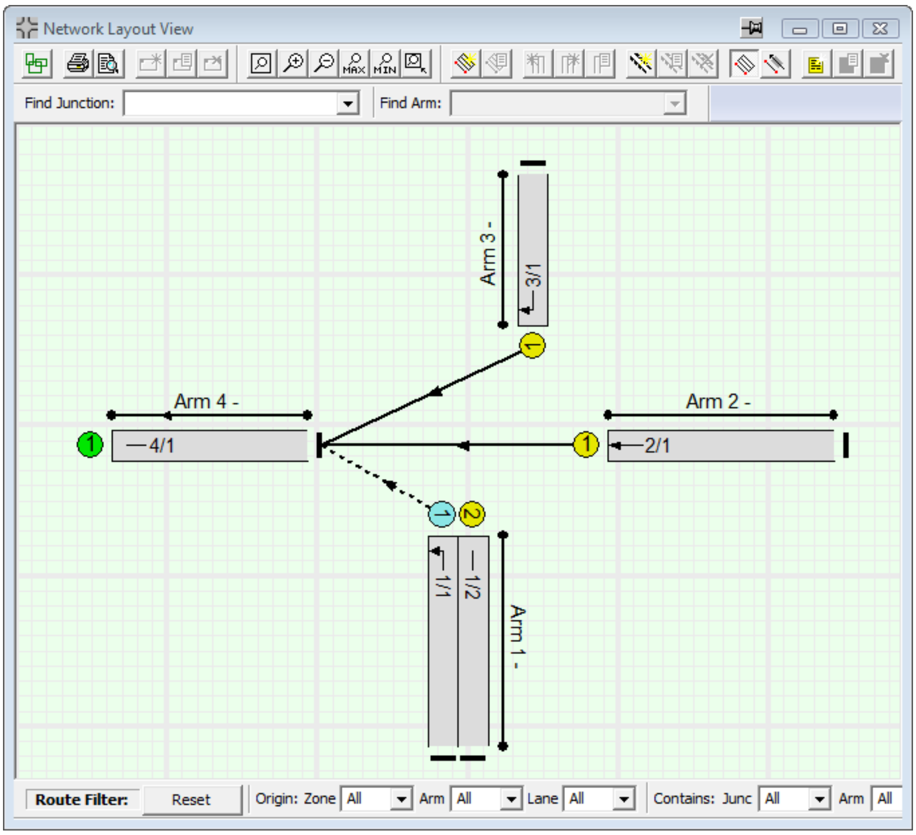


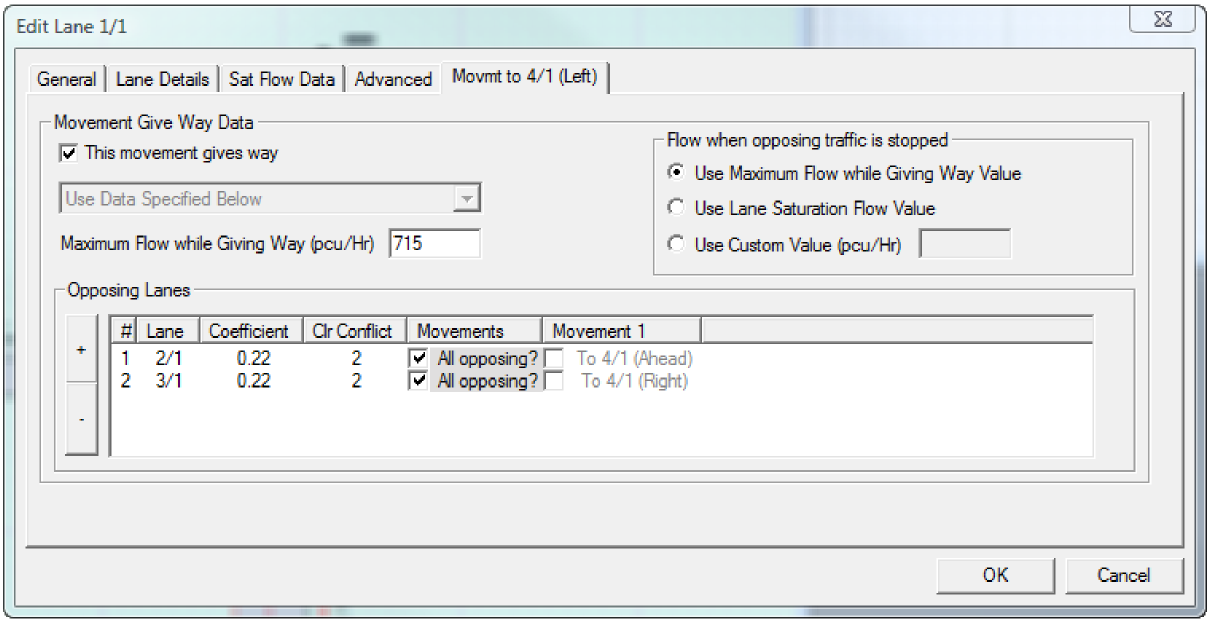


7.1.3. Example 3 – Left Turn Give Way

This example is a signal controlled junction where a left turn is controlled on a give-way basis. The left turn Lane is assumed to be long enough not to block or be blocked by the ahead traffic in the adjacent Lane. The left turners must give way to two movements (Lane 2/1 and Lane 3/1). Assuming an Intercept of 715 and coefficient of 0.22, the parameters are entered into the left turns Movement tab of the Lane 1/1 Edit Lane dialog box as shown below.





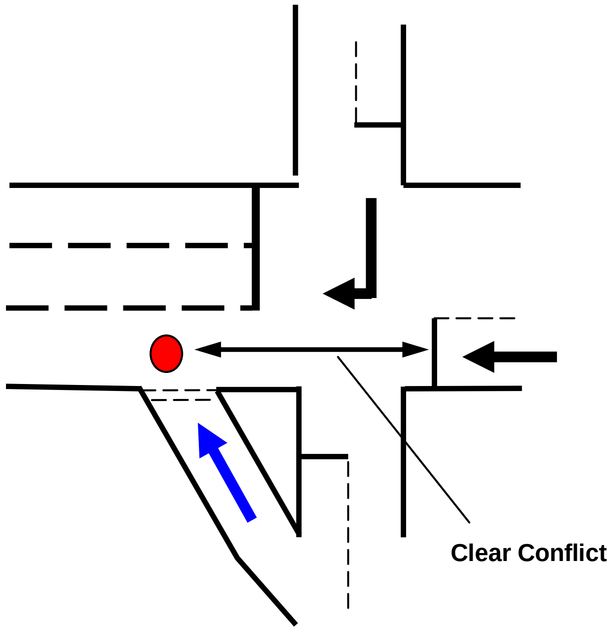


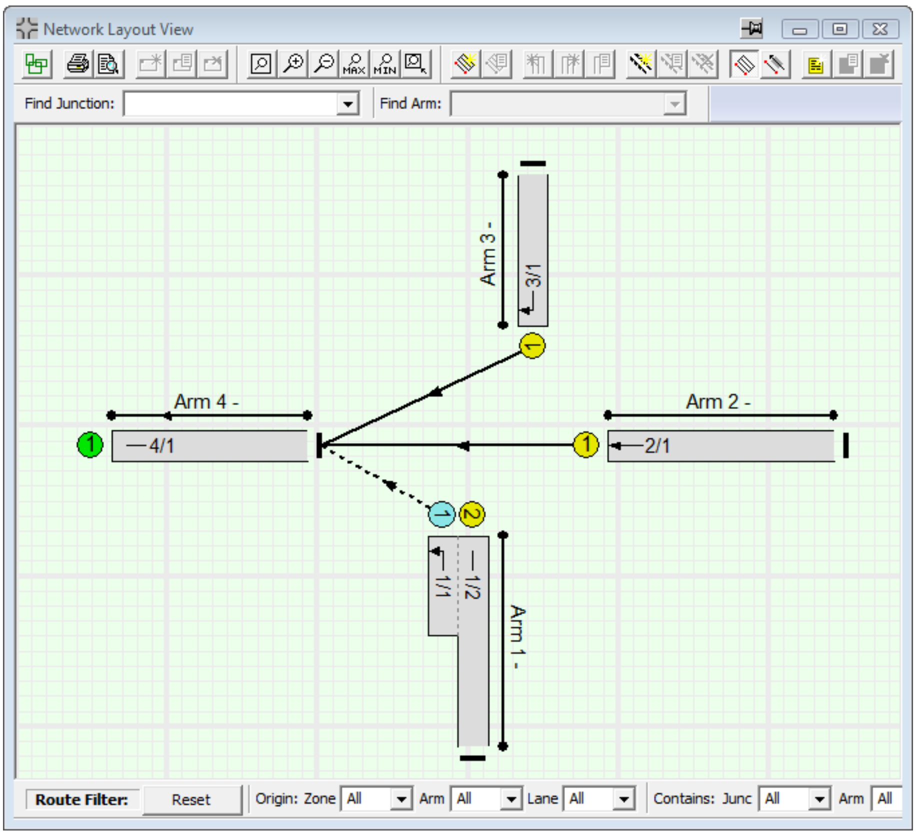
Points to note are:

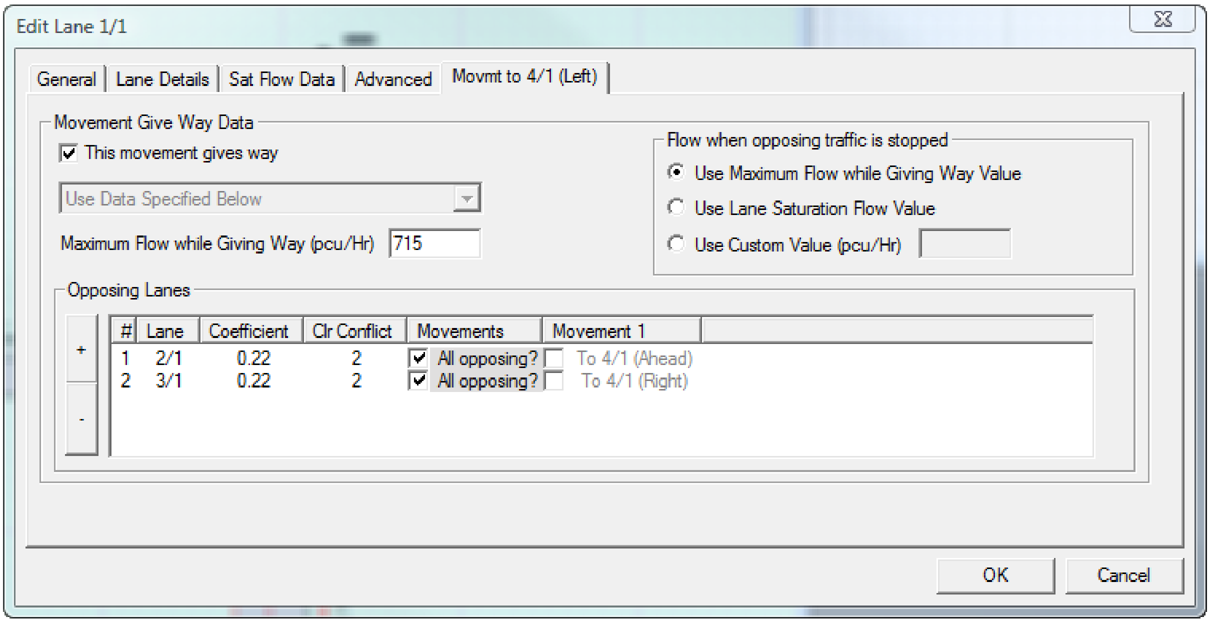
- The section marked ‘Flow when opposing Traffic is stopped’ if left set to ‘Use Lane Saturation Flow Value’ will mean that during periods of the cycle where the passing traffic is stopped the rate of egress would be the Lane saturation flow which in this case would be wrong.
- In order for LinSig to know the time at which traffic from Lane 2/1 and Lane 3/1 is passing the give way entry a clear conflict time is added for each of the opposing Lanes. The clear conflict time relates to the cruise time for vehicles travelling between the stop line and the give way point for each movement.
- In this case there is only a single movement on each Opposing Lane therefore the ‘Opposing Movements’ part of each Opposing Lane entry is set to ‘All Opposing’ for each Opposing Lane. In more complex examples only certain movements leaving each Opposing Lane may oppose. In this case the ‘All Opposing’ box should be unticked and each individual movement’s box ticked if it opposes.

7.1.4. Example 4 – Left Turn Give Way from a Short Lane

This example is identical to Example 3 but the left turn Lane is short with the potential to block back into the ahead Lane. The left turners must give way to two movements (Lane 2/1 and Lane 3/1). Assuming an Intercept of 715 and coefficient of 0.22, the parameters are entered into the left turns Movement tab of the Lane 1/1 Edit Lane dialog box as shown below.





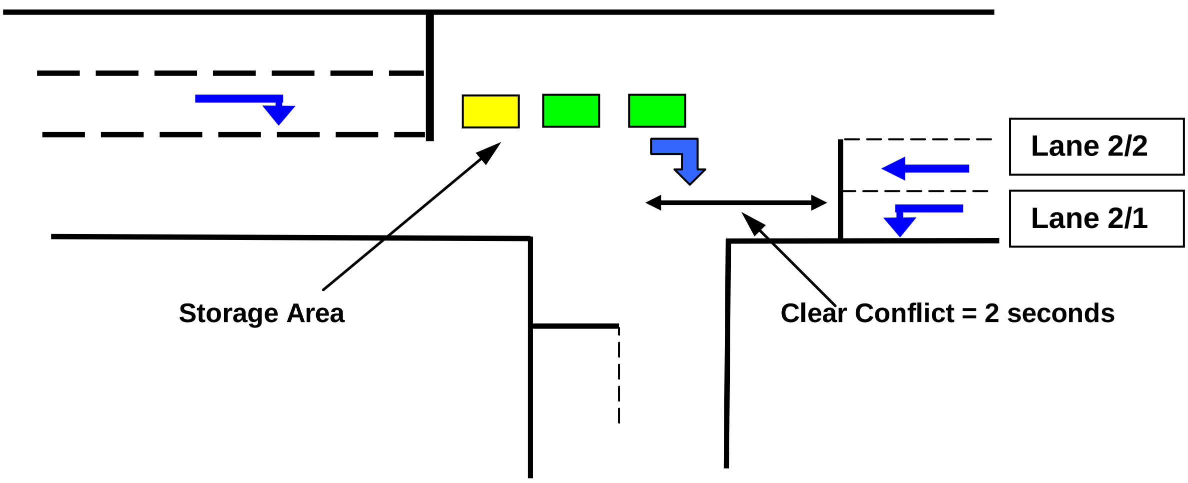


Points to note are:

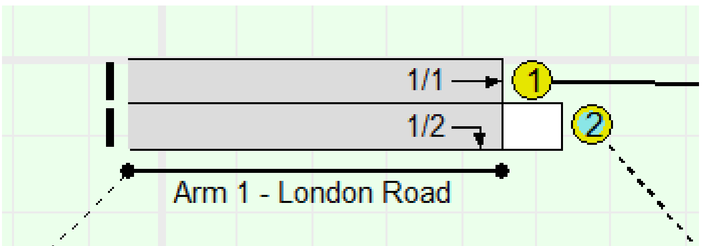
- The Lane settings are identical to those for the long give-way Lane above. Only the fact that the give-way Lane is created as a Short Lane is different.
- LinSig will model any queue build up in the give-way Lane and its effect on the traffic in the Ahead Lane.
- LinSig will model any Lane starvation effects caused by traffic queuing in the Ahead Lane preventing left turners reaching the left turn Lane.

7.1.5. Example 5 – Right Turn Opposed Movement at Signals

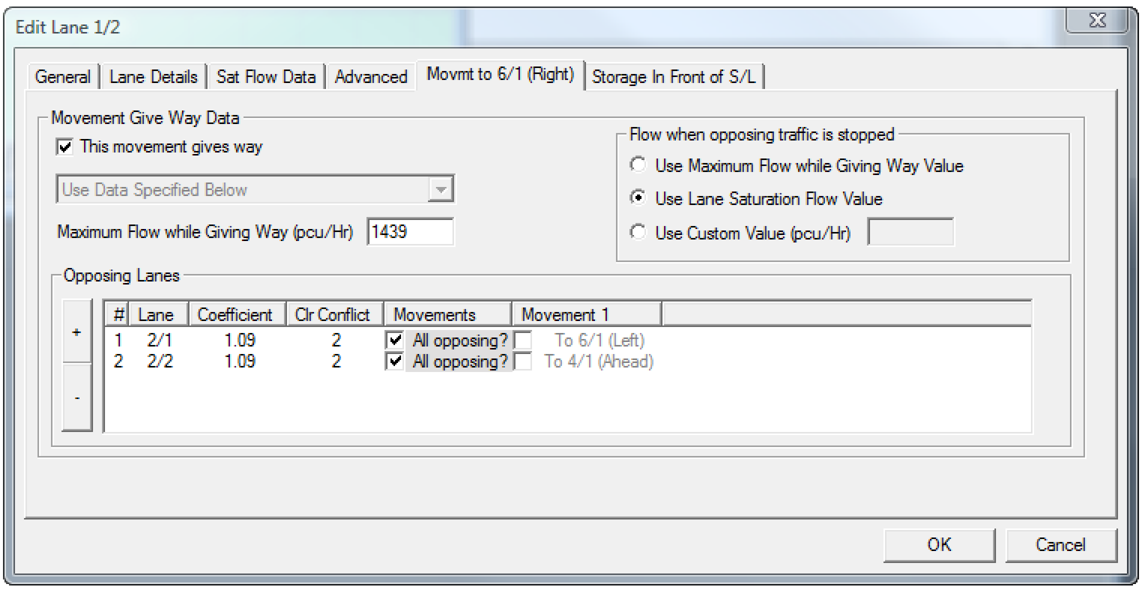
A signal controlled junction where a right turn is controlled on a give-way basis (opposed). In this example, the right turners must give way to two movements (Lane 2/1 and Lane 2/2). It is assumed that three right turners can store in front of the stop line and that two right turners will clear during the Intergreen. The Right Turn Factor is assumed to be 0.5.



The mechanism of what happens with respect to the right turning traffic is directly dependant on the method of control. However, the parameters entered into LinSig are the same and LinSig uses them as appropriate depending on the method of control used.



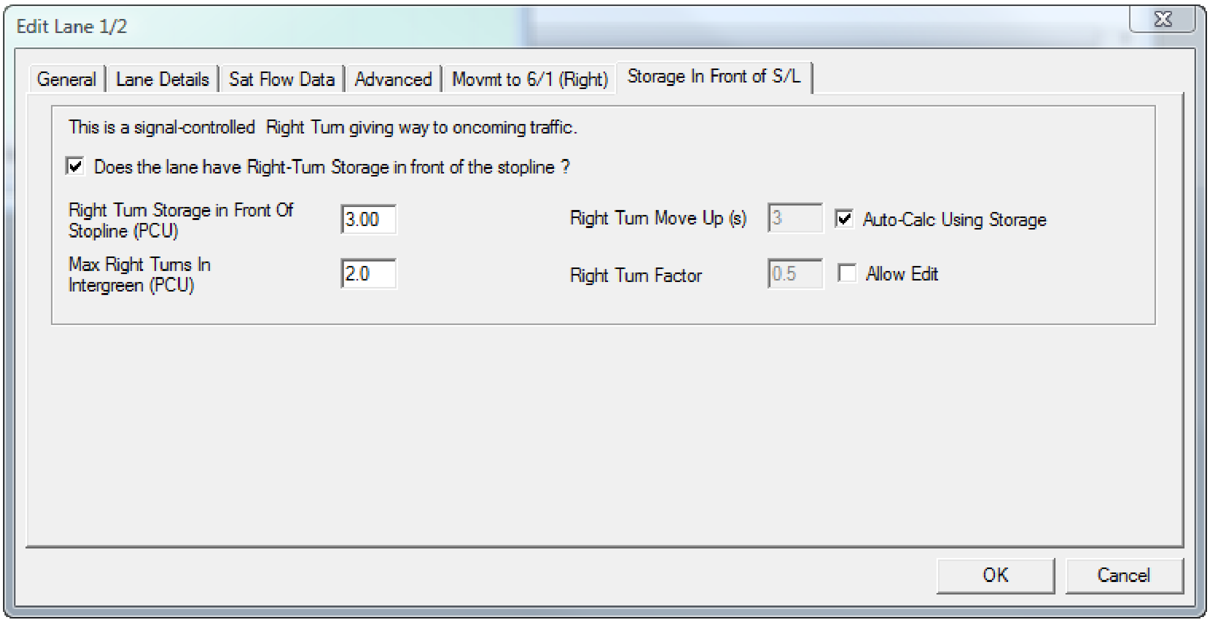
The above settings are entered in the 'Movement' and 'Storage in Front of Stop Line' tabs of the right turn Lane's Edit Lane dialog box.



Points to note on the Movement tab include:

- In this case there is only a single movement tab as all the traffic on the Lane turns right. There is therefore only a single movement – the right turn - leaving the Lane.
- The give way settings used are 1439 for the 'Maximum Flow when giving way' (sometimes known as the intercept) and 1.09 for the 'Coefficient' for each opposing movement. These values are chosen to give a similar right turn give-way capacity relationship as used in the Webster & Cobbe method in LinSig V1.
- The 'Flow When Opposing Traffic is stopped' section is set to 'Use Lane Saturation Flow Value'. This reflects the fact that in this case when the opposing traffic is clearly stopped (for example when a right turn IGA is running) traffic on the right turn will run at a much higher saturation flow equal to the Lane's main Saturation Flow specified on the Saturation Flow Data tab. This is due to right turning traffic not needing to pause and check for oncoming traffic.
- Clear Conflict times of 2 seconds have been entered for each of the Opposing Lanes.

As this Lane includes Storage in front of the stop line the 'Storage in Front of Stop Line' tab is also used to enter the Lane's settings:



Points to note on the 'Storage in Front of Stop Line' tab include:

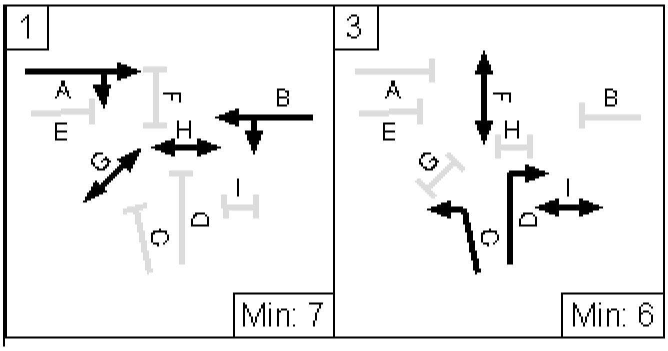
- The 'Does the Lane have Right-Turn Storage in front of Stop Line' box is ticked indicating this Lane is a Right Turn Lane with Storage in front of the Stop Line.
- The Right Turn Storage, the Maximum Turns in the Intergreen and the Right Turn Factor are entered as specified above.
- The Right Turn Move-up Time is set to use 'Auto Calc' to estimate the Right Turn Move Up time from the Right Turn Storage.

7.1.5.1. Signalling Conditions

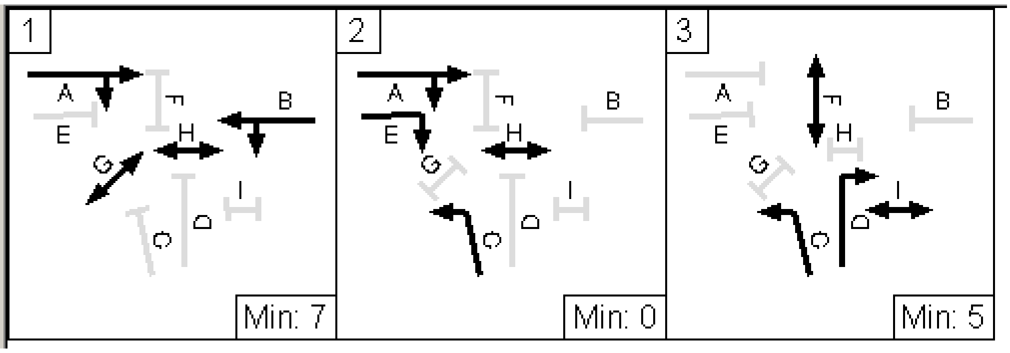
LinSig will calculate the capacity of the right turn according to the method of control set in the Stage Sequence. For example, the diagram below shows a simple Stage arrangement where there are no special opportunities for right turning traffic to turn except during gaps in Stage 1 and during the Intergreen at the end.

The capacity is simply calculated as:

> ***The number turning in gaps +***
> ***the number turning during the Intergreen***



If the method of control is modified to provide an early cut off Stage (indicative arrow) as shown below, then right turners can turn in gaps during Stage 1, at full saturation flow during Stage 2 and will also receive a bonus for the number of vehicles stored in front of the stop line prior to Stage 2 starting.

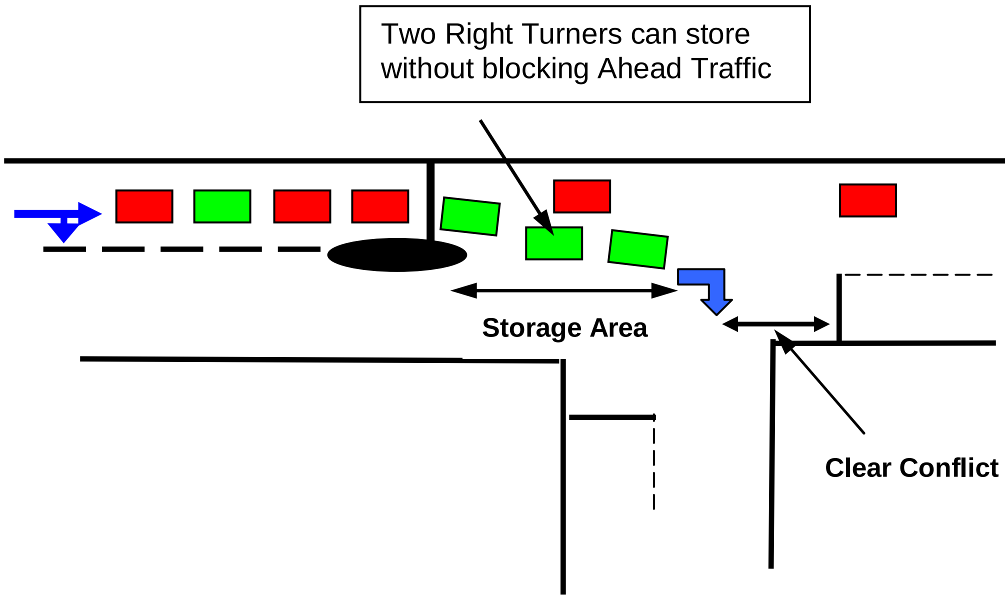


The capacity is simply calculated as:

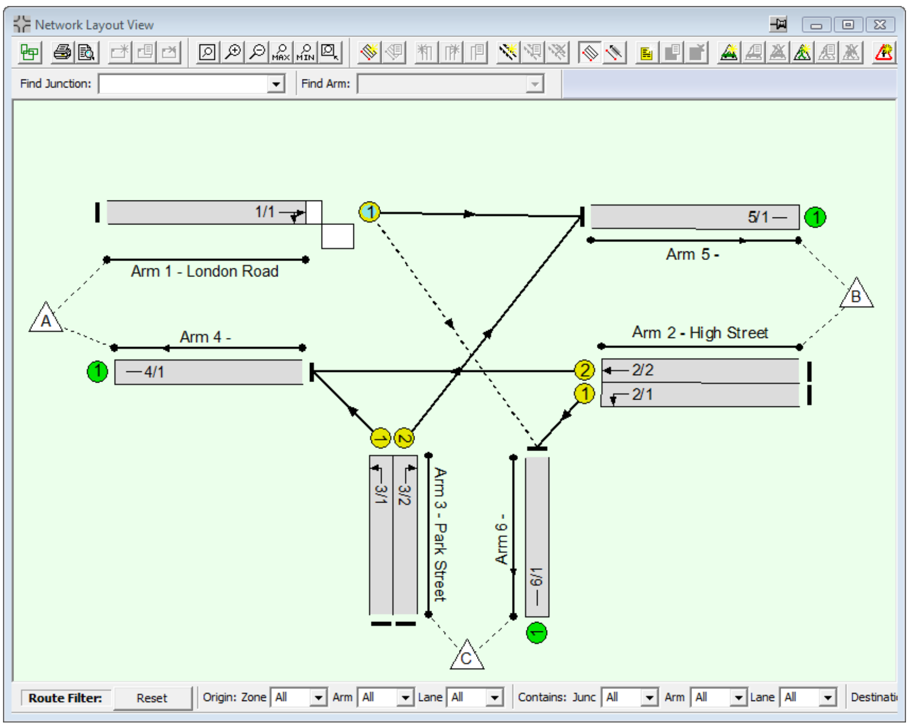
> ***The number turning in gaps +***
> ***the number turning during the Indicative Arrow +***
> ***the bonus for storage in front of the stop line (= 3 in this case)***

7.1.6. Example 6 - Mixed Right Turn Opposed Movements and Ahead Traffic in a single lane.

This example features ahead and right turning traffic sharing the same Lane. A critical factor in modelling capacity for situations which have a mixture of ahead and right turning traffic in a single lane is whether or not right turners at the front of the queue block the Ahead vehicles. LinSig has a unique feature which allows this to be modelled. The area in front of the stop line is known as the Storage Area and represents the number of right turners that can wait in front of the stop line. The number of PCU which can store before blocking is used to specify how many of these waiting PCU do not block the Ahead traffic whilst waiting.



The LinSig Model Lane Structure used to model the above is:

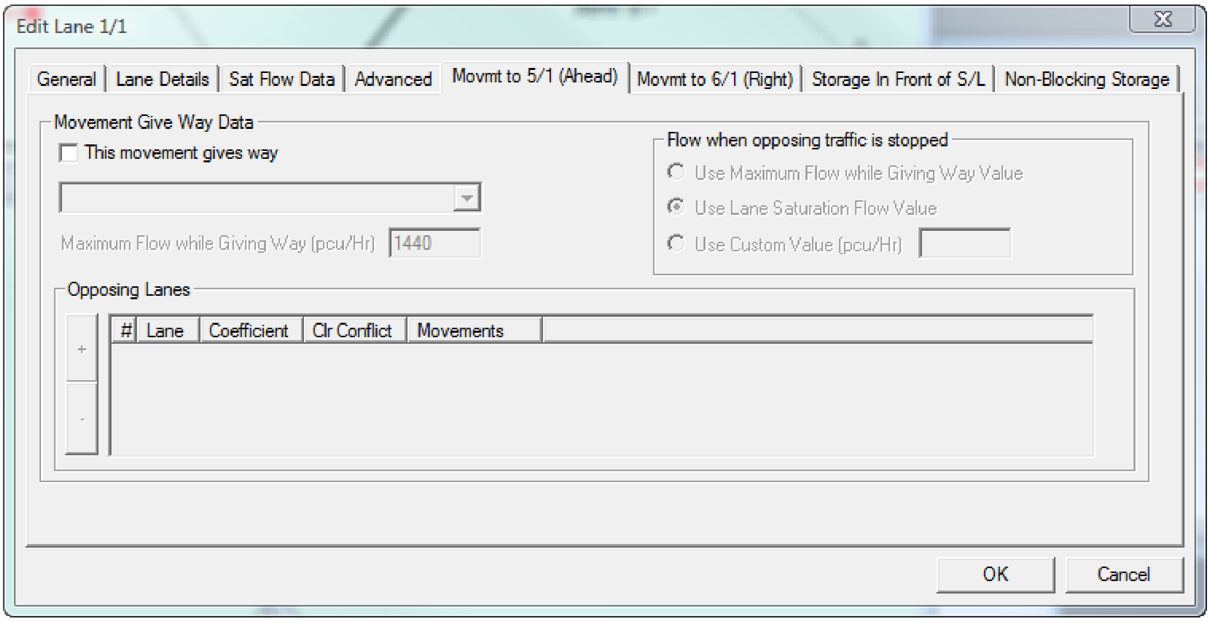


The settings governing the Right Turn Lane are entered using the following tabs of the Lane 1/1 Edit Lane dialog box.

- Movement tab for Ahead movement to Lane 5/1.
- Movement tab for Right Turn movement to Lane 6/1.
- Storage in Front of Stop Line tab.
- Non-Blocking Storage tab.

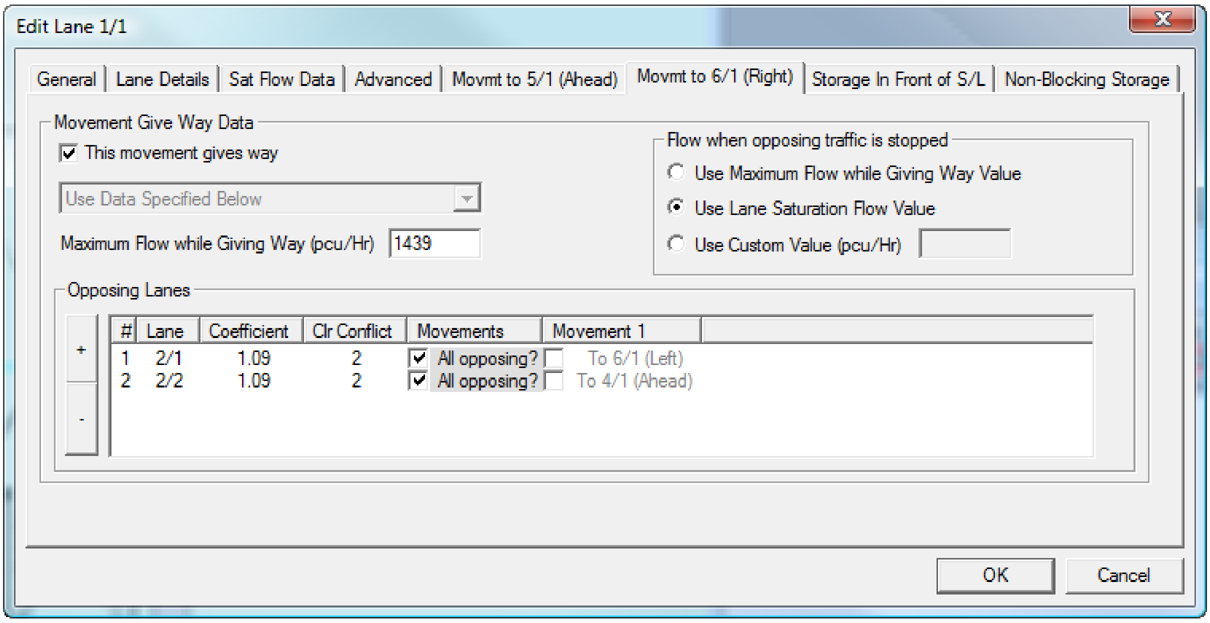
Ahead Movement Tab

The Ahead Movement tab is simply used to specify that the Ahead movement is non-give-way. This is done by unticking the 'This Movement Gives Way' box.



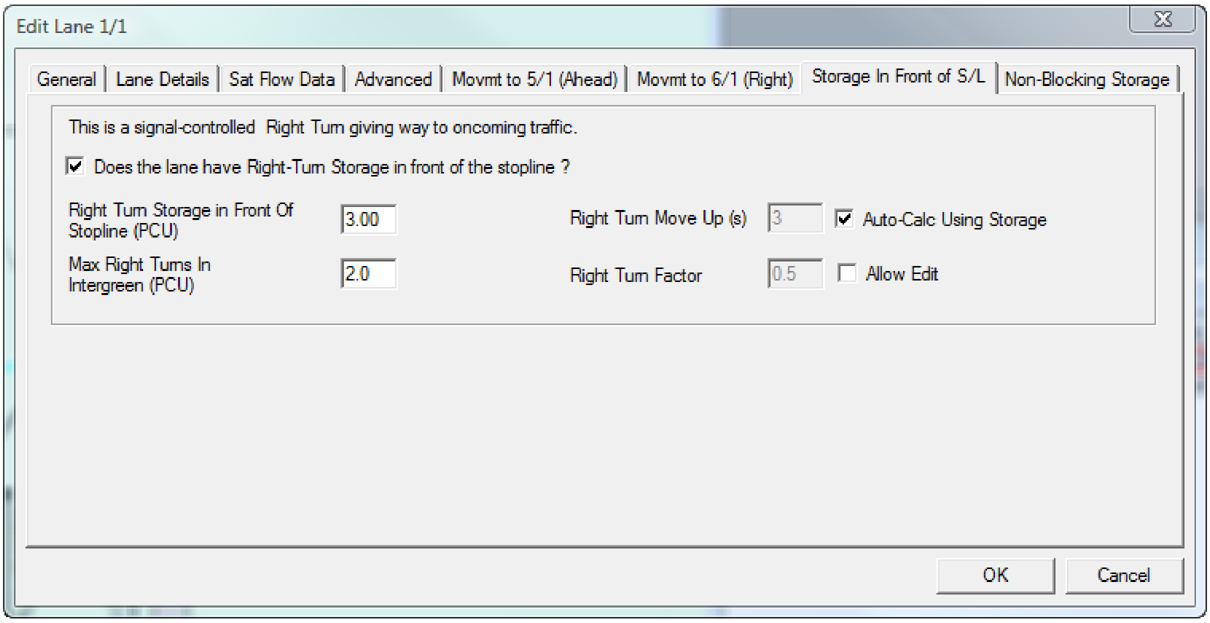
Right Turn Movement Tab

The Right Turn Movement tab is used to enter the give-way parameters for the Right Turn in a similar manner to Example 5 above.



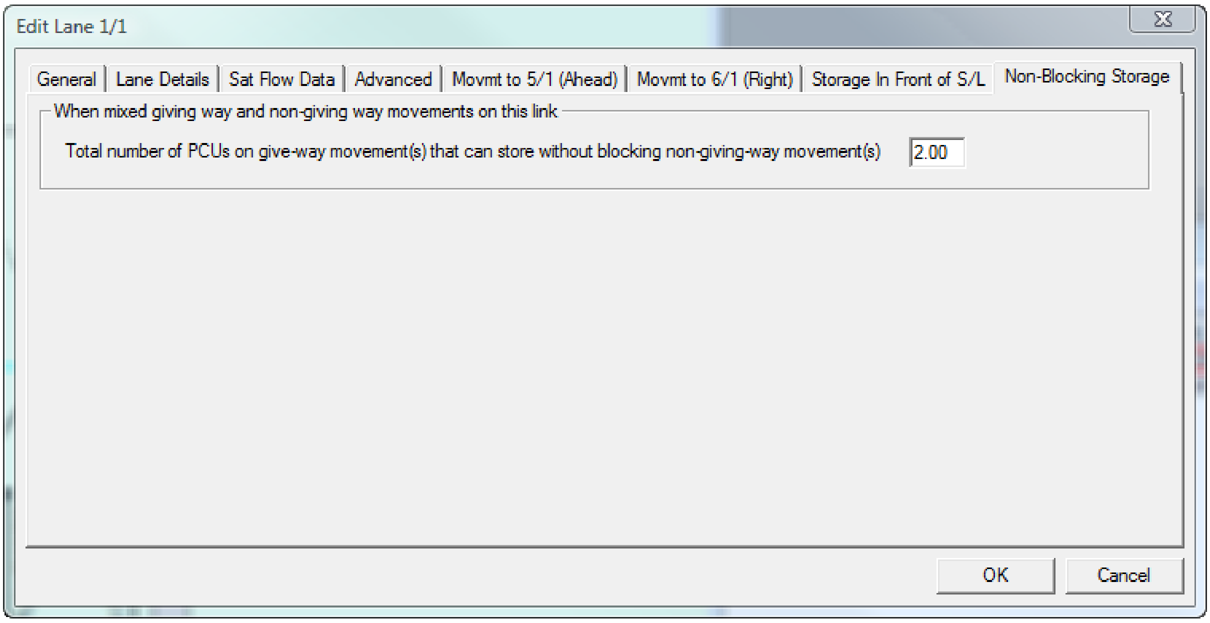
Storage in Front of Stop Line Tab

Similarly the Storage in Front of Stop Line settings are entered the same as for Example 5.



Non-Blocking Storage Tab

LinSig automatically models the interaction between the Ahead and Right turn movements sharing a single lane based on the above settings. However as discussed above the Right Turners may block the Ahead movement if they queue back out of the storage area. The 'Non-Blocking Storage' tab is used to specify how many right turning PCUs can accumulate before blocking the Ahead traffic.



The only setting on the tab is the number of PCU at the front of the storage area which do not block Ahead traffic. In this case as shown above this is 2 PCU with the third Right Turn Storage PCU blocking the Ahead traffic.

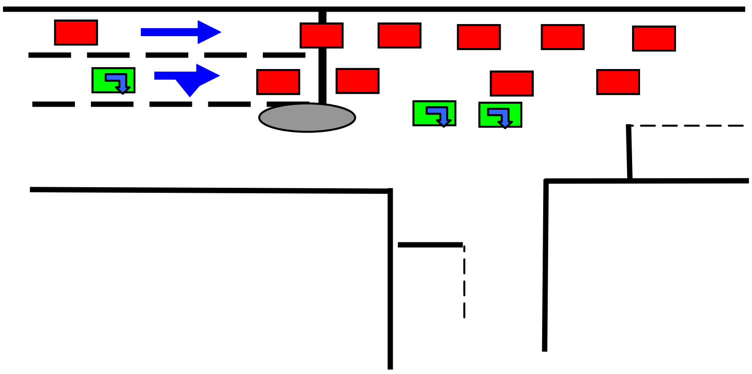
7.1.7. Example 7 - Mixed Right Turn Opposed Movements and Ahead Traffic in Multiple Lanes.

In this example the ahead traffic can choose one of two Lanes. In the right Lane however any ahead traffic choosing this Lane must share with the right turning traffic in the Lane.

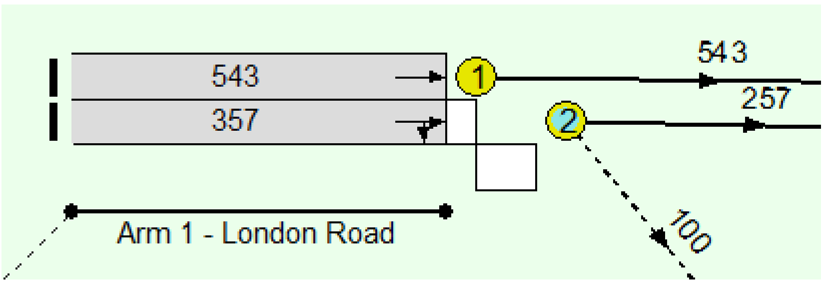
In modelling this example the difficulty is in deciding on how the Ahead traffic will distribute between the Ahead Lanes bearing in mind that once the offside lane becomes blocked, ahead traffic will be reluctant to use it.

The Lane on the offside can be set up as illustrated in Example 6.

In previous versions of LinSig trial and error was required to determine the appropriate split of ahead traffic between Lanes. In LinSig 3 the process or more straightforward as the delay based assignment considers the delay to ahead traffic in both Lanes and places just enough ahead traffic in the right Lane to give equal ahead delays in both Lanes.



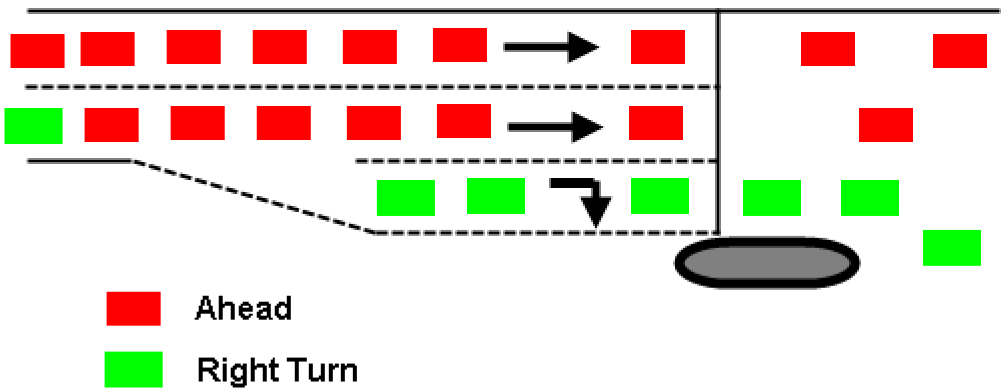
Mixed Ahead and Right Traffic in Multiple Lanes



Lane Allocation –Assigned traffic

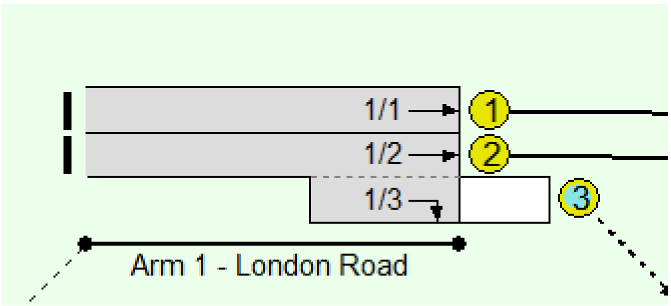
7.1.8. Example 8 - Mixed Right Turn Opposed Movements and Ahead Traffic in Multiple Flared Lanes

In this example the right turning traffic has an exclusive right turn lane but this lane is a short lane. This has been difficult to model in many signal design packages for some time including earlier versions of LinSig. LinSig Version 3 allows the situation show below to be modelled more intuitively and with significantly better accuracy than previously possible.



Mixed Ahead and Right Traffic in Multiple Lanes with flare

The Lane structure used to model the above is:



Some important points to note include:

- The left lane is assumed to be unaffected by the right turn and is therefore modelled as a separate Lane.
- The right turn Lane is modelled as a Short Lane. This is different from LinSig 2 where this situation was modelled using a right turn bay with non-blocking storage greater than the storage in front of the stop line.
- The right turn lane is modelled using the same settings as Example 7 but is created as a Short Lane.

A. Appendix A - Installation and Setup

A.1. Hardware Requirements

The minimum hardware requirements for LinSig are not onerous, however, as with all computer aided design software a well specified graphics system will make the software much easier to use and more productive. The minimum hardware specification should therefore be treated as just that – a minimum on which the software will be useable, but some tasks such as optimisation may run quite slowly. The suggested hardware specification will significantly increase LinSig's usability and should be adhered to wherever possible.

Minimum Practical Hardware specification

- PC with at least a 2 GHz processor.
- 1Gb RAM. (This is mainly used by Windows)
- 25Mb of free hard disk space.
- Minimum Graphics resolution of 1280x1024 with 16.7M colours.
- 19" Monitor.
- CD Drive (required for installation only).
- A two-button mouse.

Suggested Hardware specification for optimum productivity

- PC with a 3.0 GHz processor (or multi core running at a lower speed)
- 2-4Gb RAM.
- 25Mb of free hard disk space.
- Graphics resolution of 1920x1200 with 16.7M colours.

24" Monitor

- An additional monitor (with compatible graphics card(s)) significantly speeds up working on larger models.
- CD/DVD Drive (required for installation only).
- A three-button wheel mouse. Not essential but extremely useful for zooming graphical views.

Please note that depending on the version of Windows you are using, the hardware requirements for Windows may exceed the above.

A.2. Software Requirements

LinSig can be used on any of the following platforms:

- Microsoft Windows 7.
- Microsoft Windows Vista 32 bit.
- Microsoft Windows XP

Although LinSig isn't formally tested on 64 bit versions of Windows it is envisaged that it should run successfully. Please inform us if you would like to use LinSig on 64 bit Windows as we will produce a fully supported 64 bit version for Windows 7 if sufficient demand arises.

Although LinSig is not formally supported on earlier versions of Windows, it is envisaged that LinSig should run successfully on Microsoft Windows 2000 with Internet Explorer Version 5.5 or above. LinSig will not run on Windows 98 or earlier.

A.3. Installing LinSig

Before attempting to install LinSig please ensure you are logged into Windows as an administrator. Sometimes Antivirus Software may also interfere with installation in which case it should be temporarily disabled until installation is complete. This may require assistance or permission from your IT department.

To install LinSig from CD:

- Insert the LinSig CD into the computers CD Drive.
- If Setup starts automatically, simply follow the on screen prompts from the setup program.

Alternatively if Setup does not run automatically:

- Click on the "Start Button".
- Choose "Run" from the start menu.
- Enter the command "x:setup.exe" where x is the drive letter of your CD drive.
- Follow the on-screen prompts from the setup program.

When Setup is complete, LinSig can be started by choosing "LinSig 3" from the Programs section of the Start Menu.

If LinSig Version 2 is installed on the same PC LinSig Version 3 does NOT affect the Version 2 install and installs a new copy of Version 3.

A.4. Activating the LinSig Software Licence.

LinSig includes a sophisticated copy-protection mechanism to prevent software theft by unlicensed copying or installation of the software. The system has been designed to place as little burden as possible on legitimate licensed users whilst discouraging casual copying of the software. We regret having to require activation; however, it has become increasingly necessary over the past few years due to a high number of often inadvertent but serious multiple breaches of licence conditions.

The Activation procedure in LinSig 3 is identical to that in LinSig Version 2.

A.4.1. Definitions

The following definitions are useful in understanding the activation process:

- **Installation ID.** A 30-character code that is unique for an installation of LinSig on a particular PC. The Installation ID is created by LinSig and is based on a number of physical characteristics of the PC.
- **Activation Code.** A 36-character code provided by JCT Consultancy to unlock or activate the software on the PC. The Activation Code is calculated to be a match for an Installation ID and is therefore unique for each PC. Only if a copy of LinSig's Installation ID has a correctly matching Activation Code will LinSig run.

- **Licence Server.** A separate program that hands out licences to LinSig Workstations. This is only used on sites with Unlimited Network Licences and avoids IT Staff or users having to separately activate each PC on the network. The Licence Server also verifies PCs are actually located on the licensed site. It would normally be installed and run on a server, or other PC that is switched on all or most of the time users wish to use LinSig.
- **Workstation.** The users' computer on which LinSig is run on. Also sometimes referred to as a Client PC.

A.4.2. Product Activation for Individual PCs

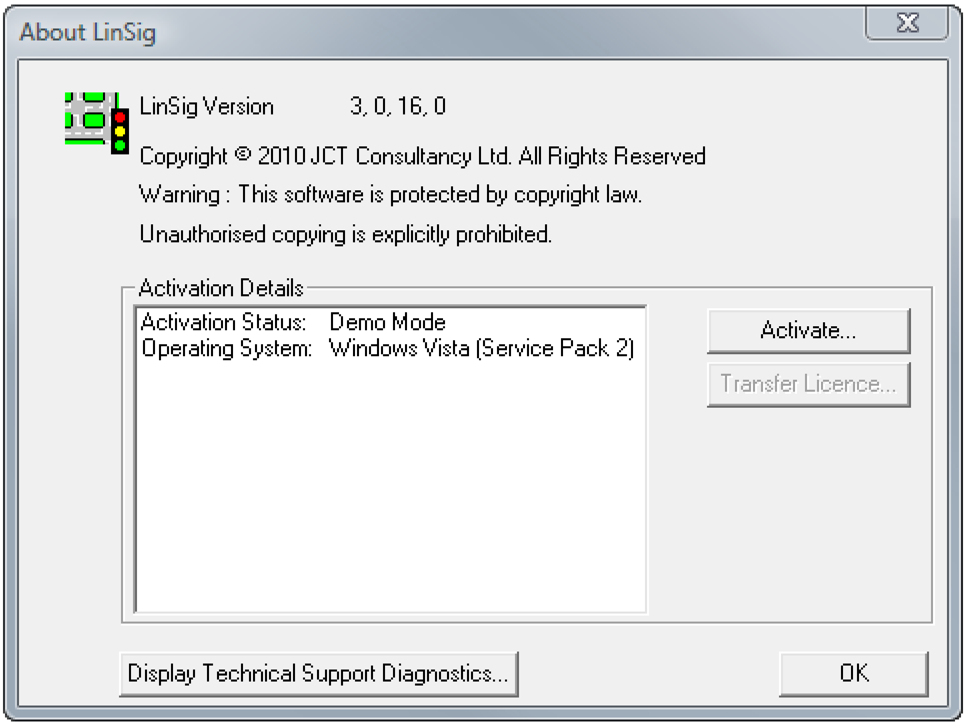
Individual PC activation applies only to Single PC, Four PC and Ten PC site licences and is not available for Unlimited Networked PC Site Licences.

Installing LinSig either from CD or by downloading will install a copy of LinSig on your PC. The software will however only work as a restricted demonstration copy unless it is activated following the procedure below. You may install the software and use it for demonstration purposes on as many PCs as required; however only the number of PCs actually licensed may be activated to allow fully functional use. Licences can be freely transferred between computers within a Site Licence's site using the procedure described later in this section.

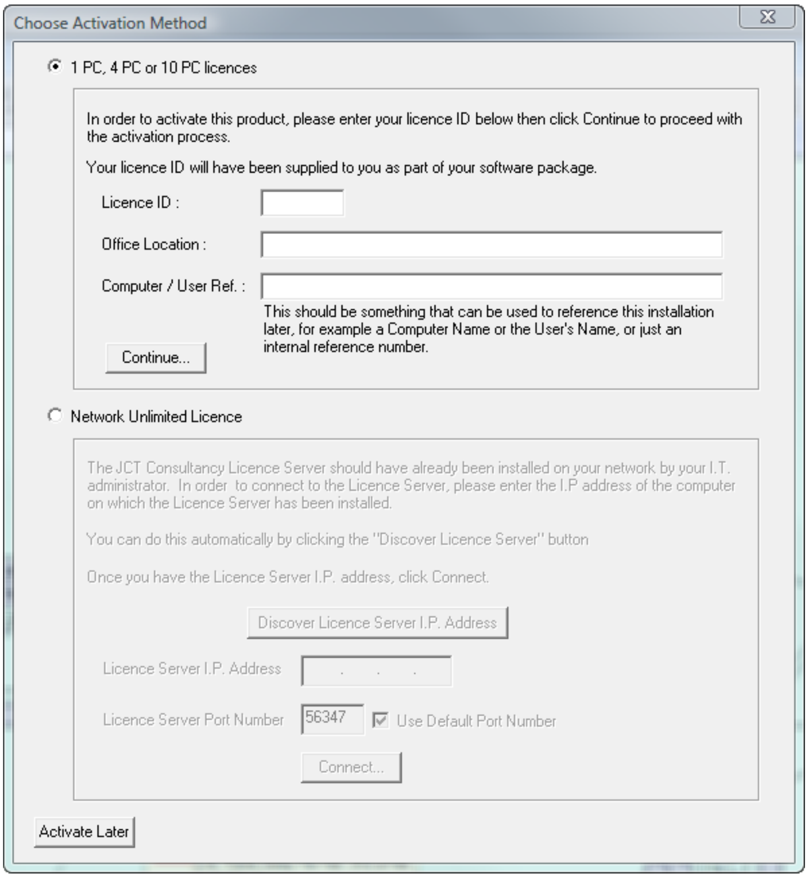
A.4.2.1. Activating the LinSig Licence for the First Time

The activation procedure is as follows:

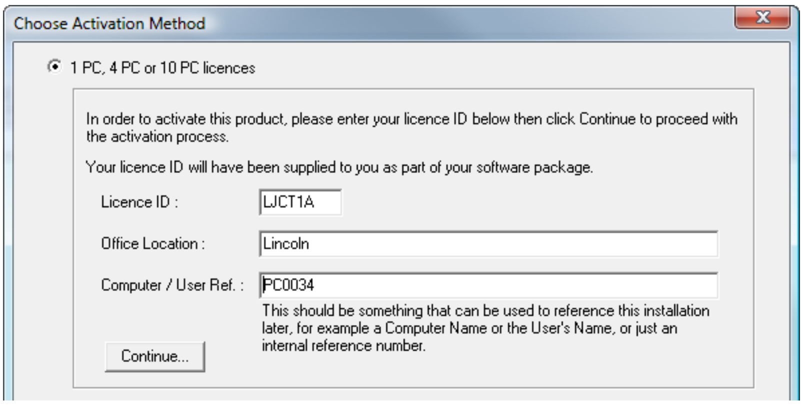
1. When running LinSig for the first time the software will present a dialog box showing information relating to the activation status of the software on the particular PC. This will show the activation status to be 'Not activated'. If the OK button is clicked, the activation process will be cancelled and LinSig will run in demonstration mode. It can still be activated later by choosing 'About LinSig…' from the 'Help…' Menu and proceeding as below.



2. Clicking the 'Activate…' button will start the activation process by requesting the type of activation. In this case, select the first option labelled '1PC, 4PC or 10PC Licence'. Activation for Unlimited Network Licences is covered later in this section.

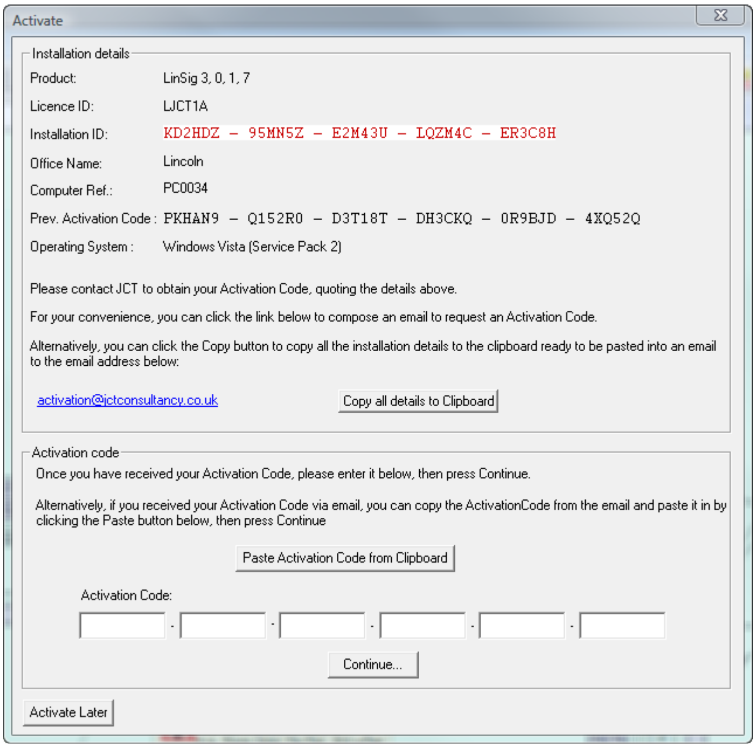


3. Find your LinSig Site Licence ID. This is the six-character code shown on both the order documentation accompanying LinSig and also on the LinSig CD. An example of its format is LJCT14. If you do not know your Licence ID please contact JCT Consultancy at this point to obtain it. Having determined your Licence ID, enter it as requested. LinSig will also request some additional information such as Office Name and Computer/User Reference. Although this information is not essential it is strongly recommended to enter it as it clearly identifies to us which PC the licence has been installed on. We are then able to use this information when your IT department requests a list of installed licences in your organisation when/if software support is renewed. Click Continue when you have entered all the information.

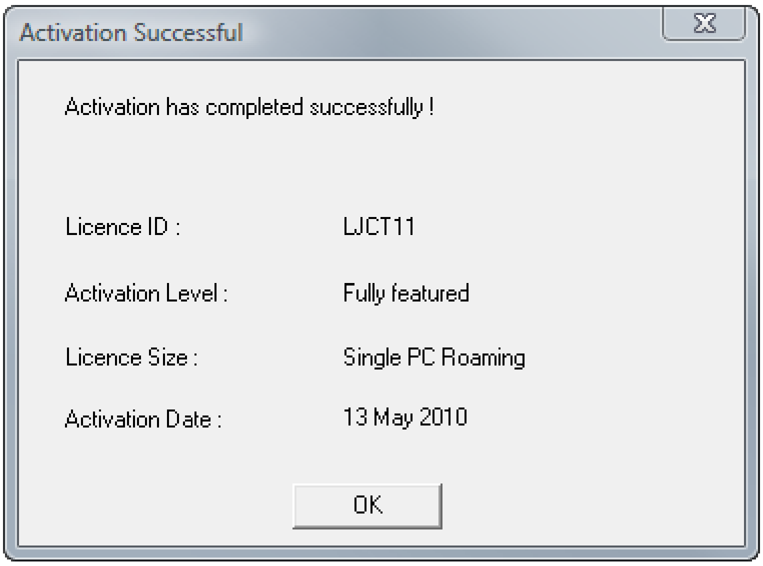


4. LinSig will provide you with an Installation ID (displayed in red) that is a customised code for the installation of LinSig on your PC. The Installation ID should be sent to

JCT Consultancy either by email or by telephone. If your email system is compatible, a hyperlink is provided in the activation dialog box that will email your details to JCT. JCT will provide you with a customised activation code for your PC by return. Whilst waiting for your code you can leave the Activation Dialog box if desired using the 'Activate Later' button. You can return to the dialog at any point following the same procedure as above.



5. When you receive your Activation Code, it should be entered into the 'Activation Code' section of the Activation dialog. Clicking the 'Continue' button will then activate LinSig and display the relevant licence details, which you should check to ensure they conform to your LinSig licence agreement.



6. You will now be able to use LinSig with no restrictions on your PC.
7. If your licence allows, further PCs can be activated using the above procedure.

A.4.2.2. Updating the LinSig Licence

Once activated LinSig can be updated with minor updates without the need to reactivate after each update. It may however be occasionally necessary to update the product activation details; for example, when software support is renewed it will be necessary to apply a new activation code to activate software support features, such as the ability to download updates, for a further year.

To update Product Activation:

1. Choose 'About LinSig…' from the 'Help…' menu within LinSig.
2. Click on 'Change Activation'.
3. If your Licence size is not changing, confirm your Licence ID by clicking 'Continue'. If you are upgrading your licence size, a new Licence ID will have been supplied with your upgrade documentation. Please ensure any new Licence ID supplied is used as retaining the old Licence ID may lead to inadvertent copy protection issues in the future.
4. LinSig will provide a new Installation ID. This will be different from the Installation ID originally used when activating LinSig for the first time.
5. Send the Installation ID to JCT as described above.
6. JCT will supply a matching Activation Code by return. When you receive the new Activation Code, enter it in the space provided and click 'Continue'.
7. Check the updated licence details displayed are as expected.

A.4.2.3. Deactivating and/or Moving LinSig to a different PC

The Product Activation system used by LinSig ensures that the software can only be used on the number of PCs actually licensed. If it is necessary to permanently remove LinSig from a PC, the licence can easily be transferred to a new PC or parked with JCT.

Please note that is essential you deactivate LinSig on the old PC before uninstalling LinSig or disposing of the PC.

Licence Parking

If you wish to dispose of a PC containing a LinSig licence before a new replacement PC is available it is possible to 'Park' the PC's licence with JCT until needed for the new PC. If you wish to Park any LinSig licences please contact JCT Software Support who will be happy to guide you through the process. You will require access to the PC being deactivated during the call.

Transferring a Licence Directly to a new PC

If you have access to both the old PC and its replacement it is possible to directly transfer the LinSig licence from the old PC to the new PC without needing to contact JCT. To carry out this transfer please follow the procedure below. This will deactivate the licence on the old PC and provide an Activation Code to activate the new PC. **You must have access to both the old and new PCs to carry out this procedure.**

On the new PC:

1. Install LinSig as normal.
2. Follow the instructions in 'Activating LinSig for the first time' up to the point where LinSig provides an installation ID. This Installation ID would normally be sent to JCT

who would supply an Activation Code. Do not send this code to JCT – the old PC being deactivated will use the new PCs Installation ID to provide the Activation Code for the new PC.

3. Make a careful note of this Installation ID for use in the next step.

On the Old PC:

1. Choose ‘About LinSig’ from the ‘Help’ menu.
2. Click the ‘Transfer Licence’ button.
3. Enter the Installation ID from the new PC as provided above.
4. An activation code for the new PC is provided. Make a note of this activation code. LinSig on the old PC has now been deactivated and can only be used as demonstration software.

On the New PC:

1. Either take up where you left off the new PC above or if LinSig has been closed follow the activation procedure as described above in ‘Activating LinSig for the first time’ up to the point where an activation code is required.
2. Enter the Activation Code provided from the old PC.
3. Click ‘Continue’. LinSig should now report that the new PC has been successfully activated, and provide details of the activated licence.
4. Check that the licence details are as expected.
5. LinSig is now correctly licensed on the new PC.

A.4.3. Product Activation for Unlimited Networked PC Licences

For users with Unlimited Networked PC Licences (UNPCL) it is not necessary to activate each PC individually, instead workstations obtain a licence from a central licence server, which authorises them to run LinSig. This benefits users by removing the need to handle large lists of Installation IDs and Activation codes, and also avoids the security risk of JCT handing out a potentially unlimited number of individual PC activations for LinSig, which may inadvertently migrate away from the licensed site.

A.4.3.1. Installing LinSig on Workstations

LinSig is installed on each workstation the same way as for non-networked installations as detailed above in ‘Installing LinSig’. However, Product Activation does NOT need to be carried out on each Workstation. If desired the LinSig CD may be copied to a networked server and LinSig installed over the network, however setup must be run on each Workstation whether locally or using a remote installation system such as SMS.

A.4.3.2. Installing and Activating the Licence Server

The Licence Server installation files are located in the ‘LicServer’ folder on the LinSig installation CD. The Licence Server can run on Windows Vista, Windows Server 2003/2008, Windows XP and Windows 2000. To install the Licence Server, run ‘setup.exe’ from the relevant subfolder, and follow the on-screen prompts.

Once the Licence Server has been installed, it needs to be activated to give out LinSig licences to Workstations. This process is carried out using the Licence Server Administration Utility that is located on the Windows ‘Start’ menu, under ‘JCT Consultancy LinSig Licence Server’, on the Licence Server PC. This utility allows an administrator to activate the Licence Server for LinSig using a similar procedure to that described above for activating an individually licensed Workstation. Once activated no further activation is required for the Licence Server or Workstations except for major product upgrades or software support renewals.

The PC on which the Licence Server is installed should be continuously available to Workstations over the network whenever they are in use, however each Workstation will store a local copy of its licence for a number of days allowing server restarts and maintenance to take place without adversely affecting LinSig users.

A.4.3.3. Telling Workstations Where to Find a Licence Server

As Workstations default to being individually licensed each Workstation must be told to use a Licence Server and also where the Licence Server is located on the network. This can be achieved either by manually configuring each Workstation or by using a Software Deployment System to pre-configure the licence mode and Licence Server location in each Workstation's registry.

Manual Configuration of Workstations

1. When running LinSig for the first time the software will present a dialog box showing information relating to the activation status of the software on the Workstation. This will show the activation status to be 'Not activated'. If the OK button is clicked, the activation process will be cancelled and LinSig will run in demonstration mode. It can still be activated later by choosing 'About LinSig…' from the 'Help…' Menu and proceeding as below.
2. Clicking the 'Activate…' button will start the activation process by requesting the type of activation. In this case, choose 'Network Unlimited Licence'.
3. Click 'Discover IP Address of Licence Server'. LinSig will search the local network for a LinSig Licence Server. If one is found its IP address is stored as the Workstations default Licence Server. If the Licence Server has not yet been set up yet or cannot be discovered automatically, the Licence Servers IP address can be entered manually. If you do not know the correct IP address please consult your IT Department, or the person responsible for installing and setting up the LinSig Licence Server.
4. Click 'Connect' to attempt to connect to the LinSig Licence Server. If the connection is successful, LinSig will display details of its licence. If the Workstation cannot connect to the Licence Server, ensure that the Licence Server is running and the Workstation can access the Licence Server across the network without interference of firewalls or similar security software.

Centralised Configuration of Workstations

Workstations can also be configured to use a particular Licence Server by using a third party Software Deployment System such as Microsoft SMS or Operations Manager to deploy additional configuration information to the registry of Workstations at installation. If you wish to use this feature, please obtain the Advanced Configuration User Guide from JCT Consultancy. This describes in detail the registry entries required to fully customise the licensing of Workstations on Unlimited Networked PC Sites.

A.4.3.4. Technical Note for IT Administrators

Please note that the Licence Server must be visible to the client PC over the network to allow the Unlimited Networked PCs Licence to function correctly. To use the Unlimited Networked PCs Licence the network must be configured to allow the Licence Server and Workstation to communicate using TCP on the port selected in the activation configuration. Please also note that the LinSig Licence forbids the forwarding of broadcasts from the Licence Server to segments of a network geographically located outside of the LinSig Site.

A.5. Obtaining and Installing Updates to LinSig

Users with current software support have free access to LinSig updates via the software support section of our web site www.jctconsultancy.co.uk. Updates will generally include bug fixes, minor requested enhancements and documentation updates.

To download updates please access our software support section of our web site www.jctconsultancy.co.uk where full instructions are provided for downloading and installing LinSig updates.

In the vast majority of cases, updates will not require the LinSig licence to be reactivated.

A.5.1.1. Automatic Update Notification

If desired LinSig can automatically notify you when updates to the software are available to download from the JCT Consultancy Web Site. In order to respect any concerns for privacy LinSig installs with automatic update notification switched off, and asks whether you would like to enable this when LinSig is run for the first time. Updates can easily be switched on at any time using the 'Program Settings and Defaults' dialog box accessed from the LinSig 'File' menu. LinSig transmits no personal information to JCT Consultancy when checking for updates.

Automatic Update Technical Note

The automatic update notification uses your computers Internet connection and should operate correctly provided your computer or company's firewall allows access to http over port 80. Please contact us if automatic update does not work correctly on your computer, as it MAY be possible (with the agreement of your IT department) for us to reconfigure LinSig to work with your firewall.

NC4

Department for Transport

TAG UNIT M1.2

Data Sources and Surveys

May 2020

Department for Transport

Transport Analysis Guidance (TAG)

https://www.gov.uk/transport-analysis-guidance-tag

This TAG unit is guidance for the **MODELLING PRACTITIONER**

This TAG unit is part of the family **M1 – MODELLING PRINCIPLES**

Technical queries and comments on this TAG unit should be referred to:

Transport Appraisal and Strategic Modelling (TASM) Division
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SW1P 4DR
tasm@dft.gov.uk

Contents

1 Introduction

1.1 Introduction to Data Sources

1.1.1 The aim of this unit is to identify what sources of transport data are available to practitioners developing transport models. The unit also addresses the methods used for gathering data including survey methodology.

1.1.2 Data collection is necessary in order to build a transport model and to inform the numerical parameters used in the model, many of which cannot be observed directly, and therefore need to be estimated using a sample of data (**model calibration**). Models should be compared against independent observed data for the current or a recent year to demonstrate that the model is of sufficiently good quality (**model validation**) to form the basis from which to calculate future forecasts.

1.1.3 One of the main constraints on data collection is the cost of conducting transport surveys. This cost can be reduced by minimising the need to collect new data. In order to reduce the costs of building a transport model, the practitioner should make use of all relevant and available transport data sets.

1.1.4 This unit lists the major available data sets and describes the data which are contained within them. It addresses transport data which are relevant to the development of demand models as well as supply or assignment models.

1.1.5 This unit also contains advice on conducting study specific surveys. It addresses the requirements of each type of survey and discusses the standards to be expected with each survey type including survey accuracy.

1.2 Relationship of this Unit to Other Advice

1.2.1 This unit excludes advice on processing traffic data for the development of demand matrices for transport models, which is set out in TAG unit M2.2 – Base Year Demand Matrix Development.

1.3 Structure of this Unit

1.3.1 After this introductory section, this unit has been divided into two main sections. Section 2 contains guidance on:

- available data sets for demand modelling including TEMPro / NTEM data
- highway traffic data sets
- Public Transport (PT) passenger data
- network data

1.3.2 Section 3 contains guidance on conducting surveys for specific studies and includes:

- data specification and requirements for demand models
- conducting highway traffic surveys and the standards and tolerances required for the data
- PT surveys and the methods to be used for gathering these data

2 Existing Data Sources

2.1 Introduction to Existing Sources

2.1.1 This section identifies existing sources of transport data held by the Department and its agencies, what these existing data sets contain and where those data sets currently reside.

2.1.2 Taking advantage of existing transport data can be of vital importance in the specification and implementation stages of model development as referred to in the Guidance for the Technical Project Manager, and will reduce costs.

2.2 Planning and Demand Data

2.2.1 Multi-modal studies should be undertaken using a transport model, with demand changes controlled by exogenously defined planning data (possibly with some feedback to land-use).

2.2.2 It is highly desirable that the planning data used should at some level be consistent with the DfT NTEM (National Trip End Model) projections, so as to ensure that different regions do not engage in competitive bidding by assuming local growth rates which are implausible when summed across the whole economy. NTEM projections can be accessed using TEMPro (Trip End Model Presentation Program).

2.2.3 TEMPro itself is a program used to distribute the results from the NTEM forecasts. The existing NTEM system works mainly at the local authority district level. Forecasts of population, households, workforce, and jobs for each district over 30 years have been prepared by the Department, after consultation. These forecasts are used in a series of models which forecast population, employment, car ownership, trip ends and traffic growth by district. The NTEM data set can be viewed using the TEMPro software. Both are available free of charge on the TEMPro website: https://www.gov.uk/government/organisations/department-for-transport/series/tempro

2.2.4 TEMPro is designed to allow detailed analysis of pre-processed trip-end, journey mileage, car ownership and population/workforce planning data from the NTEM. The pre-processed data is themselves the output from a series of models developed and run by the Department. TEMPro can also be used to provide summaries of traffic growth using data from the National Transport Model (NTM).

2.2.5 The current version is multi-modal, providing data on trips on foot, by bicycle, motor vehicle (both as a driver and passenger) by rail and by bus. Users should note, however, that TEMPro trip ends by mode are based on average rates over a wide area and do not necessarily take into account the accessibility of each zone by each transport mode.

2.2.6 In terms of spatial detail TEMPro data is available down to Middle Layer Super Output Area (MSOA). The following data sets can be used for the generation of local planning assumptions at a more detailed level than what is available within TEMPro:

- Office for National Statistics population estimates
- the Business Register and Employment Survey (BRES) employment data
- Ordnance Survey AddressBase data for land use information

2.2.7 The use of a land-use / transport interaction (LUTI) model to provide the ‘planning data’ inputs in interaction with the transport model would obviously raise a different and more specialised set of data requirements which we do not attempt to consider here.

2.3 Traffic Data

2.3.1 The Department has an extensive database of traffic count information available. The following geographical website, www.gov.uk/government/organisations/department-for-transport/series/road-traffic-statistics, provides Annual Average Daily Flow (AADF) and traffic data for every junction-to-junction link on the 'A' road and motorway network in Great Britain. It enables the user to search, view and download these data for each count point on the major road network, and view regional summaries.

2.3.2 An interactive map on the website provides a mapped background to identify traffic flows in specific areas of the country. Data from a sample of points on the minor road network are also available to download from the website.

2.3.3 Complete data sets are also available from the website http://data.gov.uk/. These include road traffic counts, local authority traffic estimates and traffic, speed and congestion data. Before accessing the data users will need to create an account at http://data.gov.uk/user/register.

2.3.4 Journey time information derived from a variety of sources including Global Positioning System (GPS) and Automated Number Plate Recognition (ANPR) data can be accessed through the Department. These data cover the Great Britain road network and contain journey time information disaggregated into 15 minute segments.

2.3.5 The primary use for these data by the Department is to monitor congestion levels and the reliability of journey times on the road network. However, the data may be of use to model developers to validate model network speeds. Access to these data can be given to practitioners working on behalf of the Department or any of its agencies by contacting the Congestion Statistics team in the Department.

2.3.6 Highways England also has a large amount of traffic data available and it is expected that full use will be made of this information. A large source of highway traffic information is the Highways England Traffic Information System (WebTRIS). WebTRIS contains traffic flow and journey time data.

2.3.7 The WebTRIS data set is a central collection and reporting point for 15 minute and hourly based traffic flow information. Traffic flow information from 1,500 roadside inductive loops on the strategic highway network can be obtained from this database. The journey time database within WebTRIS is a processing and reporting system holding all journey time data fed in via a number of sources including roadside cameras and fleet GPS.

2.3.8 Traffic flow and journey time information from WebTRIS can be obtained from the website http://webtris.highwaysengland.co.uk/.

2.3.9 In some cases, traffic data will also be available from local authorities. It is advised that users contact the authority in their area of concern to inquire about the availability and extent of traffic data.

2.4 Public Transport Data

2.4.1 As an input to PT models, it is possible to obtain rail passenger matrices from the LENNON rail ticket information database. As an initial stage, the demand estimate derived from the processing of LENNON data is a station to station trip matrix.

2.4.2 It should be noted that LENNON information has a number of limitations:

- it does not cover tickets bought for travel on the major light rail or underground systems of the UK, including the London Underground

- it cannot assign a point to point journey where a multi-modal ticket is bought (e.g. rail/bus/LRT travelcards)
- it does take account of travel that takes place without a ticket (e.g. free concessionary travel, PTE rail only travelcards) but has limitations with flat fare concessionary travel
- output LENNON information covers all days of the week (a limitation brought about by the lack of recorded data concerning the return leg of return ticket purchases, and the timing of use of season tickets)
- the information is not segmented by purpose or car ownership
- the data is not collected in production / attraction (P/A) format

These limitations will need to be considered carefully before a decision is taken to use this data set.

2.4.3 LENNON data is owned by the Association of Train Operating Companies (ATOC) and, although the Department has access to the LENNON database, the Department can only share these data with third parties working on its behalf. Any practitioners not conducting work on behalf of the Department and requiring access to LENNON data should first contact the ATOC.

2.4.4 The National Rail Travel Survey (NRTS) is a survey of passenger trips on the national rail system in Great Britain on weekdays outside school holidays. It was carried out for the London Area as part of the London Area Transport Survey (LATS) in 2001 and throughout the rest of Great Britain in 2004 and 2005. This data set includes rail passenger information disaggregated by origin / destination, ticket type, trip purpose, time of travel and demographic information. Aggregate and record level data are available from the Rail Statistics team in the Department, although personal data (such as origin post-codes) are only available for those working on behalf of the Department.

This may provide some more recent insight on user behaviour, however, it should be noted that these surveys are not conducted to provide a direct basis for expansion to represent travel demand patterns.

2.4.5 Information on rail passenger counts is available from the Department. These data contain information on passenger loads and capacity provision on individual train services. The Department also publishes aggregate statistics showing arrivals and departures at a number of cities and on routes into central London in one hour time bands throughout the day on a “typical” autumn weekday and is available at https://www.gov.uk/government/publications/. The information for individual services can be shared with third parties working on behalf of the Department, other users should contact the individual train operating companies.

2.4.6 Electronic ticket machine (ETM) data provide information on all journeys rather than a sample. ETM data provides time of travel and can be obtained over long periods of time, thereby avoiding day-to-day variations. They can also relate to the network of services as a whole. However, ETM data will only provide trip records in terms of fare stages at which passengers board or alight, and fare stages may differ between different operators. In areas where the use of travel cards, concessions and other pre-paid tickets are prevalent, ETM data may provide a less accurate picture of passenger movement. Practitioners should contact bus operators in their area of interest to enquire about the availability of ETM data.

2.4.7 Smart ticketing has been introduced in many towns and cities throughout the UK in recent years and the data captures system transactions and can be processed to provide data records on the usage of public transport. Currently operators accept a range of ticket types and smart ticketing data sets may not represent all users of the system. Nevertheless processing and analysis of this data may provide useful insights in understanding travel behaviour.

2.5 Other Sources of Data

Census Data

2.5.1 Further information on commuters journey to work and their movements is also available from the 2011 census journey to work data.

2.5.2 The census data should be used with caution, for two main reasons. First, this data source only includes trips between home and work and does not provide any information about trips for other purposes. Secondly, the correspondence between the trips recorded in the census and those that actually take place is not direct. The census records 'usual journey to work' but the average person doesn't complete their usual journey to work every day due to sickness, work leave, etc. At the aggregate level therefore the census data over-estimates journey to work trips. Nevertheless, the census journey to work data may be of use in developing transport models (e.g. providing useful information on trip distributions) as long as it can be supplemented by data from other sources.

2.5.3 Census journey to work data can be downloaded from the Government data website http://data.gov.uk/ and also at http://www.nomisweb.co.uk/.

National Travel Survey (NTS) Data

2.5.4 The NTS is the primary source of data on personal travel patterns in Great Britain. The NTS is an established household survey which has been running continuously since 1988. The survey is primarily designed to track the long-term development of trends in travel, although, short-term trends can also be detected.

2.5.5 NTS data is collected via two main sources – interviews with people in their homes and a travel diary that they keep for a week to record all their trips. The NTS covers travel by all age groups, including children. Typically the sample size every year since 2002 has been 8,000 households and 20,000 individuals, although this can vary year by year.

2.5.6 The NTS results and technical information can be downloaded at the following website: https://www.gov.uk/government/organisations/department-for-transport/series/national-travel-survey-statistics. This website also contains contact information for the NTS team in the Department.

Aviation Data

2.5.7 The Civil Aviation Authority (CAA) publishes a range of information on its website about the usage of airports around the UK. This includes summary results from the CAA Passenger Survey which contains information about the geographic origin or destination of air passengers, their purpose of travel and passenger characteristics. This survey is completed on an annual basis at Birmingham, Gatwick, Heathrow, Manchester and Stansted with a selection of other airports covered each year. Access to the full data set is available from the CAA (contact details on their website, http://www.caa.co.uk) for a fee.

2.6 Network Data

2.6.1 A significant number of national highway network data sets are now available and they can be of use in transport model development. They range in level of detail from:

- detailed road centre line representations showing all highways and details of curvature through to
- skeletal representations of major roads used for 'journey planner' packages

2.6.2 The detailed data sets are not generally suitable for direct incorporation into models, as they contain a vast amount of unnecessary detail that would complicate the model and increase memory requirements and processing times. Simplification of some of the data contained within network data sets is therefore required. However, practitioners should consider retaining some geometric data that might be required for environmental analyses, especially where the network is stored in a GIS (Geographic Information Systems) package.

2.6.3 Care should also be taken when interpreting data from freely available network data sets and journey planners. For instance, the journey planner systems usually contain information on link travel times that are generally an inter-peak average rather than representative of any particular peak time period unless specifically stated.

2.6.4 The Ordnance Survey MasterMap Integrated Transport Network (ITN) is a useful resource for verifying and building modelled networks. In conjunction with GIS packages, it can also be used as a background for modelled networks to help with comprehension of modelled representation of networks and for environmental analyses. The ITN can be downloaded from the OS OpenData website at www.ordnancesurvey.co.uk/opendata.

2.6.5 The Department currently maintains the major roads database using information from the OS ITN. The major roads database contains a series of links which are unique sections of road which make up the entirety of the major roads network in Great Britain. This database contains various fields of information about these links including link length, available traffic count information and other physical characteristics for all links greater in length than 300 metres.

2.6.6 Other important sources of data for road network modelling include:

- junction plans held by local authorities and Highways England
- traffic signal timing and phasing data held by local authorities or traffic control units
- site surveys involving observation of traffic and parking behaviour
- aerial photographs
- online mapping and satellite imaging such as Google Maps and StreetMap

2.6.7 The National Public Transport Access Node (NaPTAN) database is a UK nationwide system for uniquely identifying all the points of access to public transport in the UK. It is a core component of the UK national transport information infrastructure and is used by a number of other UK standards and information systems. Every UK public transport node including rail stations, coach termini, airports, ferry terminals and bus stops are allocated at least one identifier.

2.6.8 The NaPTAN database system is a UK national standard sponsored by the Department and supports both the public registration of bus timetables by the Vehicle and Operator Services Agency (VOSA) and the data collection for the Transport Direct Portal. Data from NaPTAN may be obtained at the website http://www.dft.gov.uk/naptan/

2.6.9 The National Public Transport Data Repository (NPTDR) database contains a snapshot of every public transport service in Great Britain for a selected week in October each year. Data is currently available from October 2004 onwards. The data set is compiled with information from many sources including public transport operators, coach services from the national coach services database and rail information from the Association of Train Operating Companies.

2.6.10 NPTDR can also be used in the production of accessibility indicators via software tools such as Accession. Further information on the NPTDR database, and the data themselves, may be found at the following website http://data.gov.uk/dataset/nptdr.

2.6.11 The nature of the deregulated bus market, with service changes permitted at short notice, means that precise coding of public transport supply from published information is often not possible. However, bus networks are now more stable than in the years immediately following deregulation.

Changes that do occur are often limited to minor adjustments to service frequencies and stopping points, often below the level of significance that would require a major adjustment to model networks. Within London, the absence of deregulation means that networks are relatively stable and published service information is generally up to date. Data for rail network modelling are easier to obtain than for bus and the level of detail available is generally greater. A rail timetable gives precise station to station travel times for each departure, whereas for buses timetable timing points can be several stops apart.

3 Study Specific Surveys

3.1 Introduction to Study Specific Surveys

3.1.1 This section of the unit provides guidance on conducting bespoke transport surveys for individual study requirements.

3.1.2 Data collection is often the largest cost of building a transport model. This cost can be reduced by minimising the quantity of new surveys. The best way to minimise data collection requirements is by taking data needs into account in the design of the model. Most models split the spatial area to be studied into sectors and are further sub-divided into zones. Data collection can be reduced by careful design of the sectors and zones. For guidance on zonal design, see TAG unit M3.1 - Highway Assignment Modelling, and TAG unit M3.2 - Public Transport Assignment.

3.1.3 Methods for data collection can generally be divided into three categories, listed in ascending order of cost:

- non-intrusive automated methods (for example automated traffic counts; emergent data sources including data from electronic devices may fall into this category)
- non-intrusive manual methods (for example, traffic counts or manual turning count surveys collected by an observer, or observed journey time surveys)
- intrusive methods (interviews with potential customers, which include road side interviews and travel diary surveys)

3.1.4 Where there is an option, therefore, the top priority is often to minimise the reliance on intrusive data collection methods, as this is likely to give the greatest cost saving, although some travel information (e.g. trip purpose) cannot normally be gathered without some form of intrusive surveys.

3.2 Demand Data Surveys

3.2.1 The advice below lists the type and sources of data required for variable demand modelling, beyond the data used for assignment modelling. In most cases only a sub-set of these data sources will be needed for a given mode. Less detailed models will require less data and may base some of their segmentation on assumptions or transfer of appropriate data from other models. As a minimum, however, any multi-stage demand model will require a database which provides, in the base year for each origin zone, the total number of trips:

- by car availability
- to each destination/attraction zone
- for each of several purposes
- by each of the modes modelled
- within each modelled time period

3.2.2 Table 1 which follows list the main data requirements for variable demand modelling.

Table 1 Demand Model Data Requirements			
Data Required	**For use in**	**Sources**	**Notes**
Population	Trip generation	NTEM, Census	From wards or Census Output Areas amalgamated to zones: advisable to categorise by sex and adult/child
Households	Trip generation	NTEM, Census	From wards or Census Output Areas amalgamated to zones
Car ownership	Trip generation, Modal split, Distribution	NTEM/NATCOP, Census, Local Household Travel Survey, Household Expenditure Survey	Averaged across zones, or might be estimated from other socio-economic data
Socio-Economic Group	Trip generation	Census, Local Household Travel Survey, Household Expenditure Survey	Not often used except in distinguishing workers from unemployed and retired, but some models categorise work travel by broad SEG groups (e.g. blue/white collar) and land-use models also require considerable SEG data.
Land-use data	Trip generation, Distribution	Census and Special Workplace Statistics, NTEM for trip ends by purpose, Local Authority planning data for employees, retail and commercial floorspace by zone.	Employees and retail space by zone enable calculation of zonal trip totals for doubly-constrained (to/from work) trip distribution, and attractions for optional trips. Some LUTI models need considerable detail for Social Economic Group (SEG), employment and floorspace data.
Car availability	Modal split, Distribution	Local Household Travel Survey, National Travel Survey (NTS)	Can be estimated from household composition and license holding
Licence holding	Trip generation, Modal split	Local Household Travel Survey, Household Expenditure Survey, National Travel Survey	Categorisation by number of licences and number of household cars indicates level of car availability
Travel to zonal destinations by: Purpose, Mode and Time of Day(Period)	Distribution, Modal split, Time-period choice	Roadside Interviews (RSIs), Mobile Network Data (MND), Automatic Number Plate Recognition (ANPR) surveys, Local Household Travel Survey, journey to work from Census, NTEM, NTS	Full detail only available from specialised local surveys, by interview or questionnaire. NTS local samples are small, but values might be adjusted from wider NTS (e.g. split of purpose by time of day).Mode might include active modes and distinguish between car driver and passenger.

Trip lengths	Distribution, Modal split	Local Household Travel Survey, National Travel Survey, journey to work Census, RSI surveys	Not used directly since distance is specified by zonal structure, but should be used in validation
Vehicle operating costs	All responses	Values from TAG unit A1.4, Values of Time and Operating Costs	Perceived money costs of a vehicle journey are less than true average cost, and are assumed to be different for business and private travel.
Vehicle occupancies	All responses – for estimating costs	RSIs, local Household Travel Survey, NTS	By purpose; often assumed from NTS or NTEM or TAG unit A1.4
Values of time	All responses	TAG unit A1.4, Values of Time and Operating Costs	Differ by purpose, and updated as appropriate. In principle, different values for behavioural modelling and standard values for appraisal

3.2.3 The sources in Table 1 are not independent. The National Trip End Model (NTEM) offers a valuable source of most of the data required to predict changes in trip ends, both trip productions based on household characteristics and trip attractions based on employment etc, as well as car availability forecasts.

3.2.4 NTEM data should be validated against local sources (if available) before the data is used. In some cases NTEM zones may be too large, so that the NTEM data may have to be adjusted in the light of local knowledge or data specific to the study zones obtained from more original sources. Effort can be saved if there has been a suitable local transport survey conducted, or if there is a local validated transport model from which the required data can be extracted.

Household Interview Surveys

3.2.5 Household surveys provide the most complete picture of travel by residents of a study area, including walking and cycling. Outputs from these surveys can be segmented by the key variables of household type, person type, trip purpose, mode and time period. However, building of trip matrices directly from household surveys is not generally practical on the grounds of cost - the method is inherently expensive per person trip recorded. The primary application of this type of data set is therefore in the segmentation of demand data collected from other sources, and for use in creating local car ownership and trip end models where the national models are not thought to be appropriate.

3.2.6 Household interview survey sample sizes are rarely sufficiently large to provide acceptably accurate estimates of trips between pairs of zones. Therefore, data from this source should not generally be used directly in the creation of trip matrices at a zonal level. However, household interview surveys are a rich data source, in the sense that actual trip-making behaviour by all modes can be linked to the characteristics of the household and travellers. This data source is useful, therefore, for demand model estimation.

Revealed Preference and Stated Preference Surveys

3.2.7 Revealed Preference (RP) refers to observations of actual behaviour, for example the mode choices that decision-makers currently make or made in the past. RP data is inherently more credible than Stated Preference (SP) data and their use, if only partially, will strengthen the credibility of demand forecasts in the appraisal framework.

3.2.8 SP refers to observations of hypothetical behaviour under controlled experimental conditions. A scheme that introduces a new mode, for example, would imply a need for SP analysis, since RP data is by definition unavailable for such a context. Developing a bespoke mode choice model, therefore, often requires new SP surveys and analysis.

3.2.9 RP data can be obtained from SP respondents, from postcard surveys (an under-used and relatively inexpensive approach), from home or phone interviews, travel diaries, as well as from the National Travel Survey and Census.

3.2.10 The collection of RP data is not without problems. There are often large biases in respondents' self reported data, underestimating the costs of their chosen mode and overestimating the costs of alternative modes. To overcome these problems it is sometimes necessary to use explanatory variables from network models and published timetable data. Even where respondents' reported data is modelled, there is often a considerable amount of missing data which needs to be collated.

3.2.11 For more information on SP and RP surveys see Supplementary Guidance - Bespoke Mode Choice Models.

3.3 Highway Surveys

3.3.1 This section covers the typical highway traffic surveys which are carried out. Highway traffic surveys are generally carried out for three purposes: matrix creation, model calibration and validation.

3.3.2 Calibration and validation data are of two kinds: traffic counts, and journey times while RSI surveys are commonly used in the matrix creation process.

3.3.3 **Traffic counts** are required for:

- expanding new roadside interviews
- re-expanding old roadside interviews
- calibrating trip matrices by means of matrix estimation
- validating the model

3.3.4 **Journey times** are required for:

- calibrating cruise speeds (speeds between junction queues)
- identifying where delays occur at junctions
- validating the model

3.3.5 Traffic counts may be obtained by automatic means (Automatic Traffic Counts, ATCs) or manually (Manual Classified Counts, MCCs). Journey times may be obtained by Moving Car Observer (MCO) surveys or from commercial sources of tracked vehicle data (such as Trafficmaster, INRIX, TomTom, HERE/NAVTEQ) or camera observations from Automatic Number-Plate Recognition systems (ANPR) or from such traffic databases listed in section 2 of this unit. In selecting the appropriate type of count and source of journey times, these factors need to be considered:

- the accuracy of the data
- the choice of survey locations
- the need for information by vehicle type
- a recognition of the costs of these data

3.3.6 Surveys should typically be carried out during a 'neutral', or representative, month avoiding main and local holiday periods, local school holidays and half terms, and other abnormal traffic periods. However, there can be instances where a particular period (e.g. weekends or school holidays) is of interest, for example in regions with relatively high levels of seasonal tourism. The period for the surveys should be selected with careful consideration of the purpose of the transport model.

3.3.7 Neutral periods are defined as Mondays to Thursdays from March through to November (excluding August), provided adequate lighting is available, and avoiding the weeks before/after Easter, the Thursday before and all of the week of a bank holiday, and the school holidays. Surveys may be carried out outside of these days/months, ensuring that the conditions being surveyed (e.g. traffic flow) are representative of the transport condition being analysed/modelled.

3.3.8 This requirement often dictates the timescale of the appraisal. Data processing may also add substantially to the study timescale.

3.3.9 In addition, if existing data is to be reused, ample time must be allowed for them to be identified, obtained from their current custodian, reprocessed as necessary, and checked for consistency and validity. Further delays may be incurred if these checks reveal that the data cannot be used.

Traffic Count Surveys

3.3.10 Manual classified counts (MCC) are required to break down traffic flows by vehicle type. This information is particularly important in an urban area, where the mixture of vehicle types may vary significantly by direction as well as at different times of day. Classified counts are required at every roadside interview site (where undertaken to understand demand patterns), and on minor parallel roads not included in the interview programme, to expand the interview sample to the total traffic flow in the corridor as a whole (see paragraph 3.3.27). Counts should be carried out in both directions on the survey day, even if interviewing is only in one direction, and should extend over all model periods. If automatic counts indicate that traffic flows at a roadside interview site were influenced by the presence of the interview survey, further manual classified counts should be made on a different day. If necessary, these alternative counts can then be used to expand the interview data to a more representative traffic flow. The vehicle classification used should correspond with that used in the interview survey itself, and this in turn should be compatible with the vehicle types represented in the traffic model.

3.3.11 Turning counts at road junctions are required for the validation of junctions in a congested assignment model. Turning counts should be carried out at all junctions within the model area that are likely to have a significant impact on journey times or delays and at junctions that are particularly significant in route choice (i.e. locations where alternative routes for critical movements may merge/diverge). In urban areas, there will often be a need to collect more turning count data than for an inter-urban model, because of the greater number of junctions that generally need to be validated.

3.3.12 Turning counts are carried out in the same manner as manual classified counts on links, except that more enumerators are generally required. They must cover the whole of each peak period, but need only cover representative parts of other time periods, depending on the time periods being modelled. Where an inter-peak model is representing an average inter-peak hour, a 12 hour period covering the two peaks and the inter-peak would be required. The vehicle classification used may be simpler than the one used for link surveys, provided that it is again compatible with the model classifications. For more complex or larger junctions, video or ANPR surveying methods may need to be employed to fully cover all turning movements at the junction.

3.3.13 Automatic traffic counts (ATC) and carrying them out is an operation requiring a substantial investment in instruments, ancillary equipment, transport, data handling systems and staff time. The volume of data that can be collected is considerable and can reveal longer term traffic volume trends, but the effort expended could prove fruitless if any one of the constituent processes involved in collecting and processing the data is deficient.

3.3.14 ATCs are used for all the purposes mentioned in paragraphs 3.3.10 to 3.3.13 and, in addition, can be used to monitor traffic flows and to provide information about the relationship between survey day traffic and longer term flow levels. Automatic counts can also be used to provide information about local 12-, 16-, 18- and 24-hour flow ratios, and daily and seasonal traffic variations, all of which are required to estimate average daily traffic flows from shorter period data.

3.3.15 Little definitive work has been published concerning the accuracy of traffic counts by automatic traffic counters. Experience suggests that the errors are machine and (particularly) installation dependent. TRRL Supplementary Report SR 514 “Estimation of annual traffic flow from short period traffic counts” contains some useful results on the efficiency and accuracy of annual estimates from short period counts. For longer term counts, the frequency and diligence of the station monitoring and servicing will be crucial.

3.3.16 Good quality counts are required for validation (as well as for calibration). The notion of using good quality counts for calibration and poorer quality counts for validation, or vice versa, should **not** be considered.

Journey Time Surveys

3.3.17 Journey time measurements are an essential part of assignment model validation for most urban traffic appraisals, since the majority of scheme benefits tend to be related to journey time savings. Comparison of observed and modelled journey times gives a measure of the appropriateness of the speed-flow relationships for a capacity restrained assignment, as well as the junction delay calculations for a congested assignment model. Journey time surveys may also be used to identify junctions which exhibit high levels of delay and that need to be modelled in detail.

3.3.18 Moving Car Observer (MCO) surveys may be undertaken, or data may be sourced from tracked vehicle data (using GPS devices), and between ANPR cameras. MCO observations record median speeds, but are likely to understate average speeds where traffic exceeds speed limits and may require many observations where journey times are particularly variable. Vehicle tracking data may be from a small sample of vehicles and potential bias should be considered and addressed. It is often appropriate to use the median rather than mean measure of average which is less sensitive to exceptional behaviour of a few users or of road conditions. The data should be demonstrated to be of sufficient accuracy (see paragraph 3.3.22) and not materially biased. Comparisons with modelled travel times will show how well total link times are modelled.

3.3.19 For general purpose models, the routes for the validation of journey times should cover as wide a range of route types as possible and cover the fully modelled area in the model as evenly as possible. For models developed for the appraisal of specific interventions, routes should include those on which it is expected traffic will be affected by the scheme, as well as covering the route including the proposed scheme itself, if appropriate.

3.3.20 The validation routes should be neither excessively long (greater than 15 km) nor excessively short (less than 3 km). Routes should not take longer to travel than the modelled time periods (although, a few minutes longer is unlikely to be problematic). Start times should be staggered, particularly if runs are undertaken on the same day. For models of actual peak hours, journey time routes ought to be no longer than about 40 minutes to allow some staggering of start times.

3.3.21 During the survey, the total travel time should be recorded separately for each road section between major junctions and, because junction delays form an important part of travel time, a separate note should be made of the delay time at each junction. Ideally, delay should be assumed to start once instantaneous speed falls below a chosen speed, say 15 kph (10 mph). Journey time runs, in both directions and in each model time period, should be made over a period of several days. Variations in travel times during peak periods should be taken into account by staggering start times, to represent fairly conditions over the time period as a whole.

3.3.22 In the case of journey times for all vehicles combined, sufficient MCO runs should be undertaken so that the 95% confidence level of the mean of the observations is ± 10% or less over a route as a whole. Four initial journey time runs (preferably each on a different day) should be made for each route, direction and model time period, and the results used to assess the variability of journey times in each case. Further runs must be made for those routes, directions or time periods in which the variability falls outside the acceptable range. In urban areas, where journey times can sometimes be erratic, this may lead to a large number of runs being required. If a satisfactory level of consistency has not been achieved after 12 runs, the results should be accepted and a special note made in the survey documentation. The accuracy of journey time data derived from other sources, such as tracked vehicle data or WebTRIS, should also be determined and taken into account when making comparisons between modelled and observed times.

3.3.23 Using separate speed/flow relationships for light and heavy vehicles, journey times applicable to these two classes of vehicle would be desirable, but not essential. For light vehicles, appropriate journey times may be obtained by restricting the Moving Car Observer method to light vehicles. For heavy vehicles, other techniques, such as video registration plate surveys may be required.

Roadside Interview (RSI) Surveys

3.3.24 Highways England can provide detailed advice on conducting and the collection of roadside interview data. The RSI survey process is disruptive and has inherent but manageable risks. Safety to the staff involved and the general travelling public can be mitigated and data integrity improved by following the documented advice.

3.3.25 Addresses should be coded either to Ordnance Survey Grid References (at least six digits) or to Post Codes. Adopting these minimal standards will ensure that data can be re-used by others at a later date.

3.3.26 Analysts should note that roadside interviews cannot be conducted on motorways. In addition, it may be impractical to conduct roadside interviews on some all purpose roads, especially where they carry high levels of traffic. Relocation of interview sites may address these problems - for example, interviewing on motorway entry slip roads may provide an alternative to interviewing on motorways.

3.3.27 RSI surveys should always be associated with a MCC survey carried out on the day of the RSI survey and a minimum two-week ATC survey. New roadside interview records should be expanded by vehicle type from the MCC on the day of survey. The surveys should be scheduled so as to minimise potential for diversions to avoid the interview site, thereby making the MCC on the day of survey atypical.

3.3.28 A number of other adjustments are required, as follows:

- conversion from the day of survey to an average weekday
- adjustment to account for diversions on the day that the interviews were conducted
- adjustment to account for day to day variability
- conversion from the month of survey to an average neutral month

3.3.29 Controlling to two-week ATCs will address the first and second of these adjustments and the third to an extent. The fourth adjustment will require factors to be developed from long-term ATCs. It should be noted that the application of each of these factors will add further uncertainty and widen the confidence intervals.

3.3.30 Traffic counts are also required to re-expand old roadside interview records. In principle, single day MCCs and two-week ATCs are required. However, bearing in mind the confidence intervals for heavy vehicles, it may not always be possible to justify the additional expense of the MCCs. If MCCs are not taken, the re-expansion will have to be done on the basis of the two-week ATC alone.

3.3.31 Guidance is also available on calculating required sample sizes when conducting RSI surveys. TAG unit M2.2 contains advice regarding the question of estimating the sample size needed to give results to the level of accuracy needed.

Data Accuracy

3.3.32 Commercial data sources such as MND, GPS tracking data and journey time data are often not collected specifically to obtain input data to transport models. They are usually processed using methods that are subject to commercial confidentiality which means that some details of the initial stages of data processing are often not known to practitioners. It is important that these limitations are understood in order to ensure that the data is used appropriately. Further advice on the use of MND and other demand data is discussed in TAG unit M2.2.

3.3.33 When an estimate of traffic flow has been made, it is desirable to know not only the estimated value but also how reliable this estimate is. A convenient way of expressing the precision is to state limits which, with a given probability (usually 95%) include the true value. It is then possible to state, for example, that the true value is unlikely to exceed some upper limit, or to be less than a lower limit, or to lie outside a pair of limits. This information may be more important than the estimate itself. These limits are known as “confidence limits”, i.e. they are limits within which it can be stated, with a given degree of confidence, that the true value lies.

3.3.34 The adoption of a particular confidence interval implies a decision concerning the accuracy required of the information presented, for example, a 95% confidence interval accepts the chance that the true value will lie outside the given limits only 5 times in 100 occurrences. The greater the accuracy demanded of the data the wider the confidence interval will be.

3.3.35 The following 95% confidence intervals for traffic counts should be assumed:

- Automatic Traffic Counts: total vehicles: ± 5%
- Manual Classified Counts: total vehicles: ± 10%

  Cars and taxis: ± 10%

  Light goods vehicles: ± 24%

  Other goods vehicles: ± 28%

  All goods vehicles: ± 18%

3.3.36 The ATC confidence intervals relate to counters with tube vehicle detectors. Counters with inductive loop may achieve greater levels of accuracy. The accuracy of radar counters is less certain but may be assumed to be the same as that of tube counters.

3.3.37 Splits between light and heavy vehicles obtained from ATCs on the basis of a 5.2m vehicle length have been shown to be subject to wide margins of error and should not be relied upon. The Highways England WebTRIS database is based on a 6.6m split, that is deemed more appropriate. Where possible spot checks against MCCs should be undertaken to verify vehicle splits derived from ATCs or WebTRIS.

3.3.38 It is normal practice for MCCs to be carried out on a single day but ATCs should be conducted for at least two full weeks. ATCs carried out for two-weeks or longer will capture some day to day variability. The confidence intervals for counts will be narrower than those listed above if more observations are carried out (for example an MCC carried out on two days), but will be wider for periods shorter than one day (for example, the morning peak).

3.3.39 Turning movement counts at junctions are normally single day MCCs (or video surveys/ ANPR at more complex junctions). Their usefulness would be increased if they were to be supplemented by two-week ATCs taken for either individual turns or on the junction entry and exit arms.

3.3.40 All data should be checked to identify and remove any that might have been affected by unusual events. Where data quality is suspect, the data should be investigated thoroughly and, if necessary, rejected.

Factoring Traffic Data

3.3.41 This section deals with the factoring of traffic count data from one base to another. Every factor has an associated reliability and the aim of factoring is always to increase the confidence interval of the result. Factoring should therefore be kept to a minimum and the factor with the lowest coefficient of variation should always be chosen where a choice of factors is available.

3.3.42 National factors are derived from databases which are usually larger than those a local study can generate. Whilst it is possible to derive factors locally, a full understanding of the accuracy of such factors is desirable to ensure that local conditions are indeed significantly different from the national average. This will involve not only an estimate of the coefficient of variation of the locally derived factors, but also an examination to determine whether the local factor is significantly different from the national one.

3.3.43 On some occasions more than one factor will have to be cumulatively applied in stages. TAG unit M2.2 provides advice on such factoring and how the resulting reliability of the combined results is calculated.

3.3.44 There are occasions when practitioners need to obtain an estimate of (usually) AADT from a short period count (normally 12 hours). In such cases the recommended approach is to derive conversion factors from nearby locations where AADT data is available.

3.4 Public Transport Surveys

3.4.1 Many major public transport schemes in areas of established development will derive a major part of their patronage by extraction from existing public transport services. Sound information about the patterns of movements served by existing services can therefore be very important for the robustness of the appraisal of the proposed scheme.

3.4.2 As explained in TAG unit M3.2 - Public Transport Assignment Modelling, an essential part of the development of a model for the appraisal of all major public transport schemes, except a bus priority strategy, will be a well-validated public transport passenger assignment model. A well-validated model requires a realistic representation of the network of services and good quality trip information. In most cases, the base year trip matrices should be developed from observations of travel movements with the minimum of trip synthesis, certainly in the corridors most directly affected by the proposed scheme. The following sub-sections provide advice on the types of survey that may be used to obtain data on movements by public transport passengers.

Passenger Counts

3.4.3 The numbers of passengers using a public transport system are required for:

- expanding interview samples
- use as constraints in matrix estimation
- validation of trip matrices and assignments

3.4.4 The counts required for expanding interview samples will depend on the method used to survey passenger movements.

3.4.5 Depending on passenger flows, passenger counts can be combined with on-board surveys. Often, on board face-to-face surveyors will be able to count the numbers of boarders and alighters at each stop before selecting respondents for interview. However, they will not be able to do so on crowded vehicles nor where each individual interview is likely to over-run the time between stops.

3.4.6 For multiple door vehicles such as trains, there may be substantial differences in passenger numbers counted at different sets of doors. Doors near station entrances will have a higher number of boarders than more remote doors. Because of this, an accurate level of count detail will only be available if counts are conducted on each set of doors.

3.4.7 Estimates of the numbers of passengers on public transport vehicles made by observers standing at the roadside will **not**, generally, be sufficiently accurate for any of the purposes listed in paragraph 3.4.3.

Movement Surveys

3.4.8 The information required about passenger movements for an assignment model is:

- origin and destination address
- access mode to public transport, including any costs
- time of travel
- type of ticket

3.4.9 Other information, such as trip purpose and car availability for the journey, will usually be required for the development of the demand model. While other sources, such as a household interview survey, may provide this information, it will normally be cost-effective to collect this additional information in passenger movement surveys.

3.4.10 The main sources of information about passenger movements are as follows:

- interviews with passengers, which may be by means of face-to-face interviews with passengers, either on-board the public transport vehicles or as they wait to board at stops and stations, or by means of self-completion questionnaires
- electronic ticket machine and smartcard data

3.4.11 The relative merits of these sources in providing the required information are as follows

Face-to-face on-board surveys

3.4.12 Face-to-face interviews with passengers on-board, providing the sample size is adequate, should provide the best quality data. The sample should be selected by the interviewer rather than being self-selected and it is easier to ensure that all the required information is provided. This method will enable origin and destination addresses to be provided, along with all the other information that may be required, such as access mode (and trip purpose and car availability, if required). A sample of interviews should be obtained on each service in the modelled area, thereby enabling a complete picture of travel to be obtained (once the sample data has been expanded to passenger counts).

3.4.13 In face-to-face interviews, the data can be collected from illiterate and, in the presence of guardians, juvenile travellers, which is not the case with self-completion surveys. In addition, non-response biases are reduced compared with self-completion surveys. The method also allows the surveyor to probe for particular information so that exact details of origin and destination can be discovered.

3.4.14 One of the biases that can arise from face-to-face surveys relates to length of journey – the longer the journey, the more likely that a passenger is to be sampled. To counter this bias, those travellers who are making only short hop journeys should have an equal chance of being sampled as those making longer journeys. To do this, the surveyor should select respondents by choosing a random passenger from those boarding at each stop.

3.4.15 Because more passengers will board at each stop during peak hours than inter-peak, surveyors will each be able to interview a smaller proportion of travellers during busy periods compared with inter-peak hours. This imbalance can be addressed by conducting an increased number of survey shifts during peak hours and by weighting data according to passenger counts. The important consideration is that the sample size during both the peak and inter-peak periods should be sufficiently large to support the creation of acceptably reliable trip matrices for these periods.

3.4.16 Consideration must be given to the choice of bus and public transport routes to be sampled. Ideally, each public transport route serving the modelled area should be surveyed at least once. These should be surveyed over the whole period for which the model will apply. Information on bus routes and services can be found using the NPTDR database referred to in paragraph 2.6.9.

3.4.17 This survey method can only be conducted with the permission of the bus or train operating companies.

Face-to-face at-stop or at-station surveys

3.4.18 Face-to-face interviews with passengers at stops and stations can provide the same scope and quality of information as on-board interviews. However, interviews are required at all stops and stations for a complete picture of travel in the modelled area. This is often uneconomic and so surveys of this kind are best targeted at major generators or attractors of travellers which, in practice, means town and city centres. It is important that all stops and stations in the targeted areas are included in the survey. If the operators will not allow surveys to be conducted on board their vehicles, the modeller will have no option but to rely on a combination of at-stop or at-station surveys and electronic ticket machine data.

3.4.19 While interviews can, in principle, be conducted with boarders and alighters at bus and light rail stops or train stations, people alighting are likely to be much less willing to be interviewed than those waiting for a service to arrive.

3.4.20 As with on-board face-to-face surveys, greater proportions of inter-peak travellers may be interviewed than peak travellers. The important consideration is that the sample size during both the peak and inter-peak periods should be sufficiently large to support the creation of acceptably reliable trip matrices for these periods.

3.4.21 Unlike on-board surveys, issues of long and short journey biases do not apply in that those making short hops are as likely to be approached for interview as those making longer journeys.

3.4.22 However, the data collected by this method are likely to be biased in that those passengers that arrive at the stop or station immediately before the vehicle arrives (‘runners’) will be under-represented. Where there are infrequent regular services, such as on trains, then this can lead to biases between regular and irregular passengers. Regular users of the service may time their arrival to the station more closely to the departure time. This bias may not be as prevalent on regular services where departure times cannot be easily predicted, such as for most urban bus routes.

3.4.23 As with on-board surveys, data collection should be conducted for the entire period for which the transport model will apply.

3.4.24 Whereas permission is often not required for surveys at bus stops, it will be required for platform or station entry or exit surveys.

Self-completion on-board surveys

3.4.25 Self-completion surveys should be regarded as a means of last resort. While, in principle, the scope of the information which may be gathered by this means is as comprehensive as that obtained by face-to-face interview, the quality is likely to be poorer in a number of respects. First, some information may not be provided. Secondly, some information may be inaccurate if the questionnaire is completed some time after the journey was made. And, thirdly, the sample of respondents will be self-selected and may therefore not be adequately representative of all travellers.

3.4.26 The method involves the distribution of self-completion questionnaires to passengers as they board vehicles. Often these questionnaires would be collected from passengers as they alight from the vehicle.

3.4.27 Although forms should be distributed with reply-paid envelopes, in order to maximise response rates, it is recommended that measures be taken to ensure that forms are completed during the journey and returned to the surveyors when alighting. For this reason survey forms should be very brief and uncomplicated. Pens and pencils should be distributed to boarders along with the survey forms.

3.4.28 The main advantage of the self-completion survey compared with face-to-face interviewing is that all passengers have an equal likelihood of being given a survey form, regardless of whether they are making long or short journeys and whether travelling during peak or inter-peak times. However, return rates do vary due to self-selection biases.

3.4.29 Where self-completion surveys are collected from, as well as distributed to, passengers, return rates of forms of up to 95% can be achieved. However, large proportions of these forms will be incomplete. Response rates to individual questions in bus surveys can vary from between 40% and 70%. Response rates to questions may be higher on trains.

3.4.30 The same issues regarding which routes and times of day to survey apply to the self-completion on-board survey as to the face-to-face interview on-board survey. Similarly, permission is necessary from operating companies for surveyors to work on board vehicles.

Self-completion at-stop and at-station surveys

3.4.31 This method is conducted by distributing self-completion forms to passengers as they enter or exit stations or as they wait at or alight at bus stops.

3.4.32 The main advantage of this method compared with an at-stop face-to-face interview is that more passengers are likely to accept survey forms than would be willing to participate in an interview. This will apply to both those who arrive at stops or stations just before the train/bus arrives and also to those on time-critical journeys. Bus passengers waiting at stops would be more likely to accept a survey form even if their bus is approaching or already at the bus stop.

3.4.33 As with on-board surveys, at stop and at station surveys will suffer from inaccuracies and limitations to the data that can be collected. Depending on the survey materials, return rates of distributed questionnaires could be as low as 15% to 25%. Furthermore, some questions will not be answered.

3.4.34 Again, sampling biases may occur depending on which stations and stops are surveyed and what times of day are covered. Litter generation of discarded survey forms can be a significant problem. Permission must be sought from station managers to distribute survey forms within stations.

Summary of the preferred approach

3.4.35 Table 2 sets out the main advantages of each survey method, along with biases that might occur, the practical difficulties of the method and likely response rates. Details of when each different type of method is most appropriate are also shown.

3.4.36 In summary, the best approach is for an adequate sample of face-to-face interviews to be conducted on-board a sample of public transport vehicles on each service in the modelled area. However, operators may not allow interviews to be conducted on their vehicles.

3.4.37 The next best approach is to conduct face-to-face interviews at stops and stations. While comprehensive coverage of Network Rail stations may be affordable, it is likely that, to be cost-effective, surveys at bus stops would have to be confined to particular areas. This means that some other source of data will be required to supplement the at-stop surveys.

3.4.38 TAG unit M2.2 provides advice on the combination of survey data together with potentially complementary Electronic Ticket Machine (ETM) and smart ticketing data. Not all operators are willing to make their information available, especially in circumstances where the proposed scheme would compete with the operator's existing services. In these instances, self-completion questionnaires issued at stops may be used in combination with face-to-face interview at-stop surveys. In such an approach, face-to-face interviews would be concentrated in the town or city centre and self-completion questionnaires distributed elsewhere. A combination of techniques should be used at a small sample of stops so that a check for bias can be made.

Table 2 Advantages and Disadvantages of Different Public Transport Survey Methods

Method	Advantage	Potential Bias	Practical Difficulties	Response Rates	Appropriate Use
On-board face-to-face survey	Individual interviews of high quality	Fewer short-journey passengers, fewer peak passengers	Impossible to administer on crowded vehicles	From 10% on crowded vehicles to 90% on quiet services	Not busy buses, particularly in peak times.
At bus stop surveys; on-platform surveys	Individual interviews of high quality	Fewer 'runners', fewer peak passengers, no passengers who use those stops not surveyed	Unproductive, expensive if administered at all bus stops	From 5% at peak times to 60% inter-peak of those visiting survey bus stops	When there is no permission for on-board interviews, where it is acceptable that some stops are not surveyed. Where attitudes towards stop facilities required.
Entry/exit surveys at stations	Individual interviews of high quality	Fewer time-critical journeys, fewer 'runners', fewer peak passengers.	Very difficult to recruit at high passenger flows	From very few at peaks to 90% inter-peak	Not during morning peak hours at busy stations.
On-board self completion survey	Highly productive	Self-selection biases. Some response bias against short-hop passengers	Poor quality and completeness of data, limited scope of data.	Up to 95% of survey forms returned but as low as 40% of questions answered	On highly crowded services, where only limited data required.
At bus stop or station self-completion survey	Productive	Self-selection biases, fewer time-critical journeys	Difficult to cover all bus stops on network, Poor quality and completeness of data, limited scope of data	Between 15% and 25% returned, with about 70% of questions answered	Where no permission for on-board survey, only limited data required, where it is acceptable that some stops are not surveyed.

4 Document Provenance

This unit consists of restructured and edited material from the following guidance units that existed in the previous TAG structure and from DMRB at August 2012:

Data Sources (TAG unit 3.1.5), the primary TAG unit containing guidance on data sources, dated June 2003.

Scope of the Model (TAG unit 3.10.2), has been incorporated where relevant to discuss principles that are applicable to demand modelling, dated April 2011.

Road Traffic and Public Transport Assignment Modelling (TAG unit 3.11.2), contains principles of data collection for assignment modelling, dated January 2006.

Highway Assignment Modelling (TAG unit 3.19), has been incorporated where relevant to discuss principles that are applicable to highway assignment modelling, dated August 2012.

DMRB Volume 5 Section 1 Part 4: TA 11/09 Traffic Surveys by Roadside Interview

DMRB Volume 12 Section 1 Part 1: Traffic Appraisal Manual

DMRB Volume 12 Section 2 Part 1: Traffic Appraisal in Urban Areas

NC5

Waterbeachnewtown east

Full Planning Application: Station

Transport Assessment & Framework Travel Plan

February 2018

RLW Estates

WATERBEACH RAILWAY STATION RELOCATION – TRANSPORT ASSESSMENT

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FIGURES

APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

1.1.1. This Transport Assessment (TA) has been prepared by WSP for RLW Estates. It accompanies a detailed planning application for the proposed relocation of Waterbeach rail station, from its existing site at Station Road Waterbeach to a new site east of Bannold Drove, Waterbeach. Upon relocation, it is expected that the existing station would be closed under the appropriate Network Rail procedures.

1.1.2. The TA includes a Framework Station Travel Plan (Framework STP), a primary aim of which is to encourage sustainable modes of travel (walk, cycle, bus and car share) to access the station.

1.1.3. Waterbeach station is served by trains calling at Kings Lynn, Ely, Cambridge and London Kings Cross operated by Great Northern Trains, along with peak period services calling at London Liverpool Street operated by Greater Anglia Trains. The proposed relocation will not in itself result in any change to this existing service provision or the frequency of services at or destinations served by Waterbeach.

1.1.4. The new station will provide significant benefits in terms of reduced operational risks compared to the existing station. The new station would also assist the delivery of Waterbeach New Town, as set out in South Cambridgeshire District Council's emerging Local Plan Policy SS/5.

1.2 SCOPING

1.2.1. The content of this TA has been discussed with transport officers of Cambridgeshire County Council (CCC), the local highway authority for roads near the site. CCC's June 2017 Guidance on Transport Assessments and TA's has also assisted with the preparation of this report.

1.2.2. Public exhibitions of the station relocation proposals were held in November 2017 and January 2018, which has also informed the scope of the assessment of transport implications arising from the proposed development.

1.2.3. The above consultations confirmed that the TA should consider the following transportation themes:

- The effects within the village of redistributing trips from the existing station to the new station;
- The suitability of Cody Road to provide vehicular access to the new station, including buses and for construction traffic;
- The extent of car parking demand generated by the existing station and how this will be accommodated within the proposed new station car park; and
- The quality of new pedestrian and cycle routes between the existing village and the new station.

1.2.4. These issues have been assessed in detail in this TA. In summary, the findings of this report demonstrate that:

- There will be minimal highway capacity impacts through the village;
- Safety improvements will accrue due to reduced use of the Station Road level crossing at the existing station;
- Cody Road has sufficient width to provide vehicular access to the new station, including for buses;

- The car parking provision for the new station has been designed so that it accommodates predicted car parking demand. Furthermore, the car park can be operated free of charge, thereby removing key incentives for displaced or overspill parking to occur elsewhere within the village;
- There will be improvements to pedestrian and cycle links to the new station, along with bus service enhancements.

1.3 WIDER PLANNING & TRANSPORT CONTEXT

1.3.1. SCDC's Proposed Submission Local Plan (July 2013) allocates a new settlement known as Waterbeach New Town under Policy SS/5 on the former Waterbeach Barracks site and land to the east and north. The site allocation area is identified on the Local Plan Policies Proposals Map Inset H, attached at Appendix D. Policy SS/5 requires a relocated Waterbeach rail station to serve the existing village and the new settlement, amongst other transport improvements.

1.3.2. A planning application for part of the Policy SS/5 Waterbeach New Town was made to SCDC in early 2017 for a residential-led development of up to 6,500 dwellings (SCDC planning application reference S/0559/17/OL). The application notes that the relocation of Waterbeach station is an important component of the transport strategy for the Policy SS/5 allocation.

1.3.3. This TA does not consider the transport impact of the Waterbeach New Town on the relocated station, because Policy SS/5 requires the relocation of the station in order for the delivery of the New Town. Furthermore, the relocated station is not dependent on the New Town, although it will significantly enhance its public transport accessibility.

1.3.4. The A10 Ely to Cambridge Corridor Study published by the Greater Cambridge Partnership in January 2018 highlights the benefit that relocation of the Waterbeach rail station would provide as part of the mode shift package option which was tested as one of the scenario options considered within the study. It is evident that this makes a significant contribution towards encouraging mode shift to more sustainable forms of travel and helps to manage traffic impacts within the A10 corridor.

1.4 REPORT FORMAT

1.4.1. The relocated station and its proposed parking and access arrangements are described in Section 2, and Section 3 discusses the local and national transport policy context in which the proposals will be assessed.

1.4.2. Existing conditions on the local transport networks in the vicinity of the existing station site and relocation site are described in Section 4. Current travel patterns to the existing station are analysed based on recent traffic surveys. Future baseline transport conditions for the new station's planned opening year of 2021 are assessed in Section 5. This 2021 baseline scenario assumes the existing station at Station Road will remain operational and that there will be no relocation.

1.4.3. The impact of the new station is assessed for the 2021 planned opening year in Section 6. Because the relocation will not increase the number of services or the number of destinations served by Waterbeach rail station, the number of passengers and therefore trips generated by the new station in 2021 is predicted to be the same as that for the existing station in 2021. Section 7 presents the Framework STP for the new station, and Section 8 concludes the TA.

2 DEVELOPMENT PROPOSALS

2.1 RELOCATED STATION SITE LOCATION AND PROPOSED FACILITIES

2.1.1. The proposed site of the relocated station is immediately east of Bannold Drove and north of Bannold Road in the northeast of the village. It is about a 1 mile travelling distance northwards along the Cambridge – Ely railway line from the existing station. The existing and proposed relocated station locations are indicated on Figure 1, and the wider area is shown on Figure 2.

2.1.2. The proposal site is currently agricultural fields either side of the railway line, and so has limited trip generation.

2.1.3. The relocated station would have the following facilities:

- Northbound and southbound platforms both allowing 8-car trains to stop;
- An 'access for all' footbridge with lifts over the railway line to provide pedestrian connection between the northbound and southbound platforms;
- Automatic ticket machines;
- Covered areas on platforms for waiting passengers;
- Emergency footbridge over railway line between the northbound and southbound platforms to provide emergency escape from the southbound platform.

2.1.4. The proposed station layout is shown on the plan at Appendix A. The new station is expected to become operational in 2021, at which point the existing station will close. In due course, when the New Town is developed, further facilities would be provided at the station, such as a new station building and vehicular access directly from the A10. When this future phase is brought forward, the station car parking accessed from Cody Road will be reduced, with the new A10 access used instead. This would mean fewer station-related vehicles travelling through the village. However these changes are beyond the scope of this Transport Assessment and would be considered as part of the wider masterplan application.

2.1.5. The proposed relocation will not in itself result in any increase in the frequency of trains stopping at or number of destinations served by Waterbeach rail station.

2.2 PROPOSED SITE ACCESS

2.2.1. Vehicular access to the proposed relocated station will be via a new link road connecting with Cody Road, as shown on the drawing attached at Appendix B. The link road will meet Cody Road via a priority T-junction about 450m north of the Cody Road / Bannold Road junction. The link road will have a carriageway width of at least 5.5m, with a 2m wide footway provided along the north side. Its length will be about 650m from Cody Road to the station. The link road will have streetlighting and be designed for a 20mph speed limit.

2.2.2. Servicing of the station will be undertaken via the new link road connecting with Cody Road.

2.2.3. Swept path assessments of the Cody Road / new link road arrangements have been undertaken for buses and refuse vehicles, and are attached at Appendix C. These indicate that these vehicles can satisfactorily travel along Cody Road and the new link road. This addresses a concern raised at the public exhibitions about the suitability of Cody Road to provide vehicular access to the new station, particularly for buses.

2.2.4. Pedestrian and cycle access to the station will be available via Cody Road and the new link road described above. There will be improvements to the Cody Road footway as shown on the plan at Appendix B.

2.2.5. Access for walking and cycling is primarily via Bannold Drove, which runs largely parallel to and about 450m east of Cody Road. Bannold Drove is currently a country lane with no streetlighting nor footway provision. It will be improved as part of the station relocation proposals to provide a 3.5m-4m wide multi-user route. Private vehicular use will be for access to adjacent properties only.

2.2.6. Bannold Drove will provide the emergency access route to the station, and as stated below will provide the main access for construction of the station, although this will naturally only be a temporary use for the duration of the construction.

2.3 PROPOSED PARKING PROVISION

2.3.1. The new station will be provided with a 200 space surface car park, accessed from the new link road described above and located immediately south of the proposed station, as shown on the station layout plan at Appendix A. The car park will be free of charge, unlike the existing station.

2.3.2. The car parking provision represents an increase of 127 spaces compared to the existing station's car park. This increase is to allow for background growth in passenger numbers using Waterbeach rail station, and to accommodate displaced and overspill parking which currently occurs outside the existing station's car park along Station Road and towards the village centre.

2.3.3. This TA indicates that the proposed provision of 200 parking spaces will accommodate the car parking demand for the station, without overspill car parking onto nearby streets such as Cody Road, Capper Road, Abbey Place, Kirby Road, Fletcher Avenue and Bannold Road. Because the car park will be free of charge, there will be no incentive for displaced car parking onto these nearby residential streets. Overspill and displaced car parking has been a key issue raised during the pre-application consultation on the station proposals.

2.3.4. Car parking for Persons of Reduced Mobility (PRM) would be provided at 5% of the total number of car parking spaces provided. There will also be two staff car parking spaces. There will be 10 drop-off / pick-up spaces and two taxi drop-off / pick-up bays. These numbers are based on Train Operating Company requirements. There will also be two bus shelters located within the station layout, as shown on the plan at Appendix A.

2.3.5. A total of 100 cycle parking spaces will be provided at the relocated station initially, with future space for expansion. This is double the observed number of cycles parked at or in the vicinity of the existing station. The spaces will be covered and lit, and located close to the station entrance as indicated on the station layout plan at Appendix A.

2.4 CONSTRUCTION TRAFFIC

2.4.1. Construction traffic impacts, including the use of Cody Road for construction vehicles and the potential impact of construction workers' vehicles being parked in nearby residential streets, were raised as key issues during the pre-application consultation period.

2.4.2. To mitigate the effects of construction traffic, a Construction Environmental Management Plan (CEMP) will therefore be submitted to and approved by South Cambridgeshire District Council and Cambridgeshire County Council prior to the start of construction of the new station. The CEMP could be secured by means of a suitably-worded planning condition. The CEMP would identify vehicular access routes to the site, prioritising the use of Bannold Drove instead of Cody Road. Construction staff car parking would be required to avoid the use of nearby residential streets.

2.4.3. The construction period of the station and the new link road to Cody Road is anticipated to be about 18 months, with the station opening in 2021.

3 TRANSPORT POLICY CONTEXT

3.1 NATIONAL PLANNING POLICY FRAMEWORK (NPPF)

3.1.1. The NPPF contains the Government's planning policies for England and how these are expected to be applied. At the heart of the NPPF is a presumption in favour of sustainable development, meaning development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

3.1.2. In Section 4, under the heading 'Promoting sustainable transport', the NPPF advises (at paragraph 29) that transport policies have an important role to play in facilitating sustainable development, and that the transport system needs to be balanced in favour of sustainable modes, i.e. walking, cycling and public transport. At the same time, it recognises that opportunities to maximise sustainable transport solutions will vary from urban to rural areas.

3.1.3. Decisions on developments that generate significant amounts of movement should take account of whether:

- The opportunities for sustainable transport have been taken up to reduce the need for major transport infrastructure, depending on the nature and location of the site;
- There is safe and suitable access to the site for all people; and
- Improvements can be undertaken within the transport network that cost effectively limit the significant impacts of the development. Development should only be prevented or refused on transport grounds where the residual cumulative impacts of development are severe (NPPF paragraph 32).

3.1.4. The NPPF also advises that plans should protect and exploit opportunities for the use of sustainable transport modes for the movement of goods or people. It therefore advises that, amongst others, developments should be located and designed where practical to:

- Give priority to pedestrian and cycle movements, and have access to high quality public transport facilities;
- Create safe and secure layouts which minimise conflicts between traffic and cyclists or pedestrians, avoiding street clutter and where appropriate establishing home zones;
- Incorporate facilities for charging plug-in and other ultra-low emission vehicles; and
- Consider the needs of people with disabilities by all modes of transport (NPPF paragraph 35).

3.1.5. The relocated station will be in accordance with the NPPF because it will enable development (the Waterbeach New Town under SCDC emerging Local Plan Policy SS/5) that has access to high quality public transport.

3.2 SOUTH CAMBRIDGESHIRE DISTRICT COUNCIL POLICIES

3.2.1. SCDC's Local Development Framework (LDF) Core Strategy was adopted in January 2007. The Development Control Policies DPD, adopted in July 2007, includes the travel objective of seeking to increase the use of sustainable modes.

3.2.2. The emerging SCDC Local Plan Proposed Submission 2013 will replace the LDF, and contains guidance and policies on the future development of the district. It notes that the transport system needs to be balanced in favour of walking, cycling and public transport, so that people have a real choice about how they travel.

3.2.3. Emerging Local Plan Policy TI/2 'Planning for Sustainable Travel', states that, amongst others:

"Development must be located and designed to reduce the need to travel, particularly by car, and promote sustainable travel appropriate to its location.

"Planning permission will only be granted for development likely to give rise to increased travel demands, where the site has (or will attain) sufficient integration and accessibility by walking, cycling or public and community transport, including:

(a) Provision of safe, direct routes within permeable layouts that facilitate and encourage short distance trips by walking and cycling between home and nearby centres of attraction, and to bus stops or railway stations, to provide real travel choice for some or all of the journey;

(b) Provision of new cycle and walking routes that connect to existing networks, including the wider Rights of Way network, to strengthen connections between villages, Northstowe, Cambridge, market towns and the wider countryside;

(c) Protection and improvement of existing cycle and walking routes, including the Rights of Way network, to ensure the effectiveness and amenity of these routes is maintained, including through maintenance, crossings, signposting and waymarking, and where appropriate widening and lighting;

(d) Provision of secure, accessible and convenient cycle parking

(e) Securing appropriate improvements to public and community transport (including infrastructure requirements).

3.2.4. SCDC's Proposed Submission Local Plan (July 2013) allocates a new settlement known as Waterbeach New Town under Policy SS/5 on the former Waterbeach Barracks site and land to the east and north. The site allocation area is identified on the Local Plan Policies Proposals Map Inset H, attached at Appendix D. Policy SS/5 requires a relocated Waterbeach rail station to serve the existing village and the new settlement, amongst other transport improvements.

3.2.5. The proposed relocated station is in accordance with the aims and policies of the Local Plan. Inherently there will be increased travel demand generated by the relocation site compared to its existing use as an agricultural field. However, there will be safe, direct and convenient walking, cycling and bus routes to the site to connect it with existing transport networks in the village. In due course, it will enable the Waterbeach New Town to promote sustainable access by having close proximity to the new station.

3.3 CAMBRIDGESHIRE COUNTY COUNCIL LOCAL TRANSPORT PLAN 3

3.3.1. CCC's Local Transport Plan 3 (LTP3) sets out objectives and transport targets for Cambridgeshire for the period 2011-2026. The main objectives of the LTP3 are:

- Enabling people to thrive, achieve their potential and improve their quality of life, for example by providing a transport network that is efficient and effective, and influencing planning decisions to incorporate green spaces that are pleasant for pedestrians and cyclists;
- Supporting and protecting vulnerable people, for example implementing road safety initiatives;
- Managing and delivering growth and development of sustainable communities, for example discouraging car use and promoting non-car modes, improve footway and cycleway improvements to facilitate active travel, influence planning decisions to reduce the need to travel, influence the design of new development to promote road safety and encourage travel by foot and bicycle; and implement Travel Plans and other smarter travel choices;

- Promoting improved skill levels and economic prosperity across the County, helping people into jobs and encouraging enterprise, and providing a transport network that is efficient and effective; and
- Meeting the challenges of climate change and enhancing the natural environment, for example encouraging behavioural change away from single occupancy car use.

3.3.2. The proposed station relocation will support these LTP objectives by enabling residents of the Waterbeach New Town to have good access to high quality public transport. It will improve safety concerns relating to the existing Automatic Half Barrier (AHB) level crossing on Station Road at the existing station, as described in this report.

3.4 ELY – CAMBRIDGE TRANSPORT STUDY

3.4.1. The Preliminary Strategic Outline Business Case for the Ely to Cambridge Transport Study (ECTS) was published in January 2018. As part of the conclusions to the report Para 7.1.2 states:

"The recommended non-private car strategy is for early implementation of the cycle measures, a relocated railway station at Waterbeach and early progression of the segregated public transport corridor from Waterbeach to Cambridge's Northern Fringe, together with park and ride provision at the New Town."

3.4.2. From the above, it can be seen that one of the key components of the strategy to counter existing capacity constraints in the Ely – Cambridge corridor is the relocation of the railway station at Waterbeach and that it should be delivered as early as possible.

3.4.3. Para 7.1.2 of the ECTS also refers to early implementation of park and ride provision which includes rail-based park and ride at the relocation railway station linked to the A10.

3.4.4. This TA does not directly consider the transport impact of the Waterbeach New Town allocation or the initial findings of the ECTS with respect to potential transfer of trips from road to rail on the relocated railway station. It is, however, made clear in the proposals for the relocated railway station that the facilities needed to accommodate the significant additional demand that will arise from the New Town and non-private car strategy of the ECTS have been considered and can be provided in the future.

3.5 WIDER PLANNING CONTEXT

3.5.1. A planning application for part of the Policy SS/5 Waterbeach New Town was made to SCDC in early 2017 for a residential-led development of up to 6,500 dwellings (SCDC planning application reference S/0559/17/OL).

3.5.2. The application notes that the relocation of Waterbeach station is an important component of the transport strategy for the Policy SS/5 allocation. In addition indicative connections linking the location of the proposed railway station to the application site are shown along with proposed connections to the A10 in line with the conclusions of the ECTS.

3.5.3. As the relocated railway station is a facilitator of this proposed component of the wider New Town proposal and its delivery of the non-private car strategy of the ECTS this TA does not consider the transport impact of this application for the reasons set out above.

4 EXISTING TRANSPORT CONDITIONS

4.1 EXISTING STATION SITE LOCATION, LAYOUT AND SERVICES

4.1.1. The existing Waterbeach rail station is located on Station Road at the southeastern extent of the village, about 330m walking distance southeast of St John The Evangelist Church. The existing station location, in the context of Waterbeach, is shown on Figure 1, and the wider area is shown on Figure 2.

4.1.2. Network Rail (NR) operates the station. The station is served by Great Northern Trains calling at Kings Lynn, Ely, Cambridge and London Kings Cross. There are also morning and evening peak services to and from London Liverpool Street, operated by Greater Anglia Trains. The current timetables for Great Northern and Greater Anglia are attached at Appendix E, with the number of services summarised in Table 1 below.

Table 1 - Number of Passenger Services at Waterbeach

Weekday Services Calling at Waterbeach		Between 0700hrs and 1000hrs	Between 1600hrs and 1900hrs	Daily
Great Northern Services	Towards Cambridge / London	6	3	24
	Towards Ely / Kings Lynn	4	4	26
Greater Anglia Services	Towards Cambridge / London	1	0	3
	Towards Ely / Kings Lynn	0	3	6
Total		11	10	59

4.1.3. In addition to the above stopping services, there are passenger and freight services between Cambridge and Ely that do not stop at Waterbeach.

4.1.4. The station has two platforms each accommodating 4 car trains and which are staggered either side of Station Road. The southbound platform (Platform 1 or the 'up' platform), for services towards Cambridge and London Kings Cross, is to the southwest of Station Road. The northbound platform (Platform 2 or the 'down' platform), for services towards Ely and Kings Lynn, is to the northeast of Station Road.

4.1.5. There is an Automatic Half Barrier (AHB) level crossing of Station Road. The crossing point between the northbound and southbound platforms is via this AHB crossing, as well as that for journeys into and out of Waterbeach on Station Road.

4.1.6. To the east of the AHB crossing, Station Road becomes Clayhithe Road. A station car park of 73 spaces is accessed off Clayhithe Road, via a priority T-junction about 105m southeast of the level crossing.

4.1.7. There are 12 cycle parking spaces at the existing station, located on the northbound platform. There is additional cycle parking in the car park.

4.2 NUMBER OF PASSENGERS USING WATERBEACH STATION

4.2.1. The Office of Rail and Road (ORR) publish annual estimates of the number of people using all stations in Great Britain, including Waterbeach. The latest data, published in December 2017, indicates that 440,142 people used the station in 2016-17 (entries and exits). The data since 2006-07 is shown in Table 2 below.

Table 2 - Waterbeach Station Use 2006-07 to 2016-17

Year	Number of Passengers
2006-07	227,281
2007-08	250,039
2008-09	277,470
2009-10	266,020
2010-11	301,376
2011-12	312,216
2012-13	335,660
2013-14	344,722
2014-15	381,202
2015-16	420,730
2016-17	440,142

4.2.2. The above data indicates that there has been a 94% increase in passenger numbers at Waterbeach station in the ten years since 2006-07. This compares with a 75% increase at Cambridge station and a 53% increase in rail passengers nationally. The corresponding average annual growth in passengers at Waterbeach over this period is 6.8%.

4.2.3. A survey of the number of passengers using peak period services was undertaken on Tuesday 31 October 2017. The survey is attached at Appendix F, and summarised in Table 3 below.

Table 3 - Waterbeach Station Weekday Survey October 2017

Passengers Using Waterbeach	For Services Between 0700hrs and 1000hrs	For Services Between 1600hrs and 1900hrs	Daily (0500hrs – 2200hrs)
Boarding services towards Cambridge / London	380	56	641
Alighting services from Cambridge / London	44	323	568
Boarding services towards Ely / Kings Lynn	18	77	118
Alighting services from Ely / Kings Lynn	62	16	112
Total	504	472	1,439

4.2.4. The discrepancy between the 641 daily boarders for services to Cambridge / London and the 568 daily alighters for services from Cambridge / London is likely to be due to the survey finishing at about 2130hrs, after which there are a further six services at Waterbeach arriving from Cambridge / London.

4.3 USE OF STATION ROAD AUTOMATIC HALF BARRIER LEVEL CROSSING

4.3.1. All passengers from the Waterbeach direction who board services towards London, and those who alight services from Ely / Kings Lynn, must either walk across the Station Road AHB level crossing or drive across, parking in the station car park. In addition, all passengers alighting services from Cambridge / London who have parked in the car park must walk across the AHB level crossing, and those who have parked in the car park and are boarding services towards Ely / Kings Lynn must walk across the AHB level crossing.

4.3.2. A survey of the level crossing use was undertaken for the period Saturday 8 July 2017 to Sunday 17 July 2017. The data is attached at Appendix G and the average weekday (0600hrs – 0000hrs, Tuesday – Thursday) use is summarised in Table 4 below.

Table 4 - Station Road Level Crossing Average Weekday Use (0600hrs – 0000hrs), July 2017

Mode of Travel on Average Weekday	Eastbound Travel	Westbound Travel	Northbound Travel	Southbound Travel
Pedestrians	609	239	n/a	n/a
Cyclists	147	137	n/a	n/a
Vehicles	2,703	2,638	n/a	n/a
Trains	n/a	n/a	86	83

4.3.3. Network Rail undertake a passive level crossing risk assessment of every level crossing across their network. The risk is partly a function of the number of users of a level crossing, along with the layout and type of barrier. NR use the All Level Crossing Risk Model (ALCRM) to assess this risk. ALCRM provides an estimate of both the individual risk and collective risk at a level crossing, whereby:

- Individual risk is the annualised probability of a fatality to a regular user, with a ranking of risk from **A,** the highest risk, to **L**, the lowest risk;
- Collective risk is the total risk for the crossing and includes the risk to the users (pedestrian and vehicle), train staff and passengers, with a ranking of risk from **1**, the highest risk, to **12**, the lowest risk.

4.3.4. The latest ALCRM assessment for the Station Road Waterbeach AHB level crossing, in October 2017, is **C1**. This is the highest level of risk for this type of crossing. Of the 419 Public Highway AHB level crossings assessed in the ALCRM, the Station Road Waterbeach AHB is ranked within the top 3. Key risk drivers identified by NR are:

- Poor visibility for approaching road vehicles;
- Crossing is near a station;
- Crossing approach;
- Blocking back;
- Frequent trains.

4.3.5. NR's Station Capacity team have recently reviewed Waterbeach station, including the level crossing, in their 'Initial Station Capacity Assessment' report (dated September 2017). On the Station Road AHB level crossing, the NR report advises that:

"The type of level crossing and protection level to pedestrians from both road and rail vehicles are no longer appropriate to the increased demand currently generated at the station. In particular, a significant proportion of PM peak alighting passengers from the "down" [northbound] *platform must cross the railway and road to reach the car park and there* [is] *insufficient provision of footpaths and crossing locations to facilitate this safely."*

4.3.6. The NR Capacity report advises that there should be level crossing improvements in the form of replacing the AHB with a full barrier, in the context of greater station demand.

4.4 MEANS OF ACCESSING THE EXISTING STATION

Pedestrian Access

4.4.1. There are narrow and incomplete footways along Station Road connecting the station with the rest of the village. This is the only pedestrian route into the village. The southern footway terminates about 160m from the station, leaving only a narrow footway along the northern side of Station Road. Thereafter, footways are only provided on both sides of Station Road immediately northwest of St John The Evangelist Church, and these allow pedestrian connections to the centre of the village.

4.4.2. There is limited footway provision on Clayhithe Road immediately southeast of the level crossing, meaning that passengers walking to / from the car park must walk partly on Clayhithe Road. There is no formal pedestrian crossing facility on Clayhithe Road or Station Road. This existing provision means that pedestrian access to and from the station is relatively poor.

4.4.3. There can be passenger congestion at the platforms accesses during ingress and egress, caused by access widths of 1.4m for the northbound platform and 1.2m for the southbound platform. This is below the minimum recommended width of 2.2m that is set out in the NR Capacity report. A ticket machine at the southbound platform's access, and cycle storage located close to the northbound platform's access, exacerbate this congestion. The congestion can mean pedestrians spilling out onto the carriageway of Station Road / Clayhithe Road, particularly due to the inadequate footway provision. The NR Capacity report recommends that the access widths should be increased.

4.4.4. The walking accessibility of the station is indicated by walking isochrones shown on the plan at Appendix H, which shows walking journey times from the site at 5 minute intervals at a typical walking speed of 4.8kph (about 3mph). This demonstrates that the entire village is within a reasonable 25 minute walk of the station, albeit the quality of the route and pedestrian provision along Station Road east of the Church is relatively poor.

Cycle Access and Parking

4.4.5. National Cycle Route (NCR) 11 connects the station with Cambridge to the south via Haling Way, which runs alongside the River Cam. East of Milton to the south, NCR 11 diverges, with one leg continuing alongside the River Cam and into Cambridge beneath the A14. Another leg diverts into Milton and then into Cambridge via the Jane Coston Cycle Bridge. The route is indicated on Figure 2. There are no formal cycle routes within Waterbeach itself, with cycling on-street.

4.4.6. The cycle accessibility of the station is indicated by cycling isochrones on the plan at Appendix H. This shows that all of Waterbeach is within a 5 – 10 minute cycle ride of the station, at a typical cycling speed of 19.2kph (12mph).

4.4.7. There are 12 cycle parking spaces at the station, on the northbound platform. An additional 32 cycle parking spaces are provided in the car park. The above NR Capacity report notes that the cycle parking provision at the station is not sufficient for the demand, and that cycles are often chained to railings beside the platform itself. This represents a serious safety issue because it reduces the pedestrian flow capacity along the platform.

Bus Access

4.4.8. The nearest bus stops are located on Clayhithe Road immediately east of the AHB level crossing as indicated on Figure 1. There are further stops on Station Road about 100m to the northwest of the station. There are no covered waiting facilities or real time passenger information provided at these stops.

4.4.9. The Go Whippet No 196 bus calls at these stops. It provides four services in weekday mornings from Waterbeach to Cambridge, two return services in early weekday afternoons and a further return service in weekday evenings. There are no weekend services. Services route along Station Road, High Street, Bannold Road and Cody Road, originating and terminating in Capper Road. The routing and timetable is attached at Appendix I.

4.4.10. The first No 196 service of the morning leaves Capper Road at 0725hrs, and calls at the Clayhithe Road stops at 0732hrs. This means bus passengers intending to continue their journey to Cambridge / London by train would miss the 0732hrs Great Northern service to Cambridge and London Kings Cross. The next train leaves Waterbeach at 0757hrs. Based on the walking isochrones at Appendix H, residents of the Capper Road area would be able to leave their homes at the same time as the No 196 bus calls at Capper Road, walk to the station and arrive there in time for the 0757hrs Great Northern service to Cambridge and London Kings Cross. If they need to travel on the 0732hrs services, they would not be able to use the No 196 service to access the station, and would need to walk or cycle instead. The timing of the No 196 service is therefore not integrated with rail services at Waterbeach station.

4.4.11. In the evening, the No 196 service departs the station towards Capper Road at 1811hrs. The preceding train from Cambridge and London Kings Cross arrives at Waterbeach at 1747hrs, meaning that people alighting this service intending to continue their journey on bus within

Waterbeach would need to wait for 24 minutes. The walking isochrones at Appendix H show that most of the village is within a 25 minute walk of the station, and so passengers alighting the train and continuing their journey within the village on foot would be likely to arrive home before those who choose to use the No 196 bus.

4.4.12. On Green Side opposite Gibson Close, about 650m walking distance to the northwest of the station, there are bus stops served by the Stagecoach No 9 / X9 service. This provides a weekday hourly service to Cambridge, the Cambridge Research Park and Ely, via High Street and Denny End Road. The routing and timetable is attached at Appendix I.

4.4.13. The first morning service calling at Green Side from the north of the village and the Research Park stops at 0820hrs. This would enable interchange with the 0836hrs Great Northern service to Cambridge and London Kings Cross. Services from Green Side also call at the Research every hour from 0756hrs. There is evidence from the station's passenger numbers in Table 3 above that travel by train to the Cambridge Research Park is popular, with 106 passengers alighting at Waterbeach in the AM peak period. Many of these could travel to the Research Park by the No 9 / X9 bus.

4.4.14. Overall, however, the existing station has relatively poor bus accessibility, with limited bus stop infrastructure and lack of integration between bus services and train services.

Vehicular Access

4.4.15. The existing station is accessed via Station Road (west of the station) and Clayhithe Road (east of the station). There are on-street parking restrictions on Clayhithe Road and Station Road. Heading into Waterbeach, there is some on-street parking allowed on the northern side of Station Road between the station and St John the Evangelist Church, and on the western side of Station Road between the Church and Chapel Close – some of this parking straddles the footway. This on-street parking effectively limits Station Road to single lane running at these locations.

4.4.16. Observations indicate that this single lane running is largely self-policing, with forward visibility and gaps in the parking enabling opposing vehicles to see and be seen by each other, and where necessary slow down to give way to oncoming vehicles already on the single lane running section, either at the start of the single lane running or at the intermittent vehicle crossovers. However, there can be localised congestion at peak periods, and this can disrupt the No 196 bus service that uses Station Road.

4.4.17. Road traffic accident records provided by Cambridgeshire County Council (CCC) does not indicate a particular road safety concern on this section of Station Road, with only 1 no. serious accident and 1 no. slight accident recorded for the most recent 5 year period, and CCC does not identify it as an accident cluster site.

Taxis

4.4.18. There is no formal taxi drop-off, pick-up or ranking area at the existing station.

4.5 CAR PARKING PROVISION

4.5.1. The station's car park, accessed via Clayhithe Road immediately southeast of the level crossing, has 73 spaces, with charges for peak travelling times as shown in Table 5 below.

Table 5 - Waterbeach Station Peak Car Parking Charges

Parking Duration	Peak Charge
Daily	£3.10
Weekly	£20.00
Monthly	£51.00
Quarterly	£127.50
Annual	£485.00
Premier	£585.00

4.5.2. Only the Premier charge guarantees a car parking space in the car park.

4.5.3. In its 'Initial Station Capacity Assessment' report on Waterbeach station, NR notes that the car park is full on a typical weekday, with evidence of on-street parking restrictions being flouted. It also notes that the Ticket Vending Machine (TVM) for the car park is located at the access to the southbound platform, which can impact on passenger flows to and from this platform. NR's RAG (Red Amber Green) rating of the existing station's car parking provision is Amber.

4.5.4. For the purposes of this TA, car parking surveys were undertaken of the station car park and on streets within 800m walking distance of the station itself, to identify overspill / displaced car parking within the village. The station car park survey was undertaken on Tuesday 31 October 2017, and the on-street parking survey was also undertaken on Tuesday 31 October 2017. The survey data is attached at Appendix J. The station car park survey indicated that the peak occupancy of the car park occurred at 09:15hrs to 09:45hrs, when 65 cars were parked in the car park.

4.5.5. Observations, and the NR report above, indicate that there is overspill car parking on nearby streets, where parking is free. Some of this is not just overspill car parking; it is as a result of avoiding the charge to park at the station car park. Furthermore, the probability of finding a space within the station car park reduces during the morning as evidenced by the car park survey. This may encourage some drivers to park on-street in Waterbeach, particularly those that have travelled through the village, as otherwise they would risk missing a train through delays incurred by entering the car park, not finding a space, then driving back into Waterbeach to find an on-street space, and potentially being held up by the level crossing being lowered.

4.5.6. The on-street car parking survey has been reviewed to estimate the number of cars that park on-street within 800m of the station, the occupants of which would then travel on train from Waterbeach station. The data indicates that there are 70 – 80 such cars that park on-street in Waterbeach. This occurs primarily on Clayhithe Road, Station Road, Lode Avenue and Chapel Street. Some of the parking is illegitimate, and some vehicles straddle footways. This further reduces the quality of pedestrian routes to the station.

4.5.7. Combining the car parking at the station car park itself with those on-street, the peak car parking demand for the station is therefore for about 145 cars on a typical weekday.

4.5.8. The station car park survey data has also been analysed to estimate the number of car drop-offs and pick-ups being made at the station. The data indicates that, in the morning peak period of 0700hrs – 1000hrs, there were 36 drop-offs, and in the evening peak period of 1600hrs – 1900hrs, there were 38 pick-ups. These numbers are based on the number of exits from the car park in the AM peak period, and the number of entries in the PM peak period.

4.6 VEHICULAR TRAFFIC FLOWS

4.6.1. Manual Classified Turning Count traffic flow surveys were undertaken during the weekday AM and PM peak periods in early July 2017 at the junctions in Waterbeach. The survey specification, including junction locations, and the traffic survey data is attached at Appendix K. The observed 2017 AM and PM peak period flows are shown in Diagrams 1 and 2 at Appendix L, corresponding to the respective three hour periods of 0700hrs to 1000hrs, and 1600hrs to 1900hrs.

4.7 STATION-RELATED TRAFFIC FLOWS

4.7.1. This TA assesses the traffic impact of relocating the station from its existing location to the proposed location east of Bannold Drove. To calculate this impact, vehicular trips to and from the existing station need to be identified, and then redistributed to the new station location. The distribution of vehicular trips to and from the existing station has been estimated based on Automatic Number Plate Recognition (ANPR) surveys. The analysis of this data indicates that the distribution of vehicular traffic to and from the station that is external to Waterbeach is as shown in Table 6, along with the most likely route choice assignment.

Table 6 - Distribution of Vehicular Trips To Existing Waterbeach Station

Origin of Trips to / Destination of Trips from Existing Waterbeach Station	Route Choice Assignment	% of Station Vehicular Trips
North of Waterbeach (including Chittering)	Via A10, Denny End Road, High Street, Station Road	10%
	Via A10, Car Dyke Road, Station Road	29%
Southeast of Waterbeach (including Horningsea)	Via Clayhithe Road	13%
Southwest (including Milton)	Via A10, Car Dyke Road, Station Road	8%
West of Waterbeach (including Landbeach / Cottenham)	Via Waterbeach Road, Car Dyke Road, Chapel Street and Station Road	40%
Total	n/a	100%

4.7.2. The resulting station-only 2017 traffic flows for the existing station are shown on Diagrams 3 and 4 at Appendix L. The redistribution of these flows to the proposed station east of Bannold Drove is described in the following sections of this TA.

4.8 RELOCATED STATION SITE LOCATION AND MEANS OF ACCESS

4.8.1. The relocated station site location is shown on Figure 1. It is about 450m east of Cody Road, and about 1 mile travelling distance along the railway line north of the existing station. The wider area is shown on Figure 2.

The relocation site is currently an agricultural field. Access on foot and cycle is available via Bannold Drove, which is currently an unlit country lane. The nearest bus services call at Bannold Road and Capper Road as described above. The proposed relocation will involve improvements to the all-mode accessibility of the site, and this is described in Section 6.

5 FUTURE BASELINE CONDITIONS – 2021

5.1 GROWTH IN RAIL PASSENGER NUMBERS USING WATERBEACH STATION

5.1.1. The previous section presented ORR data that indicates a 6.8% average per annum increase in the number of passengers using Waterbeach station over the last 10 years. Projecting this forward to 2021, there would be a 30.3% increase in passengers using the station from 2017 levels.

5.1.2. This background growth in passenger numbers has been applied to the existing station only traffic flows in Waterbeach shown on Diagrams 3 and 4, in order to identify the number of vehicular trips to and from Waterbeach station in 2021 at its existing location, i.e. assuming no relocation. The resulting 2021 future baseline station only traffic flows are shown on Diagrams 5 and 6 at Appendix L.

5.1.3. The above 30.3% increase in passenger numbers has also been applied to the number of observed passengers surveyed in October 2017 and described in the previous section. The resulting future baseline number of passengers using the station in 2021 is shown in Table 7 below.

Table 7 - Waterbeach Station Weekday Use for 2021 Future Baseline Scenario

Passengers Using Waterbeach	For Services Between 0700hrs and 1000hrs	For Services Between 1600hrs and 1900hrs	Daily (0500hrs – 2200hrs)
Boarding services towards Cambridge / London	495	73	835
Alighting services from Cambridge / London	57	421	740
Boarding services towards Ely / Kings Lynn	23	100	154
Alighting services from Ely / Kings Lynn	81	21	146
Total	656	615	1,875

5.2 BACKGROUND GROWTH IN TRAFFIC FLOWS IN WATERBEACH TO 2021

5.2.1. This TA considers the impact of the relocated station for an assessment year of 2021, which is when the relocated station would become operational and the existing station close. Future baseline station only traffic flows for 2021 have been assessed above. It is now necessary to calculate future baseline traffic flows for 2021 which includes background traffic growth on the local highway network that is unrelated to the station.

5.2.2. The first step in this process is to apply background traffic growth factors to the 2017 observed traffic flows excluding station-related traffic. Therefore, the 'existing station only' flows shown in Diagrams 3 and 4 at Appendix L have been subtracted from the total observed traffic flows for Waterbeach shown in Diagrams 1 and 2. The resulting observed 2017 traffic flows excluding any station-related traffic are shown on Diagrams 7 and 8 at Appendix L.

5.2.3. Background traffic growth factors to the assessment year of 2021 are based on the Department for Transport's National Transport Model's (NTM's) Regional Traffic Growth Forecasts 2009, adjusted for local growth using TEMPro version 7 dataset 70. The resulting background traffic growth forecasts are set out in Table 8 below.

Table 8 – Background Traffic Growth Factors for Waterbeach

Year	AM Peak Period	PM Peak Period
2017 – 2021	1.0731	1.0756

5.2.4. These growth factors have been applied to the 2017 flows excluding station traffic that are shown on Diagrams 7 and 8 at Appendix L, and the resulting 2021 future baseline flows excluding station traffic are shown on Diagrams 9 and 10. The 2021 future baseline station only traffic flows, shown on Diagrams 5 and 6, have then been added to the 2021 future baseline flows excluding station traffic in order to provide future baseline flows for 2021 with the station remaining at its existing location. These flows are shown on Diagrams 11 and 12 at Appendix L. It will be against these flows that the traffic impact of the proposed relocation is assessed, in the following section.

5.3 PLANNED TRANSPORT IMPROVEMENTS IN WATERBEACH

5.3.1. The Greater Cambridge Partnership is planning a high quality network of commuter cycle routes between Cambridge and a number of its surrounding villages, including Waterbeach. The routes will also be available for pedestrians and horse riders. Known as 'Greenways', they will be segregated from heavily trafficked roads, with the aim to increase levels of cycling and walking as main mode of travel into Cambridge.

5.3.2. A Greenway is planned to connect Waterbeach with Cambridge, and is likely to involve some or all of the following:

- Enhancements including localised widening and surfacing improvements to the existing National Cycle Route 11 that forms the Haling Way. This existing route is shown on Figure 2 and described in the previous section;
- A new route along the western side of the Cambridge to Ely railway line. There would be a new connection between Cambridge Road and the railway line via Car Dyke. The indicative route is shown on Figure 2; and
- A new route along the A10 between the Car Dyke Road junction and the Ely Road junction at the northern end of Milton but set away from the road. The indicative route is shown on Figure 2.

5.3.3. The final route alignment is to be subject to public engagement and consultation later in 2018.

5.4 FUTURE BASELINE DISTRIBUTION AND MODE SHARES

5.4.1. For local journeys within Waterbeach a review of census output areas has been undertaken with each area classified in relation to their existing accessibility to the current Waterbeach rail station in the south of the village, taking the Census 2011 distribution of local resident journeys to work by train with origins in Waterbeach as the starting point.

5.4.2. It is assumed that 75% of those who drive to the station are from outside of Waterbeach and that 60% of rail passengers in 2011 were from within the village (prior to the development of Waterbeach New Town), increasing to 62% with committed infill developments in Waterbeach taken into account for the forecast year of 2021.

5.4.3. For each output area a mode share has been assigned based on travel distance to the station and accessibility by each mode. This analysis assumes that existing bus services remain unchanged.

Table 9 - Waterbeach Existing Station 2021 Baseline Distribution and Mode Shares

Output Area	2021 Distribution	Walk	Cycle	Bus/ Shuttle	Car Driver	Car Passenger	Total
E00092291	7%	55%	30%	0%	9%	6%	100%
E00092292	10%	30%	50%	0%	12%	8%	100%
E00092293	3%	30%	50%	0%	12%	8%	100%
E00092294	1%	5%	45%	0%	30%	20%	100%
E00092295	2%	10%	45%	0%	27%	18%	100%
E00092296	1%	40%	50%	0%	6%	4%	100%
E00092297	4%	15%	40%	0%	27%	18%	100%
E00092298	4%	45%	45%	0%	6%	4%	100%
E00092299	3%	45%	45%	0%	6%	4%	100%
E00092300	3%	70%	20%	0%	6%	4%	100%
E00092301	8%	80%	10%	0%	6%	4%	100%
E00092302	8%	80%	10%	0%	6%	4%	100%
E00092303	2%	10%	40%	0%	30%	20%	100%
E00092304	5%	5%	45%	0%	30%	20%	100%
External	38%	0%	0%	5%	57%	38%	100%
Total	100%	28%	20%	2%	30%	20%	100%

5.4.4. Table 9 indicates that the overall resulting mode shares give an approximate 50:50 split between car and non-car modes in the future baseline for 2021 without the Waterbeach New Town proposals.

5.5 FUTURE BASELINE 2021 TRANSPORT CONDITIONS

5.5.1. The above 30% increase in passengers at the existing station between 2017 and 2021 will exacerbate existing concerns described in the previous section regarding access to the station. In particular:

- The ALCRM assessment of the Automatic Half Barrier Level (AHB) Crossing will continue to show a high level of risk, which may increase further as users of the crossing increase;
- There will be increased congestion at the platform accesses with Station Road / Clayhithe Road, with further potential for spilling out onto the carriageway and therefore bringing pedestrians into conflict with vehicular traffic;
- There will be increased demand for cycle parking, and because the existing supply on the northbound platform is at capacity, there would be inappropriate cycle parking at, for example the fencing along Station Road. This could further impede what is already a relatively poor quality pedestrian route along Station Road between the station and the rest of the village;

- There will be increased demand for car parking, most of which will occur on-street. For existing 2017 conditions there is demand for 145 spaces but only 73 spaces. The demand would increase to 189 spaces with background growth to 2021. Some of this additional displaced parking may be inappropriate and affect road users' inter-visibility, for example pedestrians crossing roads between parked vehicles, and parking around junction radii. Some of the parking may also straddle footways, as it currently does on Station Road between the Church and Chapel Close, and impede pedestrian movement.

5.5.2. These are each considered significant road safety concerns with the existing station for the future baseline conditions in 2021.

6 IMPACT OF PROPOSED STATION RELOCATION

6.1 REDISTRIBUTION OF VEHICULAR TRAFFIC

6.1.1. Section 4 presents analysis of the distribution of vehicular trips to the existing station, based on ANPR survey data. The station relocation will not in itself have an impact on this overall distribution, but the route choice of the trips will change. The trips have been manually reassigned based on logical routes, as shown in Table 9 below.

6.1.2. The above analysis indicates that the distribution of vehicular traffic to and from the station that is external to Waterbeach is as shown in Table 9, along with the most likely route choice assignment.

Table 10 - Distribution of Vehicular Trips To Relocated Waterbeach Station

Origin of Trips to / Destination of Trips from Relocated Waterbeach Station	Route Choice Assignment	% of Station Vehicular Trips
North of Waterbeach (including Chittering)	Via A10, Denny End Road, Bannold Road, Cody Road	39%
Southeast of Waterbeach (including Horningsea)	Via Clayhithe Road, Station Road, Way Lane, Bannold Road, Cody Road	13%
Southwest (including Milton)	Via A10, Denny End Road, Bannold Road, Cody Road	8%
West of Waterbeach (including Landbeach / Cottenham)	Via Waterbeach Road A10, Denny End Road, Bannold Road, Cody Road	40%
Total	n/a	100%

6.1.3. The 2021 future baseline station only trips shown on Diagrams 5 and 6 have been reassigned based on the above distribution of trips, and the resulting 2021 relocated station flows only are shown on Diagrams 13 and 14 at Appendix L. These flows have been added to the 2021 future baseline flows excluding the station that are shown on Diagrams 9 and 10, and the resulting 2021 future flows including the relocated station are shown on Diagrams 15 and 16 at Appendix L.

6.2 IMPACT ON HIGHWAY FLOWS

6.2.1. The previous section presented the 2021 future baseline flows assuming Waterbeach station remains at its existing location on Station Road, and these are shown on Diagrams 11 and 12 at Appendix L. The 2021 future flows with the proposed relocated station are shown on Diagrams 15 and 16 for the three hour peak period totals. The 2021 impact on peak hour highway flows between the future baseline scenario and the future scenario with the relocated station is summarised in Table 10 below for the average hourly flows during a typical weekday AM three hour peak period of 0700hrs – 1000hrs and Table 11 below for the weekday PM three hour peak period of 1600hrs – 1900hrs.

Table 11 - Highway Impact of Relocated Station in 2021 Weekday AM Three Hour Peak Period of 0700-1000hrs Average Hourly Flow (2-Way Flows)

Link in Weekday AM Peak Period 0700-1000hrs	2021 Base Average Hourly Flow with Existing Station Still Operational	2021 Average Hourly Flow with Relocated Station	Absolute Change from Base to With-Relocation Average Hourly Flow
Waterbeach Road west of A10	162	162	0
A10 Between Waterbeach Road and Car Dyke Road	1854	1809	-45
Car Dyke Rd East of A10	426	370	-56
A10 Between Waterbeach Road and Denny End Road	1768	1786	18
A10 North of Denny End Road	1848	1852	5
A10 South of Car Dyke Road	2020	2019	-1
Denny End Road Between A10 and Bannold Road	488	544	56
Cody Rd North of Bannold Road	204	277	73
Station Rd between Existing Station and St John's Church	539	503	-36
Clayhithe Road East of Existing Station	466	466	0
High Street South of Bannold Road	445	437	-7
Way Lane	218	223	4

Table 12 - Highway Impact of Relocated Station in 2021 Weekday PM Three Hour Peak Period of 1600-1900hrs Average Hourly Flow (2-way Flows)

Link in Weekday PM Peak Period 1600-1900hrs	2021 Base Average Hourly Flow with Existing Station Still Operational	2021 Average Hourly Flow with Relocated Station	Absolute Change from Base to With-Relocation Average Hourly Flow
Waterbeach Road west of A10	162	163	1
A10 Between Waterbeach Road and Car Dyke Road	1683	1637	-46
Car Dyke Rd East of A10	473	417	-57
A10 Between Waterbeach Road and Denny End Road	1582	1597	15
A10 North of Denny End Road	1690	1691	1
A10 South of Car Dyke Road	1936	1935	-1
Denny End Road Between A10 and Bannold Road	483	540	57
Cody Rd North of Bannold Road	197	270	73
Station Rd between Existing Station and St John's Church	509	471	-37
Clayhithe Road East of Existing Station	419	419	0
High Street South of Bannold Road	478	471	-7
Way Lane	249	257	9

6.2.2. There will be increases on the A10 north of Waterbeach Road, then Denny End Road, Bannold Road and Cody Road as these form the main access route to the station. The main impact is on Cody Road, which would experience an average hourly increase of 73 vehicles during peak period. This is just over 1 vehicle per minute on average which is not considered a severe impact.

6.2.3. There will be reductions on the A10 between Waterbeach Road and Car Dyke Road, along with reductions on Car Dyke Road itself, Station Road and High Street passing the Primary School as a result of the relocation.

6.3 STATION ROAD LEVEL CROSSING

6.3.1. The relocation will remove a significant number of users (both vehicles and pedestrians) from the Station Road level crossing. The above vehicular impact assessment indicates that there would be 108 – 112 fewer vehicles using the crossing (vehicles on Station Road) during the AM and PM peak three hour periods. In addition, of the 848 pedestrians that currently use the crossing on a typical weekday, the majority of these will be related to the existing station and so would be removed from the crossing with the relocation.

6.3.2. Network Rail's ALCRM assessment of the existing Station Road Automatic Half Barrier (AHB) Level Crossing is **C1**, which is a high risk and of all the AHB crossings on the network, the Station Road Waterbeach crossing is ranked in the top 3. The assessment is partly a function of the number of users of the crossing, and so the risk at the crossing will be appreciably reduced as a result of the station relocation. Furthermore, there will be far fewer users exposed to the risk at the level crossing, so the collective risk should reduce. At the new station, there will be a bridge across the railway line to connect the northbound and southbound platforms, so passengers will have a safe crossing of the railway line.

6.3.3. This reduced level crossing risk is considered a significant transport safety benefit arising from the relocation proposals.

6.4 MEANS OF ACCESSING THE RELOCATED STATION

Pedestrian Access

6.4.1. Pedestrian access to the new station will be significantly improved in comparison with the existing station, where there are narrow and incomplete footways along Station Road and pedestrian flow can be impeded by parked cars and cycles. The new station proposals include widening of footways where possible within existing extents of public highway along Cody Road, a new section of footway on Bannold Road and new sustainable access routes alongside the station access road to the north and east of Capper Road, connecting to the proposed station entrance. Bannold Drove, which is currently a single track lane would also be resurfaced to provide a multi-user route to the station.

6.4.2. The width of the accesses to the new station's platforms will be to current Network Rail standards and will not be adjacent to the access road. This is in comparison to the existing station where access widths are below standard and immediately adjacent Station Road, causing pedestrian congestion that can be in conflict with vehicular movements along Station Road.

6.4.3. The new station's pedestrian access arrangements therefore offer considerable safety benefits compared to those for the existing station. A Diversity Impact Assessment has also been carried out to ensure that all access routes are as accessible as reasonably practicable, compliant with equalities legislation and that the scheme does not discriminate against members of society with protected characteristics.

6.4.4. The walking accessibility of the new station is indicated by walking isochrones (as shown in Appendix H) of pedestrian journey times from the site at 5 minute intervals at a typical walking speed of 4.8kph (about 3mph), although it should be noted that people may walk more briskly whilst commuting. This demonstrates that most of the village is within a reasonable 25 minute walk of the station. However, residents currently living within a 5 minute walk of the existing station, would suffer a reduction in accessibility to the new station. Therefore a shuttle service will be put in place connecting to stops located within a 5 minute walk for these residents (as set out below).

Cycle Access and Cycle Parking

6.4.5. Cycle access to the new station will be via Cody Road and Bannold Drove. The development will provide routes to the station that are safe, convenient and logical in order to promote access to the station by these modes. Clear signage and way finding will be provided to guide users to the new station from the centre of the village. Within the station the proposed bridges will include cycle gullies and the AFA bridge will have lifts with sufficient capacity for cycles, to enable onward journeys by train and bike which is very popular in the local area.

6.4.6. The cycle accessibility of the new station is indicated on the cycling isochrones plan opposite. This shows that all of Waterbeach is within a 5 – 10 minute cycle ride of the new station, at a typical cycling speed of 19.2kph (12mph). The number of people living within 10 minutes cycle ride of the new station is no different to that for the existing station, although the cycle route to and cycle parking facilities at the new station will be significantly improved compared to the existing station. Bannold Drove will be for pedestrian and cycle access only to the station, as well as serving as its emergency access.

6.4.7. Cycling routes through the village will be improved, in particular along Way Lane, where priority to cyclists over vehicular traffic is proposed. There will also be localised traffic calming along Way Lane to reduce vehicular speeds and therefore make cycling an attractive option along this route.

6.4.8. There will be 100 cycle parking spaces provided at appropriate locations within the station which are covered and well lit. This is more than double the level of existing cycle parking provision at the existing station and there is further scope for increasing the level of provision as demand increases.

6.4.9. The cycle parking will be located to the north of the station car park with separate access routes which avoid conflict with vehicles at the point of entry to the station. All of the cycle parking will also be on the west side of the railway, avoiding the need for use of level crossings for access (as required at the existing station). The proposed cycle parking will be clear of footways and pedestrian accesses into the station, therefore addressing a key safety concern with the existing station where the cycle parking can cause pedestrian flows to be impeded, for example at the access / egress to the northbound carriageway.

6.4.10. The uptake of cycle parking will be monitored as part of the station Travel Plan and the level of provision will be reviewed annually to make sure that capacity keeps pace with demand.

Bus/Shuttle Service Access

6.4.11. The bus access to the existing station is relatively poor, with limited bus stop infrastructure and lack of integration between bus services and train services. The new station will have formal bus stop provision and the applicant will endeavour to secure new or extended services that provide bus access with the village which integrates with the train timetable. This bus access would include improved connections for residents nearest the existing station, so that the reduction in the walking accessibility of Waterbeach station with its relocation is offset for these residents by improved bus access. The potential bus service improvements could include one or a combination of the following:

- Extension of the No 9 / X9 Stagecoach service along Cody Road, seeking timings that integrate with the train timetable at the new Waterbeach station. Discussions have taken place with Stagecoach who have agreed to the principle of diverting their existing Service 9 bus route to the new station;
- Extension of the existing No 196 Go Whippet service along Cody Road into the station, potentially with increased frequency. This service already serves Cody Road to the south, so would only require a short extension to continue along Station Road. This would provide bus accessibility to the new station for those residents who live nearest the existing station;

6.4.12. RLW Estates are also committed to providing a bespoke shuttle service operating to stops in the south of the village close to the existing station and Greenside. The timings of the service would seek to integrate with the train timetable at the new station. The proposed shuttle vehicle will also be fully accessible for disabled users. Feedback from public consultation in 2018 indicated significant interest in this service. This would be secured via a s106 agreement.

6.4.13. This could be similar to the community vehicles provided to mitigate new development in Hardwick (SCDC application reference S/1694/16/OL) and Melbourn (SCDC application reference S/2791/14/OL). It could also be similar to the Coggeshall Community Bus in Coggeshall, Essex, which provides morning and evening runs to and from Kelvedon railway station, as well as local midday runs to provide a transport link around Coggeshall.

6.4.14. This would mean that residents near the existing station and in the south west of the village who are beyond a 25 minute walk of the new station would be able to access the shuttle service within a 5 minute walk.

6.4.15. The above bus and shuttle service options are shown in Appendix N. These improvements would offer a significant improvement in the bus accessibility of the relocated station compared to that of the existing station and would be secured as part of a s106 agreement for the proposed station relocation.

Vehicular Access

6.4.16. The vehicular access to the new station will be via Cody Road and a new link road, as shown on the access drawing attached at Appendix B. The link road will have a carriageway width of at least 5.5m, with 2m wide footways provided. Its length will be about 650m from Cody Road to the station. The link road will have street lighting and be designed for a 20mph speed limit.

6.4.17. Servicing of the station will be undertaken via the new link road connecting with Cody Road.

6.4.18. Swept path assessments of the Cody Road / new link road arrangements have been undertaken for buses and refuse vehicles, and are attached at Appendix C. These indicate that these vehicles can satisfactorily travel along Cody Road and the new link road. This address a concern raised at the public exhibition about the suitability of Cody Road to provide vehicular access to the new station, particularly for buses.

Taxis

6.4.19. There will be a taxi drop-off and pick-up point located within the station. This compares to the existing station where there is no formal drop-off or pick-up points.

6.5 CAR PARKING PROVISION

6.5.1. The previous section indicates that the future baseline car parking demand in 2021 would be for about 189 spaces. The proposed relocated station would be served by a 200 space car park, and so would accommodate this demand without overspill car parking on nearby residential streets. The relocated station car park would be free at the point of use, minimising the likelihood of any displaced car parking onto nearby residential streets buy those seeking to avoid a parking charge.

6.5.2. The proposed car park would be west of the railway line, and therefore more readily accessible than the existing car park which is east of the railway line and requires vehicles to use the level crossing.

6.5.3. These car parking arrangements offer considerable transport benefits compared to the existing station's car parking. Furthermore, the existing overspill and displaced car parking that occurs near the existing station will be removed due to the relocation, therefore delivering localised safety and congestion improvements along Station Road, Lode Avenue and streets towards the centre of the village.

6.6 TRIP DISTRIBUTION

6.6.1. For local journeys within Waterbeach a review of census output areas has been undertaken with each area classified in relation to their future accessibility to rail services (with the proposed relocated station in place), taking the 2021 future baseline distribution from Table 9 above as the starting point.

6.6.2. It is assumed that 75% of those who drive to the station are from outside of Waterbeach and that 62% of rail passengers (prior to the development of Waterbeach New Town) come from within the Waterbeach village. This includes committed infill developments t Bannold Drove and Cody Road for example.

6.6.3. For each Output Area (OA) a mode share has been assigned based on travel distance to the new station and accessibility by each mode, including the proposed bus/shuttle services.

Table 13– Relocated Station Future Mode Share and Distribution

Output Area	2021 Distribution	Walk	Cycle	Bus/ Shuttle	Car Driver	Car Passenger	Total
E00092291	7%	40%	40%	10%	6%	4%	100%
E00092292	9%	80%	10%	0%	6%	4%	100%
E00092293	3%	10%	35%	20%	21%	14%	100%
E00092294	1%	10%	45%	0%	27%	18%	100%
E00092295	2%	80%	10%	0%	6%	4%	100%
E00092296	1%	45%	45%	0%	6%	4%	100%
E00092297	4%	45%	45%	0%	6%	4%	100%
E00092298	4%	45%	45%	0%	6%	4%	100%
E00092299	3%	45%	45%	0%	6%	4%	100%
E00092300	3%	10%	35%	20%	21%	14%	100%
E00092301	8%	10%	35%	20%	21%	14%	100%
E00092302	8%	10%	35%	20%	21%	14%	100%
E00092303	3%	40%	40%	0%	12%	8%	100%
E00092304	5%	80%	10%	0%	6%	4%	100%
External	40%	0	0%	5%	57%	38%	100%
Total	100%	**25%**	**19%**	**7%**	29%	20%	100%

6.6.4. Comparing Table 13 above with the baseline mode shares in Table 9, there is likely to be very little overall change in the ratio of car and non-car mode shares, although with the improvements to bus services proposed, there is an increase in the uptake of bus services and a corresponding reduction in travel by other modes.

7 FRAMEWORK STATION TRAVEL PLAN

7.1 INTRODUCTION

7.1.1. A Station Travel Plan (STP) is defined in the Station Travel Plans Toolkit document prepared by the Rail Safety and Standards Board (RSSB) and the Association of Train Operating Companies (ATOC) as:

A management tool for improving access to and from a station and mitigating local transport and parking problems, supporting sustainable growth in rail patronage and the strategic objectives of the rail industry.

7.1.2. The RSSB & ATOC document notes that STPs focus, amongst other matters, on more sustainable transport solutions, in particular, ways of getting to and from stations other than solo car use. It also recognises that driving a car to a nearby railway station can avoid the need for a longer journey car trip, and so the management of on-site and off-site car parking, drop-offs and pick-ups are important elements of a STP.

7.1.3. This Framework STP seeks to maximise non-car trips to the station and supports more sustainable forms of travel, seeking to manage car parking demand both within the site and on surrounding roads. Its primary aim is to promote travel choices to access the station, with measures to encourage staff and station users to reduce their reliance on the private car and increase walking, cycling, bus and car sharing as means of accessing the station.

7.1.4. It is recognised that any Travel Plan is an organic document which will need updating from time to time to take account of the latest best practice in the field, along with changes in transport conditions and travel behaviour around the site in question. Furthermore, because travel planning is an ever-evolving process, some of the measures and initiatives in this Framework STP may become unsuitable in future when the relocated Waterbeach station becomes operational (scheduled for 2021, while others not considered at this stage may come forward as being appropriate. This includes consideration of the delivery of Waterbeach New Town, and the transport measures it will deliver.

7.1.5. Therefore, this first iteration of the STP – the Framework STP – accompanies the detailed planning application for the new station. In due course, it will be revised and updated to a Full STP, to be implemented for commencement of rail operations at the new station. The Full STP would be prepared by the operator of the new station.

7.2 AIMS AND OBJECTIVES

7.2.1. The key aim of this Framework STP is to promote travel choices, with measures to encourage staff and station users to reduce their reliance on the private car and increase other means of travel, primarily car sharing, bus, cycling and walking, as means of accessing the station. The Full STP will include aims related to improving customer satisfaction at the station and supporting passenger growth.

7.3 FRAMEWORK STP TARGETS

7.3.1. This Framework STP's targets relate to maximising non-car access to the new station. Maximising the active travel mode shares are particularly important as these contribute to healthy lifestyles and offer tangible health benefits for station users.

7.3.2. The baseline travel mode shares will need to be established as part of a baseline travel survey within three months of opening the new station.

7.3.3. **An initial target is to maximise non-car travel to the station, aiming to achieve a 5% per annum increase in non-car travel to the station.**

7.3.4. These targets are considered SMART because:

- Specific – it relates to station users;
- Measurable – travel surveys and monitoring will establish mode shares and monitor progress;
- Achievable / Realistic – since the targets are specific to station users, and will be assessed against future station patronage and means of access;
- Time-bound – aiming to achieve the targets within 12 months of the baseline travel survey.

7.3.5. Targets relating to increased bus use, walking, cycling and car sharing are not considered necessary in this instance, since it may be that one sustainable mode is promoted at the expense of the other.

7.4 IMPLEMENTATION, MANAGEMENT AND MONITORING

7.4.1. This Framework STP is the first step in the process towards preparing the Full STP for the new station. It contains the principles, measures and a framework for agreeing the Full STP following approval of the detailed planning application.

7.4.2. The new station operator will have the responsibility for preparing and implementing the Full STP. A Station Travel Plan Co-ordinator (STPC) will be appointed by the operator to take responsibility for the development and management of the Full STP and will be responsible for its delivery.

7.4.3. The STPC will establish a STP Steering Group for the station as a forum to exchange ideas, promote new ideas in sustainable transport and review annual travel survey results. Network Rail and the Train Operating Companies will be invited to participate in the Steering Group, as will Cambridgeshire County Council and South Cambridgeshire District Council, the Cambridgeshire Travel for Work (TfW) Partnership, local residents' groups, main employers and local bus and taxi operators. It would be through this Steering Group that the Full STP would be updated and improved over time as necessary.

7.4.4. The Full STP will be implemented for the start of operations at the new station, and the STPC will then establish the STP Steering Group. As noted above, the Steering Group will enable the development of the Full STP, which will be an organic document.

7.4.5. To determine the effectiveness of the Full STP, and so that future revisions to it are effective, monitoring and review of the targets, objectives and measures will take place at regular intervals. The STP will also involve the on-going promotion by the TPC.

7.4.6. The primary element of monitoring will be a questionnaire-based survey, which will be completed annually in order to determine travel patterns to and from the station. The occupancy of the on-site car and cycle parking would also be monitored and surveys will be compared to patronage data published annually by ORR. A baseline survey would be completed 6 months after opening and progress of the travel plan towards meeting the proposed targets would be monitored against these initial baseline mode shares.

8 CONCLUSION

8.1.1. This Transport Assessment (TA) accompanies a planning application for the proposed relocation of Waterbeach rail station in Cambridgeshire, from its existing site at Station Road to a new site east of Bannold Drove. Upon relocation, the existing station will cease to operate.

8.1.2. The TA includes a Framework Station Travel Plan (Framework STP), a primary aim of which is to encourage the uptake of sustainable modes of travel (walk, cycle, bus and car share) to access the station, in particular cycling and waking as these contribute towards healthy lifestyles.

8.1.3. The relocation of the station is required for development of the Waterbeach New Town, as set out in South Cambridgeshire District Council's emerging Local Plan. The relocation will assist with delivery of the New Town in accordance with local and national transport planning policies which seek developments that have access to high quality public transport.

8.1.4. The new station will be accessed via a new link road connecting with Cody Road. This has been designed so that it can accommodate infrequent large vehicles including buses and refuse vehicles. The link road will be provided with a 2m wide footway, and there will be improved footway provision along Cody Road. Main pedestrian and cycle access will be via Bannold Drove, which will also form the emergency access to the station.

8.1.5. There will be 200 car parking spaces at the new station. This provision is more than double the existing station car park capacity and will meet car parking demand, therefore avoiding overspill car parking onto nearby residential streets. The car park will be free of charge at the point of use for rail passengers, therefore negating the potential for displaced station parking off-site in order to avoid any charges. However, a time restriction or charges for overnight parking may be imposed to prevent misuse of the car park. The management of the car park will remain in the control of RLW Estates and will be monitored regularly as part of the Travel Plan.

8.1.6. A Construction Environmental Management Plan (CEMP) will be submitted to and approved by South Cambridgeshire District Council prior to the start of construction of the station, which would identify vehicular access routes to the site, prioritising the use of Bannold Drove instead of Cody Road, as well as requiring construction staff car parking to avoid surrounding residential streets.

8.1.7. There are a number of operational and safety concerns with the existing station, including:

- There is an Automatic Half Barrier Level (AHB) Level Crossing which Network Rail have assessed as having a high level of risk, partly due to the number of users of the crossing;
- There can be passenger congestion at the accesses to the platforms during peak periods, and as these accesses are adjacent to Station Road and Clayhithe Road, pedestrians can come into conflict with vehicular traffic;
- There is a poor pedestrian route to the station, with narrow and interrupted footways along Station Road;
- There is overspill car parking on nearby residential streets as demand for the station car park exceeds its supply. There is also displaced car parking on these streets as a result existing car parking charges in the station car park;

8.1.8. The new station is expected to become operational in 2021, at which point the existing station will close. In due course, when the New Town is developed, further facilities will be provided at the new station, such as a new station building and vehicular access directly from the A10. When this future phase is brought forward, the station car parking accessed from Cody Road will be reduced, with the new A10 access used instead. This would mean fewer station-related vehicles travelling through the village. However these changes are beyond the scope of this Transport Assessment and would be considered as part of the wider masterplan application.

8.1.9. The impact of the relocated station has been assessed for the 2021 planned opening year. Surveys have been obtained of existing station use and traffic flows in the village, and these have been analysed to assess the redistribution of trips from the existing station to the new station.

8.1.10. The impacts of the station relocation compared to retaining the existing station have been assessed for 2021 as follows:

- The number of users exposed to risk at the Station Road AHB level crossing will be significantly reduced, and the new station will have two bridges connecting the two platforms so eliminating crossing risk for station users;
- There will be improved non-car accessibility of the new station compared to the existing station, with better pedestrian links and improved, higher capacity cycle parking provision compared to the under-supply at the existing station;
- The majority of Waterbeach will continue to be within feasible walking distance and no more than a 10 minute cycle of the new station;
- Bus access enhancements would include diverting existing bus services to the new station. A bespoke shuttle service will also be secured via a s106 agreement. This will operate to stops in the south of the village close to the existing station and Greenside, seeking to integrate with the train timetables. This will greatly assist with improving the non-car accessibility of the station from the existing Waterbeach village and particularly for those living nearest to the existing station.
- Car parking will be provided at an appropriate quantity and free of charge, avoiding the potential for overspill and displaced car parking. The overspill and displaced car parking that currently takes place near the existing station will be removed;
- Station-related vehicular traffic flows overall will not change but will be redistributed. There will be increases on the A10, Denny End Road, Bannold Road and Cody Road, but reductions in flows on Car Dyke Road, High Street including passing the Primary School, and Station Road.

8.1.11. Overall, the relocated station will provide a significantly enhanced transport interchange compared to the existing station, in terms of safety and convenience of station users and more suitable for accommodating future patronage growth.

8.1.12. Based on the findings of this TA, it is considered that the impacts of the proposed Waterbeach Station relocation can be cost effectively limited through the proposed improvements in the transport network, and that the residual cumulative impacts of the relocation are not severe. Indeed, there are significant transport benefits to be secured by the removal of station-related travel demand in the vicinity of the existing station and reduced risk at the level crossing.

8.1.13. Therefore, there should be no reason on transport grounds why the Waterbeach Station relocation proposals should be prevented or refused.

FIGURES AND APPENDICES

Figure 1 – Site Location Plan

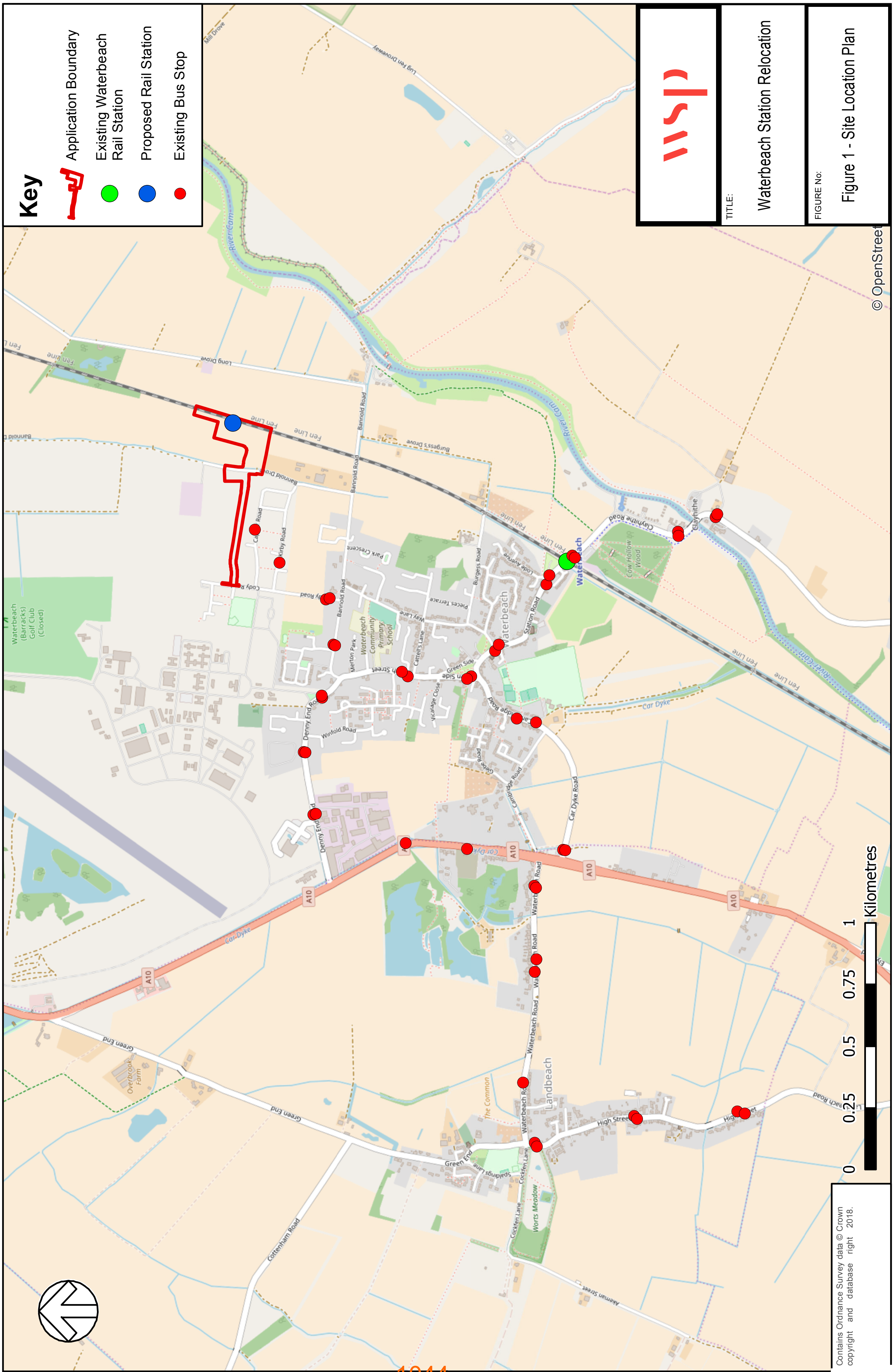
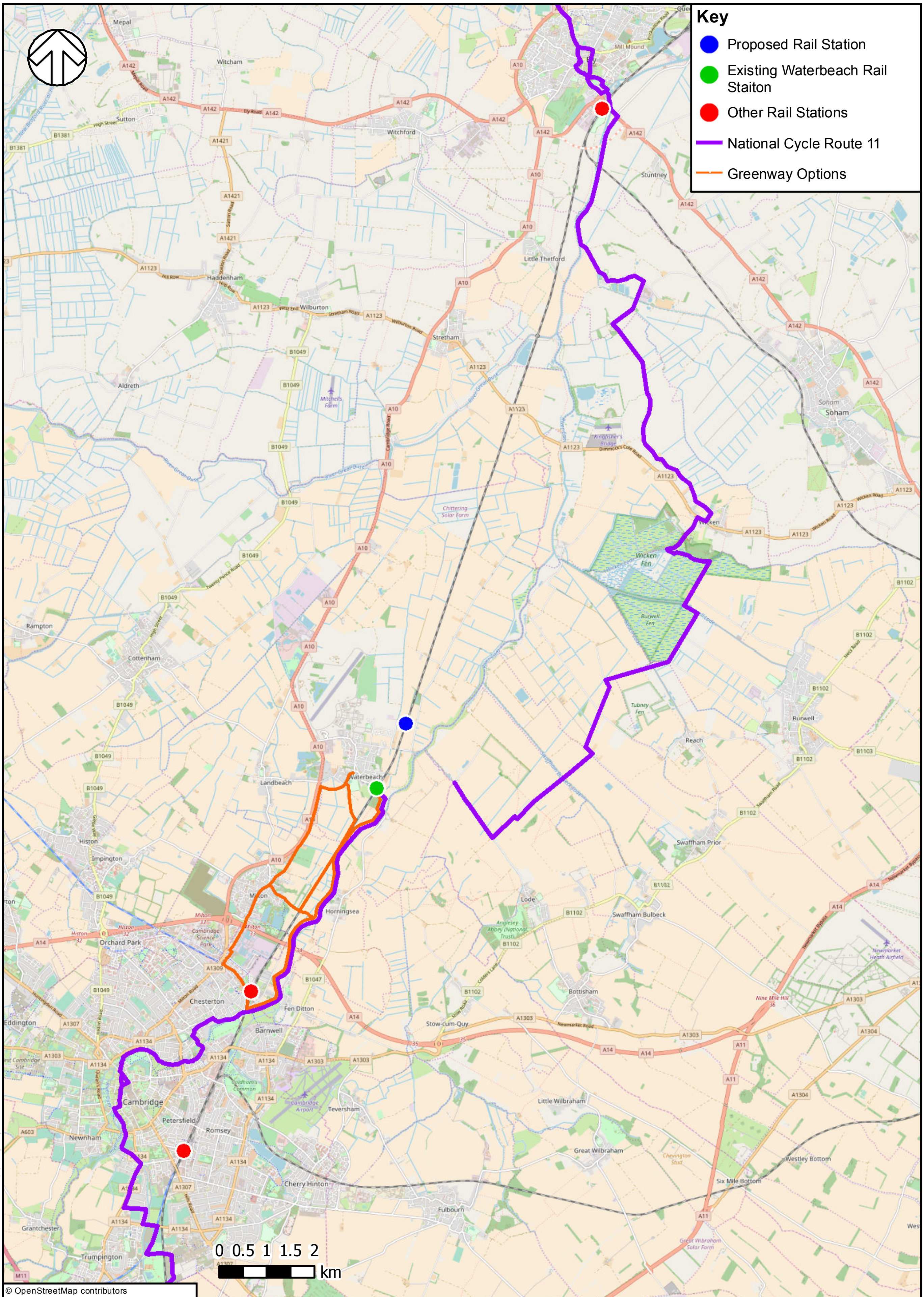

Key
Application Boundary
Existing Waterbeach Rail Station
Proposed Rail Station
Existing Bus Stop
TITLE:
Waterbeach Station Relocation
FIGURE No:
Figure 1 - Site Location Plan
0
0.25
0.5
0.75
1
Kilometres
Contains Ordnance Survey data © Crown copyright and database right 2018.
© OpenStreet
Date Modified: 23/02/2018
Drawn By: UKSML004
P_UK\WSP_D\Cambridge\DP\SML\waterbeach\sitelication.mxd

Figure 2 – Wider Site Area Plan



Date Modified: 26/01/2018 13:13 Drawn By: UKSML004

File: Created using iGIS, WSP's Online Mapping System

wsp

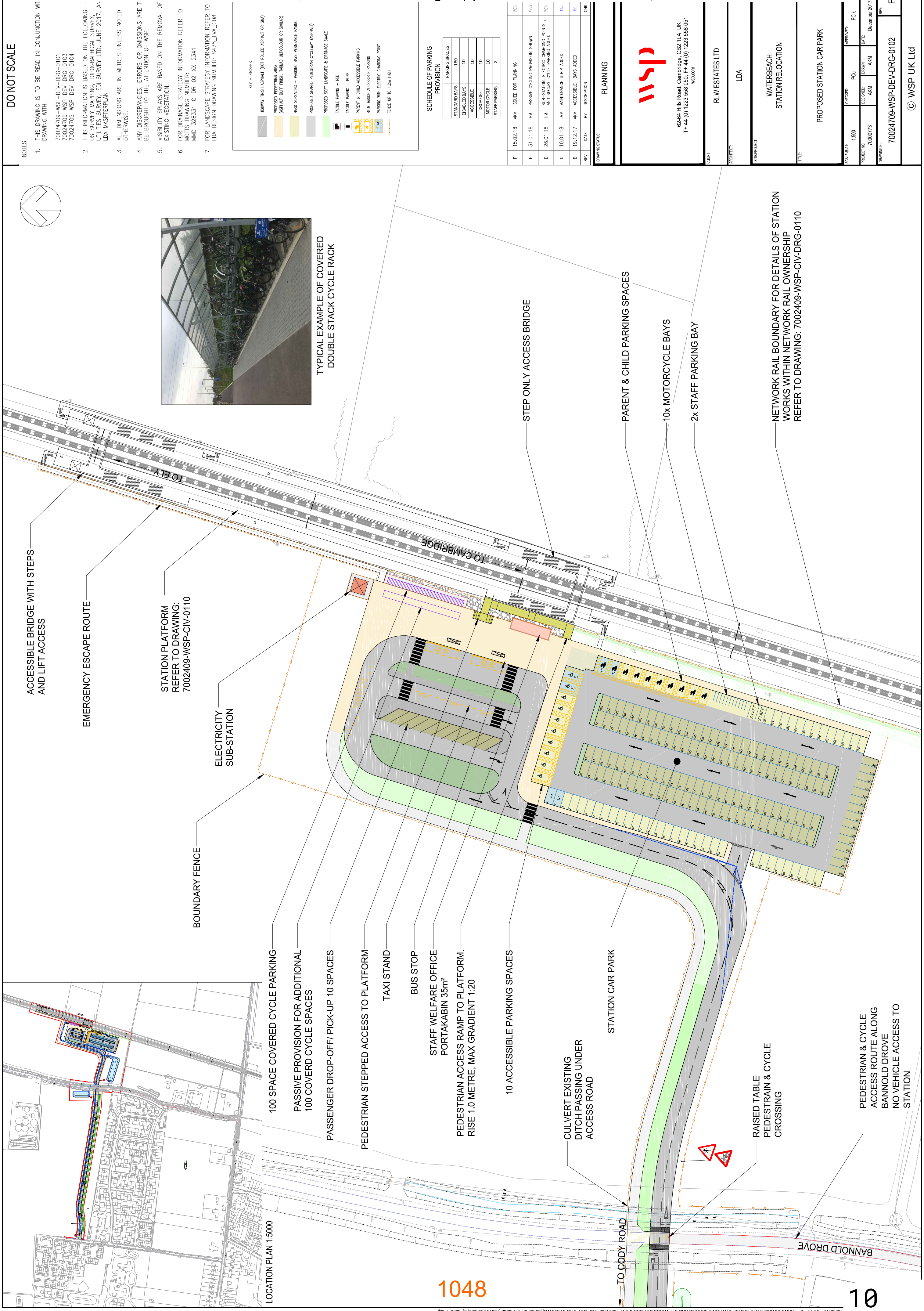
TITLE:

Waterbeach Station Relocation

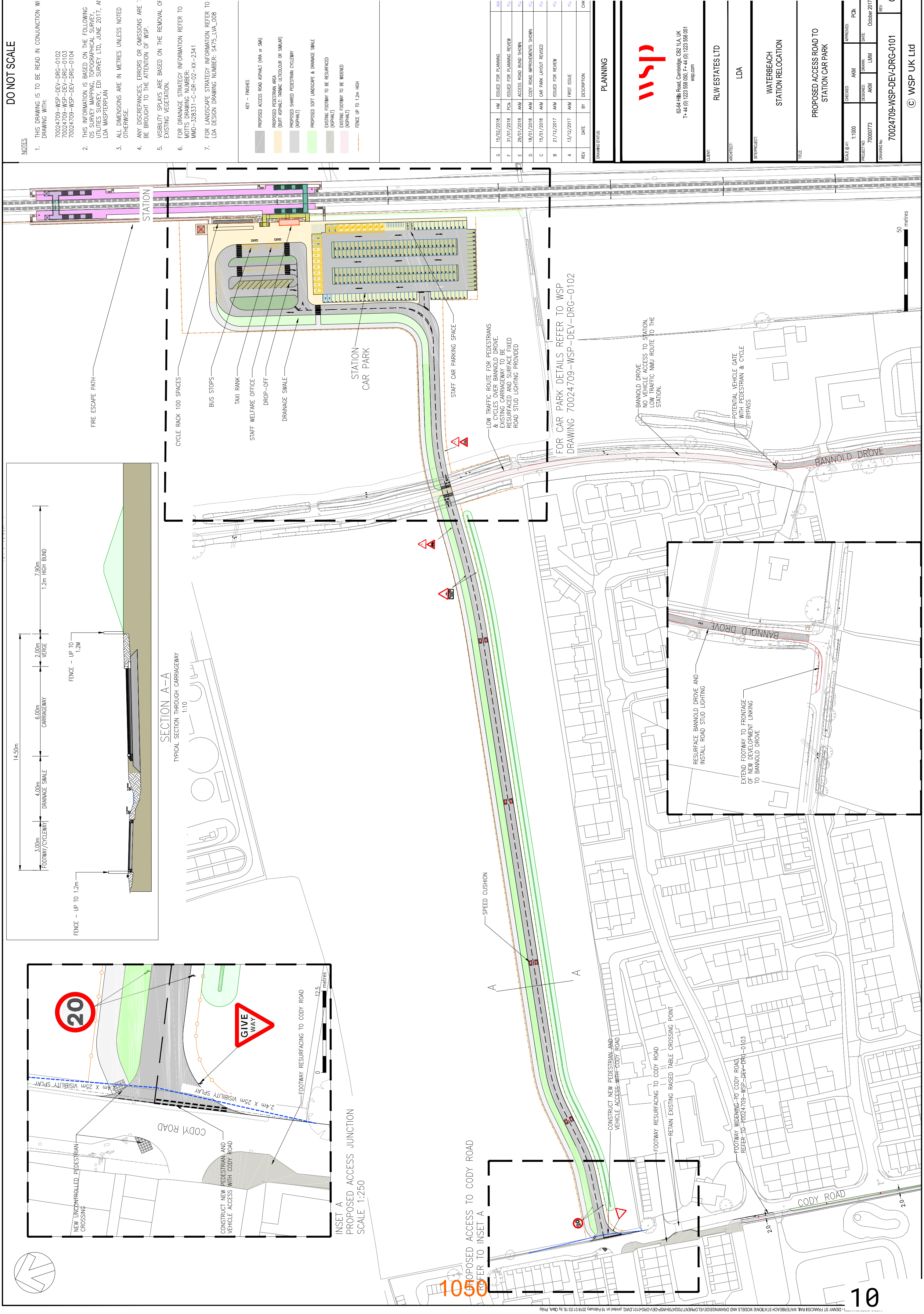
FIGURE No:

Figure 2 - Wider Area Plan

Appendix A – Proposed Station Layout Plan

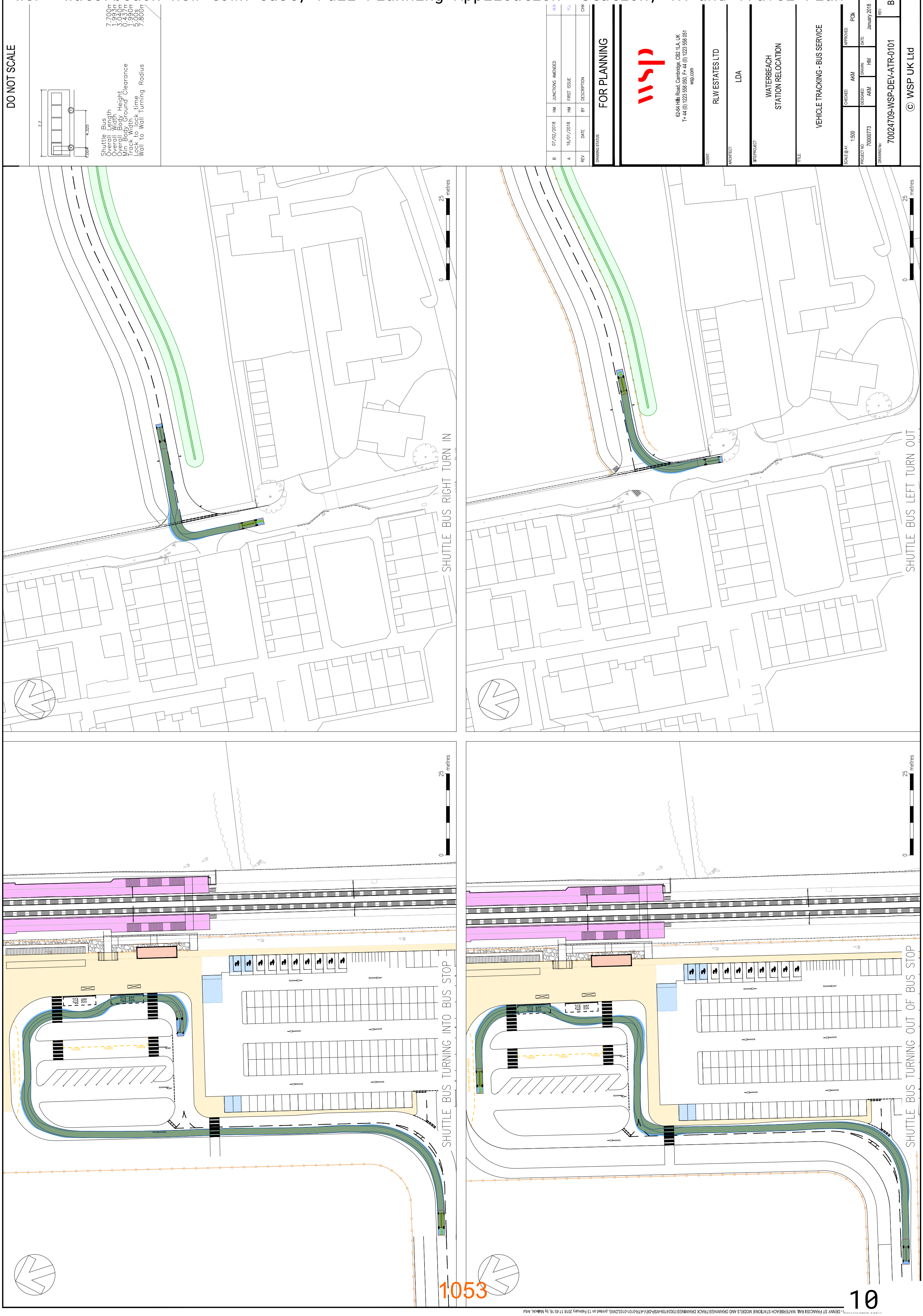

DO NOT SCALE
NOTES
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING WITH: 70024709-WSP-DEV-DRG-0101 70024709-WSP-DEV-DRG-0103 70024709-WSP-DEV-DRG-0104
2. THIS INFORMATION IS BASED ON THE FOLLOWING OS SURVEY MAPPING, TOPOGRAPHICAL SURVEY, UTILITIES SURVEY, EDI SURVEY LTD, JUNE 2017, AN LDA MASPTERPLAN
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4. ANY DISCREPANCIES, ERRORS OR OMISSIONS ARE T BE BROUGHT TO THE ATTENTION OF WSP.
5. VISIBILITY SPLAYS ARE BASED ON THE REMOVAL OF EXISTING VEGETATION.
6. FOR DRAINAGE STRATEGY INFORMATION REFER TO MOTT'S DRAWING NUMBER: MMD-328331-C-DR-02-XX-2341
7. FOR LANDSCAPE STRATEGY INFORMATION REFER TO LDA DESIGN DRAWING NUMBER: S475_LVA_008
SCHEDULE OF PARKING PROVISION
STANDARD BAYS 180
DISABLED BAYS 10
ACCESSIBLE 10
DROP-OFF 10
MOTOR CYCLE 10
STAFF PARKING 2
PLANNING
62-64 Hills Road, Cambridge, CB2 1LA, UK
RLW ESTATES LTD
LDA
WATERBEACH STATION RELOCATION
PROPOSED STATION CAR PARK
1:500
70000773
70024709-WSP-DEV-DRG-0102
F
© WSP UK Ltd
TYPICAL EXAMPLE OF COVERED DOUBLE STACK CYCLE RACK
STEP ONLY ACCESS BRIDGE
PARENT & CHILD PARKING SPACES
10x MOTORCYCLE BAYS
2x STAFF PARKING BAY
NETWORK RAIL BOUNDARY FOR DETAILS OF STATION WORKS WITHIN NETWORK RAIL OWNERSHIP REFER TO DRAWING: 7002409-WSP-CIV-DRG-0110
ACCESSIBLE BRIDGE WITH STEPS AND LIFT ACCESS
EMERGENCY ESCAPE ROUTE
STATION PLATFORM REFER TO DRAWING: 7002409-WSP-CIV-0110
ELECTRICITY SUB-STATION
BOUNDARY FENCE
TO ELY
TO CAMBRIDGE
100 SPACE COVERED CYCLE PARKING
PASSIVE PROVISION FOR ADDITIONAL 100 COVERD CYCLE SPACES
PASSENGER DROP-OFF/ PICK-UP 10 SPACES
PEDESTRIAN STEPPED ACCESS TO PLATFORM
TAXI STAND
BUS STOP
STAFF WELFARE OFFICE PORTAKABIN 35m²
PEDESTRIAN ACCESS RAMP TO PLATFORM. RISE 1.0 METRE, MAX GRADIENT 1:20
10 ACCESSIBLE PARKING SPACES
STATION CAR PARK
CULVERT EXISTING DITCH PASSING UNDER ACCESS ROAD
RAISED TABLE PEDESTRIAN & CYCLE CROSSING
PEDESTRIAN & CYCLE ACCESS ROUTE ALONG BANNOLD DROVE NO VEHICLE ACCESS TO STATION
TO CODY ROAD
BANNOLD DROVE
LOCATION PLAN 1:5000

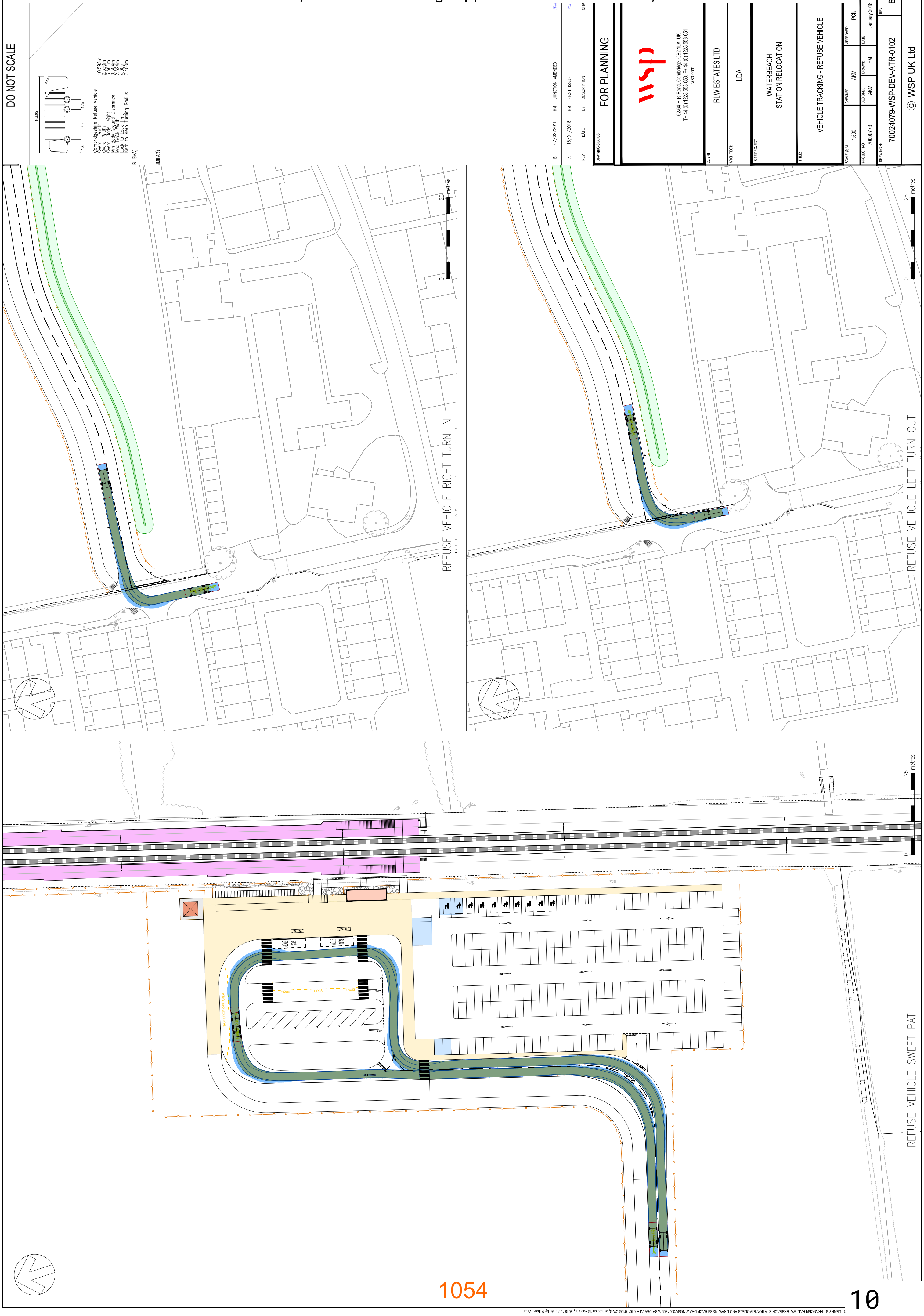
Appendix B – Station Link Road Plan

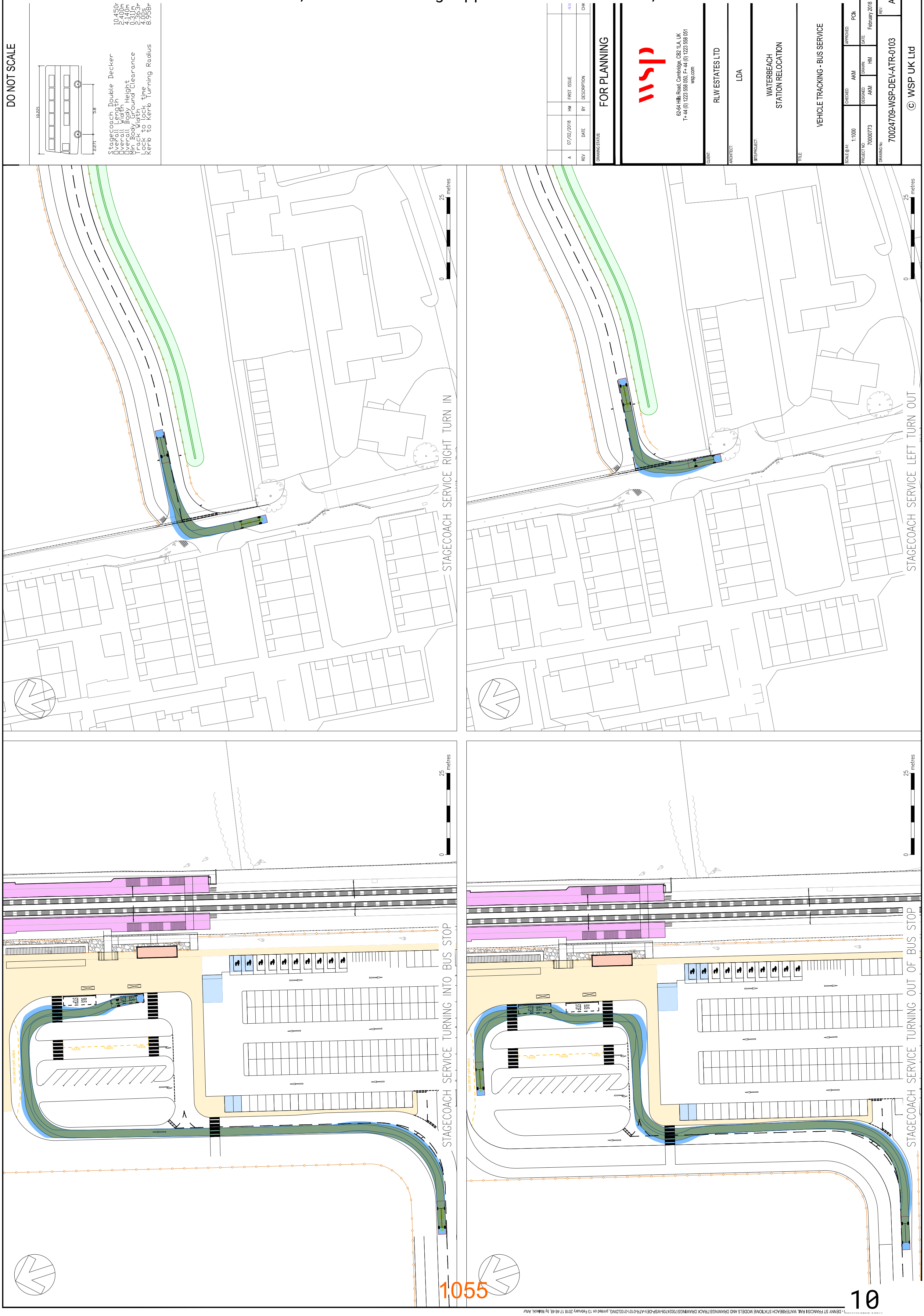

DO NOT SCALE
NOTES
PLANNING
RLW ESTATES LTD
LDA
WATERBEACH STATION RELOCATION
PROPOSED ACCESS ROAD TO STATION CAR PARK
70024709-WSP-DEV-DRG-0101
© WSP UK Ltd
STATION
STATION CAR PARK
FIRE ESCAPE PATH
CYCLE RACK 100 SPACES
BUS STOPS
TAXI RANK
STAFF WELFARE OFFICE
DROP-OFF
DRAINAGE SWALE
STAFF CAR PARKING SPACE
FOR CAR PARK DETAILS REFER TO WSP DRAWING 70024709-WSP-DEV-DRG-0102
BANNOLD DROVE
SECTION A-A
TYPICAL SECTION THROUGH CARRIAGEWAY
1:10
SPEED CUSHION
CODY ROAD
PROPOSED ACCESS TO CODY ROAD
REFER TO INSET A
INSET A
PROPOSED ACCESS JUNCTION
SCALE 1:250
GIVE WAY
20


DO NOT SCALE
NOTES
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING WITH:
70024709-WSP-DEV-DRG-0101
70024709-WSP-DEV-DRG-0102
70024709-WSP-DEV-DRG-0104
2. THIS INFORMATION IS BASED ON THE FOLLOWING OS SURVEY MAPPING, TOPOGRAPHICAL SURVEY, UTILITIES SURVEY, EDI SURVEY LTD, JUNE 2017, AND LDA MASTERPLAN
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4. ANY DISCREPANCIES, ERRORS OR OMISSIONS ARE TO BE BROUGHT TO THE ATTENTION OF WSP.
5. VISIBILITY SPLAYS ARE BASED ON THE REMOVAL OF EXISTING VEGETATION.
6. FOR DRAINAGE STRATEGY INFORMATION REFER TO MOTT'S DRAWING NUMBER: MMD-328331-C-DR-02-XX-2341
KEY - FINISHES
EXISTING FOOTWAY (ASPHALT)
EXISTING VERGE (GRASS)
EXISTING FOOTWAY TO BE RESURFACED (ASPHALT)
EXISTING FOOTWAY TO BE WIDENED (ASPHALT)
E 15.02.18 LMM ISSUED FOR PLANNING
D 02.02.18 LMM AMENDED FOLLOWING CLIENT COMMENT
C 31.01.18 PCk ISSUED FOR PLANNING
B 30.01.18 HM RED LINE BOUNDARY SHOWN
A 15.01.18 LMM ISSUED FOR PLANNING
REV DATE BY DESCRIPTION CHK
DRAWING STATUS: PLANNING
wsp
62-64 Hills Road, Cambridge, CB2 1LA, UK
T+ 44 (0) 1223 558 050, F+ 44 (0) 1223 558 051
wsp.com
CLIENT: RLW ESTATES LTD
ARCHITECT: LDA
SITE/PROJECT: WATERBEACH STATION RELOCATION
TITLE: PROPOSED CODY ROAD FOOTWAY IMPROVEMENT WORKS
SCALE @ A1: 1:500
CHECKED: PCk
APPROVED: PCu
PROJECT NO: 70000773
DESIGNED: AKM
DRAWN: AKM
DATE: December 2017
DRAWING No: 70024709-WSP-DEV-DRG-0103
REV: E
© WSP UK Ltd
PROPOSED
EXISTING RAISED TABLE CROSSING POINT TO BE RETAINED
RESURFACE EXISTING FOOTWAY
RELOCATE EXISTING LAMP COLUMN
REPLACE EXISTING PEDESTRAIN BARRIER TO 450mm CLEARANCE TO CARRIAGEWAY
RELOCATE EXISTING LAMP COLUMN
RELOCATE EXISTING LAMP COLUMN
PEDESTRIAN CROSSING POINT
CODY ROAD
CAPPER ROAD
KIRBY ROAD
2.0
2.0
EXISTING
RAISED TABLE CROSSING POINT
1.5
1.5
TYPICAL CROSS SECTIONS
LOCATION PLAN 1:5000
EXISTING
EXISTING LAMP COLUMN
EXISTING KERB
EXISTING FOOTWAY
EXISTING CARRIAGEWAY
5.5m
VERGE
WIDTH VARIES NOMINAL 1.5m
EXISTING BOUNDARY FENCE
PROPOSED
RELOCATED LAMP COLUMN
WIDEN FOOTWAY INTO EXISTING VERGE. REMAINING VERGE TO BE RETAINED EXISTING FOOTWAY TO BE RESURFACED
EXISTING KERB TO BE RETAINED
EXISTING CARRIAGEWAY TO REMAIN
WIDEN FOOTWAY
EXISTING PROPOSED 2.0m
EXISTING BOUNDARY FENCE

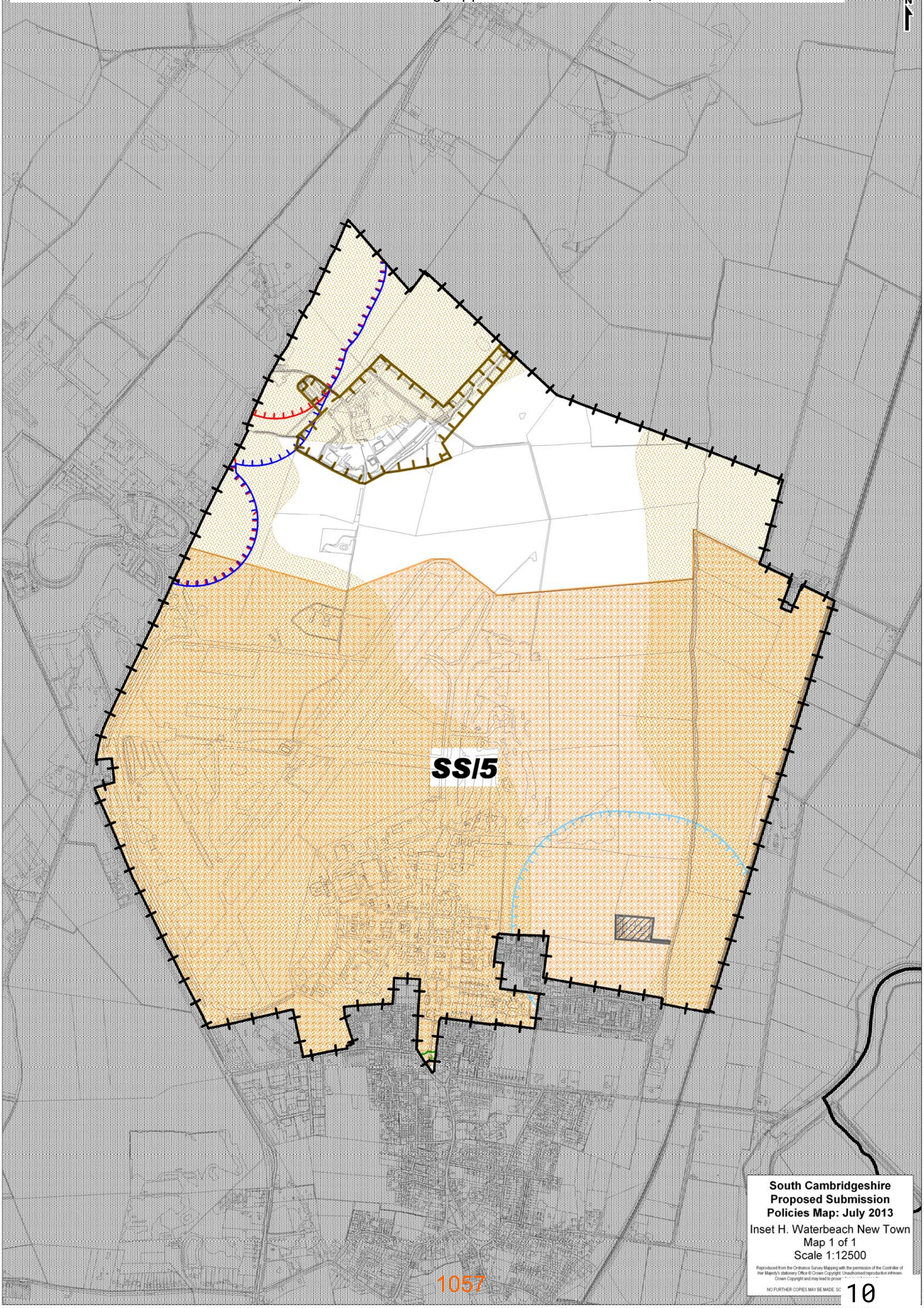
Appendix C – Swept Path Assessments


DO NOT SCALE
Shuttle Bus
FOR PLANNING
62-64 Hills Road, Cambridge, CB2 1LA, UK
wsp.com
RLW ESTATES LTD
LDA
WATERBEACH STATION RELOCATION
VEHICLE TRACKING - BUS SERVICE
B 07/02/2018 HM JUNCTIONS AMENDED
A 16/01/2018 HM FIRST ISSUE
1:500
70000773
January 2018
70024709-WSP-DEV-ATR-0101
B
© WSP UK Ltd
SHUTTLE BUS RIGHT TURN IN
SHUTTLE BUS LEFT TURN OUT
SHUTTLE BUS TURNING INTO BUS STOP
SHUTTLE BUS TURNING OUT OF BUS STOP
25 metres


DO NOT SCALE
Cambridgeshire Refuse Vehicle
FOR PLANNING
wsp
62-64 Hills Road, Cambridge, CB2 1LA, UK
wsp.com
RLW ESTATES LTD
LDA
WATERBEACH
STATION RELOCATION
VEHICLE TRACKING - REFUSE VEHICLE
B 07/02/2018 HM JUNCTION AMENDED
A 16/01/2018 HM FIRST ISSUE
1:500
70000773
January 2018
AKM
HM
70024079-WSP-DEV-ATR-0102
B
© WSP UK Ltd
REFUSE VEHICLE RIGHT TURN IN
REFUSE VEHICLE LEFT TURN OUT
REFUSE VEHICLE SWEPT PATH
metres
25
0


DO NOT SCALE
Stagecoach Double Decker
Overall Length 10.450m
Overall Width 2.400m
Overall Body Height 4.140m
Min Body Ground Clearance 0.311m
Track Width 2.363m
Lock to lock time 4.00s
Kerb to Kerb Turning Radius 8.958m
10.221
5.8
2.271
A 07/02/2018 HM FIRST ISSUE AKM
REV DATE BY DESCRIPTION CHK
DRAWING STATUS:
FOR PLANNING
wsp
62-64 Hills Road, Cambridge, CB2 1LA, UK
T+ 44 (0) 1223 558 050, F+ 44 (0) 1223 558 051
wsp.com
CLIENT:
RLW ESTATES LTD
ARCHITECT:
LDA
SITE/PROJECT:
WATERBEACH
STATION RELOCATION
TITLE:
VEHICLE TRACKING - BUS SERVICE
SCALE @ A1: 1:1000
CHECKED: AKM
APPROVED: PClk
PROJECT NO: 70000773
DESIGNED: AKM
DRAWN: HM
DATE: February 2018
DRAWING No: 70024709-WSP-DEV-ATR-0103
REV: A
© WSP UK Ltd
STAGECOACH SERVICE RIGHT TURN IN
STAGECOACH SERVICE LEFT TURN OUT
STAGECOACH SERVICE TURNING INTO BUS STOP
STAGECOACH SERVICE TURNING OUT OF BUS STOP
0
25
metres

Appendix D – Local Plan Draft Allocation


N
SS/5
South Cambridgeshire
Proposed Submission
Policies Map: July 2013
Inset H. Waterbeach New Town
Map 1 of 1
Scale 1:12500
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NO FURTHER COPIES MAY BE MADE. SC

Appendix E – Train Timetables

This timetable shows all Great Northern services that call at any station between Waterbeach and King's Lynn inclusive from 10 December 2017 to 19 May 2018. It also shows Greater Anglia services between London and stations north of Cambridge.

See separate publicity for details of other Greater Anglia services, for details of CrossCountry services or for details of the complete service between London and Cambridge.

Information correct at time of printing (October 2017). Great Northern accepts no liability for inaccuracy in the information contained in this timetable.

Bicycle policy
Restrictions apply in the peak hours for carrying non-folding bikes. Details at **greatnorthernrail.com/cyclepolicy**

National Rail Enquiries
For up to the minute travel information for the National Rail network and information on all other train operating companies 24 hours a day.
Phone: **03457 48 49 50**
Online: **nationalrail.co.uk**

Visit **greatnorthernrail.com** for timetable information, latest offers, information on engineering work, real time train running information and to register for travel alerts by text message and email.

Follow us on Twitter **@GNRailUK**

Customer relations
Phone: **0345 026 4700**
(7 days a week, 0700 to 2200, except Christmas Day)
email: **customerservices@greatnorthernrail.com**

Assisted travel
Phone: **0800 058 2844**
(7 days a week, 0700 to 2200, except Christmas Day)
Textphone: **0800 138 1018**

Traveline
For all other public transport route and timetable information
Phone: **0871 200 22 33**
Online: **traveline.info**

British Transport Police
Phone: **0800 40 50 40**
Online: **btp.police.uk**

Other websites
London public transport information, **tfl.gov.uk**
Hertfordshire public transport information, **intalink.org.uk**
Through tickets for train and bus, **plusbus.info**
Information on taxis serving rail stations, **traintaxi.co.uk**
National Cycle Network information, **sustrans.org.uk**

Independent passenger groups
Transport Focus, **transportfocus.org.uk**
London TravelWatch, **londontravelwatch.org.uk**

Fen Line Users Association
We would like to acknowledge the assistance we received from the Fen Line Users Association in promoting services on this route.

For membership details contact:
Andy Tyler, Secretary,
67 Goodwins Road,
King's Lynn, Norfolk, PE30 5PE

Phone: **07803 459 043**
Or look at the association's notice board at any Fen Line station.

Bold	Direct train
Light	Connecting train
1	First Class accommodation available
⊖	Interchange with London Underground
✈	Station within Airport terminal
GN	Operated by Great Northern
LE	Operated by Greater Anglia
a	Arrival time
b	Change at Cambridge
c	Arrives 5 minutes earlier
d	Departure time
e	Change at Stevenage
A	Service divides at Cambridge, passengers for stations to Ely / King's Lynn must travel in the front 4 carriages
B	Service divides at Cambridge, passengers for stations to Ely / King's Lynn must travel in the front 8 carriages
C	Service divides at Royston, passengers for stations to Ely / King's Lynn must travel in the front 8 carriages
D	Service divides at Royston. For an earlier arrival at Ely, passengers are advised to travel in the front 8 carriages
E	Service attaches at Cambridge to the 0610 from King's Lynn to King's Cross (depart Cambridge 0715)
F	Service attaches at Cambridge to the 0651 from King's Lynn to King's Cross (depart Cambridge 0745)
G	Service attaches at Cambridge to the 0725 from King's Lynn to King's Cross (depart Cambridge 0815)
H	To Stevenage

Mondays to Fridays

Operator		GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	LE	GN	GN	GN	GN	LE	GN	GN
Facilities		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes						A	A	A	B	A		A		A		A		A	A		A				A			A	
London Kings Cross	15 ⊖ d		05 42	06 44	07 14	07 44	08 14	08 44	09 14	09 44	10 14	10 44	11 14	11 44	12 14	12 44	13 14	13 44	14 14	14 04	14 44		15 14		15 44	16 14		16 44	17 14
London Liverpool Street	15 ⊖ d		|	05 58b	|	06 58b	07 28b	08 03b	08 58b	|	09 28b	09 58b	10 28b	10 58b	11 28b	11 58b	12 28b	12 58b	13 28b	13 58b	|		14 28b		14 58b	15 28b	**15 58**	|	16 28b
Stansted Airport	✈ d	05 16b	06 12b	|	07 21b	|	08 21b	|	09 21b	|	10 27b	|	11 27b	|	12 27b	|	13 27b	|	14 27b	|	|	15 05b	15 27b		|	16 27b	|	|	17 27b
Cambridge	d	06 15	06 52	07 33	08 06	08 38	09 09	09 35	10 15	10 35	11 04	11 35	12 04	12 35	13 04	13 35	14 04	14 35	15 07	15 28	15 35	15 48	16 06	16 19	16 35	17 05	17 21	17 40	18 06
Cambridge North	d	06 19	|	07 37	|	|	09 14	|	10 21	|	11 08	|	12 08	|	13 08	|	14 08	|	15 11	15 33	|	15 53	16 10	|	|	17 09	17 26	|	18 10
Waterbeach	d	06 23	06 58	07 41	08 12	08 44	|	09 41	|	10 41	|	11 41	|	12 41	|	13 41	|	14 41	|	15 37	15 41	15 58	|	16 26	16 42	|	17 30	17 47	|
Ely	6 a	06 33	07 08	07 51	08 22	08 54	09 28	09 51	10 37	10 51	11 21	11 51	12 22	12 51	13 21	13 51	14 21	14 51	15 24	15 47	15 51	16 11	16 23	16 35	16 51	17 23	17 42	17 56	18 23
Ely	6 d	06 33	07 08	07 51	08 22	08 54		09 51		10 51		11 51		12 51		13 51		14 51			15 51			16 36	16 52			17 57	
Littleport	d	06 40	07 16	07 58	08 29	09 01		09 58		10 58		11 58		12 58		13 58		14 58			15 58			|	17 00			18 04	
Downham Market	d	06 53	07 25	08 07	08 38	09 10		10 07		11 07		12 07		13 07		14 07		15 07			16 07			16 50a	17 10			18 13	
Watlington	d	06 59	07 32	08 13	08 44	09 16		10 13		11 13		12 13		13 13		14 13		15 13			16 13				17 15			18 19	
Kings Lynn	a	07 07	07 40	08 21	08 52	09 25		10 21		11 21		12 21		13 21		14 21		15 21			16 21				17 24			18 27	

Operator		LE	LE	GN	GN	LE	GN	GN	GN	LE	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes				A	C		D	A				A	A		A	A	A	A		A
London Kings Cross	15 ⊖ d			17 44	18 14		18 14	18 44	19 14		19 18	19 44	20 14	20 04	20 44	21 14	21 44	22 14	22 44	23 14
London Liverpool Street	15 ⊖ d	**17 07**		|	17 37b	**18 07**	|	|	18 37b	**19 07**	19 11b	|	19 28b	19 58b	|	20 28b	20 58b	21 28b	21 58b	22 28b
Stansted Airport	✈ d	|		|	18 21b	|	|	|	19 21b	|	|	|	20 21b	|	|	21 27b	22 05b	22 27b	22 57b	|
Cambridge	d	18 17	18 22	18 39	19 09	19 19	19 25	19 39	20 08	20 14	20 51	20 40	21 10	21 28	21 40	22 10	22 40	23 10	23 40	00 10
Cambridge North	d	|	18 26	|	|	|	19 31	|	20 12	|	20 55	|	|	21 34	|	22 14	22 44	23 14	23 44	00 14
Waterbeach	d	18 23	18 30	18 46	|	19 25	|	19 46	|	20 20	|	20 46	21 16	|	21 46	22 18	22 48	23 18	23 48	00 18
Ely	6 a	18 33	18 41	18 55	19 23	19 35	19 44	19 55	20 25	20 30	21 08	20 56	21 26	21 46	21 56	22 28	23 00	23 28	23 59	00 28
Ely	6 d	18 33		18 56	19 24	19 35		19 56		20 30		20 56	21 26		21 56	22 28		23 28		00 28
Littleport	d	18 40		19 03	|	19 42		20 03		20 37		21 03	21 33		22 03	22 35		23 35		00 35
Downham Market	d	18 50		19 12	19 39	19 52		20 12		20 47		21 12	21 42		22 12	22 44		23 44		00 44
Watlington	d	18 56		19 18	|	19 58		20 18		20 53		21 18	21 48		22 18	22 50		23 50		00 50
Kings Lynn	a	19 08		19 27	19 54	20 10		20 26		21 05		21 26	21 56		22 26	22 58		23 58		00 58

Saturdays

Operator		GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes						A		A		A		A		A		A		A		A		A		A	A		A	A	A
London Kings Cross	15 ⊖ d		06 44	07 44	08 44	09 44	10 14	10 44	11 14	11 44	12 14	12 44	13 14	13 44	14 14	14 44	15 14	15 44	16 14	16 44	17 14	17 44	18 14	18 44	19 14	19 44	20 14	20 44	21 14
London Liverpool Street	15 ⊖ d		05 58b	06 58b	07 58b	08 58b	09 28b	09 58b	10 28b	10 58b	11 28b	11 58b	12 28b	12 58b	13 28b	13 58b	14 28b	14 58b	15 28b	15 58b	16 28b	16 58b	17 28b	17 58b	18 28b	18 58b	19 28b	19 58b	20 28b
Stansted Airport	✈ d	05 25b	06 48b	07 48b	09 05b	09 27b	10 27b	|	11 27b	|	12 27b	|	13 27b	|	14 27b	|	15 27b	|	16 27b	|	17 27b	|	18 27b	|	19 27b	|	20 27b	|	21 27b
Cambridge	d	06 35	07 35	08 35	09 35	10 35	11 04	11 35	12 04	12 35	13 04	13 35	14 04	14 35	15 04	15 35	16 04	16 35	17 04	17 35	18 05	18 35	19 05	19 35	20 07	20 35	21 07	21 40	22 07
Cambridge North	d	|	|	|	|	|	11 08	|	12 08	|	13 08	|	14 08	|	15 08	|	16 08	|	17 08	|	18 09	|	|	|	|	|	|	21 44	|
Waterbeach	d	06 41	07 41	08 41	09 41	10 41	|	11 41	|	12 41	|	13 41	|	14 41	|	15 41	|	16 41	|	17 41	|	18 41	|	19 41	20 13	|	21 13	21 48	22 13
Ely	6 a	06 51	07 51	08 51	09 51	10 51	11 21	11 51	12 21	12 51	13 21	13 51	14 21	14 51	15 21	15 51	16 21	16 51	17 21	17 51	18 22	18 51	19 19	19 51	20 23	20 49	21 23	21 59	22 23
Ely	6 d	06 51	07 51	08 51	09 51	10 51		11 51		12 51		13 51		14 51		15 51		16 51		17 51		18 51	19 19	19 51	20 23	20 51	21 23		22 23
Littleport	d	06 58	07 58	08 58	09 58	10 58		11 58		12 58		13 58		14 58		15 58		16 58		17 58		18 58	|	19 58	20 30	|	21 30		22 30
Downham Market	d	07 07	08 07	09 07	10 07	11 07		12 07		13 07		14 07		15 07		16 07		17 07		18 07		19 07	19 35	20 07	20 39	21 08	21 39		22 39
Watlington	d	07 13	08 13	09 13	10 13	11 13		12 13		13 13		14 13		15 13		16 13		17 13		18 13		19 13	|	20 13	20 45	|	21 45		22 45
Kings Lynn	a	07 21	08 21	09 21	10 21	11 21		12 21		13 21		14 21		15 21		16 21		17 21		18 21		19 21	19 51	20 21	20 53	21 21	21 53		22 53

Operator		GN	GN	GN
Facilities		1	1	1
Notes			A	A
London Kings Cross	15 ⊖ d	21 44	22 14	23 14
London Liverpool Street	15 ⊖ d	20 58b	21 28b	22 28b
Stansted Airport	✈ d	|	22 27b	23 27b
Cambridge	d	22 37	23 10	00 10
Cambridge North	d	22 41	23 14	|
Waterbeach	d	|	23 18	00 16
Ely	6 a	22 54	23 28	00 26
Ely	6 d		23 28	00 26
Littleport	d		23 35	00 33
Downham Market	d		23 44	00 42
Watlington	d		23 50	00 48
Kings Lynn	a		23 58	00 56

10 December to 11 February and 1 April to 13 May

Operator			GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes					A	A	A	A	A	A	A	A	A	A	A	A	A	
London Kings Cross	15 ⊖	d	07 52	09 15	10 15	11 15	12 15	13 15	14 15	15 15	16 15	17 15	18 15	19 15	20 15	21 15	22 15	23 15
London Liverpool Street	15 ⊖	d	|	08 28b	09 28b	10 28b	11 28b	12 28b	13 28b	14 28b	15 28b	16 28b	17 28b	18 28b	19 28b	20 28b	21 28b	22 28b
Stansted Airport	✈	d	|	09 09b	10 25b	11 25b	12 25b	13 25b	14 25b	15 25b	16 25b	17 25b	18 25b	19 25b	20 25b	21 18b	22 25b	23 04b
Cambridge		d	09 06	10 06	11 06	12 06	13 06	14 06	15 06	16 06	17 06	18 06	19 06	20 06	21 06	22 06	23 06	00 07
Cambridge North		d	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Waterbeach		d	09 12	10 12	11 12	12 12	13 12	14 12	15 12	16 12	17 12	18 12	19 12	20 12	21 12	22 12	23 12	00 13
Ely	6	a	09 22	10 22	11 22	12 22	13 22	14 22	15 22	16 22	17 22	18 22	19 22	20 22	21 22	22 22	23 22	00 23
Ely	6	d	09 22	10 22	11 22	12 22	13 22	14 22	15 22	16 22	17 22	18 22	19 22	20 22	21 22	22 23	23 22	00 23
Littleport		d	09 29	10 29	11 29	12 29	13 29	14 29	15 29	16 29	17 29	18 29	19 29	20 29	21 29	22 30	23 29	00 30
Downham Market		d	09 38	10 38	11 38	12 38	13 38	14 38	15 38	16 38	17 38	18 38	19 38	20 38	21 38	22 39	23 38	00 39
Watlington		d	09 44	10 44	11 44	12 44	13 44	14 44	15 44	16 44	17 44	18 44	19 44	20 44	21 44	22 45	23 44	00 45
Kings Lynn		a	09 53	10 53	11 53	12 53	13 53	14 53	15 53	16 53	17 53	18 53	19 53	20 52	21 53	22 54	23 53	00 54

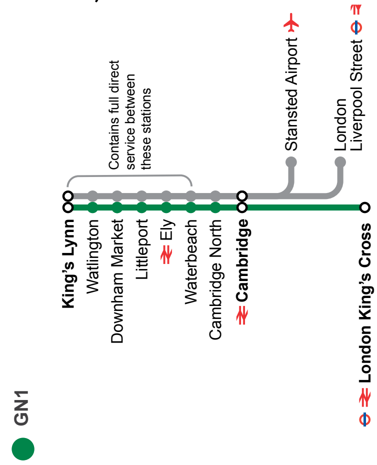
Sundays

18 February to 25 March

Operator			GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes					A	A	A	A	A	A	A	A	A	A	A	A	A	A
London Kings Cross	15 ⊖	d	08 05	09 05	10 05	11 05	12 05	13 05	14 05	15 05	16 05	17 05	18 05	19 05	20 05	21 05	22 15	23 15
London Liverpool Street	15 ⊖	d	|	08 28b	09 28b	10 28b	11 28b	12 28b	13 28b	14 28b	15 28b	16 28b	17 28b	18 28b	19 28b	20 28b	21 28b	22 57b
Stansted Airport	✈	d	|	09 09b	10 25b	11 25b	12 25b	13 25b	14 25b	15 25b	16 25b	17 25b	18 25b	19 25b	20 25b	21 18b	22 25b	23 04b
Cambridge		d	09 06	10 06	11 06	12 06	13 06	14 06	15 06	16 06	17 06	18 06	19 06	20 06	21 06	22 06	23 17	00 28
Cambridge North		d	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Waterbeach		d	09 12	10 12	11 12	12 12	13 12	14 12	15 12	16 12	17 12	18 12	19 12	20 12	21 12	22 12	23 23	00 34
Ely	6	a	09 22	10 22	11 22	12 22	13 22	14 22	15 22	16 22	17 22	18 22	19 22	20 22	21 22	22 22	23 33	00 44
Ely	6	d	09 22	10 22	11 22	12 22	13 22	14 22	15 22	16 22	17 22	18 22	19 22	20 22	21 22	22 23	23 33	00 44
Littleport		d	09 29	10 29	11 29	12 29	13 29	14 29	15 29	16 29	17 29	18 29	19 29	20 29	21 29	22 30	23 40	00 51
Downham Market		d	09 38	10 38	11 38	12 38	13 38	14 38	15 38	16 38	17 38	18 38	19 38	20 38	21 38	22 39	23 49	01 00
Watlington		d	09 44	10 44	11 44	12 44	13 44	14 44	15 44	16 44	17 44	18 44	19 44	20 44	21 44	22 45	23 55	01 06
Kings Lynn		a	09 53	10 53	11 53	12 53	13 53	14 53	15 53	16 53	17 53	18 53	19 53	20 52	21 53	22 54	00 04	01 14

Train times
10 December 2017 to 19 May 2018
London and Cambridge to Ely and King's Lynn

is timetable shows all Great Northern services that
ll at any station between Waterbeach and King's Lynn
clusive. It also shows Greater Anglia services
tween London and stations north of Cambridge.



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ain time information
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tionalrail.co.uk

y online
y tickets nationwide at greatnorthernrail.com

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rain information at your fingertips;
ameslinkrailway.com/app

Mondays to Fridays

Operator			GN	LE	GN	GN	GN	LE	GN	GN	LE	GN	GN	LE	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes						E			F			G																		
Kings Lynn		d	04 54	05 17	05 51		06 10	06 17		06 51		07 14	07 25		07 54	08 27	08 57		09 30	09 54		10 54		11 54		12 54		13 54		14 54
Watlington		d	05 01	05 24	05 58		|	06 24		06 58		07 21	|		08 01	08 34	09 04		09 38	10 01		11 01		12 01		13 01		14 01		15 01
Downham Market		d	05 08	05 31	06 05		06 22	06 31		07 05		07 28	07 37		08 08	08 41	09 11		09 49c	10 08		11 08		12 08		13 08		14 08		15 08
Littleport		d	05 17	05 40	06 14		|	06 40		07 14		07 38	|		08 17	08 50	09 20		09 58	10 17		11 17		12 17		13 17		14 17		15 17
Ely	6	a	05 25	05 49	06 22		06 42	06 49		07 22		07 47	07 55		08 25	08 58	09 28		10 06	10 25		11 25		12 25		13 26		14 25		15 25
Ely	6	d	05 25	05 50	06 22	06 38	06 47	06 50	07 15	07 22	07 30	07 48	07 56	08 00	08 26	08 58	09 28	09 49	10 07	10 25	10 58	11 25	11 58	12 25	12 58	13 26	13 58	14 25	14 58	15 25
Waterbeach		d	05 35	05 59	06 32	06 48	|	06 59	|	07 32	|	07 57	|	08 09	08 36	09 08	09 38	09 59	|	10 35	|	11 35	|	12 35	|	13 36	|	14 35	|	15 35
Cambridge North		a	05 39	06 04	|	06 53	|	07 04	07 27	|	07 42	|	|	08 14	|	|	|	|	10 19	|	11 10	|	12 10	|	13 10	|	14 10	|	15 10	|
Cambridge		a	05 44	06 10	06 39	07 00	07 04	07 10	07 33	07 39	07 47	08 04	08 10	08 20	08 43	09 15	09 45	10 06	10 23	10 41	11 15	11 41	12 15	12 41	13 15	13 42	14 16	14 41	15 15	15 41
Stansted Airport	✈	a	|	07 09b	|	|	|	|	08 09b	|	|	08 39b	|	|	09 40b	10 00b	10 40b	11 00b	|	11 40b	12 00b	12 40b	13 00b	13 40b	14 00b	14 40b	15 00b	15 40b	16 00b	|
London Liverpool Street	15 ⊖	a	07 20b	07 25	07 55b	|	|	08 25	|	08 55b	09 20	|	09 35b	09 50	10 15b	|	11 14b	11 44b	|	12 14b	12 45b	13 14b	13 44b	14 14b	14 44b	15 15b	15 45b	16 15b	16 44b	17 16b
London Kings Cross	15 ⊖	a	06 36		07 37	08 06	08 06	08 06b	08 38	08 38	09 03b	09 09	09 09		09 45	10 13	10 43	11 10	11 32	11 35	12 05	12 38	13 08	13 35	14 05	14 35	15 10	15 35	16 07	16 36

Operator			GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes																				
Kings Lynn		d			15 54		16 36			17 36		18 36		19 37		20 36			21 36	22 31
Watlington		d			16 01		16 43			17 43		18 43		19 44		20 43			21 44	22 38
Downham Market		d			16 08		16 51	17 10		17 50		18 50		19 53		20 50			21 51	22 45
Littleport		d			16 17		17 00	|		17 59		18 59		20 02		20 59			22 00	22 54
Ely	6	a			16 25		17 08	17 26		18 07		19 07		20 10		21 07			22 09	23 02
Ely	6	d	15 32	16 05	16 25	16 58	17 09	17 26	17 55	18 08	18 58	19 08	19 59	20 10	20 59	21 08	21 26	21 57	22 09	23 02
Waterbeach		d	15 42	16 15	|	|	17 18	|	|	18 17	|	19 17	|	20 20	|	21 18	|	|	22 19	23 12
Cambridge North		a	15 46	|	16 37	17 10	|	17 38	18 07	|	19 10	|	20 11	|	21 11	|	21 38	22 09	|	23 16
Cambridge		a	15 53	16 23	16 42	17 15	17 25	17 43	18 12	18 24	19 15	19 24	20 16	20 26	21 16	21 24	21 43	22 14	22 25	23 21
Stansted Airport	✈	a	16 40b	|	17 40b	|	|	|	18 54b	19 40b	|	20 39b	|	21 40b	22 00b	|	22 52b	|	|	|
London Liverpool Street	15 ⊖	a	17 44b	17 46b	18 16b	18 45b	|	19 16b	19 45b	20 15b	20 45b	21 14b	21 44b	22 14b	22 45b	|	23 15b	23 48b	00 18b	|
London Kings Cross	15 ⊖	a	17 19	17 35	17 38	18 23	18 33	18 39	19 08	19 37	20 05	20 36	21 07	21 33	22 05	22 32	22 38	23 05	23 36	00 51

Saturdays

Operator			GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes																														
Kings Lynn		d		05 54	06 54	07 54		08 54	09 25	09 54	10 26	10 54		11 54		12 54		13 54		14 54		15 54		16 54		17 54		18 35	19 35	20 35
Watlington		d		06 01	07 01	08 01		09 01	|	10 01	|	11 01		12 01		13 01		14 01		15 01		16 01		17 01		18 01		18 42	19 42	20 42
Downham Market		d		06 08	07 08	08 08		09 08	09 37	10 08	10 38	11 08		12 08		13 08		14 08		15 08		16 08		17 08		18 08		18 49	19 49	20 49
Littleport		d		06 17	07 17	08 17		09 17	|	10 17	|	11 17		12 17		13 17		14 17		15 17		16 17		17 17		18 17		18 58	19 58	20 58
Ely	6	a		06 25	07 26	08 25		09 25	09 56	10 25	10 56	11 25		12 25		13 25		14 25		15 25		16 25		17 25		18 25		19 06	20 06	21 06
Ely	6	d	05 26	06 25	07 26	08 25	08 59	09 25	09 56	10 25	10 58	11 25	11 58	12 25	12 58	13 25	13 58	14 25	14 58	15 25	15 58	16 25	16 58	17 25	17 54	18 25	18 59	19 06	20 06	21 06
Waterbeach		d	05 36	06 35	07 36	08 35	|	09 35	|	10 35	|	11 35	|	12 35	|	13 35	|	14 35	|	15 35	|	16 35	|	17 35	|	18 35	|	19 16	20 16	21 16
Cambridge North		a	05 40	06 39	|	|	09 11	|	10 08	|	11 10	|	12 10	|	13 10	|	14 10	|	15 10	|	16 10	|	17 10	|	18 06	|	19 11	|	|	|
Cambridge		a	05 45	06 44	07 42	08 41	09 15	09 41	10 13	10 41	11 15	11 41	12 15	12 41	13 15	13 41	14 15	14 41	15 15	15 41	16 15	16 41	17 15	17 41	18 11	18 41	19 16	19 23	20 23	21 23
Stansted Airport	✈	a	06 41b	07 41b	08 39b	09 40b	10 00b	10 40b	11 00b	11 40b	12 00b	12 40b	13 00b	13 40b	14 00b	14 40b	15 00b	15 40b	16 00b	16 40b	17 00b	17 40b	18 00b	|	18 53b	19 40b	20 00b	20 40b	21 40b	22 40b
London Liverpool Street	15 ⊖	a	07 14b	08 14b	09 14b	10 14b	10 44b	11 14b	11 44b	12 14b	12 44b	13 14b	13 44b	14 14b	14 44b	15 14b	15 44b	16 14b	16 44b	17 14b	17 44b	18 14b	18 44b	19 14b	19 44b	20 14b	20 44b	21 14b	22 14b	23 14b
London Kings Cross	15 ⊖	a	06 39	07 34	08 36	09 35	10 07	10 36	11 05	11 35	12 07	12 36	13 05	13 34	14 06	14 35	15 06	15 35	16 08	16 35	17 07	17 36	18 07	18 36	19 08	19 37	20 06	20 33	21 32	22 32

Operator			GN	GN	GN
Facilities			1	1	1
Notes					
Kings Lynn		d	21 35	22 26	23 10
Watlington		d	21 42	22 33	23 17
Downham Market		d	21 49	22 40	23 24
Littleport		d	21 58	22 49	23 33
Ely	6	a	22 06	22 57	23 42
Ely	6	d	22 06	22 57	23 43
Waterbeach		d	22 16	23 07	23 52
Cambridge North		a	|	|	23 57
Cambridge		a	22 23	23 13	00 01
Stansted Airport	✈	a	|	|	
London Liverpool Street	15 ⊖	a	00 14b	|	
London Kings Cross	15 ⊖	a	23 32	00 42	

10 December to 11 February and 1 April to 13 May

Operator			GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes																		
Kings Lynn		d	**08 27**	**09 27**	**10 27**	**11 27**	**12 27**	**13 27**	**14 27**	**15 27**	**16 27**	**17 27**	**17 57**	**18 27**	**19 27**	**20 27**	**21 27**	**22 27**
Watlington		d	**08 34**	**09 34**	**10 34**	**11 34**	**12 34**	**13 34**	**14 34**	**15 34**	**16 34**	**17 34**	|	**18 34**	**19 34**	**20 34**	**21 34**	**22 34**
Downham Market		d	**08 41**	**09 41**	**10 41**	**11 41**	**12 41**	**13 41**	**14 41**	**15 41**	**16 41**	**17 41**	**18 09**	**18 41**	**19 41**	**20 41**	**21 41**	**22 41**
Littleport		d	**08 50**	**09 50**	**10 50**	**11 50**	**12 50**	**13 50**	**14 50**	**15 50**	**16 50**	**17 50**	|	**18 50**	**19 50**	**20 50**	**21 50**	**22 50**
Ely	6	a	**08 58**	**09 58**	**10 58**	**11 58**	**12 58**	**13 58**	**14 58**	**15 58**	**16 58**	**17 58**	**18 25**	**18 58**	**19 58**	**20 58**	**21 58**	**22 58**
Ely	6	d	**08 58**	**09 58**	**10 58**	**11 58**	**12 58**	**13 58**	**14 58**	**15 58**	**16 58**	**17 58**	**18 26**	**18 58**	**19 58**	**20 58**	**21 58**	**22 58**
Waterbeach		d	**09 08**	**10 08**	**11 08**	**12 08**	**13 08**	**14 08**	**15 08**	**16 08**	**17 08**	**18 08**	|	**19 08**	**20 08**	**21 08**	**22 08**	**23 08**
Cambridge North		a	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Cambridge		a	**09 15**	**10 15**	**11 15**	**12 15**	**13 15**	**14 15**	**15 15**	**16 15**	**17 15**	**18 15**	**18 40**	**19 15**	**20 15**	**21 15**	**22 15**	**23 14**
Stansted Airport	✈	a	10 00b	11 00b	12 00b	13 00b	14 00b	15 00b	16 00b	17 00b	18 00b	19 00b	19 45b	20 00b	20 54b	22 00b	|	|
London Liverpool Street	15 ⊖	a	10 43b	11 43b	12 43b	13 43b	14 43b	15 43b	16 43b	17 43b	18 43b	19 43b	20 14b	20 43b	21 43b	22 43b	23 43b	|
London Kings Cross	15 ⊖	a	**10 09**	**11 08**	**12 08**	**13 08**	**14 08**	**15 08**	**16 09**	**17 09**	**18 08**	**19 09**	**19 36**	**20 09**	**21 09**	**22 10**	**23 11**	**00 42**

Sundays

18 February to 25 March

Operator			GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN	GN
Facilities			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Notes											H							
Kings Lynn		d	**08 27**	**09 27**	**10 27**	**11 27**	**12 27**	**13 27**	**14 27**	**15 27**	**16 27**	**17 27**	**17 57**	**18 27**	**19 27**	**20 27**	**21 27**	**22 27**
Watlington		d	**08 34**	**09 34**	**10 34**	**11 34**	**12 34**	**13 34**	**14 34**	**15 34**	**16 34**	**17 34**	|	**18 34**	**19 34**	**20 34**	**21 34**	**22 34**
Downham Market		d	**08 41**	**09 41**	**10 41**	**11 41**	**12 41**	**13 41**	**14 41**	**15 41**	**16 41**	**17 41**	**18 09**	**18 41**	**19 41**	**20 41**	**21 41**	**22 41**
Littleport		d	**08 50**	**09 50**	**10 50**	**11 50**	**12 50**	**13 50**	**14 50**	**15 50**	**16 50**	**17 50**	|	**18 50**	**19 50**	**20 50**	**21 50**	**22 50**
Ely	6	a	**08 58**	**09 58**	**10 58**	**11 58**	**12 58**	**13 58**	**14 58**	**15 58**	**16 58**	**17 58**	**18 25**	**18 58**	**19 58**	**20 58**	**21 58**	**22 58**
Ely	6	d	**08 58**	**09 58**	**10 58**	**11 58**	**12 58**	**13 58**	**14 58**	**15 58**	**16 58**	**17 58**	**18 26**	**18 58**	**19 58**	**20 58**	**21 58**	**22 58**
Waterbeach		d	**09 08**	**10 08**	**11 08**	**12 08**	**13 08**	**14 08**	**15 08**	**16 08**	**17 08**	**18 08**	|	**19 08**	**20 08**	**21 08**	**22 08**	**23 08**
Cambridge North		a	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Cambridge		a	**09 15**	**10 15**	**11 15**	**12 15**	**13 15**	**14 15**	**15 15**	**16 15**	**17 15**	**18 15**	**18 40**	**19 15**	**20 15**	**21 15**	**22 15**	**23 14**
Stansted Airport	✈	a	10 00b	11 00b	12 00b	13 00b	14 00b	15 00b	16 00b	17 00b	18 00b	19 00b	19 45b	20 00b	20 54b	22 00b	|	|
London Liverpool Street	15 ⊖	a	10 43b	11 43b	12 43b	13 43b	14 43b	15 43b	16 43b	17 43b	18 43b	19 43b	20 14b	20 43b	21 43b	22 43b	23 43b	|
London Kings Cross	15 ⊖	a	**10 18**	**11 20**	**12 20**	**13 15**	**14 15**	**15 15**	**16 15**	**17 15**	**18 19**	**19 18**	20 09e	**20 18**	**21 16**	**22 22**	**23 16**	**00 40**

10 Regional

Train timetable
Valid from 10 December 2017

Cambridge to Ely, Peterborough
and Norwich

greateranglia

Notes and symbols

Generic notes and symbols

Bold Times in bold are direct services operated by Greater Anglia
Italic Times in italics are connecting train services with one change of train.
Other connections may be available with further changes

0640 For the comfort and safety of all passengers, only folded cycles can be accommodated during busy times. Trains that these conditions apply to are highlighted throughout this timetable

1 First Class accommodation available
◇ Seat reservations possible
PlusBus operates from this station
Bus link
Connections with Ferry services
Airport interchange
Interchange with London Underground

a Arrival time
d Departure time
x Stops on request

FO Fridays only
FX Mondays to Thursdays only
MFO Mondays and Fridays only
SO Saturdays only

All services are operated by Greater Anglia unless otherwise shown below:

EM Operated by East Midlands Trains
GN Operated by Great Northern
XC Operated by CrossCountry

Table 10: EM, GN and XC trains are included to show the full service available between Stansted Airport, Cambridge, Cambridge North, Ely and Peterborough / Norwich. These times are correct at time of going to press but Greater Anglia cannot be held responsible for them

6 Lowestoft and Felixstowe to Ipswich

b Change at Ipswich

7 Ipswich to Cambridge and Peterborough

b Change at Manningtree and Ipswich
c Change at Ipswich
e Change at Ipswich and Manningtree

8 Norwich to Great Yarmouth and Lowestoft

b Change at Ipswich and Norwich
A Service runs 10 December to 18 March
B Service runs 25 March to 13 May
C Service runs 11 December to 23 March
D Service runs 26 March to 18 May
E Service runs 16 December to 24 March
F Service runs 31 March to 19 May

Notes and symbols

9 Norwich to Cromer and Sheringham

b Change at Ipswich and Norwich

10 Cambridge to Ely, Peterborough and Norwich

b Connection only applies on Mondays and Fridays
c Change at Bishop's Stortford and Cambridge
e Change at Cambridge
f Change at Bishop's Stortford
A Service runs 10 December to 11 February and 1 April to 13 May
B Service runs 18 February to 25 March
C Service runs 11 December to 12 February and 2 April to 14 May
D Service runs 19 February to 26 March

10

Cambridge to Ely, Peterborough and Norwich

Mondays to Fridays

		XC	XC		GN	EM		EM	GN	XC		GN	
		1◇	1◇	1	1	◇	1	◇	1	1◇	1	1	1
London Liverpool St ⊖	d		*0410b*						*0510c*	*0510*		*0528*	
Stansted Airport ✈	d		0516							0612			
Cambridge	a		0551							0642			
Cambridge	d	0515	0555	0602	0615				0652	0656	0700	0704	0721
Cambridge North	d			0606	0619						0704	0710	0725
Waterbeach	d				0623				0658				
Ipswich	d						0600						
Ely	a	0529	0609	0619	0633		0656		0708	0711	0718		0738
Ely	d	0530	0610	0619		0651	0656	0705		0712	0719		
Manea	d		0620				0707						
March	d	0546	0628			0707	0715			0729			
Whittlesea	d	0558	0639				0726			0740			
Peterborough	a	0608	0650			0725	0737			0750			
Shippea Hill	d										0728x		
Lakenheath	d												
Brandon	d			0635				0720			0738		
Thetford	d			0644				0729			0747		
Harling Road	d			0652							0755		
Eccles Road	d			0657							0800		
Attleborough	d			0703				0743			0806		
Spooner Row	d										0811x		
Wymondham	d			0711				0750			0816		
Norwich	a			0727				0813			0830		

		EM	GN	XC	EM	GN	GN		EM	GN	GN		
		◇	1	1◇	◇	1	1	1	◇	1	1	1	1◇
London Liverpool St ⊖	d		*0558*	*0625*						*0628*	*0658*		0728
Stansted Airport ✈	d			0721									
Cambridge	a			0756									
Cambridge	d		0733	0758		0802	0806	0810		0831	0838		0855
Cambridge North	d		0737			0806		0814		0836			0900
Waterbeach	d		0741				0812				0844		
Ipswich	d											0803	
Ely	a		0751	0814			0822	0827			0854	0858	
Ely	d	0744		0815	0815			0828	0848			0858	
Manea	d											0909	
March	d	0800		0832					0907			0917	
Whittlesea	d	0812										0928	
Peterborough	a	0822		0850					0925			0939	
Shippea Hill	d												
Lakenheath	d												
Brandon	d							0844					
Thetford	d				0837			0853					
Harling Road	d												
Eccles Road	d												
Attleborough	d				0851			0908					
Spooner Row	d												
Wymondham	d				0858			0915					
Norwich	a				0913			0930					

For reference to notes, please see page 3-4

10

Cambridge to Ely, Peterborough and Norwich

Mondays to Fridays

		XC		GN	EM	EM	GN	GN		XC	EM		GN
		1◇	1	1	◇	◇	1	1	1◇	1◇	◇	1	1
London Liverpool St ⊖	d						*0803*		0828	*0833e*			*0858*
Stansted Airport ✈	d	0821								0921			
Cambridge	a	0858								0958			
Cambridge	d	0901	0906	0909			0928	0935	0955	1001		1010	1015
Cambridge North	d		0911	0914			0933		1001			1014	1021
Waterbeach	d							0941					
Ipswich	d												
Ely	a	0914	0923	0928				0951		1014		1027	1037
Ely	d	0915	0926		0945	0946				1015	1017	1028	
Manea	d												
March	d	0932								1032			
Whittlesea	d												
Peterborough	a	0950				1026				1050			
Shippea Hill	d												
Lakenheath	d												
Brandon	d		0942									1044	
Thetford	d		0951		1006						1038	1053	
Harling Road	d												
Eccles Road	d												
Attleborough	d		1006									1108	
Spooner Row	d		1011x										
Wymondham	d		1015									1115	
Norwich	a		1030		1044						1112	1130	

		GN	GN	EM				XC	EM	GN		EM	GN
		1	1	◇	1	1	1◇	1◇	◇	1	1	◇	1
London Liverpool St ⊖	d						0928						*0958*
Stansted Airport ✈	d					1005		1027					
Cambridge	a					1035		1059					
Cambridge	d	1028	1035				1052	1101		1104	1110		1128
Cambridge North	d	1033					1057			1108	1114		1133
Waterbeach	d		1041										
Ipswich	d				1000								
Ely	a		1051		1058			1114		1121	1127		
Ely	d			1053	1058			1115	1121		1128	1148	
Manea	d				1109								
March	d				1117			1132				1208	
Whittlesea	d				1128								
Peterborough	a			1127	1139			1150				1224	
Shippea Hill	d												
Lakenheath	d												
Brandon	d										1144		
Thetford	d								1143		1153		
Harling Road	d												
Eccles Road	d												
Attleborough	d										1208		
Spooner Row	d												
Wymondham	d										1215		
Norwich	a								1215		1230		

For reference to notes, please see page 3-4

Cambridge to Ely, Peterborough and Norwich

Mondays to Fridays

Station		GN			XC	EM	GN		EM	GN	GN		
		1	1	1◇	1◇	◇	1	1	◇	1	1	1	1
London Liverpool St	d			1028						*1058*			
Stansted Airport	d		1105		1127								1205
Cambridge	a		1136		1159								1235
Cambridge	d	1135		1152	1201		1204	1210		1228	1235		
Cambridge North	d			1157			1208	1214		1233			
Waterbeach	d	1141									1241		
Ipswich	d											1158	
Ely	a	1151			1214		1222	1227			1251	1258	
Ely	d				1215	1216		1228	1248			1258	
Manea	d											1309	
March	d				1232							1317	
Whittlesea	d											1328	
Peterborough	a				1250				1323			1339	
Shippea Hill	d												
Lakenheath	d												
Brandon	d							1244					
Thetford	d					1238		1253					
Harling Road	d												
Eccles Road	d												
Attleborough	d							1308					
Spooner Row	d												
Wymondham	d							1315					
Norwich	a					1313		1330					

Station			XC	EM	GN		EM	GN	GN			XC	EM
		1◇	1◇	◇	1	1	◇	1	1	1	1◇	1◇	◇
London Liverpool St	d	1128						*1158*			1228		
Stansted Airport	d		1227							1305		1327	
Cambridge	a		1259							1335		1359	
Cambridge	d	1252	1301		1304	1310		1328	1335		1352	1401	
Cambridge North	d	1257			1308	1314		1333			1357		
Waterbeach	d								1341				
Ipswich	d												
Ely	a		1314		1321	1327			1351			1414	
Ely	d		1315	1317		1328	1348					1415	1416
Manea	d												
March	d		1332									1432	
Whittlesea	d												
Peterborough	a		1350				1425					1450	
Shippea Hill	d												
Lakenheath	d												
Brandon	d					1344							
Thetford	d			1339		1353							1438
Harling Road	d												
Eccles Road	d												
Attleborough	d					1408							
Spooner Row	d												
Wymondham	d					1415							
Norwich	a			1413		1430							1511

For reference to notes, please see page 3-4

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Cambridge to Ely, Peterborough and Norwich

Mondays to Fridays

		GN		EM	GN	GN				XC	EM	GN	
		1	1	◇	1	1	1	1	1◇	1◇	◇	1	1
London Liverpool St	d				*1258*				1328				
Stansted Airport	d							1405		1427			
Cambridge	a							1435		1459			
Cambridge	d	1404	1410		1428	1435			1452	1501		1507	1510
Cambridge North	d	1408	1414		1433				1457			1511	1514
Waterbeach	d					1441							
Ipswich	d						1358						
Ely	a	1421	1427			1451	1458			1514		1524	1528
Ely	d		1428	1448			1458			1515	1516		1528
Manea	d						1509						
March	d						1517			1532			
Whittlesea	d						1528						
Peterborough	a			1527			1539			1550			
Shippea Hill	d												
Lakenheath	d												
Brandon	d		1444										1544
Thetford	d		1453								1538		1553
Harling Road	d												
Eccles Road	d												
Attleborough	d		1508										1608
Spooner Row	d												
Wymondham	d		1515										1615
Norwich	a		1530								1613		1630

		EM	GN	GN				XC	EM	GN		GN	EM
		◇	1	1	1	1	1◇	1◇	◇	1	1	1	◇
London Liverpool St	d		*1358*				1428						
Stansted Airport	d				1505			1527					
Cambridge	a				1542			1558					
Cambridge	d		1528	1535		1548	1552	1601		1606	1610	1619	
Cambridge North	d		1533			1553	1557			1610	1614		
Waterbeach	d		1537	1541		1558						1626	
Ipswich	d												
Ely	a		1547	1551		1611		1614		1623	1627	1635	
Ely	d	1547						1615	1616		1628		1647
Manea	d												
March	d							1632					
Whittlesea	d												
Peterborough	a	1625						1650					1722
Shippea Hill	d												
Lakenheath	d												
Brandon	d										1644		
Thetford	d								1637		1653		
Harling Road	d												
Eccles Road	d												
Attleborough	d										1708		
Spooner Row	d												
Wymondham	d										1715		
Norwich	a								1713		1729		

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Cambridge to Ely, Peterborough and Norwich

Mondays to Fridays

		GN	GN				XC	EM	GN			EM	GN
		1	1	1	1	1◇	1◇	◇	1	1	1◇	◇	1
London Liverpool St	⊖ d	*1458*				1528					1558		
Stansted Airport	✈ d				1605		1627						
Cambridge	a				1636		1659						
Cambridge	d	1628	1635			1652	1701		1705	1710	1721		1732
Cambridge North	d	1633				1657			1709	1714	1726		1736
Waterbeach	d		1642								1730		
Ipswich	d			1600									
Ely	a		1651	1658			1714		1723	1727	1742		
Ely	d			1658			1715	1716		1728		1752	
Manea	d			1709									
March	d			1717			1732						
Whittlesea	d			1728									
Peterborough	a			1739			1750					1825	
Shippea Hill	d												
Lakenheath	d												
Brandon	d									1744			
Thetford	d							1738		1753			
Harling Road	d												
Eccles Road	d												
Attleborough	d									1808			
Spooner Row	d												
Wymondham	d									1815			
Norwich	a							1813		1829			

		GN	XC	EM	GN				EM	GN	GN		
		1	1◇	◇	1	1	1◇	1	◇	1	1	1	1◇
London Liverpool St	⊖ d		*1628e*				1707						1737
Stansted Airport	✈ d		1727										
Cambridge	a		1759										
Cambridge	d	1740	1801		1806	1811	1817	1822		1826	1839		1849
Cambridge North	d				1810	1815		1826		1830			1854
Waterbeach	d	1747					1823	1830			1846		
Ipswich	d											1749	
Ely	a	1756	1814		1823	1828	1833	1841			1855	1858	
Ely	d		1815	1820		1828			1852			1858	
Manea	d		1826									1909	
March	d		1834						1908			1917	
Whittlesea	d											1928	
Peterborough	a		1850						1926			1939	
Shippea Hill	d												
Lakenheath	d												
Brandon	d					1844							
Thetford	d			1841		1853							
Harling Road	d												
Eccles Road	d												
Attleborough	d					1908							
Spooner Row	d												
Wymondham	d					1915							
Norwich	a			1915		1929							

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Cambridge to Ely, Peterborough and Norwich

Mondays to Fridays

		XC	GN	EM			GN	EM	GN		XC	EM	GN
		1◇	1	◇	1◇	1	1	◇	1	1◇	1◇	◇	1
London Liverpool St ⊖	d				1807					1837			
Stansted Airport ✈	d	1821									1921		
Cambridge	a	1859									1959		
Cambridge	d	1901	1909		1919	1922	1925		1939	1947	2001		2008
Cambridge North	d					1926	1931			1952			2012
Waterbeach	d				1925				1946				
Ipswich	d												
Ely	a	1914	1923		1935	1939	1944		1955		2014		2025
Ely	d	1915		1928		1940		1952			2015	2018	
Manea	d												
March	d	1932									2032		
Whittlesea	d												
Peterborough	a	1950						2025			2050		
Shippea Hill	d												
Lakenheath	d												
Brandon	d					1956							
Thetford	d			1951		2004						2038	
Harling Road	d												
Eccles Road	d												
Attleborough	d					2019							
Spooner Row	d												
Wymondham	d					2027							
Norwich	a			2022		2041						2113	

				GN	GN		GN		XC	GN		GN	GN
		1◇	1	1	1	1	1	1◇	1◇	1		1	1
London Liverpool St ⊖	d	1907					*1911*	1928			*1958*		
Stansted Airport ✈	d								2021				
Cambridge	a								2059				
Cambridge	d	2014	2019	2030	2040		2051	2056	2101	2110	2115	2128	2140
Cambridge North	d		2023	2035			2055	2101			2120	2134	
Waterbeach	d	2020			2046					2116			2146
Ipswich	d					2000							
Ely	a	2030	2036		2056	2059	2108		2114	2126	2132	2146	2156
Ely	d		2037			2059			2115		2133		
Manea	d					2109							
March	d					2117			2132				
Whittlesea	d					2128							
Peterborough	a					2139			2150				
Shippea Hill	d												
Lakenheath	d												
Brandon	d		2053								2149		
Thetford	d		2101								2157		
Harling Road	d												
Eccles Road	d												
Attleborough	d		2116								2212		
Spooner Row	d												
Wymondham	d		2124								2220		
Norwich	a		2138								2235		

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Cambridge to Ely, Peterborough and Norwich

Mondays to Fridays

		EM		XC	GN		GN		XC		GN	XC	GN
		◇	1◇	1	1	1	1	1	1	1◇	1	1	1
London Liverpool St	⊖ d		2028				*2058*			2128			*2158*
Stansted Airport	✈ d		|	2127		2205			2227	|		2257	
Cambridge	a		|	2159		2234			2255	|		2326	
Cambridge	d		2152		2210		2240	2255		2258	2310		2340
Cambridge North	d		2157		2214		2244	2259		2303	2314		2344
Waterbeach	d				2218		2248				2318		2348
Ipswich	d				|		|				|		|
Ely	a				2228		2300	2312			2328		2359
Ely	d	2216						2312					
Manea	d	|						|					
March	d	|						|					
Whittlesea	d	|						|					
Peterborough	a	|						|					
Shippea Hill	d	|						|					
Lakenheath	d	|						|					
Brandon	d	|						2328					
Thetford	d	2237						2337					
Harling Road	d	|						|					
Eccles Road	d	|						|					
Attleborough	d	2251						2352					
Spooner Row	d	|						|					
Wymondham	d	2258						2359					
Norwich	a	2318						0013					

			GN
		1◇	1
London Liverpool St	⊖ d	2228	
Stansted Airport	✈ d	|	
Cambridge	a	|	
Cambridge	d	2352	0010
Cambridge North	d	2357	0014
Waterbeach	d		0018
Ipswich	d		|
Ely	a		0028
Ely	d		
Manea	d		
March	d		
Whittlesea	d		
Peterborough	a		
Shippea Hill	d		
Lakenheath	d		
Brandon	d		
Thetford	d		
Harling Road	d		
Eccles Road	d		
Attleborough	d		
Spooner Row	d		
Wymondham	d		
Norwich	a		

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Cambridge to Ely, Peterborough and Norwich

Saturdays

		XC	XC		EM	GN		EM		XC		EM	
		1◇	1◇	1	◇	1	1	◇	1◇	1◇	1	◇	1
London Liverpool St ⊖	d		*0410*						0520	*0525*			
Stansted Airport ✈	d		0525							0627			0648
Cambridge	a		0552							0656			0720
Cambridge	d	0515	0555	0605		0635			0652	0657	0700		
Cambridge North	d			0609					0657				
Waterbeach	d					0641							
Ipswich	d						0600						
Ely	a	0529	0609	0622		0651	0656			0711	0715		
Ely	d	0530	0610	0622	0648		0656	0706		0712	0716	0748	
Manea	d		0620				0707						
March	d	0546	0628		0707		0715			0728		0804	
Whittlesea	d	0558	0639				0726			0739		0814	
Peterborough	a	0608	0650		0725		0737			0749		0827	
Shippea Hill	d										0725x		
Lakenheath	d												
Brandon	d			0638				0722			0735		
Thetford	d			0647				0730			0743		
Harling Road	d			0655							0752		
Eccles Road	d			0700							0757		
Attleborough	d			0706				0744			0803		
Spooner Row	d										0808x		
Wymondham	d			0714				0751			0813		
Norwich	a			0728				0813			0830		

		GN	GN		EM	XC		EM		GN	GN		
		1	1	1◇	◇	1◇	1	◇	1	1	1	1	1◇
London Liverpool St ⊖	d	*0558*		0628						*0658*			0728
Stansted Airport ✈	d					0727			0748				
Cambridge	a					0758			0819				
Cambridge	d	0729	0735	0752		0801	0810			0829	0835		0852
Cambridge North	d	0734		0757			0814			0834			0857
Waterbeach	d		0741								0841		
Ipswich	d											0800	
Ely	a		0751			0814	0827				0851	0858	
Ely	d				0814	0815	0828	0848				0858	
Manea	d											0909	
March	d					0832		0905				0917	
Whittlesea	d											0928	
Peterborough	a					0850		0923				0939	
Shippea Hill	d												
Lakenheath	d												
Brandon	d						0844						
Thetford	d				0836		0853						
Harling Road	d												
Eccles Road	d												
Attleborough	d				0850		0908						
Spooner Row	d												
Wymondham	d				0857		0915						
Norwich	a				0915		0930						

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Cambridge to Ely, Peterborough and Norwich

Saturdays

		XC		EM	EM	GN	GN			XC	EM		EM
		1◇	1	◇	◇	1	1	1	1◇	1◇	◇	1	◇
London Liverpool St	⊖ d					*0758*			0828				
Stansted Airport	✈ d	0827						0905		0927			
Cambridge	a	0858						0937		0958			
Cambridge	d	0901	0910			0929	0935		0952	1001		1010	
Cambridge North	d		0914			0934			0957			1014	
Waterbeach	d						0941						
Ipswich	d												
Ely	a	0914	0927				0951			1014		1027	
Ely	d	0915	0928	0945	0946					1015	1021	1028	1048
Manea	d												
March	d	0932								1032			
Whittlesea	d												
Peterborough	a	0950			1021					1050			1119
Shippea Hill	d												
Lakenheath	d												
Brandon	d		0944									1044	
Thetford	d		0953	1007							1043	1053	
Harling Road	d												
Eccles Road	d												
Attleborough	d		1008									1108	
Spooner Row	d												
Wymondham	d		1015									1115	
Norwich	a		1030	1043							1115	1130	

		GN	GN				XC	EM	GN		EM	GN	GN
		1	1	1	1	1◇	1◇	◇	1	1	◇	1	1
London Liverpool St	⊖ d	*0858*				0928						*0958*	
Stansted Airport	✈ d				1005		1027						
Cambridge	a				1037		1058						
Cambridge	d	1029	1035			1052	1101		1104	1110		1129	1135
Cambridge North	d	1034				1057			1108	1114		1134	
Waterbeach	d		1041										1141
Ipswich	d			0958									
Ely	a		1051	1058			1114		1121	1127			1151
Ely	d			1058			1115	1116		1128	1148		
Manea	d			1109									
March	d			1117			1132				1205		
Whittlesea	d			1128									
Peterborough	a			1139			1149				1221		
Shippea Hill	d												
Lakenheath	d												
Brandon	d									1144			
Thetford	d							1137		1153			
Harling Road	d												
Eccles Road	d												
Attleborough	d									1208			
Spooner Row	d												
Wymondham	d									1215			
Norwich	a							1213		1230			

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Cambridge to Ely, Peterborough and Norwich

Saturdays

Station													
				XC	EM	GN		EM	GN	GN			
		■	■◇	■◇	◇	■	■	◇	■	■	■	■	■◇
London Liverpool St ⊖	d		1028						*1058*				1128
Stansted Airport ✈	d	1105		1127								1205	
Cambridge	a	1142		1158								1235	
Cambridge	d		1152	1201		1204	1210		1229	1235			1252
Cambridge North	d		1157			1208	1214		1234				1257
Waterbeach	d									1241			
Ipswich	d										1158		
Ely	a			1214		1221	1227			1251	1258		
Ely	d			1215	1216		1228	1248			1258		
Manea	d										1309		
March	d			1232							1317		
Whittlesea	d										1328		
Peterborough	a			1249				1326			1339		
Shippea Hill	d												
Lakenheath	d												
Brandon	d						1244						
Thetford	d				1238		1253						
Harling Road	d												
Eccles Road	d												
Attleborough	d						1308						
Spooner Row	d												
Wymondham	d						1315						
Norwich	a				1313		1330						

Station													
		XC	EM	GN		EM	GN	GN			XC	EM	GN
		■◇	◇	■	■	◇	■	■	■	■◇	■◇	◇	■
London Liverpool St ⊖	d						*1158*			1228			
Stansted Airport ✈	d	1227							1305		1327		
Cambridge	a	1259							1335		1358		
Cambridge	d	1301		1304	1310		1329	1335		1352	1401		1404
Cambridge North	d			1308	1314		1334			1357			1408
Waterbeach	d							1341					
Ipswich	d												
Ely	a	1314		1321	1327			1351			1414		1421
Ely	d	1315	1316		1328	1348					1415	1416	
Manea	d												
March	d	1332									1432		
Whittlesea	d												
Peterborough	a	1349				1425					1450		
Shippea Hill	d												
Lakenheath	d												
Brandon	d				1344								
Thetford	d		1337		1353							1437	
Harling Road	d												
Eccles Road	d												
Attleborough	d				1408								
Spooner Row	d												
Wymondham	d				1415								
Norwich	a		1413		1430							1513	

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Cambridge to Ely, Peterborough and Norwich

Saturdays

			EM	GN	GN				XC	EM	GN		EM
		■	◇	■	■	■	■	■◇	■◇	◇	■	■	◇
London Liverpool St ⊖	d			*1258*				1328					
Stansted Airport ✈	d						1405		1427				
Cambridge	a						1442		1458				
Cambridge	d	1410		1429	1435			1452	1501		1504	1510	
Cambridge North	d	1414		1434				1457			1508	1514	
Waterbeach	d				1441								
Ipswich	d					1358							
Ely	a	1427			1451	1458			1514		1521	1527	
Ely	d	1428	1448			1458			1515	1521		1527	1547
Manea	d					1509							
March	d					1517			1532				
Whittlesea	d					1528							
Peterborough	a		1523			1539			1549				1625
Shippea Hill	d												
Lakenheath	d											1540x	
Brandon	d	1444										1546	
Thetford	d	1453								1542		1554	
Harling Road	d												
Eccles Road	d												
Attleborough	d	1508										1609	
Spooner Row	d												
Wymondham	d	1515										1617	
Norwich	a	1530								1615		1631	

		GN	GN			XC	EM	GN		EM	GN	GN	
		■	■	■	■◇	■◇	◇	■	■	◇	■	■	■
London Liverpool St ⊖	d	*1358*			1428						*1458*		
Stansted Airport ✈	d			1505		1527							
Cambridge	a			1535		1558							
Cambridge	d	1529	1535		1552	1601		1604	1610		1629	1635	
Cambridge North	d	1534			1557			1608	1614		1634		
Waterbeach	d		1541									1641	
Ipswich	d												1558
Ely	a		1551			1614		1621	1627			1651	1658
Ely	d					1615	1616		1628	1647			1658
Manea	d												1709
March	d					1632							1717
Whittlesea	d												1728
Peterborough	a					1650				1723			1739
Shippea Hill	d												
Lakenheath	d												
Brandon	d								1644				
Thetford	d						1638		1653				
Harling Road	d												
Eccles Road	d												
Attleborough	d								1708				
Spooner Row	d												
Wymondham	d								1715				
Norwich	a						1713		1730				

For reference to notes, please see page 3-4

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Cambridge to Ely, Peterborough and Norwich

Saturdays

				XC	EM	GN		EM	GN	GN			XC
		1	1◇	1◇	◇	1	1	◇	1	1	1	1◇	1◇
London Liverpool St	⊖ d		1528						*1558*			1628	
Stansted Airport	✈ d	1605		1627							1705		1727
Cambridge	a	1635		1658							1735		1758
Cambridge	d		1652	1701		1704	1710		1729	1735		1752	1801
Cambridge North	d		1657			1708	1714		1734			1757	
Waterbeach	d									1741			
Ipswich	d												
Ely	a			1714		1721	1727			1751			1814
Ely	d			1715	1716		1728	1747					1815
Manea	d												1825
March	d			1732									1834
Whittlesea	d												
Peterborough	a			1749				1823					1851
Shippea Hill	d												
Lakenheath	d												
Brandon	d						1744						
Thetford	d				1737		1753						
Harling Road	d												
Eccles Road	d												
Attleborough	d						1808						
Spooner Row	d												
Wymondham	d						1815						
Norwich	a				1813		1830						

		EM	GN		EM	GN	GN				XC	GN	EM
		◇	1	1	◇	1	1	1	1	1◇	1◇	1	◇
London Liverpool St	⊖ d					*1658*				1728			
Stansted Airport	✈ d								1805		1827		
Cambridge	a								1835		1858		
Cambridge	d		1805	1810		1829	1835			1852	1901	1905	
Cambridge North	d		1809	1814		1834				1857			
Waterbeach	d						1841						
Ipswich	d							1758					
Ely	a		1822	1827			1851	1858			1914	1919	
Ely	d	1816		1828	1848			1858			1915		1922
Manea	d							1909					
March	d				1905			1917			1932		
Whittlesea	d							1928					
Peterborough	a				1924			1939			1950		
Shippea Hill	d												
Lakenheath	d												
Brandon	d			1844									
Thetford	d	1837		1853									1943
Harling Road	d												
Eccles Road	d												
Attleborough	d			1908									
Spooner Row	d												
Wymondham	d			1915									
Norwich	a	1913		1930									2016

For reference to notes, please see page 3-4

Cambridge to Ely, Peterborough and Norwich

Saturdays

Station				EM	GN	GN			XC	EM	GN		GN	GN
			1	◇	1	1	1	1◇	1◇	◇	1	1	1	1
London Liverpool St	⊖	d			*1758*			1828					*1858*	
Stansted Airport	✈	d					1905		1927					
Cambridge		a					1935		1958					
Cambridge		d	1910		1929	1935		1952	2001		2007	2010	2029	2035
Cambridge North		d	1914		1934			1957				2014	2034	
Waterbeach		d				1941					2013			
Ipswich		d												
Ely		a	1927			1951			2014		2023	2027		2049
Ely		d	1928	1948					2015	2016		2028		
Manea		d												
March		d							2032					
Whittlesea		d												
Peterborough		a		2023					2050					
Shippea Hill		d												
Lakenheath		d												
Brandon		d	1944									2044		
Thetford		d	1953							2038		2053		
Harling Road		d												
Eccles Road		d												
Attleborough		d	2008									2108		
Spooner Row		d												
Wymondham		d	2015									2115		
Norwich		a	2030							2113		2130		

Station						XC	GN		GN	GN		EM		XC
			1	1	1◇	1	1	1	1	1	1	◇	1◇	1
London Liverpool St	⊖	d			1928				*1958*				2028	
Stansted Airport	✈	d		2005		2027					2105			2127
Cambridge		a		2035		2058					2142			2158
Cambridge		d			2052		2107	2110	2129	2140			2152	
Cambridge North		d			2057			2114	2134	2144			2157	
Waterbeach		d					2113			2148				
Ipswich		d	1958											
Ely		a	2058				2123	2127		2159				
Ely		d	2058					2128				2217		
Manea		d	2109											
March		d	2117											
Whittlesea		d	2128											
Peterborough		a	2139											
Shippea Hill		d												
Lakenheath		d												
Brandon		d						2144						
Thetford		d						2153				2238		
Harling Road		d												
Eccles Road		d												
Attleborough		d						2208				2252		
Spooner Row		d												
Wymondham		d						2215				2259		
Norwich		a						2232				2319		

For reference to notes, please see page 3-4

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Cambridge to Ely, Peterborough and Norwich

Saturdays

			GN	GN			XC		GN	GN		XC	GN
			1	1	1	1	1	1◇	1	1	1◇	1	1
London Liverpool St	⊖	d		*2058*				2128		*2158*	2228		
Stansted Airport	✈	d			2205		2227					2327	
Cambridge	🚌	a			2245		2257					2355	
Cambridge	🚌	d	2207	2237		2255		2258	2310	2329	2352		0010
Cambridge North	🚌	d		2241		2259		2303	2314	2334	2357		
Waterbeach		d	2213						2318				0016
Ipswich	🚌	d											
Ely	🚌	a	2223	2254		2312			2328				0026
Ely	🚌	d				2312							
Manea		d											
March		d											
Whittlesea		d											
Peterborough	🚌	a											
Shippea Hill		d											
Lakenheath		d											
Brandon		d				2328							
Thetford		d				2337							
Harling Road		d											
Eccles Road		d											
Attleborough		d				2352							
Spooner Row		d											
Wymondham		d				2359							
Norwich	🚌	a				0013							

For reference to notes, please see page 3-4

Cambridge to Ely, Peterborough and Norwich

Sundays

			GN				GN					XC	GN
		1	1	1	1◇	1	1	1	1◇	1	1	1◇	1
London Liverpool St	⊖ d				*0742*		*0828*		0857		*0928*		
Stansted Airport	✈ d			0840		0909				1009		1025	
Cambridge	a			0910		0945				1044		1058	
Cambridge	d	0850	0906		0925		1006		1027		1050	1100	1106
Cambridge North	d	0854			0930				1032		1054		
Waterbeach	d		0912				1012						1112
Ipswich	d							0955					
Ely	a	0907	0922				1022	1051			1107	1114	1122
Ely	d	0907						1052			1107	1115	
Manea	d												
March	d							1109				1132	
Whittlesea	d							1120					
Peterborough	a							1131				1151	
Shippea Hill	d												
Lakenheath	d	0920x									1120x		
Brandon	d	0926									1126		
Thetford	d	0934									1134		
Harling Road	d												
Eccles Road	d												
Attleborough	d	0949									1149		
Spooner Row	d												
Wymondham	d	0957									1157		
Norwich	a	1013									1213		

		EM				XC	GN					XC	GN
		◇	1◇	1	1	1◇	1	1	1◇	1	1	1◇	1
London Liverpool St	⊖ d		0957		*1028*				1057		*1128*		
Stansted Airport	✈ d			1109		1125				1209		1225	
Cambridge	a			1144		1158				1244		1258	
Cambridge	d		1127		1150	1200	1206		1227		1250	1300	1306
Cambridge North	d		1132		1154				1232		1254		
Waterbeach	d						1212						1312
Ipswich	d							1155					
Ely	a				1207	1214	1222	1251			1307	1314	1322
Ely	d	1139			1207	1215		1252			1307	1315	
Manea	d												
March	d					1232		1309				1332	
Whittlesea	d							1320					
Peterborough	a	1211				1251		1331				1351	
Shippea Hill	d												
Lakenheath	d										1320x		
Brandon	d				1223						1326		
Thetford	d				1232						1334		
Harling Road	d												
Eccles Road	d												
Attleborough	d				1247						1349		
Spooner Row	d												
Wymondham	d				1254						1357		
Norwich	a				1312						1413		

For reference to notes, please see page 3-4

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Cambridge to Ely, Peterborough and Norwich

Sundays

					XC	EM	GN	EM					XC
		1◇	1	1	1◇	◇	1	◇	1	1◇	1	1	1◇
London Liverpool St ⊖	d	1157		*1228*						1257		*1328*	
Stansted Airport ✈	d	|	1309		1325					|	1409		1425
Cambridge	a	|	1344		1358					|	1444		1458
Cambridge	d	1327		1350	1400		1406			1427		1450	1500
Cambridge North	d	1331		1354	|		|			1432		1454	|
Waterbeach	d			|	|		1412					|	|
Ipswich	d			|	|		|		1355			|	|
Ely	a			1407	1414		1422		1451			1507	1514
Ely	d			1407	1415	1419		1440	1452			1507	1515
Manea	d			|	|	|		|	|			|	|
March	d			|	1432	|		|	1509			|	1532
Whittlesea	d			|	|	|		|	1520			|	|
Peterborough	a			|	1451	|		1513	1531			|	1551
Shippea Hill	d			|		|						|	
Lakenheath	d			|		|						|	
Brandon	d			1423		1435						1523	
Thetford	d			1432		1443						1532	
Harling Road	d			|		|						|	
Eccles Road	d			|		|						|	
Attleborough	d			1447		1457						1547	
Spooner Row	d			|		|						|	
Wymondham	d			1454		1508						1554	
Norwich	a			1513		1524						1613	

		GN	EM	EM				XC	GN	EM			
		1	◇	◇	1◇	1	1	1◇	1	◇	1	1◇	1
London Liverpool St ⊖	d				1357		*1428*					1457	
Stansted Airport ✈	d				|	1509		1525				|	1609
Cambridge	a				|	1544		1558				|	1644
Cambridge	d	1506			1527		1550	1600	1606			1627	
Cambridge North	d	|			1532		1554	|	|			1632	
Waterbeach	d	1512					|	|	1612				
Ipswich	d	|					|	|	|		1555		
Ely	a	1522					1607	1614	1622		1651		
Ely	d		1534	1546			1607	1615		1634	1652		
Manea	d		|	|			|	|		|	|		
March	d		|	1603			|	1632		|	1709		
Whittlesea	d		|	|			|	|		|	1720		
Peterborough	a		|	1620			|	1651		|	1731		
Shippea Hill	d		|				|			|			
Lakenheath	d		|				1620x			|			
Brandon	d		|				1626			|			
Thetford	d		1555				1634			1655			
Harling Road	d		|				|			|			
Eccles Road	d		|				|			|			
Attleborough	d		|				1649			|			
Spooner Row	d		|				|			|			
Wymondham	d		|				1657			|			
Norwich	a		1635				1713			1726			

For reference to notes, please see page 3-4

Cambridge to Ely, Peterborough and Norwich

Sundays

			XC	GN	EM	EM				XC	GN	EM	EM
		1	1◇	1	◇	◇	1◇	1	1	1◇	1	◇	◇
London Liverpool St ⊖	d	*1528*					1557		*1628*				
Stansted Airport ✈	d		1625					1709		1725			
Cambridge	a		1658					1745		1758			
Cambridge	d	1650	1700	1706			1727		1750	1800	1806		
Cambridge North	d	1654					1732		1754				
Waterbeach	d			1712							1812		
Ipswich	d												
Ely	a	1707	1714	1722					1807	1814	1822		
Ely	d	1707	1715		1736	1748			1807	1815		1836	1848
Manea	d												
March	d		1732							1832			
Whittlesea	d												
Peterborough	a		1751			1820				1851			1923
Shippea Hill	d												
Lakenheath	d												
Brandon	d	1723							1823				
Thetford	d	1732			1757				1832			1857	
Harling Road	d												
Eccles Road	d												
Attleborough	d	1747							1847				
Spooner Row	d												
Wymondham	d	1754							1854				
Norwich	a	1813			1830				1910			1929	

						XC	GN	EM	EM				XC
		1	1◇	1	1	1◇	1	◇	◇	1◇	1	1	1◇
London Liverpool St ⊖	d		1657		*1728*					1757		*1828*	
Stansted Airport ✈	d			1809		1825					1909		1925
Cambridge	a			1844		1858					1944		1958
Cambridge	d		1827		1850	1900	1906			1927		1950	2000
Cambridge North	d		1832		1854					1932		1954	
Waterbeach	d						1912						
Ipswich	d	1755											
Ely	a	1851			1907	1914	1922					2007	2014
Ely	d	1852			1907	1915		1926	1948			2007	2015
Manea	d												
March	d	1909				1932							2032
Whittlesea	d	1920											
Peterborough	a	1931				1951			2023				2051
Shippea Hill	d												
Lakenheath	d												
Brandon	d				1923							2023	
Thetford	d				1932			1950				2032	
Harling Road	d												
Eccles Road	d												
Attleborough	d				1947							2047	
Spooner Row	d												
Wymondham	d				1954							2054	
Norwich	a				2013			2026				2110	

For reference to notes, please see page 3-4

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Cambridge to Ely, Peterborough and Norwich

Sundays

		GN	EM			XC	GN	EM		XC			GN
		1	◇	1◇	1	1	1	◇	1◇	1	1	1	1
London Liverpool St	d			1857			*1928*		1957			*2028*	
Stansted Airport	d				2009	2025				2104	2118		
Cambridge	a				2044	2057				2132	2149		
Cambridge	d	2006		2027			2106		2127			2150	2206
Cambridge North	d			2032					2132			2154	
Waterbeach	d	2012					2112						2212
Ipswich	d												
Ely	a	2022					2122					2207	2222
Ely	d		2036					2144				2207	
Manea	d												
March	d												
Whittlesea	d												
Peterborough	a							2216					
Shippea Hill	d												
Lakenheath	d												
Brandon	d											2223	
Thetford	d		2057									2232	
Harling Road	d												
Eccles Road	d												
Attleborough	d		2111									2247	
Spooner Row	d												
Wymondham	d		2118									2254	
Norwich	a		2137									2313	

		EM			XC	GN A	GN B		XC	GN C	GN D
		◇	1◇	1	1	1	1	1◇	1	1	1
London Liverpool St	d		2057			*2128*	*2128*	2157		*2228*	*2257*
Stansted Airport	d			2209	2225				2304		
Cambridge	a			2244	2257				2335		
Cambridge	d		2227			2306	2317	2327		0007	0028
Cambridge North	d		2232					2332			
Waterbeach	d					2312	2323			0013	0034
Ipswich	d										
Ely	a					2322	2333			0023	0044
Ely	d	2230									
Manea	d										
March	d										
Whittlesea	d										
Peterborough	a										
Shippea Hill	d										
Lakenheath	d										
Brandon	d										
Thetford	d	2251									
Harling Road	d										
Eccles Road	d										
Attleborough	d	2305									
Spooner Row	d										
Wymondham	d	2312									
Norwich	a	2325									

For reference to notes, please see page 3-4

Norwich, Peterborough and Ely to Cambridge

Mondays to Fridays

		XC	XC	GN		XC	GN	GN		GN	EM	GN	
		1	1	1	1◇	1	1	1	1	1	◇	1	1◇
Norwich	d								0533		0550		
Wymondham	d								0545		0603		
Spooner Row	d								|		|		
Attleborough	d								0552		0610		
Eccles Road	d								|		|		
Harling Road	d								|		|		
Thetford	d								0606		0624		
Brandon	d								0614		|		
Lakenheath	d								|		|		
Shippea Hill	d								|		|		
Peterborough	d								|		|		
Whittlesea	d								|		|		
March	d								|		|		
Manea	d								|		|		
Ely	a								0631		0646		
Ely	d			0525	0550			0622	0631	0638		0647	0650
Ipswich	a			|	|			|	|	|		|	|
Waterbeach	d			0535	0559			0632	|	0648		|	0659
Cambridge North	d			0540	0604		0630	|	0644	0653		|	0704
Cambridge	a			0544	0610		0635	0639	0652	0700		0704	0710
Cambridge	d	0444	0517		0618	0632							0717
Stansted Airport	a	0512	0549		|	0709							|
London Liverpool St	a			*0720*	0725			*0755*					0825

		EM	GN	GN	GN	XC			EM	GN	XC	GN	
		◇	1	1	1	1	1◇	1	◇	1	1◇	1	1◇
Norwich	d							0633	0651				
Wymondham	d							0645	|				
Spooner Row	d							|	|				
Attleborough	d							0652	|				
Eccles Road	d							|	|				
Harling Road	d							|	|				
Thetford	d							0706	0719				
Brandon	d							0714	|				
Lakenheath	d							|	|				
Shippea Hill	d							|	|				
Peterborough	d	0627						|	|		0712		
Whittlesea	d	|						|	|		0720		
March	d	0643						|	|		0731		
Manea	d	|						|	|		0738		
Ely	a	0701						0731	0740		0751		
Ely	d			0715	0722		0730	0733		0748	0752	0756	0800
Ipswich	a			|	|		|	|		|	|	|	|
Waterbeach	d			|	0732		|	|		0757	|	|	0809
Cambridge North	d		0720	0728	|		0742	0746		|	|	|	0814
Cambridge	a		0725	0733	0739		0747	0753		0804	0807	0810	0820
Cambridge	d					0740	0751				0810		0821
Stansted Airport	a					0809	|				0839		|
London Liverpool St	a				*0855*		0920					*0935*	0950

0640 Cycle restrictions apply. See page 5 for details

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Mondays to Fridays

		EM	GN	GN		GN		EM	XC		GN		GN
		◇	■	■	■	■	■	◇	■◇	■◇	■	■	■
Norwich	d						0737	0757					
Wymondham	d						0749						
Spooner Row	d												
Attleborough	d						0756						
Eccles Road	d												
Harling Road	d												
Thetford	d						0810	0824					
Brandon	d						0818						
Lakenheath	d												
Shippea Hill	d												
Peterborough	d	0736			0750				0818				
Whittlesea	d				0758								
March	d	0752			0809				0834				
Manea	d				0817								
Ely	a	0811			0831		0837	0845	0852				
Ely	d			0826	0832		0838		0852		0858		0928
Ipswich	a				0928								
Waterbeach	d			0836							0908		0938
Cambridge North	d		0819			0847	0851			0906			
Cambridge	a		0824	0843		0852	0859		0908	0912	0915		0945
Cambridge	d								0910	0918		0931	
Stansted Airport	a								0940			1000	
London Liverpool St	a			*1015*					*1031*	1044			

		GN		EM	EM	GN	XC		GN		EM	GN	GN
		■	■	◇	◇	■	■◇	■◇	■	■	◇	■	■
Norwich	d		0840		0857								
Wymondham	d		0852										
Spooner Row	d												
Attleborough	d		0859										
Eccles Road	d												
Harling Road	d												
Thetford	d		0913		0924								
Brandon	d		0921										
Lakenheath	d												
Shippea Hill	d												
Peterborough	d			0859			0918				0940		
Whittlesea	d												
March	d						0934						
Manea	d												
Ely	a		0938	0942	0945		0951				1013		
Ely	d		0938			0949	0952		1007			1025	
Ipswich	a												
Waterbeach	d					0959						1035	
Cambridge North	d	0947	0951					1015	1019				1047
Cambridge	a	0953	0959			1006	1008	1020	1023			1041	1053
Cambridge	d						1010	1021		1026			
Stansted Airport	a						1040			1100			
London Liverpool St	a		*1114*				*1133*	1144					

0640 Cycle restrictions apply. See page 5 for details

For reference to notes, please see page 3-4

Norwich, Peterborough and Ely to Cambridge

Mondays to Fridays

				EM	XC	GN			EM	GN	GN		EM
		1	1	◇	1◇	1	1◇	1	◇	1	1	1	◇
Norwich	d		0940	0957								1040	1057
Wymondham	d		0952									1052	
Spooner Row	d												
Attleborough	d		0959									1059	
Eccles Road	d												
Harling Road	d												
Thetford	d		1013	1024								1113	1124
Brandon	d		1021									1121	
Lakenheath	d												
Shippea Hill	d												
Peterborough	d	0950			1018				1045				
Whittlesea	d	0958											
March	d	1009			1034								
Manea	d	1017											
Ely	a	1031	1038	1045	1052				1118			1138	1146
Ely	d	1032	1038		1052	1058				1125		1138	
Ipswich	a	1128											
Waterbeach	d									1135			
Cambridge North	d		1051			1111	1115				1147	1151	
Cambridge	a		1059		1108	1115	1120			1141	1152	1159	
Cambridge	d				1110		1121	1127					
Stansted Airport	a				1140			1200					
London Liverpool St	a		*1214*		*1233*		1245					*1314*	

		XC	GN			EM	GN	GN			EM	XC	GN
		1◇	1	1◇	1	◇	1	1	1	1	◇	1◇	1
Norwich	d									1140	1157		
Wymondham	d									1152			
Spooner Row	d												
Attleborough	d									1159			
Eccles Road	d												
Harling Road	d												
Thetford	d									1213	1224		
Brandon	d									1221			
Lakenheath	d												
Shippea Hill	d												
Peterborough	d	1118				1141			1150			1218	
Whittlesea	d								1158				
March	d	1134							1209			1234	
Manea	d								1217				
Ely	a	1152				1213			1231	1238	1245	1252	
Ely	d	1152	1158				1225		1232	1238		1252	1258
Ipswich	a								1328				
Waterbeach	d						1235						
Cambridge North	d		1211	1215				1247		1251			1311
Cambridge	a	1208	1215	1220			1241	1252		1259		1308	1315
Cambridge	d	1210		1221	1227							1310	
Stansted Airport	a	1240			1300							1340	
London Liverpool St	a	*1331*		1344						*1414*		*1431*	

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Mondays to Fridays

				EM	GN	GN		EM	XC	GN			EM
			1◇	1	◇	1	1	1	◇	1◇	1	1◇	1	◇
Norwich	d						1240	1257					
Wymondham	d						1252	|					
Spooner Row	d						|	|					
Attleborough	d						1259	|					
Eccles Road	d						|	|					
Harling Road	d						|	|					
Thetford	d						1313	1324					
Brandon	d						1321	|					
Lakenheath	d						|	|					
Shippea Hill	d						|	|					
Peterborough	d			1242			|	|	1318				1341
Whittlesea	d			|			|	|	|				|
March	d			|			|	|	1334				|
Manea	d			|			|	|	|				|
Ely	a			1314			1338	1345	1352				1413
Ely	d				1326		1338		1352	1358			
Ipswich	a				|		|		|	|			
Waterbeach	d				1336		|		|	|			
Cambridge North	d	1315			|	1347	1351		|	1411	1415		
Cambridge	a	1320			1342	1352	1359		1408	1416	1420		
Cambridge	d	1321	1327						1410		1421	1427	
Stansted Airport	a	|	1400						1440		|	1500	
London Liverpool St	a	1444					*1515*		*1531*		1545		

		GN	GN			EM	XC	GN			EM	GN	GN
		1	1	1	1	◇	1◇	1	1◇	1	◇	1	1
Norwich	d				1340	1357							
Wymondham	d				1352	|							
Spooner Row	d				|	|							
Attleborough	d				1359	|							
Eccles Road	d				|	|							
Harling Road	d				|	|							
Thetford	d				1413	1424							
Brandon	d				1421	|							
Lakenheath	d				|	|							
Shippea Hill	d				|	|							
Peterborough	d			1350	|	|	1418				1441		
Whittlesea	d			1358	|	|	|				|		
March	d			1409	|	|	1434				|		
Manea	d			1417	|	|	|				|		
Ely	a			1431	1438	1445	1452				1513		
Ely	d	1425		1432	1438		1452	1458				1525	1532
Ipswich	a	|		1528	|		|	|				|	|
Waterbeach	d	1435			|		|	|				1535	1542
Cambridge North	d	|	1447		1451		|	1511	1515			|	1547
Cambridge	a	1441	1452		1500		1508	1515	1521			1541	1553
Cambridge	d						1510		1521	1527			
Stansted Airport	a						1540		|	1600			
London Liverpool St	a		*1615*				*1633*		1644			*1716*	

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Mondays to Fridays

		EM	XC		GN	EM	GN	GN			EM	XC
		1	◇	1◇	1◇	1	◇	1	1	1	1	◇	1◇
Norwich d	1440	1457								1540	1548	
Wymondham d	1452									1552		
Spooner Row d												
Attleborough d	1459									1559	1605	
Eccles Road d											1610	
Harling Road d											1614	
Thetford d	1513	1524								1613	1623	
Brandon d	1521									1621		
Lakenheath d												
Shippea Hill d												
Peterborough d			1518			1540			1550			1618
Whittlesea d									1558			
March d			1534						1609			1634
Manea d									1617			
Ely a	1538	1545	1552			1613			1631	1638	1644	1652
Ely d	1538		1552		1605		1625		1632	1638		1652
Ipswich a									1728			
Waterbeach d					1615							
Cambridge North d	1551			1615			1638	1647		1651		
Cambridge a	1559		1608	1620	1623		1642	1652		1659		1708
Cambridge d			1610	1621								1710
Stansted Airport a			1640									1740
London Liverpool St a			*1732*	1744	*1746*		*1816*					*1838*

	GN		GN	EM	GN	GN		EM	GN	XC	GN	GN
	1	1◇	1	◇	1	1	1	◇	1	1◇	1	1
Norwich d							1638	1657				
Wymondham d							1650	1709				
Spooner Row d							1654x					
Attleborough d							1659					
Eccles Road d												
Harling Road d												
Thetford d							1713	1727				
Brandon d							1721					
Lakenheath d												
Shippea Hill d												
Peterborough d				1641						1718		
Whittlesea d										1726		
March d										1737		
Manea d										1745		
Ely a				1713			1738	1748		1758		
Ely d	1658		1709		1726		1738		1755	1759	1808	
Ipswich a												
Waterbeach d			1718								1817	
Cambridge North d	1711	1715			1739	1747	1751		1808			1847
Cambridge a	1715	1720	1725		1743	1752	1759		1812	1816	1824	1854
Cambridge d		1721								1818		
Stansted Airport a										1854		
London Liverpool St a		1845			*1916*					*1945e*	*2015*	

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Mondays to Fridays

		EM			EM	XC	GN		GN	EM	XC		EM
		◇	1	1	◇	1◇	1	1◇	1	◇	1◇	1	◇
Norwich	d			1735	1754							1840	1857
Wymondham	d			1747	1806							1852	|
Spooner Row	d			|	|							|	|
Attleborough	d			1754	1813							1859	|
Eccles Road	d			1759	|							|	|
Harling Road	d			1803	|							|	|
Thetford	d			1813	1827							1913	1924
Brandon	d			1821	|							1921	|
Lakenheath	d			|	|							|	|
Shippea Hill	d			|	|							|	|
Peterborough	d	1744	1750	|	|	1818				1845	1859	|	|
Whittlesea	d	|	1758	|	|	|				|	|	|	|
March	d	|	1809	|	|	1834				1900	1915	|	|
Manea	d	|	1817	|	|	|				|	|	|	|
Ely	a	1817	1831	1838	1848	1852				1919	1933	1938	1948
Ely	d		1832	1838		1852	1858		1908		1934	1938	
Ipswich	a		1928	|		|	|		|		|	|	
Waterbeach	d			|		|	|		1917		|	|	
Cambridge North	d			1851		|	1911	1915	|		|	1951	
Cambridge	a			1901		1908	1915	1920	1924		1952	1959	
Cambridge	d					1910		1921					
Stansted Airport	a					1940		|					
London Liverpool St	a					*2033*		2045				*2114*	

		XC		GN	GN	GN	EM			XC	GN		GN
		1◇	1◇	1	1	1	◇	1		1◇	1	1◇	1
Norwich	d								1937				
Wymondham	d								1950				
Spooner Row	d								|				
Attleborough	d								1957				
Eccles Road	d								|				
Harling Road	d								|				
Thetford	d								2012				
Brandon	d								2020				
Lakenheath	d								|				
Shippea Hill	d								|				
Peterborough	d	1918					1942	1950	|	2018			
Whittlesea	d	|					|	1958	|	|			
March	d	1934					|	2009	|	2034			
Manea	d	|					|	2017	|	|			
Ely	a	1952					2015	2031	2039	2052			
Ely	d	1952		1959	2010			2032	2039	2052	2059		2108
Ipswich	a	|		|	|			2128	|	|	|		|
Waterbeach	d	|		|	2020				|	|	|		2118
Cambridge North	d	|	2007	2012	|	2047			2052	|	2112	2115	|
Cambridge	a	2008	2013	2016	2026	2052			2058	2108	2116	2120	2124
Cambridge	d	2010	2021							2110		2121	
Stansted Airport	a	2039	|							2140		|	
London Liverpool St	a	*2131*	2144			*2214*				*2231*		2245	

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Mondays to Fridays

			GN	XC	GN		GN	EM			XC	GN	
		1	1	1◇	1	1◇	1	◇	1	1	1◇	1	1
Norwich	d								2115				2240
Wymondham	d								2127				2252
Spooner Row	d												
Attleborough	d								2134				2259
Eccles Road	d												
Harling Road	d												
Thetford	d								2148				2313
Brandon	d								2156				2321
Lakenheath	d												
Shippea Hill	d												
Peterborough	d			2116				2139		2145	2218		
Whittlesea	d									2153			
March	d			2132						2204	2236		
Manea	d									2212			
Ely	a			2150				2213	2216	2225	2254		2338
Ely	d		2126	2150	2157		2209		2216	2226	2254	2302	2338
Ipswich	a									2321			
Waterbeach	d						2219					2312	
Cambridge North	d		2139		2210	2215			2229			2317	2351
Cambridge	a		2143	2203	2214	2220	2225		2235		2310	2321	2359
Cambridge	d	2127		2210		2221							
Stansted Airport	a	2200		2252									
London Liverpool St	a		*2315*			2348			*0018*				

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Norwich, Peterborough and Ely to Cambridge

Saturdays

		XC	XC	GN			XC	GN	GN		EM	EM	
		1	1	1	1	1◇	1	1	1	1	◇	◇	1
Norwich	d									0537	0550		
Wymondham	d									0549	0602		
Spooner Row	d												
Attleborough	d									0556	0609		
Eccles Road	d												
Harling Road	d												
Thetford	d									0610	0623		
Brandon	d									0618			
Lakenheath	d												
Shippea Hill	d												
Peterborough	d											0627	
Whittlesea	d												
March	d											0643	
Manea	d												
Ely	a									0635	0644	0701	
Ely	d			0526				0625		0635			
Ipswich	a												
Waterbeach	d			0536				0635					
Cambridge North	d			0541		0615		0640	0644	0648			
Cambridge	a			0545		0620		0644	0649	0656			
Cambridge	d	0456	0542		0610	0621	0640						0710
Stansted Airport	a	0520	0608		0641		0708						0741
London Liverpool St	a			*0714*		0744				*0814*			

			XC	GN	GN		EM	XC	EM			GN	GN
		1◇	1	1	1	1	◇	1◇	◇	1◇	1	1	1
Norwich	d					0640	0653						
Wymondham	d					0652							
Spooner Row	d												
Attleborough	d					0659							
Eccles Road	d												
Harling Road	d												
Thetford	d					0713	0722						
Brandon	d					0721							
Lakenheath	d												
Shippea Hill	d												
Peterborough	d							0712	0735				
Whittlesea	d							0720					
March	d							0731	0751				
Manea	d							0738					
Ely	a					0738	0745	0752	0811				
Ely	d			0726		0738		0752	0814			0825	
Ipswich	a												
Waterbeach	d			0736								0835	
Cambridge North	d	0715			0747	0751				0815			0847
Cambridge	a	0720		0742	0752	0759		0808		0820		0841	0852
Cambridge	d	0721	0740					0810		0821	0826		
Stansted Airport	a		0808					0839			0900		
London Liverpool St	a	0844				*0914*		*0931*		0944			

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Saturdays

Station				EM	XC	GN			GN	EM	GN		EM
			1	1	◇	1◇	1	1◇	1	1	◇	1	1	◇
Norwich	d		0740	0757								0840	0857
Wymondham	d		0752									0852	
Spooner Row	d												
Attleborough	d		0759									0859	
Eccles Road	d												
Harling Road	d												
Thetford	d		0813	0824								0913	0924
Brandon	d		0821									0921	
Lakenheath	d												
Shippea Hill	d												
Peterborough	d	0750			0818					0858			
Whittlesea	d	0758											
March	d	0809			0834								
Manea	d	0817											
Ely	a	0831	0838	0845	0852					0931		0938	0945
Ely	d	0832	0838		0852	0859			0925			0938	
Ipswich	a	0928											
Waterbeach	d								0935				
Cambridge North	d		0851			0911	0915				0947	0951	
Cambridge	a		0859		0908	0915	0921		0941		0952	0959	
Cambridge	d				0910		0921	0926					
Stansted Airport	a				0940			1000					
London Liverpool St	a		*1014*		*1031*		1044					*1114*	

Station		XC	GN			EM	GN	GN			EM	XC	GN
		1◇	1	1◇	1	◇	1	1	1	1	◇	1◇	1
Norwich	d									0938	0957		
Wymondham	d									0950			
Spooner Row	d												
Attleborough	d									0957			
Eccles Road	d												
Harling Road	d												
Thetford	d									1011	1024		
Brandon	d									1019			
Lakenheath	d									1024x			
Shippea Hill	d												
Peterborough	d	0918				0943			0950			1018	
Whittlesea	d								0958				
March	d	0934							1009			1034	
Manea	d								1017				
Ely	a	0951				1016			1031	1038	1045	1052	
Ely	d	0952	0956				1025		1032	1038		1052	1058
Ipswich	a								1128				
Waterbeach	d						1035						
Cambridge North	d		1009	1015				1047		1051			1111
Cambridge	a	1008	1013	1020			1041	1052		1059		1107	1115
Cambridge	d	1010		1021	1026							1110	
Stansted Airport	a	1040			1100							1140	
London Liverpool St	a	*1131*		1144						*1214*		*1231*	

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Saturdays

				EM	GN	GN		EM	XC	GN			EM
		1◇	1	◇	1	1	1	◇	1◇	1	1◇	1	◇
Norwich	d						1040	1057					
Wymondham	d						1052						
Spooner Row	d												
Attleborough	d						1059						
Eccles Road	d												
Harling Road	d												
Thetford	d						1113	1124					
Brandon	d						1121						
Lakenheath	d												
Shippea Hill	d												
Peterborough	d			1040					1118				1141
Whittlesea	d												
March	d								1134				
Manea	d												
Ely	a			1113			1138	1146	1151				1213
Ely	d				1125		1138		1152	1158			
Ipswich	a												
Waterbeach	d				1135								
Cambridge North	d	1115				1147	1151			1211	1215		
Cambridge	a	1120			1141	1152	1159		1208	1215	1220		
Cambridge	d	1121	1126						1210		1221	1226	
Stansted Airport	a		1200						1240			1300	
London Liverpool St	a	1244					*1314*		*1331*		1344		

		GN	GN			EM	XC	GN			EM	GN	GN
		1	1	1	1	◇	1◇	1	1◇	1	◇	1	1
Norwich	d				1140	1157							
Wymondham	d				1152								
Spooner Row	d												
Attleborough	d				1159								
Eccles Road	d												
Harling Road	d												
Thetford	d				1213	1224							
Brandon	d				1221								
Lakenheath	d												
Shippea Hill	d												
Peterborough	d			1150			1218				1240		
Whittlesea	d			1158									
March	d			1209			1234						
Manea	d			1217									
Ely	a			1231	1238	1245	1252				1313		
Ely	d	1225		1232	1238		1252	1258				1325	
Ipswich	a			1328									
Waterbeach	d	1235										1335	
Cambridge North	d		1247		1251			1311	1315				1347
Cambridge	a	1241	1252		1259		1308	1315	1320			1341	1352
Cambridge	d						1310		1321	1326			
Stansted Airport	a						1340			1400			
London Liverpool St	a				*1414*		*1431*		1444				

For reference to notes, please see page 3-4

Norwich, Peterborough and Ely to Cambridge

Saturdays

Station													
			EM	XC	GN			EM	GN	GN			EM
		1	◇	1◇	1	1◇	1	◇	1	1	1	1	◇
Norwich	d	1240	1257									1340	1357
Wymondham	d	1252										1352	
Spooner Row	d												
Attleborough	d	1259										1359	
Eccles Road	d												
Harling Road	d												
Thetford	d	1313	1324									1413	1424
Brandon	d	1321										1421	
Lakenheath	d												
Shippea Hill	d												
Peterborough	d			1318				1340			1350		
Whittlesea	d										1358		
March	d			1334							1409		
Manea	d										1417		
Ely	a	1338	1345	1352				1413			1431	1438	1445
Ely	d	1338		1352	1358				1425		1432	1438	
Ipswich	a										1528		
Waterbeach	d								1435				
Cambridge North	d	1351			1411	1415				1447		1451	
Cambridge	a	1359		1408	1415	1420			1441	1452		1459	
Cambridge	d			1410		1421	1426						
Stansted Airport	a			1440			1500						
London Liverpool St	a	*1514*		*1531*		1544						*1614*	

Station													
		XC	GN			EM	GN	GN		EM	XC	GN	
		1◇	1	1◇	1	◇	1	1	1	◇	1◇	1	1◇
Norwich	d								1440	1457			
Wymondham	d								1452				
Spooner Row	d												
Attleborough	d								1459				
Eccles Road	d												
Harling Road	d												
Thetford	d								1513	1524			
Brandon	d								1521				
Lakenheath	d												
Shippea Hill	d												
Peterborough	d	1418				1443					1518		
Whittlesea	d												
March	d	1434									1534		
Manea	d												
Ely	a	1452				1518			1538	1545	1552		
Ely	d	1452	1458				1525		1538		1552	1558	
Ipswich	a												
Waterbeach	d						1535						
Cambridge North	d		1511	1515				1547	1551			1611	1615
Cambridge	a	1508	1515	1520			1541	1552	1559		1608	1615	1620
Cambridge	d	1510		1521	1526						1610		1621
Stansted Airport	a	1540			1600						1640		
London Liverpool St	a	*1631*		1644					*1714*		*1731*		1744

For reference to notes, please see page 3-4

10

Norwich, Peterborough and Ely to Cambridge

Saturdays

			EM	GN	GN			EM	XC	GN			EM
		1	◇	1	1	1	1	◇	1◇	1	1◇	1	◇
Norwich	d						1535	1552					
Wymondham	d						1547	|					
Spooner Row	d						|	|					
Attleborough	d						1554	1609					
Eccles Road	d						1559	|					
Harling Road	d						1603	|					
Thetford	d						1613	1623					
Brandon	d						1621	|					
Lakenheath	d						|	|					
Shippea Hill	d						|	|					
Peterborough	d		1541			1550	|	|	1618				1639
Whittlesea	d		|			1558	|	|	|				|
March	d		|			1609	|	|	1634				|
Manea	d		|			1617	|	|	|				|
Ely	a		1613			1631	1638	1645	1652				1713
Ely	d			1625		1632	1638		1652	1658			
Ipswich	a			|		1728	|		|	|			
Waterbeach	d			1635			|		|	|			
Cambridge North	d			|	1647		1651		|	1711	1715		
Cambridge	a			1641	1652		1659		1708	1715	1720		
Cambridge	d	1626							1710		1721	1726	
Stansted Airport	a	1700							1740		|	1800	
London Liverpool St	a						*1814*		*1831*		1844		

		GN	GN		EM	GN	XC			EM	GN	GN	
		1	1	1	◇	1	1◇	1◇	1	◇	1	1	1
Norwich	d			1638	1654								
Wymondham	d			1650	1706								
Spooner Row	d			1654x	|								
Attleborough	d			1659	|								
Eccles Road	d			|	|								
Harling Road	d			|	|								
Thetford	d			1713	1724								
Brandon	d			1721	|								
Lakenheath	d			|	|								
Shippea Hill	d			|	|								
Peterborough	d			|	|		1718			1740			1750
Whittlesea	d			|	|		1726			|			1758
March	d			|	|		1737			|			1809
Manea	d			|	|		1745			|			1817
Ely	a			1738	1745		1800			1813			1831
Ely	d	1725		1738		1754	1800				1825		1832
Ipswich	a	|		|		|	|				|		1928
Waterbeach	d	1735		|		|	|				1835		
Cambridge North	d	|	1747	1751		1807	|	1815			|	1847	
Cambridge	a	1741	1752	1759		1811	1815	1820			1841	1852	
Cambridge	d						1817	1821	1826				
Stansted Airport	a						1853	|	1900				
London Liverpool St	a			*1914*				1944					

For reference to notes, please see page 3-4

Norwich, Peterborough and Ely to Cambridge

Saturdays

				EM	XC	GN		GN		EM	GN		EM	XC
			1	◇	1◇	1	1◇	1	1	◇	1	1	◇	1◇
Norwich	🚌	d	1735	1750								1838	1857	
Wymondham		d	1747	1802								1850		
Spooner Row		d												
Attleborough		d	1754	1809								1857		
Eccles Road		d	1759											
Harling Road		d	1803											
Thetford		d	1813	1823								1911	1924	
Brandon		d	1821									1919		
Lakenheath		d												
Shippea Hill		d										1927x		
Peterborough	🚌	d			1818					1844				1918
Whittlesea		d												
March		d			1834					1901				1934
Manea		d												
Ely	🚌	a	1838	1845	1852					1919		1938	1945	1952
Ely	🚌	d	1838		1852	1859		1906				1938		1952
Ipswich	🚌	a												
Waterbeach		d						1916						
Cambridge North	🚌	d	1851			1912	1915				1947	1951		
Cambridge	🚌	a	1859		1908	1916	1920	1923			1952	1959		2008
Cambridge	🚌	d			1910		1921		1926					2010
Stansted Airport	✈	a			1940				2000					2040
London Liverpool St	⊖	a	*2014*		*2031*		2044					*2114*		*2131*

				GN		EM	GN			XC		GN		GN
			1◇	1	1	◇	1	1	1	1◇	1◇	1	1	1
Norwich	🚌	d							1940					
Wymondham		d							1952					
Spooner Row		d												
Attleborough		d							1959					
Eccles Road		d												
Harling Road		d												
Thetford		d							2013					
Brandon		d							2021					
Lakenheath		d												
Shippea Hill		d												
Peterborough	🚌	d				1941		1950		2018				
Whittlesea		d						1958						
March		d						2009		2034				
Manea		d						2017						
Ely	🚌	a				2014		2032	2038	2052				
Ely	🚌	d		2006				2032	2038	2052		2106		
Ipswich	🚌	a						2128						
Waterbeach		d		2016								2116		
Cambridge North	🚌	d	2015				2047		2051		2115			2147
Cambridge	🚌	a	2020	2023			2052		2059	2108	2120	2123		2152
Cambridge	🚌	d	2021		2026					2110	2121		2126	
Stansted Airport	✈	a			2100					2140			2200	
London Liverpool St	⊖	a	2144						*2214*	*2231*	2244			*2314*

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Saturdays

		XC		GN		EM		XC	GN		GN
		1◇	1◇	1	1	◇	1	1◇	1	1	1
Norwich	d				2110					2240	
Wymondham	d				2122					2252	
Spooner Row	d										
Attleborough	d				2129					2259	
Eccles Road	d										
Harling Road	d										
Thetford	d				2143					2313	
Brandon	d				2151					2321	
Lakenheath	d										
Shippea Hill	d										
Peterborough	d	2118				2140	2145	2214			
Whittlesea	d						2153				
March	d	2134					2204	2229			
Manea	d						2212				
Ely	a	2152			2210	2213	2225	2247		2338	
Ely	d	2152		2206	2210		2226	2248	2257	2338	2343
Ipswich	a						2322				
Waterbeach	d			2216					2307		2352
Cambridge North	d		2215		2223					2351	2357
Cambridge	a	2208	2220	2223	2231			2303	2313	2359	0001
Cambridge	d	2210	2221								
Stansted Airport	a	2240									
London Liverpool St	a	*2331*	2344		*0014*						

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Sundays

				XC	GN			XC	GN				XC
		1	1	1	1	1	1◇	1	1	1	1	1◇	1
Norwich	d									0903			
Wymondham	d									0915			
Spooner Row	d												
Attleborough	d									0922			
Eccles Road	d												
Harling Road	d												
Thetford	d									0936			
Brandon	d									0944			
Lakenheath	d									0949x			
Shippea Hill	d												
Peterborough	d												
Whittlesea	d												
March	d												
Manea	d												
Ely	a									1003			
Ely	d				0858				0958	1003			
Ipswich	a												
Waterbeach	d				0908				1008				
Cambridge North	d						0944			1016		1044	
Cambridge	a				0915		0949		1015	1022		1049	
Cambridge	d	0739	0824	0915		0924	0951	1015			1024	1051	1115
Stansted Airport	a	0809	0854	0945		1000		1045			1100		1145
London Liverpool St	a				*1043*		1114			*1143*		1214	

		GN			EM		XC	GN				XC	
		1	1	1	◇	1◇	1	1	1	1	1◇	1	1
Norwich	d		1003		1047				1103				
Wymondham	d		1015						1115				
Spooner Row	d												
Attleborough	d		1022						1122				
Eccles Road	d												
Harling Road	d												
Thetford	d		1036		1114				1136				
Brandon	d		1044						1144				
Lakenheath	d								1149x				
Shippea Hill	d												
Peterborough	d												1150
Whittlesea	d												1158
March	d												1209
Manea	d												
Ely	a		1101		1135				1203				1231
Ely	d	1058	1103					1158	1203				1232
Ipswich	a												1328
Waterbeach	d	1108						1208					
Cambridge North	d		1116			1144			1216		1244		
Cambridge	a	1115	1122			1149		1215	1222		1249		
Cambridge	d			1124		1151	1215			1224	1251	1315	
Stansted Airport	a			1200			1245			1300		1345	
London Liverpool St	a		*1243*			1314			*1343*		1414		

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Sundays

		GN				XC	GN			EM			EM
		1	1	1	1◇	1◇	1	1	1	◇	1	1◇	◇
Norwich	d		1203					1303					1347
Wymondham	d		1215					1315					
Spooner Row	d												
Attleborough	d		1222					1322					
Eccles Road	d												
Harling Road	d												
Thetford	d		1236					1336					1414
Brandon	d		1244					1344					
Lakenheath	d												
Shippea Hill	d												
Peterborough	d					1318				1343	1350		
Whittlesea	d										1358		
March	d					1334					1409		
Manea	d												
Ely	a		1301			1351		1401		1416	1431		1436
Ely	d	1258	1303			1352	1358	1403			1432		
Ipswich	a										1528		
Waterbeach	d	1308					1408						
Cambridge North	d		1316		1344			1416				1444	
Cambridge	a	1315	1322		1349	1408	1415	1422				1449	
Cambridge	d			1324	1351	1410			1424			1451	
Stansted Airport	a			1400		1445			1500				
London Liverpool St	a		*1443*		1514			*1543*				1614	

		XC	GN				EM	EM	XC	GN			EM
		1◇	1	1	1	1◇	◇	◇	1◇	1	1	1	◇
Norwich	d			1403				1453			1503		1554
Wymondham	d			1415							1515		
Spooner Row	d												
Attleborough	d			1422							1522		
Eccles Road	d												
Harling Road	d												
Thetford	d			1436				1520			1536		1621
Brandon	d			1444							1544		
Lakenheath	d										1549x		
Shippea Hill	d												
Peterborough	d	1418					1458		1518				
Whittlesea	d												
March	d	1434							1534				
Manea	d												
Ely	a	1452		1501			1531	1543	1552		1603		
Ely	d	1452	1458	1503					1552	1558	1603		
Ipswich	a												
Waterbeach	d		1508							1608			
Cambridge North	d			1516		1544					1616		
Cambridge	a	1508	1515	1522		1549			1608	1615	1622		
Cambridge	d	1510			1524	1551			1610			1624	
Stansted Airport	a	1545			1600				1645			1700	
London Liverpool St	a			*1643*		1714					*1743*		

For reference to notes, please see page 3-4

Norwich, Peterborough and Ely to Cambridge

Sundays

				EM	XC	GN				EM	EM	XC	GN
		1	1◇	◇	1◇	1	1	1	1◇	◇	◇	1◇	1
Norwich	d						1603				1654		
Wymondham	d						1615				|		
Spooner Row	d						|				|		
Attleborough	d						1622				|		
Eccles Road	d						|				|		
Harling Road	d						|				|		
Thetford	d						1636				1721		
Brandon	d						1644				|		
Lakenheath	d						|				|		
Shippea Hill	d						|				|		
Peterborough	d	1547		1558	1618		|			1659	|	1718	
Whittlesea	d	1555		|	|		|			|	|	|	
March	d	1606		|	1634		|			|	|	1734	
Manea	d	|		|	|		|			|	|	|	
Ely	a	1625		1631	1652		1701			1732	1745	1752	
Ely	d	1629			1652	1658	1703					1752	1758
Ipswich	a	1725			|	|	|					|	|
Waterbeach	d				|	1708	|					|	1808
Cambridge North	d		1644		|	|	1716		1744			|	|
Cambridge	a		1649		1708	1715	1722		1749			1808	1815
Cambridge	d		1651		1710			1724	1751			1810	
Stansted Airport	a		|		1745			1800	|			1845	
London Liverpool St	a		1814				*1843*		1914				

				GN			EM	EM	XC	GN			EM
		1	1	1	1◇	1	◇	◇	1◇	1	1	1	◇
Norwich	d	1703						1754			1803		
Wymondham	d	1715						|			1815		
Spooner Row	d	|						|			|		
Attleborough	d	1722						|			1822		
Eccles Road	d	|						|			|		
Harling Road	d	|						|			|		
Thetford	d	1736						1821			1836		
Brandon	d	1744						|			1844		
Lakenheath	d	|						|			|		
Shippea Hill	d	|						|			|		
Peterborough	d	|				1745	1757	|	1818		|		1849
Whittlesea	d	|				1753	|	|	|		|		|
March	d	|				1804	1813	|	1834		|		|
Manea	d	|				|	|	|	|		|		|
Ely	a	1801				1823	1832	1844	1852		1901		1922
Ely	d	1803		1826		1829			1852	1858	1903		
Ipswich	a	|		|		1925			|	|	|		
Waterbeach	d	|		|					|	1908	|		
Cambridge North	d	1816		|	1844				|	|	1916		
Cambridge	a	1822		1840	1849				1908	1915	1922		
Cambridge	d		1824		1851				1910			1924	
Stansted Airport	a		1900		|				1945			2000	
London Liverpool St	a	*1943*			2014						*2043*		

For reference to notes, please see page 3-4

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Norwich, Peterborough and Ely to Cambridge

Sundays

				EM	XC	GN			EM		XC	GN		
			■◇	◇	■◇	■	■	■	◇	■◇	■◇	■	■	■
Norwich	🚌	d		1856									2003	
Wymondham		d											2015	
Spooner Row		d												
Attleborough		d											2022	
Eccles Road		d												
Harling Road		d												
Thetford		d		1923									2036	
Brandon		d											2044	
Lakenheath		d												
Shippea Hill		d												
Peterborough	🚌	d			1918			1947	1959		2018			
Whittlesea		d						1955						
March		d			1934			2006			2034			
Manea		d												
Ely	🚌	a		1944	1952			2025	2032		2052		2101	
Ely	🚌	d			1952	1958		2029			2052	2058	2103	
Ipswich	🚌	a						2125						
Waterbeach		d				2008						2108		
Cambridge North	🚌	d	1944							2044			2116	
Cambridge	🚌	a	1949		2007	2015				2049	2107	2115	2122	
Cambridge	🚌	d	1951		2010		2024			2051	2110			2124
Stansted Airport	✈	a			2045		2054				2145			2200
London Liverpool St	⊖	a	2114			*2143*				2214			*2243*	

				EM	XC	GN	EM		XC	GN	
			■	◇	■◇	■	◇	■	■◇	■	■
Norwich	🚌	d		2052							2203
Wymondham		d									2215
Spooner Row		d									
Attleborough		d									2222
Eccles Road		d									
Harling Road		d									
Thetford		d		2119							2236
Brandon		d									2244
Lakenheath		d									
Shippea Hill		d									
Peterborough	🚌	d			2118		2154		2216		
Whittlesea		d									
March		d			2134				2232		
Manea		d									
Ely	🚌	a		2140	2152		2227		2251		2301
Ely	🚌	d			2152	2158			2251	2258	2303
Ipswich	🚌	a									
Waterbeach		d				2208				2308	
Cambridge North	🚌	d	2144					2244			2316
Cambridge	🚌	a	2149		2207	2215		2249	2306	2314	2322
Cambridge	🚌	d	2151		2210						
Stansted Airport	✈	a			2245						
London Liverpool St	⊖	a	*2316f*			*2343*		*0022f*			

For reference to notes, please see page 3-4

13 West Anglia

Train timetable
Valid from 10 December 2017

Kings Lynn and Ely to
London Liverpool Street direct services

greateranglia

Notes and symbols

Generic notes and symbols

Bold Times in bold are direct services operated by Greater Anglia
Italic Times in italics are connecting train services with one change of train
Other connections may be available with further changes

0640 For the comfort and safety of all passengers, only folded cycles can be accommodated during busy times. Trains that these conditions apply to are highlighted throughout this timetable

- 1 First Class accommodation available
- ◇ Seat reservations possible
- PlusBus operates from this station
- ✈ Airport interchange
- DLR Interchange with Docklands Light Railway
- ⊖ Interchange with London Underground
- Train continues in later column
- Train continued from earlier column

- a Arrival time
- d Departure time
- u Stops to pick up only

- FO Fridays only
- FX Mondays to Thursdays only
- MFO Mondays and Fridays only
- MThF Mondays, Thursdays and Fridays only
- TWO Tuesdays and Wednesdays only
- TWTh Tuesdays, Wednesdays and Thursdays only

All services are operated by Greater Anglia unless otherwise shown below:

XC Operated by CrossCountry
Table 12: XC trains are included to show the full service available between Stansted Airport, Audley End and Cambridge. These times are correct at time of going to press but Greater Anglia cannot be held responsible for them

11 Hertford East and Broxbourne to London Liverpool Street

- A Continues to Stansted Airport
- B Continues to Cambridge
- C Continues to Bishop's Stortford
- D Continues to Cambridge North
- E Continues to Ely
- F Continues to Kings Lynn
- G Continues to Bishop's Stortford (Mondays to Thursdays) and Cambridge (Fridays)

12 Cambridge and Stansted Airport to London Liverpool Street

- b The 1105 from Stansted Airport arrives 1142, the 1405 from Stansted arrives 1442
- A Continues to Birmingham New Street
- B Continues to Ely
- C Continues to Kings Lynn

14 Bishop's Stortford to Stratford

- A Continues to London Liverpool Street
- B Continues to Cambridge North

13

Kings Lynn and Ely to London Liverpool Street direct services

Mondays to Fridays

		1◇	1◇	1◇	1◇
Kings Lynn	d	0517	0617		
Watlington	d	0524	0624		
Downham Market	d	0531	0631		
Littleport	d	0540	0640		
Ely	a	0549	0649		
Ely	d	0550	0650	0730	0800
Waterbeach	d	0559	0659	|	0809
Cambridge	a	0610	0710	0747	0820
Cambridge	d	0618	0717	0751	0821
Shelford	d	|	|	0756	0826
Whittlesford Parkway	d	0625	0725	0800	0831
Great Chesterford	d	|	|	0804	0835
Audley End	d	0634	0734	0810	0840
Newport (Essex)	d	|	|	0813	0843
Elsenham	d	|	|	0819	0849
Stansted Mountfitchet	d	|	|	0822	0853
Bishops Stortford	d	0647	0747	0828	0858
Sawbridgeworth	d	|	|	0833	0903
Harlow Mill	d	|	|	0836	0906
Harlow Town	d	|	|	0840	0910
Roydon	d	|	|	0844	0914
Broxbourne	d	|	|	0848	0918
Cheshunt	d	|	|	0853	0923
Tottenham Hale ⊖	d	0708	0808	0902	0932
London Liverpool St ⊖	a	0725	0825	0920	0950

London Liverpool Street to Ely and Kings Lynn direct services

Mondays to Fridays

		1◇	1◇	1◇	1◇
London Liverpool St ⊖	d	1558	1707	1807	1907
Tottenham Hale ⊖	d	1610	1719	1819	1919
Cheshunt	d	1618	|	|	|
Broxbourne	d	1623	|	|	|
Roydon	d	1627	|	|	|
Harlow Town	d	1631	|	|	|
Harlow Mill	d	1634	|	|	|
Sawbridgeworth	d	1638	|	|	|
Bishops Stortford	d	1644	1744	1844	|
Stansted Mountfitchet	d	1648	|	|	|
Elsenham	d	1652	|	|	|
Newport (Essex)	d	1657	|	|	|
Audley End	d	1700	1756	1856	1956
Great Chesterford	d	1705	|	|	|
Whittlesford Parkway	d	1710	1804	1904	2003
Shelford	d	1714	|	|	|
Cambridge	a	1720	1815	1916	2013
Cambridge	d	1721	1817	1919	2014
Waterbeach	d	1730	1823	1925	2020
Ely	a	1742	1833	1935	2030
Ely	d		1833	1935	2030
Littleport	d		1840	1942	2037
Downham Market	d		1850	1952	2047
Watlington	d		1856	1958	2053
Kings Lynn	a		1908	2010	2105

0640 Cycle restrictions apply. See page 2 for details

For reference to notes, please see page 2

Appendix F – Passenger Survey Data

traffic survey partners

Client:	WSP
Project Number:	TSP13548
Project Name:	Station Road, Waterbeach, Cambridge
Survey Type:	Station Survey
Survey Date:	31 October 2017, Tuesday
Survey Time:	05:00 - 22:00
Weather:	Dry
Comments:	

Project Number: **TSP13548**
Project Name: **Station Road, Waterbeach, Cambridge**
Survey Type: **Station Survey**
Site No: **1**
Location: **Waterbeach Railway Station**
Date: **31 October 2017, Tuesday**

traffic survey partners

No	Time	Destination	Platform	Boarding					Alighting				
				Pssngrs	with Bike	with Pushch	with Wheelch	Total	Pssngrs	with Bike	with Pushch	with Wheelch	Total
1	05:35	Kings Cross	1	12	2			14	1				1
2	05:59	Liverpool Street	1	10	1			11	0				0
3	06:32	Kings Cross	1	35	7			42	5	2			7
4	06:48	Kings Cross	1	17	4			21	5				5
5	06:59	Liverpool Street	1	19	6			25	3				3
6	07:32	Kings Cross	1	79	14	2		95	4				4
7	08:02	Kings Cross	1	72	10			82	4				4
8	08:09	Liverpool Street	1	51	4			55	2				2
9	08:36	Kings Cross	1	62	5			67	39	4			43
10	09:08	Kings Cross	1	36	2			38	3				3
11	09:41	Kings Cross	1	29	3			32	4	1		1	6
12	09:59	Kings Cross	1	11				11	0				0
13	10:40	Kings Cross	1	29	1	1		31	0				0
14	11:38	Kings Cross	1	11				11	2				2
15	12:40	Kings Cross	1	6		1		7	1				1
16	13:36	Kings Cross	1	6				6	2	1			3
17	14:39	Kings Cross	1	8	1			9	1				1
18	15:35	Kings Cross	1	7				7	0				0
19	15:42	Kings Cross	1	4				4	0				0
20	16:15	Kings Cross	1	20		1		21	5				5
21	17:22	Kings Cross	1	23	3			26	7				7
22	18:17	Kings Cross	1	9				9	4				4
23	19:17	Kings Cross	1	6				6	5	1			6
24	20:26	Kings Cross	1	5				5	1				1
25	21:20	Kings Cross	1	6				6	3		1		4
26	06:25	Kings Lynn	2	3				3	8	3			11
27	07:03	Kings Lynn	2	0				0	2				2
28	07:41	Kings Lynn	2	6	1			7	11	1			12
29	08:12	Kings Lynn	2	4				4	12	2			14
30	08:44	Kings Lynn	2	4				4	8				8
31	09:44	Kings Lynn	2	3				3	8				8
32	10:41	Kings Lynn	2	3				3	4				4
33	11:46	Kings Lynn	2	2				2	9	1			10
34	12:41	Kings Lynn	2	1		1		2	8				8
35	13:41	Kings Lynn	2	0				0	7				7
36	14:41	Kings Lynn	2	3				3	15		1		16
37	15:37	Ely	2	1				1	23				23
38	15:41	Kings Lynn	2	0				0	9	1			10
39	15:57	Ely	2	3				3	17				17
40	16:26	Downham Market	2	6				6	35	7			42
41	16:42	Kings Lynn	2	48	5			53	38	9			47
42	17:30	Ely	2	7				7	60	13			73
43	17:48	Kings Lynn	2	7				7	48	7			55
44	18:23	Kings Lynn	2	3				3	39	5			44
45	18:30	Ely	2	0				0	3				3
46	18:46	Kings Lynn	2	1				1	59				59
47	19:25	Kings Lynn	2	3				3	32	3			35
48	19:46	Kings Lynn	2	0				0	18	2			20
49	20:26	Kings Lynn	2	0				0	19				19
50	20:55	Kings Lynn	2	1				1	13				13
51	21:18	Kings Lynn	2	2				2	8				8

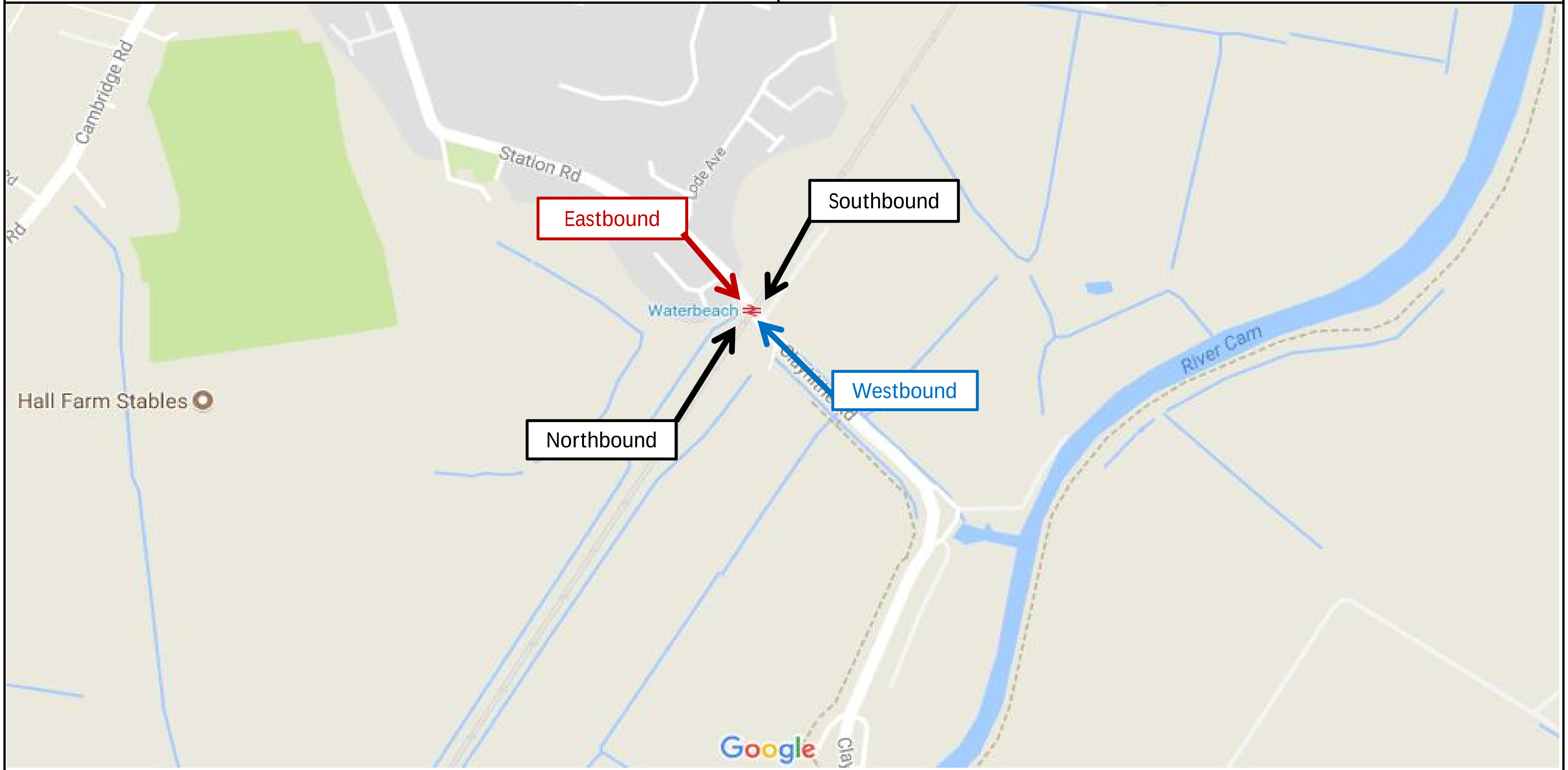
Appendix G – Level Crossing Survey

Tracsis plc
Traffic and Data Services

Client:	**WSP**
Project:	**Level Crossing Census - Waterbeach**
Site:	**Site X - Clayhithe Road Level Crossing**
Survey Date:	**Saturday 8th - Sunday 16th July 2017**
Survey Period:	**06:00 - 24:00**
Method:	**Video Observation**

Tracsis plc
Traffic and Data Services

Client :	WSP	**Site plan for :**	Site X - Clayhithe Road Level Crossing
Project :	Level Crossing Census - Waterbeach	**Date :**	Saturday 8th - Sunday 16th July 2017



Tracsis plc – Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Clayhithe Road Level Crossing
Date: Saturday 8th July 2017
AM Weather : Dry, Cloudy
PM Weather : Dry, Sunny

Linkcount

Direction : Eastbound

Time	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	4	0	0	0	0	0	0	0	0	0	4
06:15	4	2	0	0	0	0	0	0	0	0	6
06:30	4	1	0	0	0	0	0	0	0	0	5
06:45	13	2	0	0	0	0	0	0	0	0	15
1 Hr	25	5	0	0	0	0	0	0	0	0	30
07:00	10	2	0	1	0	0	0	3	0	0	16
07:15	15	2	0	0	0	0	0	5	0	0	22
07:30	15	1	1	0	0	0	0	3	0	0	20
07:45	23	2	0	0	0	0	0	1	0	0	26
1 Hr	63	7	1	1	0	0	0	12	0	0	84
08:00	21	2	0	1	0	0	0	2	0	0	26
08:15	43	5	0	0	0	0	0	0	0	0	48
08:30	34	2	0	2	0	0	0	2	0	0	40
08:45	31	3	1	1	0	0	0	0	0	0	36
1 Hr	129	12	1	4	0	0	0	4	0	0	150
09:00	33	1	1	0	0	0	0	3	0	0	38
09:15	35	3	0	2	0	0	0	3	0	0	43
09:30	29	1	0	0	0	0	0	2	0	0	32
09:45	24	1	1	2	0	0	0	1	0	0	29
1 Hr	121	6	2	4	0	0	0	9	0	0	142
10:00	48	5	2	1	0	0	0	0	0	0	56
10:15	34	4	3	1	0	0	0	5	0	0	47
10:30	34	2	1	0	0	0	0	1	0	0	38
10:45	35	4	1	2	0	0	0	0	0	0	42
1 Hr	151	15	7	4	0	0	0	6	0	0	183
11:00	36	2	0	0	0	0	0	0	0	0	38
11:15	37	2	0	1	0	0	0	11	0	0	51
11:30	37	3	0	0	0	0	0	2	0	0	42
11:45	39	2	0	0	0	0	0	8	0	0	49
1 Hr	149	9	0	1	0	0	0	21	0	0	180
6 Hrs	638	54	11	14	0	0	0	52	0	0	769
12:00	26	1	1	0	0	0	0	3	0	0	31
12:15	43	3	1	0	0	0	0	3	0	0	50
12:30	43	4	1	0	0	0	0	7	0	0	55
12:45	40	5	0	0	0	0	0	2	0	0	47
1 Hr	152	13	3	0	0	0	0	15	0	0	183
13:00	31	1	0	0	0	0	0	2	0	0	34
13:15	31	2	0	1	0	0	0	4	0	0	38
13:30	44	1	0	0	0	0	0	3	0	0	48
13:45	35	1	2	1	0	0	0	0	0	0	39
1 Hr	141	5	2	2	0	0	0	9	0	0	159
14:00	35	1	0	0	1	0	0	6	0	0	43
14:15	31	2	0	0	0	0	0	7	0	0	40
14:30	30	1	3	0	0	0	0	5	0	0	39
14:45	26	1	0	0	0	0	0	4	0	0	31
1 Hr	122	5	3	0	1	0	0	22	0	0	153
15:00	23	3	0	2	0	0	0	0	0	0	28
15:15	28	2	2	0	0	0	0	4	0	0	36
15:30	28	0	0	0	0	0	0	6	0	0	34
15:45	29	2	1	0	0	0	0	0	0	0	32
1 Hr	108	7	3	2	0	0	0	10	0	0	130
16:00	23	0	0	0	0	0	0	0	0	0	23
16:15	38	1	0	0	0	0	0	0	0	0	39
16:30	26	2	0	0	0	0	0	1	0	0	29
16:45	22	1	0	0	0	0	0	1	0	0	24
1 Hr	109	4	0	0	0	0	0	2	0	0	115
17:00	20	1	0	1	0	0	0	4	0	0	26
17:15	25	2	0	1	0	0	0	2	0	0	30
17:30	29	0	3	0	0	0	0	1	0	0	33
17:45	13	2	3	1	0	0	0	0	0	0	19
1 Hr	87	5	6	3	0	0	0	7	0	0	108
6 Hrs	719	39	17	7	1	0	0	65	0	0	848
18:00	23	1	0	0	0	0	0	5	0	0	29
18:15	27	1	0	0	0	0	0	4	0	0	32
18:30	25	0	0	0	0	0	0	1	0	0	26
18:45	30	1	1	0	0	0	0	1	0	0	33
1 Hr	105	3	1	0	0	0	0	11	0	0	120
19:00	26	2	0	0	0	0	0	1	0	0	29
19:15	24	0	1	0	0	0	0	2	0	0	27
19:30	22	0	0	0	0	0	0	0	0	0	22
19:45	12	1	0	0	0	0	0	0	0	0	13
1 Hr	84	3	1	0	0	0	0	3	0	0	91
20:00	18	0	0	0	0	0	0	2	0	0	20
20:15	7	1	0	0	0	0	0	0	0	0	8
20:30	3	1	0	0	0	0	0	0	0	0	4
20:45	8	0	0	0	0	0	0	1	0	0	9
1 Hr	36	2	0	0	0	0	0	3	0	0	41
21:00	5	1	0	0	0	0	0	6	0	0	12
21:15	8	0	0	0	0	0	0	0	0	0	8
21:30	10	0	0	1	0	0	0	0	0	0	11
21:45	7	0	0	0	0	0	0	0	0	0	7
1 Hr	30	1	0	1	0	0	0	6	0	0	38
22:00	7	0	0	0	0	0	0	0	0	0	7
22:15	6	0	0	0	0	0	0	0	0	0	6
22:30	6	0	0	0	0	0	0	0	0	0	6
22:45	4	0	0	0	0	0	0	0	0	0	4
1 Hr	23	0	0	0	0	0	0	0	0	0	23
23:00	1	0	0	0	0	0	0	0	0	0	1
23:15	3	0	0	0	0	0	0	0	0	0	3
23:30	3	0	0	0	0	0	0	0	0	0	3
23:45	2	0	0	0	0	0	0	0	0	0	2
1 Hr	9	0	0	0	0	0	0	0	0	0	9
6 Hrs	287	9	2	1	0	0	0	23	0	0	322
Total	1644	102	30	22	1	0	0	140	0	0	1939

Direction : Westbound

Time	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	2	0	0	0	0	0	0	0	0	0	2
06:15	2	0	0	0	0	0	0	0	0	0	2
06:30	4	1	0	0	0	0	0	3	0	0	8
06:45	7	1	0	0	0	0	0	0	0	0	8
1 Hr	15	2	0	0	0	0	0	3	0	0	20
07:00	1	0	0	0	0	0	0	0	0	0	1
07:15	6	1	0	0	0	0	0	0	0	0	7
07:30	6	1	0	0	0	0	0	3	0	0	10
07:45	5	1	0	0	0	0	0	1	0	0	7
1 Hr	18	3	0	0	0	0	0	4	0	0	25
08:00	8	1	1	0	0	0	0	0	0	0	10
08:15	13	4	0	1	0	0	0	0	0	0	18
08:30	9	1	0	0	0	0	0	0	0	0	10
08:45	14	1	0	0	0	0	0	1	0	0	16
1 Hr	44	7	1	1	0	0	0	1	0	0	54
09:00	17	1	0	1	0	0	0	0	0	0	19
09:15	23	2	0	1	0	0	0	1	0	0	27
09:30	19	1	1	0	0	0	0	3	0	0	24
09:45	33	5	0	1	0	0	0	0	0	0	39
1 Hr	92	9	1	3	0	0	0	4	0	0	109
10:00	33	2	0	0	0	0	0	2	0	0	37
10:15	24	4	0	0	0	0	0	4	0	0	32
10:30	32	1	0	1	0	0	0	1	0	0	35
10:45	47	1	0	0	0	0	0	1	0	0	49
1 Hr	136	8	0	1	0	0	0	8	0	0	153
11:00	39	5	1	1	0	0	0	0	0	0	46
11:15	26	5	1	1	0	0	0	1	0	0	34
11:30	36	3	1	0	0	0	0	2	0	0	42
11:45	39	1	0	1	0	0	0	7	0	0	48
1 Hr	140	14	3	3	0	0	0	10	0	0	170
6 Hrs	445	43	5	8	0	0	0	30	0	0	531
12:00	27	4	2	0	0	0	0	2	0	0	35
12:15	38	1	0	0	0	0	0	3	0	0	42
12:30	41	4	2	0	0	0	0	1	0	0	48
12:45	30	1	0	0	0	0	0	1	0	0	32
1 Hr	136	10	4	0	0	0	0	7	0	0	157
13:00	30	5	3	1	0	0	0	3	0	0	42
13:15	37	2	0	0	0	0	0	2	0	0	41
13:30	39	2	0	1	0	0	0	2	0	0	44
13:45	36	3	0	1	0	0	0	2	0	0	42
1 Hr	142	12	3	3	0	0	0	9	0	0	169
14:00	43	3	1	0	0	0	0	5	0	0	52
14:15	27	4	1	0	0	0	0	1	0	0	33
14:30	44	1	0	1	0	0	0	3	0	0	49
14:45	36	5	1	0	1	0	0	1	0	0	44
1 Hr	150	13	3	1	1	0	0	10	0	0	178
15:00	31	5	0	0	0	0	0	8	0	0	44
15:15	27	1	2	0	0	0	0	8	0	0	38
15:30	45	2	1	1	0	0	0	6	0	0	55
15:45	37	1	1	1	0	0	0	3	0	0	43
1 Hr	140	9	4	2	0	0	0	25	0	0	180
16:00	31	1	0	0	0	0	0	5	0	0	37
16:15	36	3	2	0	0	0	0	8	0	0	49
16:30	35	3	0	0	0	0	0	1	0	0	39
16:45	45	0	0	0	0	0	0	0	0	0	45
1 Hr	147	7	2	0	0	0	0	14	0	0	170
17:00	36	3	0	0	0	0	0	1	0	0	40
17:15	36	0	3	0	0	0	0	1	0	0	40
17:30	44	1	0	0	0	0	0	1	0	0	46
17:45	34	2	1	1	0	0	0	4	0	0	42
1 Hr	150	6	4	1	0	0	0	7	0	0	168
6 Hrs	865	57	20	7	1	0	0	72	0	0	1022
18:00	30	0	1	0	0	0	0	1	0	0	32
18:15	37	0	1	0	0	0	0	0	0	0	38
18:30	29	1	1	1	0	0	0	1	0	0	33
18:45	26	1	2	1	0	0	0	0	0	0	30
1 Hr	122	2	5	2	0	0	0	2	0	0	133
19:00	27	2	0	0	0	0	0	3	0	0	32
19:15	26	2	1	0	0	0	0	5	0	0	34
19:30	22	1	0	0	0	0	0	0	0	0	23
19:45	24	1	0	0	0	0	0	1	0	0	26
1 Hr	99	6	1	0	0	0	0	9	0	0	115
20:00	21	0	0	0	0	0	0	2	0	0	23
20:15	22	0	1	0	0	0	0	1	0	0	24
20:30	23	1	1	0	0	0	0	0	0	0	25
20:45	15	0	0	0	0	0	0	0	0	0	15
1 Hr	81	1	2	0	0	0	0	3	0	0	87
21:00	20	0	0	0	0	0	0	2	0	0	22
21:15	21	0	0	0	0	0	0	3	0	0	24
21:30	6	0	0	0	0	0	0	0	0	0	6
21:45	16	0	0	0	0	0	0	0	0	0	16
1 Hr	63	0	0	0	0	0	0	5	0	0	68
22:00	7	0	0	0	0	0	0	0	0	0	7
22:15	10	0	0	0	0	0	0	0	0	0	10
22:30	20	0	1	0	0	0	0	0	0	0	21
22:45	9	0	0	0	0	0	0	1	0	0	10
1 Hr	46	0	1	0	0	0	0	1	0	0	48
23:00	8	0	0	0	0	0	0	0	0	0	8
23:15	9	0	0	0	0	0	0	0	0	0	9
23:30	5	0	0	0	0	0	0	0	0	0	5
23:45	7	0	0	0	0	0	0	0	0	0	7
1 Hr	29	0	0	0	0	0	0	0	0	0	29
6 Hrs	440	9	9	2	0	0	0	20	0	0	480
Total	1750	109	34	17	1	0	0	122	0	0	2033

Direction : Eastbound

Time	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
06:00	1	0	0	0	0	0	0	0	0	1
06:15	6	0	0	0	0	0	0	0	0	6
06:30	11	0	0	0	0	0	0	0	0	11
06:45	3	0	0	0	0	0	0	0	0	3
1 Hr	21	0	0	0	0	0	0	0	0	21
07:00	2	0	0	0	0	0	0	0	0	2
07:15	22	0	0	0	0	0	0	0	0	22
07:30	7	0	0	0	0	0	0	0	0	7
07:45	1	0	0	0	0	0	0	0	0	1
1 Hr	32	0	0	0	0	0	0	0	0	32
08:00	2	0	0	0	0	0	0	0	0	2
08:15	11	0	0	1	0	0	0	0	0	12
08:30	6	0	0	0	0	0	1	0	0	7
08:45	4	0	0	0	0	0	1	0	0	5
1 Hr	23	0	0	1	0	0	2	0	0	26
09:00	2	0	0	0	0	0	0	0	0	2
09:15	15	0	0	0	0	0	1	0	0	16
09:30	12	1	0	0	0	0	0	0	0	13
09:45	2	0	0	0	0	0	1	0	0	3
1 Hr	31	1	0	0	0	0	2	0	0	34
10:00	9	0	0	0	0	0	0	0	0	9
10:15	19	0	0	0	0	0	3	0	0	22
10:30	16	0	0	0	0	0	0	0	0	16
10:45	10	0	0	0	0	0	0	0	0	10
1 Hr	54	0	0	0	0	0	3	0	0	57
11:00	3	1	0	0	0	0	0	0	0	4
11:15	21	0	0	0	0	0	0	0	0	21
11:30	19	0	0	0	0	0	0	0	0	19
11:45	0	0	0	0	0	0	0	0	0	0
1 Hr	43	1	0	0	0	0	0	0	0	44
6 Hrs	204	2	0	1	0	0	7	0	0	214
12:00	4	0	0	0	0	0	0	0	0	4
12:15	23	0	0	0	0	0	0	0	0	23
12:30	17	0	0	0	0	0	0	0	0	17
12:45	12	0	0	0	0	0	0	0	0	12
1 Hr	56	0	0	0	0	0	0	0	0	56
13:00	3	0	0	0	0	0	0	0	0	3
13:15	20	2	0	0	0	0	0	0	0	22
13:30	21	2	0	0	0	0	2	0	0	25
13:45	1	0	0	0	0	0	0	0	0	1
1 Hr	45	4	0	0	0	0	2	0	0	51
14:00	5	0	0	0	0	0	0	0	0	5
14:15	17	5	0	0	0	0	0	0	0	22
14:30	23	6	0	0	0	0	0	0	0	29
14:45	4	1	0	0	0	0	0	0	0	5
1 Hr	49	12	0	0	0	0	0	0	0	61
15:00	1	0	0	0	0	0	0	0	0	1
15:15	1	0	0	0	0	0	0	0	0	1
15:30	5	0	0	0	0	0	0	0	0	5
15:45	2	0	0	0	0	0	0	0	0	2
1 Hr	9	0	0	0	0	0	0	0	0	9
16:00	2	0	0	0	0	0	0	0	0	2
16:15	7	0	0	0	0	0	0	0	0	7
16:30	10	3	0	0	0	0	1	0	0	14
16:45	4	0	0	0	0	0	0	0	0	4
1 Hr	23	3	0	0	0	0	1	0	0	27
17:00	3	0	0	0	0	0	0	0	0	3
17:15	20	0	0	0	0	0	0	0	0	20
17:30	11	0	0	0	0	0	0	0	0	11
17:45	7	1	0	0	0	0	0	0	0	8
1 Hr	41	1	0	0	0	0	0	0	0	42
6 Hrs	223	20	0	0	0	0	3	0	0	246
18:00	5	0	0	0	0	0	0	0	0	5
18:15	5	0	0	0	0	0	1	0	1	7
18:30	10	0	0	0	0	0	0	0	0	10
18:45	5	0	0	0	0	0	0	0	0	5
1 Hr	25	0	0	0	0	0	1	0	1	27
19:00	28	0	0	0	0	0	0	0	0	28
19:15	6	0	0	0	0	0	0	0	0	6
19:30	2	0	0	0	0	0	0	0	0	2
19:45	8	0	0	0	0	0	0	0	0	8
1 Hr	44	0	0	0	0	0	0	0	0	44
20:00	11	0	0	0	0	0	0	0	0	11
20:15	8	0	0	0	0	0	0	0	0	8
20:30	2	0	0	0	0	0	0	0	0	2
20:45	0	0	0	0	0	0	0	0	0	0
1 Hr	21	0	0	0	0	0	0	0	0	21
21:00	4	0	0	0	0	0	0	0	0	4
21:15	10	0	0	0	0	0	0	0	0	10
21:30	0	0	0	0	0	0	0	0	0	0
21:45	4	0	0	0	0	0	0	0	0	4
1 Hr	18	0	0	0	0	0	0	0	0	18
22:00	2	0	0	0	0	0	0	0	0	2
22:15	2	0	0	0	0	0	0	0	0	2
22:30	0	0	0	0	0	0	0	0	0	0
22:45	0	0	0	0	0	0	0	0	0	0
1 Hr	4	0	0	0	0	0	0	0	0	4
23:00	5	0	0	0	0	0	0	0	0	5
23:15	5	0	0	0	0	0	0	0	0	5
23:30	0	0	0	0	0	0	0	0	0	0
23:45	0	0	0	0	0	0	0	0	0	0
1 Hr	10	0	0	0	0	0	0	0	0	10
6 Hrs	122	0	0	0	0	0	1	0	1	124
Total	549	22	0	1	0	0	11	0	1	584

Direction : Westbound

Time	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
06:00	2	0	0	0	0	0	0	0	0	2	2
06:15	2	0	0	0	0	0	0	0	0	2	0
06:30	10	0	0	0	0	0	0	0	0	10	3
06:45	1	0	0	0	0	0	0	0	0	1	0
1 Hr	15	0	0	0	0	0	0	0	0	15	5
07:00	0	0	0	0	0	0	0	0	0	0	2
07:15	9	0	0	0	0	0	0	0	0	9	0
07:30	3	0	0	0	0	0	0	0	0	3	2
07:45	1	0	0	0	0	0	0	0	0	1	1
1 Hr	13	0	0	0	0	0	0	0	0	13	5
08:00	1	0	0	0	0	0	0	0	0	1	1
08:15	8	0	0	1	0	0	0	0	0	9	2
08:30	6	0	0	0	0	0	0	0	0	6	1
08:45	0	0	0	0	0	0	0	0	0	0	1
1 Hr	15	0	0	1	0	0	0	0	0	16	5
09:00	3	0	0	0	0	0	0	0	0	3	2
09:15	4	0	0	0	0	0	0	0	0	4	2
09:30	5	1	0	0	0	0	0	0	0	6	2
09:45	1	0	0	0	0	0	1	0	0	2	1
1 Hr	13	1	0	0	0	0	1	0	0	15	7
10:00	13	0	0	0	0	0	0	0	0	13	2
10:15	11	0	0	0	0	0	1	0	0	12	1
10:30	6	0	0	0	0	0	1	0	0	7	2
10:45	4	0	0	0	0	0	1	0	0	5	1
1 Hr	34	0	0	0	0	0	3	0	0	37	6
11:00	2	0	0	0	0	0	0	0	0	2	4
11:15	4	0	0	0	0	0	0	0	0	4	2
11:30	15	1	0	0	0	0	0	0	0	16	2
11:45	0	0	0	0	0	0	0	0	0	0	1
1 Hr	21	1	0	0	0	0	0	0	0	22	9
6 Hrs	111	2	0	1	0	0	4	0	0	118	37
12:00	2	0	0	0	0	0	0	0	0	2	4
12:15	7	0	0	0	0	0	0	0	0	7	1
12:30	8	0	0	0	0	0	0	0	0	8	1
12:45	4	0	0	0	0	0	0	0	0	4	2
1 Hr	21	0	0	0	0	0	0	0	0	21	8
13:00	4	1	0	0	0	0	0	0	0	5	4
13:15	12	1	0	0	0	0	0	0	0	13	1
13:30	13	3	0	0	0	0	1	0	0	17	2
13:45	4	0	0	0	0	0	0	0	0	4	1
1 Hr	33	5	0	0	0	0	1	0	0	39	8
14:00	0	0	0	0	0	0	0	0	0	0	4
14:15	9	2	1	0	0	0	0	0	0	12	1
14:30	16	0	0	0	0	0	0	0	0	16	2
14:45	2	1	0	0	0	0	0	0	0	3	1
1 Hr	27	3	1	0	0	0	0	0	0	31	8
15:00	1	0	0	0	0	0	0	0	0	1	3
15:15	4	0	0	0	0	0	0	0	0	4	1
15:30	2	0	0	0	0	0	0	0	0	2	1
15:45	1	0	0	0	0	0	0	0	0	1	1
1 Hr	8	0	0	0	0	0	0	0	0	8	6
16:00	0	0	0	0	0	0	0	0	0	0	3
16:15	4	0	0	0	0	0	0	0	0	4	2
16:30	11	3	0	0	0	0	0	0	0	14	2
16:45	6	0	0	0	0	0	0	0	0	6	1
1 Hr	21	3	0	0	0	0	0	0	0	24	8
17:00	1	0	0	0	0	0	0	0	0	1	3
17:15	10	1	0	0	0	0	0	0	0	11	2
17:30	6	0	0	0	0	0	0	0	0	6	2
17:45	0	0	0	0	0	0	0	0	0	0	1
1 Hr	17	1	0	0	0	0	0	0	0	18	8
6 Hrs	127	12	1	0	0	0	1	0	0	141	46
18:00	1	0	0	0	0	0	0	0	0	1	3
18:15	1	0	0	0	0	0	0	0	1	2	2
18:30	7	0	0	0	0	0	0	0	0	7	2
18:45	3	0	0	0	0	0	0	0	0	3	1
1 Hr	12	0	0	0	0	0	0	0	1	13	8
19:00	6	0	0	0	0	0	0	0	0	6	3
19:15	3	0	0	0	0	0	0	0	0	3	3
19:30	3	1	0	0	0	0	0	0	0	4	1
19:45	5	0	0	0	0	0	0	0	0	5	1
1 Hr	17	1	0	0	0	0	0	0	0	18	8
20:00	1	0	0	0	0	0	0	0	0	1	4
20:15	9	0	0	0	0	0	0	0	0	9	1
20:30	5	1	0	0	0	0	0	0	0	6	1
20:45	5	0	0	0	0	0	0	0	0	5	1
1 Hr	20	1	0	0	0	0	0	0	0	21	7
21:00	2	0	0	0	0	0	0	0	0	2	3
21:15	7	0	0	0	0	0	0	0	0	7	1
21:30	1	0	0	0	0	0	0	0	0	1	0
21:45	0	0	0	0	0	0	0	0	0	0	1
1 Hr	10	0	0	0	0	0	0	0	0	10	5
22:00	1	0	0	0	0	0	1	0	0	2	3
22:15	5	0	0	0	0	0	0	0	0	5	2
22:30	0	0	0	0	0	0	0	0	0	0	0
22:45	1	0	0	0	0	0	0	0	0	1	2
1 Hr	7	0	0	0	0	0	1	0	0	8	7
23:00	0	0	0	0	0	0	0	0	0	0	2
23:15	3	0	0	0	0	0	0	0	0	3	2
23:30	0	0	0	0	0	0	0	0	0	0	0
23:45	1	0	0	0	0	0	0	0	0	1	2
1 Hr	4	0	0	0	0	0	0	0	0	4	6
6 Hrs	70	2	0	0	0	0	1	0	1	74	41
Total	308	16	1	1	0	0	6	0	1	333	124

	DURATION	DIRECTION
	Northbound	61
	Southbound	63
	Total	124

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
06:00:22	06:00:24	00:00:02	N
06:13:32	06:13:34	00:00:02	N
06:33:10	06:33:21	00:00:11	S
06:41:21	06:41:31	00:00:10	N
06:43:28	06:43:30	00:00:02	S
07:05:45	07:05:47	00:00:02	N
07:09:58	07:10:00	00:00:02	N
07:34:26	07:34:36	00:00:10	S
07:40:25	07:40:35	00:00:10	N
07:47:34	07:47:36	00:00:02	S
08:07:11	08:07:13	00:00:02	N
08:18:20	08:18:22	00:00:02	N
08:20:49	08:20:54	00:00:05	N
08:40:21	08:40:31	00:00:10	N
08:48:54	08:49:02	00:00:08	S
09:06:52	09:06:54	00:00:02	N
09:07:48	09:07:50	00:00:02	S
09:18:19	09:18:21	00:00:02	N
09:24:12	09:24:17	00:00:05	S
09:37:19	09:37:31	00:00:12	S
09:41:02	09:41:11	00:00:09	N
09:48:41	09:48:49	00:00:08	S
10:02:28	10:02:30	00:00:02	S
10:13:46	10:13:51	00:00:05	S
10:17:54	10:17:56	00:00:02	N
10:37:08	10:37:19	00:00:11	S
10:44:27	10:44:37	00:00:10	N
10:48:25	10:48:27	00:00:02	S
11:01:40	11:01:41	00:00:01	S
11:07:24	11:07:26	00:00:02	N
11:08:02	11:08:08	00:00:06	S
11:11:22	11:11:27	00:00:05	N
11:18:08	11:18:10	00:00:02	N
11:23:23	11:23:36	00:00:13	N
11:37:09	11:37:20	00:00:11	S
11:40:47	11:40:56	00:00:09	N
11:49:54	11:49:57	00:00:03	S
12:03:30	12:03:32	00:00:02	S
12:06:58	12:07:03	00:00:05	S
12:08:43	12:08:45	00:00:02	N
12:12:50	12:12:55	00:00:05	N
12:18:48	12:18:50	00:00:02	N
12:35:35	12:35:46	00:00:11	S
12:47:34	12:47:36	00:00:02	S
12:56:16	12:56:25	00:00:09	N
13:02:37	13:02:39	00:00:02	S
13:06:48	13:06:53	00:00:05	S
13:06:59	13:07:01	00:00:02	N
13:11:17	13:11:22	00:00:05	N
13:18:02	13:18:04	00:00:02	N
13:34:27	13:34:37	00:00:10	S
13:41:27	13:41:36	00:00:09	N
13:47:27	13:47:29	00:00:02	S
14:05:31	14:05:33	00:00:02	S
14:07:03	14:07:05	00:00:02	N
14:08:26	14:08:31	00:00:05	S
14:11:37	14:11:42	00:00:05	N
14:18:03	14:18:05	00:00:02	N
14:37:10	14:37:21	00:00:11	S
14:40:31	14:40:40	00:00:09	N
14:50:04	14:50:06	00:00:02	S
15:04:10	15:04:12	00:00:02	S
15:08:50	15:08:55	00:00:05	S
15:11:45	15:11:50	00:00:05	N
15:18:25	15:18:27	00:00:02	N
15:35:45	15:35:55	00:00:10	S
15:49:28	15:49:30	00:00:02	S
16:04:57	16:04:59	00:00:02	S
16:07:17	16:07:22	00:00:05	S
16:11:44	16:11:46	00:00:02	N
16:16:52	16:16:57	00:00:05	N
16:21:30	16:21:39	00:00:09	N
16:34:34	16:34:44	00:00:10	S
16:42:27	16:42:36	00:00:09	N
16:49:27	16:49:29	00:00:02	S
17:06:34	17:06:39	00:00:05	S
17:07:48	17:07:51	00:00:03	N
17:10:48	17:10:51	00:00:03	S
17:21:03	17:21:07	00:00:04	N
17:24:51	17:24:53	00:00:02	N
17:37:09	17:37:19	00:00:10	S
17:42:19	17:42:27	00:00:08	N
17:54:09	17:54:11	00:00:02	S
18:02:35	18:02:40	00:00:05	S
18:10:50	18:10:51	00:00:01	S
18:12:48	18:12:53	00:00:05	N
18:18:42	18:18:44	00:00:02	N
18:22:42	18:22:46	00:00:04	N
18:34:28	18:34:37	00:00:09	S
18:40:59	18:41:09	00:00:10	N
18:56:47	18:56:49	00:00:02	S
19:01:35	19:01:37	00:00:02	S
19:07:26	19:07:31	00:00:05	S
19:08:04	19:08:07	00:00:03	N
19:15:02	19:15:12	00:00:10	S
19:15:19	19:15:23	00:00:04	N
19:20:23	19:20:25	00:00:02	N
19:43:31	19:43:40	00:00:09	N
19:58:47	19:58:49	00:00:02	S
20:05:21	20:05:23	00:00:02	S
20:08:50	20:08:53	00:00:03	N
20:12:15	20:12:24	00:00:09	N
20:14:53	20:15:03	00:00:10	S
20:23:41	20:23:43	00:00:02	N
20:40:15	20:40:20	00:00:05	N
20:49:49	20:49:51	00:00:02	S
21:03:15	21:03:16	00:00:01	S
21:13:14	21:13:25	00:00:11	N
21:14:45	21:14:55	00:00:10	S
21:18:43	21:18:45	00:00:02	N
21:48:56	21:49:09	00:00:13	N
22:01:59	22:02:01	00:00:02	S
22:12:25	22:12:38	00:00:13	N
22:14:56	22:15:10	00:00:14	S
22:18:56	22:18:59	00:00:03	S
22:22:03	22:22:06	00:00:03	S
22:53:20	22:53:25	00:00:05	N
22:59:08	22:59:10	00:00:02	S
23:03:18	23:03:20	00:00:02	N
23:07:17	23:07:27	00:00:10	S
23:20:17	23:20:22	00:00:05	S
23:22:23	23:22:33	00:00:10	N
23:51:51	23:52:04	00:00:13	S
23:57:24	23:57:26	00:00:02	S

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Drop off	07:12:12	07:12:47	WSJ
Drop off	07:31:55	07:32:33	ESJ
Drop off	07:32:50	07:33:29	ESJ
Pick up	07:41:41	07:41:52	WSJ
Drop off	08:12:50	08:13:22	ESJ
Drop off	09:27:30	09:27:57	ESJ
Pick up	09:39:19	09:42:25	ESJ
Pick up	09:49:18	09:49:39	ESJ
Drop off	10:25:18	10:25:23	WSJ
Pick up	10:26:21	10:26:25	ESJ
Drop off	10:35:58	10:38:13	ESJ
Waiting	11:00:38	11:03:10	ESJ
Pick up	11:08:21	11:08:47	ESJ
Vehicle stopped near level crossing	12:57:52	12:58:06	ESJ
Waiting	12:58:30	12:59:59	WSJ
Drop off	13:13:30	13:13:41	ESJ
Drop off	14:09:35	14:09:41	WSJ
Drop off	14:17:10	14:22:58	ESJ
Drop off	14:19:46	14:20:04	ESJ
Pick up	16:39:20	16:44:15	ESJ
Parking	17:02:07	17:38:44	ESJ
Parking	17:30:36	17:44:48	ESJ
Pick up	17:46:00	17:46:26	ESJ
Peds Crossing After The Red Signal	18:40:31	18:40:38	WB
Parking	18:59:30	19:12:08	ESJ
Parking	19:04:26	19:17:07	ESJ
Drop off	19:11:59	19:17:50	ESJ
Waiting	19:19:40	19:22:20	ESJ
Drop off	19:52:02	19:52:09	ESJ
Drop off	20:39:32	20:42:10	WSJ
Waiting	21:02:49	21:05:25	ESJ
Waiting	23:20:59	23:24:55	WSJ

Tracsis plc
Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Clayhithe Road Level Crossing
Date: Sunday 9th July 2017

AM Weather : Dry, sunny spells
PM Weather : Dry, sunny spells

Linkcount

Direction : Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	2	0	0	0	0	0	0	0	0	0	2
06:15	3	0	0	0	0	0	0	1	0	0	4
06:30	7	0	0	0	0	0	0	0	0	0	7
06:45	6	0	0	0	0	0	0	1	0	0	7
1 Hr	18	0	0	0	0	0	0	2	0	0	20
07:00	4	1	0	0	0	0	0	0	0	0	5
07:15	1	0	0	1	0	0	0	2	0	0	4
07:30	5	0	0	0	0	0	0	1	0	0	6
07:45	12	2	0	0	0	0	0	1	0	0	15
1 Hr	22	3	0	1	0	0	0	4	0	0	30
08:00	8	1	0	0	0	0	0	1	0	0	10
08:15	15	1	0	0	0	0	0	3	0	0	19
08:30	15	0	0	0	0	0	0	1	0	0	16
08:45	12	2	0	0	0	0	0	5	0	0	19
1 Hr	50	4	0	0	0	0	0	10	0	0	64
09:00	22	3	0	0	0	0	0	4	0	0	29
09:15	21	0	1	0	0	0	0	2	0	0	24
09:30	31	2	0	0	0	0	0	0	0	0	33
09:45	32	1	0	1	0	0	0	1	0	0	35
1 Hr	106	6	1	1	0	0	0	7	0	0	121
10:00	28	1	0	0	0	0	0	1	0	0	30
10:15	39	2	1	0	0	0	0	0	0	0	42
10:30	42	1	0	0	0	0	0	4	0	0	47
10:45	39	1	1	2	0	0	0	5	0	0	48
1 Hr	148	5	2	2	0	0	0	10	0	0	167
11:00	38	0	1	0	0	0	0	0	0	0	39
11:15	39	2	0	0	0	0	0	1	0	0	42
11:30	28	0	0	0	0	0	0	4	0	0	32
11:45	46	2	1	0	0	0	0	4	0	0	53
1 Hr	151	4	2	0	0	0	0	9	0	0	166
6 Hrs	495	22	5	4	0	0	0	42	0	0	568

Direction : Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	3	0	0	0	0	0	0	0	0	0	3
06:15	0	0	0	0	0	0	0	0	0	0	0
06:30	2	0	0	0	0	0	0	1	0	0	3
06:45	4	0	0	0	0	0	0	1	0	0	5
1 Hr	9	0	0	0	0	0	0	2	0	0	11
07:00	1	1	0	0	0	0	0	0	0	0	2
07:15	2	1	0	0	0	0	0	1	0	0	4
07:30	4	0	0	0	0	0	0	0	0	0	4
07:45	5	0	0	0	0	0	0	1	0	0	6
1 Hr	12	2	0	0	0	0	0	2	0	0	16
08:00	2	0	0	0	0	0	0	1	0	0	3
08:15	5	3	0	1	0	0	0	1	0	0	10
08:30	6	0	1	0	0	0	0	2	0	0	9
08:45	8	0	0	0	0	0	0	0	0	0	8
1 Hr	21	3	1	1	0	0	0	4	0	0	30
09:00	14	0	0	0	0	0	0	1	0	0	15
09:15	16	3	0	0	0	0	0	1	0	0	20
09:30	13	0	1	1	0	0	0	11	0	0	26
09:45	20	1	0	0	0	0	0	1	0	0	22
1 Hr	63	4	1	1	0	0	0	14	0	0	83
10:00	14	1	0	1	0	0	0	1	0	0	17
10:15	15	2	0	0	0	0	0	0	0	0	17
10:30	23	0	0	0	0	0	0	1	0	0	24
10:45	25	0	0	0	0	0	0	0	0	0	25
1 Hr	77	3	0	1	0	0	0	2	0	0	83
11:00	26	0	1	0	0	0	0	4	0	0	31
11:15	30	0	0	1	0	0	0	2	0	0	33
11:30	37	1	2	1	0	0	0	2	0	0	43
11:45	40	1	0	1	0	0	0	2	0	0	44
1 Hr	133	2	3	3	0	0	0	10	0	0	151
6 Hrs	315	14	5	6	0	0	0	34	0	0	374

Direction : Eastbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
06:00	0	0	0	0	0	0	0	0	0	0
06:15	0	0	0	0	0	0	0	0	0	0
06:30	0	0	0	0	0	0	0	0	0	0
06:45	1	0	0	0	0	0	0	0	0	1
1 Hr	1	0	0	0	0	0	0	0	0	1
07:00	0	0	0	0	0	0	0	0	0	0
07:15	2	0	0	0	0	0	0	0	0	2
07:30	3	0	0	0	0	0	0	0	0	3
07:45	1	0	0	0	0	0	0	0	0	1
1 Hr	6	0	0	0	0	0	0	0	0	6
08:00	1	0	0	0	0	0	0	0	0	1
08:15	4	0	0	0	0	0	0	0	0	4
08:30	4	0	1	0	0	0	0	0	0	5
08:45	13	4	0	0	0	0	1	0	0	18
1 Hr	22	4	1	0	0	0	1	0	0	28
09:00	9	0	0	0	0	0	0	0	0	9
09:15	1	0	0	0	0	0	0	0	0	1
09:30	2	0	0	0	0	0	0	0	0	2
09:45	20	2	1	0	0	0	0	0	0	23
1 Hr	32	2	1	0	0	0	0	0	0	35
10:00	19	0	0	0	0	0	0	0	0	19
10:15	5	0	0	0	0	0	0	0	0	5
10:30	4	0	0	0	0	0	0	0	0	4
10:45	13	0	2	0	0	0	0	0	0	15
1 Hr	41	0	2	0	0	0	0	0	0	43
11:00	20	0	0	0	0	0	0	0	0	20
11:15	3	1	0	0	0	0	2	0	0	6
11:30	4	0	0	0	0	0	1	0	0	5
11:45	8	0	0	0	0	0	2	0	0	10
1 Hr	35	1	0	0	0	0	5	0	0	41
6 Hrs	137	7	4	0	0	0	6	0	0	154

Direction : Westbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
06:00	0	0	0	0	0	0	0	0	0	0
06:15	0	0	0	0	0	0	0	0	0	0
06:30	0	0	0	0	0	0	0	0	0	0
06:45	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0
07:00	1	0	0	0	0	0	0	0	0	1
07:15	0	0	0	0	0	0	0	0	0	0
07:30	0	0	0	0	0	0	0	0	0	0
07:45	1	0	0	0	0	0	0	0	0	1
1 Hr	2	0	0	0	0	0	0	0	0	2
08:00	1	0	0	0	0	0	0	0	0	1
08:15	1	0	0	0	0	0	0	0	0	1
08:30	1	0	1	0	0	0	0	0	0	2
08:45	5	3	0	0	0	0	0	0	0	8
1 Hr	8	3	1	0	0	0	0	0	0	12
09:00	4	0	0	0	0	0	0	0	0	4
09:15	3	0	0	0	0	0	0	0	0	3
09:30	3	0	0	0	0	0	0	0	0	3
09:45	11	0	0	0	0	0	0	0	0	11
1 Hr	21	0	0	0	0	0	0	0	0	21
10:00	9	0	0	0	0	0	0	0	0	9
10:15	3	0	0	0	0	0	0	0	0	3
10:30	5	0	0	0	0	0	0	0	0	5
10:45	4	0	0	0	0	0	0	0	0	4
1 Hr	21	0	0	0	0	0	0	0	0	21
11:00	10	1	0	0	0	0	0	0	0	11
11:15	0	0	0	0	0	0	0	0	0	0
11:30	0	0	0	0	0	0	0	0	0	0
11:45	7	2	0	0	0	0	0	0	0	9
1 Hr	17	3	0	0	0	0	0	0	0	20
6 Hrs	69	6	1	0	0	0	0	0	0	76

	TRAINS
06:00	0
06:15	0
06:30	0
06:45	0
1 Hr	0
07:00	0
07:15	0
07:30	0
07:45	0
1 Hr	0
08:00	0
08:15	0
08:30	0
08:45	1
1 Hr	1
09:00	2
09:15	0
09:30	0
09:45	0
1 Hr	2
10:00	3
10:15	0
10:30	0
10:45	1
1 Hr	4
11:00	4
11:15	0
11:30	0
11:45	1
1 Hr	5
6 Hrs	12

Linkcount

Direction : Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	22	2	0	1	0	0	0	4	0	0	29
12:15	36	0	0	0	0	0	0	1	0	0	37
12:30	34	1	0	0	0	0	0	5	0	0	40
12:45	33	1	0	0	0	0	0	5	0	0	39
1 Hr	125	4	0	1	0	0	0	15	0	0	145
13:00	46	3	1	0	0	0	0	3	0	0	53
13:15	30	1	0	0	0	0	0	4	0	0	35
13:30	19	3	0	0	0	0	0	1	0	0	23
13:45	35	1	2	0	0	0	0	6	0	0	44
1 Hr	130	8	3	0	0	0	0	14	0	0	155
14:00	38	0	1	2	0	0	0	2	0	0	43
14:15	33	1	0	0	0	0	0	3	0	0	37
14:30	30	1	0	0	0	0	0	2	0	0	33
14:45	25	0	0	0	0	0	0	2	0	0	27
1 Hr	126	2	1	2	0	0	0	9	0	0	140
15:00	34	1	1	0	0	0	0	12	0	0	48
15:15	20	1	0	1	0	0	0	0	0	0	22
15:30	20	4	0	0	0	0	0	2	0	0	26
15:45	21	0	0	1	0	0	0	0	0	0	22
1 Hr	95	6	1	2	0	0	0	14	0	0	118
16:00	21	0	0	0	0	0	0	3	0	0	24
16:15	23	0	1	0	0	0	0	1	0	0	25
16:30	25	1	0	0	0	0	0	3	0	0	29
16:45	32	0	0	0	0	0	0	1	0	0	33
1 Hr	101	1	1	0	0	0	0	8	0	0	111
17:00	19	1	0	0	0	0	0	4	0	0	24
17:15	15	1	0	0	0	0	0	3	0	0	19
17:30	21	1	0	1	0	0	0	3	0	0	26
17:45	28	1	0	0	0	0	0	5	0	0	34
1 Hr	83	4	0	1	0	0	0	15	0	0	103
6 Hrs	660	25	6	6	0	0	0	75	0	0	772

Direction : Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	26	0	0	0	0	0	0	3	0	0	29
12:15	32	2	1	0	0	0	0	2	0	0	37
12:30	49	0	0	0	0	0	0	7	0	0	56
12:45	33	3	3	0	0	0	0	6	0	0	45
1 Hr	140	5	4	0	0	0	0	18	0	0	167
13:00	45	4	1	0	0	0	0	4	0	0	54
13:15	41	1	0	0	0	0	0	6	0	0	48
13:30	39	2	0	0	0	0	0	6	0	0	47
13:45	40	2	0	0	0	0	0	6	0	0	48
1 Hr	165	9	1	0	0	0	0	22	0	0	197
14:00	43	2	3	1	0	0	0	5	0	0	54
14:15	32	0	0	0	0	0	0	4	0	0	36
14:30	32	3	2	0	0	0	0	1	0	0	38
14:45	33	1	1	0	0	0	0	4	0	0	39
1 Hr	140	6	6	1	0	0	0	14	0	0	167
15:00	39	3	0	0	0	0	0	1	0	0	43
15:15	37	4	0	1	0	0	0	0	0	0	42
15:30	35	3	1	1	0	0	0	7	0	0	47
15:45	50	2	0	0	0	0	0	0	0	0	52
1 Hr	161	12	1	2	0	0	0	8	0	0	184
16:00	50	1	1	0	0	0	0	6	0	0	58
16:15	40	1	1	1	0	0	0	3	0	0	46
16:30	33	3	0	0	0	0	0	3	0	0	39
16:45	38	2	0	0	0	0	0	1	0	0	41
1 Hr	161	7	2	1	0	0	0	13	0	0	184
17:00	35	0	0	2	0	0	0	6	0	0	43
17:15	37	1	1	0	0	0	0	1	0	0	40
17:30	22	0	0	0	0	0	0	4	0	0	26
17:45	28	0	0	0	0	0	0	2	0	0	30
1 Hr	122	1	1	2	0	0	0	13	0	0	139
6 Hrs	889	40	15	6	0	0	0	88	0	0	1038

Direction : Eastbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
12:00	25	4	0	0	0	0	0	0	0	29
12:15	0	0	0	0	0	0	0	0	0	0
12:30	0	0	0	0	0	0	0	0	0	0
12:45	5	1	0	0	0	0	0	0	0	6
1 Hr	30	5	0	0	0	0	0	0	0	35
13:00	29	4	0	0	0	0	0	0	0	33
13:15	0	0	0	0	0	0	0	0	0	0
13:30	5	3	0	0	0	0	1	0	0	9
13:45	10	0	0	0	0	0	0	0	0	10
1 Hr	44	7	0	0	0	0	1	0	0	52
14:00	20	2	0	0	0	0	0	0	0	22
14:15	1	0	0	0	0	0	0	0	0	1
14:30	2	0	0	0	0	0	0	0	0	2
14:45	11	3	0	0	0	0	1	0	0	15
1 Hr	34	5	0	0	0	0	1	0	0	40
15:00	13	0	0	0	0	0	0	0	0	13
15:15	2	0	0	0	0	0	0	0	0	2
15:30	0	0	0	0	0	0	0	0	0	0
15:45	6	0	0	0	0	0	0	0	0	6
1 Hr	21	0	0	0	0	0	0	0	0	21
16:00	19	0	0	0	0	0	2	0	0	21
16:15	5	0	0	0	0	0	0	0	0	5
16:30	5	0	0	0	0	0	1	0	0	6
16:45	12	0	0	0	0	0	1	0	0	13
1 Hr	41	0	0	0	0	0	4	0	0	45
17:00	4	0	0	0	0	0	0	0	0	4
17:15	15	3	1	0	0	0	1	0	0	20
17:30	6	0	0	0	0	0	0	0	0	6
17:45	2	0	0	0	0	0	0	0	0	2
1 Hr	27	3	1	0	0	0	1	0	0	32
6 Hrs	197	20	1	0	0	0	7	0	0	225

Direction : Westbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
12:00	10	2	0	0	0	0	0	0	0	12
12:15	2	0	0	0	0	0	0	0	0	2
12:30	1	0	0	0	0	0	0	0	0	1
12:45	1	0	0	0	0	0	0	0	0	1
1 Hr	14	2	0	0	0	0	0	0	0	16
13:00	10	0	0	0	0	0	1	0	0	11
13:15	1	0	0	0	0	0	0	0	0	1
13:30	2	0	0	0	0	0	0	0	0	2
13:45	8	0	0	0	0	0	0	0	0	8
1 Hr	21	0	0	0	0	0	1	0	0	22
14:00	5	2	0	0	0	0	0	0	0	7
14:15	0	0	0	0	0	0	1	0	0	1
14:30	3	1	0	0	0	0	2	0	0	6
14:45	4	0	0	0	0	0	0	0	0	4
1 Hr	12	3	0	0	0	0	3	0	0	18
15:00	5	0	0	0	0	0	0	0	0	5
15:15	1	0	0	0	0	0	0	0	0	1
15:30	9	1	0	0	0	0	1	0	0	11
15:45	4	0	0	0	0	0	0	0	0	4
1 Hr	19	1	0	0	0	0	1	0	0	21
16:00	12	0	0	0	0	0	1	0	0	13
16:15	4	0	0	0	0	0	0	0	0	4
16:30	6	0	0	0	0	0	0	0	0	6
16:45	5	0	0	0	0	0	1	0	0	6
1 Hr	27	0	0	0	0	0	2	0	0	29
17:00	14	2	0	0	0	0	0	0	0	16
17:15	4	2	0	0	0	0	0	0	0	6
17:30	6	0	0	0	0	0	0	0	0	6
17:45	6	0	0	0	0	0	0	0	0	6
1 Hr	30	4	0	0	0	0	0	0	0	34
6 Hrs	123	10	0	0	0	0	7	0	0	140

	TRAINS
12:00	4
12:15	0
12:30	0
12:45	1
1 Hr	5
13:00	4
13:15	0
13:30	0
13:45	1
1 Hr	5
14:00	5
14:15	0
14:30	0
14:45	1
1 Hr	6
15:00	4
15:15	1
15:30	0
15:45	1
1 Hr	6
16:00	4
16:15	1
16:30	0
16:45	1
1 Hr	6
17:00	5
17:15	0
17:30	0
17:45	1
1 Hr	6
6 Hrs	34

Linkcount

Direction : Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	26	3	0	1	0	0	0	4	0	0	34
18:15	20	0	1	1	0	0	0	2	0	0	24
18:30	12	1	0	0	0	0	0	2	0	0	15
18:45	19	0	0	0	0	0	0	1	0	0	20
1 Hr	77	4	1	2	0	0	0	9	0	0	93
19:00	29	1	0	0	0	0	0	1	0	0	31
19:15	12	2	0	0	0	0	0	5	0	0	19
19:30	13	1	0	0	0	0	0	0	0	0	14
19:45	22	1	1	0	0	0	0	0	0	0	24
1 Hr	76	5	1	0	0	0	0	6	0	0	88
20:00	13	0	1	0	0	0	0	0	0	0	14
20:15	9	0	0	0	0	0	0	0	0	0	9
20:30	6	1	0	0	0	0	0	0	0	0	7
20:45	7	0	0	0	0	0	0	1	0	0	8
1 Hr	35	1	1	0	0	0	0	1	0	0	38
21:00	7	0	0	0	0	0	0	3	0	0	10
21:15	8	0	0	0	0	0	0	1	0	0	9
21:30	3	0	0	0	0	0	0	0	0	0	3
21:45	5	0	0	0	0	0	0	1	0	0	6
1 Hr	23	0	0	0	0	0	0	5	0	0	28
22:00	2	0	0	0	0	0	0	0	0	0	2
22:15	4	0	0	0	0	0	0	0	0	0	4
22:30	0	0	0	0	0	0	0	0	0	0	0
22:45	1	0	0	0	0	0	0	0	0	0	1
1 Hr	7	0	0	0	0	0	0	0	0	0	7
23:00	3	0	0	0	0	0	0	0	0	0	3
23:15	3	0	0	0	0	0	0	0	0	0	3
23:30	1	0	0	0	0	0	0	0	0	0	1
23:45	3	0	0	0	0	0	0	0	0	0	3
1 Hr	10	0	0	0	0	0	0	0	0	0	10
6 Hrs	228	10	3	2	0	0	0	21	0	0	264
Total	1383	57	14	12	0	0	0	138	0	0	1604

Direction : Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	25	0	0	0	0	0	0	6	0	0	31
18:15	25	1	0	0	0	0	0	0	0	0	26
18:30	23	2	1	1	0	0	0	1	0	0	28
18:45	21	0	0	0	0	0	0	3	0	0	24
1 Hr	94	3	1	1	0	0	0	10	0	0	109
19:00	22	1	1	0	0	0	0	0	0	0	24
19:15	28	1	0	0	0	0	0	3	0	0	32
19:30	20	1	0	0	0	0	0	3	0	0	24
19:45	23	1	1	0	0	0	0	2	0	0	27
1 Hr	93	4	2	0	0	0	0	8	0	0	107
20:00	21	0	2	0	0	0	0	1	0	0	24
20:15	19	0	1	0	0	0	0	1	0	0	21
20:30	19	0	0	1	0	0	0	1	0	0	21
20:45	20	2	0	0	0	0	0	1	0	0	23
1 Hr	79	2	3	1	0	0	0	4	0	0	89
21:00	13	2	0	0	0	0	0	0	0	0	15
21:15	12	0	0	0	0	0	0	1	0	0	13
21:30	12	0	0	0	0	0	0	0	0	0	12
21:45	10	0	0	0	0	0	0	0	0	0	10
1 Hr	47	2	0	0	0	0	0	1	0	0	50
22:00	11	1	0	0	0	0	0	1	0	0	13
22:15	11	0	0	0	0	0	0	0	0	0	11
22:30	4	0	0	0	0	0	0	0	0	0	4
22:45	6	0	0	0	0	0	0	0	0	0	6
1 Hr	32	1	0	0	0	0	0	1	0	0	34
23:00	2	1	0	0	0	0	0	0	0	0	3
23:15	7	0	0	0	0	0	0	0	0	0	7
23:30	3	0	0	1	0	0	0	0	0	0	4
23:45	4	0	0	0	0	0	0	0	0	0	4
1 Hr	16	1	0	1	0	0	0	0	0	0	18
6 Hrs	361	13	6	3	0	0	0	24	0	0	407
Total	1565	67	26	15	0	0	0	146	0	0	1819

Direction : Eastbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Pushchair/ Pram	Pushchair/ Pram	Scooter	Railway Personnel	Total
18:00	11	2	0	0	0	0	0	0	0	13
18:15	17	0	0	0	0	0	0	0	0	17
18:30	5	0	0	0	0	0	0	0	0	5
18:45	5	0	0	0	0	0	0	0	0	5
1 Hr	38	2	0	0	0	0	0	0	0	40
19:00	11	0	0	0	0	0	0	0	0	11
19:15	16	2	0	0	0	0	0	0	0	18
19:30	3	0	0	0	0	0	0	0	0	3
19:45	7	0	0	0	0	0	0	0	0	7
1 Hr	37	2	0	0	0	0	0	0	0	39
20:00	8	0	0	0	0	0	0	0	0	8
20:15	1	0	0	0	0	0	0	0	0	1
20:30	2	0	0	0	0	0	0	0	0	2
20:45	4	0	0	0	0	0	0	0	0	4
1 Hr	15	0	0	0	0	0	0	0	0	15
21:00	0	0	0	0	0	0	0	0	0	0
21:15	1	0	0	0	0	0	0	0	0	1
21:30	0	0	0	0	0	0	0	0	0	0
21:45	1	0	0	0	0	0	0	0	0	1
1 Hr	2	0	0	0	0	0	0	0	0	2
22:00	0	0	0	0	0	0	0	0	0	0
22:15	6	0	0	0	0	0	0	0	0	6
22:30	0	0	0	0	0	0	0	0	0	0
22:45	0	0	0	0	0	0	0	0	0	0
1 Hr	6	0	0	0	0	0	0	0	0	6
23:00	0	0	0	0	0	0	0	0	0	0
23:15	3	0	0	0	0	0	0	0	0	3
23:30	0	0	0	0	0	0	0	0	0	0
23:45	0	0	0	0	0	0	0	0	0	0
1 Hr	3	0	0	0	0	0	0	0	0	3
6 Hrs	101	4	0	0	0	0	0	0	0	105
Total	435	31	5	0	0	0	13	0	0	484

Direction : Westbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
18:00	7	0	0	0	0	0	0	0	0	7
18:15	3	0	0	0	0	0	0	0	0	3
18:30	1	0	0	0	0	0	0	0	0	1
18:45	5	0	0	0	0	0	0	0	0	5
1 Hr	16	0	0	0	0	0	0	0	0	16
19:00	5	0	0	0	0	0	0	0	0	5
19:15	5	0	0	0	0	0	0	0	0	5
19:30	1	0	0	0	0	0	0	0	0	1
19:45	3	0	0	0	0	0	0	0	0	3
1 Hr	14	0	0	0	0	0	0	0	0	14
20:00	8	0	0	0	0	0	0	0	0	8
20:15	8	0	0	0	0	0	0	0	0	8
20:30	3	0	0	0	0	0	0	0	0	3
20:45	6	0	0	0	0	0	0	0	0	6
1 Hr	25	0	0	0	0	0	0	0	0	25
21:00	2	0	0	0	0	0	0	0	0	2
21:15	3	0	0	0	0	0	0	0	0	3
21:30	2	0	0	0	0	0	0	0	0	2
21:45	0	0	0	0	0	0	0	0	0	0
1 Hr	7	0	0	0	0	0	0	0	0	7
22:00	4	0	0	0	0	0	0	0	0	4
22:15	3	0	0	0	0	0	0	0	0	3
22:30	0	0	0	0	0	0	0	0	0	0
22:45	0	0	0	0	0	0	0	0	0	0
1 Hr	7	0	0	0	0	0	0	0	0	7
23:00	1	0	0	0	0	0	0	0	0	1
23:15	1	0	0	0	0	0	0	0	0	1
23:30	0	0	0	0	0	0	0	0	0	0
23:45	1	0	0	0	0	0	0	0	0	1
1 Hr	3	0	0	0	0	0	0	0	0	3
6 Hrs	72	0	0	0	0	0	0	0	0	72
Total	264	16	1	0	0	0	7	0	0	288

	TRAINS
18:00	3
18:15	2
18:30	1
18:45	0
1 Hr	6
19:00	6
19:15	1
19:30	0
19:45	1
1 Hr	8
20:00	4
20:15	0
20:30	0
20:45	0
1 Hr	4
21:00	2
21:15	1
21:30	0
21:45	1
1 Hr	4
22:00	2
22:15	1
22:30	0
22:45	0
1 Hr	3
23:00	2
23:15	1
23:30	0
23:45	0
1 Hr	3
6 Hrs	28
Total	74

DURATION	DIRECTION
Northbound	36
Southbound	38
Total	74

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
08:58:39	08:58:42	00:00:03	N
09:10:51	09:11:00	00:00:09	S
09:11:49	09:12:00	00:00:11	N
10:06:39	10:06:49	00:00:10	S
10:11:32	10:11:41	00:00:09	N
10:12:26	10:12:28	00:00:02	S
10:58:20	10:58:22	00:00:02	N
11:05:38	11:05:40	00:00:02	N
11:06:40	11:06:49	00:00:09	S
11:11:37	11:11:45	00:00:08	N
11:13:50	11:13:52	00:00:02	S
11:58:42	11:58:44	00:00:02	N
12:06:36	12:06:38	00:00:02	N
12:08:21	12:08:30	00:00:09	S
12:12:14	12:12:23	00:00:09	N
12:14:53	12:14:54	00:00:01	S
12:58:19	12:58:21	00:00:02	N
13:05:19	13:05:22	00:00:03	N
13:08:56	13:09:06	00:00:10	S
13:11:50	13:12:02	00:00:12	N
13:13:08	13:13:11	00:00:03	S
13:57:44	13:57:46	00:00:02	N
14:05:13	14:05:15	00:00:02	S
14:05:29	14:05:31	00:00:02	N
14:07:53	14:08:04	00:00:11	S
14:12:03	14:12:13	00:00:10	N
14:13:08	14:13:10	00:00:02	S
14:58:10	14:58:13	00:00:03	N
15:06:22	15:06:24	00:00:02	N
15:06:35	15:06:38	00:00:03	S
15:09:48	15:09:59	00:00:11	S
15:11:32	15:11:40	00:00:08	N
15:15:27	15:15:29	00:00:02	S
15:58:50	15:58:52	00:00:02	N
16:03:06	16:03:08	00:00:02	S
16:05:49	16:05:51	00:00:02	N
16:06:59	16:07:11	00:00:12	S
16:11:31	16:11:40	00:00:09	N
16:15:42	16:15:44	00:00:02	S
16:58:59	16:59:02	00:00:03	N
17:05:40	17:05:42	00:00:02	S
17:05:57	17:06:00	00:00:03	N
17:08:04	17:08:13	00:00:09	S
17:12:05	17:12:07	00:00:02	S
17:14:53	17:15:01	00:00:08	N
17:58:00	17:58:02	00:00:02	N
18:07:45	18:07:47	00:00:02	S
18:09:28	18:09:30	00:00:02	N
18:10:45	18:10:56	00:00:11	S
18:15:37	18:15:39	00:00:02	S
18:16:04	18:16:14	00:00:10	N
18:34:25	18:34:27	00:00:02	N
19:00:52	19:00:56	00:00:04	N
19:01:57	19:01:59	00:00:02	S
19:08:10	19:08:12	00:00:02	N
19:10:07	19:10:17	00:00:10	S
19:13:55	19:14:05	00:00:10	N
19:14:28	19:14:30	00:00:02	S
19:22:41	19:22:42	00:00:01	S
19:58:23	19:58:25	00:00:02	N
20:02:13	20:02:15	00:00:02	S
20:05:37	20:05:39	00:00:02	N
20:09:49	20:10:01	00:00:12	S
20:11:59	20:12:06	00:00:07	N
21:02:55	21:02:57	00:00:02	S
21:06:48	21:07:02	00:00:14	S
21:16:22	21:16:24	00:00:02	S
21:58:25	21:58:27	00:00:02	N
22:07:14	22:07:16	00:00:02	S
22:10:21	22:10:33	00:00:12	S
22:17:56	22:18:07	00:00:11	N
23:00:20	23:00:22	00:00:02	S
23:12:26	23:12:35	00:00:09	S
23:17:19	23:17:29	00:00:10	N

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Vehicle stopped near level crossing	09:01:46	09:02:35	ESJ
Drop off	09:00:42	09:00:44	WSJ
Waiting	09:08:56	09:13:29	ESJ
Drop off	09:45:16	09:47:18	ESJ
Drop off	09:47:58	09:48:11	ESJ
Drop off	09:58:31	09:58:39	ESJ
Drop off	09:59:14	10:00:45	ESJ
Pick up	10:13:35	10:13:48	WSJ
Parking	11:04:44	11:13:20	ESJ
Pick up	11:13:26	11:14:00	WSJ
Waiting	11:44:30	11:46:41	ESJ
Pick up	11:45:52	11:46:02	ESJ
Drop off	11:58:26	11:58:46	WSJ
Parking	12:11:17	12:18:50	ESJ
Waiting	12:44:38	12:46:52	ESJ
Pick up	13:11:49	13:15:58	ESJ
Pick up	13:26:37	13:26:55	WSJ
Drop off	15:04:22	15:04:35	WSJ
Drop off	15:53:18	15:54:06	ESJ
Drop off	15:57:57	15:59:09	ESJ
Parking	16:49:42	17:10:18	ESJ
Pick up	17:12:48	17:17:19	ESJ
Parking	17:51:05	17:52:15	ESJ
Drop off	17:52:03	17:52:17	ESJ
Pick up	18:23:37	18:24:01	SEJ
Pick up	18:28:35	18:30:01	SEJ
Pick up	18:39:54	18:40:10	ESJ
Pick up	18:59:26	19:12:09	ESJ
Drop off	19:04:26	19:04:33	ESJ
Drop off	19:13:27	19:15:14	ESJ
Waiting	19:21:51	19:24:05	ESJ
Drop off	19:52:05	19:53:12	ESJ
Drop off	20:03:43	20:03:54	ESJ
Parking	20:53:05	20:58:06	ESJ
Drop off	20:59:03	21:02:54	ESJ
Drop off	21:07:27	21:08:48	WSJ
Waiting	22:07:42	22:10:02	ESJ
Pick up	23:18:56	23:19:34	WSJ
Vehicle stopped near level crossing	23:19:43	23:20:36	ESJ
Waiting	23:36:41	23:37:41	WSJ

Tracsis plc
Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Clayhithe Road Level Crossing
Date: Monday 10th July 2017

AM Weather : Cloudy, dry
PM Weather : Cloudy, dry

Linkcount

Direction: Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	21	3	0	0	0	0	0	0	0	0	24
06:15	37	6	0	2	0	0	0	5	0	0	50
06:30	40	4	0	0	0	0	0	6	0	0	50
06:45	72	6	2	1	0	0	0	3	0	0	84
1 Hr	170	19	2	3	0	0	0	14	0	0	208
07:00	71	15	0	2	0	0	0	3	0	0	91
07:15	102	8	0	1	0	0	0	3	0	1	115
07:30	79	11	1	0	0	1	0	10	0	0	102
07:45	104	3	2	1	0	0	0	8	0	0	118
1 Hr	356	37	3	4	0	1	0	24	0	1	426
08:00	73	5	0	1	0	0	0	15	0	0	94
08:15	91	15	0	0	0	0	0	9	0	0	115
08:30	97	7	0	0	0	0	0	12	0	0	116
08:45	82	10	4	0	0	0	0	15	0	0	111
1 Hr	343	37	4	1	0	0	0	51	0	0	436
09:00	106	10	0	1	0	0	0	6	0	0	123
09:15	88	13	0	2	0	0	0	2	0	0	105
09:30	111	17	1	3	1	1	0	4	0	0	138
09:45	87	8	0	5	0	0	0	1	0	1	102
1 Hr	392	48	1	11	1	1	0	13	0	1	468
10:00	97	13	1	2	0	1	0	0	0	0	114
10:15	99	22	0	8	0	1	0	1	0	0	131
10:30	49	11	0	3	0	0	0	2	0	0	65
10:45	40	12	0	3	0	0	0	0	0	0	55
1 Hr	285	58	1	16	0	2	0	3	0	0	365
11:00	30	11	0	4	0	1	0	0	0	0	46
11:15	39	5	0	3	0	0	0	2	0	0	49
11:30	39	4	0	1	0	1	0	1	0	1	47
11:45	35	8	0	1	0	0	0	0	0	0	44
1 Hr	143	28	0	9	0	2	0	3	0	1	186
6 Hrs	1689	227	11	44	1	6	0	108	0	3	2089

Direction: Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	4	0	0	0	0	0	0	0	0	0	4
06:15	8	1	0	0	0	0	0	0	0	0	9
06:30	3	0	0	0	0	0	0	1	0	0	4
06:45	14	1	0	0	0	0	0	1	0	0	16
1 Hr	29	2	0	0	0	0	0	2	0	0	33
07:00	9	1	0	0	0	0	0	1	0	0	11
07:15	16	8	1	0	0	0	0	2	0	0	27
07:30	16	2	1	0	0	0	0	1	0	0	20
07:45	23	3	1	1	0	0	0	4	0	0	32
1 Hr	64	14	3	1	0	0	0	8	0	0	90
08:00	26	5	0	0	0	0	0	0	0	0	31
08:15	28	8	1	0	0	0	0	2	0	0	39
08:30	25	2	0	2	0	0	0	5	0	0	34
08:45	29	8	0	0	0	0	0	3	0	0	40
1 Hr	108	23	1	2	0	0	0	10	0	0	144
09:00	27	5	0	1	0	0	0	2	0	0	35
09:15	21	6	0	0	0	0	0	1	0	0	28
09:30	22	6	1	1	0	0	0	0	0	0	30
09:45	24	7	1	0	0	1	0	1	0	0	34
1 Hr	94	24	2	2	0	1	0	4	0	0	127
10:00	31	6	0	1	0	0	0	1	0	0	39
10:15	27	2	0	0	0	0	0	1	0	0	30
10:30	33	3	0	1	0	0	0	3	0	0	40
10:45	21	7	0	0	0	0	0	1	0	0	29
1 Hr	112	18	0	2	0	0	0	6	0	0	138
11:00	21	8	0	1	0	0	0	2	0	0	32
11:15	26	0	0	0	0	0	0	3	0	0	29
11:30	36	7	1	0	0	0	0	3	0	0	47
11:45	35	2	1	2	0	0	0	2	0	0	42
1 Hr	118	17	2	3	0	0	0	10	0	0	150
6 Hrs	525	98	8	10	0	1	0	40	0	0	682

	Eastbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	Westbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
06:00	6	0	0	0	0	0	0	0	0	6	4	0	0	0	0	0	0	0	0	4	3
06:15	24	0	0	0	0	0	0	0	0	24	4	0	0	0	0	0	0	0	0	4	1
06:30	18	0	0	0	0	0	0	0	0	18	21	0	0	0	0	0	0	0	0	21	2
06:45	25	1	0	0	0	0	0	0	0	26	6	0	0	0	0	0	0	0	0	6	4
1 Hr	73	1	0	0	0	0	0	0	0	74	35	0	0	0	0	0	0	0	0	35	10
07:00	3	0	0	0	0	0	1	0	0	4	6	0	0	0	0	0	0	0	0	6	2
07:15	51	0	0	0	0	0	0	0	0	51	5	0	0	0	0	0	0	0	0	5	5
07:30	10	0	0	0	0	0	0	0	0	10	10	0	0	0	0	0	0	0	0	10	3
07:45	45	0	0	0	0	0	0	0	0	44	12	0	0	0	0	0	0	0	0	12	1
1 Hr	109	0	0	0	0	0	1	0	0	109	33	0	0	0	0	0	0	0	0	33	11
08:00	28	1	0	0	0	0	1	0	0	27	9	0	0	0	0	0	0	0	0	9	5
08:15	23	0	0	0	0	0	0	0	0	22	5	0	0	0	0	0	0	0	0	5	2
08:30	28	0	0	0	0	0	0	0	0	27	4	0	0	0	0	0	0	0	0	4	2
08:45	17	0	0	0	0	0	1	0	0	17	5	0	0	0	0	0	0	0	0	5	1
1 Hr	96	1	0	0	0	0	2	0	0	93	23	0	0	0	0	0	0	0	0	23	10
09:00	12	0	0	0	0	0	0	0	0	12	4	0	0	0	0	0	0	0	0	4	3
09:15	15	0	0	0	0	0	0	0	0	15	13	0	0	0	0	0	1	0	0	14	2
09:30	12	0	0	0	0	0	1	0	0	13	3	0	0	0	0	0	0	0	0	3	1
09:45	26	2	0	0	0	0	0	0	0	28	5	0	0	0	0	0	0	0	0	5	3
1 Hr	65	2	0	0	0	0	1	0	0	68	25	0	0	0	0	0	1	0	0	26	9
10:00	3	0	0	0	0	0	0	0	0	3	2	1	0	0	0	0	0	0	0	3	2
10:15	8	0	0	0	0	0	0	0	1	9	5	0	0	0	0	0	0	0	1	6	3
10:30	13	0	0	0	0	0	0	0	0	13	5	0	0	0	0	0	0	0	0	5	2
10:45	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
1 Hr	25	0	0	0	0	0	0	0	1	26	13	1	0	0	0	0	0	0	1	15	8
11:00	1	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	6	6	4
11:15	5	0	0	0	0	0	0	0	5	10	3	0	0	0	0	0	0	0	1	4	1
11:30	7	0	0	0	0	0	0	0	0	7	2	0	0	0	0	0	0	0	0	2	2
11:45	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	1
1 Hr	15	0	0	0	0	0	0	0	6	21	7	0	0	0	0	0	0	0	7	14	8
6 Hrs	15	0	0	0	0	0	0	0	6	391	7	0	0	0	0	0	0	0	7	146	56

Linkcount

Direction: Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	35	6	1	0	0	0	0	5	0	0	47
12:15	42	4	0	2	0	0	0	2	0	0	50
12:30	40	9	1	0	0	0	0	1	0	0	51
12:45	27	4	1	0	0	0	0	0	0	0	32
1 Hr	144	23	3	2	0	0	0	8	0	0	180
13:00	40	2	0	0	0	0	0	0	0	0	42
13:15	37	5	0	0	2	0	0	4	0	0	48
13:30	37	5	0	1	0	1	0	2	0	0	46
13:45	29	0	0	0	0	0	0	1	0	0	30
1 Hr	143	12	0	1	2	1	0	7	0	0	166
14:00	27	4	1	0	0	0	0	0	0	0	32
14:15	22	2	0	0	0	0	0	0	0	0	24
14:30	23	4	0	1	0	0	0	0	0	0	28
14:45	25	3	0	2	0	0	0	0	0	0	30
1 Hr	97	13	1	3	0	0	0	0	0	0	114
15:00	29	2	0	0	0	0	0	0	0	0	31
15:15	21	3	0	1	0	0	0	0	0	0	25
15:30	35	3	1	0	0	0	0	3	0	0	42
15:45	30	8	0	0	0	0	0	2	0	0	40
1 Hr	115	16	1	1	0	0	0	5	0	0	138
16:00	35	3	0	2	0	0	0	5	0	0	45
16:15	30	4	0	1	0	0	0	2	0	0	37
16:30	29	10	1	0	0	0	0	2	0	0	42
16:45	27	1	0	0	0	0	0	3	0	0	31
1 Hr	121	18	1	3	0	0	0	12	0	0	155
17:00	41	2	0	1	0	0	0	5	0	0	49
17:15	20	2	1	0	0	0	0	3	0	0	26
17:30	41	3	0	0	0	0	0	2	0	0	46
17:45	30	6	2	0	0	0	0	3	0	0	41
1 Hr	132	13	3	1	0	0	0	13	0	0	162
6 Hrs	752	95	9	11	2	1	0	45	0	0	915

Direction: Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	41	3	1	1	0	0	0	0	0	0	46
12:15	36	2	0	2	0	0	0	3	0	0	43
12:30	32	4	1	0	0	0	0	1	0	0	38
12:45	34	4	0	0	0	1	0	0	0	0	39
1 Hr	143	13	2	3	0	1	0	4	0	0	166
13:00	28	7	1	2	0	0	0	2	0	0	40
13:15	26	7	0	1	0	0	0	1	0	0	35
13:30	33	5	0	0	0	0	0	0	0	0	38
13:45	36	3	0	1	0	0	0	0	0	0	40
1 Hr	123	22	1	4	0	0	0	3	0	0	153
14:00	38	7	1	1	0	0	0	1	0	0	48
14:15	44	5	0	1	1	0	0	0	0	0	51
14:30	33	3	0	1	0	0	0	2	0	0	39
14:45	47	9	1	1	0	1	0	2	0	0	61
1 Hr	162	24	2	4	1	1	0	5	0	0	199
15:00	39	6	1	3	0	0	0	2	0	0	51
15:15	45	11	0	0	0	0	0	1	0	0	57
15:30	42	10	1	0	0	1	0	4	0	0	58
15:45	56	11	0	0	0	0	0	2	0	0	69
1 Hr	182	38	2	3	0	1	0	9	0	0	235
16:00	48	6	0	0	0	0	0	1	0	0	55
16:15	68	6	0	2	0	0	0	4	0	0	80
16:30	56	7	0	0	0	0	0	5	0	0	68
16:45	67	9	1	1	0	0	0	3	0	0	81
1 Hr	239	28	1	3	0	0	0	13	0	0	284
17:00	67	5	0	1	0	0	0	4	0	0	77
17:15	57	7	4	1	0	0	0	7	0	0	76
17:30	82	2	1	0	0	0	0	0	0	0	85
17:45	70	5	1	0	0	0	0	8	0	0	84
1 Hr	276	19	6	2	0	0	0	19	0	0	322
6 Hrs	1125	144	14	19	1	3	0	53	0	0	1359

	Eastbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	Westbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
12:00	4	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	1	3
12:15	15	0	0	0	0	0	1	0	0	16	6	0	0	0	0	0	0	0	0	6	2
12:30	7	0	0	0	0	0	0	0	0	7	4	0	0	0	0	0	0	0	0	4	1
12:45	7	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	3	2
1 Hr	33	0	0	0	0	0	1	0	0	34	14	0	0	0	0	0	0	0	0	14	8
13:00	2	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	1	3
13:15	8	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	3	2
13:30	3	0	0	0	0	0	0	0	0	3	5	1	0	0	0	0	1	0	0	7	2
13:45	3	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	1	2
1 Hr	16	0	0	0	0	0	0	0	0	15	10	1	0	0	0	0	1	0	0	12	9
14:00	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	4
14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14:30	8	0	0	0	0	0	0	0	0	8	2	0	0	0	0	0	0	0	0	2	2
14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	10	0	0	0	0	0	0	0	0	10	4	0	0	0	0	0	0	0	0	4	8
15:00	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	4
15:15	5	3	0	0	0	0	0	0	0	8	2	0	0	0	0	0	0	0	0	2	1
15:30	5	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	2	4
15:45	7	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	3	2
1 Hr	19	3	0	0	0	0	0	0	0	22	9	0	0	0	0	0	0	0	0	9	11
16:00	10	0	0	0	0	0	1	0	0	9	6	0	0	0	0	0	0	0	0	6	4
16:15	7	3	0	0	0	0	0	0	0	8	2	0	0	0	0	0	1	0	0	3	3
16:30	5	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	2	2
16:45	1	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0	0	5	1
1 Hr	23	3	0	0	0	0	1	0	0	23	12	3	0	0	0	0	1	0	0	16	10
17:00	6	0	0	0	0	0	1	0	0	7	1	0	0	0	0	0	0	0	0	1	4
17:15	5	0	0	0	0	0	0	0	0	5	9	0	0	0	0	0	0	0	0	9	2
17:30	18	0	0	0	0	0	0	0	0	18	5	0	0	0	0	0	0	0	0	5	2
17:45	13	0	0	0	0	0	0	0	0	13	3	0	0	0	0	0	1	0	0	4	3
1 Hr	42	0	0	0	0	0	1	0	0	43	18	0	0	0	0	0	1	0	0	19	11
6 Hrs	42	0	0	0	0	0	1	0	0	147	17	0	0	0	0	0	1	0	0	74	57

Linkcount

Direction: Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	32	1	1	0	0	0	0	5	0	0	39
18:15	23	3	0	0	0	0	0	2	0	0	28
18:30	30	3	0	0	0	0	0	0	0	0	33
18:45	30	0	1	1	1	0	0	1	0	0	34
1 Hr	115	7	2	1	1	0	0	8	0	0	134
19:00	25	1	0	1	0	0	0	0	0	0	27
19:15	7	1	0	1	0	0	0	0	0	0	9
19:30	13	1	1	0	0	0	0	0	0	0	15
19:45	13	3	0	0	0	0	0	0	0	0	16
1 Hr	58	6	1	2	0	0	0	0	0	0	67
20:00	22	3	0	1	0	0	0	2	0	0	28
20:15	9	1	0	0	0	0	0	0	0	0	10
20:30	11	2	0	0	0	0	0	2	0	0	15
20:45	9	0	0	0	0	0	0	1	0	0	10
1 Hr	51	6	0	1	0	0	0	5	0	0	63
21:00	8	1	1	0	0	0	0	1	0	0	11
21:15	14	0	0	0	0	0	0	2	0	0	16
21:30	7	0	0	0	0	0	0	0	0	0	7
21:45	1	0	0	0	0	0	0	1	0	0	2
1 Hr	30	1	1	0	0	0	0	4	0	0	36
22:00	8	0	0	0	0	0	0	0	0	0	8
22:15	5	0	1	0	0	0	0	0	0	0	6
22:30	1	0	0	0	0	0	0	0	0	0	1
22:45	1	0	0	0	0	0	0	0	0	0	1
1 Hr	15	0	1	0	0	0	0	0	0	0	16
23:00	1	0	0	0	0	0	0	0	0	0	1
23:15	0	1	0	0	0	0	0	0	0	0	1
23:30	1	0	0	0	0	0	0	0	0	0	1
23:45	2	0	0	0	0	0	0	0	0	0	2
1 Hr	4	1	0	0	0	0	0	0	0	0	5
6 Hrs	273	21	5	4	1	0	0	17	0	0	321
Total	2714	343	25	59	4	7	0	170	0	3	3325

Direction: Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	41	2	3	1	0	0	0	7	0	0	54
18:15	50	8	0	1	0	0	0	10	0	0	69
18:30	46	4	2	1	0	0	0	10	0	0	63
18:45	51	3	0	0	0	0	0	3	0	0	57
1 Hr	188	17	5	3	0	0	0	30	0	0	243
19:00	39	2	0	0	0	0	0	3	0	0	44
19:15	35	3	0	0	0	0	0	1	0	0	39
19:30	45	1	0	0	0	0	0	0	0	0	46
19:45	26	3	2	1	1	0	0	0	0	0	33
1 Hr	145	9	2	1	1	0	0	4	0	0	162
20:00	25	2	0	0	0	0	0	1	0	0	28
20:15	23	1	0	0	0	0	0	3	0	0	27
20:30	21	2	0	0	0	0	0	3	0	0	26
20:45	15	3	0	0	0	0	0	2	0	0	20
1 Hr	84	8	0	0	0	0	0	9	0	0	101
21:00	12	1	0	0	0	0	0	1	0	0	14
21:15	27	1	0	0	0	0	0	1	0	0	29
21:30	12	0	1	0	0	0	0	1	0	0	14
21:45	16	0	0	0	0	0	0	0	0	0	16
1 Hr	67	2	1	0	0	0	0	3	0	0	73
22:00	14	0	0	0	0	0	0	1	0	0	15
22:15	9	0	0	0	0	0	0	0	0	0	9
22:30	6	0	0	1	0	0	0	0	0	0	7
22:45	6	0	0	0	0	0	0	0	0	0	6
1 Hr	35	0	0	1	0	0	0	1	0	0	37
23:00	6	0	0	0	0	0	0	0	0	0	6
23:15	6	0	0	0	0	0	0	0	0	0	6
23:30	4	0	0	0	0	0	0	0	0	0	4
23:45	2	0	0	0	0	0	0	0	0	0	2
1 Hr	18	0	0	0	0	0	0	0	0	0	18
6 Hrs	537	36	8	5	1	0	0	47	0	0	634
Total	2187	278	30	34	2	4	0	140	0	0	2675

	Eastbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Pushchair/ Pram	Pushchair/ Pram	Scooter	Railway Personnel	Total	Westbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
18:00	11	0	0	0	0	0	0	0	0	11	3	0	0	0	0	0	0	0	0	3	3
18:15	6	0	0	0	0	0	0	0	0	6	8	0	0	0	0	0	0	0	0	8	3
18:30	10	0	0	0	0	0	0	0	0	10	3	0	0	0	0	0	0	0	0	3	1
18:45	25	0	0	0	0	0	0	0	0	25	2	0	0	0	0	0	0	0	0	2	3
1 Hr	52	0	0	0	0	0	0	0	0	52	16	0	0	0	0	0	0	0	0	16	10
19:00	6	0	0	0	0	0	1	0	0	7	6	0	0	0	0	0	0	0	0	6	3
19:15	1	0	0	0	0	0	0	0	0	1	6	0	0	0	0	0	0	0	0	6	3
19:30	18	0	0	0	0	0	0	0	0	18	6	0	0	0	0	0	0	0	0	6	3
19:45	16	0	0	0	0	0	0	0	0	16	1	1	0	0	0	0	0	0	0	2	2
1 Hr	41	0	0	0	0	0	1	0	0	42	19	1	0	0	0	0	0	0	0	20	11
20:00	11	0	0	0	0	0	0	0	0	11	10	0	0	0	0	0	0	0	0	10	3
20:15	8	0	0	0	0	0	0	0	0	8	2	0	0	0	0	0	0	0	0	2	4
20:30	1	0	0	0	0	0	0	0	0	1	9	1	0	0	0	0	0	0	0	10	0
20:45	13	5	0	0	0	0	0	0	0	18	4	2	0	0	0	0	0	0	0	6	3
1 Hr	33	5	0	0	0	0	0	0	0	38	25	3	0	0	0	0	0	0	0	28	10
21:00	4	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	2	3
21:15	8	0	0	0	0	0	0	0	0	8	4	0	0	0	0	0	0	0	0	4	3
21:30	1	0	0	0	0	0	0	0	0	1	7	0	0	0	0	0	0	0	0	7	2
21:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	13	0	0	0	0	0	0	0	0	13	13	0	0	0	0	0	0	0	0	13	9
22:00	5	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	2	3
22:15	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	3
22:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1 Hr	5	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0	3	8
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
23:15	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3
23:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	7
6 Hrs	145	5	0	0	0	0	1	0	0	151	76	4	0	0	0	0	0	0	0	80	55
Total	202	5	0	0	0	0	2	0	6	689	100	4	0	0	0	0	1	0	7	300	168

Northbound	84
Southbound	84
Total	168

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
06:00:03	06:00:05	00:00:02	N
06:09:50	06:09:52	00:00:02	N
06:14:17	06:14:20	00:00:03	N
06:23:03	06:23:15	00:00:12	N
06:30:52	06:31:01	00:00:09	S
06:41:34	06:41:36	00:00:02	S
06:47:16	06:47:26	00:00:10	S
06:51:04	06:51:09	00:00:05	N
06:55:33	06:55:38	00:00:05	S
06:59:58	07:00:09	00:00:11	S
07:03:03	07:03:06	00:00:03	N
07:07:45	07:07:47	00:00:02	N
07:16:22	07:16:27	00:00:05	N
07:19:23	07:19:26	00:00:03	N
07:23:40	07:23:44	00:00:04	S
07:24:50	07:25:01	00:00:11	N
07:29:06	07:29:09	00:00:03	N
07:30:38	07:30:49	00:00:11	S
07:39:20	07:39:25	00:00:05	S
07:41:56	07:41:58	00:00:02	S
07:56:53	07:57:04	00:00:11	S
08:01:54	08:01:56	00:00:02	S
08:03:32	08:03:33	00:00:01	N
08:07:53	08:07:55	00:00:02	S
08:10:49	08:11:00	00:00:11	S
08:11:06	08:11:17	00:00:11	N
08:16:24	08:16:34	00:00:10	N
08:20:59	08:21:01	00:00:02	N
08:43:44	08:43:55	00:00:11	N
08:44:32	08:44:45	00:00:13	S
08:50:43	08:50:45	00:00:02	S
09:02:54	09:02:56	00:00:02	S
09:08:17	09:08:28	00:00:11	S
09:10:22	09:10:23	00:00:01	N
09:16:06	09:16:08	00:00:02	N
09:19:28	09:19:30	00:00:02	N
09:39:33	09:39:44	00:00:11	S
09:47:18	09:47:20	00:00:02	S
09:54:39	09:54:48	00:00:09	N
09:58:24	09:58:34	00:00:10	S
10:03:58	10:04:01	00:00:03	S
10:10:09	10:10:11	00:00:02	N
10:18:52	10:18:55	00:00:03	N
10:19:28	10:19:30	00:00:02	S
10:24:30	10:24:35	00:00:05	N
10:37:15	10:37:27	00:00:12	S
10:41:14	10:41:25	00:00:11	N
10:49:37	10:49:39	00:00:02	S
11:04:29	11:04:31	00:00:02	S
11:07:14	11:07:16	00:00:02	N
11:07:54	11:07:59	00:00:05	S
11:12:05	11:12:10	00:00:05	N
11:18:38	11:18:40	00:00:02	N
11:36:33	11:36:44	00:00:11	S
11:43:33	11:43:42	00:00:09	N
11:51:43	11:51:46	00:00:03	S
12:05:24	12:05:26	00:00:02	S
12:07:48	12:07:53	00:00:05	S
12:10:58	12:11:00	00:00:02	N
12:19:04	12:19:06	00:00:02	N
12:21:42	12:21:44	00:00:02	N
12:37:56	12:38:07	00:00:11	S
12:48:07	12:48:16	00:00:09	N
12:48:36	12:48:38	00:00:02	S
13:06:37	13:06:39	00:00:02	N
13:07:39	13:07:41	00:00:02	S
13:11:04	13:11:07	00:00:03	S
13:20:31	13:20:33	00:00:02	N
13:25:35	13:25:39	00:00:04	N
13:39:41	13:39:51	00:00:10	S
13:44:27	13:44:36	00:00:09	N
13:49:22	13:49:24	00:00:02	S
13:59:56	14:00:11	00:00:15	N
14:08:40	14:08:42	00:00:02	N
14:08:57	14:09:00	00:00:03	S
14:11:27	14:11:32	00:00:05	S
14:12:12	14:12:17	00:00:05	N
14:17:54	14:17:56	00:00:02	N
14:39:10	14:39:21	00:00:11	S
14:40:40	14:40:49	00:00:09	N
14:50:06	14:50:08	00:00:02	S
15:02:35	15:02:38	00:00:03	S
15:06:47	15:06:52	00:00:05	S
15:09:24	15:09:26	00:00:02	N
15:14:14	15:14:17	00:00:03	N
15:18:48	15:18:50	00:00:02	N
15:36:23	15:36:33	00:00:10	N
15:37:23	15:37:34	00:00:11	S
15:40:16	15:40:27	00:00:11	N
15:41:06	15:41:18	00:00:12	S
15:51:26	15:51:29	00:00:03	S
15:56:55	15:57:06	00:00:11	N
16:02:50	16:02:52	00:00:02	S
16:09:15	16:09:18	00:00:03	N
16:13:51	16:13:56	00:00:05	N
16:14:24	16:14:34	00:00:10	S
16:18:24	16:18:27	00:00:03	N
16:21:30	16:21:33	00:00:03	S
16:25:03	16:25:13	00:00:10	N
16:33:21	16:33:23	00:00:02	S
16:42:46	16:42:55	00:00:09	N
16:49:50	16:49:52	00:00:02	S
17:07:24	17:07:27	00:00:03	N
17:07:26	17:07:27	00:00:01	S
17:10:48	17:10:53	00:00:05	S
17:11:28	17:11:33	00:00:05	N
17:17:40	17:17:51	00:00:11	S
17:18:23	17:18:25	00:00:02	N
17:33:00	17:33:13	00:00:13	N
17:34:08	17:34:10	00:00:02	S
17:50:08	17:50:11	00:00:03	S
17:55:53	17:56:03	00:00:10	N
17:55:53	17:55:56	00:00:03	S
18:03:35	18:03:40	00:00:05	S
18:07:51	18:07:54	00:00:03	S
18:09:08	18:09:10	00:00:02	N
18:16:40	18:16:50	00:00:10	S
18:17:02	18:17:07	00:00:05	N
18:21:19	18:21:21	00:00:02	N
18:30:31	18:30:44	00:00:13	N
18:46:21	18:46:32	00:00:11	N
18:48:10	18:48:12	00:00:02	S
18:53:57	18:54:00	00:00:03	S
19:01:33	19:01:35	00:00:02	S
19:07:05	19:07:10	00:00:05	S
19:07:08	19:07:09	00:00:01	N
19:17:48	19:17:53	00:00:05	N
19:21:53	19:22:02	00:00:09	S
19:29:53	19:29:55	00:00:02	N
19:34:25	19:34:28	00:00:03	N
19:37:42	19:37:53	00:00:11	N
19:43:35	19:43:37	00:00:02	S
19:47:33	19:47:36	00:00:03	S
19:47:46	19:47:56	00:00:10	N
20:02:06	20:02:08	00:00:02	S
20:07:10	20:07:12	00:00:02	S
20:07:21	20:07:23	00:00:02	N
20:15:28	20:15:33	00:00:05	N
20:21:37	20:21:48	00:00:11	S
20:22:37	20:22:48	00:00:11	N
20:27:31	20:27:33	00:00:02	N
20:46:54	20:47:03	00:00:09	N
20:48:55	20:48:56	00:00:01	S
20:58:02	20:58:04	00:00:02	N
21:02:00	21:02:02	00:00:02	S
21:08:06	21:08:08	00:00:02	N
21:09:53	21:09:58	00:00:05	S
21:15:24	21:15:37	00:00:13	N
21:18:22	21:18:33	00:00:11	S
21:24:26	21:24:27	00:00:01	N
21:34:32	21:34:35	00:00:03	S
21:38:10	21:38:13	00:00:03	S
21:52:12	21:52:14	00:00:02	N
22:00:44	22:01:00	00:00:16	N
22:06:03	22:06:05	00:00:02	S
22:11:02	22:11:05	00:00:03	S
22:17:49	22:17:57	00:00:08	N
22:17:56	22:18:07	00:00:11	S
22:25:38	22:25:40	00:00:02	S
22:48:31	22:48:35	00:00:04	S
22:49:00	22:49:12	00:00:12	N
23:03:15	23:03:17	00:00:02	S
23:03:24	23:03:26	00:00:02	N
23:11:13	23:11:25	00:00:12	S
23:17:49	23:18:01	00:00:12	N
23:18:22	23:18:24	00:00:02	S
23:25:18	23:25:36	00:00:18	N
23:49:50	23:49:52	00:00:02	S

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Parking	06:10:28	06:23:21	ESJ
Drop off	06:35:05	06:35:56	ESJ
Drop off	08:06:22	08:06:48	ESJ
Pick up	08:20:26	08:20:49	ESJ
Drop off	08:31:22	08:31:42	ESJ
Pick up	08:33:33	08:33:42	ESJ
Drop off	08:34:16	08:34:26	WSJ
Drop off	08:39:04	08:39:18	ESJ
Pick up	08:53:27	08:53:37	ESJ
Drop off	09:01:58	09:02:26	ESJ
Drop off	09:05:15	09:07:41	ESJ
Parking	09:33:35	09:56:12	ESJ
Drop off	10:26:07	10:26:50	WSJ
Parking	11:09:19	11:44:00	WSJ
Drop off	12:14:55	12:16:07	ESJ
Drop off	13:17:31	13:17:48	WSJ
Parking	13:28:21	13:41:04	ESJ
Parking	14:18:33	14:40:22	ESJ
Drop off	14:31:03	14:31:43	ESJ
Drop off	15:21:30	15:21:59	ESJ
Drop off	16:04:52	16:05:55	WSJ
Drop off	17:03:51	17:04:39	ESJ
Drop off	17:07:48	17:08:39	ESJ
Pick up	17:31:03	17:35:42	ESJ
Parking	17:37:44	17:38:35	ESJ
Drop off	18:05:26	18:05:54	WSJ
Pick up	18:28:27	18:32:29	ESJ
Pick up	18:28:40	18:32:29	ESJ
Parking	18:35:39	18:48:28	ESJ
Parking	19:35:01	19:39:57	ESJ
Drop off	20:07:52	20:09:46	WSJ
Waiting	20:18:52	20:20:53	ESJ
Parking	21:39:34	22:01:19	ESJ
Drop off	22:08:23	22:08:50	WSJ

Tracsis plc
Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Clayhithe Road Level Crossing
Date: Tuesday 11th July 2017

AM Weather : Dry, cloudy
PM Weather : Rain showers

Linkcount

Direction : Eastbound (vehicles)

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	18	2	1	0	0	0	0	0	0	0	21
06:15	42	7	0	1	0	0	0	3	0	0	53
06:30	52	6	0	1	0	0	0	7	0	0	66
06:45	45	3	0	0	0	0	0	3	0	0	51
1 Hr	157	18	1	2	0	0	0	13	0	0	191
07:00	83	9	2	1	0	0	0	4	0	0	99
07:15	81	11	0	2	0	0	0	9	0	1	104
07:30	104	12	1	2	0	1	0	5	0	0	125
07:45	110	7	1	1	0	0	0	6	0	0	125
1 Hr	378	39	4	6	0	1	0	24	0	1	453
08:00	78	11	1	0	0	0	0	10	0	0	100
08:15	96	9	1	1	0	0	0	10	0	0	117
08:30	93	6	1	1	0	0	0	6	0	0	107
08:45	74	6	0	1	0	0	0	5	0	0	86
1 Hr	341	32	3	3	0	0	0	31	0	0	410
09:00	61	4	0	1	0	0	0	7	0	0	73
09:15	62	7	0	2	0	0	0	3	0	0	74
09:30	51	2	2	0	1	1	0	1	0	0	58
09:45	46	6	0	3	0	0	0	1	0	0	56
1 Hr	220	19	2	6	1	1	0	12	0	0	261
10:00	30	2	0	1	0	0	0	1	0	0	34
10:15	32	3	0	0	0	0	0	1	0	0	36
10:30	28	7	0	0	0	0	0	1	0	0	36
10:45	23	6	2	0	0	0	0	1	0	0	32
1 Hr	113	18	2	1	0	0	0	4	0	0	138
11:00	27	3	0	2	0	0	0	1	0	0	33
11:15	46	3	0	0	0	0	0	1	0	0	50
11:30	33	5	0	0	1	1	0	1	0	0	41
11:45	27	3	0	0	0	0	0	3	0	0	33
1 Hr	133	14	0	2	1	1	0	6	0	0	157
6 Hrs	1342	140	12	20	2	3	0	90	0	1	1610

Direction : Westbound (vehicles)

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	5	1	1	1	0	0	0	0	0	0	8
06:15	5	2	1	0	0	0	0	0	0	0	8
06:30	6	1	0	0	0	0	0	2	0	0	9
06:45	11	3	0	0	0	0	0	1	0	0	15
1 Hr	27	7	2	1	0	0	0	3	0	0	40
07:00	9	4	0	0	0	0	0	1	0	0	14
07:15	16	3	1	0	0	0	0	4	0	0	24
07:30	15	6	0	1	0	0	0	1	0	0	23
07:45	29	5	0	0	0	0	0	0	0	0	34
1 Hr	69	18	1	1	0	0	0	6	0	0	95
08:00	29	7	0	0	0	0	0	2	0	0	38
08:15	21	4	0	0	0	0	0	2	0	0	27
08:30	34	3	0	1	0	0	0	2	0	0	40
08:45	33	6	0	0	0	0	0	1	0	0	40
1 Hr	117	20	0	1	0	0	0	7	0	0	145
09:00	24	1	0	0	0	0	0	5	0	0	30
09:15	19	5	0	0	0	0	0	1	0	0	25
09:30	23	1	0	0	0	0	0	1	0	0	25
09:45	19	4	0	2	0	0	0	1	0	0	26
1 Hr	85	11	0	2	0	0	0	8	0	0	106
10:00	25	8	0	0	0	0	0	1	0	0	34
10:15	17	1	1	0	0	0	0	1	0	0	20
10:30	20	5	0	1	0	0	0	1	0	0	27
10:45	22	6	0	1	0	0	0	0	0	0	29
1 Hr	84	20	1	2	0	0	0	3	0	0	110
11:00	26	1	0	3	1	0	0	0	0	0	31
11:15	25	4	0	0	0	0	0	0	0	0	29
11:30	26	7	0	3	0	0	0	0	0	0	36
11:45	31	1	0	2	0	0	0	1	0	0	35
1 Hr	108	13	0	8	1	0	0	1	0	0	131
6 Hrs	490	89	4	15	1	0	0	28	0	0	627

Direction : Eastbound (pedestrians)

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
06:00	4	0	0	0	0	0	0	0	0	4
06:15	28	0	0	0	0	0	0	0	0	28
06:30	16	1	0	0	0	0	0	0	0	17
06:45	15	0	0	0	0	0	0	0	0	15
1 Hr	63	1	0	0	0	0	0	0	0	64
07:00	5	0	0	0	0	0	0	0	0	5
07:15	46	0	0	0	0	0	0	0	0	46
07:30	10	0	0	0	0	0	0	0	0	10
07:45	37	0	0	0	0	0	0	0	0	37
1 Hr	98	0	0	0	0	0	0	0	0	98
08:00	33	0	0	0	0	0	0	0	2	35
08:15	23	0	0	0	0	0	0	0	0	23
08:30	30	0	0	0	0	0	0	0	0	30
08:45	13	0	0	0	0	0	1	0	3	17
1 Hr	99	0	0	0	0	0	1	0	5	105
09:00	14	0	0	0	0	0	0	0	0	14
09:15	10	0	0	0	0	0	0	0	0	10
09:30	18	0	0	0	0	0	0	0	0	18
09:45	10	0	0	0	0	0	0	0	1	11
1 Hr	52	0	0	0	0	0	0	0	1	53
10:00	9	1	0	0	0	0	0	0	2	12
10:15	7	0	0	0	0	0	0	0	1	8
10:30	6	0	0	0	0	0	1	0	1	8
10:45	0	0	0	0	0	0	0	0	2	2
1 Hr	22	1	0	0	0	0	1	0	6	30
11:00	3	0	0	0	0	0	0	0	1	4
11:15	6	0	0	0	0	0	1	0	1	8
11:30	5	0	0	0	0	0	0	0	2	7
11:45	2	0	0	0	0	0	0	0	0	2
1 Hr	16	0	0	0	0	0	1	0	4	21
6 Hrs	350	2	0	0	0	0	3	0	16	371

Direction : Westbound (pedestrians)

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
06:00	2	0	0	0	0	0	0	0	0	2
06:15	3	0	0	0	0	0	0	0	0	3
06:30	18	0	0	0	0	0	0	0	0	18
06:45	4	0	0	0	0	0	0	0	0	4
1 Hr	27	0	0	0	0	0	0	0	0	27
07:00	5	0	0	0	0	0	0	0	0	5
07:15	6	0	0	0	0	0	0	0	0	6
07:30	7	0	0	0	0	0	0	0	0	7
07:45	11	0	0	0	0	0	0	0	1	12
1 Hr	29	0	0	0	0	0	0	0	1	30
08:00	10	0	0	0	0	0	0	0	1	11
08:15	6	0	0	0	0	0	0	0	0	6
08:30	3	0	0	0	0	0	0	0	2	5
08:45	5	0	0	0	0	0	0	0	1	6
1 Hr	24	0	0	0	0	0	0	0	4	28
09:00	4	0	0	0	0	0	0	0	0	4
09:15	1	0	0	0	0	0	0	0	2	3
09:30	5	0	0	0	0	0	0	0	0	5
09:45	11	0	0	0	0	0	0	0	0	11
1 Hr	21	0	0	0	0	0	0	0	2	23
10:00	4	1	0	0	0	0	0	0	2	7
10:15	1	0	0	0	0	0	0	0	1	2
10:30	2	0	0	0	0	0	0	0	0	2
10:45	2	0	0	0	0	0	0	0	2	4
1 Hr	9	1	0	0	0	0	0	0	5	15
11:00	4	0	0	0	0	0	0	0	0	4
11:15	1	0	0	0	0	0	0	0	2	3
11:30	3	0	0	0	0	0	0	0	2	5
11:45	0	0	0	0	0	0	0	0	1	1
1 Hr	8	0	0	0	0	0	0	0	5	13
6 Hrs	118	1	0	0	0	0	0	0	17	136

	TRAINS
06:00	2
06:15	2
06:30	2
06:45	4
1 Hr	10
07:00	3
07:15	3
07:30	4
07:45	2
1 Hr	12
08:00	4
08:15	3
08:30	1
08:45	2
1 Hr	10
09:00	4
09:15	1
09:30	1
09:45	3
1 Hr	9
10:00	2
10:15	3
10:30	2
10:45	1
1 Hr	8
11:00	3
11:15	2
11:30	1
11:45	3
1 Hr	9
6 Hrs	58

Linkcount

Direction : Eastbound (vehicles)

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	35	5	0	2	0	0	0	0	0	0	42
12:15	29	1	0	0	0	0	0	0	0	0	30
12:30	27	3	0	0	0	0	0	0	0	0	30
12:45	23	11	0	1	0	0	0	2	0	0	37
1 Hr	114	20	0	3	0	0	0	2	0	0	139
13:00	25	3	0	0	0	0	0	0	0	0	28
13:15	30	6	0	0	0	0	0	0	0	0	36
13:30	30	6	1	0	0	1	0	1	0	0	39
13:45	29	3	0	0	0	0	0	0	0	0	32
1 Hr	114	18	1	0	0	1	0	1	0	0	135
14:00	21	6	0	0	0	0	0	0	0	0	27
14:15	28	2	0	0	0	0	0	0	0	0	30
14:30	26	4	0	0	0	0	0	0	0	0	30
14:45	31	7	0	0	0	0	0	0	0	0	38
1 Hr	106	19	0	0	0	0	0	0	0	0	125
15:00	37	3	0	0	0	0	0	1	0	0	41
15:15	20	5	0	0	0	0	0	2	0	0	27
15:30	29	2	0	0	0	0	0	1	0	0	32
15:45	19	2	0	0	0	0	0	1	0	0	22
1 Hr	105	12	0	0	0	0	0	5	0	0	122
16:00	41	10	0	1	0	0	0	9	0	0	61
16:15	26	3	0	0	0	0	0	1	0	0	30
16:30	28	4	1	0	0	0	0	0	0	0	33
16:45	43	1	0	0	0	0	0	1	0	0	45
1 Hr	138	18	1	1	0	0	0	11	0	0	169
17:00	35	3	0	0	0	0	0	4	0	0	42
17:15	46	1	0	0	0	0	0	2	0	0	49
17:30	42	1	0	1	0	0	0	1	0	0	45
17:45	26	2	0	0	0	0	0	1	0	0	29
1 Hr	149	7	0	1	0	0	0	8	0	0	165
6 Hrs	726	94	2	5	0	1	0	27	0	0	855

Direction : Westbound (vehicles)

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	32	3	1	1	0	0	0	1	0	0	38
12:15	30	3	0	3	0	0	0	0	0	0	36
12:30	28	2	0	0	0	0	0	1	0	0	31
12:45	29	7	1	1	0	1	0	1	0	0	40
1 Hr	119	15	2	5	0	1	0	3	0	0	145
13:00	26	5	0	0	0	0	0	2	0	0	33
13:15	34	7	0	2	0	0	0	0	0	0	43
13:30	31	5	0	0	0	0	0	1	0	0	37
13:45	23	7	0	1	0	0	0	2	0	0	33
1 Hr	114	24	0	3	0	0	0	5	0	0	146
14:00	43	9	0	0	0	0	0	0	0	0	52
14:15	37	6	0	2	0	0	0	1	0	0	46
14:30	34	5	0	0	0	0	0	2	0	0	41
14:45	43	12	0	2	0	1	0	3	0	0	61
1 Hr	157	32	0	4	0	1	0	6	0	0	200
15:00	41	8	0	0	0	0	0	0	0	0	49
15:15	37	7	0	0	0	0	0	0	0	0	44
15:30	40	11	0	0	0	0	0	4	0	0	55
15:45	78	8	1	4	0	0	0	3	0	0	94
1 Hr	196	34	1	4	0	0	0	7	0	0	242
16:00	52	6	0	0	0	0	0	1	0	0	59
16:15	60	6	1	1	0	0	0	3	0	0	71
16:30	50	9	1	2	0	0	0	1	0	0	63
16:45	78	7	0	0	0	0	0	4	0	0	89
1 Hr	240	28	2	3	0	0	0	9	0	0	282
17:00	77	8	0	0	0	0	0	1	0	0	86
17:15	71	8	0	0	0	0	0	5	0	0	84
17:30	74	5	0	3	0	1	0	6	0	0	89
17:45	68	4	0	3	0	1	0	4	0	0	80
1 Hr	290	25	0	6	0	2	0	16	0	0	339
6 Hrs	1116	158	5	25	0	4	0	46	0	0	1354

Direction : Eastbound (pedestrians)

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
12:00	0	0	0	0	0	0	0	0	0	0
12:15	6	0	0	0	0	0	1	0	2	9
12:30	10	0	0	0	0	0	0	0	0	10
12:45	5	0	0	0	0	0	0	0	0	5
1 Hr	21	0	0	0	0	0	1	0	2	24
13:00	4	2	0	0	0	0	0	0	0	6
13:15	3	0	0	0	0	0	0	0	0	3
13:30	8	0	0	0	0	0	0	0	0	8
13:45	0	0	0	0	0	0	0	0	0	0
1 Hr	15	2	0	0	0	0	0	0	0	17
14:00	0	0	0	0	0	0	0	0	0	0
14:15	4	0	0	0	0	0	0	0	0	4
14:30	10	0	0	0	0	0	0	0	0	10
14:45	0	0	0	0	0	0	0	0	0	0
1 Hr	14	0	0	0	0	0	0	0	0	14
15:00	1	0	0	0	0	0	0	0	0	1
15:15	10	0	0	0	0	0	0	0	0	10
15:30	9	1	0	0	0	0	0	0	0	10
15:45	3	0	0	0	0	0	0	0	0	3
1 Hr	23	1	0	0	0	0	0	0	0	24
16:00	8	0	0	0	0	0	0	0	0	8
16:15	5	0	0	0	0	0	0	0	0	5
16:30	17	0	0	0	0	0	0	0	0	17
16:45	4	0	0	0	0	0	0	0	0	4
1 Hr	34	0	0	0	0	0	0	0	0	34
17:00	6	0	0	0	0	0	0	0	0	6
17:15	3	0	0	0	0	0	0	0	0	3
17:30	7	0	0	0	0	0	0	0	0	7
17:45	5	0	0	0	0	0	0	0	0	5
1 Hr	21	0	0	0	0	0	0	0	0	21
6 Hrs	128	3	0	0	0	0	1	0	2	134

Direction : Westbound (pedestrians)

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
12:00	0	0	0	0	0	0	0	0	0	0
12:15	0	0	0	0	0	0	0	0	0	0
12:30	3	0	0	0	0	0	0	0	0	3
12:45	1	0	0	0	0	0	0	0	0	1
1 Hr	4	0	0	0	0	0	0	0	0	4
13:00	1	0	0	0	0	0	0	0	0	1
13:15	1	0	0	0	0	0	0	0	0	1
13:30	1	0	0	0	0	0	0	0	0	1
13:45	0	0	0	0	0	0	0	0	0	0
1 Hr	3	0	0	0	0	0	0	0	0	3
14:00	0	0	0	0	0	0	0	0	0	0
14:15	1	0	0	0	0	0	0	0	0	1
14:30	4	0	0	0	0	0	0	0	0	4
14:45	0	0	0	0	0	0	0	0	0	0
1 Hr	5	0	0	0	0	0	0	0	0	5
15:00	1	0	0	0	0	0	0	0	0	1
15:15	5	0	0	0	0	0	0	0	0	5
15:30	3	0	0	0	0	0	0	0	0	3
15:45	0	0	0	0	0	0	0	0	0	0
1 Hr	9	0	0	0	0	0	0	0	0	9
16:00	4	0	0	0	0	0	0	0	0	4
16:15	3	0	2	0	0	0	0	0	0	5
16:30	3	0	0	0	0	0	0	0	0	3
16:45	1	0	0	0	0	0	0	0	0	1
1 Hr	11	0	2	0	0	0	0	0	0	13
17:00	5	0	0	0	0	0	0	0	0	5
17:15	4	0	0	0	0	0	0	0	0	4
17:30	3	0	0	0	0	0	0	0	0	3
17:45	1	0	0	0	0	0	0	0	0	1
1 Hr	13	0	0	0	0	0	0	0	0	13
6 Hrs	45	0	2	0	0	0	0	0	0	47

	TRAINS
12:00	4
12:15	1
12:30	1
12:45	2
1 Hr	8
13:00	3
13:15	1
13:30	2
13:45	2
1 Hr	8
14:00	3
14:15	1
14:30	2
14:45	1
1 Hr	7
15:00	4
15:15	1
15:30	4
15:45	2
1 Hr	11
16:00	4
16:15	4
16:30	2
16:45	1
1 Hr	11
17:00	3
17:15	3
17:30	2
17:45	2
1 Hr	10
6 Hrs	55

Linkcount

Direction : Eastbound (vehicles)

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	28	3	0	0	0	0	0	6	0	0	37
18:15	31	2	0	0	0	0	0	1	0	0	34
18:30	26	1	0	0	0	0	0	1	0	0	28
18:45	16	0	0	1	0	0	0	1	0	0	18
1 Hr	101	6	0	1	0	0	0	9	0	0	117
19:00	30	2	0	0	0	0	0	0	0	0	32
19:15	28	5	0	0	0	0	0	0	0	0	33
19:30	19	4	0	0	0	0	0	0	0	0	23
19:45	14	2	0	0	0	0	0	0	0	0	16
1 Hr	91	13	0	0	0	0	0	0	0	0	104
20:00	17	1	0	0	0	0	0	0	0	0	18
20:15	5	2	0	0	0	0	0	0	0	0	7
20:30	11	0	0	0	0	0	0	0	0	0	11
20:45	6	0	0	0	0	0	0	0	0	0	6
1 Hr	39	3	0	0	0	0	0	0	0	0	42
21:00	10	0	0	0	0	0	0	0	0	0	10
21:15	7	1	0	0	0	0	0	0	0	0	8
21:30	7	2	0	0	0	0	0	0	0	0	9
21:45	1	0	0	0	0	0	0	0	0	0	1
1 Hr	25	3	0	0	0	0	0	0	0	0	28
22:00	7	0	0	1	0	0	0	0	0	0	8
22:15	7	0	0	0	0	0	0	0	0	0	7
22:30	3	0	0	0	0	0	0	0	0	0	3
22:45	3	0	0	0	0	0	0	0	0	0	3
1 Hr	20	0	0	1	0	0	0	0	0	0	21
23:00	0	0	0	0	0	0	0	0	0	0	0
23:15	0	0	0	0	0	0	0	0	0	0	0
23:30	1	0	0	0	0	1	0	0	0	0	2
23:45	0	0	0	0	0	0	0	0	0	0	0
1 Hr	1	0	0	0	0	1	0	0	0	0	2
6 Hrs	277	25	0	2	0	1	0	9	0	0	314
Total	2345	259	14	27	2	5	0	126	0	1	2779

Direction : Westbound (vehicles)

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	71	3	1	0	0	1	0	3	0	0	79
18:15	59	5	0	0	0	0	0	6	0	0	70
18:30	37	3	0	0	0	0	0	5	0	0	45
18:45	66	3	1	0	0	0	0	5	0	0	75
1 Hr	233	14	2	0	0	1	0	19	0	0	269
19:00	37	2	0	0	0	0	0	2	0	0	41
19:15	38	3	1	0	0	0	0	0	0	0	42
19:30	21	4	0	0	0	0	0	0	0	0	25
19:45	46	3	0	0	0	0	0	1	0	0	50
1 Hr	142	12	1	0	0	0	0	3	0	0	158
20:00	22	7	0	0	0	0	0	1	0	0	30
20:15	25	0	1	0	0	0	0	1	0	0	27
20:30	15	0	0	0	0	0	0	3	0	0	18
20:45	25	0	0	0	0	0	0	2	0	0	27
1 Hr	87	7	1	0	0	0	0	7	0	0	102
21:00	12	0	0	1	0	0	0	0	0	0	13
21:15	16	0	0	0	0	0	0	0	0	0	16
21:30	23	2	0	0	0	0	0	0	0	0	25
21:45	17	2	0	0	0	0	0	0	0	0	19
1 Hr	68	4	0	1	0	0	0	0	0	0	73
22:00	19	1	0	1	0	0	0	0	0	0	21
22:15	15	0	0	0	0	0	0	0	0	0	15
22:30	7	0	0	0	0	0	0	1	0	0	8
22:45	7	0	0	0	0	0	0	0	0	0	7
1 Hr	48	1	0	1	0	0	0	1	0	0	51
23:00	3	0	0	0	0	0	0	1	0	0	4
23:15	8	0	0	0	0	0	0	0	0	0	8
23:30	6	0	0	1	0	0	0	0	0	0	7
23:45	4	0	0	0	0	0	0	0	0	0	4
1 Hr	21	0	0	1	0	0	0	1	0	0	23
6 Hrs	599	38	4	3	0	1	0	31	0	0	676
Total	2205	285	13	43	1	5	0	105	0	0	2657

Direction : Eastbound (pedestrians)

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Pushchair/ Pram	Pushchair/ Pram	Scooter	Railway Personnel	Total
18:00	31	0	0	0	0	0	0	0	0	31
18:15	13	0	0	0	0	0	0	0	0	13
18:30	5	0	0	0	0	0	0	0	0	5
18:45	14	0	0	0	1	0	0	0	0	15
1 Hr	63	0	0	0	1	0	0	0	0	64
19:00	1	0	0	0	0	0	0	0	0	1
19:15	2	0	0	0	0	0	0	0	0	2
19:30	14	0	0	0	0	0	0	0	0	14
19:45	18	0	0	0	0	0	0	0	0	18
1 Hr	35	0	0	0	0	0	0	0	0	35
20:00	5	0	0	0	0	0	0	0	0	5
20:15	0	0	0	0	0	0	0	0	0	0
20:30	7	0	0	0	0	0	0	0	0	7
20:45	10	0	0	0	0	0	0	0	0	10
1 Hr	22	0	0	0	0	0	0	0	0	22
21:00	0	0	0	0	0	0	0	0	0	0
21:15	4	0	0	0	0	0	0	0	0	4
21:30	1	0	0	0	0	0	0	0	0	1
21:45	7	1	0	0	0	0	0	0	0	8
1 Hr	12	1	0	0	0	0	0	0	0	13
22:00	3	0	0	0	0	0	0	0	0	3
22:15	5	0	0	0	0	0	0	0	0	5
22:30	0	0	0	0	0	0	0	0	0	0
22:45	0	0	0	0	0	0	0	0	0	0
1 Hr	8	0	0	0	0	0	0	0	0	8
23:00	0	0	0	0	0	0	0	0	0	0
23:15	7	0	0	0	0	0	0	0	0	7
23:30	0	0	0	0	0	0	0	0	0	0
23:45	1	0	0	0	0	0	0	0	0	1
1 Hr	8	0	0	0	0	0	0	0	0	8
6 Hrs	148	1	0	0	1	0	0	0	0	150
Total	626	6	0	0	1	0	4	0	18	655

Direction : Westbound (pedestrians)

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
18:00	4	0	0	0	0	0	0	0	0	4
18:15	8	1	0	0	0	0	0	0	0	9
18:30	6	0	0	0	0	0	0	0	0	6
18:45	0	0	0	0	0	0	0	0	0	0
1 Hr	18	1	0	0	0	0	0	0	0	19
19:00	2	0	0	0	0	0	0	0	0	2
19:15	1	0	0	0	0	0	0	0	0	1
19:30	2	0	0	0	0	0	0	0	0	2
19:45	2	0	0	0	0	0	0	0	0	2
1 Hr	7	0	0	0	0	0	0	0	0	7
20:00	1	0	0	0	0	0	0	0	0	1
20:15	2	0	0	0	0	0	0	0	0	2
20:30	6	0	0	0	0	0	0	0	0	6
20:45	1	0	0	0	0	0	0	0	0	1
1 Hr	10	0	0	0	0	0	0	0	0	10
21:00	0	0	0	0	0	0	0	0	0	0
21:15	4	0	0	0	0	0	0	0	0	4
21:30	2	0	0	0	0	0	0	0	0	2
21:45	1	0	0	0	0	0	0	0	0	1
1 Hr	7	0	0	0	0	0	0	0	0	7
22:00	0	0	0	0	0	0	0	0	0	0
22:15	5	0	0	0	0	0	0	0	0	5
22:30	0	0	0	0	0	0	0	0	0	0
22:45	0	0	0	0	0	0	0	0	0	0
1 Hr	5	0	0	0	0	0	0	0	0	5
23:00	0	0	0	0	0	0	0	0	0	0
23:15	0	0	0	0	0	0	0	0	0	0
23:30	0	0	0	0	0	0	0	0	0	0
23:45	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0
6 Hrs	47	1	0	0	0	0	0	0	0	48
Total	210	2	2	0	0	0	0	0	17	231

	TRAINS
18:00	5
18:15	3
18:30	2
18:45	2
1 Hr	12
19:00	4
19:15	1
19:30	3
19:45	3
1 Hr	11
20:00	3
20:15	3
20:30	1
20:45	3
1 Hr	10
21:00	3
21:15	3
21:30	3
21:45	1
1 Hr	10
22:00	2
22:15	2
22:30	2
22:45	0
1 Hr	6
23:00	2
23:15	3
23:30	1
23:45	3
1 Hr	9
6 Hrs	58
Total	171

	DURATION	DIRECTION
Northbound		87
Southbound		84
Total		171

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
6:00:03	6:00:05	00:00:02	N
6:10:10	6:10:12	00:00:02	N
6:19:39	6:19:42	00:00:03	N
6:24:25	6:24:36	00:00:11	N
6:30:57	6:31:06	00:00:09	S
6:39:47	6:39:49	00:00:02	S
6:46:54	6:47:04	00:00:10	S
6:51:00	6:51:10	00:00:10	N
06:55:20	06:55:24	00:00:04	S
06:59:10	06:59:22	00:00:12	S
07:02:36	07:02:38	00:00:02	N
07:05:07	07:05:18	00:00:11	N
07:09:43	07:09:45	00:00:02	N
07:18:42	07:18:47	00:00:05	N
07:22:41	07:22:44	00:00:03	N
07:23:58	07:24:03	00:00:05	S
07:31:28	07:31:30	00:00:02	N
07:32:16	07:32:25	00:00:09	S
07:39:41	07:39:46	00:00:05	S
07:42:00	07:42:03	00:00:03	S
07:49:42	07:49:52	00:00:10	N
07:59:03	07:59:12	00:00:09	S
08:03:35	08:03:36	00:00:01	N
08:04:53	08:04:55	00:00:02	S
08:09:39	08:09:41	00:00:02	S
08:12:20	08:12:30	00:00:10	S
08:18:16	08:18:18	00:00:02	N
08:21:21	08:21:32	00:00:11	S
08:21:27	08:21:39	00:00:12	N
08:34:36	08:34:48	00:00:12	S
08:46:44	08:46:46	00:00:02	S
08:48:50	08:49:00	00:00:10	N
09:03:14	09:03:16	00:00:02	S
09:06:32	09:06:34	00:00:02	N
09:07:28	09:07:39	00:00:11	S
09:14:49	09:14:52	00:00:03	N
09:26:50	09:26:52	00:00:02	N
09:43:43	09:43:57	00:00:14	S
09:46:10	09:46:21	00:00:11	N
09:47:34	09:47:37	00:00:03	S
09:57:57	09:58:07	00:00:10	S
10:02:18	10:02:20	00:00:02	S
10:07:53	10:07:55	00:00:02	N
10:15:44	10:15:47	00:00:03	S
10:19:15	10:19:18	00:00:03	N
10:24:43	10:24:47	00:00:04	N
10:40:36	10:40:46	00:00:10	N
10:43:36	10:43:45	00:00:09	S
10:47:33	10:47:35	00:00:02	S
11:02:21	11:02:23	00:00:02	S
11:06:54	11:06:59	00:00:05	S
11:08:10	11:08:12	00:00:02	N
11:23:11	11:23:13	00:00:02	N
11:28:30	11:28:35	00:00:05	N
11:35:24	11:35:36	00:00:12	S
11:46:04	11:46:18	00:00:14	N
11:50:06	11:50:08	00:00:02	S
11:54:51	11:55:03	00:00:12	N
12:04:24	12:04:26	00:00:02	S
12:06:59	12:07:04	00:00:05	S
12:09:04	12:09:06	00:00:02	N
12:13:30	12:13:35	00:00:05	N
12:17:47	12:17:50	00:00:03	N
12:39:51	12:40:01	00:00:10	S
12:48:06	12:48:08	00:00:02	S
12:52:59	12:53:09	00:00:10	N
13:03:44	13:03:46	00:00:02	S
13:06:44	13:06:46	00:00:02	N
13:07:34	13:07:39	00:00:05	S
13:18:16	13:18:18	00:00:02	N
13:34:37	13:34:48	00:00:11	S
13:41:47	13:41:56	00:00:09	N
13:46:50	13:46:52	00:00:02	S
13:56:02	13:56:14	00:00:12	N
14:02:47	14:02:49	00:00:02	S
14:11:22	14:11:24	00:00:02	N
14:14:57	14:15:02	00:00:05	N
14:18:46	14:18:48	00:00:02	N
14:36:32	14:36:44	00:00:12	S
14:40:47	14:40:56	00:00:09	N
14:48:19	14:48:21	00:00:02	S
15:02:42	15:02:44	00:00:02	S
15:06:37	15:06:42	00:00:05	S
15:06:51	15:06:53	00:00:02	N
15:14:19	15:14:21	00:00:02	N
15:18:19	15:18:21	00:00:02	N
15:36:09	15:36:19	00:00:10	N
15:38:44	15:38:57	00:00:13	S
15:40:40	15:40:50	00:00:10	N
15:42:57	15:43:08	00:00:11	S
15:47:55	15:47:57	00:00:02	S
15:56:44	15:56:57	00:00:13	N
16:06:42	16:06:44	00:00:02	S
16:07:22	16:07:24	00:00:02	N
16:13:28	16:13:33	00:00:05	N
16:14:14	16:14:24	00:00:10	S
16:18:03	16:18:05	00:00:02	N
16:21:40	16:21:51	00:00:11	N
16:22:00	16:22:02	00:00:02	S
16:24:56	16:25:06	00:00:10	N
16:36:03	16:36:06	00:00:03	S
16:41:25	16:41:36	00:00:11	N
16:46:55	16:46:57	00:00:02	S
17:06:52	17:06:57	00:00:05	S
17:09:45	17:09:46	00:00:01	S
17:11:40	17:11:45	00:00:05	N
17:15:57	17:15:59	00:00:02	N
17:18:50	17:19:01	00:00:11	S
17:22:06	17:22:08	00:00:02	N
17:31:16	17:31:29	00:00:13	N
17:38:55	17:38:58	00:00:03	S
17:49:07	17:49:09	00:00:02	S
17:54:03	17:54:05	00:00:02	S
18:03:42	18:03:47	00:00:05	S
18:04:09	18:04:18	00:00:09	N
18:07:34	18:07:36	00:00:02	S
18:09:07	18:09:09	00:00:02	N
18:14:29	18:14:34	00:00:05	N
18:16:55	18:17:05	00:00:10	S
18:19:04	18:19:06	00:00:02	N
18:24:36	18:24:46	00:00:10	N
18:30:05	18:30:18	00:00:13	N
18:44:47	18:44:57	00:00:10	N
18:46:39	18:46:41	00:00:02	S
18:53:06	18:53:09	00:00:03	S
19:01:32	19:01:35	00:00:03	S
19:06:34	19:06:35	00:00:01	N
19:07:06	19:07:11	00:00:05	S
19:14:10	19:14:15	00:00:05	N
19:29:43	19:29:45	00:00:02	N
19:34:00	19:34:02	00:00:02	N
19:41:08	19:41:19	00:00:11	S
19:43:17	19:43:26	00:00:09	N
19:45:17	19:45:20	00:00:03	S
19:48:08	19:48:18	00:00:10	N
19:48:44	19:48:46	00:00:02	S
20:01:50	20:01:52	00:00:02	S
20:06:56	20:06:58	00:00:02	N
20:07:30	20:07:32	00:00:02	S
20:15:12	20:15:17	00:00:05	N
20:22:15	20:22:25	00:00:10	S
20:28:04	20:28:06	00:00:02	N
20:38:08	20:38:19	00:00:11	N
20:46:18	20:46:26	00:00:08	N
20:48:35	20:48:36	00:00:01	S
20:58:04	20:58:06	00:00:02	N
21:01:07	21:01:10	00:00:03	S
21:08:11	21:08:16	00:00:05	S
21:10:36	21:10:38	00:00:02	N
21:16:23	21:16:35	00:00:12	N
21:18:32	21:18:42	00:00:10	S
21:23:58	21:23:59	00:00:01	N
21:34:41	21:34:44	00:00:03	S
21:37:03	21:37:05	00:00:02	N
21:43:32	21:43:37	00:00:05	S
21:46:27	21:46:39	00:00:12	N
22:05:39	22:05:41	00:00:02	S
22:08:32	22:08:34	00:00:02	S
22:17:26	22:17:38	00:00:12	S
22:24:55	22:25:07	00:00:12	N
22:39:13	22:39:14	00:00:01	S
22:44:56	22:44:57	00:00:01	S
23:02:28	23:02:29	00:00:01	S
23:09:45	23:09:48	00:00:03	N
23:16:46	23:16:59	00:00:13	S
23:22:51	23:23:04	00:00:13	N
23:27:16	23:27:31	00:00:15	N
23:33:08	23:33:23	00:00:15	N
23:47:41	23:47:52	00:00:11	N
23:47:45	23:47:48	00:00:03	S
23:54:42	23:54:44	00:00:02	S

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Drop off	06:12:13	06:12:49	ESJ
Drop off	06:13:47	06:14:04	WSJ
Parking	06:21:04	06:27:36	WSJ
Parking	06:46:17	06:52:44	ESJ
Waiting	06:53:10	06:55:08	WSJ
Vehicle stopped near level crossing	06:57:07	06:57:26	ESJ
Pick up	07:00:06	07:00:34	ESJ
Drop off	07:14:30	07:14:37	WSJ
Drop off	07:35:31	07:35:51	ESJ
Railway personnel taking photos	08:00:15	08:00:46	On Track
Pick up	08:20:05	08:22:53	ESJ
Pick up	08:51:41	08:52:19	ESJ
Pick up	08:55:08	08:55:28	ESJ
Railway Personnel At Work Near the track	09:18:02	12:23:52	WSJ
Waiting	09:20:44	09:21:32	ESJ
Drop off	09:50:07	09:50:49	ESJ
Waste collection	09:57:54	09:59:08	WSJ
Pick up	14:41:46	14:41:52	ESJ
Pick up	15:37:09	15:38:17	ESJ
Drop off	16:11:45	16:11:49	ESJ
Drop off	16:12:38	16:12:54	ESJ
Pick up	16:42:40	16:43:40	ESJ
Drop off	16:49:53	16:50:04	ESJ
Pick up	17:04:28	17:04:55	ESJ
Drop off	17:10:31	17:10:44	ESJ
Pick up	17:33:10	17:33:27	ESJ
Waiting	19:07:43	19:09:15	ESJ
Drop off	19:12:50	19:14:08	WSJ
Pick up	19:39:35	19:43:11	ESJ
Pick up	19:50:12	19:50:37	ESJ
Pick up	19:50:15	19:53:26	ESJ
Parking	20:10:31	20:21:38	ESJ
Drop off	22:20:00	22:23:45	ESJ
Pick up	22:24:00	22:26:17	ESJ
Unloading	23:37:45	23:39:49	WSJ
Pick up	23:48:02	23:48:59	WSJ

Tracsis plc
Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Clayhithe Road Level Crossing
Date: Wednesday 12th July 2017

AM Weather : Cloudy, dry
PM Weather : Sunny, dry

Linkcount

Direction : Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	17	3	0	0	0	0	0	0	0	0	20
06:15	27	5	0	1	0	0	0	1	0	0	34
06:30	47	5	1	0	0	0	0	5	0	0	58
06:45	68	6	0	1	0	0	0	3	0	0	78
1 Hr	159	19	1	2	0	0	0	9	0	0	190
07:00	71	14	2	0	0	0	0	4	0	0	91
07:15	87	9	0	4	0	0	0	7	0	0	107
07:30	76	9	0	0	0	1	0	4	0	0	90
07:45	98	6	0	0	0	0	0	4	0	0	108
1 Hr	332	38	2	4	0	1	0	19	0	0	396
08:00	94	9	2	1	0	0	0	11	0	0	117
08:15	93	10	0	1	0	0	0	10	0	0	114
08:30	93	11	0	1	0	1	0	4	0	0	110
08:45	83	10	0	2	0	0	0	9	0	0	104
1 Hr	363	40	2	5	0	1	0	34	0	0	445
09:00	83	6	1	2	0	0	0	3	0	0	95
09:15	59	6	0	1	0	0	0	0	0	0	66
09:30	46	3	0	1	0	1	0	4	0	0	55
09:45	47	5	0	0	0	0	0	0	0	0	52
1 Hr	235	20	1	4	0	1	0	7	0	0	268
10:00	58	5	0	0	0	0	0	0	0	0	63
10:15	32	5	0	1	0	0	0	1	0	0	39
10:30	29	2	0	1	0	0	0	3	0	0	35
10:45	23	5	0	1	0	0	0	0	0	0	29
1 Hr	142	17	0	3	0	0	0	4	0	0	166
11:00	32	4	0	0	0	0	0	1	0	0	37
11:15	36	4	2	1	0	0	0	1	0	0	44
11:30	41	1	0	1	0	1	0	0	0	0	44
11:45	32	3	0	2	0	0	0	0	0	0	37
1 Hr	141	12	2	4	0	1	0	2	0	0	162
6 Hrs	1372	146	8	22	0	4	0	75	0	0	1627

Direction : Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	2	2	0	0	0	0	0	1	0	0	5
06:15	4	3	0	0	0	0	0	0	0	0	7
06:30	6	2	0	0	0	0	0	4	0	0	12
06:45	13	0	0	0	0	0	0	4	0	0	17
1 Hr	25	7	0	0	0	0	0	9	0	0	41
07:00	10	4	0	1	0	0	0	1	0	0	16
07:15	17	6	1	2	0	0	0	0	0	0	26
07:30	18	4	0	0	0	0	0	1	0	0	23
07:45	33	6	0	0	0	0	0	4	0	0	43
1 Hr	78	20	1	3	0	0	0	6	0	0	108
08:00	23	6	0	0	0	0	0	2	0	0	31
08:15	30	4	0	1	0	0	0	1	0	0	36
08:30	30	5	0	0	0	0	0	2	0	0	37
08:45	32	6	1	0	0	0	0	0	0	0	39
1 Hr	115	21	1	1	0	0	0	5	0	0	143
09:00	29	3	1	0	0	0	0	0	0	0	33
09:15	22	4	0	2	0	1	0	0	0	0	29
09:30	25	3	0	3	0	1	0	0	0	0	32
09:45	23	5	0	0	0	0	0	2	0	0	30
1 Hr	99	15	1	5	0	2	0	2	0	0	124
10:00	21	1	0	1	0	0	0	0	0	0	23
10:15	17	7	0	1	0	0	0	0	0	0	25
10:30	21	4	0	0	0	0	0	1	0	0	26
10:45	26	7	0	3	0	0	0	1	0	0	37
1 Hr	85	19	0	5	0	0	0	2	0	0	111
11:00	29	6	0	1	0	0	0	0	0	0	36
11:15	29	3	0	2	0	0	0	2	0	0	36
11:30	32	3	0	1	0	0	0	0	0	0	36
11:45	32	5	0	2	0	0	0	0	0	0	39
1 Hr	122	17	0	6	0	0	0	2	0	0	147
6 Hrs	524	99	3	20	0	2	0	26	0	0	674

Direction : Eastbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
06:00	2	0	0	0	0	0	0	0	0	2
06:15	12	1	0	0	0	0	0	0	0	13
06:30	8	0	0	0	0	0	0	0	0	8
06:45	24	0	0	0	0	0	0	0	0	24
1 Hr	46	1	0	0	0	0	0	0	0	47
07:00	3	0	0	0	0	0	0	0	0	3
07:15	37	0	0	0	0	0	0	0	0	37
07:30	7	0	0	0	0	0	0	0	0	7
07:45	32	0	0	0	0	0	0	0	0	32
1 Hr	79	0	0	0	0	0	0	0	0	79
08:00	25	0	0	0	0	0	0	0	0	25
08:15	16	0	0	0	0	0	0	0	0	16
08:30	29	0	0	0	0	0	0	0	0	29
08:45	15	0	0	0	0	0	0	0	0	15
1 Hr	85	0	0	0	0	0	0	0	0	85
09:00	13	0	0	0	0	0	0	0	0	13
09:15	9	0	0	0	0	0	0	0	0	9
09:30	14	0	0	0	0	0	0	0	0	14
09:45	11	0	0	0	0	0	0	0	0	11
1 Hr	47	0	0	0	0	0	0	0	0	47
10:00	1	0	0	0	0	0	0	0	0	1
10:15	14	0	0	0	0	0	1	0	0	15
10:30	9	0	0	0	0	0	0	0	0	9
10:45	4	0	0	0	0	0	0	0	0	4
1 Hr	28	0	0	0	0	0	1	0	0	29
11:00	0	0	0	0	0	0	0	0	0	0
11:15	12	0	0	0	0	0	0	0	0	12
11:30	6	0	0	0	0	0	0	0	0	6
11:45	2	0	0	0	0	0	0	0	0	2
1 Hr	20	0	0	0	0	0	0	0	0	20
6 Hrs	305	1	0	0	0	0	1	0	0	307

Direction : Westbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
06:00	2	0	0	0	0	0	0	0	0	2	3
06:15	1	0	0	0	0	0	0	0	0	1	1
06:30	16	0	0	0	0	0	0	0	0	16	3
06:45	3	0	0	0	0	0	0	0	0	3	4
1 Hr	22	0	0	0	0	0	0	0	0	22	11
07:00	3	0	0	0	0	0	0	0	0	3	2
07:15	3	0	0	0	0	0	0	0	0	3	3
07:30	4	0	0	0	0	0	0	0	0	4	5
07:45	5	0	0	0	0	0	0	0	0	5	1
1 Hr	15	0	0	0	0	0	0	0	0	15	11
08:00	5	0	0	0	0	0	0	0	0	5	5
08:15	3	0	0	0	0	0	0	0	0	3	2
08:30	4	0	0	0	0	0	0	0	0	4	2
08:45	1	0	0	0	0	0	0	0	0	1	1
1 Hr	13	0	0	0	0	0	0	0	0	13	10
09:00	1	0	0	0	0	0	0	0	0	1	3
09:15	0	0	0	0	0	0	0	0	0	0	2
09:30	4	0	0	0	0	0	0	0	0	4	2
09:45	0	0	0	0	0	0	0	0	0	0	2
1 Hr	5	0	0	0	0	0	0	0	0	5	9
10:00	2	0	0	0	0	0	0	0	0	2	2
10:15	7	0	0	0	0	0	1	0	0	8	3
10:30	0	0	0	0	0	0	0	0	0	0	2
10:45	1	0	0	0	0	0	0	0	0	1	1
1 Hr	10	0	0	0	0	0	1	0	0	11	8
11:00	0	0	0	0	0	0	0	0	0	0	4
11:15	2	0	0	0	0	0	0	0	0	2	1
11:30	2	0	0	0	0	0	0	0	0	2	1
11:45	1	0	0	0	0	0	0	0	0	1	2
1 Hr	5	0	0	0	0	0	0	0	0	5	8
6 Hrs	70	0	0	0	0	0	1	0	0	71	57

Linkcount

Direction : Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	39	4	0	2	0	0	0	1	0	0	46
12:15	31	6	0	1	0	0	0	1	0	0	39
12:30	23	4	0	1	0	0	0	0	0	0	28
12:45	32	3	0	1	0	0	0	0	0	0	36
1 Hr	125	17	0	5	0	0	0	2	0	0	149
13:00	24	5	0	0	0	0	0	0	0	0	29
13:15	38	1	0	0	0	0	0	6	0	0	45
13:30	25	2	0	0	0	0	0	1	0	0	29
13:45	15	2	0	1	0	0	0	1	0	0	19
1 Hr	102	10	0	1	0	0	0	8	0	0	122
14:00	33	6	1	1	0	0	0	0	0	0	41
14:15	35	2	0	0	0	0	0	4	0	0	41
14:30	29	3	0	0	0	0	0	1	0	0	33
14:45	28	3	1	0	0	1	0	1	0	0	34
1 Hr	125	14	2	1	0	1	0	6	0	0	149
15:00	29	4	0	0	0	0	0	0	0	0	33
15:15	21	4	0	0	0	0	0	1	0	0	26
15:30	20	3	0	0	0	0	0	0	0	0	23
15:45	39	5	0	0	0	0	0	1	0	0	45
1 Hr	109	16	0	0	0	0	0	2	0	0	127
16:00	32	8	0	0	0	0	0	7	0	0	47
16:15	31	7	2	0	0	0	0	2	0	0	42
16:30	32	4	0	1	0	0	0	2	0	0	39
16:45	39	3	1	0	0	0	0	1	0	0	44
1 Hr	134	22	3	1	0	0	0	12	0	0	172
17:00	40	3	0	0	0	0	0	2	0	0	45
17:15	40	4	0	1	0	0	0	4	0	0	49
17:30	38	3	0	0	0	0	0	1	0	0	42
17:45	41	2	0	1	0	0	0	3	0	0	47
1 Hr	159	12	0	2	0	0	0	10	0	0	183
6 Hrs	754	91	5	10	0	2	0	40	0	0	902

Direction : Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	35	6	2	2	0	0	0	1	0	0	46
12:15	20	3	0	2	0	0	0	0	0	0	25
12:30	48	8	0	0	0	0	0	2	0	0	58
12:45	39	7	1	0	0	1	0	0	0	0	48
1 Hr	142	24	3	4	0	1	0	3	0	0	177
13:00	25	6	0	1	0	0	0	0	0	0	32
13:15	30	1	0	2	0	0	0	1	0	0	34
13:30	25	5	0	1	0	0	0	1	0	0	32
13:45	43	7	0	0	0	0	0	0	0	0	50
1 Hr	123	19	0	4	0	0	0	2	0	0	148
14:00	46	8	0	0	0	0	0	1	0	0	55
14:15	42	6	1	2	0	0	0	1	0	0	52
14:30	40	5	0	2	0	0	0	0	0	0	47
14:45	37	9	0	0	0	1	0	2	0	0	49
1 Hr	165	28	1	4	0	1	0	4	0	0	203
15:00	45	4	0	1	0	0	0	0	0	0	50
15:15	47	5	2	1	0	0	0	0	0	0	55
15:30	44	9	0	1	0	1	0	1	0	0	56
15:45	56	9	1	0	0	0	0	4	0	0	70
1 Hr	192	27	3	3	0	1	0	5	0	0	231
16:00	75	9	2	2	0	0	0	2	0	0	90
16:15	74	10	0	1	0	0	0	4	0	0	89
16:30	85	8	2	2	0	0	0	4	0	0	101
16:45	60	12	1	0	0	0	0	3	0	0	76
1 Hr	294	39	5	5	0	0	0	13	0	0	356
17:00	91	10	0	0	0	0	0	9	0	0	110
17:15	84	7	1	0	0	0	0	10	0	0	102
17:30	66	2	1	0	0	0	0	6	0	0	75
17:45	86	6	0	0	0	0	0	4	0	0	96
1 Hr	327	25	2	0	0	0	0	29	0	0	383
6 Hrs	1243	162	14	20	0	3	0	56	0	0	1498

Direction : Eastbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
12:00	1	0	0	0	0	0	0	0	0	1
12:15	7	0	0	0	0	0	0	0	0	7
12:30	6	0	0	0	0	0	0	0	3	9
12:45	1	0	0	0	0	0	0	0	0	1
1 Hr	15	0	0	0	0	0	0	0	3	18
13:00	3	0	0	0	0	0	0	0	0	3
13:15	3	1	0	0	0	0	0	0	0	4
13:30	5	0	0	0	0	0	0	0	1	6
13:45	2	0	0	0	0	0	0	0	1	3
1 Hr	13	1	0	0	0	0	0	0	2	16
14:00	0	0	0	0	0	0	0	0	0	0
14:15	3	0	0	0	0	0	0	0	0	3
14:30	4	1	0	0	0	0	0	0	0	5
14:45	11	0	0	0	0	0	0	0	0	11
1 Hr	18	1	0	0	0	0	0	0	0	19
15:00	2	0	0	0	0	0	0	0	0	2
15:15	3	0	0	0	0	0	0	0	0	3
15:30	4	0	0	0	0	0	0	0	0	4
15:45	2	0	0	0	0	0	0	0	0	2
1 Hr	11	0	0	0	0	0	0	0	0	11
16:00	8	0	0	0	0	0	0	0	0	8
16:15	4	0	2	0	0	0	1	0	0	7
16:30	17	0	0	0	0	0	0	0	0	17
16:45	2	0	0	0	0	0	0	0	0	2
1 Hr	31	0	2	0	0	0	1	0	0	34
17:00	8	0	0	0	0	0	0	0	0	8
17:15	1	0	0	0	0	0	0	0	0	1
17:30	11	0	0	0	0	0	0	0	0	11
17:45	21	2	0	0	0	0	0	0	0	23
1 Hr	41	2	0	0	0	0	0	0	0	43
6 Hrs	129	4	2	0	0	0	1	0	5	141

Direction : Westbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
12:00	4	0	0	0	0	0	0	0	0	4	4
12:15	1	0	0	0	0	0	0	0	3	4	1
12:30	7	0	0	0	0	0	0	0	0	7	2
12:45	1	0	0	0	0	0	0	0	0	1	2
1 Hr	13	0	0	0	0	0	0	0	3	16	9
13:00	1	0	0	0	0	0	0	0	0	1	4
13:15	0	0	0	0	0	0	0	0	1	1	2
13:30	3	0	0	0	0	0	0	0	0	3	2
13:45	2	1	0	0	0	0	0	0	1	4	2
1 Hr	6	1	0	0	0	0	0	0	2	9	10
14:00	1	0	0	0	0	0	0	0	0	1	2
14:15	0	0	0	0	0	0	0	0	0	0	3
14:30	8	0	0	0	0	0	0	0	0	8	1
14:45	2	0	0	0	0	0	0	0	0	2	2
1 Hr	11	0	0	0	0	0	0	0	0	11	8
15:00	2	0	0	0	0	0	0	0	0	2	4
15:15	2	0	0	0	0	0	0	0	0	2	1
15:30	1	0	0	0	0	0	0	0	0	1	4
15:45	1	0	0	0	0	0	0	0	0	1	2
1 Hr	6	0	0	0	0	0	0	0	0	6	11
16:00	3	0	0	0	0	0	0	0	0	3	4
16:15	5	0	0	0	0	0	1	0	0	6	3
16:30	11	0	0	0	0	0	0	0	0	11	2
16:45	5	0	0	0	0	0	0	0	0	5	1
1 Hr	24	0	0	0	0	0	1	0	0	25	10
17:00	2	0	0	0	0	0	0	0	0	2	4
17:15	10	0	0	0	0	0	0	0	0	10	3
17:30	3	2	0	0	0	0	0	0	0	5	1
17:45	5	0	0	0	0	0	0	0	0	5	3
1 Hr	20	2	0	0	0	0	0	0	0	22	11
6 Hrs	80	3	0	0	0	0	1	0	5	89	59

Linkcount

Direction : Eastbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	39	1	0	0	0	0	0	1	0	0	41
18:15	43	2	0	1	0	0	0	4	0	0	50
18:30	45	3	1	0	0	0	0	3	0	0	52
18:45	28	1	1	0	0	0	0	3	0	0	33
1 Hr	155	7	2	1	0	0	0	11	0	0	176
19:00	20	4	0	0	0	0	0	3	0	0	27
19:15	20	1	0	0	0	0	0	1	0	0	22
19:30	21	1	0	0	0	0	0	0	0	0	22
19:45	15	0	0	0	0	0	0	1	0	0	16
1 Hr	76	6	0	0	0	0	0	5	0	0	87
20:00	19	0	0	0	0	0	0	2	0	0	21
20:15	14	2	0	0	0	0	0	2	0	0	18
20:30	11	0	0	0	0	0	0	0	0	0	11
20:45	10	0	1	0	0	0	0	0	0	0	11
1 Hr	54	2	1	0	0	0	0	4	0	0	61
21:00	11	1	1	0	0	0	0	1	0	0	14
21:15	4	0	0	0	0	0	0	4	0	0	8
21:30	8	0	0	0	0	0	0	4	0	0	12
21:45	5	0	0	0	0	0	0	1	0	0	6
1 Hr	28	1	1	0	0	0	0	10	0	0	40
22:00	2	1	0	1	0	0	0	0	0	0	4
22:15	3	0	0	0	0	0	0	0	0	0	3
22:30	6	1	0	1	0	0	0	1	0	0	9
22:45	3	0	0	0	0	0	0	0	0	0	3
1 Hr	14	2	0	2	0	0	0	1	0	0	19
23:00	1	0	0	0	0	0	0	0	0	0	1
23:15	2	0	0	0	0	0	0	0	0	0	2
23:30	2	0	0	0	0	0	0	0	0	0	2
23:45	0	0	0	0	0	0	0	0	0	0	0
1 Hr	5	0	0	0	0	0	0	0	0	0	5
6 Hrs	332	18	4	3	0	0	0	31	0	0	388
Total	2458	255	17	35	0	6	0	146	0	0	2917

Direction : Westbound

	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	71	2	1	2	0	1	0	5	0	0	82
18:15	91	6	1	0	0	0	0	13	0	0	111
18:30	93	3	1	0	0	0	0	7	0	0	104
18:45	62	1	1	0	0	0	0	6	0	0	70
1 Hr	317	12	4	2	0	1	0	31	0	0	367
19:00	42	3	0	0	0	0	0	3	0	0	48
19:15	42	1	1	0	0	0	0	5	0	0	49
19:30	33	4	0	0	0	0	0	4	0	0	41
19:45	31	4	1	0	0	0	0	3	0	0	39
1 Hr	148	12	2	0	0	0	0	15	0	0	177
20:00	32	2	1	0	0	0	0	1	0	0	36
20:15	29	2	1	0	0	0	0	7	0	0	39
20:30	39	0	1	0	0	0	0	6	0	0	46
20:45	38	0	0	1	0	0	0	4	0	0	43
1 Hr	138	4	3	1	0	0	0	18	0	0	164
21:00	24	0	0	0	0	0	0	2	0	0	26
21:15	26	3	0	0	0	0	0	1	0	0	30
21:30	25	0	0	0	0	0	0	0	0	0	25
21:45	19	0	0	0	0	0	0	0	0	0	19
1 Hr	94	3	0	0	0	0	0	3	0	0	100
22:00	8	0	0	0	0	0	0	1	0	0	9
22:15	7	0	0	0	0	0	0	1	0	0	8
22:30	10	0	0	0	0	0	0	0	0	0	10
22:45	13	1	0	0	0	0	0	0	0	0	14
1 Hr	38	1	0	0	0	0	0	2	0	0	41
23:00	4	1	0	0	0	0	0	0	0	0	5
23:15	12	1	0	0	0	0	0	0	0	0	13
23:30	4	0	0	2	0	0	0	0	0	0	6
23:45	8	0	0	0	0	0	0	0	0	0	8
1 Hr	28	2	0	2	0	0	0	0	0	0	32
6 Hrs	763	34	9	5	0	1	0	69	0	0	881
Total	2530	295	26	45	0	6	0	151	0	0	3053

Direction : Eastbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Pushchair/ Pram	Pushchair/ Pram	Scooter	Railway Personnel	Total
18:00	13	0	0	0	0	0	0	0	0	13
18:15	17	0	0	0	0	0	0	0	0	17
18:30	4	0	0	0	0	0	0	0	0	4
18:45	22	0	0	0	0	0	0	0	0	22
1 Hr	56	0	0	0	0	0	0	0	0	56
19:00	4	0	0	0	0	0	0	0	0	4
19:15	9	0	0	0	0	0	0	0	0	9
19:30	10	0	0	0	1	0	0	0	0	11
19:45	9	0	0	0	0	0	0	0	0	9
1 Hr	32	0	0	0	1	0	0	0	0	33
20:00	6	0	0	0	0	0	0	0	0	6
20:15	8	0	0	0	0	0	0	0	0	8
20:30	0	0	0	0	0	0	0	0	0	0
20:45	9	0	0	0	0	0	0	0	0	9
1 Hr	23	0	0	0	0	0	0	0	0	23
21:00	1	0	0	0	0	0	0	0	0	1
21:15	9	0	0	0	0	0	0	0	0	9
21:30	1	0	0	0	0	0	0	0	0	1
21:45	6	0	0	0	0	0	0	0	0	6
1 Hr	17	0	0	0	0	0	0	0	0	17
22:00	3	2	0	0	0	0	0	0	0	5
22:15	0	0	0	0	0	0	0	0	0	0
22:30	0	0	0	0	0	0	0	0	0	0
22:45	4	0	0	0	0	0	0	0	0	4
1 Hr	7	2	0	0	0	0	0	0	0	9
23:00	0	0	0	0	0	0	0	0	0	0
23:15	3	0	0	0	0	0	0	0	0	3
23:30	2	0	0	0	0	0	0	0	0	2
23:45	2	0	0	0	0	0	0	0	0	2
1 Hr	7	0	0	0	0	0	0	0	0	7
6 Hrs	142	2	0	0	1	0	0	0	0	145
Total	576	7	2	0	1	0	2	0	5	593

Direction : Westbound

	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
18:00	5	0	0	0	0	0	0	0	0	5	3
18:15	7	0	0	0	0	0	0	0	0	7	5
18:30	8	0	0	0	0	0	0	0	0	8	2
18:45	5	0	0	0	0	0	0	0	0	5	3
1 Hr	25	0	0	0	0	0	0	0	0	25	13
19:00	3	0	0	0	0	0	0	0	0	3	3
19:15	5	0	0	0	0	0	0	0	0	5	2
19:30	8	0	0	0	0	0	0	0	0	8	4
19:45	3	0	0	0	0	0	0	0	0	3	2
1 Hr	19	0	0	0	0	0	0	0	0	19	11
20:00	4	0	0	0	0	0	0	0	0	4	3
20:15	5	0	0	0	0	0	0	0	0	5	4
20:30	6	0	0	0	0	0	0	0	0	6	0
20:45	6	0	0	0	0	0	0	0	0	6	3
1 Hr	21	0	0	0	0	0	0	0	0	21	10
21:00	2	0	0	0	0	0	0	0	0	2	3
21:15	6	0	0	0	0	0	0	0	0	6	3
21:30	2	0	0	0	0	0	0	0	0	2	3
21:45	0	0	0	0	0	0	0	0	0	0	1
1 Hr	10	0	0	0	0	0	0	0	0	10	10
22:00	0	0	0	0	0	0	0	0	0	0	2
22:15	5	2	0	0	0	0	0	0	0	7	3
22:30	0	0	0	0	0	0	0	0	0	0	0
22:45	0	0	0	0	0	0	0	0	0	0	2
1 Hr	5	2	0	0	0	0	0	0	0	7	7
23:00	1	0	0	0	0	0	0	0	0	1	3
23:15	1	0	0	0	0	0	0	0	0	1	3
23:30	2	0	0	0	0	0	0	0	0	2	0
23:45	0	0	0	0	0	0	0	0	0	0	2
1 Hr	4	0	0	0	0	0	0	0	0	4	8
6 Hrs	84	2	0	0	0	0	0	0	0	86	59
Total	234	5	0	0	0	0	2	0	5	246	175

Northbound	89
Southbound	87
Total	176

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
05:59:59	06:00:09	00:00:10	S
06:02:03	06:02:06	00:00:03	N
06:08:37	06:08:39	00:00:02	N
06:13:04	06:13:06	00:00:02	N
06:22:56	06:23:08	00:00:12	N
06:31:16	06:31:29	00:00:13	S
06:32:28	06:32:32	00:00:04	N
06:42:13	06:42:15	00:00:02	S
06:47:01	06:47:12	00:00:11	N
06:55:31	06:55:36	00:00:05	S
06:57:52	06:58:00	00:00:08	N
06:58:58	06:59:07	00:00:09	S
07:03:51	07:03:53	00:00:02	N
07:08:42	07:08:44	00:00:02	N
07:17:58	07:18:01	00:00:03	N
07:22:24	07:22:29	00:00:05	N
07:23:52	07:23:56	00:00:04	S
07:30:28	07:30:37	00:00:09	S
07:31:31	07:31:34	00:00:03	N
07:40:29	07:40:39	00:00:10	N
07:41:39	07:41:41	00:00:02	S
07:44:10	07:44:15	00:00:05	S
07:57:16	07:57:26	00:00:10	S
08:04:00	08:04:02	00:00:02	S
08:06:08	08:06:10	00:00:02	N
08:06:57	08:06:59	00:00:02	S
08:09:46	08:09:57	00:00:11	S
08:13:46	08:13:56	00:00:10	N
08:17:04	08:17:20	00:00:16	S
08:18:29	08:18:31	00:00:02	N
08:36:22	08:36:32	00:00:10	S
08:43:41	08:43:54	00:00:13	N
08:51:35	08:51:37	00:00:02	S
09:00:53	09:00:57	00:00:04	S
09:08:05	09:08:06	00:00:01	N
09:08:38	09:08:48	00:00:10	S
09:18:16	09:18:18	00:00:02	N
09:21:33	09:21:35	00:00:02	N
09:36:41	09:36:52	00:00:11	S
09:43:44	09:43:56	00:00:12	N
09:55:02	09:55:04	00:00:02	S
09:58:03	09:58:13	00:00:10	S
10:06:50	10:06:52	00:00:02	S
10:08:39	10:08:41	00:00:02	N
10:15:15	10:15:17	00:00:02	S
10:19:04	10:19:06	00:00:02	N
10:24:35	10:24:40	00:00:05	N
10:38:46	10:38:59	00:00:13	S
10:42:49	10:42:59	00:00:10	N
10:48:52	10:48:54	00:00:02	S
11:02:16	11:02:18	00:00:02	S
11:06:36	11:06:38	00:00:02	N
11:06:41	11:06:46	00:00:05	S
11:12:14	11:12:21	00:00:07	N
11:18:53	11:18:55	00:00:02	N
11:36:10	11:36:20	00:00:10	S
11:46:27	11:46:35	00:00:08	N
11:47:50	11:47:52	00:00:02	S
12:01:59	12:02:01	00:00:02	S
12:06:45	12:06:50	00:00:05	S
12:08:14	12:08:16	00:00:02	N
12:12:16	12:12:29	00:00:13	N
12:17:53	12:17:55	00:00:02	S
12:39:08	12:39:20	00:00:12	S
12:42:26	12:42:37	00:00:11	N
12:47:25	12:47:42	00:00:17	N
12:47:30	12:47:32	00:00:02	S
13:06:18	13:06:20	00:00:02	S
13:08:59	13:09:04	00:00:05	S
13:10:28	13:10:30	00:00:02	N
13:14:45	13:14:50	00:00:05	N
13:19:50	13:19:52	00:00:02	N
13:26:02	13:26:10	00:00:08	S
13:35:34	13:35:46	00:00:12	S
13:41:36	13:41:45	00:00:09	N
13:49:20	13:49:22	00:00:02	S
13:57:41	13:57:51	00:00:10	N
14:04:50	14:04:52	00:00:02	S
14:07:30	14:07:35	00:00:05	S
14:18:33	14:18:36	00:00:03	N
14:24:55	14:25:00	00:00:05	N
14:28:02	14:28:08	00:00:06	N
14:33:36	14:33:46	00:00:10	S
14:45:24	14:45:34	00:00:10	N
14:46:58	14:47:00	00:00:02	S
15:02:52	15:02:54	00:00:02	S
15:07:57	15:08:02	00:00:05	S
15:09:00	15:09:02	00:00:02	N
15:14:20	15:14:22	00:00:02	N
15:18:10	15:18:13	00:00:03	N
15:36:46	15:36:47	00:00:01	N
15:38:08	15:38:20	00:00:12	S
15:40:50	15:40:59	00:00:09	N
15:42:35	15:42:45	00:00:10	S
15:48:07	15:48:09	00:00:02	S
15:56:03	15:56:13	00:00:10	N
16:07:17	16:07:18	00:00:01	S
16:08:00	16:08:02	00:00:02	N
16:13:33	16:13:37	00:00:04	N
16:13:53	16:14:04	00:00:11	S
16:17:59	16:18:01	00:00:02	N
16:21:41	16:21:43	00:00:02	S
16:25:16	16:25:25	00:00:09	N
16:33:17	16:33:20	00:00:03	S
16:40:49	16:40:58	00:00:09	N
16:48:12	16:48:14	00:00:02	S
17:05:42	17:05:43	00:00:01	S
17:06:47	17:06:49	00:00:02	N
17:08:50	17:08:55	00:00:05	S
17:11:43	17:11:48	00:00:05	N
17:17:47	17:17:58	00:00:11	S
17:18:16	17:18:18	00:00:02	N
17:29:28	17:29:38	00:00:10	N
17:35:03	17:35:05	00:00:02	S
17:46:06	17:46:16	00:00:10	N
17:52:49	17:52:52	00:00:03	S
17:55:15	17:55:17	00:00:02	S
18:04:18	18:04:23	00:00:05	S
18:08:39	18:08:40	00:00:01	N
18:10:47	18:10:49	00:00:02	S
18:15:21	18:15:26	00:00:05	N
18:16:48	18:16:57	00:00:09	S
18:20:39	18:20:41	00:00:02	N
18:24:29	18:24:38	00:00:09	N
18:29:40	18:29:50	00:00:10	N
18:39:09	18:39:16	00:00:07	N
18:44:29	18:44:38	00:00:09	N
18:47:29	18:47:31	00:00:02	S
18:49:21	18:49:36	00:00:15	N
18:51:25	18:51:28	00:00:03	S
19:01:43	19:01:45	00:00:02	S
19:07:26	19:07:27	00:00:01	N
19:08:06	19:08:11	00:00:05	S
19:15:16	19:15:22	00:00:06	N
19:18:41	19:18:52	00:00:11	S
19:30:01	19:30:03	00:00:02	N
19:32:38	19:32:50	00:00:12	N
19:37:08	19:37:10	00:00:02	N
19:43:31	19:43:33	00:00:02	S
19:45:17	19:45:26	00:00:09	N
19:51:17	19:51:19	00:00:02	S
20:07:03	20:07:05	00:00:02	N
20:07:56	20:07:58	00:00:02	S
20:12:09	20:12:11	00:00:02	S
20:16:47	20:16:51	00:00:04	N
20:20:18	20:20:20	00:00:02	N
20:25:18	20:25:27	00:00:09	S
20:27:23	20:27:26	00:00:03	N
20:47:23	20:47:25	00:00:02	S
20:46:17	20:46:25	00:00:08	N
20:58:11	20:58:14	00:00:03	N
21:00:55	21:00:58	00:00:03	S
21:10:37	21:10:39	00:00:02	N
21:10:41	21:10:46	00:00:05	S
21:15:53	21:16:03	00:00:10	N
21:17:00	21:17:11	00:00:11	S
21:24:21	21:24:23	00:00:02	N
21:34:35	21:34:38	00:00:03	S
21:36:57	21:37:02	00:00:05	S
21:37:17	21:37:20	00:00:03	N
21:46:34	21:46:45	00:00:11	N
22:06:18	22:06:20	00:00:02	S
22:10:27	22:10:29	00:00:02	S
22:17:29	22:17:40	00:00:11	S
22:22:41	22:22:52	00:00:11	N
22:25:55	22:25:57	00:00:02	S
22:48:53	22:49:05	00:00:12	N
22:51:48	22:51:51	00:00:03	S
23:02:32	23:02:34	00:00:02	S
23:03:00	23:03:02	00:00:02	N
23:14:24	23:14:35	00:00:11	S
23:18:01	23:18:04	00:00:03	S
23:19:24	23:19:34	00:00:10	N
23:23:58	23:24:02	00:00:04	N
23:47:42	23:47:44	00:00:02	S
23:47:57	23:48:08	00:00:11	N

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Pick up	07:01:21	07:01:44	ESJ
Waiting	08:12:11	08:15:22	ESJ
Drop off	08:21:03	08:21:16	ESJ
Drop off	09:27:32	09:27:45	WSJ
Waiting	09:28:44	09:30:21	ESJ
Drop off	09:44:28	09:47:58	ESJ
Drop off	09:46:46	09:47:17	ESJ
Waiting	09:48:12	09:50:13	ESJ
Waiting	10:13:45	10:17:50	ESJ
Drop off	11:30:31	11:31:01	ESJ
Waiting	13:28:36	13:30:41	ESJ
Pick up	13:31:12	13:38:09	ESJ
Waiting	15:20:50	15:22:52	ESJ
Waiting	15:35:11	15:38:00	ESJ
Drop off	16:20:46	16:20:53	ESJ
Drop off	16:22:29	16:22:47	ESJ
Drop off	16:26:49	16:27:02	ESJ
Pick up	17:30:27	17:31:00	ESJ
Pick up	17:44:18	17:48:38	ESJ
Vehicle stopped near level crossing	17:47:20	17:47:51	WSJ
Waiting	19:20:33	19:23:18	ESJ
Drop off	20:11:34	20:12:54	ESJ
Drop off	20:16:07	20:20:13	ESJ
Pick up	20:29:41	20:30:12	ESJ
Parking	20:37:09	20:47:26	ESJ
Pick up	20:47:45	20:48:03	WSJ
Pick up	20:49:31	20:49:47	ESJ
Waiting	21:08:29	21:10:12	ESJ
Waiting	21:43:19	21:46:43	ESJ
Pick up	21:47:41	21:47:53	WSJ
Drop off	22:17:59	22:18:07	WSJ
Drop off	22:37:10	22:38:27	WSJ
Vehicle stopped near level crossing	22:56:19	22:56:50	ESJ

Tracsis plc
Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Claythite Road Level Crossing
Date: Thursday 13th July 2017

AM Weather : Dry, sunny spells
PM Weather : Dry, sunny spells

Linkcount

Direction : Eastbound

Time	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	15	1	0	0	0	0	0	1	0	0	17
06:15	32	4	0	0	0	0	0	3	0	0	39
06:30	54	5	1	0	0	0	0	2	0	0	62
06:45	61	6	3	1	0	0	0	6	0	0	77
1 Hr	162	16	4	1	0	0	0	12	0	0	195
07:00	73	16	2	2	0	0	0	2	0	0	95
07:15	85	7	0	0	0	0	0	8	0	0	100
07:30	89	9	1	0	1	1	0	8	0	0	109
07:45	89	8	2	0	0	1	0	10	0	0	110
1 Hr	336	40	5	2	1	2	0	28	0	0	414
08:00	86	6	0	1	0	0	0	15	0	0	108
08:15	73	8	0	0	0	0	0	10	0	0	91
08:30	92	10	0	0	0	0	0	7	0	0	109
08:45	94	3	1	1	0	0	0	6	0	0	105
1 Hr	345	27	1	2	0	0	0	38	0	0	413
09:00	77	5	0	2	0	0	0	6	0	0	90
09:15	58	3	0	1	0	0	0	1	0	0	63
09:30	49	7	1	1	0	1	0	4	0	0	63
09:45	34	5	1	1	0	0	0	2	0	0	43
1 Hr	218	20	2	5	0	1	0	13	0	0	259
10:00	31	6	0	1	0	0	0	3	0	0	41
10:15	38	2	0	0	0	0	0	3	0	0	43
10:30	51	5	0	2	2	0	0	2	0	0	62
10:45	40	5	0	2	0	0	0	0	0	0	47
1 Hr	160	18	0	5	2	0	0	8	0	0	193
11:00	35	5	1	0	0	0	0	1	0	0	42
11:15	38	5	0	0	0	0	0	3	0	0	46
11:30	43	4	0	0	0	1	0	1	0	0	49
11:45	27	2	0	0	0	0	0	0	0	0	29
1 Hr	143	16	1	0	0	1	0	5	0	0	166
6 Hrs	1364	137	13	15	3	4	0	104	0	0	1640

Direction : Westbound

Time	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	2	1	0	0	0	0	0	1	0	0	4
06:15	5	1	0	0	0	0	0	0	0	0	6
06:30	3	3	0	0	0	0	0	4	0	0	10
06:45	15	2	0	0	0	0	0	2	0	0	19
1 Hr	25	7	0	0	0	0	0	7	0	0	39
07:00	12	2	0	0	0	0	0	0	0	0	14
07:15	14	5	1	0	0	0	0	2	0	0	22
07:30	17	3	1	0	0	0	0	3	0	0	24
07:45	26	2	1	1	0	0	0	1	0	0	31
1 Hr	69	12	3	1	0	0	0	6	0	0	91
08:00	29	5	1	0	0	0	0	3	0	0	38
08:15	24	1	0	1	0	0	0	4	0	0	30
08:30	30	5	0	0	0	0	0	1	0	0	36
08:45	23	5	0	0	0	0	0	0	0	0	28
1 Hr	106	16	1	1	0	0	0	8	0	0	132
09:00	21	4	0	2	0	0	0	3	0	0	30
09:15	21	1	0	0	0	0	0	3	0	0	25
09:30	22	6	0	0	0	0	0	2	0	0	30
09:45	21	5	0	0	0	0	0	2	0	0	28
1 Hr	85	16	0	2	0	0	0	10	0	0	113
10:00	22	5	0	3	0	0	0	0	0	0	30
10:15	26	1	0	0	0	0	0	0	0	0	27
10:30	25	6	1	0	0	0	0	0	0	0	32
10:45	21	6	1	0	0	0	0	1	0	0	29
1 Hr	94	18	2	3	0	0	0	1	0	0	118
11:00	27	4	0	1	0	0	0	2	0	0	34
11:15	25	7	1	0	0	0	0	0	0	0	33
11:30	28	4	0	0	0	0	0	5	0	0	37
11:45	35	6	1	1	0	0	0	0	0	0	43
1 Hr	115	21	2	2	0	0	0	7	0	0	147
6 Hrs	494	90	8	9	0	0	0	39	0	0	640

Direction : Eastbound

Time	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
06:00	1	0	0	0	0	0	0	0	0	1
06:15	24	0	0	0	0	0	0	0	0	24
06:30	13	0	0	0	0	0	0	0	0	13
06:45	17	0	0	0	0	0	0	0	0	17
1 Hr	55	0	0	0	0	0	0	0	0	55
07:00	7	0	0	0	0	0	0	0	0	7
07:15	45	0	1	0	0	0	0	0	0	46
07:30	4	0	0	0	0	0	0	0	0	4
07:45	32	0	0	0	0	0	0	0	0	32
1 Hr	88	0	1	0	0	0	0	0	0	89
08:00	38	0	0	0	0	0	0	0	0	38
08:15	20	0	0	0	0	0	0	0	0	20
08:30	28	0	0	0	0	0	0	0	0	28
08:45	10	0	0	0	0	0	0	0	0	10
1 Hr	96	0	0	0	0	0	0	0	0	96
09:00	11	0	0	0	0	0	1	0	0	12
09:15	8	0	0	0	0	0	0	0	0	8
09:30	8	0	0	0	0	0	1	0	0	9
09:45	8	0	1	0	0	0	0	0	0	9
1 Hr	35	0	1	0	0	0	2	0	0	38
10:00	1	0	0	0	0	0	0	0	0	1
10:15	15	0	0	0	0	0	0	0	0	15
10:30	7	0	0	0	1	0	0	0	0	8
10:45	3	0	0	0	0	0	0	0	0	3
1 Hr	26	0	0	0	1	0	0	0	0	27
11:00	7	0	0	0	0	0	0	0	1	8
11:15	4	1	0	0	0	0	1	0	0	6
11:30	5	0	0	0	0	0	0	0	0	5
11:45	5	0	0	0	0	0	0	0	0	5
1 Hr	21	1	0	0	0	0	1	0	1	24
6 Hrs	321	1	2	0	1	0	3	0	1	329

Direction : Westbound

Time	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
06:00	0	0	0	0	0	0	0	0	0	0	3
06:15	4	0	0	0	0	0	0	0	0	4	2
06:30	15	0	0	0	0	0	0	0	0	15	2
06:45	9	0	0	0	0	0	0	0	0	9	2
1 Hr	28	0	0	0	0	0	0	0	0	28	9
07:00	5	0	0	0	0	0	0	0	0	5	4
07:15	2	0	0	0	0	0	0	0	0	2	3
07:30	6	0	0	0	0	0	0	0	0	6	4
07:45	3	0	0	0	0	0	0	0	0	3	2
1 Hr	16	0	0	0	0	0	0	0	0	16	13
08:00	7	0	0	0	0	0	0	0	0	7	3
08:15	1	0	0	0	0	0	0	0	0	1	3
08:30	11	0	0	0	0	0	0	0	0	11	1
08:45	6	0	0	0	0	0	0	0	0	6	2
1 Hr	25	0	0	0	0	0	0	0	0	25	9
09:00	10	0	0	0	0	0	0	0	0	10	3
09:15	6	0	0	0	0	0	0	0	0	6	2
09:30	4	0	0	0	0	0	0	0	0	4	0
09:45	2	0	0	0	0	0	0	0	0	2	2
1 Hr	22	0	0	0	0	0	0	0	0	22	7
10:00	0	0	0	0	0	0	1	0	0	1	2
10:15	8	0	0	0	0	0	0	0	0	8	1
10:30	3	0	0	0	0	0	0	0	0	3	2
10:45	1	0	0	0	0	0	0	0	0	1	1
1 Hr	12	0	0	0	0	0	1	0	0	13	6
11:00	2	0	0	0	0	0	0	0	1	3	3
11:15	0	0	0	0	0	0	0	0	0	0	2
11:30	5	0	0	0	0	0	0	0	0	5	1
11:45	2	0	0	0	0	0	0	0	0	2	2
1 Hr	9	0	0	0	0	0	0	0	1	10	8
6 Hrs	112	0	0	0	0	0	1	0	1	114	52

Linkcount

Direction : Eastbound

Time	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	36	2	2	0	0	0	0	2	0	0	42
12:15	38	2	2	2	0	0	0	0	0	0	44
12:30	33	2	0	1	0	0	0	0	0	0	36
12:45	29	5	0	1	0	0	0	0	0	0	35
1 Hr	136	11	4	4	0	0	0	2	0	0	157
13:00	33	3	1	0	0	0	0	2	0	0	39
13:15	23	2	0	0	0	0	0	1	0	0	26
13:30	39	2	0	1	0	1	0	1	0	0	44
13:45	15	4	0	2	0	0	0	2	0	0	23
1 Hr	110	11	1	3	0	1	0	6	0	0	132
14:00	23	2	0	0	0	0	0	0	0	0	25
14:15	25	6	1	0	0	0	0	3	0	0	35
14:30	20	4	2	0	1	0	0	0	0	0	27
14:45	30	3	1	0	0	0	0	0	0	0	34
1 Hr	98	15	4	0	1	0	0	3	0	0	121
15:00	26	3	0	1	0	0	0	1	0	0	31
15:15	21	4	1	1	0	0	0	0	0	0	27
15:30	22	4	0	1	0	0	0	1	0	0	28
15:45	25	8	0	1	0	0	0	0	0	0	34
1 Hr	94	19	1	4	0	0	0	2	0	0	120
16:00	33	5	0	1	0	0	0	6	0	0	45
16:15	22	5	2	0	0	0	0	1	0	0	30
16:30	30	1	0	0	0	0	0	1	0	0	32
16:45	44	3	0	0	0	0	0	0	0	0	47
1 Hr	129	14	2	1	0	0	0	8	0	0	154
17:00	31	1	0	0	0	0	0	9	0	0	41
17:15	29	1	0	0	0	0	0	6	0	0	36
17:30	34	1	0	0	0	0	0	4	0	0	39
17:45	30	1	0	0	0	0	0	2	0	0	33
1 Hr	124	4	0	0	0	0	0	21	0	0	149
6 Hrs	691	74	12	12	1	1	0	42	0	0	833

Direction : Westbound

Time	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	28	3	0	3	0	0	0	3	0	0	37
12:15	32	2	1	1	0	0	0	3	0	0	39
12:30	34	5	0	0	0	0	0	5	0	0	44
12:45	30	8	0	1	0	1	0	1	0	1	42
1 Hr	124	18	1	5	0	1	0	12	0	1	162
13:00	27	4	2	0	0	0	0	1	0	0	34
13:15	31	11	0	0	2	0	0	1	0	0	45
13:30	36	3	1	1	0	0	0	2	0	0	43
13:45	31	6	0	1	0	0	0	0	0	0	38
1 Hr	125	24	3	2	2	0	0	4	0	0	160
14:00	28	5	0	1	0	0	0	0	0	0	34
14:15	25	4	0	2	0	0	0	1	0	0	32
14:30	34	4	0	2	0	1	0	1	0	0	42
14:45	37	4	1	1	0	0	0	0	0	0	43
1 Hr	124	17	1	6	0	1	0	2	0	0	151
15:00	33	11	1	0	0	0	0	1	0	0	46
15:15	31	10	0	0	0	0	0	0	0	0	41
15:30	42	8	0	0	0	1	0	0	0	0	51
15:45	56	13	3	0	0	0	0	2	0	0	74
1 Hr	162	42	4	0	0	1	0	3	0	0	212
16:00	63	0	1	2	0	0	0	2	0	0	68
16:15	65	6	3	0	0	0	0	5	0	0	79
16:30	57	8	2	1	0	0	0	3	0	0	71
16:45	70	10	0	1	0	0	0	6	0	0	87
1 Hr	255	24	6	4	0	0	0	16	0	0	305
17:00	63	6	2	1	0	1	0	3	0	0	76
17:15	64	9	0	0	0	0	0	7	0	0	80
17:30	68	5	0	1	0	0	0	10	0	0	84
17:45	67	5	1	1	0	0	0	4	0	0	78
1 Hr	262	25	3	3	0	1	0	24	0	0	318
6 Hrs	1052	150	18	20	2	4	0	61	0	1	1308

Direction : Eastbound

Time	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
12:00	4	0	0	0	0	0	0	0	0	4
12:15	7	0	0	0	0	0	0	0	0	7
12:30	1	0	0	0	0	0	0	0	0	1
12:45	6	0	0	0	0	0	1	0	0	7
1 Hr	18	0	0	0	0	0	1	0	0	19
13:00	2	0	0	0	0	0	0	0	0	2
13:15	9	2	0	0	0	0	0	0	0	11
13:30	6	0	2	0	0	0	1	0	0	9
13:45	4	0	0	0	0	0	0	0	0	4
1 Hr	21	2	2	0	0	0	1	0	0	26
14:00	0	0	0	0	0	0	0	0	0	0
14:15	5	0	0	0	0	0	0	0	0	5
14:30	5	0	0	0	0	0	1	0	0	6
14:45	0	0	0	0	0	0	0	0	0	0
1 Hr	10	0	0	0	0	0	1	0	0	11
15:00	1	0	0	0	0	0	0	0	0	1
15:15	0	0	0	0	0	0	0	0	0	0
15:30	2	0	0	0	0	0	0	0	0	2
15:45	0	0	0	0	0	0	0	0	0	0
1 Hr	3	0	0	0	0	0	0	0	0	3
16:00	7	0	0	0	0	0	0	0	0	7
16:15	4	0	0	0	0	0	0	0	0	4
16:30	3	0	1	0	0	0	0	0	0	4
16:45	13	0	0	0	0	0	1	0	0	14
1 Hr	27	0	1	0	0	0	1	0	0	29
17:00	10	0	0	0	0	0	0	0	0	10
17:15	3	0	0	0	0	0	0	0	0	3
17:30	11	0	0	0	0	0	0	0	0	11
17:45	2	0	0	0	0	0	0	0	0	2
1 Hr	26	0	0	0	0	0	0	0	0	26
6 Hrs	105	2	3	0	0	0	5	0	0	115

Direction : Westbound

Time	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
12:00	1	0	0	0	0	0	1	0	0	2	3
12:15	2	0	0	0	0	0	0	0	0	2	2
12:30	2	0	0	0	0	0	0	0	0	2	2
12:45	6	0	0	0	0	0	0	0	0	6	1
1 Hr	11	0	0	0	0	0	1	0	0	12	8
13:00	0	0	0	0	0	0	0	0	0	0	4
13:15	1	0	0	0	0	0	0	0	0	1	1
13:30	4	0	0	0	0	0	0	0	0	4	2
13:45	0	0	0	0	0	0	0	0	0	0	2
1 Hr	5	0	0	0	0	0	0	0	0	5	9
14:00	1	0	0	0	0	0	0	0	0	1	4
14:15	2	0	0	0	0	0	0	0	0	2	1
14:30	7	0	0	0	0	0	0	0	0	7	2
14:45	0	0	0	0	0	0	0	0	0	0	1
1 Hr	10	0	0	0	0	0	0	0	0	10	8
15:00	1	0	0	0	1	0	0	0	0	2	3
15:15	1	0	0	0	0	0	0	0	0	1	2
15:30	6	0	0	0	0	0	1	0	0	7	3
15:45	0	0	0	0	0	0	0	0	0	0	3
1 Hr	8	0	0	0	1	0	1	0	0	10	11
16:00	0	0	0	0	0	0	0	0	0	0	2
16:15	3	0	0	0	0	0	0	0	0	3	3
16:30	4	0	0	0	0	0	0	0	0	4	2
16:45	4	0	0	0	0	0	1	0	0	5	2
1 Hr	11	0	0	0	0	0	1	0	0	12	9
17:00	3	0	0	0	0	0	0	0	0	3	3
17:15	3	0	0	0	0	0	0	0	0	3	3
17:30	1	0	0	0	0	0	0	0	0	1	1
17:45	1	0	0	0	0	0	0	0	0	1	3
1 Hr	8	0	0	0	0	0	0	0	0	8	10
6 Hrs	53	0	0	0	1	0	3	0	0	57	55

Linkcount

Direction : Eastbound

Time	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	46	2	1	1	0	1	0	3	0	0	54
18:15	26	2	0	0	0	0	0	1	0	0	29
18:30	27	2	3	0	0	0	0	0	0	0	32
18:45	29	2	0	0	0	0	0	4	0	0	35
1 Hr	128	8	4	1	0	1	0	8	0	0	150
19:00	28	3	1	0	0	0	0	2	0	0	34
19:15	27	0	0	0	0	0	0	3	0	0	30
19:30	18	1	1	0	0	0	0	0	0	0	20
19:45	11	1	1	0	0	0	0	1	0	0	14
1 Hr	84	5	3	0	0	0	0	6	0	0	98
20:00	13	2	0	0	0	0	0	1	0	0	16
20:15	18	1	0	0	0	0	0	2	0	0	21
20:30	11	2	0	0	0	0	0	1	0	0	14
20:45	7	0	1	0	0	0	0	0	0	0	8
1 Hr	49	5	1	0	0	0	0	4	0	0	59
21:00	7	1	1	0	0	0	0	0	0	0	9
21:15	10	0	0	0	0	0	0	0	0	0	10
21:30	12	0	0	0	0	0	0	0	0	0	12
21:45	2	0	0	0	0	0	0	1	0	0	3
1 Hr	31	1	1	0	0	0	0	1	0	0	34
22:00	10	0	0	0	0	0	0	2	0	0	12
22:15	7	0	0	0	0	0	0	0	0	0	7
22:30	2	0	0	0	0	0	0	0	0	0	2
22:45	10	0	0	0	0	0	0	0	0	0	10
1 Hr	29	0	0	0	0	0	0	2	0	0	31
23:00	1	0	0	0	0	0	0	1	0	0	2
23:15	3	0	0	0	0	0	0	0	0	0	3
23:30	3	0	0	1	0	0	0	0	0	0	4
23:45	0	0	0	0	0	0	0	0	0	0	0
1 Hr	7	0	0	1	0	0	0	1	0	0	9
6 Hrs	328	19	9	2	0	1	0	22	0	0	381
Total	2383	230	34	29	4	6	0	168	0	0	2854

Direction : Westbound

Time	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	49	5	1	0	0	1	0	8	0	0	64
18:15	49	3	0	0	0	0	0	8	0	0	60
18:30	59	2	0	0	0	0	0	14	0	0	75
18:45	35	3	1	1	0	0	0	0	0	0	40
1 Hr	192	13	2	1	0	1	0	30	0	0	239
19:00	31	4	0	2	0	0	0	7	0	0	44
19:15	41	1	1	0	0	0	0	3	0	0	46
19:30	16	1	0	0	0	0	0	6	0	0	23
19:45	41	2	0	0	0	0	0	0	0	0	43
1 Hr	129	8	1	2	0	0	0	16	0	0	156
20:00	26	3	1	0	0	0	0	0	0	0	30
20:15	32	1	1	0	0	0	0	2	0	0	36
20:30	18	1	0	0	0	0	0	0	0	0	19
20:45	18	4	1	0	0	0	0	2	0	0	25
1 Hr	94	9	3	0	0	0	0	4	0	0	110
21:00	19	1	0	0	0	0	0	0	0	0	20
21:15	27	0	0	0	0	0	0	2	0	0	29
21:30	22	0	0	1	0	0	0	1	0	0	24
21:45	17	0	1	0	0	0	0	1	0	0	19
1 Hr	85	1	1	1	0	0	0	4	0	0	92
22:00	10	0	1	0	0	0	0	0	0	0	11
22:15	12	0	0	0	0	0	0	0	0	0	12
22:30	10	0	0	0	0	0	0	0	0	0	10
22:45	11	0	0	0	0	0	0	1	0	0	12
1 Hr	43	0	1	0	0	0	0	1	0	0	45
23:00	3	0	0	0	0	0	0	0	0	0	3
23:15	12	2	0	0	0	0	0	0	0	0	14
23:30	3	0	0	0	0	0	0	0	0	0	3
23:45	3	0	0	1	0	0	0	0	0	0	4
1 Hr	21	2	0	1	0	0	0	0	0	0	24
6 Hrs	564	33	8	5	0	1	0	55	0	0	666
Total	2110	273	34	34	2	5	0	155	0	1	2614

Direction : Eastbound

Time	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Pushchair/ Pram	Pushchair/ Pram	Scooter	Railway Personnel	Total
18:00	8	0	0	0	0	0	0	0	0	8
18:15	0	0	0	0	0	0	0	0	0	0
18:30	16	0	0	0	0	0	0	0	0	16
18:45	3	0	0	0	0	0	0	0	0	3
1 Hr	27	0	0	0	0	0	0	0	0	27
19:00	13	0	0	0	0	0	0	0	0	13
19:15	24	2	0	0	0	0	0	0	0	26
19:30	2	0	3	0	0	0	0	0	0	5
19:45	16	0	0	0	0	0	0	0	0	16
1 Hr	55	2	3	0	0	0	0	0	0	60
20:00	3	0	0	0	0	0	0	0	0	3
20:15	14	0	0	0	0	0	0	0	0	14
20:30	2	0	0	0	0	0	0	0	0	2
20:45	6	0	0	0	0	0	0	0	0	6
1 Hr	25	0	0	0	0	0	0	0	0	25
21:00	0	0	0	0	0	0	0	0	0	0
21:15	5	0	0	0	0	0	0	0	0	5
21:30	4	0	0	0	0	0	0	0	0	4
21:45	2	0	0	0	0	0	0	0	0	2
1 Hr	11	0	0	0	0	0	0	0	0	11
22:00	6	0	0	0	0	0	0	0	0	6
22:15	0	0	0	0	0	0	0	0	0	0
22:30	4	0	0	0	0	0	0	0	0	4
22:45	2	0	0	0	0	0	0	0	0	2
1 Hr	12	0	0	0	0	0	0	0	0	12
23:00	0	0	0	0	0	0	0	0	0	0
23:15	0	0	0	0	0	0	0	0	0	0
23:30	0	0	0	0	0	0	0	0	0	0
23:45	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0
6 Hrs	130	2	3	0	0	0	0	0	0	135
Total	556	5	8	0	1	0	8	0	1	579

Direction : Westbound

Time	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
18:00	6	0	0	0	0	0	0	0	0	6	3
18:15	7	0	0	0	0	0	0	0	0	7	3
18:30	4	0	0	0	0	0	0	0	0	4	1
18:45	4	0	0	0	0	0	0	0	0	4	2
1 Hr	21	0	0	0	0	0	0	0	0	21	9
19:00	7	0	0	0	0	0	0	0	0	7	3
19:15	4	0	0	0	0	0	0	0	0	4	3
19:30	4	0	0	0	0	0	0	0	0	4	3
19:45	5	0	0	0	0	0	0	0	0	5	2
1 Hr	20	0	0	0	0	0	0	0	0	20	11
20:00	3	0	0	0	0	0	0	0	0	3	3
20:15	2	0	0	0	0	0	0	0	0	2	2
20:30	3	0	0	0	0	0	0	0	0	3	1
20:45	4	0	0	0	0	0	0	0	0	4	3
1 Hr	12	0	0	0	0	0	0	0	0	12	9
21:00	2	0	0	0	0	0	0	0	0	2	3
21:15	4	0	0	0	0	0	0	0	0	4	3
21:30	1	0	0	0	0	0	0	0	0	1	3
21:45	1	0	0	0	0	0	0	0	0	1	1
1 Hr	8	0	0	0	0	0	0	0	0	8	10
22:00	2	0	0	0	0	0	0	0	0	2	2
22:15	0	0	0	0	0	0	0	0	0	0	3
22:30	3	0	0	0	0	0	0	0	0	3	0
22:45	2	0	0	0	0	0	0	0	0	2	2
1 Hr	7	0	0	0	0	0	0	0	0	7	7
23:00	0	0	0	0	0	0	0	0	0	0	3
23:15	2	0	0	0	0	0	0	0	0	2	3
23:30	0	0	0	0	0	0	0	0	0	0	0
23:45	0	0	0	0	0	0	0	0	0	0	2
1 Hr	2	0	0	0	0	0	0	0	0	2	8
6 Hrs	70	0	0	0	0	0	0	0	0	70	54
Total	235	0	0	0	1	0	4	0	1	241	161

		DURATION	DIRECTION
		Northbound	82
		Southbound	79
		Total	161

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
06:00:16	06:00:18	00:00:02	N
06:10:10	06:10:13	00:00:03	N
06:12:39	06:12:42	00:00:03	N
06:23:02	06:23:13	00:00:11	N
06:27:25	06:27:30	00:00:05	N
06:30:33	06:30:43	00:00:10	S
06:44:03	06:44:05	00:00:02	S
06:46:56	06:47:07	00:00:11	S
06:55:22	06:55:27	00:00:05	S
07:00:42	07:00:52	00:00:10	S
07:02:20	07:02:32	00:00:12	N
07:08:30	07:08:32	00:00:02	N
07:12:49	07:12:51	00:00:02	N
07:15:38	07:15:40	00:00:02	N
07:23:59	07:24:04	00:00:05	S
07:26:53	07:26:58	00:00:05	N
07:31:58	07:32:10	00:00:12	S
07:33:11	07:33:20	00:00:09	N
07:41:33	07:41:40	00:00:07	N
07:41:40	07:41:42	00:00:02	S
07:47:58	07:48:03	00:00:05	S
07:58:24	07:58:35	00:00:11	S
08:02:53	08:02:55	00:00:02	S
08:09:04	08:09:07	00:00:03	S
08:12:43	08:12:54	00:00:11	S
08:15:41	08:15:42	00:00:01	N
08:19:06	08:19:15	00:00:09	N
08:24:48	08:24:51	00:00:03	N
08:35:06	08:35:09	00:00:03	S
08:48:17	08:48:19	00:00:02	S
08:48:31	08:48:40	00:00:09	N
09:01:57	09:01:59	00:00:02	S
09:07:04	09:07:07	00:00:03	N
09:14:46	09:14:49	00:00:03	N
09:18:57	09:19:03	00:00:06	N
09:24:06	09:24:19	00:00:13	S
09:51:00	09:51:02	00:00:02	S
09:58:49	09:59:01	00:00:12	S
10:05:22	10:05:24	00:00:02	S
10:10:04	10:10:06	00:00:02	N
10:18:28	10:18:30	00:00:02	N
10:31:20	10:31:33	00:00:13	N
10:40:36	10:40:47	00:00:11	N
10:49:55	10:49:57	00:00:02	S
11:07:19	11:07:21	00:00:02	N
11:07:23	11:07:28	00:00:05	S
11:12:11	11:12:16	00:00:05	N
11:18:18	11:18:20	00:00:02	N
11:21:59	11:22:01	00:00:02	S
11:40:39	11:40:48	00:00:09	S
11:49:48	11:49:50	00:00:02	S
11:53:41	11:53:54	00:00:13	N
12:03:55	12:03:57	00:00:02	S
12:06:09	12:06:14	00:00:05	S
12:08:07	12:08:09	00:00:02	N
12:18:32	12:18:34	00:00:02	N
12:27:01	12:27:06	00:00:05	N
12:33:41	12:33:46	00:00:05	S
12:41:48	12:41:58	00:00:10	N
12:52:41	12:52:50	00:00:09	S
13:04:46	13:04:48	00:00:02	S
13:07:14	13:07:16	00:00:02	N
13:09:30	13:09:35	00:00:05	S
13:12:21	13:12:24	00:00:03	N
13:17:45	13:17:47	00:00:02	N
13:36:52	13:37:03	00:00:11	S
13:42:37	13:42:50	00:00:13	N
13:47:43	13:47:44	00:00:01	N
13:54:08	13:54:10	00:00:02	S
14:04:15	14:04:17	00:00:02	S
14:08:15	14:08:26	00:00:11	S
14:08:54	14:08:57	00:00:03	N
14:12:22	14:12:27	00:00:05	N
14:17:30	14:17:32	00:00:02	N
14:34:00	14:34:12	00:00:12	S
14:42:24	14:42:34	00:00:10	N
14:48:28	14:48:30	00:00:02	S
15:03:48	15:03:50	00:00:02	S
15:07:31	15:07:33	00:00:02	N
15:07:46	15:07:51	00:00:05	S
15:18:21	15:18:23	00:00:02	N
15:28:12	15:28:17	00:00:05	N
15:31:56	15:32:09	00:00:13	N
15:34:26	15:34:38	00:00:12	S
15:42:35	15:42:49	00:00:14	N
15:46:31	15:46:39	00:00:08	N
15:49:40	15:49:42	00:00:02	S
15:52:22	15:52:27	00:00:05	S
16:03:38	16:03:39	00:00:01	S
16:09:09	16:09:11	00:00:02	N
16:16:22	16:16:36	00:00:14	S
16:17:05	16:17:10	00:00:05	N
16:23:29	16:23:32	00:00:03	N
16:35:13	16:35:15	00:00:02	S
16:39:48	16:39:58	00:00:10	S
16:45:26	16:45:36	00:00:10	N
16:54:02	16:54:04	00:00:02	S
17:07:05	17:07:06	00:00:01	S
17:09:33	17:09:38	00:00:05	S
17:09:52	17:09:54	00:00:02	N
17:18:48	17:18:51	00:00:03	N
17:19:41	17:19:51	00:00:10	S
17:22:19	17:22:24	00:00:05	N
17:30:24	17:30:38	00:00:14	N
17:46:43	17:46:53	00:00:10	N
17:48:52	17:48:54	00:00:02	S
17:53:14	17:53:17	00:00:03	S
18:03:31	18:03:36	00:00:05	S
18:07:27	18:07:28	00:00:01	N
18:07:50	18:07:52	00:00:02	S
18:17:12	18:17:23	00:00:11	S
18:18:56	18:19:01	00:00:05	N
18:22:45	18:22:47	00:00:02	N
18:30:03	18:30:16	00:00:13	N
18:54:40	18:54:42	00:00:02	S
18:57:00	18:57:03	00:00:03	S
19:02:18	19:02:20	00:00:02	S
19:07:01	19:07:06	00:00:05	S
19:09:52	19:09:54	00:00:02	N
19:16:36	19:16:48	00:00:12	S
19:16:55	19:17:00	00:00:05	N
19:24:46	19:24:54	00:00:08	N
19:30:47	19:30:49	00:00:02	N
19:34:09	19:34:11	00:00:02	N
19:43:08	19:43:10	00:00:02	S
19:47:52	19:48:01	00:00:09	N
19:48:24	19:48:26	00:00:02	S
20:02:23	20:02:34	00:00:11	S
20:06:36	20:06:38	00:00:02	N
20:08:10	20:08:12	00:00:02	S
20:23:11	20:23:16	00:00:05	N
20:25:53	20:26:04	00:00:11	N
20:30:11	20:30:13	00:00:02	N
20:49:35	20:49:44	00:00:09	N
20:50:31	20:50:32	00:00:01	S
20:58:30	20:58:33	00:00:03	N
21:00:54	21:00:56	00:00:02	S
21:08:44	21:08:46	00:00:02	N
21:09:02	21:09:07	00:00:05	S
21:16:49	21:17:00	00:00:11	N
21:21:41	21:21:54	00:00:13	S
21:23:47	21:23:48	00:00:01	N
21:34:51	21:34:53	00:00:02	S
21:39:00	21:39:02	00:00:02	N
21:43:21	21:43:24	00:00:03	S
21:48:39	21:48:49	00:00:10	N
22:04:09	22:04:10	00:00:01	S
22:06:36	22:06:39	00:00:03	S
22:17:20	22:17:29	00:00:09	S
22:17:55	22:18:06	00:00:11	N
22:24:30	22:24:32	00:00:02	S
22:48:13	22:48:27	00:00:14	N
22:48:32	22:48:40	00:00:08	S
23:02:38	23:02:39	00:00:01	S
23:02:51	23:02:53	00:00:02	N
23:13:56	23:14:08	00:00:12	S
23:18:38	23:18:40	00:00:02	S
23:22:37	23:22:49	00:00:12	N
23:27:20	23:27:21	00:00:01	N
23:47:40	23:47:42	00:00:02	S
23:53:45	23:53:57	00:00:12	N

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Drop off	08:04:43	08:04:50	WSJ
Drop off	06:25:29	06:25:37	ESJ
Pick up	07:01:34	07:01:59	ESJ
Drop off	08:37:43	08:37:55	ESJ
Drop off	11:21:41	11:21:56	ESJ
Drop off	11:25:18	11:25:29	ESJ
Pick up	11:32:32	11:33:17	ESJ
Vehicle Stopped To Talk With An Adult Near Level Crossing	12:03:03	12:04:06	WSJ
Parking	13:34:23	13:48:35	ESJ
Drop off	14:59:25	15:00:19	ESJ
Waiting	15:06:13	15:08:13	ESJ
Drop off	16:05:41	16:06:51	ESJ
Parking	16:34:59	16:42:01	WSJ
Drop off	16:35:11	16:36:02	ESJ
Drop off	17:32:30	17:32:40	WSJ
Drop off	18:29:05	18:29:24	WSJ
Parking	18:58:38	19:30:19	ESJ
Pick up	19:24:35	19:27:12	ESJ
Pick up	19:26:07	19:26:14	WSJ
Pick up	19:26:54	19:28:35	ESJ
Pick up	19:48:46	19:49:36	WSJ
Waiting	19:59:51	20:02:00	ESJ
Pick up	20:23:31	20:28:19	ESJ
Waiting	22:45:56	22:48:57	ESJ
Pick up	22:53:24	22:53:44	WSJ

Tracsis plc
Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Clayhithe Road Level Crossing
Date: Friday 14th July 2017

AM Weather : Dry, cloudy
PM Weather : Dry, cloudy

Linkcount

Time	EB Car	EB Lgv	EB Mcl	EB Hgv	EB Tractor & Trailers	EB Bus	EB Horse Riders	EB Pcl	EB Herded Animals & Horses	EB Large / Slow Vehicles	EB Total	WB Car	WB Lgv	WB Mcl	WB Hgv	WB Tractor & Trailers	WB Bus	WB Horse Riders	WB Pcl	WB Herded Animals & Horses	WB Large / Slow Vehicles	WB Total
06:00	11	1	0	0	0	0	0	1	0	0	13	3	0	0	0	0	0	0	0	0	0	3
06:15	37	6	0	1	0	0	0	3	0	0	47	2	3	0	0	0	0	0	1	0	0	6
06:30	29	5	1	0	0	0	0	3	0	0	38	5	1	0	0	0	0	0	3	0	0	9
06:45	62	12	2	0	0	0	0	4	0	0	80	11	0	0	0	0	0	0	3	0	0	14
1 Hr	139	24	3	1	0	0	0	11	0	0	178	21	4	0	0	0	0	0	7	0	0	32
07:00	74	11	3	2	0	0	0	2	0	0	92	11	0	0	0	0	0	0	1	0	0	12
07:15	82	1	1	2	0	0	0	10	0	0	96	10	4	1	0	0	0	0	0	0	0	15
07:30	70	6	2	0	0	1	0	3	0	0	82	21	3	0	0	0	0	0	1	0	0	25
07:45	82	9	3	1	0	0	0	9	0	0	104	21	5	1	0	0	0	0	2	0	0	29
1 Hr	308	27	9	5	0	1	0	24	0	0	374	63	12	2	0	0	0	0	4	0	0	81
08:00	73	7	0	0	0	0	0	10	0	0	90	27	4	0	1	0	0	0	1	0	0	33
08:15	73	9	0	1	0	0	0	11	0	0	94	26	5	0	1	0	0	0	1	0	0	33
08:30	69	5	0	0	0	0	0	5	0	0	79	21	3	1	4	0	0	0	4	0	0	33
08:45	69	8	1	4	1	0	0	6	0	0	89	23	4	1	0	0	0	0	2	0	0	30
1 Hr	284	29	1	5	1	0	0	32	0	0	352	97	16	2	6	0	0	0	8	0	0	129
09:00	61	4	0	1	0	0	0	4	0	0	70	24	1	0	0	0	0	0	2	0	0	27
09:15	56	2	0	0	0	0	0	4	0	0	62	23	6	2	1	0	0	0	2	0	0	34
09:30	53	4	0	1	0	1	0	1	0	0	60	21	3	2	0	0	0	0	1	0	0	27
09:45	34	6	1	1	0	2	0	2	0	0	46	31	4	0	0	0	0	0	1	0	0	36
1 Hr	204	16	1	3	0	3	0	11	0	0	238	99	14	4	1	0	0	0	6	0	0	124
10:00	41	6	0	1	0	0	0	0	0	0	48	13	3	0	0	0	0	0	2	0	0	18
10:15	42	4	0	0	0	0	0	1	0	0	47	18	8	0	2	0	0	0	4	0	0	32
10:30	28	3	0	1	0	0	0	5	0	0	37	24	4	0	1	1	0	0	0	0	0	30
10:45	25	5	0	0	0	0	0	0	0	1	31	18	3	0	1	0	0	0	0	0	0	22
1 Hr	136	18	0	2	0	0	0	6	0	1	163	73	18	0	4	1	0	0	6	0	0	102
11:00	26	5	0	2	0	0	0	1	0	0	34	21	4	0	0	0	0	0	3	0	0	28
11:15	39	4	2	1	1	0	0	0	0	0	47	30	3	1	0	0	0	0	0	0	0	34
11:30	28	7	0	1	0	1	0	1	0	0	38	35	3	0	0	0	0	0	0	0	0	38
11:45	36	4	1	0	0	0	0	0	0	0	41	34	5	0	0	0	0	0	1	0	0	40
1 Hr	129	20	3	4	1	1	0	2	0	0	160	120	15	1	0	0	0	0	4	0	0	140
6 Hrs	1200	134	17	20	2	5	0	86	0	1	1465	473	79	9	11	1	0	0	35	0	0	608

Time	EB Adult	EB Accompanied Child	EB Unaccompanied Child	EB Elderly	EB Impaired	EB Wheelchair	EB Pushchair/ Pram	EB Scooter	EB Railway Personnel	EB Total	WB Adult	WB Accompanied Child	WB Unaccompanied Child	WB Elderly	WB Impaired	WB Wheelchair	WB Pushchair/ Pram	WB Scooter	WB Railway Personnel	WB Total	TRAINS
06:00	4	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	2	2
06:15	16	0	0	0	0	0	0	0	0	16	2	0	0	0	0	0	0	0	0	2	2
06:30	9	0	0	0	0	0	0	0	0	9	16	0	0	0	0	0	0	0	0	16	2
06:45	16	1	0	0	0	0	0	0	0	17	5	0	0	0	0	0	0	0	0	5	4
1 Hr	45	1	0	0	0	0	0	0	0	46	25	0	0	0	0	0	0	0	0	25	10
07:00	2	0	0	0	0	0	1	0	0	3	2	0	0	0	0	0	0	0	0	2	4
07:15	32	0	1	0	0	0	0	0	0	33	1	0	0	0	0	0	0	0	0	1	2
07:30	12	0	0	0	0	0	0	0	0	12	4	0	0	0	0	0	0	0	0	4	5
07:45	34	0	0	0	0	0	0	0	0	34	8	0	0	0	0	0	0	0	0	8	1
1 Hr	80	0	1	0	0	0	1	0	0	82	15	0	0	0	0	0	0	0	0	15	12
08:00	38	0	0	0	0	0	0	0	0	38	15	0	0	0	0	0	0	0	0	15	5
08:15	20	0	0	0	0	0	0	0	0	20	2	0	0	0	0	0	0	0	0	2	2
08:30	23	0	0	0	0	0	0	0	0	23	2	0	0	0	0	0	0	0	0	2	2
08:45	9	0	0	0	0	0	0	0	0	9	2	0	0	0	0	0	0	0	0	2	1
1 Hr	90	0	0	0	0	0	0	0	0	90	21	0	0	0	0	0	0	0	0	21	10
09:00	19	0	0	0	0	0	0	0	0	19	3	0	0	0	0	0	0	0	0	3	3
09:15	13	0	0	0	0	0	1	0	0	14	3	0	0	0	0	0	0	0	0	3	2
09:30	13	0	0	0	0	0	0	0	0	13	5	0	0	0	0	0	0	0	0	5	2
09:45	8	0	0	0	0	0	1	0	0	9	5	0	0	0	0	0	0	0	0	5	2
1 Hr	53	0	0	0	0	0	2	0	0	55	16	0	0	0	0	0	0	0	0	16	9
10:00	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	3
10:15	7	0	0	0	0	0	0	0	0	7	6	0	0	0	0	0	0	0	0	6	2
10:30	4	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	2	1
10:45	4	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	2	2
1 Hr	17	0	0	0	0	0	0	0	0	17	12	0	0	0	0	0	0	0	0	12	8
11:00	4	0	0	0	0	0	0	0	0	4	3	1	0	0	0	0	0	0	0	4	3
11:15	10	0	0	0	0	0	1	0	0	11	2	0	0	0	2	0	0	0	0	4	2
11:30	5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	2
11:45	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	1
1 Hr	19	0	0	0	0	0	1	0	0	20	7	1	0	0	2	0	0	0	0	10	8
6 Hrs	304	1	1	0	0	0	4	0	0	310	96	1	0	0	2	0	0	0	0	99	57

Linkcount

Time	EB Car	EB Lgv	EB Mcl	EB Hgv	EB Tractor & Trailers	EB Bus	EB Horse Riders	EB Pcl	EB Herded Animals & Horses	EB Large / Slow Vehicles	EB Total	WB Car	WB Lgv	WB Mcl	WB Hgv	WB Tractor & Trailers	WB Bus	WB Horse Riders	WB Pcl	WB Herded Animals & Horses	WB Large / Slow Vehicles	WB Total
12:00	30	5	1	1	0	0	0	2	0	0	39	29	5	0	1	0	0	0	0	0	0	35
12:15	31	4	0	0	0	0	0	7	0	0	42	34	6	0	2	0	0	0	3	0	0	45
12:30	39	3	0	1	0	0	0	2	0	0	45	35	3	1	0	0	1	0	3	0	0	43
12:45	36	2	0	1	0	0	0	0	0	0	39	44	8	0	0	0	0	0	1	0	0	53
1 Hr	136	14	1	3	0	0	0	11	0	0	165	142	22	1	3	0	1	0	7	0	0	176
13:00	43	6	0	0	1	0	0	2	0	0	52	36	4	1	2	0	0	0	0	0	0	43
13:15	29	6	0	0	0	0	0	4	0	0	39	33	4	0	1	0	0	0	2	0	0	40
13:30	24	2	2	0	0	1	0	3	0	0	32	30	5	0	1	0	0	0	2	0	0	38
13:45	25	5	1	0	0	0	0	2	0	0	33	48	8	2	0	0	0	0	0	0	0	58
1 Hr	121	19	3	0	1	1	0	11	0	0	156	147	21	3	4	0	0	0	4	0	0	179
14:00	30	5	0	0	0	0	0	1	0	0	36	29	5	0	1	0	0	0	0	0	0	35
14:15	24	8	0	0	0	0	0	1	0	0	33	51	7	0	2	0	0	0	0	0	0	60
14:30	33	4	0	2	0	0	0	4	0	0	43	39	9	0	1	0	1	0	1	0	0	51
14:45	26	2	0	1	0	0	0	1	0	0	30	57	6	1	2	0	0	0	2	0	0	68
1 Hr	113	19	0	3	0	0	0	7	0	0	142	176	27	1	6	0	1	0	3	0	0	214
15:00	36	2	0	0	0	0	0	1	0	0	39	38	11	1	1	0	0	0	1	0	0	52
15:15	12	1	1	0	0	0	0	0	0	0	14	29	7	1	1	0	0	0	1	0	0	39
15:30	29	2	1	0	0	0	0	1	0	0	33	51	10	1	0	1	0	0	1	0	0	64
15:45	29	6	1	0	0	0	0	0	0	0	36	63	4	0	2	0	0	0	3	0	0	72
1 Hr	106	11	3	0	0	0	0	2	0	0	122	181	32	3	4	1	0	0	6	0	0	227
16:00	31	8	0	1	0	0	0	2	0	0	42	53	12	1	0	0	0	0	1	0	0	67
16:15	29	3	2	0	0	0	0	2	0	0	36	73	9	0	0	0	0	0	2	0	0	84
16:30	33	3	0	0	0	0	0	2	0	0	38	76	5	1	0	0	2	0	3	0	0	87
16:45	41	4	0	1	0	0	0	2	0	0	48	57	5	1	0	0	0	0	1	0	0	64
1 Hr	133	18	2	2	0	0	0	9	0	0	164	259	31	3	0	0	2	0	7	0	0	302
17:00	33	3	0	0	0	0	0	7	0	0	43	58	4	2	0	0	0	0	4	0	0	68
17:15	32	2	0	0	0	0	0	2	0	0	36	61	2	0	2	0	0	0	6	0	0	71
17:30	24	1	0	0	0	0	0	5	0	0	30	73	3	1	0	0	0	0	11	0	0	88
17:45	28	4	1	1	0	0	0	3	0	0	37	61	2	1	0	1	1	0	4	0	0	70
1 Hr	117	10	1	1	0	0	0	17	0	0	146	253	11	4	2	1	1	0	25	0	0	297
6 Hrs	726	91	10	9	1	1	0	57	0	0	895	1158	144	15	19	2	5	0	52	0	0	1395

Time	EB Adult	EB Accompanied Child	EB Unaccompanied Child	EB Elderly	EB Impaired	EB Wheelchair	EB Pushchair/ Pram	EB Scooter	EB Railway Personnel	EB Total	WB Adult	WB Accompanied Child	WB Unaccompanied Child	WB Elderly	WB Impaired	WB Wheelchair	WB Pushchair/ Pram	WB Scooter	WB Railway Personnel	WB Total	TRAINS
12:00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	4
12:15	9	0	0	0	0	0	0	0	0	9	5	0	0	0	0	0	0	0	0	5	1
12:30	5	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0	3	2
12:45	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
1 Hr	15	0	0	0	0	0	0	0	0	15	9	0	0	0	0	0	0	0	0	9	8
13:00	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4
13:15	18	0	0	0	0	0	0	0	0	18	1	0	0	0	0	0	0	0	0	1	1
13:30	8	0	0	0	0	0	0	0	0	8	5	0	0	0	0	0	0	0	0	5	1
13:45	6	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	3
1 Hr	33	0	0	0	0	0	0	0	0	33	6	0	0	0	0	0	0	0	0	6	9
14:00	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	4
14:15	7	0	0	0	0	0	1	0	0	8	2	0	0	0	0	0	0	0	0	2	1
14:30	9	1	0	0	0	0	0	0	0	10	7	0	0	0	0	0	0	0	0	7	2
14:45	3	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	1	1
1 Hr	20	1	0	0	0	0	1	0	0	22	12	0	0	0	0	0	0	0	0	12	8
15:00	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	4
15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
15:30	27	3	0	0	0	0	0	0	0	30	6	0	0	0	0	0	1	0	0	7	4
15:45	3	0	0	0	0	0	0	0	0	3	6	0	0	0	0	0	0	0	0	6	1
1 Hr	31	3	0	0	0	0	0	0	0	34	14	0	0	0	0	0	1	0	0	15	10
16:00	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	3
16:15	5	0	0	0	0	0	2	0	0	7	5	0	0	0	0	0	0	0	0	5	5
16:30	9	0	0	0	0	0	0	0	0	9	5	0	0	0	0	0	0	0	0	5	2
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	18	0	0	0	0	0	2	0	0	20	10	0	0	0	0	0	0	0	0	10	11
17:00	11	0	0	0	0	0	0	0	0	11	2	0	0	0	0	0	0	0	0	2	3
17:15	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	4
17:30	12	0	0	0	0	0	0	0	0	12	3	0	0	0	0	0	0	0	0	3	0
17:45	5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	3
1 Hr	29	0	0	0	0	0	0	0	0	29	7	0	0	0	0	0	0	0	0	7	10
6 Hrs	146	4	0	0	0	0	3	0	0	153	58	0	0	0	0	0	1	0	0	59	56

Linkcount

Time	EB Car	EB Lgv	EB Mcl	EB Hgv	EB Tractor & Trailers	EB Bus	EB Horse Riders	EB Pcl	EB Herded Animals & Horses	EB Large / Slow Vehicles	EB Total	WB Car	WB Lgv	WB Mcl	WB Hgv	WB Tractor & Trailers	WB Bus	WB Horse Riders	WB Pcl	WB Herded Animals & Horses	WB Large / Slow Vehicles	WB Total
18:00	62	2	0	1	0	1	0	4	0	0	70	37	0	1	0	0	0	0	4	0	0	42
18:15	50	6	1	0	0	0	0	7	0	0	64	31	1	0	0	0	0	0	6	0	0	38
18:30	49	4	0	0	0	0	0	4	0	0	57	28	1	0	0	0	0	0	0	0	0	29
18:45	41	5	0	1	0	0	0	5	0	0	52	27	3	0	1	0	0	0	2	0	0	33
1 Hr	202	17	1	2	0	1	0	20	0	0	243	123	5	1	1	0	0	0	12	0	0	142
19:00	35	5	0	0	0	0	0	1	0	0	41	27	0	0	0	0	0	0	3	0	0	30
19:15	34	0	1	2	0	0	0	2	0	0	39	26	1	0	0	0	0	0	3	0	0	30
19:30	32	1	1	0	0	0	0	3	0	0	37	23	2	0	0	0	0	0	2	0	0	27
19:45	35	0	0	1	0	0	0	2	0	0	38	19	0	0	0	0	0	0	1	0	0	20
1 Hr	136	6	2	3	0	0	0	8	0	0	155	95	3	0	0	0	0	0	9	0	0	107
20:00	27	0	0	2	0	0	0	0	0	0	29	21	0	2	1	0	0	0	2	0	0	26
20:15	23	1	0	0	0	0	0	3	0	0	27	14	0	0	0	0	0	0	1	0	0	15
20:30	22	1	0	0	0	0	0	1	0	0	24	10	0	0	0	0	0	0	0	0	0	10
20:45	19	2	0	0	0	0	0	1	0	0	22	6	0	0	1	0	0	0	1	0	0	8
1 Hr	91	3	0	2	0	0	0	6	0	0	102	51	0	2	2	0	0	0	4	0	0	59
21:00	15	0	0	0	0	0	0	0	0	0	15	9	0	1	0	0	0	0	0	0	0	10
21:15	17	3	0	0	0	0	0	4	0	0	24	12	1	0	0	0	0	0	2	0	0	15
21:30	20	1	1	0	0	0	0	0	0	0	22	7	1	0	0	0	0	0	0	0	0	8
21:45	17	1	0	0	0	0	0	0	0	0	18	8	0	0	0	0	0	0	0	0	0	8
1 Hr	69	5	1	0	0	0	0	4	0	0	79	36	2	1	0	0	0	0	2	0	0	41
22:00	13	0	0	0	0	0	0	0	0	0	13	6	0	0	0	0	0	0	0	0	0	6
22:15	11	0	0	0	0	0	0	3	0	0	14	7	0	0	0	0	0	0	1	0	0	8
22:30	15	0	0	0	0	0	0	0	0	0	15	6	0	0	0	0	0	0	0	0	0	6
22:45	10	0	0	0	0	0	0	0	0	0	10	5	0	0	0	0	0	0	0	0	0	5
1 Hr	49	0	0	0	0	0	0	3	0	0	52	24	0	0	0	0	0	0	1	0	0	25
23:00	4	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	1	0	0	5
23:15	8	0	0	0	0	0	0	2	0	0	10	0	0	0	0	0	0	0	0	0	0	0
23:30	14	0	0	0	0	0	0	1	0	0	15	0	0	0	0	0	0	0	0	0	0	0
23:45	8	0	0	0	0	0	0	2	0	0	10	2	0	0	0	0	0	0	0	0	0	2
1 Hr	34	0	0	0	0	0	0	5	0	0	39	6	0	0	0	0	0	0	1	0	0	7
6 Hrs	581	31	4	7	0	1	0	46	0	0	670	335	10	4	3	0	0	0	29	0	0	381
Total	2507	256	31	36	3	7	0	189	0	1	3030	1966	233	28	33	3	5	0	116	0	0	2384

Time	EB Adult	EB Accompanied Child	EB Unaccompanied Child	EB Elderly	EB Impaired	EB Pushchair/ Pram	EB Pushchair/ Pram	EB Scooter	EB Railway Personnel	EB Total	WB Adult	WB Accompanied Child	WB Unaccompanied Child	WB Elderly	WB Impaired	WB Wheelchair	WB Pushchair/ Pram	WB Scooter	WB Railway Personnel	WB Total	TRAINS
18:00	27	0	0	0	0	0	0	0	0	27	7	0	0	0	0	0	1	0	0	8	3
18:15	21	1	0	0	0	0	0	0	0	22	6	0	0	0	0	0	0	0	0	6	4
18:30	2	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	1	2
18:45	19	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	2
1 Hr	69	1	0	0	0	0	0	0	0	70	14	0	0	0	0	0	1	0	0	15	11
19:00	7	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	3	3
19:15	9	0	0	0	0	0	0	0	0	9	6	0	0	0	0	0	0	0	0	6	3
19:30	3	0	0	0	0	0	0	0	0	3	10	1	0	0	0	0	0	0	0	11	3
19:45	8	0	0	0	0	0	0	0	0	8	4	0	0	0	0	0	0	0	0	4	2
1 Hr	27	0	0	0	0	0	0	0	0	27	23	1	0	0	0	0	0	0	0	24	11
20:00	4	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	2	3
20:15	8	0	0	0	0	0	0	0	0	8	3	0	0	0	0	0	0	0	0	3	4
20:30	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0
20:45	1	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	3	2
1 Hr	13	0	0	0	0	0	0	0	0	13	10	0	0	0	0	0	0	0	0	10	9
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
21:15	8	0	0	0	0	0	0	0	0	8	4	0	0	0	0	0	0	0	0	4	4
21:30	7	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	3	2
21:45	2	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	1
1 Hr	17	0	0	0	0	0	0	0	0	17	10	0	0	0	0	0	0	0	0	10	10
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
22:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
22:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:45	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5	3
1 Hr	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5	7
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
23:15	7	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	3	3
23:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:45	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2
1 Hr	10	0	0	0	0	0	0	0	0	10	3	0	0	0	0	0	0	0	0	3	7
6 Hrs	136	1	0	0	0	0	0	0	0	137	65	1	0	0	0	0	1	0	0	67	55
Total	586	6	1	0	0	0	7	0	0	600	219	2	0	0	2	0	2	0	0	225	168

Northbound	84
Southbound	84
Total	168

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
06:01:28	06:01:30	00:00:02	N
06:10:18	06:10:20	00:00:02	N
06:17:33	06:17:36	00:00:03	N
06:22:58	06:23:09	00:00:11	N
06:31:35	06:31:45	00:00:10	S
06:42:21	06:42:23	00:00:02	S
06:47:27	06:47:37	00:00:10	S
06:50:16	06:50:21	00:00:05	N
06:55:17	06:55:22	00:00:05	S
06:57:58	06:58:08	00:00:10	N
07:00:22	07:00:33	00:00:11	S
07:02:48	07:02:50	00:00:02	N
07:08:21	07:08:23	00:00:02	N
07:10:48	07:10:51	00:00:03	N
07:19:13	07:19:18	00:00:05	N
07:26:47	07:26:52	00:00:05	S
07:30:44	07:30:53	00:00:09	S
07:32:20	07:32:22	00:00:02	N
07:41:39	07:41:41	00:00:02	S
07:42:21	07:42:29	00:00:08	N
07:44:15	07:44:20	00:00:05	S
07:58:21	07:58:29	00:00:08	S
08:02:42	08:02:44	00:00:02	S
08:03:18	08:03:20	00:00:02	N
08:05:13	08:05:15	00:00:02	S
08:10:05	08:10:18	00:00:13	S
08:11:21	08:11:31	00:00:10	N
08:17:57	08:17:59	00:00:02	N
08:18:23	08:18:39	00:00:16	S
08:39:55	08:40:04	00:00:09	S
08:43:24	08:43:35	00:00:11	N
08:48:55	08:48:57	00:00:02	S
09:02:59	09:03:01	00:00:02	S
09:06:21	09:06:22	00:00:01	N
09:08:37	09:08:46	00:00:09	S
09:15:33	09:15:39	00:00:06	N
09:18:23	09:18:27	00:00:04	N
09:39:11	09:39:21	00:00:10	S
09:44:21	09:44:32	00:00:11	N
09:50:06	09:50:08	00:00:02	S
09:57:35	09:57:45	00:00:10	S
10:03:34	10:03:36	00:00:02	S
10:11:14	10:11:16	00:00:02	N
10:14:59	10:15:01	00:00:02	S
10:18:02	10:18:04	00:00:02	N
10:23:41	10:23:46	00:00:05	N
10:41:25	10:41:37	00:00:12	S
10:45:58	10:46:07	00:00:09	N
10:50:10	10:50:12	00:00:02	S
11:01:02	11:01:04	00:00:02	S
11:08:32	11:08:34	00:00:02	N
11:08:50	11:08:55	00:00:05	S
11:17:12	11:17:17	00:00:05	N
11:21:03	11:21:05	00:00:02	N
11:43:21	11:43:32	00:00:11	N
11:44:10	11:44:20	00:00:10	S
11:48:56	11:48:58	00:00:02	S
12:03:49	12:03:51	00:00:02	S
12:06:31	12:06:36	00:00:05	S
12:10:22	12:10:24	00:00:02	N
12:14:19	12:14:24	00:00:05	N
12:19:56	12:19:58	00:00:02	N
12:38:13	12:38:22	00:00:09	S
12:40:38	12:40:47	00:00:09	N
12:50:05	12:50:07	00:00:02	S
13:04:57	13:05:00	00:00:03	S
13:07:13	13:07:17	00:00:04	S
13:08:22	13:08:24	00:00:02	N
13:12:58	13:13:02	00:00:04	N
13:17:52	13:17:54	00:00:02	N
13:39:34	13:39:43	00:00:09	S
13:45:36	13:45:45	00:00:09	N
13:48:44	13:48:46	00:00:02	S
13:57:01	13:57:07	00:00:06	N
14:04:08	14:04:10	00:00:02	S
14:06:47	14:06:52	00:00:05	S
14:09:15	14:09:17	00:00:02	N
14:13:05	14:13:09	00:00:04	N
14:17:34	14:17:36	00:00:02	N
14:39:33	14:39:43	00:00:10	S
14:40:58	14:41:06	00:00:08	N
14:46:33	14:46:35	00:00:02	S
15:07:03	15:07:06	00:00:03	S
15:07:51	15:07:53	00:00:02	N
15:09:23	15:09:27	00:00:04	S
15:14:26	15:14:28	00:00:02	N
15:18:19	15:18:22	00:00:03	N
15:37:14	15:37:29	00:00:15	N
15:39:22	15:39:34	00:00:12	S
15:41:17	15:41:26	00:00:09	N
15:43:46	15:43:57	00:00:11	S
15:56:17	15:56:29	00:00:12	N
16:00:55	16:00:58	00:00:03	S
16:10:58	16:10:59	00:00:01	S
16:11:13	16:11:15	00:00:02	N
16:15:01	16:15:15	00:00:14	S
16:16:05	16:16:10	00:00:05	N
16:21:16	16:21:18	00:00:02	S
16:24:36	16:24:38	00:00:02	N
16:27:16	16:27:26	00:00:10	N
16:40:52	16:40:54	00:00:02	S
16:41:38	16:41:49	00:00:11	N
16:51:58	16:52:00	00:00:02	S
17:04:47	17:04:49	00:00:02	S
17:08:13	17:08:15	00:00:02	N
17:08:34	17:08:39	00:00:05	S
17:18:11	17:18:13	00:00:02	N
17:22:30	17:22:41	00:00:11	S
17:22:48	17:22:57	00:00:09	N
17:29:41	17:29:53	00:00:12	N
17:47:08	17:47:11	00:00:03	S
17:49:28	17:49:32	00:00:04	S
17:53:30	17:53:32	00:00:02	S
18:05:39	18:05:51	00:00:12	N
18:07:45	18:07:47	00:00:02	S
18:13:29	18:13:30	00:00:01	N
18:19:09	18:19:13	00:00:04	N
18:22:29	18:22:40	00:00:11	S
18:23:09	18:23:11	00:00:02	N
18:26:41	18:26:53	00:00:12	N
18:31:15	18:31:28	00:00:13	N
18:44:27	18:44:37	00:00:10	N
18:55:07	18:55:09	00:00:02	S
18:58:06	18:58:08	00:00:02	S
19:02:39	19:02:41	00:00:02	S
19:07:09	19:07:10	00:00:01	N
19:07:16	19:07:21	00:00:05	S
19:15:30	19:15:35	00:00:05	N
19:24:28	19:24:38	00:00:10	N
19:29:58	19:30:09	00:00:11	S
19:30:36	19:30:38	00:00:02	N
19:33:59	19:34:02	00:00:03	N
19:42:46	19:42:48	00:00:02	S
19:46:29	19:46:38	00:00:09	N
19:49:00	19:49:02	00:00:02	S
20:00:18	20:00:20	00:00:02	S
20:06:51	20:06:53	00:00:02	N
20:07:34	20:07:36	00:00:02	S
20:17:18	20:17:23	00:00:05	N
20:19:51	20:20:02	00:00:11	N
20:22:46	20:22:57	00:00:11	S
20:26:57	20:26:59	00:00:02	N
20:49:33	20:49:35	00:00:02	S
20:58:06	20:58:09	00:00:03	N
21:01:49	21:01:50	00:00:01	S
21:08:32	21:08:34	00:00:02	N
21:10:13	21:10:18	00:00:05	S
21:16:26	21:16:35	00:00:09	S
21:18:12	21:18:26	00:00:14	N
21:23:06	21:23:11	00:00:05	S
21:23:51	21:23:53	00:00:02	N
21:34:29	21:34:31	00:00:02	S
21:42:07	21:42:10	00:00:03	N
21:45:51	21:46:02	00:00:11	N
22:02:16	22:02:17	00:00:01	S
22:06:30	22:06:32	00:00:02	S
22:17:39	22:17:50	00:00:11	N
22:25:59	22:26:09	00:00:10	S
22:48:46	22:48:47	00:00:01	S
22:51:04	22:51:14	00:00:10	N
22:53:44	22:53:48	00:00:04	S
23:02:31	23:02:33	00:00:02	S
23:06:01	23:06:03	00:00:02	N
23:16:33	23:16:47	00:00:14	S
23:20:38	23:20:41	00:00:03	S
23:21:24	23:21:36	00:00:12	N
23:49:32	23:49:34	00:00:02	S
23:50:07	23:50:22	00:00:15	N

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Survey Vehicle	06:04:57	06:16:40	ESJ
Parking	06:24:31	07:56:04	ESJ
Pick up	07:01:05	07:01:34	ESJ
Drop off	07:29:32	07:29:43	ESJ
Pick up	07:37:48	07:40:47	ESJ
Pick up	07:48:25	07:49:02	ESJ
Drop off	08:30:21	08:30:27	ESJ
Drop off	08:35:07	08:35:22	ESJ
Vehicle Stopped To Talk With An Adult & Then Left	08:45:50	08:46:44	ESJ
Drop off	09:27:26	09:27:41	ESJ
Drop off	09:33:04	09:36:44	ESJ
Parking	09:39:38	09:45:16	ESJ
Pick up	09:45:29	09:45:55	WSJ
Vehicle stopped near level crossing	11:13:23	11:13:43	WSJ
Waste collection	11:13:24	11:14:28	WSJ
Parking	11:16:32	15:53:00	WSJ
Drop off	11:22:59	11:24:21	ESJ
Drop off	12:24:59	12:25:37	ESJ
Drop off	12:33:00	12:33:10	ESJ
Drop off	13:25:51	13:26:17	ESJ
Pick up	13:59:53	14:01:29	ESJ
Drop off	14:25:39	14:26:10	ESJ
Drop off	14:27:03	14:27:32	ESJ
Parking	14:36:59	14:41:48	ESJ
Drop off	14:53:15	14:54:18	WSJ
Drop off	15:08:20	15:08:46	ESJ
Parking	15:13:33	15:23:52	ESJ
Parking	15:13:34	15:23:53	ESJ
Drop off	15:48:27	15:49:49	ESJ
Drop off	16:18:21	16:19:15	ESJ
Drop off & Pick up	16:38:35	16:43:43	ESJ
Drop off	16:51:13	16:55:19	ESJ
Pick up	17:30:59	17:31:55	ESJ
Drop off	19:22:01	19:22:18	WSJ
Pick up	19:23:20	19:26:39	ESJ
Parking	19:35:47	19:48:11	ESJ
Pick up	20:21:07	20:22:38	ESJ
Pick up	20:21:24	20:22:28	ESJ

Tracsis plc
Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Clayhithe Road Level Crossing
Date: Saturday 15th July 2017

AM Weather : Cloudy, rain showers
PM Weather : Cloudy, dry

Linkcount

	Eastbound Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total	Westbound Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
06:00	4	0	0	0	0	0	0	2	0	0	6	0	1	0	0	0	0	0	0	0	0	1
06:15	6	1	0	0	0	0	0	2	0	0	9	1	1	0	0	0	0	0	0	0	0	2
06:30	3	0	0	0	0	0	0	1	0	0	4	1	0	0	0	0	0	0	3	0	0	4
06:45	8	3	0	0	0	0	0	0	0	0	11	5	1	0	0	0	0	0	1	0	0	7
1 Hr	21	4	0	0	0	0	0	5	0	0	30	7	3	0	0	0	0	0	4	0	0	14
07:00	12	1	0	0	0	0	0	1	0	0	14	4	1	0	0	0	0	0	0	0	0	5
07:15	14	2	0	0	0	0	0	2	0	0	18	4	0	1	0	0	0	0	0	0	0	5
07:30	19	4	0	1	0	0	0	2	0	0	26	7	5	0	0	0	0	0	0	0	0	12
07:45	13	3	1	0	0	0	0	1	0	0	18	5	2	0	2	1	0	0	0	0	0	10
1 Hr	58	10	1	1	0	0	0	6	0	0	76	20	8	1	2	1	0	0	0	0	0	32
08:00	16	1	0	0	0	0	0	2	0	0	19	7	2	0	0	0	0	0	0	0	0	9
08:15	26	2	1	0	0	0	0	2	0	0	31	8	2	0	0	0	0	0	0	0	0	10
08:30	34	2	0	0	0	0	0	2	0	0	38	8	2	0	0	0	0	0	1	0	0	11
08:45	31	3	0	1	0	0	0	1	0	0	36	12	2	0	0	0	0	0	0	0	0	14
1 Hr	107	8	1	1	0	0	0	7	0	0	124	35	8	0	0	0	0	0	1	0	0	44
09:00	29	2	0	0	0	0	0	1	0	0	32	7	2	0	0	0	0	0	3	0	0	12
09:15	26	2	0	0	0	0	0	3	0	0	31	13	0	0	1	0	0	0	0	0	0	14
09:30	40	1	0	0	0	0	0	2	0	0	43	25	1	0	0	1	0	0	2	0	0	29
09:45	28	4	2	0	0	0	0	0	0	0	34	23	4	0	0	0	0	0	5	0	0	32
1 Hr	123	9	2	0	0	0	0	6	0	0	140	68	7	0	1	1	0	0	10	0	0	87
10:00	32	1	0	0	0	0	0	2	0	0	35	20	3	0	1	0	0	0	4	0	0	28
10:15	51	0	0	0	0	0	0	3	0	0	54	22	2	4	0	0	0	0	0	0	0	28
10:30	39	2	0	0	0	0	0	2	0	0	43	31	5	1	1	0	0	0	2	0	0	40
10:45	37	4	0	0	0	0	0	0	0	0	41	30	2	4	0	0	0	0	1	0	0	37
1 Hr	159	7	0	0	0	0	0	7	0	0	173	103	12	9	2	0	0	0	7	0	0	133
11:00	32	5	0	0	0	0	0	0	0	0	37	38	2	0	0	0	0	0	1	0	0	41
11:15	42	0	0	0	0	0	0	4	0	0	46	38	1	0	0	0	0	0	0	0	0	39
11:30	54	3	0	0	0	0	0	0	0	0	57	43	2	0	0	0	0	0	1	0	0	46
11:45	31	2	0	0	0	0	0	1	0	0	34	44	2	0	1	0	0	0	3	0	0	50
1 Hr	159	10	0	0	0	0	0	5	0	0	174	163	7	0	1	0	0	0	5	0	0	176
6 Hrs	627	48	4	2	0	0	0	36	0	0	717	396	45	10	6	2	0	0	27	0	0	486

	Eastbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	Westbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
06:15	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
06:30	7	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	3	3
06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	11	0	0	0	0	0	0	0	0	11	3	0	0	0	0	0	0	0	0	3	5
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
07:15	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
07:30	8	0	0	0	0	0	0	0	0	8	4	0	0	0	0	0	0	0	0	4	2
07:45	3	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	2	1
1 Hr	15	0	0	0	0	0	0	0	0	15	6	0	0	0	0	0	0	0	0	6	5
08:00	2	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	2
08:15	6	1	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	1
08:30	7	0	0	0	0	0	0	0	0	7	5	0	0	0	0	0	0	0	0	5	1
08:45	3	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	1	1
1 Hr	18	1	0	0	0	0	0	0	0	19	9	0	0	0	0	0	0	0	0	9	5
09:00	10	0	0	0	0	0	0	0	0	10	2	0	0	0	0	0	0	0	0	2	3
09:15	9	0	0	0	0	0	0	0	0	9	3	0	0	0	0	0	0	0	0	3	1
09:30	4	0	0	0	0	0	1	0	0	5	2	0	0	0	0	0	0	0	0	2	2
09:45	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1
1 Hr	26	0	0	0	0	0	1	0	0	27	7	0	0	0	0	0	0	0	0	7	7
10:00	2	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	3
10:15	13	1	0	0	0	0	0	0	0	14	8	0	0	0	0	0	0	0	0	8	1
10:30	8	0	0	0	0	0	0	0	0	8	8	1	0	0	0	0	0	0	0	9	2
10:45	6	0	0	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	0	3	1
1 Hr	29	1	0	0	0	0	1	0	0	31	19	1	0	0	0	0	0	0	0	20	7
11:00	3	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
11:15	14	1	0	0	0	0	1	0	0	16	1	0	0	0	0	0	0	0	0	1	2
11:30	7	0	0	0	0	0	0	0	0	7	10	1	0	0	0	0	0	0	0	11	2
11:45	12	2	0	0	0	0	1	0	0	15	2	0	0	0	0	0	0	0	0	2	1
1 Hr	36	3	0	0	0	0	2	0	0	41	16	1	0	0	0	0	0	0	0	17	8
6 Hrs	135	5	0	0	0	0	4	0	0	144	60	2	0	0	0	0	0	0	0	62	37

Linkcount

	Eastbound Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total	Westbound Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
12:00	27	1	0	0	0	0	0	0	0	0	28	27	1	1	1	0	0	0	0	0	0	30
12:15	40	2	0	0	0	0	0	1	0	0	43	30	3	0	0	0	0	0	0	0	0	33
12:30	34	0	0	0	0	0	0	0	0	0	34	36	4	1	1	0	0	0	5	0	0	47
12:45	33	3	0	0	0	0	0	1	0	0	37	32	1	0	0	0	0	0	2	0	0	35
1 Hr	134	6	0	0	0	0	0	2	0	0	142	125	9	2	2	0	0	0	7	0	0	145
13:00	37	5	2	1	0	0	0	3	0	0	48	35	2	1	1	0	0	0	2	0	0	41
13:15	35	1	0	0	0	0	0	3	0	0	39	47	1	0	0	0	0	0	2	0	0	50
13:30	35	0	0	0	0	0	0	1	0	0	36	41	6	0	0	0	0	0	2	0	0	49
13:45	27	0	0	0	0	0	0	0	0	0	27	41	1	1	0	0	0	0	4	0	0	47
1 Hr	134	6	2	1	0	0	0	7	0	0	150	164	10	2	1	0	0	0	10	0	0	187
14:00	27	2	1	0	0	0	0	4	0	0	34	30	2	0	0	0	0	0	2	0	0	34
14:15	28	1	0	0	0	0	0	1	0	0	30	37	1	0	1	0	0	0	0	0	0	39
14:30	32	2	0	0	0	0	0	5	0	0	39	24	2	0	0	0	0	0	0	0	0	26
14:45	24	1	1	0	0	0	0	1	0	0	27	41	1	0	0	0	0	0	1	0	0	43
1 Hr	111	6	2	0	0	0	0	11	0	0	130	132	6	0	1	0	0	0	3	0	0	142
15:00	28	2	0	0	0	0	0	0	0	0	30	23	1	0	0	0	0	0	0	0	0	24
15:15	28	1	0	0	0	0	0	3	0	0	32	33	0	2	0	0	0	0	2	0	0	37
15:30	38	5	0	1	0	0	0	3	0	0	47	25	4	1	0	0	0	0	4	0	0	34
15:45	28	0	0	1	0	0	0	1	0	0	30	47	3	0	0	0	0	0	2	0	0	52
1 Hr	122	8	0	2	0	0	0	7	0	0	139	128	8	3	0	0	0	0	8	0	0	147
16:00	27	1	0	0	0	0	0	2	0	0	30	34	0	0	1	0	0	0	0	0	0	35
16:15	31	0	0	1	0	0	0	2	0	0	34	42	3	1	2	0	0	0	2	0	0	50
16:30	30	0	0	0	0	0	0	1	0	0	31	43	2	0	0	0	0	0	0	0	0	45
16:45	24	1	1	0	0	0	0	3	0	0	29	53	1	3	0	0	0	0	2	0	0	59
1 Hr	112	2	1	1	0	0	0	8	0	0	124	172	6	4	3	0	0	0	4	0	0	189
17:00	24	2	0	1	0	0	0	1	0	0	28	36	2	0	0	0	0	0	1	0	0	39
17:15	19	2	1	0	0	0	0	3	0	0	25	42	1	0	0	0	0	0	0	0	0	43
17:30	13	0	0	1	0	0	0	0	0	0	14	42	0	1	0	0	0	0	3	0	0	46
17:45	28	1	0	0	0	0	0	1	0	0	30	31	1	0	0	0	0	0	0	0	0	32
1 Hr	84	5	1	2	0	0	0	5	0	0	97	151	4	1	0	0	0	0	4	0	0	160
6 Hrs	697	33	6	6	0	0	0	40	0	0	782	872	43	12	7	0	0	0	36	0	0	970

	Eastbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	Westbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
12:00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	4
12:15	13	0	0	0	0	0	0	0	0	13	4	0	0	0	0	0	0	0	0	4	1
12:30	12	2	0	0	0	0	0	0	0	14	8	0	0	0	0	0	0	0	0	8	1
12:45	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	2
1 Hr	26	2	0	0	0	0	0	0	0	28	14	0	0	0	0	0	0	0	0	14	8
13:00	6	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	3
13:15	10	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	1
13:30	7	0	0	0	0	0	0	0	0	7	4	1	0	0	0	0	1	0	0	6	1
13:45	5	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	2	2
1 Hr	28	0	0	0	0	0	0	0	0	28	6	1	0	0	0	0	1	0	0	8	7
14:00	5	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	2	3
14:15	12	1	0	0	0	0	0	0	0	13	6	1	0	0	0	0	0	0	0	7	1
14:30	13	1	0	0	0	0	0	0	0	14	15	1	0	0	0	0	0	0	0	16	2
14:45	9	1	0	0	0	0	0	0	0	10	2	0	0	0	0	0	0	0	0	2	1
1 Hr	39	3	0	0	0	0	0	0	0	42	25	2	0	0	0	0	0	0	0	27	7
15:00	2	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	4
15:15	7	1	0	0	0	0	0	0	0	8	4	0	0	0	0	0	0	0	0	4	1
15:30	4	0	0	0	0	0	0	0	0	4	11	1	0	0	0	0	0	0	0	12	0
15:45	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1
1 Hr	15	1	0	0	0	0	0	0	0	16	18	1	0	0	0	0	0	0	0	19	6
16:00	3	0	0	0	0	0	0	0	0	3	1	2	0	0	0	0	0	0	0	3	4
16:15	14	3	0	0	0	0	1	0	0	18	4	0	0	0	0	0	0	0	0	4	2
16:30	16	0	0	0	0	0	0	0	0	16	3	1	0	0	0	0	0	0	0	4	2
16:45	9	2	0	0	0	0	0	0	0	11	2	0	0	0	0	0	0	0	0	2	1
1 Hr	42	5	0	0	0	0	1	0	0	48	10	3	0	0	0	0	0	0	0	13	9
17:00	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	3
17:15	14	0	0	0	0	0	0	0	0	14	3	0	0	0	0	0	0	0	0	3	2
17:30	7	0	0	0	0	0	1	0	0	8	11	0	0	0	0	0	0	0	0	11	2
17:45	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
1 Hr	23	0	0	0	0	0	1	0	0	24	16	0	0	0	0	0	0	0	0	16	8
6 Hrs	173	11	0	0	0	0	2	0	0	186	89	7	0	0	0	0	1	0	0	97	45

Linkcount

	Eastbound Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total	Westbound Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
18:00	15	1	0	1	0	0	0	2	0	0	19	38	1	0	0	0	0	0	1	0	0	40
18:15	20	0	0	0	0	0	0	1	0	0	21	28	2	0	1	0	0	0	1	0	0	32
18:30	16	2	0	0	0	0	0	1	0	0	19	23	0	0	0	0	0	0	1	0	0	24
18:45	16	1	0	0	0	0	0	1	0	0	18	28	1	0	1	0	0	0	1	0	0	31
1 Hr	67	4	0	1	0	0	0	5	0	0	77	117	4	0	2	0	0	0	4	0	0	127
19:00	25	2	0	0	0	0	0	0	0	0	27	15	0	0	0	0	0	0	0	0	0	15
19:15	14	0	0	0	0	0	0	0	0	0	14	15	0	0	0	0	0	0	6	0	0	21
19:30	11	0	0	0	0	0	0	2	0	0	13	25	0	0	0	0	0	0	0	0	0	25
19:45	24	0	0	0	0	0	0	1	0	0	25	14	1	0	1	0	0	0	1	0	0	17
1 Hr	74	2	0	0	0	0	0	3	0	0	79	69	1	0	1	0	0	0	7	0	0	78
20:00	12	0	0	0	0	0	0	1	0	0	13	21	0	0	0	0	0	0	0	0	0	21
20:15	10	1	0	0	0	0	0	0	0	0	11	27	0	0	0	0	0	0	0	0	0	27
20:30	7	0	0	0	0	0	0	0	0	0	7	20	0	1	0	0	0	0	0	0	0	21
20:45	6	0	0	1	0	0	0	0	0	0	7	11	1	0	0	0	0	0	0	0	0	12
1 Hr	35	1	0	1	0	0	0	1	0	0	38	79	1	1	0	0	0	0	0	0	0	81
21:00	11	0	1	0	0	0	0	0	0	0	12	15	1	1	0	0	0	0	0	0	0	17
21:15	5	0	1	0	0	0	0	0	0	0	6	14	0	1	0	0	0	0	0	0	0	15
21:30	5	0	0	0	0	0	0	0	0	0	5	12	0	0	1	0	0	0	0	0	0	13
21:45	5	0	0	0	0	0	0	1	0	0	6	13	1	0	0	0	0	0	0	0	0	14
1 Hr	26	0	2	0	0	0	0	1	0	0	29	54	2	2	1	0	0	0	0	0	0	59
22:00	7	1	0	0	0	0	0	0	0	0	8	10	0	0	0	0	0	0	0	0	0	10
22:15	4	0	0	0	0	0	0	0	0	0	4	12	0	0	0	0	0	0	0	0	0	12
22:30	9	0	0	0	0	0	0	0	0	0	9	7	0	0	0	0	0	0	1	0	0	8
22:45	3	0	0	0	0	0	0	0	0	0	3	10	0	0	0	0	0	0	0	0	0	10
1 Hr	23	1	0	0	0	0	0	0	0	0	24	39	0	0	0	0	0	0	1	0	0	40
23:00	4	0	0	0	0	0	0	3	0	0	7	7	0	0	0	0	0	0	0	0	0	7
23:15	7	0	0	0	0	0	0	0	0	0	7	10	0	0	0	0	0	0	0	0	0	10
23:30	3	0	0	0	0	0	0	0	0	0	3	6	0	0	0	0	0	0	0	0	0	6
23:45	5	0	0	0	0	0	0	0	0	0	5	14	0	0	0	0	0	0	0	0	0	14
1 Hr	19	0	0	0	0	0	0	3	0	0	22	37	0	0	0	0	0	0	0	0	0	37
6 Hrs	244	8	2	2	0	0	0	13	0	0	269	395	8	3	4	0	0	0	12	0	0	422
Total	1568	89	12	10	0	0	0	89	0	0	1768	1663	96	25	17	2	0	0	75	0	0	1878

	Eastbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Pushchair/ Pram	Pushchair/ Pram	Scooter	Railway Personnel	Total	Westbound Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total	TRAINS
18:00	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	3
18:15	3	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	2	1
18:30	7	0	0	0	0	0	0	0	0	7	7	3	0	0	0	0	0	0	0	10	1
18:45	8	0	0	1	0	0	1	0	0	10	0	0	0	0	0	0	0	0	0	0	2
1 Hr	20	0	0	1	0	0	1	0	0	22	11	3	0	0	0	0	0	0	0	14	7
19:00	4	0	0	0	0	0	0	0	0	4	9	0	0	0	0	0	0	0	0	9	3
19:15	3	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	2	2
19:30	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
19:45	8	0	0	0	0	0	0	0	0	8	2	0	0	0	0	0	0	0	0	2	1
1 Hr	15	0	0	0	0	0	0	0	0	15	14	0	0	0	0	0	0	0	0	14	6
20:00	19	0	0	0	0	0	0	0	0	19	3	0	0	0	0	0	0	0	0	3	3
20:15	7	0	0	0	0	0	0	0	0	7	2	0	0	0	0	0	0	0	0	2	2
20:30	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
20:45	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
1 Hr	28	0	0	0	0	0	0	0	0	28	5	0	0	0	0	0	0	0	0	5	5
21:00	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	0
21:15	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	0
21:30	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2
21:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	2	0	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0	0	0	5	3
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
22:15	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	4	1
22:30	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0
22:45	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
1 Hr	1	0	0	0	0	0	0	0	0	1	7	0	0	0	0	0	0	0	0	7	5
23:00	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5	2
23:15	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	2
23:30	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
23:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	4	0	0	0	0	0	0	0	0	4	6	0	0	0	0	0	0	0	0	6	5
6 Hrs	70	0	0	1	0	0	1	0	0	72	48	3	0	0	0	0	0	0	0	51	31
Total	378	16	0	1	0	0	7	0	0	402	197	12	0	0	0	0	1	0	0	210	113

Northbound	56	
Southbound	57	
Total	113	

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
06:07:31	06:07:32	00:00:01	N
06:13:06	06:13:09	00:00:03	N
06:34:51	06:35:02	00:00:11	S
06:40:59	06:41:10	00:00:11	N
06:44:24	06:44:26	00:00:02	S
07:05:46	07:05:49	00:00:03	N
07:08:12	07:08:14	00:00:02	N
07:36:39	07:36:49	00:00:10	S
07:40:27	07:40:36	00:00:09	N
07:47:33	07:47:35	00:00:02	S
08:00:41	08:00:43	00:00:02	S
08:06:29	08:06:31	00:00:02	N
08:17:53	08:17:55	00:00:02	N
08:40:09	08:40:21	00:00:12	S
08:47:38	08:47:40	00:00:02	S
09:00:06	09:00:15	00:00:09	N
09:02:26	09:02:28	00:00:02	S
09:10:32	09:10:35	00:00:03	N
09:18:08	09:18:10	00:00:02	N
09:35:42	09:35:51	00:00:09	S
09:40:45	09:40:55	00:00:10	N
09:46:47	09:46:49	00:00:02	S
10:03:59	10:04:01	00:00:02	S
10:06:32	10:06:34	00:00:02	N
10:06:43	10:06:48	00:00:05	S
10:18:26	10:18:28	00:00:02	N
10:36:47	10:36:57	00:00:10	S
10:44:31	10:44:42	00:00:11	N
10:53:40	10:53:42	00:00:02	S
11:07:53	11:07:58	00:00:05	S
11:12:44	11:12:45	00:00:01	S
11:12:56	11:12:59	00:00:03	N
11:15:08	11:15:13	00:00:05	N
11:20:53	11:20:55	00:00:02	N
11:43:13	11:43:25	00:00:12	S
11:44:05	11:44:15	00:00:10	N
11:49:07	11:49:09	00:00:02	S
12:02:08	12:02:10	00:00:02	S
12:06:42	12:06:47	00:00:05	S
12:08:49	12:08:51	00:00:02	N
12:13:04	12:13:09	00:00:05	N
12:18:08	12:18:10	00:00:02	N
12:40:59	12:41:12	00:00:13	N
12:49:09	12:49:20	00:00:11	S
12:52:41	12:52:43	00:00:02	S
13:04:05	13:04:07	00:00:02	S
13:06:53	13:06:58	00:00:05	S
13:11:54	13:11:56	00:00:02	N
13:17:45	13:17:47	00:00:02	N
13:38:16	13:38:27	00:00:11	S
13:45:28	13:45:38	00:00:10	N
13:49:15	13:49:17	00:00:02	S
14:02:58	14:02:59	00:00:01	S
14:07:48	14:07:51	00:00:03	N
14:12:47	14:12:52	00:00:05	N
14:18:39	14:18:41	00:00:02	N
14:40:52	14:41:03	00:00:11	S
14:44:58	14:45:07	00:00:09	N
14:49:37	14:49:39	00:00:02	S
15:05:47	15:05:49	00:00:02	N
15:08:54	15:08:59	00:00:05	S
15:09:19	15:09:21	00:00:02	N
15:14:39	15:14:44	00:00:05	N
15:18:36	15:18:38	00:00:02	N
15:48:06	15:48:08	00:00:02	S
16:01:54	16:01:56	00:00:02	S
16:04:54	16:05:05	00:00:11	N
16:06:53	16:06:58	00:00:05	S
16:08:55	16:08:57	00:00:02	N
16:15:25	16:15:29	00:00:04	N
16:19:12	16:19:14	00:00:02	N
16:36:44	16:36:53	00:00:09	S
16:40:53	16:41:02	00:00:09	N
16:49:01	16:49:04	00:00:03	S
17:01:24	17:01:26	00:00:02	S
17:06:50	17:06:55	00:00:05	S
17:10:21	17:10:23	00:00:02	N
17:15:59	17:16:04	00:00:05	N
17:20:41	17:20:43	00:00:02	N
17:36:54	17:37:06	00:00:12	S
17:41:22	17:41:32	00:00:10	N
17:53:29	17:53:31	00:00:02	S
18:02:41	18:02:46	00:00:05	S
18:07:55	18:07:57	00:00:02	N
18:10:34	18:10:35	00:00:01	S
18:19:22	18:19:24	00:00:02	N
18:39:53	18:40:04	00:00:11	S
18:45:49	18:46:02	00:00:13	N
18:46:47	18:46:49	00:00:02	S
19:02:02	19:02:04	00:00:02	S
19:06:34	19:06:36	00:00:02	N
19:10:20	19:10:25	00:00:05	N
19:17:42	19:17:54	00:00:12	S
19:18:05	19:18:07	00:00:02	N
19:46:22	19:46:24	00:00:02	S
20:02:07	20:02:09	00:00:02	S
20:07:13	20:07:15	00:00:02	N
20:12:57	20:13:08	00:00:11	N
20:15:27	20:15:38	00:00:11	S
20:17:42	20:17:44	00:00:02	N
21:41:34	21:41:39	00:00:05	N
21:43:05	21:43:10	00:00:05	S
21:46:26	21:46:36	00:00:10	N
22:03:03	22:03:05	00:00:02	S
22:14:46	22:14:56	00:00:10	S
22:19:14	22:19:16	00:00:02	S
22:45:46	22:45:52	00:00:06	N
22:56:30	22:56:32	00:00:02	S
23:02:30	23:02:32	00:00:02	N
23:11:44	23:11:49	00:00:05	S
23:18:15	23:18:27	00:00:12	N
23:24:38	23:24:47	00:00:09	S
23:51:25	23:51:34	00:00:09	S

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Pick up	08:47:25	08:48:01	WSJ
Drop off	10:04:01	10:04:10	WSJ
Drop off	10:19:39	10:20:03	ESJ
Drop off	10:24:45	10:25:39	ESJ
Drop off	11:25:54	11:26:15	ESJ
Parking	11:33:36	11:47:08	ESJ
Drop off	11:36:47	11:42:38	ESJ
Pick up	11:45:22	11:45:43	ESJ
Drop off	11:49:50	11:49:58	WSJ
Drop off	14:23:59	14:25:16	ESJ
Pick up	15:35:28	15:35:40	ESJ
Pick up	15:43:58	15:44:29	WSJ
Drop off	16:22:27	16:24:36	ESJ
Parking	16:40:49	16:45:57	ESJ
Drop off	16:53:24	16:53:34	ESJ
Parking	17:00:06	17:39:06	ESJ
Pick up	17:39:31	17:43:22	ESJ
Drop off	18:58:52	18:59:32	ESJ
Pick up	21:02:45	21:10:37	ESJ
Pick up	22:13:12	22:16:53	ESJ
Waiting	23:57:10	23:59:45	ESJ

Tracsis plc
Traffic and Data Services

Client: WSP
Project: Level Crossing Census - Waterbeach
Site: Site X - Clayhithe Road Level Crossing
Date: Sunday 16th July 2017

AM Weather : Dry, cloudy
PM Weather : Dry, cloudy

Linkcount

Vehicles – Direction: Eastbound (EB) / Westbound (WB)

Time	EB Car	EB Lgv	EB Mcl	EB Hgv	EB Tractor & Trailers	EB Bus	EB Horse Riders	EB Pcl	EB Herded Animals & Horses	EB Large / Slow Vehicles	EB Total	WB Car	WB Lgv	WB Mcl	WB Hgv	WB Tractor & Trailers	WB Bus	WB Horse Riders	WB Pcl	WB Herded Animals & Horses	WB Large / Slow Vehicles	WB Total
06:00	5	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	1
06:15	10	1	0	0	0	0	0	0	0	0	11	2	2	0	0	0	0	0	0	0	0	4
06:30	4	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	2	0	0	2
06:45	5	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	0	0	5
1 Hr	24	2	0	0	0	0	0	0	0	0	26	8	2	0	0	0	0	0	2	0	0	12
07:00	8	1	1	0	0	0	0	1	0	0	11	3	1	1	0	0	0	0	0	0	0	5
07:15	4	1	0	0	0	0	0	1	0	0	6	4	1	1	0	0	0	0	0	0	0	6
07:30	7	0	0	0	0	1	0	2	0	0	10	4	1	0	0	0	0	0	1	0	0	6
07:45	10	0	0	0	0	0	0	0	0	0	10	5	1	0	0	0	0	0	3	0	0	9
1 Hr	29	2	1	0	0	1	0	4	0	0	37	16	4	2	0	0	0	0	4	0	0	26
08:00	12	0	0	0	0	0	0	3	0	0	15	2	0	0	0	0	0	0	0	0	0	2
08:15	14	0	0	1	0	0	0	0	0	0	15	10	0	0	0	0	0	0	1	0	0	11
08:30	16	0	0	1	0	0	0	1	0	0	18	6	0	0	1	0	0	0	3	0	0	10
08:45	15	1	0	1	0	0	0	16	0	0	33	8	0	0	0	0	0	0	0	0	0	8
1 Hr	57	1	0	3	0	0	0	20	0	0	81	26	0	0	1	0	0	0	4	0	0	31
09:00	27	0	0	1	0	0	0	4	0	0	32	8	0	0	1	0	0	0	2	0	0	11
09:15	21	0	0	0	0	0	0	0	0	0	21	9	0	0	0	0	0	0	2	0	0	11
09:30	35	1	0	0	0	0	0	1	0	0	37	9	1	0	0	0	0	0	0	0	0	10
09:45	28	0	0	0	0	0	0	1	0	0	29	13	1	0	0	0	0	0	0	0	0	14
1 Hr	111	1	0	1	0	0	0	6	0	0	119	39	2	0	1	0	0	0	4	0	0	46
10:00	36	3	0	0	0	0	0	2	0	0	41	13	1	0	0	0	0	0	1	0	0	15
10:15	35	1	2	0	0	0	0	1	0	0	39	16	2	0	0	0	0	0	0	0	0	18
10:30	28	2	0	0	0	0	0	5	0	0	35	21	1	0	1	0	0	0	3	0	0	26
10:45	48	3	0	0	0	0	0	1	0	0	52	20	0	0	0	0	0	0	2	0	0	22
1 Hr	147	9	2	0	0	0	0	9	0	0	167	70	4	0	1	0	0	0	6	0	0	81
11:00	32	2	0	0	0	0	0	4	0	0	38	23	0	0	0	0	0	0	1	0	0	24
11:15	37	1	1	0	0	0	0	4	0	0	43	40	2	0	0	0	0	0	3	0	0	45
11:30	34	1	1	0	0	0	0	0	0	0	36	21	1	0	0	0	0	0	0	0	0	22
11:45	47	2	0	1	0	0	0	2	0	0	52	29	5	0	0	0	5	0	0	0	0	39
1 Hr	150	6	2	1	0	0	0	10	0	0	169	113	8	0	0	0	5	0	4	0	0	130
6 Hrs	518	21	5	5	0	1	0	49	0	0	599	272	20	2	3	0	5	0	24	0	0	326

Pedestrians – Direction: Eastbound (EB) / Westbound (WB)

Time	EB Adult	EB Accompanied Child	EB Unaccompanied Child	EB Elderly	EB Impaired	EB Wheelchair	EB Pushchair/ Pram	EB Scooter	EB Railway Personnel	EB Total	WB Adult	WB Accompanied Child	WB Unaccompanied Child	WB Elderly	WB Impaired	WB Wheelchair	WB Pushchair/ Pram	WB Scooter	WB Railway Personnel	WB Total	TRAINS
06:00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
06:15	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0
06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	2	0
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
07:30	1	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	3	0
07:45	2	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	1	0
1 Hr	5	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	0	0	4	0
08:00	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	0
08:15	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0
08:30	6	0	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	2	0
08:45	25	1	0	0	0	0	0	0	0	26	11	0	0	0	0	0	0	0	0	11	2
1 Hr	33	1	0	0	0	0	0	0	0	34	16	0	0	0	0	0	0	0	0	16	2
09:00	14	2	0	0	0	0	0	0	0	16	9	1	0	0	0	0	0	0	0	10	2
09:15	2	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	0
09:30	3	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	3	0
09:45	9	0	0	0	0	0	0	0	0	9	8	0	0	0	0	0	0	0	0	8	0
1 Hr	28	2	0	0	0	0	0	0	0	30	23	1	0	0	0	0	0	0	0	24	2
10:00	14	0	0	0	0	0	1	0	0	15	3	0	0	0	0	0	0	0	0	3	2
10:15	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1
10:30	16	0	0	0	0	0	0	0	0	16	8	0	0	0	0	0	0	0	0	8	0
10:45	14	0	0	0	0	0	2	0	0	16	5	0	0	0	0	0	1	0	0	6	1
1 Hr	47	0	0	0	0	0	3	0	0	50	16	0	0	0	0	0	1	0	0	17	4
11:00	12	0	0	0	0	0	0	0	0	12	4	0	0	0	0	0	0	0	0	4	4
11:15	6	2	0	0	0	0	0	0	0	8	7	1	0	0	0	0	0	0	0	8	0
11:30	2	1	0	0	0	0	1	0	0	4	5	0	0	0	0	0	0	0	0	5	0
11:45	19	0	0	0	0	0	0	0	0	19	6	0	0	0	0	0	0	0	0	6	1
1 Hr	39	3	0	0	0	0	1	0	0	43	22	1	0	0	0	0	0	0	0	23	5
6 Hrs	152	6	0	0	0	0	4	0	1	163	82	2	0	0	0	0	1	0	1	86	13

Linkcount

Vehicles – Direction: Eastbound (EB) / Westbound (WB)

Time	EB Car	EB Lgv	EB Mcl	EB Hgv	EB Tractor & Trailers	EB Bus	EB Horse Riders	EB Pcl	EB Herded Animals & Horses	EB Large / Slow Vehicles	EB Total	WB Car	WB Lgv	WB Mcl	WB Hgv	WB Tractor & Trailers	WB Bus	WB Horse Riders	WB Pcl	WB Herded Animals & Horses	WB Large / Slow Vehicles	WB Total
12:00	36	1	0	0	0	0	0	4	0	0	41	35	0	0	1	0	0	0	5	0	0	41
12:15	42	2	0	0	0	0	0	0	0	0	44	34	1	0	0	0	0	0	4	0	0	39
12:30	39	1	0	0	0	0	0	1	0	0	41	34	0	0	1	0	0	0	2	0	0	37
12:45	34	2	0	0	1	0	0	6	0	0	43	36	2	0	0	0	0	0	2	0	0	40
1 Hr	151	6	0	0	1	0	0	11	0	0	169	139	3	0	2	0	0	0	13	0	0	157
13:00	39	2	0	1	0	0	0	1	0	0	43	41	1	0	1	0	0	0	1	0	0	44
13:15	29	0	0	0	0	0	0	3	0	0	32	49	2	0	0	0	0	0	0	0	0	51
13:30	21	1	0	0	0	0	0	2	0	0	24	43	1	1	1	0	0	0	3	0	0	49
13:45	20	1	1	1	0	0	0	3	0	0	26	32	4	0	1	0	0	0	0	0	0	37
1 Hr	109	4	1	2	0	0	0	9	0	0	125	165	8	1	3	0	0	0	4	0	0	181
14:00	31	1	0	0	0	0	0	4	0	0	36	34	2	0	0	0	0	0	5	0	0	41
14:15	29	3	0	1	0	0	0	0	0	0	33	28	0	0	0	0	0	0	3	0	0	31
14:30	26	0	1	0	0	0	0	0	0	0	27	31	4	0	0	0	0	0	6	0	0	41
14:45	25	0	0	0	0	0	0	8	0	0	33	35	0	0	0	0	0	0	3	0	0	38
1 Hr	111	4	1	1	0	0	0	12	0	0	129	128	6	0	0	0	0	0	17	0	0	151
15:00	26	0	0	0	0	0	0	4	0	0	30	32	2	0	1	0	0	0	5	0	0	40
15:15	22	1	0	1	0	0	0	0	0	0	24	32	1	0	0	0	0	0	2	0	0	35
15:30	26	0	0	0	0	0	0	1	0	0	27	40	0	0	0	0	0	0	4	0	0	44
15:45	20	0	0	0	0	0	0	4	0	0	24	30	1	0	0	0	0	0	3	0	0	34
1 Hr	94	1	0	1	0	0	0	9	0	0	105	134	4	0	1	0	0	0	14	0	0	153
16:00	20	1	0	0	0	0	0	3	0	0	24	41	0	0	0	0	0	0	1	0	0	42
16:15	13	0	1	0	0	0	0	3	0	0	17	53	2	2	0	0	0	0	0	0	0	57
16:30	18	1	0	0	0	0	0	0	0	0	19	47	1	1	0	0	0	0	1	0	0	50
16:45	21	1	1	0	0	0	0	4	0	0	27	38	0	0	0	0	0	0	4	0	0	42
1 Hr	72	3	2	0	0	0	0	10	0	0	87	179	3	3	0	0	0	0	6	0	0	191
17:00	16	1	0	0	0	0	0	1	0	0	18	40	1	0	0	0	0	0	4	0	0	45
17:15	23	1	1	0	0	0	0	1	0	0	26	25	2	0	0	0	0	0	1	0	0	28
17:30	20	1	0	0	0	0	0	0	0	0	21	43	1	0	0	0	0	0	3	0	0	47
17:45	22	1	0	0	0	0	0	1	0	0	24	17	3	0	0	0	0	0	2	0	0	22
1 Hr	81	4	1	0	0	0	0	3	0	0	89	125	7	0	0	0	0	0	10	0	0	142
6 Hrs	618	22	5	4	1	0	0	54	0	0	704	870	31	4	6	0	0	0	64	0	0	975

Pedestrians – Direction: Eastbound (EB) / Westbound (WB)

Time	EB Adult	EB Accompanied Child	EB Unaccompanied Child	EB Elderly	EB Impaired	EB Wheelchair	EB Pushchair/ Pram	EB Scooter	EB Railway Personnel	EB Total	WB Adult	WB Accompanied Child	WB Unaccompanied Child	WB Elderly	WB Impaired	WB Wheelchair	WB Pushchair/ Pram	WB Scooter	WB Railway Personnel	WB Total	TRAINS
12:00	12	0	0	0	0	0	0	0	0	12	5	0	0	0	0	0	0	0	0	5	3
12:15	3	0	0	0	0	0	0	0	0	3	5	0	0	0	0	0	0	0	0	5	2
12:30	5	0	0	0	0	0	1	0	0	6	2	0	0	0	0	0	0	0	0	2	0
12:45	8	2	0	0	0	0	0	0	0	10	4	0	0	0	0	0	0	0	0	4	1
1 Hr	28	2	0	0	0	0	1	0	0	31	16	0	0	0	0	0	0	0	0	16	6
13:00	18	0	0	0	0	0	0	0	0	18	4	0	0	0	0	0	0	0	0	4	4
13:15	4	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
13:30	5	2	0	0	0	0	0	1	0	8	2	1	0	0	0	0	1	0	0	4	0
13:45	1	0	0	0	0	0	0	0	0	1	6	0	0	0	0	0	0	0	0	6	1
1 Hr	28	2	0	0	0	0	0	1	0	31	13	1	0	0	0	0	1	0	0	15	5
14:00	11	0	0	0	0	0	0	0	0	11	4	0	0	0	0	0	0	0	0	4	5
14:15	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	1	0	6	0
14:30	4	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	4	0
14:45	8	7	1	0	0	0	0	0	0	16	3	0	0	0	0	0	0	0	0	3	1
1 Hr	23	7	1	0	0	0	0	0	0	31	15	1	0	0	0	0	0	1	0	17	6
15:00	8	0	0	0	0	0	0	0	0	8	4	0	1	2	0	0	1	0	0	8	3
15:15	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2
15:30	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
15:45	6	0	0	0	0	0	0	0	0	6	9	1	0	0	0	0	0	0	0	10	1
1 Hr	17	0	0	0	0	0	0	0	0	17	14	1	1	2	0	0	1	0	0	19	6
16:00	18	0	0	0	0	0	0	0	0	18	7	0	0	0	0	0	0	0	0	7	4
16:15	5	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	2	1
16:30	3	1	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	1	0
16:45	11	0	0	0	0	0	0	0	0	11	7	0	0	0	0	0	0	0	0	7	1
1 Hr	37	1	0	0	0	0	0	0	0	38	17	0	0	0	0	0	0	0	0	17	6
17:00	8	2	0	0	0	0	0	0	0	10	15	0	0	0	0	0	0	0	0	15	3
17:15	16	2	0	0	0	0	0	0	0	18	3	0	0	0	0	0	0	0	0	3	2
17:30	6	0	0	0	0	0	0	0	0	6	4	0	0	0	0	0	0	0	0	4	0
17:45	14	0	0	0	0	0	0	0	0	14	6	0	0	0	0	0	0	0	0	6	1
1 Hr	44	4	0	0	0	0	0	0	0	48	28	0	0	0	0	0	0	0	0	28	6
6 Hrs	177	16	1	0	0	0	1	1	0	196	103	3	1	2	0	0	2	1	0	112	35

Linkcount

Vehicles – Direction: Eastbound (EB) / Westbound (WB)

Time	EB Car	EB Lgv	EB Mcl	EB Hgv	EB Tractor & Trailers	EB Bus	EB Horse Riders	EB Pcl	EB Herded Animals & Horses	EB Large / Slow Vehicles	EB Total	WB Car	WB Lgv	WB Mcl	WB Hgv	WB Tractor & Trailers	WB Bus	WB Horse Riders	WB Pcl	WB Herded Animals & Horses	WB Large / Slow Vehicles	WB Total
18:00	23	1	0	0	0	0	0	4	0	0	28	23	1	0	0	0	1	0	2	0	0	27
18:15	17	0	0	0	0	0	0	1	0	0	18	33	2	0	1	0	0	0	1	0	0	37
18:30	14	1	0	0	0	0	0	2	0	0	17	22	1	1	0	0	0	0	1	0	0	25
18:45	13	0	1	1	0	0	0	0	0	0	15	23	2	1	1	0	0	0	0	0	0	27
1 Hr	67	2	1	1	0	0	0	7	0	0	78	101	6	2	2	0	1	0	4	0	0	116
19:00	13	0	2	0	0	0	0	0	0	0	15	25	2	0	1	0	0	0	1	0	0	29
19:15	20	0	0	0	0	0	0	1	0	0	21	20	1	0	0	0	0	0	2	0	0	23
19:30	13	0	0	0	0	0	0	0	0	0	13	13	1	1	0	0	0	0	0	0	0	15
19:45	9	0	0	0	0	0	0	0	0	0	9	17	2	0	0	0	0	0	0	0	0	19
1 Hr	55	0	2	0	0	0	0	1	0	0	58	75	6	1	1	0	0	0	3	0	0	86
20:00	15	0	0	0	0	0	0	0	0	0	15	23	0	0	0	0	0	0	1	0	0	24
20:15	9	0	1	0	0	0	0	0	0	0	10	13	1	1	0	0	0	0	0	0	0	15
20:30	10	0	0	0	0	0	0	1	0	0	11	12	0	0	0	0	0	0	0	0	0	12
20:45	4	1	0	0	0	0	0	0	0	0	5	11	0	0	0	0	0	0	0	0	0	11
1 Hr	38	1	1	0	0	0	0	1	0	0	41	59	1	1	0	0	0	0	1	0	0	62
21:00	8	0	0	0	0	0	0	1	0	0	9	6	0	0	0	0	0	0	0	0	0	6
21:15	5	0	0	1	0	0	0	1	0	0	7	6	0	1	0	0	0	0	0	0	0	7
21:30	3	0	0	0	0	0	0	0	0	0	3	7	0	0	0	0	0	0	0	0	0	7
21:45	5	0	0	0	0	0	0	0	0	0	5	15	0	0	0	0	0	0	0	0	0	15
1 Hr	21	0	0	1	0	0	0	2	0	0	24	34	0	1	0	0	0	0	0	0	0	35
22:00	3	0	0	0	0	0	0	0	0	0	3	5	0	0	0	0	0	0	1	0	0	6
22:15	2	0	0	0	0	0	0	0	0	0	2	13	1	1	0	0	0	0	0	0	0	15
22:30	2	0	0	0	0	0	0	0	0	0	2	7	0	1	0	0	0	0	0	0	0	8
22:45	0	0	0	0	0	0	0	1	0	0	1	5	1	0	0	0	0	0	0	0	0	6
1 Hr	7	0	0	0	0	0	0	1	0	0	8	30	2	2	0	0	0	0	1	0	0	35
23:00	0	0	0	0	0	0	0	1	0	0	1	4	0	0	0	0	0	0	0	0	0	4
23:15	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1
23:30	4	0	0	0	0	0	0	0	0	0	4	2	0	1	0	0	0	0	0	0	0	3
23:45	3	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	3
1 Hr	8	0	0	0	0	0	0	1	0	0	9	10	0	1	0	0	0	0	0	0	0	11
6 Hrs	196	3	4	2	0	0	0	13	0	0	218	309	15	7	4	0	1	0	9	0	0	345
Total	1332	46	14	11	1	1	0	116	0	0	1521	1451	66	13	13	0	6	0	97	0	0	1646

Pedestrians – Direction: Eastbound (EB) / Westbound (WB)

Time	EB Adult	EB Accompanied Child	EB Unaccompanied Child	EB Elderly	EB Impaired	EB Pushchair/ Pram	EB Pushchair/ Pram	EB Scooter	EB Railway Personnel	EB Total	WB Adult	WB Accompanied Child	WB Unaccompanied Child	WB Elderly	WB Impaired	WB Wheelchair	WB Pushchair/ Pram	WB Scooter	WB Railway Personnel	WB Total	TRAINS
18:00	6	0	0	0	0	0	0	0	0	6	5	0	1	0	0	0	0	0	0	6	3
18:15	14	2	0	0	0	0	0	0	0	16	8	0	0	0	0	0	0	0	0	8	2
18:30	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1
18:45	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
1 Hr	23	2	0	0	0	0	0	0	0	25	14	0	1	0	0	0	0	0	0	15	7
19:00	7	0	0	0	0	0	0	0	0	7	2	0	0	0	0	0	0	0	0	2	3
19:15	9	0	0	0	0	0	0	0	0	9	5	0	0	0	0	0	0	0	0	5	2
19:30	5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
19:45	0	0	3	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	3	1
1 Hr	21	0	3	0	0	0	0	0	0	24	10	0	0	0	0	0	0	0	0	10	6
20:00	5	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	1	3
20:15	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
20:30	3	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	4	0
20:45	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
1 Hr	10	0	0	0	0	0	0	0	0	10	6	0	0	0	0	0	0	0	0	6	4
21:00	5	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	1	2
21:15	3	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	4	3
21:30	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0
21:45	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
1 Hr	10	0	0	0	0	0	0	0	0	10	6	0	0	0	0	0	0	0	0	6	6
22:00	1	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	4	3
22:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22:45	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	1
1 Hr	2	0	0	0	0	0	0	0	0	2	4	2	0	0	0	0	0	0	0	6	5
23:00	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3
23:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3
6 Hrs	67	2	3	0	0	0	0	0	0	72	40	2	1	0	0	0	0	0	0	43	31
Total	396	24	4	0	0	0	5	1	1	431	225	7	2	2	0	0	3	1	1	241	79

TRAIN ARRIVAL	TRAIN DEPARTURE	DURATION	DIRECTION
		Northbound	40
		Southbound	39
		Total	79
08:46:28	08:46:31	00:00:03	S
08:58:17	08:58:19	00:00:02	N
09:07:59	09:08:10	00:00:11	S
09:11:54	09:12:03	00:00:09	N
10:07:53	10:08:03	00:00:10	S
10:13:01	10:13:04	00:00:03	S
10:17:39	10:17:49	00:00:10	N
10:58:41	10:58:43	00:00:02	N
11:06:15	11:06:17	00:00:02	N
11:11:32	11:11:42	00:00:10	N
11:11:59	11:12:01	00:00:02	S
11:14:45	11:14:56	00:00:11	S
11:59:10	11:59:12	00:00:02	N
12:06:44	12:06:46	00:00:02	N
12:10:36	12:10:47	00:00:11	S
12:12:45	12:12:54	00:00:09	N
12:16:27	12:16:29	00:00:02	S
12:20:19	12:20:26	00:00:07	N
12:58:36	12:58:38	00:00:02	N
13:05:39	13:05:41	00:00:02	N
13:08:46	13:08:56	00:00:10	S
13:11:43	13:11:54	00:00:11	N
13:12:36	13:12:39	00:00:03	S
13:59:30	13:59:32	00:00:02	N
14:04:47	14:04:49	00:00:02	S
14:06:13	14:06:15	00:00:02	N
14:07:38	14:07:48	00:00:10	S
14:12:00	14:12:08	00:00:08	N
14:12:43	14:12:45	00:00:02	S
14:58:07	14:58:09	00:00:02	N
15:05:12	15:05:15	00:00:03	S
15:05:32	15:05:34	00:00:02	N
15:09:22	15:09:32	00:00:10	S
15:15:14	15:15:16	00:00:02	S
15:19:46	15:19:56	00:00:10	N
15:58:19	15:58:21	00:00:02	N
16:03:06	16:03:08	00:00:02	S
16:06:51	16:06:53	00:00:02	N
16:11:44	16:11:55	00:00:11	N
16:11:56	16:11:58	00:00:02	S
16:16:52	16:17:03	00:00:11	S
16:58:45	16:58:47	00:00:02	N
17:05:42	17:05:45	00:00:03	N
17:07:19	17:07:22	00:00:03	S
17:11:28	17:11:38	00:00:10	S
17:15:55	17:15:58	00:00:03	S
17:17:11	17:17:22	00:00:11	N
17:57:52	17:57:54	00:00:02	N
18:02:41	18:02:42	00:00:01	S
18:06:39	18:06:41	00:00:02	N
18:13:20	18:13:33	00:00:13	S
18:15:35	18:15:44	00:00:09	N
18:17:10	18:17:12	00:00:02	S
18:37:39	18:37:41	00:00:02	S
18:57:59	18:58:01	00:00:02	N
19:01:41	19:01:43	00:00:02	S
19:06:49	19:06:51	00:00:02	N
19:13:16	19:13:27	00:00:11	N
19:16:15	19:16:25	00:00:10	S
19:19:55	19:19:58	00:00:03	S
19:58:12	19:58:14	00:00:02	N
20:02:11	20:02:13	00:00:02	S
20:06:31	20:06:34	00:00:03	N
20:10:11	20:10:21	00:00:10	S
20:17:41	20:17:51	00:00:10	N
21:00:30	21:00:32	00:00:02	S
21:13:50	21:14:00	00:00:10	N
21:17:20	21:17:33	00:00:13	S
21:21:09	21:21:14	00:00:05	N
21:21:57	21:22:00	00:00:03	S
21:58:29	21:58:32	00:00:03	N
22:01:55	22:01:56	00:00:01	S
22:08:26	22:08:35	00:00:09	S
22:11:39	22:11:49	00:00:10	N
22:43:01	22:43:04	00:00:03	N
22:59:29	22:59:30	00:00:01	S
23:08:43	23:08:53	00:00:10	S
23:12:24	23:12:34	00:00:10	N
23:13:58	23:14:00	00:00:02	S

OBSERVATION	START TIME	END TIME	DIRECTION FROM CROSSING
Pick up	10:08:58	10:09:27	ESJ
Waiting	10:20:10	10:23:07	ESJ
Parking	11:56:50	12:05:01	ESJ
Vehicle stopped near level crossing	12:28:44	12:29:30	ESJ
Vehicle stopped near level crossing	13:23:35	13:23:56	ESJ
Pick up	14:23:15	14:24:48	ESJ
Parking	15:13:46	15:21:48	ESJ
Waiting	15:26:04	15:27:57	ESJ
Drop off	16:08:29	16:09:11	ESJ
Pick up	16:12:37	16:14:05	ESJ
Pick up	16:14:23	16:19:51	ESJ
Pick up	16:18:38	16:18:55	ESJ
Pick up	16:47:02	16:48:06	ESJ
Drop off	17:00:26	17:00:54	ESJ
Waiting	17:04:32	17:13:15	ESJ
Parking	18:03:26	18:18:15	ESJ
Drop off	18:56:30	18:56:47	ESJ
Drop off	19:10:43	19:12:55	ESJ
Waiting	19:19:22	19:20:37	ESJ
Waiting	19:20:24	19:23:57	ESJ
Parking	19:21:43	19:31:16	ESJ
Waiting	19:58:52	20:02:28	ESJ
Pick up	21:02:51	21:03:54	ESJ
Vehicle stopped near level crossing	22:14:10	22:14:44	ESJ
Pick up	23:29:31	23:29:45	WSJ
Waiting	23:37:01	23:38:34	WSJ

Tracsis plc
Traffic and Data Services

Client : WSP
Project : Level Crossing Census - Waterbeach
Site : Site X - Clayhithe Road Level Crossing
Date : Saturday 8th - Sunday 16th July 2017

Direction : **Eastbound**

Day		Date	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
Day 1	Saturday	08/07/2017	1644	102	30	22	1	0	0	140	0	0	1939
Day 2	Sunday	09/07/2017	1383	57	14	12	0	0	0	138	0	0	1604
Day 3	Monday	10/07/2017	2714	343	25	59	4	7	0	170	0	3	3325
Day 4	Tuesday	11/07/2017	2345	259	14	27	2	5	0	126	0	1	2779
Day 5	Wednesday	12/07/2017	2458	255	17	35	0	6	0	146	0	0	2917
Day 6	Thursday	13/07/2017	2383	230	34	29	4	6	0	168	0	0	2854
Day 7	Friday	14/07/2017	2507	256	31	36	3	7	0	189	0	1	3030
Day 8	Saturday	15/07/2017	1568	89	12	10	0	0	0	89	0	0	1768
Day 9	Sunday	16/07/2017	1332	46	14	11	1	1	0	116	0	0	1521
			18334	1637	191	241	15	32	0	1282	0	5	21737

Direction : **Westbound**

Day		Date	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
Day 1	Saturday	08/07/2017	1750	109	34	17	1	0	0	122	0	0	2033
Day 2	Sunday	09/07/2017	1565	67	26	15	0	0	0	146	0	0	1819
Day 3	Monday	10/07/2017	2187	278	30	34	2	4	0	140	0	0	2675
Day 4	Tuesday	11/07/2017	2205	285	13	43	1	5	0	105	0	0	2657
Day 5	Wednesday	12/07/2017	2530	295	26	45	0	6	0	151	0	0	3053
Day 6	Thursday	13/07/2017	2110	273	34	34	2	5	0	155	0	1	2614
Day 7	Friday	14/07/2017	1966	233	28	33	3	5	0	116	0	0	2384
Day 8	Saturday	15/07/2017	1663	96	25	17	2	0	0	75	0	0	1878
Day 9	Sunday	16/07/2017	1451	66	13	13	0	6	0	97	0	0	1646
			17427	1702	229	251	11	31	0	1107	0	1	20759

Direction : **Eastbound**

Day	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
Day 1	549	22	0	1	0	0	11	0	1	584
Day 2	435	31	5	0	0	0	13	0	0	484
Day 3	202	5	0	0	0	0	2	0	6	215
Day 4	626	6	0	0	1	0	4	0	18	655
Day 5	576	7	2	0	1	0	2	0	5	593
Day 6	556	5	8	0	1	0	8	0	1	579
Day 7	586	6	1	0	0	0	7	0	0	600
Day 8	378	16	0	1	0	0	7	0	0	402
Day 9	396	24	4	0	0	0	5	1	1	431
	4304	122	20	2	3	0	59	1	32	4543

Direction : **Westbound**

Day	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
Day 1	308	16	1	1	0	0	6	0	1	333
Day 2	264	16	1	0	0	0	7	0	0	288
Day 3	100	4	0	0	0	0	1	0	7	112
Day 4	210	2	2	0	0	0	0	0	17	231
Day 5	234	5	0	0	0	0	2	0	5	246
Day 6	235	0	0	0	1	0	4	0	1	241
Day 7	219	2	0	0	2	0	2	0	0	225
Day 8	197	12	0	0	0	0	1	0	0	210
Day 9	225	7	2	2	0	0	3	1	1	241
	1992	64	6	3	3	0	26	1	32	2127

Day	Northbound Trains	Southbound Trains
Day 1	61	63
Day 2	36	38
Day 3	84	84
Day 4	87	84
Day 5	89	87
Day 6	82	79
Day 7	84	84
Day 8	56	57
Day 9	40	39
	619	615

Direction : **Combined**

Day		Date	Car	Lgv	Mcl	Hgv	Tractor & Trailers	Bus	Horse Riders	Pcl	Herded Animals & Horses	Large / Slow Vehicles	Total
Day 1	Saturday	08/07/2017	3394	211	64	39	2	0	0	262	0	0	3972
Day 2	Sunday	09/07/2017	2948	124	40	27	0	0	0	284	0	0	3423
Day 3	Monday	10/07/2017	4901	621	55	93	6	11	0	310	0	3	6000
Day 4	Tuesday	11/07/2017	4550	544	27	70	3	10	0	231	0	1	5436
Day 5	Wednesday	12/07/2017	4988	550	43	80	0	12	0	297	0	0	5970
Day 6	Thursday	13/07/2017	4493	503	68	63	6	11	0	323	0	1	5468
Day 7	Friday	14/07/2017	4473	489	59	69	6	12	0	305	0	1	5414
Day 8	Saturday	15/07/2017	3231	185	37	27	2	0	0	164	0	0	3646
Day 9	Sunday	16/07/2017	2783	112	27	24	1	7	0	213	0	0	3167
			35761	3339	420	492	26	63	0	2389	0	6	42496

Direction : **Combined**

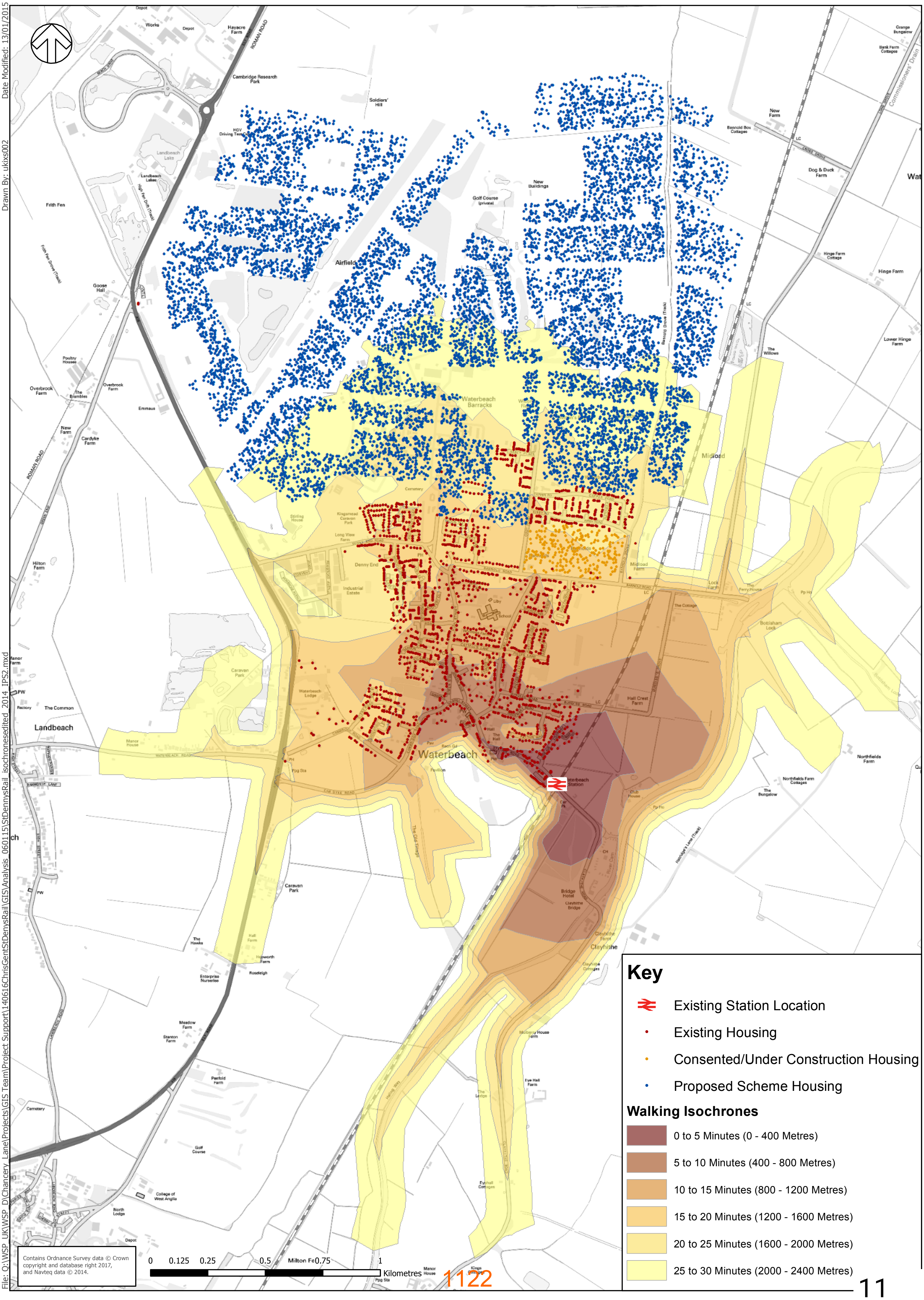
Day	Adult	Accompanied Child	Unaccompanied Child	Elderly	Impaired	Wheelchair	Pushchair/ Pram	Scooter	Railway Personnel	Total
Day 1	857	38	1	2	0	0	17	0	2	917
Day 2	699	47	6	0	0	0	20	0	0	772
Day 3	302	9	0	0	0	0	3	0	13	327
Day 4	836	8	2	0	1	0	4	0	35	886
Day 5	810	12	2	0	1	0	4	0	10	839
Day 6	791	5	8	0	2	0	12	0	2	820
Day 7	805	8	1	0	2	0	9	0	0	825
Day 8	575	28	0	1	0	0	8	0	0	612
Day 9	621	31	6	2	0	0	8	2	2	672
	6296	186	26	5	6	0	85	2	64	6670

Day	Trains Combined
Day 1	124
Day 2	74
Day 3	168
Day 4	171
Day 5	176
Day 6	161
Day 7	168
Day 8	113
Day 9	79
	1234

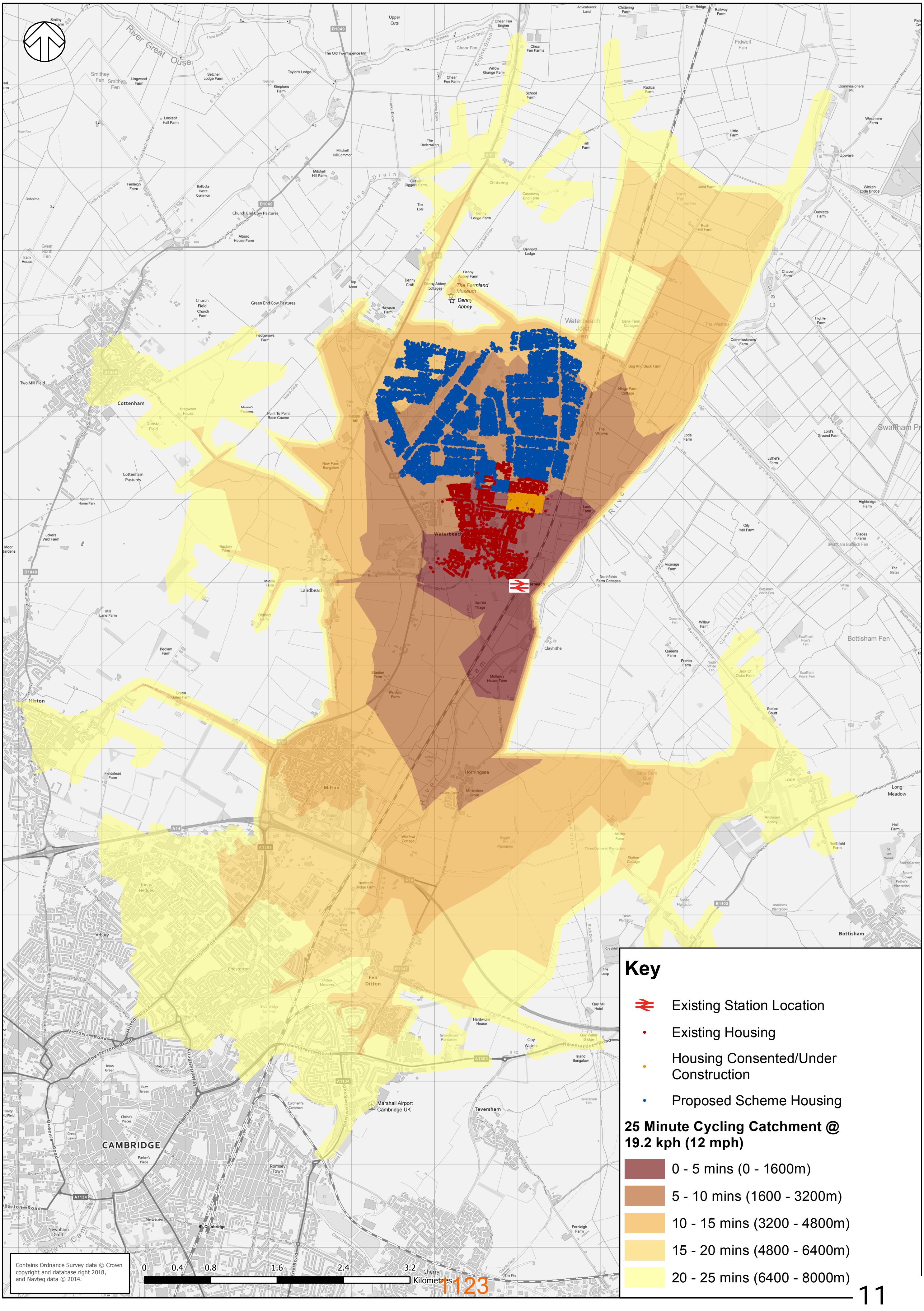
Appendix H – Walking and Cycling Isochrones

WSP 'Waterbeach new town east, Full Planning Application- Station, TA and Travel Plan

Walking Isochrone from Existing Station

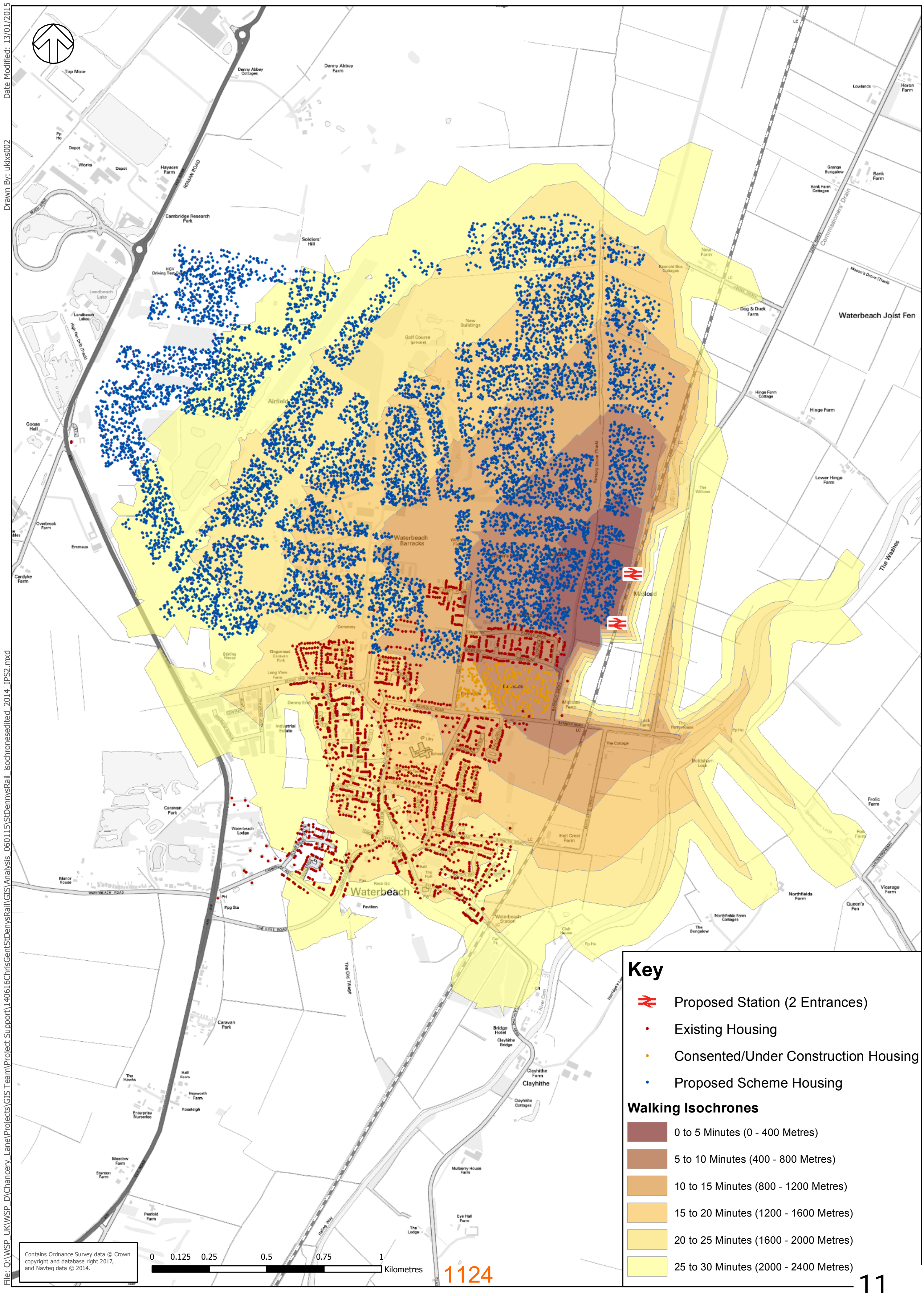


Cycling Isochrone from Existing Station

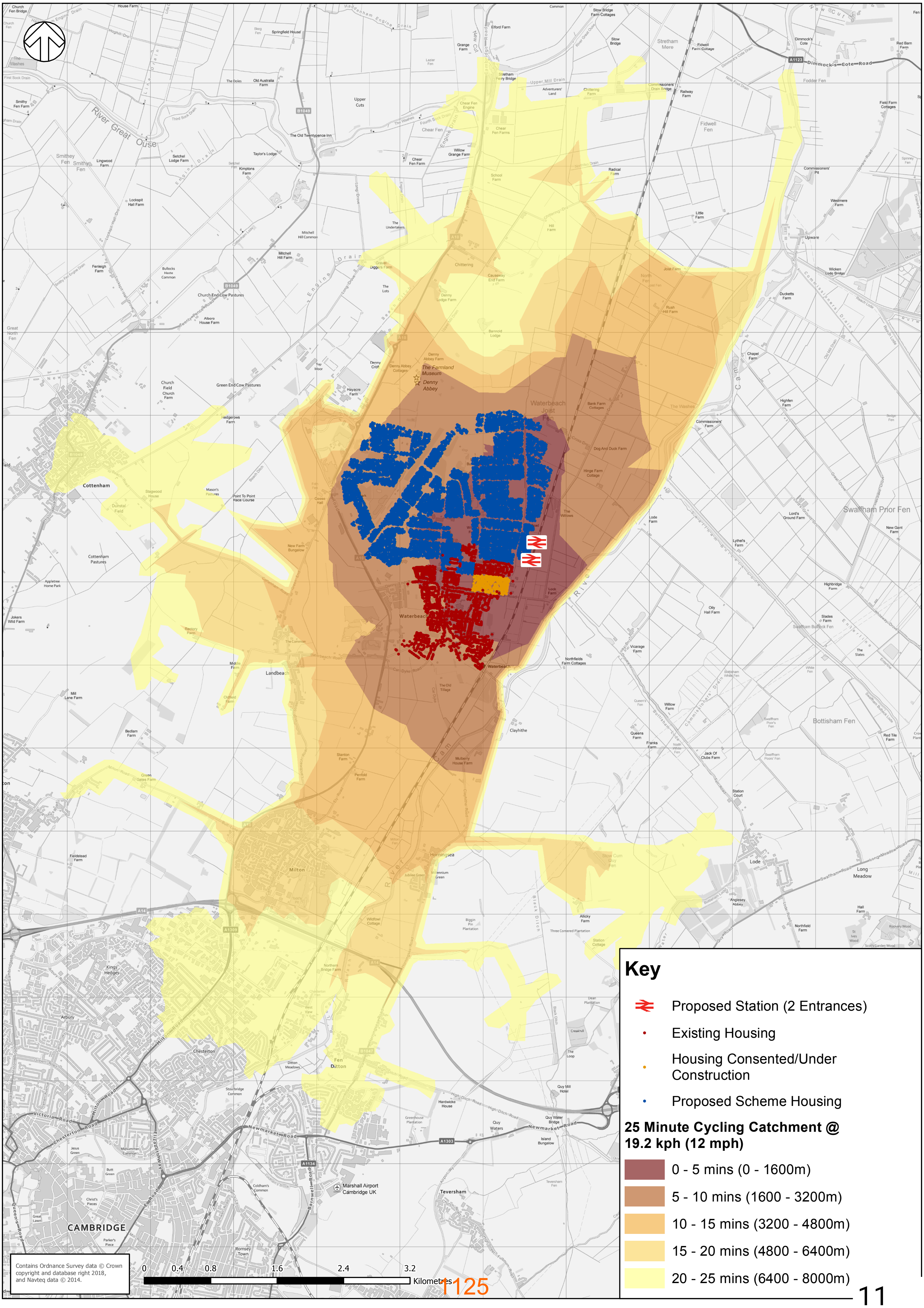


WSP 'Waterbeach new town east, Full Planning Application- Station, TA and Travel Plan

Walking Isochrone from Proposed Station



Cycling Isochrone from Proposed Station



Appendix I – Bus Timetables

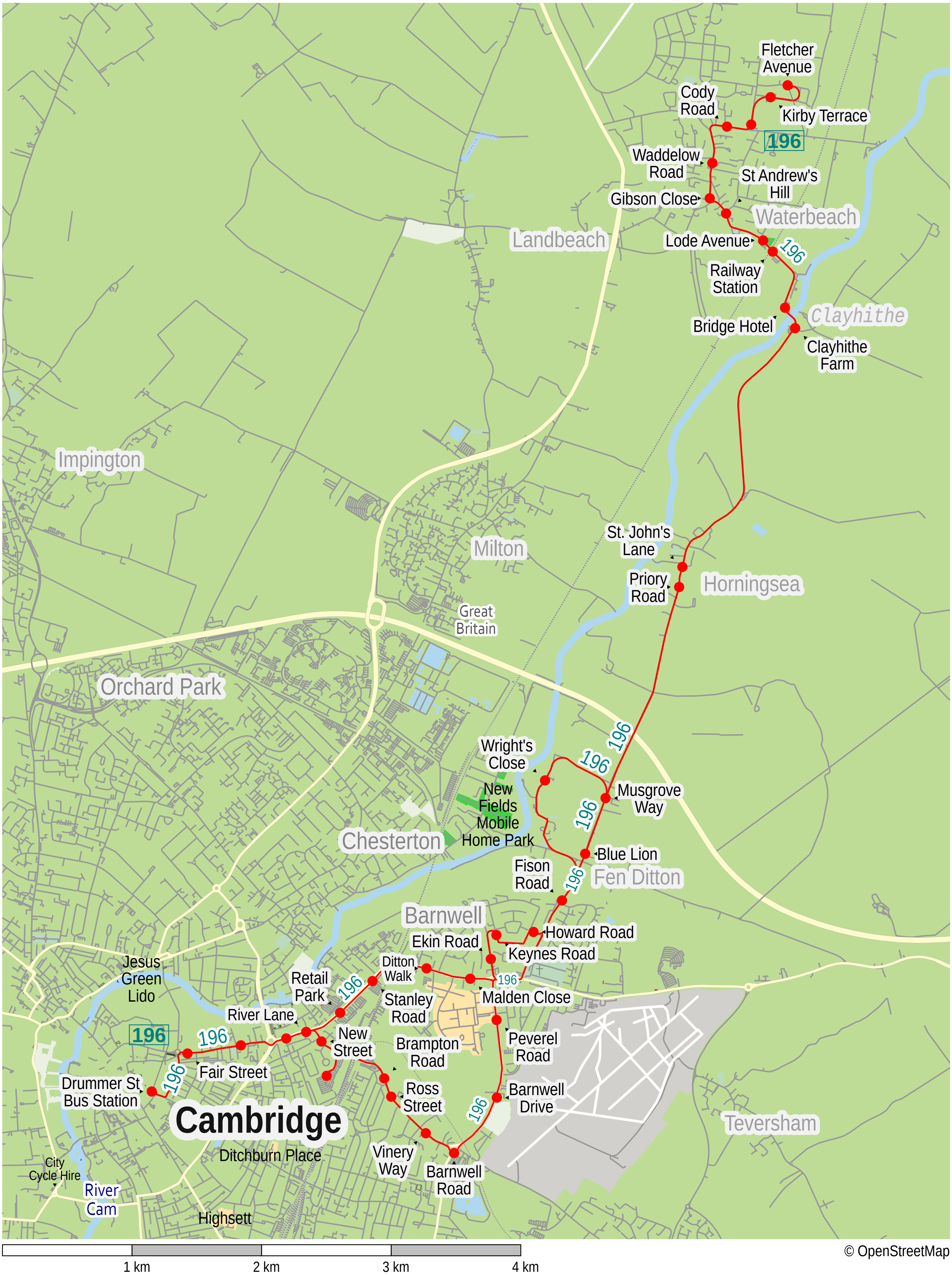
traveline public transport info
0871 200 22 33
Calls cost 12p per minute plus your phone company's access charge

Route map for Whippet Coaches service 196 (outbound)

ea-20196_(1).y08 (outbound)

traveline public transport info 0871 200 22 33 Calls cost 12p per minute plus your phone company's access charge

Route map for Whippet Coaches service 196 (inbound)



196 Cambridge - Fen Ditton - Waterbeach

Whippet Coaches

The information on this timetable is expected to be valid until at least 3rd January 2018. Where we know of variations, before or after this date, then we show these at the top of each affected column in the table.

Direction of stops: where shown (eg: W-bound) this is the compass direction towards which the bus is pointing when it stops

Mondays to Fridays

Cambridge, Drummer St Bus Station (Bay 9)	1215	1415	1745
Cambridge, opp Napier Street	1220	1420	1750
Cambridge, o/s Beehive Retail Park	1225	1425	|
Cambridge, opp Barnwell Road	1229	1429	|
Cambridge, nr Howard Road	1232	1432	|
Fen Ditton, opp Wright's Close	1239	1439	|
Fen Ditton, opp Blue Lion	1243	1443	1805
Horningsea, nr St. John's Lane	1246	1446	1808
Clayhithe, opp Bridge Hotel	1248	1448	1810
Waterbeach, opp Railway Station	1250	1450	1811
Waterbeach, opp Fletcher Avenue	1255	1455	1816
Waterbeach, nr Kirby Terrace	1257	1457	1818

Saturdays

no service

Sundays

no service

Christmas Eve (Sunday 24th December)

no service

Christmas Day (Monday 25th December)

no service

Boxing Day (Tuesday 26th December)

no service

Wednesday 27th December

same as Mondays to Fridays

Thursday 28th December

same as Mondays to Fridays

Friday 29th December

same as Mondays to Fridays

Saturday 30th December

no service

New Year's Eve (Sunday 31st December)

no service

New Year's Day (Monday 1st January)

no service

Cambridgeshire County Council04/12/2017 0903

196 Waterbeach - Fen Ditton - Cambridge

Whippet Coaches

The information on this timetable is expected to be valid until at least 3rd January 2018. Where we know of variations, before or after this date, then we show these at the top of each affected column in the table.

Direction of stops: where shown (eg: W-bound) this is the compass direction towards which the bus is pointing when it stops

Mondays to Fridays

Waterbeach, opp Fletcher Avenue	0725	0930	1130	1330
Waterbeach, nr Kirby Terrace	0727	0932	1132	1332
Waterbeach, o/s Railway Station	0732	0937	1137	1337
Clayhithe, nr Bridge Hotel	0733	0939	1139	1339
Horningsea, opp St. John's Lane	0735	0941	1141	1341
Fen Ditton, nr Blue Lion	0743	0944	1144	1344
Fen Ditton, nr Wright's Close	|	0948	1148	1348
Cambridge, opp Howard Road	|	0955	1155	1355
Cambridge, opp Barnwell Road	|	0958	1158	1358
Cambridge, o/s Beehive Retail Park	|	1002	1202	1402
Cambridge, nr Napier Street	0758	1007	1207	1407
Cambridge, Drummer St Bus Station (Bay 9)	0800	1010	1210	1410

Saturdays
no service

Sundays
no service

Christmas Eve (Sunday 24th December)
no service

Christmas Day (Monday 25th December)
no service

Boxing Day (Tuesday 26th December)
no service

Wednesday 27th December
same as Mondays to Fridays

Thursday 28th December
same as Mondays to Fridays

Friday 29th December
same as Mondays to Fridays

Saturday 30th December
no service

New Year's Eve (Sunday 31st December)
no service

New Year's Day (Monday 1st January)
no service

196 Cambridge - Fen Ditton - Waterbeach

Whippet Coaches

For times of the next departures from a particular stop you can use **traveline-txt** - by sending the SMS code to **84268**. Add the service number after the code if you just want a specific service - eg: **buctdgtd 60**. The return message from **traveline-txt** will show the next three departures, and it currently costs 25p plus any message sending charge. Departure times will be real-time predictions where available, or scheduled departure times if not.

You can also get the same information by using the SMS code at www.nextbuses.mobi (only normal browsing charges apply) or through several iPhone or Android apps that offer access to **NextBuses**.

NOTE: SMS codes are different in each direction. Make sure you choose the right direction from these lists.

SMS Code	Stop Name	Street	ATCO Code
CMBDATJM	Cambridge, Drummer St Bus Station (Bay 9)	Drummer Street	0500CCITY274
CMBDAJAP	Cambridge, opp Fair Street	Maids Causeway	0500CCITY104
CMBDAJAJ	Cambridge, opp Napier Street	Newmarket Road	0500CCITY102
CMBDAMGP	Cambridge, nr Elizabeth Way	Newmarket Road	0500CCITY169
CMBDAMJT	Cambridge, opp New Street	Coldham's Lane	0500CCITY177
CMBDAMGW	Cambridge, o/s Beehive Retail Park	Coldham's Lane	0500CCITY171
CMBDAMAM	Romsey Town, opp Brampton Road	Coldham's Lane	0500CCITY154
CMBDAPGT	Romsey Town, opp Ross Street	Coldham's Lane	0500CCITY219
CMBDAJAD	Romsey Town, opp Vinery Way	Coldham's Lane	0500CCITY100
CMBDADTG	Cambridge, opp Barnwell Road	Brooks Road	0500CCITY039
CMBDAMTA	Cambridge, opp Uphall Road	Barnwell Road	0500CCITY186
CMBDADWG	Cambridge, opp Barnwell Drive	Barnwell Road	0500CCITY046
CMBDATMJ	Cambridge, opp Peverel Road	Barnwell Road	0500CCITY281
CMBDAJWM	Cambridge, nr Newmarket Road	Barnwell Road	0500CCITY148
CMBDAMAP	Cambridge, opp Ekin Road	Wadloes Road	0500CCITY155
CMBDAMAW	Cambridge, nr Howard Road	Dudley Road	0500CCITY157
CMBDAMGD	Cambridge, nr River Lane	Newmarket Road	0500CCITY166
CMBDAMGA	Cambridge, nr Stanley Road	Newmarket Road	0500CCITY165
CMBDAMTP	Cambridge, nr Ditton Walk	Newmarket Road	0500CCITY191
CMBDATPT	Cambridge, opp Malden Close	Newmarket Road	0500CCITY290
CMBGJPAJ	Cambridge, opp Fison Road	Ditton Lane	0500CCITY480
CMBGDTWG	Fen Ditton, opp Wright's Close	Green End	0500SFENN012
CMBDWDWP	Fen Ditton, opp Blue Lion	Horningsea Road	0500SFENN011
CMBDWDTJ	Fen Ditton, opp Musgrove Way	Horningsea Road	0500SFENN002
CMBGADGD	Horningsea, nr Priory Road	High Street	0500SHORN001
CMBGADGM	Horningsea, nr St. John's Lane	High Street	0500SHORN003
CMBGADGT	Clayhithe, nr Clayhithe Farm	Clayhithe Road	0500SHORN005
CMBGDADT	Clayhithe, opp Bridge Hotel	Clayhithe Road	0500SWATE015
CMBGDAJP	Waterbeach, opp Railway Station	Clayhithe Road	0500SWATE028
CMBGDADJ	Waterbeach, opp Lode Avenue	Station Road	0500SWATE012
CMBGAWTD	Waterbeach, opp St Andrew's Hill	Station Road	0500SWATE004
CMBGDAJG	Waterbeach, nr Gibson Close	Greenside	0500SWATE026
CMBGDADW	Waterbeach, nr Waddelow Road	High Street	0500SWATE016
CMBGDAGP	Waterbeach, nr Cody Road	Bannold Road	0500SWATE021
CMBGDAJT	Waterbeach, opp Surgery	Cody Road	0500SWATE029
CMBGDADA	Waterbeach, opp Fletcher Avenue	Capper Road	0500SWATE010
CMBGJGJT	Waterbeach, nr Kirby Terrace	Kirby Road	0500SWATE031

196 Waterbeach - Fen Ditton - Cambridge

Whippet Coaches

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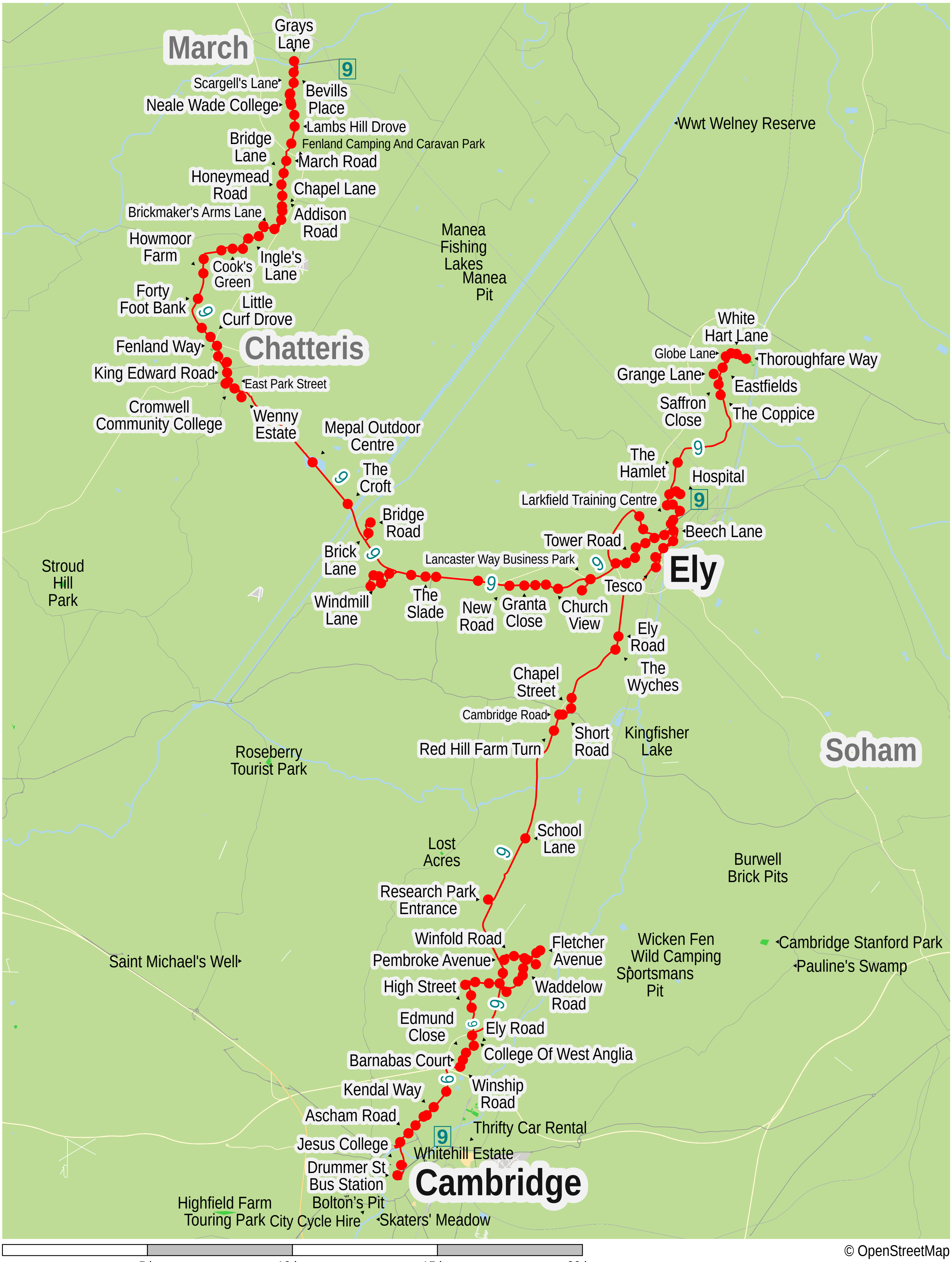
You can also get the same information by using the SMS code at www.nextbuses.mobi (only normal browsing charges apply) or through several iPhone or Android apps that offer access to **NextBuses**.

NOTE: SMS codes are different in each direction. Make sure you choose the right direction from these lists.

SMS Code	Stop Name	Street	ATCO Code
CMBGDADA	Waterbeach, opp Fletcher Avenue	Capper Road	0500SWATE010
CMBGJGJT	Waterbeach, nr Kirby Terrace	Kirby Road	0500SWATE031
CMBGJGJW	Waterbeach, o/s Surgery	Cody Road	0500SWATE032
CMBGDAJD	Waterbeach, opp Cody Road	Bannold Road	0500SWATE025
CMBGDAGD	Waterbeach, opp Waddelow Road	High Street	0500SWATE018
CMBGDAGW	Waterbeach, opp Gibson Close	Greenside	0500SWATE023
CMBGAWTG	Waterbeach, nr St Andrew's Hill	Station Road	0500SWATE005
CMBGDADG	Waterbeach, nr Lode Avenue	Station Road	0500SWATE011
CMBGDAGM	Waterbeach, o/s Railway Station	Clayhithe Road	0500SWATE020
CMBGDADM	Clayhithe, nr Bridge Hotel	Clayhithe Road	0500SWATE013
CMBGADGW	Clayhithe, opp Clayhithe Farm	Clayhithe Road	0500SHORN006
CMBGADGJ	Horningsea, opp St. John's Lane	High Street	0500SHORN002
CMBGADGP	Horningsea, opp Priory Road	High Street	0500SHORN004
CMBDWDWD	Fen Ditton, nr Musgrove Way	Horningsea Road	0500SFENN007
CMBDWDWG	Fen Ditton, nr Blue Lion	Horningsea Road	0500SFENN008
CMBDWDTW	Fen Ditton, nr Wright's Close	Green End	0500SFENN005
CMBDWDTG	Cambridge, nr Fison Road	Ditton Lane	0500SFENN001
CMBDAMDA	Cambridge, opp Howard Road	Dudley Road	0500CCITY158
CMBDAMAT	Cambridge, nr Dudley Road	Keynes Road	0500CCITY156
CMBDAJWJ	Cambridge, nr Ekin Road	Wadloes Road	0500CCITY146
CMBDADWM	Cambridge, nr Peverel Road	Barnwell Road	0500CCITY048
CMBDADWJ	Cambridge, nr Barnwell Drive	Barnwell Road	0500CCITY047
CMBDADTG	Cambridge, opp Barnwell Road	Brooks Road	0500CCITY039
CMBDAJAG	Romsey Town, nr Vinery Way	Coldham's Lane	0500CCITY101
CMBDAJPG	Romsey Town, nr Ross Street	Coldham's Lane	0500CCITY131
CMBDAMJA	Romsey Town, nr Brampton Road	Coldham's Lane	0500CCITY172
CMBDAMGW	Cambridge, o/s Beehive Retail Park	Coldham's Lane	0500CCITY171
CMBDAMGT	Cambridge, nr New Street	Coldham's Lane	0500CCITY170
CMBDAPGW	Cambridge, nr Malden Close	Newmarket Road	0500CCITY220
CMBDAPDW	Cambridge, opp Ditton Walk	Newmarket Road	0500CCITY213
CMBDAMDW	Cambridge, opp Stanley Road	Newmarket Road	0500CCITY164
CMBGJPMP	Cambridge, o/s Retail Park	Newmarket Road	0500CCITY482
CMBDAPGD	Cambridge, opp River Lane	Newmarket Road	0500CCITY215
CMBDAMGM	Cambridge, opp Elizabeth Way	Newmarket Road	0500CCITY168
CMBDAJAM	Cambridge, nr Napier Street	Newmarket Road	0500CCITY103
CMBGJWMD	Cambridge, nr Fair Street	Maids Causeway	0500CCITY515
CMBDATJM	Cambridge, Drummer St Bus Station (Bay 9)	Drummer Street	0500CCITY274

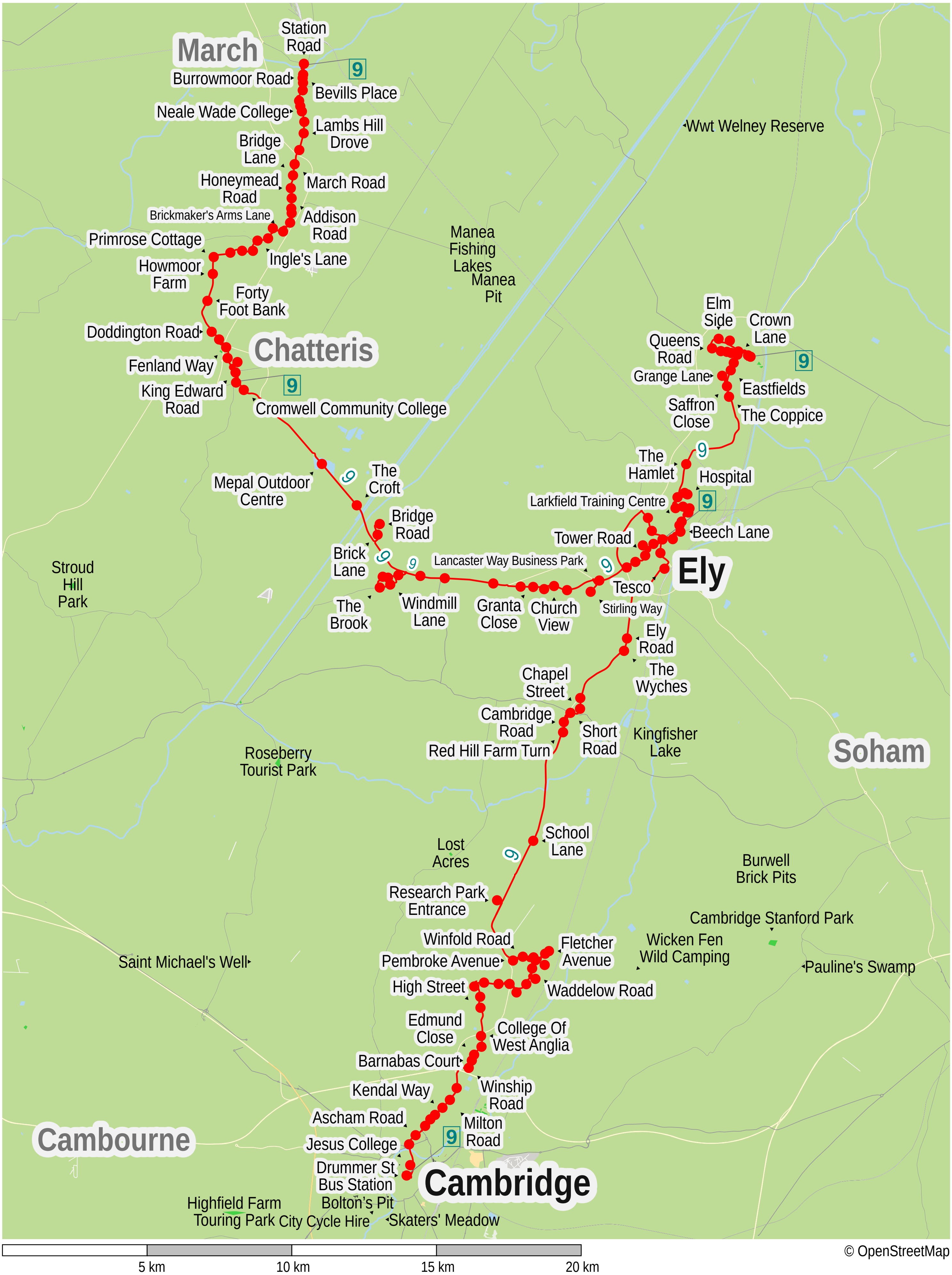
Route map for Stagecoach in Cambridge service 9 (outbound)



ea-20009A(1).y08 (outbound)

traveline public transport info 0871 200 22 33 Calls cost 12p per minute plus your phone company's access charge

Route map for Stagecoach in Cambridge service 9 (inbound)



ea-20009A(1).y08 (inbound)

9/X9 Cambridge - Waterbeach - Ely - Littleport - Chatteris

Stagecoach in Cambridge

The information on this timetable is expected to be valid until at least 3rd January 2018. Where we know of variations, before or after this date, then we show these at the top of each affected column in the table.

Direction of stops: where shown (eg: W-bound) this is the compass direction towards which the bus is pointing when it stops

Mondays to Fridays

Service		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Cambridge, Drummer St Bus Station (Bay 6)		—	0730	—	0800	—	0830	0900	—	0930	1000	1030	1100	—	—	1130	1200	1230	1300
Cambridge, nr Science Park		—	0742	—	0812	—	0842	0912	—	0942	1012	1042	1112	—	—	1142	1212	1242	1312
Milton, nr College of West Anglia		—	0747	—	0817	—	0847	0918	—	0947	1018	1047	1118	—	—	1147	1218	1247	1318
Waterbeach, nr Gibson Close		—	0756	—	|	—	0856	—	—	0956	—	1056	—	—	—	1156	—	1256	—
Waterbeach, opp Fletcher Avenue		—	0759	—	|	—	0859	—	—	0959	—	1059	—	—	—	1159	—	1259	—
Landbeach, adj Research Park Entrance		—	0809	—	0827	—	0909	—	—	1009	—	1109	—	—	—	1209	—	1309	—
Little Thetford, nr The Wyches		—	0821	—	0839	—	0921	—	—	1021	—	1121	—	—	—	1221	—	1321	—
Ely, o/s Tesco		—	0828	—	0846	—	0928	—	—	1028	—	1128	—	—	—	1228	—	1328	—
Ely, Market Street (Stop A)		0645	0837	0845	0855	0905	0937	—	0945	1037	—	1137	—	1145	1145	1237	—	1337	—
Sutton, nr Vermuyden Gardens		0703	—	0903	—	|	—	—	1003	—	—	—	—	|	1203	—	—	—	—
Mepal, opp Bridge Road		0710	—	0910	—	|	—	—	1010	—	—	—	—	|	1210	—	—	—	—
Chatteris, East Park Street (NW-bound)	arr	|	—	|	—	|	—	—	1019	—	—	—	—	|	1219	—	—	—	—
Chatteris, East Park Street (NW-bound)	dep	|	—	|	—	|	—	—	1022	—	—	—	—	|	1222	—	—	—	—
Chatteris, East Park Street (SE-bound)		0719	—	0919	—	|	—	—	|	—	—	—	—	|	|	—	—	—	—
Doddington, opp Ingle's Lane		—	—	—	—	|	—	—	1032	—	—	—	—	|	1232	—	—	—	—
Wimblington, opp Addison Road		—	—	—	—	|	—	—	1037	—	—	—	—	|	1237	—	—	—	—
March, nr Grays Lane		—	—	—	—	|	—	—	1047	—	—	—	—	|	1247	—	—	—	—
Ely, o/s Hospital		—	—	—	—	0915	—	—	—	—	—	—	—	1155	—	—	—	—	—
Littleport, opp 5 Thoroughfare Way		—	—	—	—	0925	—	—	—	—	—	—	—	1205	—	—	—	—	—

Mondays to Fridays

Service		9	9	9	9	9	9	9	9	9	9	9	9	9	9	X9	X9	X9	X9
Service Restrictions								1	2										
Notes								SchC	SchO										
Cambridge, Drummer St Bus Station (Bay 6)		—	—	1330	1400	1430	1500	—	—	1530	1600	—	—	1650	—	1720	1750	—	1820
Cambridge, nr Science Park		—	—	1342	1412	1442	1512	—	—	1542	1612	—	—	1702	—	1734	1804	—	1834
Milton, nr College of West Anglia		—	—	1347	1418	1447	1518	—	—	1547	1618	—	—	1707	—	|	|	—	|
Waterbeach, nr Gibson Close		—	—	1356	—	1456	—	—	—	1556	—	—	—	1716	—	|	|	—	|
Waterbeach, opp Fletcher Avenue		—	—	1359	—	1459	—	—	—	1559	—	—	—	|	—	|	|	—	|
Landbeach, adj Research Park Entrance		—	—	1409	—	1509	—	—	—	1609	—	—	—	1723	—	1749	1819	—	1849
Little Thetford, nr The Wyches		—	—	1421	—	1521	—	—	—	1621	—	—	—	1735	—	1801	1831	—	1901
Ely, o/s Tesco		—	—	1428	—	1528	—	—	—	1628	—	—	—	1742	—	1808	1838	—	1908
Ely, Market Street (Stop A)		1345	1345	1437	—	1537	—	1545	1545	1637	—	1645	1705	1751	1800	1817	1847	1852	1917
Ely, opp Community College		|	|	—	—	—	—	|	1548	—	—	|	|	—	|	|	—	|	|
Sutton, nr Vermuyden Gardens		|	1403	—	—	—	—	1603	1603	—	—	|	|	—	1818	|	—	1910	|
Mepal, opp Bridge Road		|	1410	—	—	—	—	1610	1610	—	—	|	|	—	1825	|	—	1917	|
Chatteris, East Park Street (NW-bound)	arr	|	1419	—	—	—	—	1619	1619	—	—	|	|	—	|	|	—	|	|
Chatteris, East Park Street (NW-bound)	dep	|	1422	—	—	—	—	1622	1622	—	—	|	|	—	|	|	—	|	|
Chatteris, East Park Street (SE-bound)		|	|	—	—	—	—	|	|	—	—	|	|	—	1834	|	—	1926	|
Doddington, opp Ingle's Lane		|	1432	—	—	—	—	1632	1632	—	—	|	|	—	—	|	—	—	|
Wimblington, opp Addison Road		|	1437	—	—	—	—	1637	1637	—	—	|	|	—	—	|	—	—	|
March, nr Grays Lane		|	1447	—	—	—	—	1647	1647	—	—	|	|	—	—	|	—	—	|
Ely, o/s Hospital		1355	—	—	—	—	—	—	—	—	—	1655	1715	—	—	1827	—	—	1927
Littleport, opp 5 Thoroughfare Way		1405	—	—	—	—	—	—	—	—	—	—	1725	—	—	1837	—	—	1937
Littleport, nr Crown Lane		—	—	—	—	—	—	—	—	—	—	—	—	—	—	1848	—	—	1948

Mondays to Fridays

Service	X9
Cambridge, Drummer St Bus Station (Bay 6)	1920
Cambridge, nr Science Park	1934
Landbeach, adj Research Park Entrance	1949
Little Thetford, nr The Wyches	2001
Ely, o/s Tesco	2008
Ely, Market Street (Stop A)	2017

Saturdays

Service		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Cambridge, Drummer St Bus Station (Bay 6)		—	0730	—	0800	—	0830	0900	—	0930	1000	1030	1100	—	—	1130	1200	1230	1300
Cambridge, nr Science Park		—	0742	—	0812	—	0842	0912	—	0942	1012	1042	1112	—	—	1142	1212	1242	1312
Milton, nr College of West Anglia		—	0747	—	0817	—	0847	0918	—	0947	1018	1047	1118	—	—	1147	1218	1247	1318
Waterbeach, nr Gibson Close		—	0756	—	|	—	0856	—	—	0956	—	1056	—	—	—	1156	—	1256	—
Waterbeach, opp Fletcher Avenue		—	0759	—	|	—	0859	—	—	0959	—	1059	—	—	—	1159	—	1259	—
Landbeach, adj Research Park Entrance		—	0809	—	0827	—	0909	—	—	1009	—	1109	—	—	—	1209	—	1309	—
Little Thetford, nr The Wyches		—	0821	—	0839	—	0921	—	—	1021	—	1121	—	—	—	1221	—	1321	—
Ely, o/s Tesco		—	0828	—	0846	—	0928	—	—	1028	—	1128	—	—	—	1228	—	1328	—
Ely, Market Street (Stop A)		0645	0837	0845	0855	0905	0937	—	0945	1037	—	1137	—	1145	1145	1237	—	1337	—
Sutton, nr Vermuyden Gardens		0703	—	0903	—	|	—	—	1003	—	—	—	—	|	1203	—	—	—	—
Mepal, opp Bridge Road		0710	—	0910	—	|	—	—	1010	—	—	—	—	|	1210	—	—	—	—
Chatteris, East Park Street (NW-bound)	arr	|	—	|	—	|	—	—	1019	—	—	—	—	|	1219	—	—	—	—
Chatteris, East Park Street (NW-bound)	dep	|	—	|	—	|	—	—	1022	—	—	—	—	|	1222	—	—	—	—
Chatteris, East Park Street (SE-bound)		0719	—	0919	—	|	—	—	|	—	—	—	—	|	|	—	—	—	—
Doddington, opp Ingle's Lane		—	—	—	—	|	—	—	1032	—	—	—	—	|	1232	—	—	—	—
Wimblington, opp Addison Road		—	—	—	—	|	—	—	1037	—	—	—	—	|	1237	—	—	—	—
March, nr Grays Lane		—	—	—	—	|	—	—	1047	—	—	—	—	|	1247	—	—	—	—
Ely, o/s Hospital		—	—	—	—	0915	—	—	—	—	—	—	—	1155	—	—	—	—	—
Littleport, opp 5 Thoroughfare Way		—	—	—	—	0925	—	—	—	—	—	—	—	1205	—	—	—	—	—

Service Restrictions: **1** - only 20.12.17 to 22.12.17, 12.2.18 to 16.2., 3.4. to 13.4.
2 - not 20.12.17 to 22.12.17, 12.2.18 to 16.2., 3.4. to 13.4.

Notes: **SchC** - Runs when schools are closed
SchO - Runs Mon-Fri when schools are open

Cambridgeshire County Council04/12/2017 0903

9/X9 Cambridge - Waterbeach - Ely - Littleport - Chatteris

Stagecoach in Cambridge

The information on this timetable is expected to be valid until at least 3rd January 2018. Where we know of variations, before or after this date, then we show these at the top of each affected column in the table.

Direction of stops: where shown (eg: W-bound) this is the compass direction towards which the bus is pointing when it stops

Saturdays

	Service	9	9	9	9	9	9	9	9	9	9	9	9	9	9	X9	X9	X9	X9
Cambridge, Drummer St Bus Station (Bay 6)		—	—	1330	1400	—	1430	1500	—	1530	1600	—	—	1650	—	1720	1750	—	1820
Cambridge, nr Science Park		—	—	1342	1412	—	1442	1512	—	1542	1612	—	—	1702	—	1734	1804	—	1834
Milton, nr College of West Anglia		—	—	1347	1418	—	1447	1518	—	1547	1618	—	—	1707	—			—	
Waterbeach, nr Gibson Close		—	—	1356	—	—	1456	—	—	1556	—	—	—	1716	—			—	
Waterbeach, opp Fletcher Avenue		—	—	1359	—	—	1459	—	—	1559	—	—	—		—			—	
Landbeach, adj Research Park Entrance		—	—	1409	—	—	1509	—	—	1609	—	—	—	1723	—	1749	1819	—	1849
Little Thetford, nr The Wyches		—	—	1421	—	—	1521	—	—	1621	—	—	—	1735	—	1801	1831	—	1901
Ely, o/s Tesco		—	—	1428	—	—	1528	—	—	1628	—	—	—	1742	—	1808	1838	—	1908
Ely, Market Street (Stop A)		1345	1345	1437	—	1445	1537	—	1545	1637	—	1645	1705	1751	1800	1817	1847	1852	1917
Sutton, nr Vermuyden Gardens			1403	—	—		—	—	1603	—	—			—	1818		—	1910	
Mepal, opp Bridge Road			1410	—	—		—	—	1610	—	—			—	1825		—	1917	
Chatteris, East Park Street (NW-bound)	arr		1419	—	—		—	—	1619	—	—			—			—		
Chatteris, East Park Street (NW-bound)	dep		1422	—	—		—	—	1622	—	—			—			—		
Chatteris, East Park Street (SE-bound)				—	—		—	—		—	—			—	1834		—	1926	
Doddington, opp Ingle's Lane			1432	—	—		—	—	1632	—	—			—	—		—	—	
Wimblington, opp Addison Road			1437	—	—		—	—	1637	—	—			—	—		—	—	
March, nr Grays Lane			1447	—	—		—	—	1647	—	—			—	—		—	—	
Ely, o/s Hospital		1355	—	—	—	1455	—	—	—	—	—	1655	1715	—	—	1827	—	—	1927
Littleport, opp 5 Thoroughfare Way		1405	—	—	—	1505	—	—	—	—	—	—	1725	—	—	1837	—	—	1937
Littleport, nr Crown Lane		—	—	—	—	—	—	—	—	—	—	—	—	—	—	1848	—	—	1948

Saturdays

	Service	X9
Cambridge, Drummer St Bus Station (Bay 6)		1920
Cambridge, nr Science Park		1934
Landbeach, adj Research Park Entrance		1949
Little Thetford, nr The Wyches		2001
Ely, o/s Tesco		2008
Ely, Market Street (Stop A)		2017

Sundays

no service

Christmas Eve (Sunday 24th December)

no service

Christmas Day (Monday 25th December)

no service

Boxing Day (Tuesday 26th December)

no service

Wednesday 27th December

same as Saturdays

Thursday 28th December

same as Saturdays

Friday 29th December

same as Saturdays

Saturday 30th December

same as Saturdays

New Year's Eve (Sunday 31st December)

no service

New Year's Day (Monday 1st January)

no service

Cambridgeshire County Council04/12/2017 0903

9/X9 Chatteris - Littleport - Ely - Waterbeach - Cambridge

Stagecoach in Cambridge

The information on this timetable is expected to be valid until at least 3rd January 2018. Where we know of variations, before or after this date, then we show these at the top of each affected column in the table.

Direction of stops: where shown (eg: W-bound) this is the compass direction towards which the bus is pointing when it stops

Mondays to Fridays

	Service	X9	X9	X9	X9	X9	9	X9	9	9	9	9	9	9	9	9	9	9	9
	Service Restrictions									2	1								
	Notes									SchO	SchC								
Chatteris, East Park Street (SE-bound)	dep	—	—	0550	—	—	0640	—	—	0720	0720	—	—	—	0920	—	—	—	—
Mepal, opp Bridge Road		—	—	0601	—	—	0651	—	—	0731	0731	—	—	—	0931	—	—	—	—
Sutton, nr Vermuyden Gardens		—	—	0606	—	—	0656	—	—	0736	0736	—	—	—	0936	—	—	—	—
Witchford, nr Clover End		—	—	0618	—	—	0708	—	—	0748	0748	—	—	—	0948	—	—	—	—
Ely, o/s Community College		—	—		—	—		—	—	0755		—	—	—		—	—	—	—
Littleport, opp 5 Thoroughfare Way		—	—		—	0618		—	0718			—	—	0925		—	—	—	—
Littleport, nr Crown Lane		—	—		—	0628		—	0728			—	—	0935		—	—	—	—
Ely, Market Street (Stop B)		0530	0600	0628	0630	0650	0718	0720	0750	0803	0803	—	0905	0957	1003	—	1005	—	1105
Little Thetford, nr The Wyches		0540	0610	—	0640	0700	—	0730	0800	—	—	—	0915	—	—	—	1015	—	1115
Landbeach, adj Research Park Entrance		0553	0623	—	0653	0713	—	0743	0812	—	—	—	0927	—	—	—	1027	—	1127
Waterbeach, opp Fletcher Avenue				—			—			—	—	—	0935	—	—	—	1035	—	1135
Waterbeach, opp Gibson Close				—			—		0820	—	—	—	0938	—	—	—	1038	—	1138
Cambridge, opp Science Park		0608	0638	—	0708	0733	—	0803	0845	—	—	0923	0953	—	—	1023	1053	1123	1153
Cambridge, Drummer St Bus Station (Bay 6)		0620	0650	—	0720	0750	—	0820	0902	—	—	0935	1005	—	—	1035	1105	1135	1205

Mondays to Fridays

	Service	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
March, nr Station Road		1052	—	—	—	—	—	1252	—	—	—	—	—	1452	—	—	1537	—	—
Wimblington, nr Addison Road		1102	—	—	—	—	—	1302	—	—	—	—	—	1502	—	—	1547	—	—
Doddington, nr Ingle's Lane		1107	—	—	—	—	—	1307	—	—	—	—	—	1507	—	—	1552	—	—
Chatteris, East Park Street (SE-bound)	arr	1117	—	—	—	—	—	1317	—	—	—	—	—	1517	—	—	1602	—	—
Chatteris, East Park Street (SE-bound)	dep	1120	—	—	—	—	—	1320	—	—	—	—	—	1520	—	—	1605	—	—
Mepal, opp Bridge Road		1131	—	—	—	—	—	1331	—	—	—	—	—	1531	—	—	1616	—	—
Sutton, nr Vermuyden Gardens		1136	—	—	—	—	—	1336	—	—	—	—	—	1536	—	—	1621	—	—
Witchford, nr Clover End		1148	—	—	—	—	—	1348	—	—	—	—	—	1548	—	—	1633	—	—
Littleport, opp 5 Thoroughfare Way			—	—	1205	—	—		—	—	1405	—	—		—	—		—	—
Littleport, nr Crown Lane			—	—	1215	—	—		—	—	1415	—	—		—	—		—	—
Ely, Market Street (Stop B)		1203	—	1205	1237	—	1305	1403	—	1405	1437	—	1505	1603	—	1605	1648	—	1705
Little Thetford, nr The Wyches		—	—	1215	—	—	1315	—	—	1415	—	—	1515	—	—	1615	—	—	1715
Landbeach, adj Research Park Entrance		—	—	1227	—	—	1327	—	—	1427	—	—	1527	—	—	1627	—	—	1727
Waterbeach, opp Fletcher Avenue		—	—	1235	—	—	1335	—	—	1435	—	—	1535	—	—	1635	—	—	1735
Waterbeach, opp Gibson Close		—	—	1238	—	—	1338	—	—	1438	—	—	1538	—	—	1638	—	—	1738
Cambridge, opp Science Park		—	1223	1253	—	1323	1353	—	1423	1453	—	1523	1553	—	1623	1653	—	1723	1753
Cambridge, Drummer St Bus Station (Bay 6)		—	1235	1305	—	1335	1405	—	1435	1505	—	1535	1605	—	1635	1705	—	1735	1805

Mondays to Fridays

	Service	9	9	9	9	9	9
March, nr Station Road		—	—	—	—	1707	—
Wimblington, nr Addison Road		—	—	—	—	1717	—
Doddington, nr Ingle's Lane		—	—	—	—	1722	—
Chatteris, East Park Street (SE-bound)	arr	—	—	—	—	1732	—
Chatteris, East Park Street (SE-bound)	dep	—	—	—	—	1735	1835
Mepal, opp Bridge Road		—	—	—	—	1746	1846
Sutton, nr Vermuyden Gardens		—	—	—	—	1751	1851
Witchford, nr Clover End		—	—	—	—	1803	1903
Littleport, opp 5 Thoroughfare Way		—	1725	—	—		
Littleport, nr Crown Lane		—	1735	—	—		
Ely, Market Street (Stop B)		1705	1757	—	1805	1818	1918
Little Thetford, nr The Wyches		—	—	—	1815	—	—
Landbeach, adj Research Park Entrance		—	—	—	1827	—	—
Waterbeach, opp Fletcher Avenue		—	—	—	1835	—	—
Waterbeach, opp Gibson Close		—	—	—	1838	—	—
Cambridge, opp Science Park		—	—	1828	1853	—	—
Cambridge, Drummer St Bus Station (Bay 6)		—	—	1840	1905	—	—

Saturdays

	Service	X9	X9	X9	X9	X9	9	X9	9	9	9	9	9	9	9	9	9	9	9
March, nr Station Road		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1052
Wimblington, nr Addison Road		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1102
Doddington, nr Ingle's Lane		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1107
Chatteris, East Park Street (SE-bound)	arr	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1117
Chatteris, East Park Street (SE-bound)	dep	—	—	0550	—	—	0640	—	—	0720	—	—	—	0920	—	—	—	—	1120
Mepal, opp Bridge Road		—	—	0601	—	—	0651	—	—	0731	—	—	—	0931	—	—	—	—	1131
Sutton, nr Vermuyden Gardens		—	—	0606	—	—	0656	—	—	0736	—	—	—	0936	—	—	—	—	1136
Witchford, nr Clover End		—	—	0618	—	—	0708	—	—	0748	—	—	—	0948	—	—	—	—	1148
Littleport, opp 5 Thoroughfare Way		—	—		—	0618		—	0718		—	—	0925		—	—	—	—	
Littleport, nr Crown Lane		—	—		—	0628		—	0728		—	—	0935		—	—	—	—	
Ely, Market Street (Stop B)		0530	0600	0628	0630	0650	0718	0720	0750	0803	—	0905	0957	1003	—	1005	—	1105	1203
Little Thetford, nr The Wyches		0540	0610	—	0640	0700	—	0730	0800	—	—	0915	—	—	—	1015	—	1115	—
Landbeach, adj Research Park Entrance		0553	0623	—	0653	0713	—	0743	0812	—	—	0927	—	—	—	1027	—	1127	—
Waterbeach, opp Fletcher Avenue				—			—			—	—	0935	—	—	—	1035	—	1135	—
Waterbeach, opp Gibson Close				—			—		0820	—	—	0938	—	—	—	1038	—	1138	—
Cambridge, opp Science Park		0608	0638	—	0708	0733	—	0803	0845	—	0923	0953	—	—	1023	1053	1123	1153	—
Cambridge, Drummer St Bus Station (Bay 6)		0620	0650	—	0720	0750	—	0820	0902	—	0935	1005	—	—	1035	1105	1135	1205	—

Service Restrictions: **1** - only 20.12.17 to 22.12.17, 12.2.18 to 16.2., 3.4. to 13.4.
2 - not 20.12.17 to 22.12.17, 12.2.18 to 16.2., 3.4. to 13.4.

Notes: **SchC** - Runs when schools are closed
SchO - Runs Mon-Fri when schools are open

Cambridgeshire County Council04/12/2017 0903

9/X9 Chatteris - Littleport - Ely - Waterbeach - Cambridge

Stagecoach in Cambridge

The information on this timetable is expected to be valid until at least 3rd January 2018. Where we know of variations, before or after this date, then we show these at the top of each affected column in the table.

Direction of stops: where shown (eg: W-bound) this is the compass direction towards which the bus is pointing when it stops

Saturdays

Service		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
March, nr Station Road		—	—	—	—	—	1252	—	—	—	—	—	—	1452	—	—	—	—	—
Wimblington, nr Addison Road		—	—	—	—	—	1302	—	—	—	—	—	—	1502	—	—	—	—	—
Doddington, nr Ingle's Lane		—	—	—	—	—	1307	—	—	—	—	—	—	1507	—	—	—	—	—
Chatteris, East Park Street (SE-bound)	arr	—	—	—	—	—	1317	—	—	—	—	—	—	1517	—	—	—	—	—
Chatteris, East Park Street (SE-bound)	dep	—	—	—	—	—	1320	—	—	—	—	—	—	1520	—	—	—	—	—
Mepal, opp Bridge Road		—	—	—	—	—	1331	—	—	—	—	—	—	1531	—	—	—	—	—
Sutton, nr Vermuyden Gardens		—	—	—	—	—	1336	—	—	—	—	—	—	1536	—	—	—	—	—
Witchford, nr Clover End		—	—	—	—	—	1348	—	—	—	—	—	—	1548	—	—	—	—	—
Littleport, opp 5 Thoroughfare Way		—	—	1205	—	—	|	—	—	1405	—	—	1505	|	—	—	—	—	—
Littleport, nr Crown Lane		—	—	1215	—	—	|	—	—	1415	—	—	1515	|	—	—	—	—	—
Ely, Market Street (Stop B)		—	1205	1237	—	1305	1403	—	1405	1437	—	1505	1537	1603	—	1605	—	1705	1705
Little Thetford, nr The Wyches		—	1215	—	—	1315	—	—	1415	—	—	1515	—	—	—	1615	—	1715	—
Landbeach, adj Research Park Entrance		—	1227	—	—	1327	—	—	1427	—	—	1527	—	—	—	1627	—	1727	—
Waterbeach, opp Fletcher Avenue		—	1235	—	—	1335	—	—	1435	—	—	1535	—	—	—	1635	—	1735	—
Waterbeach, opp Gibson Close		—	1238	—	—	1338	—	—	1438	—	—	1538	—	—	—	1638	—	1738	—
Cambridge, opp Science Park		1223	1253	—	1323	1353	—	1423	1453	—	1523	1553	—	—	1623	1653	1723	1753	—
Cambridge, Drummer St Bus Station (Bay 6)		1235	1305	—	1335	1405	—	1435	1505	—	1535	1605	—	—	1635	1705	1735	1805	—

Saturdays

Service		9	9	9	9
March, nr Station Road		—	—	1707	—
Wimblington, nr Addison Road		—	—	1717	—
Doddington, nr Ingle's Lane		—	—	1722	—
Chatteris, East Park Street (SE-bound)	arr	—	—	1732	—
Chatteris, East Park Street (SE-bound)	dep	—	—	1735	1835
Mepal, opp Bridge Road		—	—	1746	1846
Sutton, nr Vermuyden Gardens		—	—	1751	1851
Witchford, nr Clover End		—	—	1803	1903
Littleport, opp 5 Thoroughfare Way		1725	—	|	|
Littleport, nr Crown Lane		1735	—	|	|
Ely, Market Street (Stop B)		1757	1805	1818	1918
Little Thetford, nr The Wyches		—	1815	—	—
Landbeach, adj Research Park Entrance		—	1827	—	—
Waterbeach, opp Fletcher Avenue		—	1835	—	—
Waterbeach, opp Gibson Close		—	1838	—	—
Cambridge, opp Science Park		—	1853	—	—
Cambridge, Drummer St Bus Station (Bay 6)		—	1905	—	—

Sundays

no service

Christmas Eve (Sunday 24th December)

no service

Christmas Day (Monday 25th December)

no service

Boxing Day (Tuesday 26th December)

no service

Wednesday 27th December

same as Saturdays

Thursday 28th December

same as Saturdays

Friday 29th December

same as Saturdays

Saturday 30th December

same as Saturdays

New Year's Eve (Sunday 31st December)

no service

New Year's Day (Monday 1st January)

no service

9/X9 Cambridge - Waterbeach - Ely - Littleport - Chatteris

Stagecoach in Cambridge

For times of the next departures from a particular stop you can use **traveline-txt** - by sending the SMS code to **84268**. Add the service number after the code if you just want a specific service - eg: **buctdgtd 60**. The return message from **traveline-txt** will show the next three departures, and it currently costs 25p plus any message sending charge. Departure times will be real-time predictions where available, or scheduled departure times if not.

You can also get the same information by using the SMS code at www.nextbuses.mobi (only normal browsing charges apply) or through several iPhone or Android apps that offer access to **NextBuses**.

NOTE: SMS codes are different in each direction. Make sure you choose the right direction from these lists.

SMS Code	Stop Name	Street	ATCO Code
CMBDAJDW	Cambridge, Drummer St Bus Station (Bay 6)	Drummer Street	0500CCITY114
CMBDAJDJ	Cambridge, o/s Jesus College	Victoria Avenue	0500CCITY110
CMBDGATM	Chesterton, nr Westbrook Centre	Milton Road	0500CCITY387
CMBDAGDA	Chesterton, nr Ascham Road	Milton Road	0500CCITY058
CMBDAGTW	Chesterton, opp Union Lane	Milton Road	0500CCITY092
CMBDAGJD	Chesterton, nr Downham's Lane	Milton Road	0500CCITY066
CMBDAJTP	Chesterton, opp Fraser Road	Milton Road	0500CCITY141
CMBDAJTM	Chesterton, opp Kendal Way	Milton Road	0500CCITY140
CMBDGDPG	Cambridge, nr Science Park	Milton Road	0500CCITY428
CMBGAMDA	Milton, opp Winship Road	Cambridge Road	0500SMILT006
CMBGAMDG	Milton, opp Barnabas Court	Cambridge Road	0500SMILT007
CMBGAMAT	Milton, nr Edmund Close	High Street	0500SMILT004
CMBGAMAW	Milton, opp Ely Road	High Street	0500SMILT005
CMBGAMAM	Milton, nr College of West Anglia	Landbeach Road	0500SMILT002
CMBGMGAT	Waterbeach, nr Caravan Park	Ely Road	0500SLAND016
CMBGAGDJ	Landbeach, opp 134 High Street	High Street	0500SLAND006
CMBGAGDG	Landbeach, opp Walnut Farm	High Street	0500SLAND005
CMBGAGAW	Landbeach, nr Cockfen Lane	High Street	0500SLAND003
CMBGAGDT	Landbeach, opp Matthew Parker Close	Waterbeach Road	0500SLAND009
CMBGAGDP	Landbeach, nr Manor House	Waterbeach Road	0500SLAND008
CMBGAGDM	Landbeach, o/s 137 Waterbeach Road	Waterbeach Road	0500SLAND007
CMBGAGJG	Waterbeach, Car Dyke Road (E-bound)	Car Dyke Road	0500SLAND013
CMBGDADP	Waterbeach, opp Recreation Ground	Cambridge Road	0500SWATE014
CMBGDAJG	Waterbeach, nr Gibson Close	Greenside	0500SWATE026
CMBGDADW	Waterbeach, nr Waddelow Road	High Street	0500SWATE016
CMBGDADA	Waterbeach, opp Fletcher Avenue	Capper Road	0500SWATE010
CMBGJGJT	Waterbeach, nr Kirby Terrace	Kirby Road	0500SWATE031
CMBGJGJW	Waterbeach, o/s Surgery	Cody Road	0500SWATE032
CMBGDAJD	Waterbeach, opp Cody Road	Bannold Road	0500SWATE025
CMBGDAGJ	Waterbeach, opp Barracks	Denny End Road	0500SWATE019
CMBGDAGA	Waterbeach, nr Winfold Road	Denny End Road	0500SWATE017
CMBGDAJA	Waterbeach, nr Pembroke Avenue	Denny End Road	0500SWATE024
CMBGAGJM	Landbeach, adj Research Park Entrance	Cambridge Research Park Entrance	0500SLAND014
CMBGAWPT	Chittering, opp School Lane	Ely Road	0500SWATE001
CMBDJGDT	Stretham, nr Red Hill Farm Turn	Cambridge Road	0500ESTRE001
CMBGJWPG	Stretham, o/s 20 Cambridge Road	Cambridge Road	0500ESTRE010
CMBDJGJP	Stretham, opp Short Road	Wilburton Road	0500ESTRE007
CMBDJGJG	Stretham, opp Chapel Street	High Street	0500ESTRE005
CMBDJGJW	Stretham, opp Walnut Tree Close	Ely Road	0500ESTRE009
CMBDJDAM	Little Thetford, nr The Wyches	Ely Road	0500ELITT001
CMBGMJAW	Little Thetford, opp Ely Road	Ely Road	0500ELITT004
CMBDGPAM	Ely, o/s Tesco	Angel Drove	0500EELYY001
CMBGJTJA	Ely, nr Back Hill	Broad Street	0500EELYY097
CMBGJTGW	Ely, opp Cardinals Way	Broad Street	0500EELYY096
CMBDGTJA	Ely, nr Bell Holt	Lisle Lane	0500EELYY068
CMBGDWTW	Ely, opp Beech Lane	Prickwillow Road	0500EELYY080
CMBGDWPM	Ely, nr Springhead Lane	Prickwillow Road	0500EELYY074
CMBDGTDA	Ely, Market Street (Stop A)	Market Street	0500EELYY054
CMBDGPAP	Ely, opp W Fen Road	St Mary's Street	0500EELYY002
CMBGMDJT	Ely, opp Mariott Drive	Cambridge Road	0500EELYY107
CMBDGPMG	Ely, opp Tower Road	Cambridge Road	0500EELYY028
CMBGMDMG	Ely, nr Gateway Gardens	Witchford Road	0500EELYY108
CMBDGTJM	Ely, opp Norfolk Road	Witchford Road	0500EELYY071
CMBDGPGM	Ely, opp Northwold	Downham Road	0500EELYY015
CMBGJWPM	Ely, opp Community College	Downham Road	0500EELYY099
CMBGJGAT	Ely, nr Lancaster Way Business Park	Witchford Road	0500EELYY086
CMBGMTAG	Ely, opp Stirling Way	Lancaster Way	0500EELYY125
CMBDJMJD	Witchford, opp Bedwell Hey Lane	Main Street	0500EWITD002
CMBDJMJM	Witchford, opp Church View	Main Street	0500EWITD004
CMBDJMPG	Witchford, opp Clover End	Main Street	0500EWITD010
CMBDJMJA	Witchford, opp Granta Close	Main Street	0500EWITD001
CMBDJMJT	Witchford, nr New Road	Sutton Road	0500EWITD006
CMBDJGWP	Wentworth, nr Church Road	Ely Road	0500EWENT004
CMBDJGWT	Witcham Toll, nr Haddenham Road	Ely Road	0500EWENT005
CMBDJGWJ	Witcham Toll, opp The Slade	Ely Road	0500EWENT002
CMBDJGPD	Sutton, opp The Chestnuts	Ely Road	0500ESUTT009
CMBDJGMA	Sutton, opp Park Road	Ely Road	0500ESUTT001
CMBDJGPA	Sutton, nr Vermuyden Gardens	The Brook	0500ESUTT008
CMBDJGMW	Sutton, opp Brookside	The Brook	0500ESUTT007
CMBDJGMT	Sutton, nr The Brook	High Street	0500ESUTT006
CMBDJGMD	Sutton, opp Windmill Lane	High Street	0500ESUTT002
CMBDJGMG	Sutton, nr Park Road	Ely Road	0500ESUTT003
CMBDJDJA	Mepal, nr Brick Lane	Sutton Road	0500EMEPA004
CMBDJDGP	Mepal, opp Bridge Road	School Lane	0500EMEPA001
CMBDJDGW	Mepal, opp Brick Lane	Sutton Road	0500EMEPA003
CMBGMPDG	Mepal, opp Iretons Way	Iretons Way	0500EMEPA009
CMBGMPDJ	Mepal, o/s Mepal Outdoor Centre	Iretons Way	0500EMEPA010
CMBGMJDA	Chatteris, nr Wenny Estate	Wenny Road	0500FCHAT030

Continued on next page.

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NOTE: SMS codes are different in each direction. Make sure you choose the right direction from these lists.

SMS Code	Stop Name	Street	ATCO Code
CMBDJPJM	Chatteris, o/s Cromwell Community College	Wenny Road	0500FCHAT029
CMBDJPDA	Chatteris, East Park Street (NW-bound)	East Park Street	0500FCHAT002
CMBGJATP	Chatteris, nr East Park Street	Victoria Street	0500FCHAT019
CMBDJPGJ	Chatteris, East Park Street (SE-bound)	East Park Street	0500FCHAT011
CMBDJPGT	Chatteris, nr King Edward Road	High Street	0500FCHAT014
CMBGMPAD	Chatteris, nr Ash Grove	High Street	0500FCHAT032
CMBDJPDW	Chatteris, opp Dock Road	Bridge Street	0500FCHAT008
CMBDJPDP	Chatteris, nr Fenland Way	Bridge Street	0500FCHAT006
CMBDJPJD	Chatteris, opp Little Curf Drove	Doddington Road	0500FCHAT026
CMBDJPDG	Chatteris, o/s 19 Doddington Road	Doddington Road	0500FCHAT003
CMBDJPDT	Chatteris, nr Forty Foot Bank	Doddington Road	0500FCHAT007
CMBDJPMW	Doddington, opp Howmoor Farm	Primrose Hill	0500FDODD006
CMBDJPMG	Doddington, o/s Primrose Cottage	Primrose Hill	0500FDODD002
CMBGMDJM	Doddington, o/s 9 Primrose Hill	Primrose Hill	0500FDODD025
CMBDJPMD	Doddington, opp Cook's Green	Newgate Street	0500FDODD001
CMBGMDJG	Doddington, adj Thistledown	New Street	0500FDODD024
CMBDJPTW	Doddington, opp Ingle's Lane	High Street	0500FDODD014
CMBDJPTD	Doddington, opp Childs Lane	Wimblington Road	0500FDODD008
-	Doddington, Wimblington Road Hail & Ride (E-bound)	Wimblington Road	0500FDODD015
CMBDMGJW	Wimblington, opp Brickmaker's Arms Lane	Doddington Road	0500FWIMB012
CMBDMGDJ	Wimblington, nr Rays Court	Doddington Road	0500FWIMB001
-	Wimblington, Doddington Road Hail & Ride (N-bound)	Doddington Road	0500FWIMB015
CMBDMGJT	Wimblington, opp Chapel Lane	Doddington Road	0500FWIMB011
CMBDMGJP	Wimblington, opp Addison Road	March Road	0500FWIMB010
CMBDMGJD	Wimblington, opp Honeymead Road	March Road	0500FWIMB007
CMBDMGDM	Wimblington, opp Bridge Lane	March Road	0500FWIMB002
CMBDMGJM	Wimblington, o/s 53 March Road	March Road	0500FWIMB009
CMBGJADA	March, opp Isle Of Ely Way	Wimblington Road	0500FMARC082
CMBDJWPD	March, opp Lambs Hill Drove	Wimblington Road	0500FMARC028
CMBDJWMD	March, opp 8 Wimblington Road	Wimblington Road	0500FMARC021
CMBDJWTW	Town End, opp Neale Wade College	The Avenue	0500FMARC040
CMBGJAJM	March, opp Monument View	The Avenue	0500FMARC095
-	March, The Avenue Hail & Ride (N-bound)	The Avenue	0500FMARC087
CMBGJAWM	March, nr Causeway Close	The Causeway	0500FMARC097
CMBDJWGM	March, opp Scargell's Lane	High Street	0500FMARC009
CMBGJAGJ	March, opp Bevills Place	High Street	0500FMARC053
CMBDJWMP	March, nr Grays Lane	Broad Street	0500FMARC024
CMBDGPAT	Ely, o/s 7 Beech Lane	Beech Lane	0500EELYY003
CMBDGPWD	Ely, opp Cemetery	New Barns Avenue	0500EELYY041
CMBDGPWT	Ely, opp Larkfield Training Centre	High Barns	0500EELYY046
CMBDGPWP	Ely, opp Spring Meadow Infants School	High Barns	0500EELYY045
CMBGMDJA	Ely, opp Bishop Laney Drive	King's Avenue	0500EELYY105
CMBDGPJP	Ely, opp King's Avenue	Lynn Road	0500EELYY023
CMBDGPJT	Ely, o/s Lily House	Lynn Road	0500EELYY024
CMBDGPGW	Ely, nr Morton Close	Davison Road	0500EELYY018
CMBDGPGP	Ely, o/s Hospital	Davison Road	0500EELYY016
CMBGMJPM	Chettisham, nr The Hamlet	Lynn Road	0500EELYY122
CMBDJAWJ	Littleport, opp The Coppice	Ely Road	0500ELITP044
CMBDJAJA	Littleport, nr Saffron Close	Ely Road	0500ELITP011
CMBDJAGW	Littleport, nr Grange Lane	Ely Road	0500ELITP010
CMBDJADP	Littleport, opp Eastfields	Ely Road	0500ELITP001
CMBDJAGM	Littleport, nr Upton Lane	High Street	0500ELITP007
CMBGMPGA	Littleport, nr Globe Lane	Main Street	0500ELITP054
CMBDJAJM	Littleport, nr White Hart Lane	Victoria Street	0500ELITP014
CMBDJAWG	Littleport, opp 5 Thoroughfare Way	Thoroughfare Way	0500ELITP043
CMBDJAGD	Littleport, nr Granby Street	Wellington Street	0500ELITP005
CMBDJAGA	Littleport, nr Church Lane	Wellington Street	0500ELITP004
CMBDJADW	Littleport, opp Brookside Grove	Wisbech Road	0500ELITP003
CMBDJADT	Littleport, opp Elm Side	Wisbech Road	0500ELITP002
CMBDJAMJ	Littleport, nr Queens Road	Gilbert Road	0500ELITP021
CMBDJAMA	Littleport, nr Atkins Close	Parson's Lane	0500ELITP018
CMBDJAJT	Littleport, nr Friar's Way	Parson's Lane	0500ELITP016
CMBGDWGD	Littleport, o/s Health Centre	Parson's Lane	0500ELITP051
CMBDJAJP	Littleport, nr Crown Lane	Church Lane	0500ELITP015

9/X9 Chatteris - Littleport - Ely - Waterbeach - Cambridge

Stagecoach in Cambridge

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NOTE: SMS codes are different in each direction. Make sure you choose the right direction from these lists.

SMS Code	Stop Name	Street	ATCO Code
CMBDJWPT	March, nr Station Road	Broad Street	0500FMARC032
CMBGJAJP	March, nr Bevills Place	High Street	0500FMARC096
CMBGJAGM	March, opp Burrowmoor Road	High Street	0500FMARC042
CMBDJWMJ	March, adj Scargell's Lane	High Street	0500FMARC023
CMBDJWJP	March, opp Springfield Avenue	The Causeway	0500FMARC017
-	March, The Avenue Hail & Ride (S-bound)	The Avenue	0500FMARC084
CMBGDWTA	March, nr Monument View	The Avenue	0500FMARC094
CMBDJWTM	Town End, nr Neale Wade College	Wimblington Road	0500FMARC038
CMBDJWMA	March, o/s 32 Wimblington Road	Wimblington Road	0500FMARC020
CMBDJWTD	March, nr Lambs Hill Drove	Wimblington Road	0500FMARC035
CMBDJWPM	March, nr Isle Of Ely Way	Wimblington Road	0500FMARC031
CMBDMGDP	Wimblington, March Road (SW-bound)	March Road	0500FWIMB003
CMBDMGJG	Wimblington, nr Bridge Lane	March Road	0500FWIMB008
CMBDMGDT	Wimblington, nr Honeymead Road	March Road	0500FWIMB004
CMBDMGJA	Wimblington, nr Addison Road	March Road	0500FWIMB006
CMBDMGMA	Wimblington, nr Chapel Lane	Doddington Road	0500FWIMB013
-	Wimblington, Doddington Road Hail & Ride (S-bound)	Doddington Road	0500FWIMB014
CMBDMGDW	Wimblington, opp Rays Court	Doddington Road	0500FWIMB005
CMBDJPMP	Wimblington, nr Brickmaker's Arms Lane	Wimblington Road	0500FDODD004
-	Doddington, Wimblington Road Hail & Ride (W-bound)	Wimblington Road	0500FDODD021
CMBGMDJD	Doddington, nr Childs Lane	Wimblington Road	0500FDODD023
CMBDJPMJ	Doddington, nr Ingle's Lane	High Street	0500FDODD003
CMBDJPTM	Doddington, opp Thistledown	New Street	0500FDODD011
CMBDJPTJ	Doddington, nr Cook's Green	Newgate Street	0500FDODD010
CMBDJPTG	Doddington, opp 9 Primrose Hill	Primrose Hill	0500FDODD009
CMBDJPTP	Doddington, opp Primrose Cottage	Primrose Hill	0500FDODD012
CMBDJPTA	Doddington, o/s Howmoor Farm	Primrose Hill	0500FDODD007
CMBGMJWT	Chatteris, opp Forty Foot Bank	Doddington Road	0500FCHAT031
CMBDJPDJ	Chatteris, opp 15 Doddington Road	Doddington Road	0500FCHAT004
CMBDJPGA	Chatteris, nr Little Curf Drove	Doddington Road	0500FCHAT009
CMBDJPDM	Chatteris, opp Fenland Way	Bridge Street	0500FCHAT005
CMBGJAGD	Chatteris, nr Dock Road	Bridge Street	0500FCHAT024
CMBDJPAW	Chatteris, opp Ash Grove	High Street	0500FCHAT001
CMBDJPGM	Chatteris, opp King Edward Road	High Street	0500FCHAT012
CMBDJPGJ	Chatteris, East Park Street (SE-bound)	East Park Street	0500FCHAT011
CMBDJPGW	Chatteris, opp Cromwell Community College	Wenny Road	0500FCHAT015
CMBGMPDM	Mepal, opp Mepal Outdoor Centre	Iretons Way	0500EMEPA011
CMBGMPDA	Mepal, o/s Iretons Way	Iretons Way	0500EMEPA008
CMBDJDJA	Mepal, nr Brick Lane	Sutton Road	0500EMEPA004
CMBDJDGP	Mepal, opp Bridge Road	School Lane	0500EMEPA001
CMBDJDGW	Mepal, opp Brick Lane	Sutton Road	0500EMEPA003
CMBDJGMA	Sutton, opp Park Road	Ely Road	0500ESUTT001
CMBDJGPA	Sutton, nr Vermuyden Gardens	The Brook	0500ESUTT008
CMBDJGMW	Sutton, opp Brookside	The Brook	0500ESUTT007
CMBDJGMT	Sutton, nr The Brook	High Street	0500ESUTT006
CMBDJGMD	Sutton, opp Windmill Lane	High Street	0500ESUTT002
CMBDJGMG	Sutton, nr Park Road	Ely Road	0500ESUTT003
CMBDJGMP	Sutton, nr The Chestnuts	Ely Road	0500ESUTT005
CMBDJGWG	Witcham Toll, opp Haddenham Road	Ely Road	0500EWENT001
CMBDJGWM	Wentworth, opp Church Road	Sutton Road	0500EWENT003
CMBDJMJP	Witchford, opp New Road	Main Street	0500EWITD005
CMBDJMJG	Witchford, nr Granta Close	Main Street	0500EWITD003
CMBDJMJW	Witchford, nr Clover End	Main Street	0500EWITD007
CMBDJMPA	Witchford, nr Church View	Main Street	0500EWITD008
CMBDJMPD	Witchford, nr Bedwell Hey Lane	Main Street	0500EWITD009
CMBGMTAG	Ely, opp Stirling Way	Lancaster Way	0500EELYY125
CMBGJGAW	Ely, opp Lancaster Way Business Park	Witchford Road	0500EELYY087
CMBDGTDW	Ely, nr Norfolk Road	Witchford Road	0500EELYY060
CMBGMDMJ	Ely, opp Gateway Gardens	Witchford Road	0500EELYY109
CMBDGPDJ	Ely, nr Tower Road	Cambridge Road	0500EELYY007
CMBGMDJP	Ely, adj Mariott Drive	Cambridge Road	0500EELYY106
CMBDGPDT	Ely, nr W Fen Road	St Mary's Street	0500EELYY010
CMBGJTWG	Ely, o/s Community College	Downham Road	0500EELYY098
CMBDGPGT	Ely, nr Northwold	Downham Road	0500EELYY017
CMBDJAWG	Littleport, opp 5 Thoroughfare Way	Thoroughfare Way	0500ELITP043
CMBDJAGD	Littleport, nr Granby Street	Wellington Street	0500ELITP005
CMBDJAGA	Littleport, nr Church Lane	Wellington Street	0500ELITP004
CMBDJADW	Littleport, opp Brookside Grove	Wisbech Road	0500ELITP003
CMBDJADT	Littleport, opp Elm Side	Wisbech Road	0500ELITP002
CMBDJAMJ	Littleport, nr Queens Road	Gilbert Road	0500ELITP021
CMBDJAMA	Littleport, nr Atkins Close	Parson's Lane	0500ELITP018
CMBDJAJT	Littleport, nr Friar's Way	Parson's Lane	0500ELITP016
CMBGDWGD	Littleport, o/s Health Centre	Parson's Lane	0500ELITP051
CMBDJAJP	Littleport, nr Crown Lane	Church Lane	0500ELITP015
CMBDJAJD	Littleport, opp Upton Lane	High Street	0500ELITP012
CMBDJAGP	Littleport, nr Eastfields	Ely Road	0500ELITP008
CMBDJAGJ	Littleport, opp Grange Lane	Ely Road	0500ELITP006
CMBDJAJW	Littleport, opp Saffron Close	Ely Road	0500ELITP017

Continued on next page.

9/X9 Chatteris - Littleport - Ely - Waterbeach - Cambridge

Stagecoach in Cambridge

Continued from previous page.

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SMS Code	Stop Name	Street	ATCO Code
CMBDJAGT	Littleport, nr The Coppice	Ely Road	0500ELITP009
CMBDGPTD	Chettisham, opp The Hamlet	Lynn Road	0500EELYY034
CMBDGPGW	Ely, nr Morton Close	Davison Road	0500EELYY018
CMBDGPGP	Ely, o/s Hospital	Davison Road	0500EELYY016
CMBDGPJG	Ely, opp Lily House	Lynn Road	0500EELYY021
CMBDGPJW	Ely, nr King's Avenue	Lynn Road	0500EELYY025
CMBGMDGW	Ely, nr Bishop Laney Drive	King's Avenue	0500EELYY104
CMBGMDWJ	Ely, adj Goodwin Grove	King's Avenue	0500EELYY114
CMBDGPGA	Ely, o/s Spring Meadow Infants School	High Barns	0500EELYY012
CMBDGPTA	Ely, nr Larkfield Training Centre	High Barns	0500EELYY033
CMBDGPWG	Ely, nr Cemetery	New Barns Avenue	0500EELYY042
CMBDGTAT	Ely, opp 7 Beech Lane	Beech Lane	0500EELYY052
CMBGDWPM	Ely, nr Springhead Lane	Prickwillow Road	0500EELYY074
CMBDGTAP	Ely, Market Street (Stop B)	Market Street	0500EELYY051
CMBGDWTM	Ely, nr King's School	Back Hill	0500EELYY079
CMBDGPAM	Ely, o/s Tesco	Angel Drove	0500EELYY001
CMBGMJAT	Little Thetford, o/s Ely Road	Ely Road	0500ELITT003
CMBDJDAM	Little Thetford, nr The Wyches	Ely Road	0500ELITT001
CMBDJGJD	Stretham, nr Walnut Tree Close	Ely Road	0500ESTRE004
CMBDJGJM	Stretham, nr Chapel Street	High Street	0500ESTRE006
CMBDJGJT	Stretham, nr Short Road	Wilburton Road	0500ESTRE008
CMBDJGDW	Stretham, o/s 33 Cambridge Road	Cambridge Road	0500ESTRE002
CMBDJGJA	Stretham, opp Red Hill Farm Turn	Cambridge Road	0500ESTRE003
CMBGAWPW	Chittering, nr School Lane	Ely Road	0500SWATE002
CMBGAGJM	Landbeach, adj Research Park Entrance	Cambridge Research Park Entrance	0500SLAND014
CMBGAWTW	Waterbeach, opp Pembroke Avenue	Denny End Road	0500SWATE009
CMBGAWTM	Waterbeach, opp Winfold Road	Denny End Road	0500SWATE007
CMBGAWTA	Waterbeach, o/s Barracks	Denny End Road	0500SWATE003
CMBGDADA	Waterbeach, opp Fletcher Avenue	Capper Road	0500SWATE010
CMBGJGJT	Waterbeach, nr Kirby Terrace	Kirby Road	0500SWATE031
CMBGJGJW	Waterbeach, o/s Surgery	Cody Road	0500SWATE032
CMBGDAJD	Waterbeach, opp Cody Road	Bannold Road	0500SWATE025
CMBGDAGD	Waterbeach, opp Waddelow Road	High Street	0500SWATE018
CMBGDAGW	Waterbeach, opp Gibson Close	Greenside	0500SWATE023
CMBGDAJM	Waterbeach, nr Recreation Ground	Cambridge Road	0500SWATE027
CMBGAGJD	Waterbeach, Car Dyke Road (W-bound)	Car Dyke Road	0500SLAND012
CMBGAGJA	Landbeach, opp 137 Waterbeach Road	Waterbeach Road	0500SLAND011
CMBGAGDW	Landbeach, opp Manor House	Waterbeach Road	0500SLAND010
CMBGMJWP	Landbeach, nr Matthew Parker Close	Waterbeach Road	0500SLAND017
CMBGAGJP	Landbeach, opp Cockfen Lane	High Street	0500SLAND015
CMBGAGDA	Landbeach, nr Walnut Farm	High Street	0500SLAND004
CMBGAGAT	Landbeach, o/s 134 High Street	High Street	0500SLAND002
CMBGAMAM	Milton, nr College of West Anglia	Landbeach Road	0500SMILT002
CMBGAMDJ	Milton, nr Ely Road	High Street	0500SMILT008
CMBGAMAJ	Milton, opp Edmund Close	Cambridge Road	0500SMILT001
CMBGAMAP	Milton, nr Barnabas Court	Cambridge Road	0500SMILT003
CMBGAMDM	Milton, nr Winship Road	Cambridge Road	0500SMILT009
CMBGAGAP	Waterbeach, opp Caravan Park	Ely Road	0500SLAND001
CMBDAWTM	Cambridge, opp Science Park	Milton Road	0500CCITY345
CMBDAWDG	Chesterton, Milton Road (SW-bound)	Milton Road	0500CCITY307
CMBDAMAG	Chesterton, nr Kendal Way	Milton Road	0500CCITY152
CMBDAGAT	Chesterton, nr Fraser Road	Milton Road	0500CCITY056
CMBDGDGM	Chesterton, opp Downham's Lane	Milton Road	0500CCITY407
CMBDAGPM	Chesterton, nr Union Lane	Milton Road	0500CCITY083
CMBDAGAD	Chesterton, opp Ascham Road	Milton Road	0500CCITY051
CMBDGAWA	Chesterton, opp Westbrook Centre	Milton Road	0500CCITY390
CMBDAJDG	Cambridge, opp Jesus College	Victoria Avenue	0500CCITY109
CMBDAJDW	Cambridge, Drummer St Bus Station (Bay 6)	Drummer Street	0500CCITY114

Cambridgeshire County Council04/12/2017 0903

Appendix J – Car Parking Survey Data

traffic survey partners

Client: WSP

Project Number: TSP13457

Project Name: Station Car Park, Waterbeach

Survey Type: Parking Duration

Survey Date: 31 October 2017, Tuesday

Survey Time: Between 07:00 - 10:00 and 16:00 - 19:00

Station Road, Waterbeach

	OCCUPANCY																						
STREET	Beat @ 07:00	Beat @ 07:15	Beat @ 07:30	Beat @ 07:45	Beat @ 08:00	Beat @ 08:15	Beat @ 08:30	Beat @ 08:45	Beat @ 09:00	Beat @ 09:15	Beat @ 09:30	Beat @ 09:45	Beat @ 16:00	Beat @ 16:15	Beat @ 16:30	Beat @ 16:45	Beat @ 17:00	Beat @ 17:15	Beat @ 17:30	Beat @ 17:45	Beat @ 18:00	Beat @ 18:30	Beat @ 18:45
Station Road Car Park (73 spaces)	21	25	32	41	44	49	57	60	62	65	65	65	64	64	64	62	59	54	53	48	44	39	34
Total	21	25	32	41	44	49	57	60	62	65	65	65	64	64	64	62	59	54	53	48	44	39	34

	% OCCUPANCY																						
	Beat @ 07:00	Beat @ 07:15	Beat @ 07:30	Beat @ 07:45	Beat @ 08:00	Beat @ 08:15	Beat @ 08:30	Beat @ 08:45	Beat @ 09:00	Beat @ 09:15	Beat @ 09:30	Beat @ 09:45	Beat @ 16:00	Beat @ 16:15	Beat @ 16:30	Beat @ 16:45	Beat @ 17:00	Beat @ 17:15	Beat @ 17:30	Beat @ 17:45	Beat @ 18:00	Beat @ 18:30	Beat @ 18:45
Station Road Car Park (73 spaces)	29%	34%	44%	56%	60%	67%	78%	82%	85%	89%	89%	89%	88%	88%	88%	85%	81%	74%	73%	66%	60%	53%	47%

Station Road, Waterbeach

Station Road Car Park (73 spaces)

.	Duration												
Arrival Time	00:00:00	00:15:00	00:30:00	00:45:00	01:00:00	01:15:00	01:30:00	01:45:00	02:00:00	02:15:00	02:30:00	02:45:00	Total
07:00:00									1		1	19	21
07:15:00											4		4
07:30:00							1		1	5			7
07:45:00									9				9
08:00:00								3					3
08:15:00							5						5
08:30:00						8							8
08:45:00					3								3
09:00:00				2									2
09:15:00			5										5
09:45:00	2												2
16:00:00	1	1	4	4	5	1	8	5		6	5	24	64
16:15:00											1		1
16:30:00										1			1
16:45:00									2				2
17:00:00								1					1
17:45:00					3								3
18:00:00				1									1
18:30:00		1											1

traffic survey partners

Client: WSP

Project Number: TSP13457

Project Name: Station Road, Waterbeach

Survey Type: Parking Duration

Survey Date: 31 October 2017, Tuesday

Survey Time: Between 07:00 - 10:00 and 16:00 - 19:00

Station Road, Waterbeach

.	Waiting Restrictions																		
Row Labels	ACCESS/DROP KERB	BUS STOP	DOUBLE YELLOW	DOUBLE YELLOW/ACCESS	DOUBLE YELLOW/DROP KERB	DROP KERB/PEDESTRIAN CROSSING	DROPPED KERB	DROPPED KERB/WHITE LINE	DY/DK PEDESTRANISED	Lay By	Off Road Parking	PARKING BAY - ECHELON	PEDESTRIANISED DROPPED KERB	RESTRICTED CARRIAGE WAY	UNRESTRICTED BAY	UNRESTRICTED UNDESIRABLE	WHITE LINE	ZEBRA CROSSING	ZIG ZAG	Total
BURGES ROAD	27						6				4			28	65	17				147
CAMBRIDGE ROAD							14							0	35					49
CHAPEL STREET	4		13		3	0	1			7				1	1			1	4	35
CLAYHITHE ROAD	17		49	5			1							210						282
GREEN SIDE	2	1	17		6	0	14	4						7	62		1			114
LODE AVENUE	6		11		2		11	1							33					64
PAYTON WAY							14					3		2	53					72
PIECES TERRACE							9						0	2	14					25
ROSEMARY ROAD	3						31							2	62					98
ST ANDREWS HILL							2	0						2	30					34
STATION ROAD	6	2	81	5	11		2				2				27	20			2	158
WAY LANE							21							2	41					64
WHITHMORE WAY			6						0				0		1					7
Total	65	3	177	10	22	0	126	5	0	7	6	3	0	256	424	37	1	1	6	1149

Station Road, Waterbeach

STREET	REGULATION	OCCUPANCY Beat @ 07:00	Beat @ 07:15	Beat @ 07:30	Beat @ 07:45	Beat @ 08:00	Beat @ 08:15	Beat @ 08:30	Beat @ 08:45	Beat @ 09:00	Beat @ 09:15	Beat @ 09:30	Beat @ 09:45	Beat @ 16:00	Beat @ 16:15	Beat @ 16:30	Beat @ 16:45	Beat @ 17:00	Beat @ 17:15	Beat @ 17:30	Beat @ 17:45	Beat @ 18:00	Beat @ 18:15	Beat @ 18:30	Beat @ 18:45	No of Bays
CLAYHITHE ROAD	ACCESS/DROP KERB																									17
	DOUBLE YELLOW	1	1	2	2	3	3	3	3	4	4	4	5	6	6	6	6	6	6	6	6	6	7	4	3	49
	DROPPED KERB																									1
	RESTRICTED CARRIAGE WAY																									210
	DOUBLE YELLOW/ACCESS					1	1																			5
WHITHMORE WAY	UNRESTRICTED BAY																									1
	DOUBLE YELLOW																									6
	PEDESTRIANISED DROPPED KERB																									0
	DY/DK PEDESTRANISED																									0
STATION ROAD	UNRESTRICTED BAY	22	22	24	24	23	23	22	21	21	21	21	21	22	22	21	22	22	24	22	21	21	21	18	17	27
	DOUBLE YELLOW/DROP KERB																									11
	ACCESS/DROP KERB																									6
	DOUBLE YELLOW	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	81
	DROPPED KERB	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	DOUBLE YELLOW/ACCESS																									5
	UNRESTRICTED UNDESIRABLE																									20
	ZIG ZAG																									2
	BUS STOP																									2
	Off Road Parking	2	2	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	2	2				1	1	2
CHAPEL STREET	UNRESTRICTED BAY																									1
	DOUBLE YELLOW/DROP KERB																									3
	ACCESS/DROP KERB																									4
	DOUBLE YELLOW																									13
	DROPPED KERB																									1
	RESTRICTED CARRIAGE WAY																									1
	ZIG ZAG																									4
	ZEBRA CROSSING																									1
	DROP KERB/PEDESTRIAN CROSSING																									0
	Lay By	1	1	1	3	5	5	5	5	5	5	6	6	5	5	6	5	5	6	6	4	4	5	4	4	7
CAMBRIDGE ROAD	UNRESTRICTED BAY											2	2								1	1				35
	DROPPED KERB																									14
	RESTRICTED CARRIAGE WAY																									0
GREEN SIDE	UNRESTRICTED BAY	19	18	20	19	18	20	21	22	21	27	29	32	36	35	33	33	34	35	33	32	31	32	29	28	62
	DOUBLE YELLOW/DROP KERB										1	1								1				1		6
	ACCESS/DROP KERB																									2
	DOUBLE YELLOW													1	2	2	1	1	1	2	2	1	1	2	2	17
	DROPPED KERB													2	4	2	2	2	3	4	2	2	3	3	3	14
	RESTRICTED CARRIAGE WAY																									7
	DROP KERB/PEDESTRIAN CROSSING										1															0
	WHITE LINE																	1								1
	BUS STOP											1		2	1	2			1							1
	DROPPED KERB/WHITE LINE																			1	1	1	2	2	2	4
ST ANDREWS HILL	UNRESTRICTED BAY	7	7	7	7	7	7	7	7	7	10	10	9	8	9	9	10	10	10	10	9	8	8	8	7	30
	DROPPED KERB	3	3	3	3	3	1	1	3	3	3	3	3	1	1	3	3	3	3	3	3	2	2	2	2	2
	RESTRICTED CARRIAGE WAY											1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
	DROPPED KERB/WHITE LINE																									0
WAY LANE	UNRESTRICTED BAY	4	4	5	6	6	5	5	4	3	3	3	3	4	3	3	3	3	3	3	3	4	4	4	4	41
	DROPPED KERB	1	1	1	1	2	2	2	2	3	2	1	1	3	2	3	2	3	3	4	5	5	5	5	4	21
	RESTRICTED CARRIAGE WAY																									2
BURGES ROAD	UNRESTRICTED BAY	11	11	11	12	12	8	8	7	8	8	8	7	12	12	12	12	12	11	12	10	12	11	11	10	65
	ACCESS/DROP KERB												1													27
	DROPPED KERB																									6
	RESTRICTED CARRIAGE WAY																									28
	UNRESTRICTED UNDESIRABLE																									17
	Off Road Parking				1	1	1	1	1	1	1	1	1	2	2	2	1									4
PIECES TERRACE	UNRESTRICTED BAY	2	2	2	1	1	2	3	2	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	14
	DROPPED KERB																									9
	RESTRICTED CARRIAGE WAY																									2
	PEDESTRIANISED DROPPED KERB																									0
ROSEMARY ROAD	UNRESTRICTED BAY	14	14	16	14	14	13	15	14	16	16	17	15	15	15	16	14	14	15	13	11	8	9	11	11	62
	ACCESS/DROP KERB																									3
	DROPPED KERB	9	8	8	8	8	8	6	6	7	6	6	6	4	4	4	5	5	6	6	7	7	7	7	7	31
	RESTRICTED CARRIAGE WAY																									2
PAYTON WAY	UNRESTRICTED BAY	5	5	5	5	5	5	5	5	5	6	5	5	5	5	5	4	4	6	6	6	6	6	5	5	53
	DROPPED KERB	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
	RESTRICTED CARRIAGE WAY																									2
	PARKING BAY - ECHELON																									3
LODE AVENUE	UNRESTRICTED BAY	15	15	15	17	17	16	17	17	18	18	19	20	18	18	16	15	15	16	14	14	14	14	13	13	33
	DOUBLE YELLOW/DROP KERB																									2
	ACCESS/DROP KERB																									6
	DOUBLE YELLOW																									11
	DROPPED KERB	1	1	1	2	2	2	2	2	2	3	2	2	2	2	2	2	2	3	3	3	2	2	2	2	11
	DROPPED KERB/WHITE LINE							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total		123	121	129	133	136	130	132	129	135	145	150	150	160	159	158	151	153	163	160	149	144	148	141	134	

STREET	REGULATION	% OCCUPANCY Beat @ 07:00	Beat @ 07:15	Beat @ 07:30	Beat @ 07:45	Beat @ 08:00	Beat @ 08:15	Beat @ 08:30	Beat @ 08:45	Beat @ 09:00	Beat @ 09:15	Beat @ 09:30	Beat @ 09:45	Beat @ 16:00	Beat @ 16:15	Beat @ 16:30	Beat @ 16:45	Beat @ 17:00	Beat @ 17:15	Beat @ 17:30	Beat @ 17:45	Beat @ 18:00	Beat @ 18:15	Beat @ 18:30	Beat @ 18:45
CLAYHITHE ROAD	ACCESS/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DOUBLE YELLOW	2%	2%	4%	4%	6%	6%	6%	6%	8%	8%	8%	10%	12%	12%	12%	12%	12%	12%	12%	12%	12%	14%	8%	6%
	DROPPED KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DOUBLE YELLOW/ACCESS	0%	0%	0%	0%	20%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
WHITHMORE WAY	UNRESTRICTED BAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DOUBLE YELLOW	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	PEDESTRIANISED DROPPED KERB																								
	DY/DK PEDESTRANISED																								
STATION ROAD	UNRESTRICTED BAY	81%	81%	89%	89%	85%	85%	81%	78%	78%	78%	78%	78%	81%	81%	78%	81%	81%	89%	81%	78%	78%	78%	67%	63%
	DOUBLE YELLOW/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	ACCESS/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DOUBLE YELLOW	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	5%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	DROPPED KERB	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	DOUBLE YELLOW/ACCESS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	UNRESTRICTED UNDESIRABLE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	ZIG ZAG	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	BUS STOP	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Off Road Parking	100%	100%	100%	100%	100%	100%	100%	50%	50%	50%	50%	50%	100%	100%	100%	100%	100%	100%	100%	0%	0%	0%	50%	50%
CHAPEL STREET	UNRESTRICTED BAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DOUBLE YELLOW/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	ACCESS/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DOUBLE YELLOW	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DROPPED KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	ZIG ZAG	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	ZEBRA CROSSING	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DROP KERB/PEDESTRIAN CROSSING																								
	Lay By	14%	14%	14%	43%	71%	71%	71%	71%	71%	71%	86%	86%	71%	71%	86%	71%	71%	86%	86%	57%	57%	71%	57%	57%
CAMBRIDGE ROAD	UNRESTRICTED BAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	6%	0%	0%	0%	0%	0%	0%	0%	3%	3%	0%	0%	0%
	DROPPED KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	RESTRICTED CARRIAGE WAY																								
GREEN SIDE	UNRESTRICTED BAY	31%	29%	32%	31%	29%	32%	34%	35%	34%	44%	47%	52%	58%	56%	53%	53%	55%	56%	53%	52%	50%	52%	47%	45%
	DOUBLE YELLOW/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	17%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%	0%	17%	0%
	ACCESS/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DOUBLE YELLOW	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	12%	12%	6%	6%	6%	12%	12%	6%	6%	12%	12%
	DROPPED KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	14%	29%	14%	14%	14%	21%	29%	14%	14%	21%	21%	21%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DROP KERB/PEDESTRIAN CROSSING																								
	WHITE LINE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
	BUS STOP	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	200%	100%	200%	0%	0%	100%	0%	0%	0%	0%	0%	0%
	DROPPED KERB/WHITE LINE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	25%	25%	50%	50%	50%
ST ANDREWS HILL	UNRESTRICTED BAY	23%	23%	23%	23%	23%	23%	23%	23%	23%	33%	33%	30%	27%	30%	30%	33%	33%	33%	33%	30%	27%	27%	27%	23%
	DROPPED KERB	150%	150%	150%	150%	150%	50%	50%	150%	150%	150%	150%	150%	50%	50%	150%	150%	150%	150%	150%	150%	100%	100%	100%	100%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
	DROPPED KERB/WHITE LINE																								
WAY LANE	UNRESTRICTED BAY	10%	10%	12%	15%	15%	12%	12%	10%	7%	7%	7%	7%	10%	7%	7%	7%	7%	7%	7%	7%	10%	10%	10%	10%
	DROPPED KERB	5%	5%	5%	5%	10%	10%	10%	10%	14%	10%	5%	5%	14%	10%	14%	10%	14%	14%	19%	24%	24%	24%	24%	19%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
BURGES ROAD	UNRESTRICTED BAY	17%	17%	17%	18%	18%	12%	12%	11%	12%	12%	12%	11%	18%	18%	18%	18%	18%	17%	18%	15%	18%	17%	17%	15%
	ACCESS/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DROPPED KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	UNRESTRICTED UNDESIRABLE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Off Road Parking	0%	0%	0%	25%	25%	25%	25%	25%	25%	25%	25%	25%	50%	50%	50%	25%	0%	0%	0%	0%	0%	0%	0%	0%
PIECES TERRACE	UNRESTRICTED BAY	14%	14%	14%	7%	7%	14%	21%	14%	21%	14%	14%	14%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
	DROPPED KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	PEDESTRIANISED DROPPED KERB																								
ROSEMARY ROAD	UNRESTRICTED BAY	23%	23%	26%	23%	23%	21%	24%	23%	26%	26%	27%	24%	24%	24%	26%	23%	23%	24%	21%	18%	13%	15%	18%	18%
	ACCESS/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DROPPED KERB	29%	26%	26%	26%	26%	26%	19%	19%	23%	19%	19%	19%	13%	13%	13%	16%	16%	19%	19%	23%	23%	23%	23%	23%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAYTON WAY	UNRESTRICTED BAY	9%	9%	9%	9%	9%	9%	9%	9%	9%	11%	9%	9%	9%	9%	9%	8%	8%	11%	11%	11%	11%	11%	9%	9%
	DROPPED KERB	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
	RESTRICTED CARRIAGE WAY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	PARKING BAY - ECHELON	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
LODE AVENUE	UNRESTRICTED BAY	45%	45%	45%	52%	52%	48%	52%	52%	55%	55%	58%	61%	55%	55%	48%	45%	45%	48%	42%	42%	42%	42%	39%	39%
	DOUBLE YELLOW/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	ACCESS/DROP KERB	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DOUBLE YELLOW	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	DROPPED KERB	9%	9%	9%	18%	18%	18%	18%	18%	18%	27%	18%	18%	18%	18%	18%	18%	18%	27%	27%	27%	18%	18%	18%	18%
	DROPPED KERB/WHITE LINE	0%	0%	0%	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total																									

Station Road, Waterbeach

.		Duration												
STREET	REGULATION	00:00:00	00:15:00	00:30:00	00:45:00	01:00:00	01:15:00	01:30:00	01:45:00	02:00:00	02:15:00	02:30:00	02:45:00	Total
CLAYHITHE ROAD	DOUBLE YELLOW	1		1	1				1		4	1	3	12
	DOUBLE YELLOW/ACCESS		1											1
STATION ROAD	UNRESTRICTED BAY	1	4		2	2	6	3	1	1	7	1	28	56
	DOUBLE YELLOW	1											6	7
	DROPPED KERB												4	4
	Off Road Parking		1					3					1	5
CHAPEL STREET	Lay By	2	2	1	1		1	2	4	2			2	17
CAMBRIDGE ROAD	UNRESTRICTED BAY		3											3
GREEN SIDE	UNRESTRICTED BAY	38	11	18	7	4	6	5	2	9	4	1	23	128
	DOUBLE YELLOW/DROP KERB	2	1											3
	DOUBLE YELLOW	6											1	7
	DROPPED KERB	5		1									2	8
	DROP KERB/PEDESTRIAN CROSSING	1												1
	WHITE LINE	1												1
	BUS STOP	5	1											6
	DROPPED KERB/WHITE LINE			1			1							2
ST ANDREWS HILL	UNRESTRICTED BAY	1	2	3	1			1	2	2	1	3	8	24
	DROPPED KERB					4			1		2		1	8
	RESTRICTED CARRIAGE WAY		1										1	2
WAY LANE	UNRESTRICTED BAY	5	1	1	1	5		1			1		3	18
	DROPPED KERB	3			1		1		2		1		2	10
BURGES ROAD	UNRESTRICTED BAY	8	2	5	2	4		3	1		1	2	11	39
	ACCESS/DROP KERB	1												1
	Off Road Parking			1	1					1				3
PIECES TERRACE	UNRESTRICTED BAY	2		1				1					2	6
ROSEMARY ROAD	UNRESTRICTED BAY	7	2	9	1	2	2	2	4	2	1		16	48
	DROPPED KERB	4		1		2	2			2			9	20
PAYTON WAY	UNRESTRICTED BAY			2		1		1			1		8	13
	DROPPED KERB												2	2
LODE AVENUE	UNRESTRICTED BAY	2	3	2	2	2	4	1	1	3	1		23	44
	DROPPED KERB	2					2	1	2				1	8
	DROPPED KERB/WHITE LINE						1						1	2
Total		98	35	47	20	26	26	24	21	22	24	8	158	509

Appendix K – Traffic Survey Specification and Data

Tracsis plc
Traffic and Data Services

Junction Turning Count

Dashboard

3-Star Data (CSV Expo

Contact Us

Project Number	3790-TAD
Project Name	Waterbeach
Client	WSP
Sites	Sites 1 - 10
Survey Date	11/07/2017
Survey Time	07:00-19:00
Weather	Dry, cloudy AM, PM rain showers
Observations	

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 1 - Ely Road(NNW) / Denny End Road / Ely Road(SSE)

Origin Arm A Ely Road(NNW)

	Destination : Arm A Ely Road(NNW)						Total	Destination : Arm B Denny End Road						Total	Destination : Arm C Ely Road(SSE)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	0	0	0	0	0	0	0	61	10	2	1	0	2	76	169	47	13	8	2	2	241	317
07:15	0	0	0	0	0	0	0	56	12	2	0	0	0	70	171	32	9	9	5	1	227	297
07:30	0	0	0	0	0	0	0	80	8	4	0	0	1	93	168	17	13	10	0	2	210	303
07:45	0	0	0	0	0	0	0	62	13	2	1	0	0	78	162	24	5	8	0	2	201	279
1 Hr	0	0	0	0	0	0	0	259	43	10	2	0	3	317	670	120	40	35	7	7	879	1196
08:00	0	0	0	0	0	0	0	63	6	2	0	2	1	74	127	28	5	10	3	2	175	249
08:15	0	0	0	0	0	0	0	64	9	0	0	1	0	74	126	23	13	10	0	3	175	249
08:30	0	0	0	0	0	0	0	43	5	0	0	0	1	49	111	12	7	12	2	0	144	193
08:45	0	0	0	0	0	0	0	44	4	1	0	1	0	50	112	12	8	6	0	0	138	188
1 Hr	0	0	0	0	0	0	0	214	24	3	0	4	2	247	476	75	33	38	5	5	632	879
09:00	0	0	0	0	0	0	0	41	6	2	0	0	1	50	102	22	14	9	1	1	149	199
09:15	0	0	0	0	0	0	0	33	6	4	1	0	0	44	138	12	9	7	1	1	168	212
09:30	0	0	0	0	0	0	0	32	6	2	0	0	2	42	126	19	8	13	2	2	170	212
09:45	0	0	0	0	0	0	0	21	5	1	0	0	0	27	114	31	5	16	0	0	166	193
1 Hr	0	0	0	0	0	0	0	127	23	9	1	0	3	163	480	84	36	45	4	4	653	816
10:00	0	0	0	0	0	0	0	18	5	0	0	0	0	23	104	17	6	6	0	1	134	157
10:15	0	0	0	0	0	0	0	17	4	3	0	0	0	24	105	8	9	7	0	1	130	154
10:30	0	0	0	0	0	0	0	27	4	0	0	0	0	31	95	15	12	12	1	1	136	167
10:45	0	0	0	0	0	0	0	14	6	2	1	0	0	23	111	16	13	10	0	0	150	173
1 Hr	0	0	0	0	0	0	0	76	19	5	1	0	0	101	415	56	40	35	1	3	550	651
11:00	0	0	0	0	0	0	0	14	5	0	0	0	0	19	92	20	12	9	0	2	135	154
11:15	0	0	0	0	0	0	0	24	2	2	0	0	0	28	76	17	10	14	1	1	119	147
11:30	0	0	0	0	0	0	0	16	5	2	0	0	0	23	76	15	14	14	0	0	119	142
11:45	0	0	0	0	0	0	0	19	5	2	0	0	0	26	94	22	19	9	0	1	145	171
1 Hr	0	0	0	0	0	0	0	73	17	6	0	0	0	96	338	74	55	46	1	4	518	614
12:00	0	0	0	0	0	0	0	22	6	1	0	0	0	29	77	14	9	8	0	0	108	137
12:15	0	0	0	0	0	0	0	17	4	1	0	0	0	22	79	19	9	12	0	0	119	141
12:30	0	0	0	0	0	0	0	16	1	0	1	0	0	18	65	16	13	14	1	0	109	127
12:45	0	0	0	0	0	0	0	21	2	2	1	1	0	27	91	11	7	20	0	1	130	157
1 Hr	0	0	0	0	0	0	0	76	13	4	2	1	0	96	312	60	38	54	1	1	466	562
13:00	0	0	0	0	0	0	0	12	4	1	0	0	0	17	74	8	5	13	1	0	101	118
13:15	0	0	0	0	0	0	0	23	5	1	1	0	0	30	82	24	10	14	2	1	133	163
13:30	0	0	0	0	0	0	0	20	5	2	0	0	2	29	98	20	9	13	0	0	140	169
13:45	0	0	0	0	0	0	0	23	3	0	0	0	0	26	82	23	11	14	0	0	130	156
1 Hr	0	0	0	0	0	0	0	78	17	4	1	0	2	102	336	75	35	54	3	1	504	606
14:00	0	0	0	0	0	0	0	15	2	0	0	0	0	17	91	23	6	13	0	0	133	150
14:15	0	0	0	0	0	0	0	16	5	1	0	0	0	22	77	9	11	12	1	2	112	134
14:30	0	0	0	0	0	0	0	15	5	0	0	0	0	20	106	20	9	9	2	0	146	166
14:45	0	0	0	0	0	0	0	17	7	0	0	0	0	24	94	16	8	5	1	1	125	149
1 Hr	0	0	0	0	0	0	0	63	19	1	0	0	0	83	368	68	34	39	4	3	516	599
15:00	0	0	0	0	0	0	0	15	5	1	1	0	0	22	90	17	7	6	0	0	120	142
15:15	0	0	0	0	0	0	0	11	2	3	0	0	0	16	76	20	3	6	1	1	107	123
15:30	0	0	0	0	0	0	0	12	3	2	1	0	0	18	77	24	6	12	0	0	119	137
15:45	0	0	0	0	0	0	0	12	1	1	0	0	0	14	84	20	7	8	0	1	120	134
1 Hr	0	0	0	0	0	0	0	50	11	7	2	0	0	70	327	81	23	32	1	2	466	536
16:00	0	0	0	0	0	0	0	15	6	0	0	0	0	21	79	20	6	10	0	0	115	136
16:15	0	0	0	0	0	0	0	23	4	1	2	0	0	30	112	27	2	8	0	0	149	179
16:30	0	0	0	0	0	0	0	20	1	1	0	0	0	22	104	15	1	5	1	1	127	149
16:45	0	0	0	0	0	0	0	23	5	0	0	0	0	28	115	17	6	3	0	1	142	170
1 Hr	0	0	0	0	0	0	0	81	16	2	2	0	0	101	410	79	15	26	1	2	533	634
17:00	0	0	0	0	0	0	0	23	0	0	0	0	0	23	124	18	2	5	0	1	150	173
17:15	0	0	0	0	0	0	0	27	0	0	0	0	0	27	131	12	1	3	1	2	150	177
17:30	0	0	0	0	0	0	0	22	3	0	0	0	0	25	123	8	4	3	1	0	139	164
17:45	0	0	0	0	0	0	0	21	4	0	0	0	0	25	105	9	1	3	0	2	120	145
1 Hr	0	0	0	0	0	0	0	93	7	0	0	0	0	100	483	47	8	14	2	5	559	659
18:00	0	0	0	0	0	0	0	18	2	0	0	1	0	21	93	10	1	0	0	3	107	128
18:15	0	0	0	0	0	0	0	20	1	0	0	0	0	21	89	7	1	1	0	0	98	119
18:30	0	0	0	0	0	0	0	14	2	1	0	0	0	17	82	7	3	3	1	0	96	113
18:45	0	0	0	0	0	0	0	17	0	0	0	0	0	17	61	7	1	4	0	0	73	90
1 Hr	0	0	0	0	0	0	0	69	5	1	0	1	0	76	325	31	6	8	1	3	374	450
Total	0	0	0	0	0	0	0	1259	214	52	11	6	10	1552	4940	850	363	426	31	40	6650	8202

Origin Arm B Denny End Road

	Destination : Arm A Ely Road(NNW)						Total	Destination : Arm B Denny End Road						Total	Destination : Arm C Ely Road(SSE)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	9	8	1	0	0	0	18	0	0	0	0	0	0	0	20	6	1	1	0	0	28	46
07:15	7	3	0	0	0	0	10	0	0	0	0	0	0	0	21	2	0	0	0	0	23	33
07:30	25	6	1	0	0	0	32	0	0	0	0	0	0	0	22	3	0	0	0	1	26	58
07:45	21	6	1	0	0	0	28	0	0	0	0	0	0	0	19	5	0	0	0	0	24	52
1 Hr	62	23	3	0	0	0	88	0	0	0	0	0	0	0	82	16	1	1	0	1	101	189
08:00	26	2	1	2	0	0	31	0	0	0	0	0	0	0	17	5	1	0	0	0	23	54
08:15	28	4	0	0	0	0	32	0	0	0	0	0	0	0	16	4	1	0	0	0	21	53
08:30	35	7	2	0	0	0	44	0	0	0	0	0	0	0	12	3	1	0	0	1	17	61
08:45	25	4	1	1	1	0	32	0	0	0	0	0	0	0	20	3	1	0	0	0	24	56
1 Hr	114	17	4	3	1	0	139	0	0	0	0	0	0	0	65	15	4	0	0	1	85	224
09:00	16	2	1	0	1	0	20	0	0	0	0	0	0	0	16	3	4	2	0	0	25	45
09:15	13	3	1	1	0	0	18	0	0	0	0	0	0	0	15	2	3	2	0	0	22	40
09:30	16	6	0	0	0	0	22	0	0	0	0	0	0	0	20	7	3	1	0	0	31	53
09:45	7	1	3	0	1	0	12	0	0	0	0	0	0	0	18	2	0	3	0	0	23	35
1 Hr	52	12	5	1	2	0	72	0	0	0	0	0	0	0	69	14	10	8	0	0	101	173
10:00	19	4	0	0	0	0	23	0	0	0	0	0	0	0	18	6	1	1	0	0	26	49
10:15	13	6	2	0	0	0	21	0	0	0	0	0	0	0	17	6	4	0	0	0	27	48
10:30	18	5	3	0	0	0	26	0	0	0	0	0	0	0	11	3	2	1	0	0	17	43
10:45	15	3	0	0	0	0	18	0	0	0	0	0	0	0	10	7	1	1	0	1	20	38
1 Hr	65	18	5	0	0	0	88	0	0	0	0	0	0	0	56	22	8	3	0	1	90	178
11:00	17	4	1	0	0	0	22	0	0	0	0	0	0	0	10	4	2	0	0	0	16	38
11:15	22	5	4	0	0	0	31	0	0	0	0	0	0	0	13	3	0	1	0	0	17	48
11:30	17	3	2	1	0	0	23	0	0	0	0	0	0	0	9	5	1	2	0	0	17	40
11:45	18	2	3	0	0	0	23	0	0	0	0	0	0	0	11	5	2	4	0	0	22	45
1 Hr	74	14	10	1	0	0	99	0	0	0	0	0	0	0	43	17	5	7	0	0	72	171
12:00	23	2	2	0	0	0	27	0	0	0	0	0	0	0	28	3	3	1	0	0	35	62
12:15	20	5	0	0	0	0	25	0	0	0	0	0	0	0	14	6	3	1	0	0	24	49
12:30	22	4	1	0	0	0	27	0	0	0	0	0	0	0	19	1	1	0	0	0	21	48
12:45	14	7	3	0	1	0	25	0	0	0	0	0	0	0	15	2	2	1	0	0	20	45

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 1 - Ely Road(NNW) / Denny End Road / Ely Road(SSE)

1 Hr	79	18	6	0	1	0	104	0	0	0	0	0	0	0	76	12	9	3	0	0	100	204
13:00	24	4	4	0	0	0	32	0	0	0	0	0	0	0	21	2	3	2	0	0	28	60
13:15	18	5	3	0	0	0	26	0	0	0	0	0	0	0	18	7	0	1	0	0	26	52
13:30	27	9	0	0	0	1	37	0	0	0	0	0	0	0	19	7	1	0	0	0	27	64
13:45	23	4	1	1	1	0	30	0	0	0	0	0	0	0	12	6	1	1	0	0	20	50
1 Hr	92	22	8	1	1	1	125	0	0	0	0	0	0	0	70	22	5	4	0	0	101	226
14:00	25	7	2	0	0	0	34	0	0	0	0	0	0	0	10	4	2	1	0	0	17	51
14:15	28	5	3	0	0	1	37	0	0	0	0	0	0	0	16	5	1	1	0	0	23	60
14:30	28	9	0	0	0	0	37	0	0	0	0	0	0	0	18	3	3	2	0	0	26	63
14:45	18	6	6	0	0	0	30	0	0	0	0	0	0	0	15	4	2	1	0	0	22	52
1 Hr	99	27	11	0	0	1	138	0	0	0	0	0	0	0	59	16	8	5	0	0	88	226
15:00	18	6	0	1	0	0	25	0	0	0	0	0	0	0	27	6	6	1	0	0	40	65
15:15	24	8	1	0	0	0	33	0	0	0	0	0	0	0	17	8	3	1	0	0	29	62
15:30	26	8	2	0	1	0	37	0	0	0	0	0	0	0	18	9	0	0	1	0	28	65
15:45	39	11	6	0	0	1	57	0	0	0	0	0	0	0	17	2	1	1	0	1	22	79
1 Hr	107	33	9	1	1	1	152	0	0	0	0	0	0	0	79	25	10	3	1	1	119	271
16:00	66	11	1	3	0	1	82	0	0	0	0	0	0	0	33	3	1	1	0	1	39	121
16:15	47	6	1	0	0	0	54	0	0	0	0	0	0	0	26	5	1	0	0	1	33	87
16:30	78	13	1	0	0	1	93	0	0	0	0	0	0	0	48	0	0	0	0	0	48	141
16:45	59	5	1	3	0	1	69	0	0	0	0	0	0	0	37	2	2	1	0	1	43	112
1 Hr	250	35	4	6	0	3	298	0	0	0	0	0	0	0	144	10	4	2	0	3	163	461
17:00	63	4	0	0	0	0	67	0	0	0	0	0	0	0	57	5	0	0	0	0	62	129
17:15	36	5	0	0	0	0	41	0	0	0	0	0	0	0	44	5	1	0	0	0	50	91
17:30	59	3	0	0	0	0	62	0	0	0	0	0	0	0	46	3	1	1	0	1	52	114
17:45	50	4	2	0	2	0	58	0	0	0	0	0	0	0	26	2	0	0	0	0	28	86
1 Hr	208	16	2	0	2	0	228	0	0	0	0	0	0	0	173	15	2	1	0	1	192	420
18:00	57	4	0	0	0	0	61	0	0	0	0	0	0	0	34	1	1	0	0	0	36	97
18:15	39	3	0	0	0	0	42	0	0	0	0	0	0	0	19	1	0	0	1	0	21	63
18:30	31	3	0	0	0	0	34	0	0	0	0	0	0	0	20	3	0	0	0	0	23	57
18:45	27	4	1	0	0	1	33	0	0	0	0	0	0	0	13	2	1	1	1	0	18	51
1 Hr	154	14	1	0	0	1	170	0	0	0	0	0	0	0	86	7	2	1	2	0	98	268
Total	1356	249	68	13	8	7	1701	0	0	0	0	0	0	0	1002	191	68	38	3	8	1310	3011

Origin Arm C Ely Road(SSE)

	Destination : Arm A Ely Road(NNW)						Total	**Destination :** Arm B Denny End Road						Total	**Destination :** Arm C Ely Road(SSE)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	75	25	5	9	0	2	116	22	6	0	1	1	0	30	0	0	0	0	0	0	0	146
07:15	86	24	7	6	0	1	124	29	9	0	1	1	1	41	0	0	0	0	0	0	0	165
07:30	104	20	3	9	0	1	137	45	8	0	3	1	2	59	0	0	0	0	0	0	0	196
07:45	114	17	11	7	1	2	152	35	5	1	0	1	0	42	0	0	0	0	0	0	0	194
1 Hr	379	86	26	31	1	6	529	131	28	1	5	4	3	172	0	0	0	0	0	0	0	701
08:00	100	12	7	5	0	1	125	32	6	0	0	1	0	39	0	0	0	0	0	0	0	164
08:15	106	12	12	14	1	0	145	40	4	3	1	0	0	48	0	0	0	0	0	0	0	193
08:30	109	15	9	4	0	3	140	37	3	5	1	1	0	47	0	0	0	0	0	0	0	187
08:45	111	14	10	10	0	1	146	45	6	2	5	0	0	58	0	0	0	0	0	0	0	204
1 Hr	426	53	38	33	1	5	556	154	19	10	7	2	0	192	0	0	0	0	0	0	0	748
09:00	104	15	3	7	1	0	130	27	5	3	2	1	0	38	0	0	0	0	0	0	0	168
09:15	75	16	10	10	0	1	112	22	2	1	1	0	0	26	0	0	0	0	0	0	0	138
09:30	66	19	10	7	1	0	103	18	0	3	1	0	0	22	0	0	0	0	0	0	0	125
09:45	78	14	13	10	1	0	116	29	8	2	1	1	0	41	0	0	0	0	0	0	0	157
1 Hr	323	64	36	34	3	1	461	96	15	9	5	2	0	127	0	0	0	0	0	0	0	588
10:00	58	15	12	13	1	0	99	24	9	1	1	0	0	35	0	0	0	0	0	0	0	134
10:15	66	24	14	18	0	0	122	14	3	1	2	0	0	20	0	0	0	0	0	0	0	142
10:30	67	14	5	11	0	0	97	9	4	1	0	0	0	14	0	0	0	0	0	0	0	111
10:45	76	26	15	9	0	0	126	16	3	2	1	1	0	23	0	0	0	0	0	0	0	149
1 Hr	267	79	46	51	1	0	444	63	19	5	4	1	0	92	0	0	0	0	0	0	0	536
11:00	80	20	14	11	1	0	126	5	5	2	1	0	0	13	0	0	0	0	0	0	0	139
11:15	73	19	16	17	0	0	125	15	6	2	2	0	0	25	0	0	0	0	0	0	0	150
11:30	64	15	14	9	0	1	103	9	7	1	1	0	0	18	0	0	0	0	0	0	0	121
11:45	80	25	10	10	0	1	126	19	1	1	1	0	1	23	0	0	0	0	0	0	0	149
1 Hr	297	79	54	47	1	2	480	48	19	6	5	0	1	79	0	0	0	0	0	0	0	559
12:00	90	11	15	18	1	0	135	20	4	1	0	0	0	25	0	0	0	0	0	0	0	160
12:15	72	15	13	18	1	0	119	12	6	2	0	0	0	20	0	0	0	0	0	0	0	139
12:30	86	24	11	12	1	1	135	24	3	2	2	0	0	31	0	0	0	0	0	0	0	166
12:45	66	18	15	15	0	1	115	17	5	1	0	0	0	23	0	0	0	0	0	0	0	138
1 Hr	314	68	54	63	3	2	504	73	18	6	2	0	0	99	0	0	0	0	0	0	0	603
13:00	75	16	10	16	2	0	119	24	5	3	0	0	0	32	0	0	0	0	0	0	0	151
13:15	99	20	9	18	0	0	146	18	4	1	1	0	0	24	0	0	0	0	0	0	0	170
13:30	80	13	12	9	0	0	114	15	3	2	0	0	0	20	0	0	0	0	0	0	0	134
13:45	103	23	18	10	1	0	155	16	8	1	2	0	0	27	0	0	0	0	0	0	0	182
1 Hr	357	72	49	53	3	0	534	73	20	7	3	0	0	103	0	0	0	0	0	0	0	637
14:00	104	21	19	12	2	1	159	12	3	3	2	0	1	21	0	0	0	0	0	0	0	180
14:15	101	16	9	15	0	1	142	8	3	6	0	0	0	17	0	0	0	0	0	0	0	159
14:30	98	25	9	14	0	1	147	19	4	1	1	0	0	25	0	0	0	0	0	0	0	172
14:45	99	28	12	12	0	0	151	11	2	2	3	0	0	18	0	0	0	0	0	0	0	169
1 Hr	402	90	49	53	2	3	599	50	12	12	6	0	1	81	0	0	0	0	0	0	0	680
15:00	120	31	9	11	0	0	171	11	4	1	0	0	0	16	0	0	0	0	0	0	0	187
15:15	111	27	6	10	1	1	156	13	4	2	1	0	0	20	0	0	0	0	0	0	0	176
15:30	131	29	15	5	0	0	180	22	3	5	2	0	0	32	0	0	0	0	0	0	0	212
15:45	129	26	7	6	0	0	168	18	1	0	1	0	0	20	0	0	0	0	0	0	0	188
1 Hr	491	113	37	32	1	1	675	64	12	8	4	0	0	88	0	0	0	0	0	0	0	763
16:00	149	28	9	8	0	1	195	5	4	0	0	0	0	9	0	0	0	0	0	0	0	204
16:15	163	33	10	7	1	0	214	6	1	0	0	0	0	7	0	0	0	0	0	0	0	221
16:30	167	26	5	4	0	1	203	11	1	1	1	0	0	14	0	0	0	0	0	0	0	217
16:45	145	21	6	4	2	4	182	11	2	1	0	0	0	14	0	0	0	0	0	0	0	196
1 Hr	624	108	30	23	3	6	794	33	8	2	1	0	0	44	0	0	0	0	0	0	0	838
17:00	118	15	5	8	0	1	147	15	4	2	0	0	0	21	0	0	0	0	0	0	0	168
17:15	133	21	3	5	1	2	165	20	8	2	0	0	0	30	0	0	0	0	0	0	0	195
17:30	156	7	4	6	1	2	176	25	3	0	0	0	1	29	0	0	0	0	0	0	0	205
17:45	158	9	1	4	1	1	174	25	2	0	0	0	0	27	0	0	0	0	0	0	0	201
1 Hr	565	52	13	23	3	6	662	85	17	4	0	0	1	107	0	0	0	0	0	0	0	769
18:00	178	6	2	2	1	4	193	18	2	1	0	0	1	22	0	0	0	0	0	0	0	215
18:15	149	8	4	3	1	1	166	17	0	1	0	0	0	18	0	0	0	0	0	0	0	184
18:30	129	13	1	2	0	1	146	14	2	0	1	0	0	17	0	0	0	0	0	0	0	163
18:45	97	9	2	3	1	1	113	10	3	1	1	0	0	15	0	0	0	0	0	0	0	128
1 Hr	553	36	9	10	3	7	618	59	7	3	2	0	1	72	0	0	0	0	0	0	0	690
Total	4998	900	441	453	25	39	6856	929	194	73	44	9	7	1256	0	0	0	0	0	0	0	8112

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3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 1 - Ely Road(NNW) / Denny End Road / Ely Road(SSE)

ORIGIN SUMMARY

	Origin : Arm A Ely Road(NNW)						Total	Origin : Arm B Denny End Road						Total	Origin : Arm C Ely Road(SSE)						Total	Origin Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	230	57	15	9	2	4	317	29	14	2	1	0	0	46	97	31	5	10	1	2	146	509
07:15	227	44	11	9	5	1	297	28	5	0	0	0	0	33	115	33	7	7	1	2	165	495
07:30	248	25	17	10	0	3	303	47	9	1	0	0	1	58	149	28	3	12	1	3	196	557
07:45	224	37	7	9	0	2	279	40	11	1	0	0	0	52	149	22	12	7	2	2	194	525
1 Hr	929	163	50	37	7	10	1196	144	39	4	1	0	1	189	510	114	27	36	5	9	701	2086
08:00	190	34	7	10	5	3	249	43	7	2	2	0	0	54	132	18	7	5	1	1	164	467
08:15	190	32	13	10	1	3	249	44	8	1	0	0	0	53	146	16	15	15	1	0	193	495
08:30	154	17	7	12	2	1	193	47	10	3	0	0	1	61	146	18	14	5	1	3	187	441
08:45	156	16	9	6	1	0	188	45	7	2	1	1	0	56	156	20	12	15	0	1	204	448
1 Hr	690	99	36	38	9	7	879	179	32	8	3	1	1	224	580	72	48	40	3	5	748	1851
09:00	143	28	16	9	1	2	199	32	5	5	2	1	0	45	131	20	6	9	2	0	168	412
09:15	171	18	13	8	1	1	212	28	5	4	3	0	0	40	97	18	11	11	0	1	138	390
09:30	158	25	10	13	2	4	212	36	13	3	1	0	0	53	84	19	13	8	1	0	125	390
09:45	135	36	6	16	0	0	193	25	3	3	3	1	0	35	107	22	15	11	2	0	157	385
1 Hr	607	107	45	46	4	7	816	121	26	15	9	2	0	173	419	79	45	39	5	1	588	1577
10:00	122	22	6	6	0	1	157	37	10	1	1	0	0	49	82	24	13	14	1	0	134	340
10:15	122	12	12	7	0	1	154	30	12	6	0	0	0	48	80	27	15	20	0	0	142	344
10:30	122	19	12	12	1	1	167	29	8	5	1	0	0	43	76	18	6	11	0	0	111	321
10:45	125	22	15	11	0	0	173	25	10	1	1	0	1	38	92	29	17	10	1	0	149	360
1 Hr	491	75	45	36	1	3	651	121	40	13	3	0	1	178	330	98	51	55	2	0	536	1365
11:00	106	25	12	9	0	2	154	27	8	3	0	0	0	38	85	25	16	12	1	0	139	331
11:15	100	19	12	14	1	1	147	35	8	4	1	0	0	48	88	25	18	19	0	0	150	345
11:30	92	20	16	14	0	0	142	26	8	3	3	0	0	40	73	22	15	10	0	1	121	303
11:45	113	27	21	9	0	1	171	29	7	5	4	0	0	45	99	26	11	11	0	2	149	365
1 Hr	411	91	61	46	1	4	614	117	31	15	8	0	0	171	345	98	60	52	1	3	559	1344
12:00	99	20	10	8	0	0	137	51	5	5	1	0	0	62	110	15	16	18	1	0	160	359
12:15	96	23	10	12	0	0	141	34	11	3	1	0	0	49	84	21	15	18	1	0	139	329
12:30	81	17	13	15	1	0	127	41	5	2	0	0	0	48	110	27	13	14	1	1	166	341
12:45	112	13	9	21	1	1	157	29	9	5	1	1	0	45	83	23	16	15	0	1	138	340
1 Hr	388	73	42	56	2	1	562	155	30	15	3	1	0	204	387	86	60	65	3	2	603	1369
13:00	86	12	6	13	1	0	118	45	6	7	2	0	0	60	99	21	13	16	2	0	151	329
13:15	105	29	11	15	2	1	163	36	12	3	1	0	0	52	117	24	10	19	0	0	170	385
13:30	118	25	11	13	0	2	169	46	16	1	0	0	1	64	95	16	14	9	0	0	134	367
13:45	105	26	11	14	0	0	156	35	10	2	2	1	0	50	119	31	19	12	1	0	182	388
1 Hr	414	92	39	55	3	3	606	162	44	13	5	1	1	226	430	92	56	56	3	0	637	1469
14:00	106	25	6	13	0	0	150	35	11	4	1	0	0	51	116	24	22	14	2	2	180	381
14:15	93	14	12	12	1	2	134	44	10	4	1	0	1	60	109	19	15	15	0	1	159	353
14:30	121	25	9	9	2	0	166	46	12	3	2	0	0	63	117	29	10	15	0	1	172	401
14:45	111	23	8	5	1	1	149	33	10	8	1	0	0	52	110	30	14	15	0	0	169	370
1 Hr	431	87	35	39	4	3	599	158	43	19	5	0	1	226	452	102	61	59	2	4	680	1505
15:00	105	22	8	7	0	0	142	45	12	6	2	0	0	65	131	35	10	11	0	0	187	394
15:15	87	22	6	6	1	1	123	41	16	4	1	0	0	62	124	31	8	11	1	1	176	361
15:30	89	27	8	13	0	0	137	44	17	2	0	2	0	65	153	32	20	7	0	0	212	414
15:45	96	21	8	8	0	1	134	56	13	7	1	0	2	79	147	27	7	7	0	0	188	401
1 Hr	377	92	30	34	1	2	536	186	58	19	4	2	2	271	555	125	45	36	1	1	763	1570
16:00	94	26	6	10	0	0	136	99	14	2	4	0	2	121	154	32	9	8	0	1	204	461
16:15	135	31	3	10	0	0	179	73	11	2	0	0	1	87	169	34	10	7	1	0	221	487
16:30	124	16	2	5	1	1	149	126	13	1	0	0	1	141	178	27	6	5	0	1	217	507
16:45	138	22	6	3	0	1	170	96	7	3	4	0	2	112	156	23	7	4	2	4	196	478
1 Hr	491	95	17	28	1	2	634	394	45	8	8	0	6	461	657	116	32	24	3	6	838	1933
17:00	147	18	2	5	0	1	173	120	9	0	0	0	0	129	133	19	7	8	0	1	168	470
17:15	158	12	1	3	1	2	177	80	10	1	0	0	0	91	153	29	5	5	1	2	195	463
17:30	145	11	4	3	1	0	164	105	6	1	1	0	1	114	181	10	4	6	1	3	205	483
17:45	126	13	1	3	0	2	145	76	6	2	0	2	0	86	183	11	1	4	1	1	201	432
1 Hr	576	54	8	14	2	5	659	381	31	4	1	2	1	420	650	69	17	23	3	7	769	1848
18:00	111	12	1	0	1	3	128	91	5	1	0	0	0	97	196	8	3	2	1	5	215	440
18:15	109	8	1	1	0	0	119	58	4	0	0	1	0	63	166	8	5	3	1	1	184	366
18:30	96	9	4	3	1	0	113	51	6	0	0	0	0	57	143	15	1	3	0	1	163	333
18:45	78	7	1	4	0	0	90	40	6	2	1	1	1	51	107	12	3	4	1	1	128	269
1 Hr	394	36	7	8	2	3	450	240	21	3	1	2	1	268	612	43	12	12	3	8	690	1408
Total	6199	1064	415	437	37	50	8202	2358	440	136	51	11	15	3011	5927	1094	514	497	34	46	8112	19325

DESTINATION SUMMARY

	Destination : Arm A Ely Road(NNW)						Total	Destination : Arm B Denny End Road						Total	Destination : Arm C Ely Road(SSE)						Total	Dest Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	84	33	6	9	0	2	134	83	16	2	2	1	2	106	189	53	14	9	2	2	269	509
07:15	93	27	7	6	0	1	134	85	21	2	1	1	1	111	192	34	9	9	5	1	250	495
07:30	129	26	4	9	0	1	169	125	16	4	3	1	3	152	190	20	13	10	0	3	236	557
07:45	135	23	12	7	1	2	180	97	18	3	1	1	0	120	181	29	5	8	0	2	225	525
1 Hr	441	109	29	31	1	6	617	390	71	11	7	4	6	489	752	136	41	36	7	8	980	2086
08:00	126	14	8	7	0	1	156	95	12	2	0	3	1	113	144	33	6	10	3	2	198	467
08:15	134	16	12	14	1	0	177	104	13	3	1	1	0	122	142	27	14	10	0	3	196	495
08:30	144	22	11	4	0	3	184	80	8	5	1	1	1	96	123	15	8	12	2	1	161	441
08:45	136	18	11	11	1	1	178	89	10	3	5	1	0	108	132	15	9	6	0	0	162	448
1 Hr	540	70	42	36	2	5	695	368	43	13	7	6	2	439	541	90	37	38	5	6	717	1851
09:00	120	17	4	7	2	0	150	68	11	5	2	1	1	88	118	25	18	11	1	1	174	412
09:15	88	19	11	11	0	1	130	55	8	5	2	0	0	70	153	14	12	9	1	1	190	390
09:30	82	25	10	7	1	0	125	50	6	5	1	0	2	64	146	26	11	14	2	2	201	390
09:45	85	15	16	10	2	0	128	50	13	3	1	1	0	68	132	33	5	19	0	0	189	385
1 Hr	375	76	41	35	5	1	533	223	38	18	6	2	3	290	549	98	46	53	4	4	754	1577
10:00	77	19	12	13	1	0	122	42	14	1	1	0	0	58	122	23	7	7	0	1	160	340
10:15	79	30	16	18	0	0	143	31	7	4	2	0	0	44	122	14	13	7	0	1	157	344
10:30	85	19	8	11	0	0	123	36	8	1	0	0	0	45	106	18	14	13	1	1	153	321
10:45	91	29	15	9	0	0	144	30	9	4	2	1	0	46	121	23	14	11	0	1	170	360
1 Hr	332	97	51	51	1	0	532	139	38	10	5	1	0	193	471	78	48	38	1	4	640	1365
11:00	97	24	15	11	1	0	148	19	10	2	1	0	0	32	102	24	14	9	0	2	151	331
11:15	95	24	20	17	0	0	156	39	8	4	2	0	0	53	89	20	10	15	1	1	136	345
11:30	81	18	16	10	0	1	126	25	12	3	1	0	0	41	85	20	15	16	0	0	136	303
11:45	98	27	13	10	0	1	149	38	6	3	1	0	1	49	105	27	21	13	0	1	167	365
1 Hr	371	93	64	48	1	2	579	121	36	12	5	0	1	175	381	91	60	53	1	4	590	1344
12:00	113	13	17	18	1	0	162	42	10	2	0	0	0	54	105	17	12	9	0	0	143	359
12:15	92	20	13	18	1	0	144	29	10	3	0	0	0	42	93	25	12	13	0	0	143	329
12:30	108	28	12	12	1	1	162	40	4	2	3	0	0	49	84	17	14	14	1	0	130	341

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3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 1 - Ely Road(NNW) / Denny End Road / Ely Road(SSE)

12:45	80	25	18	15	1	1	140	38	7	3	1	1	0	50	106	13	9	21	0	1	150	340
1 Hr	393	86	60	63	4	2	608	149	31	10	4	1	0	195	388	72	47	57	1	1	566	1369
13:00	99	20	14	16	2	0	151	36	9	4	0	0	0	49	95	10	8	15	1	0	129	329
13:15	117	25	12	18	0	0	172	41	9	2	2	0	0	54	100	31	10	15	2	1	159	385
13:30	107	22	12	9	0	1	151	35	8	4	0	0	2	49	117	27	10	13	0	0	167	367
13:45	126	27	19	11	2	0	185	39	11	1	2	0	0	53	94	29	12	15	0	0	150	388
1 Hr	449	94	57	54	4	1	659	151	37	11	4	0	2	205	406	97	40	58	3	1	605	1469
14:00	129	28	21	12	2	1	193	27	5	3	2	0	1	38	101	27	8	14	0	0	150	381
14:15	129	21	12	15	0	2	179	24	8	7	0	0	0	39	93	14	12	13	1	2	135	353
14:30	126	34	9	14	0	1	184	34	9	1	1	0	0	45	124	23	12	11	2	0	172	401
14:45	117	34	18	12	0	0	181	28	9	2	3	0	0	42	109	20	10	6	1	1	147	370
1 Hr	501	117	60	53	2	4	737	113	31	13	6	0	1	164	427	84	42	44	4	3	604	1505
15:00	138	37	9	12	0	0	196	26	9	2	1	0	0	38	117	23	13	7	0	0	160	394
15:15	135	35	7	10	1	1	189	24	6	5	1	0	0	36	93	28	6	7	1	1	136	361
15:30	157	37	17	5	1	0	217	34	6	7	3	0	0	50	95	33	6	12	1	0	147	414
15:45	168	37	13	6	0	1	225	30	2	1	1	0	0	34	101	22	8	9	0	2	142	401
1 Hr	598	146	46	33	2	2	827	114	23	15	6	0	0	158	406	106	33	35	2	3	585	1570
16:00	215	39	10	11	0	2	277	20	10	0	0	0	0	30	112	23	7	11	0	1	154	461
16:15	210	39	11	7	1	0	268	29	5	1	2	0	0	37	138	32	3	8	0	1	182	487
16:30	245	39	6	4	0	2	296	31	2	2	1	0	0	36	152	15	1	5	1	1	175	507
16:45	204	26	7	7	2	5	251	34	7	1	0	0	0	42	152	19	8	4	0	2	185	478
1 Hr	874	143	34	29	3	9	1092	114	24	4	3	0	0	145	554	89	19	28	1	5	696	1933
17:00	181	19	5	8	0	1	214	38	4	2	0	0	0	44	181	23	2	5	0	1	212	470
17:15	169	26	3	5	1	2	206	47	8	2	0	0	0	57	175	17	2	3	1	2	200	463
17:30	215	10	4	6	1	2	238	47	6	0	0	0	1	54	169	11	5	4	1	1	191	483
17:45	208	13	3	4	3	1	232	46	6	0	0	0	0	52	131	11	1	3	0	2	148	432
1 Hr	773	68	15	23	5	6	890	178	24	4	0	0	1	207	656	62	10	15	2	6	751	1848
18:00	235	10	2	2	1	4	254	36	4	1	0	1	1	43	127	11	2	0	0	3	143	440
18:15	188	11	4	3	1	1	208	37	1	1	0	0	0	39	108	8	1	1	1	0	119	366
18:30	160	16	1	2	0	1	180	28	4	1	1	0	0	34	102	10	3	3	1	0	119	333
18:45	124	13	3	3	1	2	146	27	3	1	1	0	0	32	74	9	2	5	1	0	91	269
1 Hr	707	50	10	10	3	8	788	128	12	4	2	1	1	148	411	38	8	9	3	3	472	1408
Total	6354	1149	509	466	33	46	8557	2188	408	125	55	15	17	2808	5942	1041	431	464	34	48	7960	19325

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017
Site 2 - Ely Road(NNE) / Ely Road(SSW) / Waterbeach Road

Origin Arm A Ely Road(NNE)

	Destination : Arm A Ely Road(NNE)							Destination : Arm B Ely Road(SSW)							Destination : Arm C Waterbeach Road							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Arm Totals
07:00	0	0	0	0	0	0	0	179	55	13	8	2	1	258	0	1	0	0	0	0	1	259
07:15	0	0	0	0	0	0	0	187	37	7	10	5	2	248	1	0	0	0	0	0	1	249
07:30	0	0	0	0	0	0	0	197	19	15	10	0	3	244	1	1	0	0	0	0	2	246
07:45	0	0	0	0	0	0	0	179	27	4	7	0	2	219	0	0	0	0	0	0	0	219
1 Hr	0	0	0	0	0	0	0	742	138	39	35	7	8	969	2	2	0	0	0	0	4	973
08:00	0	0	0	0	0	0	0	135	35	8	8	2	2	190	2	0	0	0	0	0	2	192
08:15	0	0	0	0	0	0	0	159	24	11	13	1	2	210	0	1	0	0	0	0	1	211
08:30	0	0	0	0	0	0	0	120	17	9	8	0	2	156	1	1	0	0	0	0	2	158
08:45	0	0	0	0	0	0	0	135	16	10	11	2	0	174	1	0	0	0	0	0	1	175
1 Hr	0	0	0	0	0	0	0	549	92	38	40	5	6	730	4	2	0	0	0	0	6	736
09:00	0	0	0	0	0	0	0	121	25	19	11	1	1	178	1	0	0	0	0	0	1	179
09:15	0	0	0	0	0	0	0	148	15	10	9	1	1	184	0	0	0	0	0	0	0	184
09:30	0	0	0	0	0	0	0	135	23	11	13	2	3	187	3	0	1	0	0	0	4	191
09:45	0	0	0	0	0	0	0	137	36	7	17	0	0	197	1	0	0	0	0	0	1	198
1 Hr	0	0	0	0	0	0	0	541	99	47	50	4	5	746	5	0	1	0	0	0	6	752
10:00	0	0	0	0	0	0	0	120	22	7	7	0	1	157	2	2	0	0	0	0	4	161
10:15	0	0	0	0	0	0	0	122	16	12	8	0	1	159	3	1	0	0	0	0	4	163
10:30	0	0	0	0	0	0	0	103	17	14	13	1	1	149	3	1	0	0	0	0	4	153
10:45	0	0	0	0	0	0	0	126	25	10	10	0	0	171	1	0	0	0	0	0	1	172
1 Hr	0	0	0	0	0	0	0	471	80	43	38	1	3	636	9	4	0	0	0	0	13	649
11:00	0	0	0	0	0	0	0	96	18	15	10	0	3	142	1	0	0	0	0	0	1	143
11:15	0	0	0	0	0	0	0	98	18	10	16	1	1	144	1	0	0	0	0	0	1	145
11:30	0	0	0	0	0	0	0	77	20	13	14	0	0	124	3	1	0	0	0	0	4	128
11:45	0	0	0	0	0	0	0	110	23	25	13	0	1	172	1	0	0	0	0	0	1	173
1 Hr	0	0	0	0	0	0	0	381	79	63	53	1	5	582	6	1	0	0	0	0	7	589
12:00	0	0	0	0	0	0	0	102	19	12	11	0	0	144	4	0	0	0	0	0	4	148
12:15	0	0	0	0	0	0	0	88	24	13	11	0	0	136	2	0	0	0	0	0	2	138
12:30	1	0	0	0	0	0	1	82	19	13	14	1	0	129	1	0	0	0	0	0	1	131
12:45	0	0	0	0	0	0	0	111	15	8	21	0	0	155	1	0	0	0	0	0	1	156
1 Hr	1	0	0	0	0	0	1	383	77	46	57	1	0	564	8	0	0	0	0	0	8	573
13:00	0	0	0	0	0	0	0	93	8	6	16	1	0	124	2	0	0	0	0	0	2	126
13:15	0	0	0	0	0	0	0	95	27	16	13	2	1	154	4	1	0	0	0	0	5	159
13:30	0	0	0	0	0	0	0	114	30	8	16	0	0	168	0	1	0	0	0	0	1	169
13:45	0	0	0	0	0	0	0	105	31	10	13	0	0	159	3	0	0	0	0	0	3	162
1 Hr	0	0	0	0	0	0	0	407	96	40	58	3	1	605	9	2	0	0	0	0	11	616
14:00	0	0	0	0	0	0	0	100	26	8	15	0	0	149	1	0	0	0	0	0	1	150
14:15	0	0	0	0	0	0	0	89	16	11	11	1	2	130	1	0	1	0	0	0	2	132
14:30	0	0	0	0	0	0	0	122	20	10	13	2	0	167	0	2	2	0	0	0	4	171
14:45	0	0	0	0	0	0	0	111	12	9	6	1	1	140	1	0	0	0	0	0	1	141
1 Hr	0	0	0	0	0	0	0	422	74	38	45	4	3	586	3	2	3	0	0	0	8	594
15:00	0	0	0	0	0	0	0	114	28	15	6	0	0	163	3	0	0	0	0	0	3	166
15:15	0	0	0	0	0	0	0	92	27	6	8	1	2	136	1	2	0	0	0	0	3	139
15:30	0	0	0	0	0	0	0	87	31	5	12	1	0	136	3	0	0	0	0	0	3	139
15:45	0	0	0	0	0	0	0	101	23	6	7	0	1	138	3	2	1	0	0	0	6	144
1 Hr	0	0	0	0	0	0	0	394	109	32	33	2	3	573	10	4	1	0	0	0	15	588
16:00	0	0	0	0	0	0	0	122	24	9	10	0	1	166	1	2	0	0	0	1	4	170
16:15	0	0	0	0	0	0	0	127	32	3	8	0	2	172	4	1	0	0	0	0	5	177
16:30	0	0	0	0	0	0	0	156	19	2	6	1	1	185	8	0	0	0	0	0	8	193
16:45	0	0	0	0	0	0	0	149	18	7	3	0	2	179	10	0	0	0	0	0	10	189
1 Hr	0	0	0	0	0	0	0	554	93	21	27	1	6	702	23	3	0	0	0	1	27	729
17:00	0	0	0	0	0	0	0	178	21	3	6	0	1	209	8	0	0	0	0	0	8	217
17:15	0	0	0	0	0	0	0	163	18	2	3	1	2	189	11	0	0	0	0	0	11	200
17:30	1	0	0	0	0	0	1	168	9	5	4	1	1	188	10	2	0	0	0	0	12	201
17:45	0	0	0	0	0	0	0	131	9	1	2	0	2	145	5	2	0	0	0	0	7	152
1 Hr	1	0	0	0	0	0	1	640	57	11	15	2	6	731	34	4	0	0	0	0	38	770
18:00	0	0	0	0	0	0	0	112	9	2	1	0	3	127	7	2	0	0	0	0	9	136
18:15	0	0	0	0	0	0	0	115	8	1	1	0	0	125	4	1	0	0	0	0	5	130
18:30	0	0	0	0	0	0	0	94	9	3	3	2	0	111	1	2	0	0	0	0	3	114
18:45	0	0	0	0	0	0	0	78	8	1	3	1	0	91	2	0	0	0	0	0	2	93
1 Hr	0	0	0	0	0	0	0	399	34	7	8	3	3	454	14	5	0	0	0	0	19	473
Total	2	0	0	0	0	0	2	5883	1028	425	459	34	49	7878	127	29	5	0	0	1	162	8042

Origin Arm B Ely Road(SSW)

	Destination : Arm A Ely Road(NNE)							Destination : Arm B Ely Road(SSW)							Destination : Arm C Waterbeach Road							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Arm Totals
07:00	81	28	5	9	1	2	126	0	0	0	0	0	0	0	5	0	0	0	1	0	6	132
07:15	114	33	8	9	1	3	168	0	0	0	0	0	0	0	4	1	0	0	1	0	6	174
07:30	130	26	4	10	1	4	175	0	0	0	0	0	0	0	2	1	0	0	0	0	3	178
07:45	142	22	12	6	2	2	186	0	0	0	0	0	0	0	8	1	0	0	0	1	10	196
1 Hr	467	109	29	34	5	11	655	0	0	0	0	0	0	0	19	3	0	0	2	1	25	680
08:00	122	16	7	6	2	1	154	0	0	0	0	0	0	0	9	2	1	0	2	0	14	168
08:15	148	16	17	14	0	0	195	0	0	0	0	0	0	0	5	0	0	0	3	0	8	203
08:30	136	20	13	5	0	3	177	0	0	0	0	0	0	0	13	0	0	0	0	0	13	190
08:45	140	20	12	14	0	1	187	0	0	0	0	0	0	0	5	2	0	0	1	0	8	195
1 Hr	546	72	49	39	2	5	713	0	0	0	0	0	0	0	32	4	1	0	6	0	43	756
09:00	122	17	6	10	2	0	157	0	0	0	0	0	0	0	6	0	1	0	0	1	8	165
09:15	89	19	8	11	0	1	128	0	0	0	0	0	0	0	7	2	1	0	0	0	10	138
09:30	92	19	13	7	3	0	134	0	0	0	0	0	0	0	5	0	0	0	0	0	5	139
09:45	100	22	16	11	0	0	149	0	0	0	0	0	0	0	5	1	0	0	1	0	7	156
1 Hr	403	77	43	39	5	1	568	0	0	0	0	0	0	0	23	3	2	0	1	1	30	598
10:00	85	20	12	15	1	0	133	0	0	0	0	0	0	0	4	1	2	0	0	0	7	140
10:15	70	28	14	19	0	0	131	0	0	0	0	0	0	0	7	3	0	0	0	0	10	141
10:30	78	19	6	11	0	0	114	0	0	0	0	0	0	0	5	1	1	0	0	0	7	121
10:45	91	30	17	9	1	0	148	0	0	0	0	0	0	0	9	3	1	0	1	0	14	162
1 Hr	324	97	49	54	2	0	526	0	0	0	0	0	0	0	25	8	4	0	1	0	38	564
11:00	84	26	16	12	1	0	139	0	0	0	0	0	0	0	2	2	0	0	0	0	4	143
11:15	86	26	17	19	0	0	148	0	0	0	0	0	0	0	7	2	0	0	0	0	9	157
11:30	70	21	14	10	0	1	116	0	0	0	0	0	0	0	3	1	0	0	0	0	4	120
11:45	101	24	13	11	0	2	151	0	0	0	0	0	0	0	7	0	0	0	1	0	8	159
1 Hr	341	97	60	52	1	3	554	0	0	0	0	0	0	0	19	5	0	0	1	0	25	579
12:00	105	17	14	19	1	0	156	0	0	0	0	0	0	0	7	0	0	0	0	0	7	163
12:15	84	23	16	18	1	1	143	0	0	0	0	0	0	0	3	0	1	0	0	0	4	147
12:30	110	27	15	14	1	1	168	0	0	0	0	0	0	0	7	0	1	0	0	0	8	176
12:45	84	20	15	14	0	1	134	0	0	0	0	0	0	0	11	3	0	0	1	0	15	149
1 Hr	383	87	60	65	3	3	601	0	0	0	0	0	0	0	28	3	2	0	1	0	34	635
13:00	96	21	15	13	2	0	147	0	0	0	0	0	0	0	5	2	0	0	0	0	7	154

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Traffic and Data Services

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3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 2 - Ely Road(NNE) / Ely Road(SSW) / Waterbeach Road

13:15	108	17	10	19	0	0	154	0	0	0	0	0	0	0	2	0	0	0	0	0	2	156
13:30	98	18	14	11	0	0	141	0	0	0	0	0	0	0	4	1	0	0	0	0	5	146
13:45	117	33	19	10	2	0	181	0	0	0	0	0	0	0	8	0	0	0	1	0	9	190
1 Hr	419	89	58	53	4	0	623	0	0	0	0	0	0	0	19	3	0	0	1	0	23	646
14:00	121	22	25	14	1	2	185	0	0	0	0	0	0	0	11	5	1	0	0	0	17	202
14:15	105	18	13	15	0	1	152	0	0	0	0	0	0	0	5	1	1	0	0	0	7	159
14:30	111	29	11	15	0	1	167	0	0	0	0	0	0	0	1	2	0	0	0	0	3	170
14:45	117	32	14	15	0	0	178	0	0	0	0	0	0	0	8	0	0	0	1	1	10	188
1 Hr	454	101	63	59	1	4	682	0	0	0	0	0	0	0	25	8	2	0	1	1	37	719
15:00	137	34	10	11	1	0	193	0	0	0	0	0	0	0	7	0	0	0	0	0	7	200
15:15	128	30	12	10	0	1	181	0	0	0	0	0	0	0	4	2	0	0	0	0	6	187
15:30	138	30	16	6	0	0	190	0	0	0	0	0	0	0	6	3	0	0	1	0	10	200
15:45	144	29	7	8	0	0	188	0	0	0	0	0	0	0	14	6	0	0	0	0	20	208
1 Hr	547	123	45	35	1	1	752	0	0	0	0	0	0	0	31	11	0	0	1	0	43	795
16:00	177	35	8	10	0	1	231	0	0	0	0	0	0	0	13	1	0	0	1	0	15	246
16:15	156	33	12	6	1	0	208	1	0	0	0	0	0	1	19	1	0	0	1	0	21	230
16:30	161	25	3	5	1	1	196	0	0	0	0	0	0	0	14	1	0	0	0	0	15	211
16:45	153	26	8	3	1	4	195	0	0	0	0	0	0	0	19	2	0	0	0	0	21	216
1 Hr	647	119	31	24	3	6	830	1	0	0	0	0	0	1	65	5	0	0	2	0	72	903
17:00	137	21	6	9	1	1	175	0	0	0	0	0	0	0	13	0	0	0	1	0	14	189
17:15	149	21	5	4	0	2	181	0	0	0	0	0	0	0	10	3	0	0	0	0	13	194
17:30	181	10	4	6	1	3	205	0	0	0	0	0	0	0	13	0	0	0	0	0	13	218
17:45	177	12	1	4	1	2	197	0	0	0	0	0	0	0	11	1	0	0	0	0	12	209
1 Hr	644	64	16	23	3	8	758	0	0	0	0	0	0	0	47	4	0	0	1	0	52	810
18:00	196	6	3	2	1	4	212	0	0	0	0	0	0	0	23	0	0	0	1	0	24	236
18:15	165	11	5	3	1	1	186	0	0	0	0	0	0	0	11	0	0	0	0	0	11	197
18:30	146	14	1	3	0	1	165	0	0	0	0	0	0	0	14	1	0	0	0	0	15	180
18:45	101	9	3	5	1	1	120	0	0	0	0	0	0	0	10	2	0	0	0	0	12	132
1 Hr	608	40	12	13	3	7	683	0	0	0	0	0	0	0	58	3	0	0	1	0	62	745
Total	5783	1075	515	490	33	49	7945	1	0	0	0	0	0	1	391	60	11	0	19	3	484	8430

Origin Arm C Waterbeach Road

	Destination : Arm A Ely Road(NNE)						Total	Destination : Arm B Ely Road(SSW)						Total	Destination : Arm C Waterbeach Road						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	4	1	0	0	0	0	5	17	0	0	0	0	0	17	0	0	0	0	0	0	0	22
07:15	8	1	0	0	0	0	9	16	2	0	0	0	0	18	0	0	0	0	0	0	0	27
07:30	14	1	0	0	0	0	15	14	2	1	0	0	1	18	0	0	0	0	0	0	0	33
07:45	10	0	0	0	0	0	10	17	5	0	0	0	0	22	0	0	0	0	0	0	0	32
1 Hr	36	3	0	0	0	0	39	64	9	1	0	0	1	75	0	0	0	0	0	0	0	114
08:00	7	0	0	0	0	0	7	15	7	0	0	0	0	22	0	0	0	0	0	0	0	29
08:15	7	1	0	0	0	0	8	25	4	0	0	0	0	29	0	0	0	0	0	0	0	37
08:30	10	0	0	0	1	0	11	21	2	0	0	0	0	23	0	0	0	0	0	0	0	34
08:45	13	0	0	0	0	0	13	18	1	0	0	1	0	20	0	0	0	0	0	0	0	33
1 Hr	37	1	0	0	1	0	39	79	14	0	0	1	0	94	0	0	0	0	0	0	0	133
09:00	2	0	1	0	0	0	3	17	0	0	0	0	0	17	0	0	0	0	0	0	0	20
09:15	4	2	1	0	0	0	7	11	1	1	0	0	0	13	0	0	0	0	0	0	0	20
09:30	3	0	0	0	0	0	3	8	0	0	0	1	0	9	0	0	0	0	0	0	0	12
09:45	4	0	0	0	0	0	4	6	0	0	0	0	0	6	0	0	0	0	0	0	0	10
1 Hr	13	2	2	0	0	0	17	42	1	1	0	1	0	45	0	0	0	0	0	0	0	62
10:00	3	2	0	0	0	0	5	11	1	1	0	0	0	13	0	0	0	0	0	0	0	18
10:15	4	0	1	0	0	0	5	3	1	0	0	0	0	4	0	0	0	0	0	0	0	9
10:30	0	0	0	0	0	0	0	6	0	0	0	1	0	7	0	0	0	0	0	0	0	7
10:45	1	0	0	1	0	0	2	12	0	0	0	0	0	12	0	0	0	0	0	0	0	14
1 Hr	8	2	1	1	0	0	12	32	2	1	0	1	0	36	0	0	0	0	0	0	0	48
11:00	1	1	1	0	0	0	3	6	2	0	0	0	0	8	0	0	0	0	0	0	0	11
11:15	2	0	1	0	0	0	3	12	3	0	0	0	0	15	0	0	0	0	0	0	0	18
11:30	2	1	0	0	0	0	3	8	1	0	0	1	0	10	0	0	0	0	0	0	0	13
11:45	1	1	0	0	0	0	2	4	2	0	0	0	0	6	0	0	0	0	0	0	0	8
1 Hr	6	3	2	0	0	0	11	30	8	0	0	1	0	39	0	0	0	0	0	0	0	50
12:00	3	0	0	0	0	0	3	8	0	0	0	0	0	8	0	0	0	0	0	0	0	11
12:15	4	0	0	0	0	0	4	8	0	1	0	0	0	9	0	0	0	0	0	0	0	13
12:30	3	0	0	0	0	0	3	8	0	1	0	0	0	9	0	0	0	0	0	0	0	12
12:45	2	0	0	0	0	0	2	3	4	1	0	1	0	9	0	0	0	0	0	0	0	11
1 Hr	12	0	0	0	0	0	12	27	4	3	0	1	0	35	0	0	0	0	0	0	0	47
13:00	3	1	0	0	0	0	4	3	3	0	0	0	0	6	0	0	0	0	0	0	0	10
13:15	4	1	0	0	0	0	5	3	1	0	0	0	0	4	0	0	0	0	0	0	0	9
13:30	1	0	0	0	0	0	1	6	2	0	0	1	0	9	0	0	0	0	0	0	0	10
13:45	6	0	0	0	0	0	6	8	0	0	0	0	0	8	0	0	0	0	0	0	0	14
1 Hr	14	2	0	0	0	0	16	20	6	0	0	1	0	27	0	0	0	0	0	0	0	43
14:00	0	1	0	0	0	0	1	10	2	0	0	0	0	12	0	0	0	0	0	0	0	13
14:15	1	0	0	0	0	0	1	6	0	0	0	0	0	6	0	0	0	0	0	0	0	7
14:30	0	0	0	0	0	0	0	6	1	1	0	1	0	9	0	0	0	0	0	0	0	9
14:45	6	0	0	0	0	0	6	6	0	0	0	0	0	6	0	0	0	0	0	0	0	12
1 Hr	7	1	0	0	0	0	8	28	3	1	0	1	0	33	0	0	0	0	0	0	0	41
15:00	2	0	0	0	0	0	2	14	2	0	0	0	0	16	0	0	0	0	0	0	0	18
15:15	1	0	0	0	0	0	1	10	0	0	0	0	0	10	0	0	0	0	0	0	0	11
15:30	2	0	2	0	0	0	4	4	3	0	0	3	0	10	0	0	0	0	0	0	0	14
15:45	5	0	1	0	0	0	6	10	1	0	0	1	0	12	0	0	0	0	0	0	0	18
1 Hr	10	0	3	0	0	0	13	38	6	0	0	4	0	48	0	0	0	0	0	0	0	61
16:00	1	2	0	0	0	0	3	6	0	0	0	0	0	6	0	0	0	0	0	0	0	9
16:15	4	0	0	0	0	0	4	11	2	0	0	0	0	13	0	0	0	0	0	0	0	17
16:30	6	0	0	0	0	0	6	13	2	0	0	0	0	15	0	0	0	0	0	0	0	21
16:45	2	0	0	0	0	0	2	7	3	0	0	0	0	10	0	0	0	0	0	0	0	12
1 Hr	13	2	0	0	0	0	15	37	7	0	0	0	0	44	0	0	0	0	0	0	0	59
17:00	3	0	0	0	0	0	3	8	1	0	0	0	0	9	0	0	0	0	0	0	0	12
17:15	2	3	0	0	0	0	5	11	1	0	0	0	0	12	0	0	0	0	0	0	0	17
17:30	2	0	0	0	0	0	2	10	0	0	0	1	0	11	0	0	0	0	0	0	0	13
17:45	3	0	0	0	0	0	3	6	0	0	0	0	0	6	0	0	0	0	0	0	0	9
1 Hr	10	3	0	0	0	0	13	35	2	0	0	1	0	38	0	0	0	0	0	0	0	51
18:00	1	0	0	0	0	0	1	10	2	0	0	0	0	12	0	0	0	0	0	0	0	13
18:15	2	0	0	0	0	0	2	7	2	0	0	1	0	10	0	0	0	0	0	0	0	12
18:30	1	0	0	0	0	0	1	9	1	0	0	1	0	11	0	0	0	0	0	0	0	12
18:45	4	1	0	0	0	0	5	10	0	0	0	0	0	10	0	0	0	0	0	0	0	15
1 Hr	8	1	0	0	0	0	9	36	5	0	0	2	0	43	0	0	0	0	0	0	0	52
Total	174	20	8	1	1	0	204	468	67	7	0	14	1	557	0	0	0	0	0	0	0	761

ORIGIN SUMMARY

Origin : Arm A Ely Road(NNE)						Total	Origin : Arm B Ely Road(SSW)						Total	Origin : Arm C Waterbeach Road						Total	Origin Totals
Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		

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Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 2 - Ely Road(NNE) / Ely Road(SSW) / Waterbeach Road

	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Total
07:00	179	56	13	8	2	1	259	86	28	5	9	2	2	132	21	1	0	0	0	0	22	413
07:15	188	37	7	10	5	2	249	118	34	8	9	2	3	174	24	3	0	0	0	0	27	450
07:30	198	20	15	10	0	3	246	132	27	4	10	1	4	178	28	3	1	0	0	1	33	457
07:45	179	27	4	7	0	2	219	150	23	12	6	2	3	196	27	5	0	0	0	0	32	447
1 Hr	744	140	39	35	7	8	973	486	112	29	34	7	12	680	100	12	1	0	0	1	114	1767
08:00	137	35	8	8	2	2	192	131	18	8	6	4	1	168	22	7	0	0	0	0	29	389
08:15	159	25	11	13	1	2	211	153	16	17	14	3	0	203	32	5	0	0	0	0	37	451
08:30	121	18	9	8	0	2	158	149	20	13	5	0	3	190	31	2	0	0	1	0	34	382
08:45	136	16	10	11	2	0	175	145	22	12	14	1	1	195	31	1	0	0	1	0	33	403
1 Hr	553	94	38	40	5	6	736	578	76	50	39	8	5	756	116	15	0	0	2	0	133	1625
09:00	122	25	19	11	1	1	179	128	17	7	10	2	1	165	19	0	1	0	0	0	20	364
09:15	148	15	10	9	1	1	184	96	21	9	11	0	1	138	15	3	2	0	0	0	20	342
09:30	138	23	12	13	2	3	191	97	19	13	7	3	0	139	11	0	0	0	1	0	12	342
09:45	138	36	7	17	0	0	198	105	23	16	11	1	0	156	10	0	0	0	0	0	10	364
1 Hr	546	99	48	50	4	5	752	426	80	45	39	6	2	598	55	3	3	0	1	0	62	1412
10:00	122	24	7	7	0	1	161	89	21	14	15	1	0	140	14	3	1	0	0	0	18	319
10:15	125	17	12	8	0	1	163	77	31	14	19	0	0	141	7	1	1	0	0	0	9	313
10:30	106	18	14	13	1	1	153	83	20	7	11	0	0	121	6	0	0	0	1	0	7	281
10:45	127	25	10	10	0	0	172	100	33	18	9	2	0	162	13	0	0	1	0	0	14	348
1 Hr	480	84	43	38	1	3	649	349	105	53	54	3	0	564	40	4	2	1	1	0	48	1261
11:00	97	18	15	10	0	3	143	86	28	16	12	1	0	143	7	3	1	0	0	0	11	297
11:15	99	18	10	16	1	1	145	93	28	17	19	0	0	157	14	3	1	0	0	0	18	320
11:30	80	21	13	14	0	0	128	73	22	14	10	0	1	120	10	2	0	0	1	0	13	261
11:45	111	23	25	13	0	1	173	108	24	13	11	1	2	159	5	3	0	0	0	0	8	340
1 Hr	387	80	63	53	1	5	589	360	102	60	52	2	3	579	36	11	2	0	1	0	50	1218
12:00	106	19	12	11	0	0	148	112	17	14	19	1	0	163	11	0	0	0	0	0	11	322
12:15	90	24	13	11	0	0	138	87	23	17	18	1	1	147	12	0	1	0	0	0	13	298
12:30	84	19	13	14	1	0	131	117	27	16	14	1	1	176	11	0	1	0	0	0	12	319
12:45	112	15	8	21	0	0	156	95	23	15	14	1	1	149	5	4	1	0	1	0	11	316
1 Hr	392	77	46	57	1	0	573	411	90	62	65	4	3	635	39	4	3	0	1	0	47	1255
13:00	95	8	6	16	1	0	126	101	23	15	13	2	0	154	6	4	0	0	0	0	10	290
13:15	99	28	16	13	2	1	159	110	17	10	19	0	0	156	7	2	0	0	0	0	9	324
13:30	114	31	8	16	0	0	169	102	19	14	11	0	0	146	7	2	0	0	1	0	10	325
13:45	108	31	10	13	0	0	162	125	33	19	10	3	0	190	14	0	0	0	0	0	14	366
1 Hr	416	98	40	58	3	1	616	438	92	58	53	5	0	646	34	8	0	0	1	0	43	1305
14:00	101	26	8	15	0	0	150	132	27	26	14	1	2	202	10	3	0	0	0	0	13	365
14:15	90	16	12	11	1	2	132	110	19	14	15	0	1	159	7	0	0	0	0	0	7	298
14:30	122	22	12	13	2	0	171	112	31	11	15	0	1	170	6	1	1	0	1	0	9	350
14:45	112	12	9	6	1	1	141	125	32	14	15	1	1	188	12	0	0	0	0	0	12	341
1 Hr	425	76	41	45	4	3	594	479	109	65	59	2	5	719	35	4	1	0	1	0	41	1354
15:00	117	28	15	6	0	0	166	144	34	10	11	1	0	200	16	2	0	0	0	0	18	384
15:15	93	29	6	8	1	2	139	132	32	12	10	0	1	187	11	0	0	0	0	0	11	337
15:30	90	31	5	12	1	0	139	144	33	16	6	1	0	200	6	3	2	0	3	0	14	353
15:45	104	25	7	7	0	1	144	158	35	7	8	0	0	208	15	1	1	0	1	0	18	370
1 Hr	404	113	33	33	2	3	588	578	134	45	35	2	1	795	48	6	3	0	4	0	61	1444
16:00	123	26	9	10	0	2	170	190	36	8	10	1	1	246	7	2	0	0	0	0	9	425
16:15	131	33	3	8	0	2	177	176	34	12	6	2	0	230	15	2	0	0	0	0	17	424
16:30	164	19	2	6	1	1	193	175	26	3	5	1	1	211	19	2	0	0	0	0	21	425
16:45	159	18	7	3	0	2	189	172	28	8	3	1	4	216	9	3	0	0	0	0	12	417
1 Hr	577	96	21	27	1	7	729	713	124	31	24	5	6	903	50	9	0	0	0	0	59	1691
17:00	186	21	3	6	0	1	217	150	21	6	9	2	1	189	11	1	0	0	0	0	12	418
17:15	174	18	2	3	1	2	200	159	24	5	4	0	2	194	13	4	0	0	0	0	17	411
17:30	179	11	5	4	1	1	201	194	10	4	6	1	3	218	12	0	0	0	1	0	13	432
17:45	136	11	1	2	0	2	152	188	13	1	4	1	2	209	9	0	0	0	0	0	9	370
1 Hr	675	61	11	15	2	6	770	691	68	16	23	4	8	810	45	5	0	0	1	0	51	1631
18:00	119	11	2	1	0	3	136	219	6	3	2	2	4	236	11	2	0	0	0	0	13	385
18:15	119	9	1	1	0	0	130	176	11	5	3	1	1	197	9	2	0	0	1	0	12	339
18:30	95	11	3	3	2	0	114	160	15	1	3	0	1	180	10	1	0	0	1	0	12	306
18:45	80	8	1	3	1	0	93	111	11	3	5	1	1	132	14	1	0	0	0	0	15	240
1 Hr	413	39	7	8	3	3	473	666	43	12	13	4	7	745	44	6	0	0	2	0	52	1270
Total	6012	1057	430	459	34	50	8042	6175	1135	526	490	52	52	8430	642	87	15	1	15	1	761	17233

DESTINATION SUMMARY

	Destination : Arm A Ely Road(NNE)						Total	**Destination :** Arm B Ely Road(SSW)						Total	**Destination :** Arm C Waterbeach Road						Total	Dest Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	85	29	5	9	1	2	131	196	55	13	8	2	1	275	5	1	0	0	1	0	7	413
07:15	122	34	8	9	1	3	177	203	39	7	10	5	2	266	5	1	0	0	1	0	7	450
07:30	144	27	4	10	1	4	190	211	21	16	10	0	4	262	3	2	0	0	0	0	5	457
07:45	152	22	12	6	2	2	196	196	32	4	7	0	2	241	8	1	0	0	0	1	10	447
1 Hr	503	112	29	34	5	11	694	806	147	40	35	7	9	1044	21	5	0	0	2	1	29	1767
08:00	129	16	7	6	2	1	161	150	42	8	8	2	2	212	11	2	1	0	2	0	16	389
08:15	155	17	17	14	0	0	203	184	28	11	13	1	2	239	5	1	0	0	3	0	9	451
08:30	146	20	13	5	1	3	188	141	19	9	8	0	2	179	14	1	0	0	0	0	15	382
08:45	153	20	12	14	0	1	200	153	17	10	11	3	0	194	6	2	0	0	1	0	9	403
1 Hr	583	73	49	39	3	5	752	628	106	38	40	6	6	824	36	6	1	0	6	0	49	1625
09:00	124	17	7	10	2	0	160	138	25	19	11	1	1	195	7	0	1	0	0	1	9	364
09:15	93	21	9	11	0	1	135	159	16	11	9	1	1	197	7	2	1	0	0	0	10	342
09:30	95	19	13	7	3	0	137	143	23	11	13	3	3	196	8	0	1	0	0	0	9	342
09:45	104	22	16	11	0	0	153	143	36	7	17	0	0	203	6	1	0	0	1	0	8	364
1 Hr	416	79	45	39	5	1	585	583	100	48	50	5	5	791	28	3	3	0	1	1	36	1412
10:00	88	22	12	15	1	0	138	131	23	8	7	0	1	170	6	3	2	0	0	0	11	319
10:15	74	28	15	19	0	0	136	125	17	12	8	0	1	163	10	4	0	0	0	0	14	313
10:30	78	19	6	11	0	0	114	109	17	14	13	2	1	156	8	2	1	0	0	0	11	281
10:45	92	30	17	10	1	0	150	138	25	10	10	0	0	183	10	3	1	0	1	0	15	348
1 Hr	332	99	50	55	2	0	538	503	82	44	38	2	3	672	34	12	4	0	1	0	51	1261
11:00	85	27	17	12	1	0	142	102	20	15	10	0	3	150	3	2	0	0	0	0	5	297
11:15	88	26	18	19	0	0	151	110	21	10	16	1	1	159	8	2	0	0	0	0	10	320
11:30	72	22	14	10	0	1	119	85	21	13	14	1	0	134	6	2	0	0	0	0	8	261
11:45	102	25	13	11	0	2	153	114	25	25	13	0	1	178	8	0	0	0	1	0	9	340
1 Hr	347	100	62	52	1	3	565	411	87	63	53	2	5	621	25	6	0	0	1	0	32	1218
12:00	108	17	14	19	1	0	159	110	19	12	11	0	0	152	11	0	0	0	0	0	11	322
12:15	88	23	16	18	1	1	147	96	24	14	11	0	0	145	5	0	1	0	0	0	6	298
12:30	114	27	15	14	1	1	172	90	19	14	14	1	0	138	8	0	1	0	0	0	9	319
12:45	86	20	15	14	0	1	136	114	19	9	21	1	0	164	12	3	0	0	1	0	16	316
1 Hr	396	87	60	65	3	3	614	410	81	49	57	2	0	599	36	3	2	0	1	0	42	1255
13:00	99	22	15	13	2	0	151	96	11	6	16	1	0	130	7	2	0	0	0	0	9	290
13:15	112	18	10	19	0	0	159	98	28	16	13	2	1	158	6	1	0	0	0	0	7	324
13:30	99	18	14	11	0	0	142	120	32	8	16	1	0	177	4	2	0	0	0	0	6	325
13:45	123	33	19	10	2	0	187	113	31	10	13	0	0	167	11	0	0	0	1	0	12	366

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3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 2 - Ely Road(NNE) / Ely Road(SSW) / Waterbeach Road

1 Hr	433	91	58	53	4	0	639	427	102	40	58	4	1	632	28	5	0	0	1	0	34	1305
14:00	121	23	25	14	1	2	186	110	28	8	15	0	0	161	12	5	1	0	0	0	18	365
14:15	106	18	13	15	0	1	153	95	16	11	11	1	2	136	6	1	2	0	0	0	9	298
14:30	111	29	11	15	0	1	167	128	21	11	13	3	0	176	1	4	2	0	0	0	7	350
14:45	123	32	14	15	0	0	184	117	12	9	6	1	1	146	9	0	0	0	1	1	11	341
1 Hr	461	102	63	59	1	4	690	450	77	39	45	5	3	619	28	10	5	0	1	1	45	1354
15:00	139	34	10	11	1	0	195	128	30	15	6	0	0	179	10	0	0	0	0	0	10	384
15:15	129	30	12	10	0	1	182	102	27	6	8	1	2	146	5	4	0	0	0	0	9	337
15:30	140	30	18	6	0	0	194	91	34	5	12	4	0	146	9	3	0	0	1	0	13	353
15:45	149	29	8	8	0	0	194	111	24	6	7	1	1	150	17	8	1	0	0	0	26	370
1 Hr	557	123	48	35	1	1	765	432	115	32	33	6	3	621	41	15	1	0	1	0	58	1444
16:00	178	37	8	10	0	1	234	128	24	9	10	0	1	172	14	3	0	0	1	1	19	425
16:15	160	33	12	6	1	0	212	139	34	3	8	0	2	186	23	2	0	0	1	0	26	424
16:30	167	25	3	5	1	1	202	169	21	2	6	1	1	200	22	1	0	0	0	0	23	425
16:45	155	26	8	3	1	4	197	156	21	7	3	0	2	189	29	2	0	0	0	0	31	417
1 Hr	660	121	31	24	3	6	845	592	100	21	27	1	6	747	88	8	0	0	2	1	99	1691
17:00	140	21	6	9	1	1	178	186	22	3	6	0	1	218	21	0	0	0	1	0	22	418
17:15	151	24	5	4	0	2	186	174	19	2	3	1	2	201	21	3	0	0	0	0	24	411
17:30	184	10	4	6	1	3	208	178	9	5	4	2	1	199	23	2	0	0	0	0	25	432
17:45	180	12	1	4	1	2	200	137	9	1	2	0	2	151	16	3	0	0	0	0	19	370
1 Hr	655	67	16	23	3	8	772	675	59	11	15	3	6	769	81	8	0	0	1	0	90	1631
18:00	197	6	3	2	1	4	213	122	11	2	1	0	3	139	30	2	0	0	1	0	33	385
18:15	167	11	5	3	1	1	188	122	10	1	1	1	0	135	15	1	0	0	0	0	16	339
18:30	147	14	1	3	0	1	166	103	10	3	3	3	0	122	15	3	0	0	0	0	18	306
18:45	105	10	3	5	1	1	125	88	8	1	3	1	0	101	12	2	0	0	0	0	14	240
1 Hr	616	41	12	13	3	7	692	435	39	7	8	5	3	497	72	8	0	0	1	0	81	1270
Total	5959	1095	523	491	34	49	8151	6352	1095	432	459	48	50	8436	518	89	16	0	19	4	646	17233

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 3 - Ely Road(NNE) / Car Dyke Road / Ely Road(SSW)

Origin Arm A Ely Road(NNE)

	Destination : Arm A Ely Road(NNE)						Total	Destination : Arm B Car Dyke Road						Total	Destination : Arm C Ely Road(SSW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	0	0	0	0	0	0	0	16	0	0	0	0	0	16	186	56	11	9	2	1	265	281
07:15	0	0	0	0	0	0	0	13	1	0	0	0	0	14	190	39	7	10	5	2	253	267
07:30	0	0	0	0	0	0	0	12	2	1	0	0	0	15	194	21	15	10	0	3	243	258
07:45	0	0	0	0	0	0	0	17	4	0	0	0	0	21	185	28	5	7	0	2	227	248
1 Hr	0	0	0	0	0	0	0	58	7	1	0	0	0	66	755	144	38	36	7	8	988	1054
08:00	0	0	0	0	0	0	0	18	9	0	0	0	0	27	131	33	8	8	2	2	184	211
08:15	0	0	0	0	0	0	0	28	5	0	0	0	0	33	157	23	11	13	1	2	207	240
08:30	0	0	0	0	0	0	0	21	2	1	0	0	0	24	120	15	8	8	0	2	153	177
08:45	0	0	0	0	0	0	0	19	2	1	0	1	0	23	131	15	9	11	2	0	168	191
1 Hr	0	0	0	0	0	0	0	86	18	2	0	1	0	107	539	86	36	40	5	6	712	819
09:00	0	0	0	0	0	0	0	21	1	1	0	0	0	23	125	24	18	10	2	1	180	203
09:15	0	0	0	0	0	0	0	11	1	1	0	0	0	13	146	15	10	10	1	1	183	196
09:30	0	0	0	0	0	0	0	7	3	0	0	1	1	12	135	20	11	13	2	2	183	195
09:45	0	0	0	0	0	0	0	8	0	1	0	0	0	9	141	34	6	17	0	0	198	207
1 Hr	0	0	0	0	0	0	0	47	5	3	0	1	1	57	547	93	45	50	5	4	744	801
10:00	0	0	0	0	0	0	0	9	1	0	0	0	0	10	123	23	8	7	0	1	162	172
10:15	0	0	0	0	0	0	0	5	0	0	0	0	0	5	122	18	12	8	0	1	161	166
10:30	0	0	0	0	0	0	0	5	0	0	0	0	0	5	103	16	15	12	1	1	148	153
10:45	0	0	0	0	0	0	0	8	3	0	0	0	0	11	130	20	9	11	0	0	170	181
1 Hr	0	0	0	0	0	0	0	27	4	0	0	0	0	31	478	77	44	38	1	3	641	672
11:00	0	0	0	0	0	0	0	5	0	0	0	0	0	5	97	20	14	10	0	3	144	149
11:15	0	0	0	0	0	0	0	11	4	0	0	0	0	15	99	19	10	15	1	1	145	160
11:30	0	0	0	0	0	0	0	5	2	0	0	1	0	8	82	19	12	15	0	0	128	136
11:45	0	0	0	0	0	0	0	5	2	0	0	0	0	7	111	22	25	13	0	1	172	179
1 Hr	0	0	0	0	0	0	0	26	8	0	0	1	0	35	389	80	61	53	1	5	589	624
12:00	0	0	0	0	0	0	0	9	0	0	0	0	0	9	102	19	12	11	0	0	144	153
12:15	0	0	0	0	0	0	0	7	0	0	0	0	0	7	89	24	15	11	0	0	139	146
12:30	0	0	0	0	0	0	0	8	1	1	0	0	0	10	82	18	11	14	1	0	126	136
12:45	0	0	0	0	0	0	0	4	2	1	0	0	1	8	112	17	9	20	1	0	159	167
1 Hr	0	0	0	0	0	0	0	28	3	2	0	0	1	34	385	78	47	56	2	0	568	602
13:00	0	0	0	0	0	0	0	7	3	0	0	0	0	10	91	9	6	16	1	0	123	133
13:15	0	0	1	0	0	0	1	1	3	1	1	0	0	6	96	30	12	14	1	1	154	161
13:30	0	0	0	0	0	0	0	6	2	0	0	1	0	9	118	27	10	13	1	0	169	178
13:45	0	0	0	0	0	0	0	5	1	0	0	0	0	6	117	29	9	14	0	0	169	175
1 Hr	0	0	1	0	0	0	1	19	9	1	1	1	0	31	422	95	37	57	3	1	615	647
14:00	0	0	0	0	0	0	0	11	1	0	0	0	0	12	99	26	10	15	0	0	150	162
14:15	0	0	0	0	0	0	0	4	0	0	0	0	0	4	96	15	11	11	1	2	136	140
14:30	0	0	0	0	0	0	0	6	1	1	0	1	0	9	122	22	10	13	2	0	169	178
14:45	0	0	0	0	0	0	0	5	0	0	0	0	0	5	112	15	8	7	1	1	144	149
1 Hr	0	0	0	0	0	0	0	26	2	1	0	1	0	30	429	78	39	46	4	3	599	629
15:00	0	0	0	0	0	0	0	16	1	0	0	0	0	17	112	30	15	7	0	0	164	181
15:15	0	0	0	0	0	0	0	8	0	0	0	0	0	8	96	27	6	7	1	2	139	147
15:30	0	0	0	0	0	0	0	5	2	1	0	3	0	11	88	29	4	13	1	0	135	146
15:45	0	0	0	0	0	0	0	10	1	0	0	1	0	12	102	23	6	7	0	1	139	151
1 Hr	0	0	0	0	0	0	0	39	4	1	0	4	0	48	398	109	31	34	2	3	577	625
16:00	0	0	0	0	0	0	0	12	0	1	0	0	0	13	119	24	8	10	0	1	162	175
16:15	0	0	0	0	0	0	0	14	1	0	0	0	0	15	130	31	3	8	0	2	174	189
16:30	0	0	0	0	0	0	0	5	2	0	0	0	0	7	156	21	1	6	1	1	186	193
16:45	0	0	0	0	0	0	0	8	4	0	0	1	0	13	142	18	7	3	0	2	172	185
1 Hr	0	0	0	0	0	0	0	39	7	1	0	1	0	48	547	94	19	27	1	6	694	742
17:00	0	0	0	0	0	0	0	9	1	0	0	0	0	10	176	23	3	6	0	1	209	219
17:15	0	0	0	0	0	0	0	12	1	0	0	0	0	13	165	18	3	3	1	2	192	205
17:30	0	0	0	0	0	0	0	6	0	0	0	1	0	7	171	9	5	4	1	1	191	198
17:45	0	0	0	0	0	0	0	6	0	0	0	0	0	6	133	11	1	3	0	2	150	156
1 Hr	0	0	0	0	0	0	0	33	2	0	0	1	0	36	645	61	12	16	2	6	742	778
18:00	0	0	0	0	0	0	0	9	2	1	0	0	0	12	110	9	1	1	0	3	124	136
18:15	0	0	0	0	0	0	0	5	2	0	0	1	0	8	121	8	1	1	0	0	131	139
18:30	0	0	0	0	0	0	0	8	1	0	0	1	0	10	96	10	3	3	2	0	114	124
18:45	0	0	0	0	0	0	0	8	0	0	0	0	0	8	77	8	1	3	1	0	90	98
1 Hr	0	0	0	0	0	0	0	30	5	1	0	2	0	38	404	35	6	8	3	3	459	497
Total	0	0	1	0	0	0	1	458	74	13	1	13	2	561	5938	1030	415	461	36	48	7928	8490

Origin Arm B Car Dyke Road

	Destination : Arm A Ely Road(NNE)						Total	Destination : Arm B Car Dyke Road						Total	Destination : Arm C Ely Road(SSW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	5	1	0	0	0	0	6	0	0	0	0	0	0	0	32	8	2	0	0	0	42	48
07:15	3	0	0	0	1	0	4	0	0	0	0	0	0	0	31	7	1	1	0	0	40	44
07:30	3	1	0	0	0	1	5	0	0	0	0	0	0	0	59	7	1	0	0	1	68	73
07:45	7	0	0	0	0	1	8	0	0	0	0	0	0	0	36	4	2	0	0	0	42	50
1 Hr	18	2	0	0	1	2	23	0	0	0	0	0	0	0	158	26	6	1	0	1	192	215
08:00	10	3	0	0	2	0	15	0	0	0	0	0	0	0	35	2	0	0	1	0	38	53
08:15	3	0	0	0	3	0	6	0	0	0	0	0	0	0	41	4	1	0	0	0	46	52
08:30	20	0	0	0	0	0	20	0	0	0	0	0	0	0	49	7	0	0	0	0	56	76
08:45	4	2	1	0	1	0	8	0	0	0	0	0	0	0	31	4	0	1	0	0	36	44
1 Hr	37	5	1	0	6	0	49	0	0	0	0	0	0	0	156	17	1	1	1	0	176	225
09:00	4	0	0	0	0	0	4	0	0	0	0	0	0	0	28	5	1	0	0	2	36	40
09:15	7	3	1	0	0	0	11	0	0	0	0	0	0	0	32	7	1	0	0	0	40	51
09:30	3	1	0	0	0	0	4	0	0	0	0	0	0	0	29	7	1	0	0	0	37	41
09:45	3	0	0	0	1	0	4	0	0	0	0	0	0	0	33	5	1	0	0	1	40	44
1 Hr	17	4	1	0	1	0	23	0	0	0	0	0	0	0	122	24	4	0	0	3	153	176
10:00	3	3	1	0	0	0	7	0	0	0	0	0	0	0	36	4	0	0	0	0	40	47
10:15	4	3	0	0	0	0	7	0	0	0	0	0	0	0	22	7	1	0	0	0	30	37
10:30	4	0	0	0	0	0	4	0	0	0	0	0	0	0	23	2	2	0	0	0	27	31
10:45	7	2	0	0	1	0	10	0	0	0	0	0	0	0	29	2	1	0	0	0	32	42
1 Hr	18	8	1	0	1	0	28	0	0	0	0	0	0	0	110	15	4	0	0	0	129	157
11:00	4	2	0	0	0	0	6	0	0	0	0	0	0	0	20	3	0	0	0	0	23	29
11:15	3	2	0	0	0	0	5	0	0	0	0	0	0	0	21	2	0	0	0	0	23	28
11:30	2	1	1	0	0	0	4	0	0	0	0	0	0	0	22	2	0	0	0	0	24	28
11:45	10	1	0	0	1	0	12	0	0	0	0	0	0	0	22	4	2	0	0	0	28	40
1 Hr	19	6	1	0	1	0	27	0	0	0	0	0	0	0	85	11	2	0	0	0	98	125
12:00	6	0	0	0	0	0	6	0	0	0	0	0	0	0	23	2	0	0	0	0	25	31
12:15	5	0	1	0	0	0	6	0	0	0	0	0	0	0	31	6	1	0	0	0	38	44
12:30	8	1	1	0	0	0	10	0	0	0	0	0	0	0	27	4	0	0	0	1	32	42
12:45	9	2	1	0	1	0	13	0	0	0	0	0	0	0	15	7	0	0	0	0	22	35

Tracsis plc
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3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 3 - Ely Road(NNE) / Car Dyke Road / Ely Road(SSW)

	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Arm Totals
1 Hr	28	3	3	0	1	0	35	0	0	0	0	0	0	0	96	19	1	0	0	1	117	152
13:00	2	2	0	0	0	0	4	0	0	0	0	0	0	0	14	6	0	0	0	0	20	24
13:15	6	1	1	0	0	0	8	0	0	0	0	0	0	0	23	9	0	1	0	0	33	41
13:30	2	1	0	0	0	0	3	0	0	0	0	0	0	0	23	3	1	0	0	0	27	30
13:45	10	1	1	0	1	1	14	0	0	0	0	0	0	0	28	5	1	0	0	0	34	48
1 Hr	20	5	2	0	1	1	29	0	0	0	0	0	0	0	88	23	2	1	0	0	114	143
14:00	12	4	0	0	0	0	16	0	0	0	0	0	0	0	19	6	1	0	0	1	27	43
14:15	5	1	0	0	0	0	6	0	0	0	0	0	0	0	16	3	0	0	0	0	19	25
14:30	2	1	0	0	0	0	3	0	0	0	0	0	0	0	26	2	0	0	0	0	28	31
14:45	12	2	0	0	1	0	15	0	0	0	0	0	0	0	34	4	1	1	1	0	41	56
1 Hr	31	8	0	0	1	0	40	0	0	0	0	0	0	0	95	15	2	1	1	1	115	155
15:00	8	1	0	0	0	0	9	0	0	0	0	0	0	0	26	6	0	1	0	0	33	42
15:15	6	4	0	0	0	1	11	0	0	0	0	0	0	0	31	1	1	0	0	0	33	44
15:30	7	3	0	0	1	0	11	0	0	0	0	0	0	0	25	0	0	0	0	0	25	36
15:45	14	5	0	0	1	0	20	0	0	0	0	0	0	0	30	7	1	0	0	0	38	58
1 Hr	35	13	0	0	2	1	51	0	0	0	0	0	0	0	112	14	2	1	0	0	129	180
16:00	9	1	0	0	0	0	10	0	0	0	0	0	0	0	27	6	2	0	1	0	36	46
16:15	5	0	0	0	0	0	5	0	1	0	0	0	0	1	25	12	0	0	0	1	38	44
16:30	10	1	0	0	0	1	12	0	0	0	0	0	0	0	39	4	1	0	0	1	45	57
16:45	15	1	0	0	0	0	16	0	0	0	0	0	0	0	23	1	1	0	0	0	25	41
1 Hr	39	3	0	0	0	1	43	0	1	0	0	0	0	1	114	23	4	0	1	2	144	188
17:00	10	0	0	0	1	0	11	0	0	0	0	0	0	0	27	3	1	0	0	1	32	43
17:15	9	1	0	0	0	0	10	0	0	0	0	0	0	0	21	1	0	0	0	0	22	32
17:30	14	0	3	0	0	0	17	0	0	0	0	0	0	0	36	3	0	0	0	0	39	56
17:45	9	1	0	0	0	0	10	0	0	0	0	0	0	0	30	1	2	0	0	0	33	43
1 Hr	42	2	3	0	1	0	48	0	0	0	0	0	0	0	114	8	3	0	0	1	126	174
18:00	19	0	0	0	1	1	21	0	0	0	0	0	0	0	30	2	0	0	1	0	33	54
18:15	9	0	0	0	0	0	9	0	0	0	0	0	0	0	20	4	1	0	0	0	25	34
18:30	12	1	0	0	0	0	13	0	0	0	0	0	0	0	26	0	0	0	0	0	26	39
18:45	15	2	0	0	0	0	17	0	0	0	0	0	0	0	39	2	0	0	0	0	41	58
1 Hr	55	3	0	0	1	1	60	0	0	0	0	0	0	0	115	8	1	0	1	0	125	185
Total	359	62	12	0	17	6	456	0	1	0	0	0	0	1	1365	203	32	5	4	9	1618	2075

Origin : Arm C Ely Road(SSW)

	Destination : Arm A Ely Road(NNE)						Total	Destination : Arm B Car Dyke Road						Total	Destination : Arm C Ely Road(SSW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	82	24	6	9	1	2	124	10	3	1	1	0	0	15	0	0	0	0	0	0	0	139
07:15	116	36	8	9	1	3	173	18	6	0	1	0	1	26	0	0	0	0	0	0	0	199
07:30	130	25	4	10	1	3	173	25	6	1	0	0	0	32	0	0	0	0	0	0	0	205
07:45	143	23	12	7	2	1	188	20	7	0	0	0	0	27	0	0	0	0	0	0	0	215
1 Hr	471	108	30	35	5	9	658	73	22	2	2	0	1	100	0	0	0	0	0	0	0	758
08:00	121	14	8	6	2	1	152	18	2	1	0	0	0	21	0	0	0	0	0	0	0	173
08:15	149	18	17	14	0	0	198	17	6	0	0	0	0	23	0	0	0	0	0	0	0	221
08:30	128	19	13	5	0	3	168	17	7	1	0	0	0	25	0	0	0	0	0	0	0	193
08:45	140	19	11	14	0	1	185	17	3	0	0	0	0	20	0	0	0	0	0	0	0	205
1 Hr	538	70	49	39	2	5	703	69	18	2	0	0	0	89	0	0	0	0	0	0	0	792
09:00	123	17	7	10	2	0	159	24	5	4	0	0	0	33	0	0	0	0	0	0	0	192
09:15	89	18	8	11	0	1	127	21	3	0	0	0	0	24	0	0	0	0	0	0	0	151
09:30	93	19	13	7	3	0	135	22	5	0	0	0	0	27	0	0	0	0	0	0	0	162
09:45	102	21	16	11	0	0	150	17	1	1	0	0	0	19	0	0	0	0	0	0	0	169
1 Hr	407	75	44	39	5	1	571	84	14	5	0	0	0	103	0	0	0	0	0	0	0	674
10:00	83	20	13	15	1	0	132	14	5	0	1	0	0	20	0	1	0	0	0	0	1	153
10:15	77	26	14	19	0	0	136	15	5	2	0	0	0	22	0	0	0	0	0	0	0	158
10:30	80	20	7	11	0	0	118	11	1	0	0	0	0	12	0	0	0	0	0	0	0	130
10:45	94	31	19	9	1	0	154	27	1	0	0	0	0	28	0	0	0	0	0	0	0	182
1 Hr	334	97	53	54	2	0	540	67	12	2	1	0	0	82	0	1	0	0	0	0	1	623
11:00	82	26	15	13	1	0	137	18	4	2	0	0	1	25	0	0	0	0	0	0	0	162
11:15	90	27	18	18	0	0	153	21	1	2	0	0	0	24	0	0	0	0	0	0	0	177
11:30	72	21	12	10	0	1	116	18	5	0	2	0	0	25	0	0	0	0	0	0	0	141
11:45	98	22	13	11	0	2	146	26	4	2	0	0	0	32	0	0	0	0	0	0	0	178
1 Hr	342	96	58	52	1	3	552	83	14	6	2	0	1	106	0	0	0	0	0	0	0	658
12:00	108	17	14	19	1	0	159	20	2	0	0	0	0	22	0	0	0	0	0	0	0	181
12:15	85	21	16	18	1	1	142	23	6	0	0	0	0	29	0	0	0	0	0	0	0	171
12:30	109	28	15	14	1	1	168	22	5	0	0	0	0	27	0	0	0	0	0	0	0	195
12:45	86	21	13	15	0	1	136	20	4	1	0	0	0	25	0	0	0	0	0	0	0	161
1 Hr	388	87	58	66	3	3	605	85	17	1	0	0	0	103	0	0	0	0	0	0	0	708
13:00	99	20	14	14	2	0	149	27	2	0	0	0	1	30	0	0	0	0	0	0	0	179
13:15	105	17	9	19	0	0	150	24	7	0	0	0	0	31	0	0	0	0	0	0	0	181
13:30	103	19	13	12	0	0	147	19	8	0	0	0	1	28	0	0	0	0	0	0	0	175
13:45	120	32	17	10	3	0	182	30	11	0	0	0	0	41	0	0	0	0	0	0	0	223
1 Hr	427	88	53	55	5	0	628	100	28	0	0	0	2	130	0	0	0	0	0	0	0	758
14:00	119	22	27	14	1	2	185	23	1	1	0	0	0	25	0	0	0	0	0	0	0	210
14:15	106	18	14	15	0	1	154	29	1	0	0	0	1	31	0	0	0	0	0	0	0	185
14:30	111	30	11	15	0	1	168	25	2	0	0	0	0	27	0	0	0	0	0	0	0	195
14:45	114	28	13	15	0	0	170	29	2	0	0	0	0	31	0	0	0	0	0	0	0	201
1 Hr	450	98	65	59	1	4	677	106	6	1	0	0	1	114	0	0	0	0	0	0	0	791
15:00	137	33	11	11	1	0	193	32	4	1	0	0	0	37	0	0	0	0	0	0	0	230
15:15	127	29	12	10	0	0	178	33	9	1	0	0	0	43	0	0	0	0	0	0	0	221
15:30	139	29	16	6	0	0	190	35	3	1	0	0	1	40	0	0	0	0	0	0	0	230
15:45	145	31	7	8	0	0	191	32	6	1	0	0	0	39	0	0	0	0	0	0	0	230
1 Hr	548	122	46	35	1	0	752	132	22	4	0	0	1	159	0	0	0	0	0	0	0	911
16:00	192	33	8	10	0	1	244	27	8	0	0	1	0	36	0	0	0	0	0	0	0	280
16:15	170	34	12	6	2	0	224	45	8	0	0	0	0	53	0	0	0	0	0	0	0	277
16:30	164	23	3	5	1	1	197	44	6	2	0	0	1	53	0	0	0	0	0	0	0	250
16:45	154	26	8	3	1	4	196	32	4	0	0	0	0	36	0	0	0	0	0	0	0	232
1 Hr	680	116	31	24	4	6	861	148	26	2	0	1	1	178	0	0	0	0	0	0	0	1039
17:00	127	20	3	9	1	1	161	57	7	3	0	0	0	67	0	0	0	0	0	0	0	228
17:15	149	24	5	4	0	2	184	50	3	0	0	0	2	55	0	0	0	0	0	0	0	239
17:30	182	9	4	6	1	3	205	61	4	0	0	0	1	66	0	0	0	0	0	0	0	271
17:45	183	10	1	4	1	2	201	56	1	1	0	0	1	59	0	0	0	0	0	0	0	260
1 Hr	641	63	13	23	3	8	751	224	15	4	0	0	4	247	0	0	0	0	0	0	0	998
18:00	200	6	3	2	1	3	215	58	9	1	0	0	0	68	0	0	0	0	0	0	0	283
18:15	163	13	5	3	1	1	186	39	1	2	0	0	0	42	0	0	0	0	0	0	0	228
18:30	148	14	1	3	0	1	167	45	1	0	0	0	0	46	0	0	0	0	0	0	0	213
18:45	99	12	3	6	1	2	123	26	2	1	0	0	0	29	0	0	0	0	0	0	0	152
1 Hr	610	45	12	14	3	7	691	168	13	4	0	0	0	185	0	0	0	0	0	0	0	876
Total	5836	1065	512	495	35	46	7989	1339	207	33	5	1	11	1596	0	1	0	0	0	0	1	9586

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Junction Turning Count
11/07/2017

Site 3 - Ely Road(NNE) / Car Dyke Road / Ely Road(SSW)

ORIGIN SUMMARY

	Origin : Arm A Ely Road(NNE)							Origin : Arm B Car Dyke Road							Origin : Arm C Ely Road(SSW)							Origin Totals
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	
07:00	202	56	11	9	2	1	281	37	9	2	0	0	0	48	92	27	7	10	1	2	139	468
07:15	203	40	7	10	5	2	267	34	7	1	1	1	0	44	134	42	8	10	1	4	199	510
07:30	206	23	16	10	0	3	258	62	8	1	0	0	2	73	155	31	5	10	1	3	205	536
07:45	202	32	5	7	0	2	248	43	4	2	0	0	1	50	163	30	12	7	2	1	215	513
1 Hr	813	151	39	36	7	8	1054	176	28	6	1	1	3	215	544	130	32	37	5	10	758	2027
08:00	149	42	8	8	2	2	211	45	5	0	0	3	0	53	139	16	9	6	2	1	173	437
08:15	185	28	11	13	1	2	240	44	4	1	0	3	0	52	166	24	17	14	0	0	221	513
08:30	141	17	9	8	0	2	177	69	7	0	0	0	0	76	145	26	14	5	0	3	193	446
08:45	150	17	10	11	3	0	191	35	6	1	1	1	0	44	157	22	11	14	0	1	205	440
1 Hr	625	104	38	40	6	6	819	193	22	2	1	7	0	225	607	88	51	39	2	5	792	1836
09:00	146	25	19	10	2	1	203	32	5	1	0	0	2	40	147	22	11	10	2	0	192	435
09:15	157	16	11	10	1	1	196	39	10	2	0	0	0	51	110	21	8	11	0	1	151	398
09:30	142	23	11	13	3	3	195	32	8	1	0	0	0	41	115	24	13	7	3	0	162	398
09:45	149	34	7	17	0	0	207	36	5	1	0	1	1	44	119	22	17	11	0	0	169	420
1 Hr	594	98	48	50	6	5	801	139	28	5	0	1	3	176	491	89	49	39	5	1	674	1651
10:00	132	24	8	7	0	1	172	39	7	1	0	0	0	47	97	26	13	16	1	0	153	372
10:15	127	18	12	8	0	1	166	26	10	1	0	0	0	37	92	31	16	19	0	0	158	361
10:30	108	16	15	12	1	1	153	27	2	2	0	0	0	31	91	21	7	11	0	0	130	314
10:45	138	23	9	11	0	0	181	36	4	1	0	1	0	42	121	32	19	9	1	0	182	405
1 Hr	505	81	44	38	1	3	672	128	23	5	0	1	0	157	401	110	55	55	2	0	623	1452
11:00	102	20	14	10	0	3	149	24	5	0	0	0	0	29	100	30	17	13	1	1	162	340
11:15	110	23	10	15	1	1	160	24	4	0	0	0	0	28	111	28	20	18	0	0	177	365
11:30	87	21	12	15	1	0	136	24	3	1	0	0	0	28	90	26	12	12	0	1	141	305
11:45	116	24	25	13	0	1	179	32	5	2	0	1	0	40	124	26	15	11	0	2	178	397
1 Hr	415	88	61	53	2	5	624	104	17	3	0	1	0	125	425	110	64	54	1	4	658	1407
12:00	111	19	12	11	0	0	153	29	2	0	0	0	0	31	128	19	14	19	1	0	181	365
12:15	96	24	15	11	0	0	146	36	6	2	0	0	0	44	108	27	16	18	1	1	171	361
12:30	90	19	12	14	1	0	136	35	5	1	0	0	1	42	131	33	15	14	1	1	195	373
12:45	116	19	10	20	1	1	167	24	9	1	0	1	0	35	106	25	14	15	0	1	161	363
1 Hr	413	81	49	56	2	1	602	124	22	4	0	1	1	152	473	104	59	66	3	3	708	1462
13:00	98	12	6	16	1	0	133	16	8	0	0	0	0	24	126	22	14	14	2	1	179	336
13:15	97	33	14	15	1	1	161	29	10	1	1	0	0	41	129	24	9	19	0	0	181	383
13:30	124	29	10	13	2	0	178	25	4	1	0	0	0	30	122	27	13	12	0	1	175	383
13:45	122	30	9	14	0	0	175	38	6	2	0	1	1	48	150	43	17	10	3	0	223	446
1 Hr	441	104	39	58	4	1	647	108	28	4	1	1	1	143	527	116	53	55	5	2	758	1548
14:00	110	27	10	15	0	0	162	31	10	1	0	0	1	43	142	23	28	14	1	2	210	415
14:15	100	15	11	11	1	2	140	21	4	0	0	0	0	25	135	19	14	15	0	2	185	350
14:30	128	23	11	13	3	0	178	28	3	0	0	0	0	31	136	32	11	15	0	1	195	404
14:45	117	15	8	7	1	1	149	46	6	1	1	2	0	56	143	30	13	15	0	0	201	406
1 Hr	455	80	40	46	5	3	629	126	23	2	1	2	1	155	556	104	66	59	1	5	791	1575
15:00	128	31	15	7	0	0	181	34	7	0	1	0	0	42	169	37	12	11	1	0	230	453
15:15	104	27	6	7	1	2	147	37	5	1	0	0	1	44	160	38	13	10	0	0	221	412
15:30	93	31	5	13	4	0	146	32	3	0	0	1	0	36	174	32	17	6	0	1	230	412
15:45	112	24	6	7	1	1	151	44	12	1	0	1	0	58	177	37	8	8	0	0	230	439
1 Hr	437	113	32	34	6	3	625	147	27	2	1	2	1	180	680	144	50	35	1	1	911	1716
16:00	131	24	9	10	0	1	175	36	7	2	0	1	0	46	219	41	8	10	1	1	280	501
16:15	144	32	3	8	0	2	189	30	13	0	0	0	1	44	215	42	12	6	2	0	277	510
16:30	161	23	1	6	1	1	193	49	5	1	0	0	2	57	208	29	5	5	1	2	250	500
16:45	150	22	7	3	1	2	185	38	2	1	0	0	0	41	186	30	8	3	1	4	232	458
1 Hr	586	101	20	27	2	6	742	153	27	4	0	1	3	188	828	142	33	24	5	7	1039	1969
17:00	185	24	3	6	0	1	219	37	3	1	0	1	1	43	184	27	6	9	1	1	228	490
17:15	177	19	3	3	1	2	205	30	2	0	0	0	0	32	199	27	5	4	0	4	239	476
17:30	177	9	5	4	2	1	198	50	3	3	0	0	0	56	243	13	4	6	1	4	271	525
17:45	139	11	1	3	0	2	156	39	2	2	0	0	0	43	239	11	2	4	1	3	260	459
1 Hr	678	63	12	16	3	6	778	156	10	6	0	1	1	174	865	78	17	23	3	12	998	1950
18:00	119	11	2	1	0	3	136	49	2	0	0	2	1	54	258	15	4	2	1	3	283	473
18:15	126	10	1	1	1	0	139	29	4	1	0	0	0	34	202	14	7	3	1	1	228	401
18:30	104	11	3	3	3	0	124	38	1	0	0	0	0	39	193	15	1	3	0	1	213	376
18:45	85	8	1	3	1	0	98	54	4	0	0	0	0	58	125	14	4	6	1	2	152	308
1 Hr	434	40	7	8	5	3	497	170	11	1	0	2	1	185	778	58	16	14	3	7	876	1558
Total	6396	1104	429	462	49	50	8490	1724	266	44	5	21	15	2075	7175	1273	545	500	36	57	9586	20151

DESTINATION SUMMARY

	Destination : Arm A Ely Road(NNE)							Destination : Arm B Car Dyke Road							Destination : Arm C Ely Road(SSW)							Dest Totals
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	
07:00	87	25	6	9	1	2	130	26	3	1	1	0	0	31	218	64	13	9	2	1	307	468
07:15	119	36	8	9	2	3	177	31	7	0	1	0	1	40	221	46	8	11	5	2	293	510
07:30	133	26	4	10	1	4	178	37	8	2	0	0	0	47	253	28	16	10	0	4	311	536
07:45	150	23	12	7	2	2	196	37	11	0	0	0	0	48	221	32	7	7	0	2	269	513
1 Hr	489	110	30	35	6	11	681	131	29	3	2	0	1	166	913	170	44	37	7	9	1180	2027
08:00	131	17	8	6	4	1	167	36	11	1	0	0	0	48	166	35	8	8	3	2	222	437
08:15	152	18	17	14	3	0	204	45	11	0	0	0	0	56	198	27	12	13	1	2	253	513
08:30	148	19	13	5	0	3	188	38	9	2	0	0	0	49	169	22	8	8	0	2	209	446
08:45	144	21	12	14	1	1	193	36	5	1	0	1	0	43	162	19	9	12	2	0	204	440
1 Hr	575	75	50	39	8	5	752	155	36	4	0	1	0	196	695	103	37	41	6	6	888	1836
09:00	127	17	7	10	2	0	163	45	6	5	0	0	0	56	153	29	19	10	2	3	216	435
09:15	96	21	9	11	0	1	138	32	4	1	0	0	0	37	178	22	11	10	1	1	223	398
09:30	96	20	13	7	3	0	139	29	8	0	0	1	1	39	164	27	12	13	2	2	220	398
09:45	105	21	16	11	1	0	154	25	1	2	0	0	0	28	174	39	7	17	0	1	238	420
1 Hr	424	79	45	39	6	1	594	131	19	8	0	1	1	160	669	117	49	50	5	7	897	1651
10:00	86	23	14	15	1	0	139	23	6	0	1	0	0	30	159	28	8	7	0	1	203	372
10:15	81	29	14	19	0	0	143	20	5	2	0	0	0	27	144	25	13	8	0	1	191	361
10:30	84	20	7	11	0	0	122	16	1	0	0	0	0	17	126	18	17	12	1	1	175	314
10:45	101	33	19	9	2	0	164	35	4	0	0	0	0	39	159	22	10	11	0	0	202	405
1 Hr	352	105	54	54	3	0	568	94	16	2	1	0	0	113	588	93	48	38	1	3	771	1452
11:00	86	28	15	13	1	0	143	23	4	2	0	0	1	30	117	23	14	10	0	3	167	340
11:15	93	29	18	18	0	0	158	32	5	2	0	0	0	39	120	21	10	15	1	1	168	365
11:30	74	22	13	10	0	1	120	23	7	0	2	1	0	33	104	21	12	15	0	0	152	305
11:45	108	23	13	11	1	2	158	31	6	2	0	0	0	39	133	26	27	13	0	1	200	397
1 Hr	361	102	59	52	2	3	579	109	22	6	2	1	1	141	474	91	63	53	1	5	687	1407
12:00	114	17	14	19	1	0	165	29	2	0	0	0	0	31	125	21	12	11	0	0	169	365
12:15	90	21	17	18	1	1	148	30	6	0	0	0	0	36	120	30	16	11	0	0	177	361
12:30	117	29	16	14	1	1	178	30	6	1	0	0	0	37	109	22	11	14	1	1	158	373

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Site 3 - Ely Road(NNE) / Car Dyke Road / Ely Road(SSW)

12:45	95	23	14	15	1	1	149	24	6	2	0	0	1	33	127	24	9	20	1	0	181	363
1 Hr	416	90	61	66	4	3	640	113	20	3	0	0	1	137	481	97	48	56	2	1	685	1462
13:00	101	22	14	14	2	0	153	34	5	0	0	0	1	40	105	15	6	16	1	0	143	336
13:15	111	18	11	19	0	0	159	25	10	1	1	0	0	37	119	39	12	15	1	1	187	383
13:30	105	20	13	12	0	0	150	25	10	0	0	1	1	37	141	30	11	13	1	0	196	383
13:45	130	33	18	10	4	1	196	35	12	0	0	0	0	47	145	34	10	14	0	0	203	446
1 Hr	447	93	56	55	6	1	658	119	37	1	1	1	2	161	510	118	39	58	3	1	729	1548
14:00	131	26	27	14	1	2	201	34	2	1	0	0	0	37	118	32	11	15	0	1	177	415
14:15	111	19	14	15	0	1	160	33	1	0	0	0	1	35	112	18	11	11	1	2	155	350
14:30	113	31	11	15	0	1	171	31	3	1	0	1	0	36	148	24	10	13	2	0	197	404
14:45	126	30	13	15	1	0	185	34	2	0	0	0	0	36	146	19	9	8	2	1	185	406
1 Hr	481	106	65	59	2	4	717	132	8	2	0	1	1	144	524	93	41	47	5	4	714	1575
15:00	145	34	11	11	1	0	202	48	5	1	0	0	0	54	138	36	15	8	0	0	197	453
15:15	133	33	12	10	0	1	189	41	9	1	0	0	0	51	127	28	7	7	1	2	172	412
15:30	146	32	16	6	1	0	201	40	5	2	0	3	1	51	113	29	4	13	1	0	160	412
15:45	159	36	7	8	1	0	211	42	7	1	0	1	0	51	132	30	7	7	0	1	177	439
1 Hr	583	135	46	35	3	1	803	171	26	5	0	4	1	207	510	123	33	35	2	3	706	1716
16:00	201	34	8	10	0	1	254	39	8	1	0	1	0	49	146	30	10	10	1	1	198	501
16:15	175	34	12	6	2	0	229	59	10	0	0	0	0	69	155	43	3	8	0	3	212	510
16:30	174	24	3	5	1	2	209	49	8	2	0	0	1	60	195	25	2	6	1	2	231	500
16:45	169	27	8	3	1	4	212	40	8	0	0	1	0	49	165	19	8	3	0	2	197	458
1 Hr	719	119	31	24	4	7	904	187	34	3	0	2	1	227	661	117	23	27	2	8	838	1969
17:00	137	20	3	9	2	1	172	66	8	3	0	0	0	77	203	26	4	6	0	2	241	490
17:15	158	25	5	4	0	2	194	62	4	0	0	0	2	68	186	19	3	3	1	2	214	476
17:30	196	9	7	6	1	3	222	67	4	0	0	1	1	73	207	12	5	4	1	1	230	525
17:45	192	11	1	4	1	2	211	62	1	1	0	0	1	65	163	12	3	3	0	2	183	459
1 Hr	683	65	16	23	4	8	799	257	17	4	0	1	4	283	759	69	15	16	2	7	868	1950
18:00	219	6	3	2	2	4	236	67	11	2	0	0	0	80	140	11	1	1	1	3	157	473
18:15	172	13	5	3	1	1	195	44	3	2	0	1	0	50	141	12	2	1	0	0	156	401
18:30	160	15	1	3	0	1	180	53	2	0	0	1	0	56	122	10	3	3	2	0	140	376
18:45	114	14	3	6	1	2	140	34	2	1	0	0	0	37	116	10	1	3	1	0	131	308
1 Hr	665	48	12	14	4	8	751	198	18	5	0	2	0	223	519	43	7	8	4	3	584	1558
Total	6195	1127	525	495	52	52	8446	1797	282	46	6	14	13	2158	7303	1234	447	466	40	57	9547	20151

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11/07/2017

Site 4 - Bannold Road / High Street / Denny End Road

Origin Arm A Bannold Road

	Destination : Arm A Bannold Road						Total	Destination : Arm B High Street						Total	Destination : Arm C Denny End Road						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	0	0	0	0	0	0	0	6	2	1	0	0	0	9	13	3	0	0	0	0	16	25
07:15	0	0	0	0	0	0	0	7	3	0	0	1	0	11	14	3	0	0	0	0	17	28
07:30	0	0	0	0	0	0	0	20	1	0	0	0	0	21	21	2	0	0	0	0	23	44
07:45	0	0	0	0	0	0	0	11	3	0	0	0	0	14	14	1	0	0	0	0	15	29
1 Hr	0	0	0	0	0	0	0	44	9	1	0	1	0	55	62	9	0	0	0	0	71	126
08:00	0	0	0	0	0	0	0	16	2	0	0	0	0	18	12	1	1	1	0	0	15	33
08:15	0	0	0	0	0	0	0	11	0	0	0	1	0	12	17	3	0	1	0	0	21	33
08:30	0	0	0	0	0	0	0	21	1	0	0	0	0	22	16	1	0	0	0	0	17	39
08:45	0	0	0	0	0	0	0	16	1	0	0	0	0	17	16	0	1	1	0	0	18	35
1 Hr	0	0	0	0	0	0	0	64	4	0	0	1	0	69	61	5	2	3	0	0	71	140
09:00	0	0	0	0	0	0	0	8	1	2	0	0	0	11	17	0	3	3	1	0	24	35
09:15	0	0	0	0	0	0	0	8	1	0	0	0	0	9	12	1	0	2	0	0	15	24
09:30	0	0	0	0	0	0	0	14	2	1	0	1	0	18	11	2	1	2	0	0	16	34
09:45	0	0	0	0	0	0	0	6	1	1	0	1	0	9	10	1	2	1	1	0	15	24
1 Hr	0	0	0	0	0	0	0	36	5	4	0	2	0	47	50	4	6	8	2	0	70	117
10:00	0	0	0	0	0	0	0	15	1	0	0	0	0	16	13	2	0	1	0	0	16	32
10:15	0	0	0	0	0	0	0	10	1	0	0	0	0	11	8	7	3	0	0	0	18	29
10:30	0	0	0	0	0	0	0	7	1	2	0	0	0	10	9	0	0	1	0	0	10	20
10:45	0	0	0	0	0	0	0	12	2	0	0	1	0	15	8	1	0	0	0	0	9	24
1 Hr	0	0	0	0	0	0	0	44	5	2	0	1	0	52	38	10	3	2	0	0	53	105
11:00	0	0	0	0	0	0	0	6	2	0	0	0	0	8	10	3	0	0	0	0	13	21
11:15	0	0	0	0	0	0	0	7	0	0	0	0	0	7	6	6	0	1	0	0	13	20
11:30	0	0	0	0	0	0	0	3	0	1	0	1	0	5	5	4	0	3	0	0	12	17
11:45	0	0	0	0	0	0	0	10	0	0	0	1	0	11	6	0	1	3	0	0	10	21
1 Hr	0	0	0	0	0	0	0	26	2	1	0	2	0	31	27	13	1	7	0	0	48	79
12:00	0	0	0	0	0	0	0	8	3	0	0	0	0	11	7	0	1	1	0	0	9	20
12:15	0	0	0	0	0	0	0	11	3	1	0	0	0	15	9	1	3	0	0	0	13	28
12:30	0	0	0	0	0	0	0	10	1	1	0	0	0	12	14	1	0	0	0	0	15	27
12:45	0	0	0	0	0	0	0	11	4	0	0	1	0	16	7	1	2	2	1	0	13	29
1 Hr	0	0	0	0	0	0	0	40	11	2	0	1	0	54	37	3	6	3	1	0	50	104
13:00	0	0	0	0	0	0	0	6	2	0	0	0	0	8	12	3	1	2	0	0	18	26
13:15	0	0	0	0	0	0	0	2	1	0	0	0	0	3	9	1	0	0	0	1	11	14
13:30	0	0	0	0	0	0	0	10	1	0	0	1	0	12	11	4	1	1	0	1	18	30
13:45	0	0	0	0	0	0	0	9	3	0	0	1	0	13	4	0	1	0	0	0	5	18
1 Hr	0	0	0	0	0	0	0	27	7	0	0	2	0	36	36	8	3	3	0	2	52	88
14:00	0	0	0	0	0	0	0	6	2	1	0	0	0	9	7	4	3	1	0	0	15	24
14:15	0	0	0	0	0	0	0	8	1	0	0	0	0	9	11	6	1	0	0	0	18	27
14:30	0	0	0	0	0	0	0	14	3	0	0	0	0	17	12	4	0	2	0	0	18	35
14:45	0	0	0	0	0	0	0	14	0	1	1	1	0	17	6	2	2	1	0	0	11	28
1 Hr	0	0	0	0	0	0	0	42	6	2	1	1	0	52	36	16	6	4	0	0	62	114
15:00	0	0	0	0	0	0	0	14	2	0	0	0	0	16	6	2	2	0	0	0	10	26
15:15	0	0	0	0	0	0	0	8	0	0	0	0	0	8	4	2	1	1	0	0	8	16
15:30	0	0	0	0	0	0	0	4	2	1	0	1	0	8	20	6	1	0	1	0	28	36
15:45	0	0	0	0	0	0	0	8	5	0	0	1	0	14	12	4	2	3	0	0	21	35
1 Hr	0	0	0	0	0	0	0	34	9	1	0	2	0	46	42	14	6	4	1	0	67	113
16:00	0	0	0	0	0	0	0	10	2	0	0	0	0	12	10	5	1	1	0	0	17	29
16:15	0	0	0	0	0	0	0	9	1	0	0	0	1	11	10	2	0	0	0	0	12	23
16:30	0	0	0	0	0	0	0	11	1	0	0	0	0	12	6	0	0	0	0	0	6	18
16:45	0	0	0	0	0	0	0	6	0	0	0	0	0	6	11	0	1	2	0	0	14	20
1 Hr	0	0	0	0	0	0	0	36	4	0	0	0	1	41	37	7	2	3	0	0	49	90
17:00	0	0	0	0	0	0	0	9	3	0	0	1	1	14	9	0	1	0	0	0	10	24
17:15	0	0	0	0	0	0	0	7	0	0	0	0	0	7	8	3	0	0	0	0	11	18
17:30	0	0	0	0	0	0	0	10	1	0	0	0	0	11	16	1	0	0	0	0	17	28
17:45	0	0	0	0	0	0	0	10	0	0	0	0	0	10	11	1	0	0	0	0	12	22
1 Hr	0	0	0	0	0	0	0	36	4	0	0	1	1	42	44	5	1	0	0	0	50	92
18:00	0	0	0	0	0	0	0	15	3	0	0	1	0	19	9	1	0	0	0	0	10	29
18:15	0	0	0	0	0	0	0	6	2	0	0	0	0	8	9	2	0	0	0	0	11	19
18:30	0	0	0	0	0	0	0	10	0	0	0	0	0	10	8	1	0	0	0	0	9	19
18:45	0	0	0	0	0	0	0	8	0	0	0	0	0	8	10	0	0	0	0	0	10	18
1 Hr	0	0	0	0	0	0	0	39	5	0	0	1	0	45	36	4	0	0	0	0	40	85
Total	0	0	0	0	0	0	0	468	71	13	1	15	2	570	506	98	36	37	4	2	683	1253

Origin Arm B High Street

	Destination : Arm A Bannold Road						Total	Destination : Arm B High Street						Total	Destination : Arm C Denny End Road						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	3	5	0	1	0	0	9	0	0	0	0	0	0	0	8	5	1	1	0	0	15	24
07:15	4	3	0	0	0	0	7	0	0	0	0	0	0	0	11	4	0	0	0	1	16	23
07:30	8	2	1	0	0	0	11	0	0	0	0	0	0	0	22	5	1	0	0	0	28	39
07:45	8	6	0	0	0	0	14	0	0	0	0	0	0	0	17	6	1	0	0	0	24	38
1 Hr	23	16	1	1	0	0	41	0	0	0	0	0	0	0	58	20	3	1	0	1	83	124
08:00	6	1	0	0	0	0	7	1	0	0	0	0	0	1	34	2	1	0	0	0	37	45
08:15	6	3	0	0	0	0	9	1	0	0	0	0	0	1	28	6	0	0	0	1	35	45
08:30	4	0	0	0	0	0	4	1	0	0	0	0	0	1	36	3	0	0	1	0	40	45
08:45	4	1	0	0	1	0	6	1	0	0	0	0	0	1	32	3	0	0	0	0	35	42
1 Hr	20	5	0	0	1	0	26	4	0	0	0	0	0	4	130	14	1	0	1	1	147	177
09:00	10	0	3	0	0	0	13	0	0	0	0	0	0	0	18	3	1	0	0	0	22	35
09:15	9	0	0	0	0	0	9	0	0	0	0	0	0	0	15	5	0	0	0	0	20	29
09:30	2	3	0	0	1	0	6	0	0	0	0	0	0	0	23	2	0	0	0	0	25	31
09:45	10	0	0	0	0	0	10	0	1	0	0	0	0	1	20	2	1	0	0	0	23	34
1 Hr	31	3	3	0	1	0	38	0	1	0	0	0	0	1	76	12	2	0	0	0	90	129
10:00	8	3	0	0	0	0	11	1	0	0	0	0	0	1	17	8	0	0	0	0	25	37
10:15	4	1	0	0	0	0	5	1	0	0	0	0	0	1	17	3	1	1	0	0	22	28
10:30	4	2	0	0	1	0	7	0	0	0	0	0	0	0	15	2	2	0	0	0	19	26
10:45	13	1	0	0	0	0	14	1	0	0	0	0	0	1	12	1	0	0	0	0	13	28
1 Hr	29	7	0	0	1	0	37	3	0	0	0	0	0	3	61	14	3	1	0	0	79	119
11:00	9	0	0	0	0	0	9	1	0	0	0	0	0	1	17	2	1	0	0	1	21	31
11:15	5	2	0	0	0	0	7	0	0	0	0	0	0	0	17	3	3	0	0	0	23	30
11:30	4	0	0	0	1	0	5	0	0	0	0	0	0	0	20	6	2	0	0	0	28	33
11:45	8	1	0	0	0	0	9	0	0	0	0	0	0	0	18	5	5	0	0	0	28	37
1 Hr	26	3	0	0	1	0	30	1	0	0	0	0	0	1	72	16	11	0	0	1	100	131
12:00	3	5	0	0	0	0	8	0	0	0	0	0	0	0	28	5	0	0	0	1	34	42
12:15	8	3	1	0	0	0	12	0	0	0	0	0	0	0	26	4	0	0	0	0	30	42
12:30	4	1	0	0	0	0	5	1	0	0	0	0	0	1	22	1	1	0	0	0	24	30
12:45	6	1	1	0	2	0	10	1	0	0	0	0	0	1	19	8	1	0	0	1	29	40

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 4 - Bannold Road / High Street / Denny End Road

	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Arm Totals
1 Hr	21	10	2	0	2	0	35	2	0	0	0	0	0	2	95	18	2	0	0	2	117	154
13:00	8	2	0	0	0	1	11	0	0	0	0	0	0	0	27	8	1	0	0	0	36	47
13:15	4	0	0	0	0	0	4	0	0	0	0	0	0	0	34	8	1	0	0	1	44	48
13:30	4	1	0	0	1	0	6	0	0	0	0	0	0	0	23	5	0	0	0	0	28	34
13:45	10	1	0	0	0	0	11	0	0	0	0	0	0	0	23	7	1	1	0	0	32	43
1 Hr	26	4	0	0	1	1	32	0	0	0	0	0	0	0	107	28	3	1	0	1	140	172
14:00	6	1	0	0	0	0	7	0	0	1	0	0	0	1	25	5	0	0	0	1	31	39
14:15	11	2	0	0	0	0	13	0	0	0	0	0	0	0	25	4	2	0	0	0	31	44
14:30	5	0	0	0	0	0	5	0	0	0	0	0	0	0	25	6	0	0	0	0	31	36
14:45	10	1	0	0	1	0	12	0	0	0	0	0	0	0	20	8	3	0	0	0	31	43
1 Hr	32	4	0	0	1	0	37	0	0	1	0	0	0	1	95	23	5	0	0	1	124	162
15:00	8	0	0	0	0	0	8	1	0	0	0	0	0	1	21	4	0	0	0	0	25	34
15:15	15	2	0	0	0	0	17	0	0	0	0	0	0	0	28	7	1	0	0	0	36	53
15:30	18	3	0	0	0	0	21	2	0	0	0	0	0	2	31	6	0	0	1	0	38	61
15:45	7	3	1	0	1	0	12	1	0	0	0	0	0	1	44	10	4	0	0	1	59	72
1 Hr	48	8	1	0	1	0	58	4	0	0	0	0	0	4	124	27	5	0	1	1	158	220
16:00	8	0	0	0	0	0	8	0	0	0	0	0	0	0	37	7	0	0	1	0	45	53
16:15	7	3	0	0	0	0	10	0	0	0	0	0	0	0	50	7	1	0	0	0	58	68
16:30	16	1	0	0	0	1	18	0	0	0	0	0	0	0	37	12	1	0	0	1	51	69
16:45	6	2	0	0	1	0	9	0	0	0	0	0	0	0	54	5	1	1	0	0	61	70
1 Hr	37	6	0	0	1	1	45	0	0	0	0	0	0	0	178	31	3	1	1	1	215	260
17:00	5	2	0	0	0	0	7	0	0	0	0	0	0	0	52	4	0	0	0	0	56	63
17:15	21	3	0	0	0	0	24	0	0	0	0	0	0	0	56	8	0	0	0	0	64	88
17:30	17	2	0	0	0	0	19	0	0	0	0	0	0	0	53	4	0	0	1	0	58	77
17:45	18	0	0	0	0	0	18	0	0	0	0	0	0	0	49	4	2	0	1	0	56	74
1 Hr	61	7	0	0	0	0	68	0	0	0	0	0	0	0	210	20	2	0	2	0	234	302
18:00	20	3	0	0	0	0	23	0	0	0	0	0	0	0	42	6	0	0	0	1	49	72
18:15	18	1	0	0	0	0	19	2	0	0	0	0	0	2	34	4	0	0	1	0	39	60
18:30	11	0	0	0	0	0	11	1	0	0	0	0	0	1	32	2	0	0	0	0	34	46
18:45	10	1	0	0	0	0	11	0	0	0	0	0	0	0	33	3	0	0	1	1	38	49
1 Hr	59	5	0	0	0	0	64	3	0	0	0	0	0	3	141	15	0	0	2	2	160	227
Total	413	78	7	1	10	2	511	17	1	1	0	0	0	19	1347	238	40	4	7	11	1647	2177

Origin : Arm C Denny End Road

	Destination : Arm A Bannold Road						Total	Destination : Arm B High Street						Total	Destination : Arm C Denny End Road						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	4	1	1	1	0	0	7	49	8	1	1	1	2	62	0	0	0	0	0	0	0	69
07:15	10	7	0	0	1	0	18	53	6	2	0	0	0	61	0	0	0	0	0	0	0	79
07:30	8	3	0	2	0	0	13	69	8	2	1	0	1	81	0	0	0	0	0	0	0	94
07:45	6	2	1	1	0	0	10	49	12	3	0	2	0	66	0	0	0	0	0	0	0	76
1 Hr	28	13	2	4	1	0	48	220	34	8	2	3	3	270	0	0	0	0	0	0	0	318
08:00	7	1	1	0	1	0	10	41	8	0	0	1	1	51	0	0	0	0	0	0	0	61
08:15	5	1	1	0	0	0	7	49	5	2	0	2	1	59	0	0	0	0	0	0	0	66
08:30	8	1	2	1	0	0	12	28	2	0	0	1	1	32	0	0	0	0	0	0	0	44
08:45	10	1	1	4	0	0	16	42	3	0	0	1	0	46	0	0	0	0	0	0	0	62
1 Hr	30	4	5	5	1	0	45	160	18	2	0	5	3	188	0	0	0	0	0	0	0	233
09:00	4	3	3	2	1	0	13	42	9	1	0	0	2	54	0	0	0	0	0	0	0	67
09:15	6	1	5	2	0	0	14	30	3	0	0	0	0	33	0	0	0	0	0	0	0	47
09:30	7	0	0	1	0	1	9	30	2	0	0	0	1	33	0	0	0	0	0	0	0	42
09:45	12	3	1	1	1	0	18	30	7	1	0	0	0	38	0	0	0	0	0	0	0	56
1 Hr	29	7	9	6	2	1	54	132	21	2	0	0	3	158	0	0	0	0	0	0	0	212
10:00	7	3	0	0	0	0	10	17	2	2	0	0	0	21	0	0	0	0	0	0	0	31
10:15	7	4	0	2	0	0	13	20	3	1	0	0	0	24	0	0	0	0	0	0	0	37
10:30	9	1	0	0	0	0	10	22	4	0	0	0	0	26	0	0	0	0	0	0	0	36
10:45	7	3	1	0	1	0	12	16	5	0	0	0	0	21	0	0	0	0	0	0	0	33
1 Hr	30	11	1	2	1	0	45	75	14	3	0	0	0	92	0	0	0	0	0	0	0	137
11:00	2	3	0	2	0	0	7	19	3	0	0	0	0	22	0	0	0	0	0	0	0	29
11:15	18	2	2	2	0	0	24	31	2	0	0	0	0	33	0	0	0	0	0	0	0	57
11:30	2	1	3	1	0	0	7	14	6	0	0	0	0	20	0	0	0	0	0	0	0	27
11:45	10	2	1	1	0	0	14	25	4	0	0	0	0	29	0	0	0	0	0	0	0	43
1 Hr	32	8	6	6	0	0	52	89	15	0	0	0	0	104	0	0	0	0	0	0	0	156
12:00	9	4	1	0	0	0	14	28	6	1	0	0	0	35	0	1	0	0	0	0	1	50
12:15	6	1	0	0	0	0	7	27	3	1	0	0	0	31	0	0	0	0	0	0	0	38
12:30	7	1	0	3	0	0	11	24	2	0	0	0	1	27	0	0	1	0	0	0	1	39
12:45	10	2	0	1	1	0	14	20	6	1	0	0	0	27	0	0	0	0	0	0	0	41
1 Hr	32	8	1	4	1	0	46	99	17	3	0	0	1	120	0	1	1	0	0	0	2	168
13:00	5	2	2	0	0	0	9	21	3	0	0	0	0	24	0	0	0	0	0	0	0	33
13:15	16	2	1	1	0	0	20	30	5	1	0	0	1	37	0	0	0	0	0	0	0	57
13:30	4	1	1	0	0	0	6	24	6	2	0	0	2	34	0	0	0	0	0	0	0	40
13:45	5	1	0	1	0	0	7	22	4	0	0	0	1	27	0	0	0	0	0	0	0	34
1 Hr	30	6	4	2	0	0	42	97	18	3	0	0	4	122	0	0	0	0	0	0	0	164
14:00	6	1	3	1	0	0	11	14	2	0	0	0	0	16	0	0	0	0	0	0	0	27
14:15	7	1	2	1	0	0	11	22	4	0	0	0	0	26	0	0	0	0	0	0	0	37
14:30	11	0	0	0	0	0	11	23	5	0	0	0	1	29	0	0	0	0	0	0	0	40
14:45	13	3	0	2	0	0	18	21	6	0	0	0	0	27	0	0	0	0	0	0	0	45
1 Hr	37	5	5	4	0	0	51	80	17	0	0	0	1	98	0	0	0	0	0	0	0	149
15:00	13	2	1	0	0	0	16	17	2	0	0	0	0	19	0	0	0	0	0	0	0	35
15:15	7	1	1	1	0	0	10	9	2	1	0	0	0	12	0	0	0	0	0	0	0	22
15:30	11	2	1	3	0	0	17	21	1	1	0	0	0	23	0	0	0	0	0	0	0	40
15:45	12	0	0	0	0	0	12	13	5	0	0	0	0	18	0	0	0	0	0	0	0	30
1 Hr	43	5	3	4	0	0	55	60	10	2	0	0	0	72	0	0	0	0	0	0	0	127
16:00	8	1	0	0	0	0	9	25	9	0	0	0	0	34	0	0	0	0	0	0	0	43
16:15	5	0	1	0	0	0	6	32	5	0	0	0	0	37	0	0	0	0	0	0	0	43
16:30	9	0	1	1	0	0	11	49	5	1	0	0	1	56	0	0	0	0	0	0	0	67
16:45	14	0	0	0	0	0	14	36	4	0	0	0	0	40	0	0	0	0	0	0	0	54
1 Hr	36	1	2	1	0	0	40	142	23	1	0	0	1	167	0	0	0	0	0	0	0	207
17:00	10	3	0	0	0	0	13	44	1	0	0	0	0	45	0	0	0	0	0	0	0	58
17:15	15	0	0	0	0	0	15	32	0	0	0	0	0	32	0	0	0	0	0	0	0	47
17:30	19	2	0	0	0	0	21	39	2	1	0	0	0	42	0	0	0	0	0	0	0	63
17:45	15	2	0	0	0	1	18	20	0	0	0	0	0	20	0	0	0	0	0	0	0	38
1 Hr	59	7	0	0	0	1	67	135	3	1	0	0	0	139	0	0	0	0	0	0	0	206
18:00	21	0	0	0	1	0	22	36	2	0	0	0	0	38	0	1	0	0	0	0	1	61
18:15	13	0	1	0	0	0	14	23	1	0	0	0	0	24	0	0	0	0	0	0	0	38
18:30	13	1	0	0	0	0	14	21	1	0	0	0	0	22	0	0	0	0	0	0	0	36
18:45	12	3	0	0	0	0	15	17	1	0	0	0	0	18	0	0	0	0	0	0	0	33
1 Hr	59	4	1	0	1	0	65	97	5	0	0	0	0	102	0	1	0	0	0	0	1	168
Total	445	79	39	38	7	2	610	1386	195	25	2	8	16	1632	0	2	1	0	0	0	3	2245

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3790-TAD Waterbeach
Junction Turning Count
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Site 4 - Bannold Road / High Street / Denny End Road

ORIGIN SUMMARY

	Origin : Arm A Bannold Road						Total	Origin : Arm B High Street						Total	Origin : Arm C Denny End Road						Total	Origin Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	19	5	1	0	0	0	25	11	10	1	2	0	0	24	53	9	2	2	1	2	69	118
07:15	21	6	0	0	1	0	28	15	7	0	0	0	1	23	63	13	2	0	1	0	79	130
07:30	41	3	0	0	0	0	44	30	7	2	0	0	0	39	77	11	2	3	0	1	94	177
07:45	25	4	0	0	0	0	29	25	12	1	0	0	0	38	55	14	4	1	2	0	76	143
1 Hr	106	18	1	0	1	0	126	81	36	4	2	0	1	124	248	47	10	6	4	3	318	568
08:00	28	3	1	1	0	0	33	41	3	1	0	0	0	45	48	9	1	0	2	1	61	139
08:15	28	3	0	1	1	0	33	35	9	0	0	0	1	45	54	6	3	0	2	1	66	144
08:30	37	2	0	0	0	0	39	41	3	0	0	1	0	45	36	3	2	1	1	1	44	128
08:45	32	1	1	1	0	0	35	37	4	0	0	1	0	42	52	4	1	4	1	0	62	139
1 Hr	125	9	2	3	1	0	140	154	19	1	0	2	1	177	190	22	7	5	6	3	233	550
09:00	25	1	5	3	1	0	35	28	3	4	0	0	0	35	46	12	4	2	1	2	67	137
09:15	20	2	0	2	0	0	24	24	5	0	0	0	0	29	36	4	5	2	0	0	47	100
09:30	25	4	2	2	1	0	34	25	5	0	0	1	0	31	37	2	0	1	0	2	42	107
09:45	16	2	3	1	2	0	24	30	3	1	0	0	0	34	42	10	2	1	1	0	56	114
1 Hr	86	9	10	8	4	0	117	107	16	5	0	1	0	129	161	28	11	6	2	4	212	458
10:00	28	3	0	1	0	0	32	26	11	0	0	0	0	37	24	5	2	0	0	0	31	100
10:15	18	8	3	0	0	0	29	22	4	1	1	0	0	28	27	7	1	2	0	0	37	94
10:30	16	1	2	1	0	0	20	19	4	2	0	1	0	26	31	5	0	0	0	0	36	82
10:45	20	3	0	0	1	0	24	26	2	0	0	0	0	28	23	8	1	0	1	0	33	85
1 Hr	82	15	5	2	1	0	105	93	21	3	1	1	0	119	105	25	4	2	1	0	137	361
11:00	16	5	0	0	0	0	21	27	2	1	0	0	1	31	21	6	0	2	0	0	29	81
11:15	13	6	0	1	0	0	20	22	5	3	0	0	0	30	49	4	2	2	0	0	57	107
11:30	8	4	1	3	1	0	17	24	6	2	0	1	0	33	16	7	3	1	0	0	27	77
11:45	16	0	1	3	1	0	21	26	6	5	0	0	0	37	35	6	1	1	0	0	43	101
1 Hr	53	15	2	7	2	0	79	99	19	11	0	1	1	131	121	23	6	6	0	0	156	366
12:00	15	3	1	1	0	0	20	31	10	0	0	0	1	42	37	11	2	0	0	0	50	112
12:15	20	4	4	0	0	0	28	34	7	1	0	0	0	42	33	4	1	0	0	0	38	108
12:30	24	2	1	0	0	0	27	27	2	1	0	0	0	30	31	3	1	3	0	1	39	96
12:45	18	5	2	2	2	0	29	26	9	2	0	2	1	40	30	8	1	1	1	0	41	110
1 Hr	77	14	8	3	2	0	104	118	28	4	0	2	2	154	131	26	5	4	1	1	168	426
13:00	18	5	1	2	0	0	26	35	10	1	0	0	1	47	26	5	2	0	0	0	33	106
13:15	11	2	0	0	0	1	14	38	8	1	0	0	1	48	46	7	2	1	0	1	57	119
13:30	21	5	1	1	1	1	30	27	6	0	0	1	0	34	28	7	3	0	0	2	40	104
13:45	13	3	1	0	1	0	18	33	8	1	1	0	0	43	27	5	0	1	0	1	34	95
1 Hr	63	15	3	3	2	2	88	133	32	3	1	1	2	172	127	24	7	2	0	4	164	424
14:00	13	6	4	1	0	0	24	31	6	1	0	0	1	39	20	3	3	1	0	0	27	90
14:15	19	7	1	0	0	0	27	36	6	2	0	0	0	44	29	5	2	1	0	0	37	108
14:30	26	7	0	2	0	0	35	30	6	0	0	0	0	36	34	5	0	0	0	1	40	111
14:45	20	2	3	2	1	0	28	30	9	3	0	1	0	43	34	9	0	2	0	0	45	116
1 Hr	78	22	8	5	1	0	114	127	27	6	0	1	1	162	117	22	5	4	0	1	149	425
15:00	20	4	2	0	0	0	26	30	4	0	0	0	0	34	30	4	1	0	0	0	35	95
15:15	12	2	1	1	0	0	16	43	9	1	0	0	0	53	16	3	2	1	0	0	22	91
15:30	24	8	2	0	2	0	36	51	9	0	0	1	0	61	32	3	2	3	0	0	40	137
15:45	20	9	2	3	1	0	35	52	13	5	0	1	1	72	25	5	0	0	0	0	30	137
1 Hr	76	23	7	4	3	0	113	176	35	6	0	2	1	220	103	15	5	4	0	0	127	460
16:00	20	7	1	1	0	0	29	45	7	0	0	1	0	53	33	10	0	0	0	0	43	125
16:15	19	3	0	0	0	1	23	57	10	1	0	0	0	68	37	5	1	0	0	0	43	134
16:30	17	1	0	0	0	0	18	53	13	1	0	0	2	69	58	5	2	1	0	1	67	154
16:45	17	0	1	2	0	0	20	60	7	1	1	1	0	70	50	4	0	0	0	0	54	144
1 Hr	73	11	2	3	0	1	90	215	37	3	1	2	2	260	178	24	3	1	0	1	207	557
17:00	18	3	1	0	1	1	24	57	6	0	0	0	0	63	54	4	0	0	0	0	58	145
17:15	15	3	0	0	0	0	18	77	11	0	0	0	0	88	47	0	0	0	0	0	47	153
17:30	26	2	0	0	0	0	28	70	6	0	0	1	0	77	58	4	1	0	0	0	63	168
17:45	21	1	0	0	0	0	22	67	4	2	0	1	0	74	35	2	0	0	0	1	38	134
1 Hr	80	9	1	0	1	1	92	271	27	2	0	2	0	302	194	10	1	0	0	1	206	600
18:00	24	4	0	0	1	0	29	62	9	0	0	0	1	72	57	3	0	0	1	0	61	162
18:15	15	4	0	0	0	0	19	54	5	0	0	1	0	60	36	1	1	0	0	0	38	117
18:30	18	1	0	0	0	0	19	44	2	0	0	0	0	46	34	2	0	0	0	0	36	101
18:45	18	0	0	0	0	0	18	43	4	0	0	1	1	49	29	4	0	0	0	0	33	100
1 Hr	75	9	0	0	1	0	85	203	20	0	0	2	2	227	156	10	1	0	1	0	168	480
Total	974	169	49	38	19	4	1253	1777	317	48	5	17	13	2177	1831	276	65	40	15	18	2245	5675

DESTINATION SUMMARY

	Destination : Arm A Bannold Road						Total	Destination : Arm B High Street						Total	Destination : Arm C Denny End Road						Total	Dest Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	7	6	1	2	0	0	16	55	10	2	1	1	2	71	21	8	1	1	0	0	31	118
07:15	14	10	0	0	1	0	25	60	9	2	0	1	0	72	25	7	0	0	0	1	33	130
07:30	16	5	1	2	0	0	24	89	9	2	1	0	1	102	43	7	1	0	0	0	51	177
07:45	14	8	1	1	0	0	24	60	15	3	0	2	0	80	31	7	1	0	0	0	39	143
1 Hr	51	29	3	5	1	0	89	264	43	9	2	4	3	325	120	29	3	1	0	1	154	568
08:00	13	2	1	0	1	0	17	58	10	0	0	1	1	70	46	3	2	1	0	0	52	139
08:15	11	4	1	0	0	0	16	61	5	2	0	3	1	72	45	9	0	1	0	1	56	144
08:30	12	1	2	1	0	0	16	50	3	0	0	1	1	55	52	4	0	0	1	0	57	128
08:45	14	2	1	4	1	0	22	59	4	0	0	1	0	64	48	3	1	1	0	0	53	139
1 Hr	50	9	5	5	2	0	71	228	22	2	0	6	3	261	191	19	3	3	1	1	218	550
09:00	14	3	6	2	1	0	26	50	10	3	0	0	2	65	35	3	4	3	1	0	46	137
09:15	15	1	5	2	0	0	23	38	4	0	0	0	0	42	27	6	0	2	0	0	35	100
09:30	9	3	0	1	1	1	15	44	4	1	0	1	1	51	34	4	1	2	0	0	41	107
09:45	22	3	1	1	1	0	28	36	9	2	0	1	0	48	30	3	3	1	1	0	38	114
1 Hr	60	10	12	6	3	1	92	168	27	6	0	2	3	206	126	16	8	8	2	0	160	458
10:00	15	6	0	0	0	0	21	33	3	2	0	0	0	38	30	10	0	1	0	0	41	100
10:15	11	5	0	2	0	0	18	31	4	1	0	0	0	36	25	10	4	1	0	0	40	94
10:30	13	3	0	0	1	0	17	29	5	2	0	0	0	36	24	2	2	1	0	0	29	82
10:45	20	4	1	0	1	0	26	29	7	0	0	1	0	37	20	2	0	0	0	0	22	85
1 Hr	59	18	1	2	2	0	82	122	19	5	0	1	0	147	99	24	6	3	0	0	132	361
11:00	11	3	0	2	0	0	16	26	5	0	0	0	0	31	27	5	1	0	0	1	34	81
11:15	23	4	2	2	0	0	31	38	2	0	0	0	0	40	23	9	3	1	0	0	36	107
11:30	6	1	3	1	1	0	12	17	6	1	0	1	0	25	25	10	2	3	0	0	40	77
11:45	18	3	1	1	0	0	23	35	4	0	0	1	0	40	24	5	6	3	0	0	38	101
1 Hr	58	11	6	6	1	0	82	116	17	1	0	2	0	136	99	29	12	7	0	1	148	366
12:00	12	9	1	0	0	0	22	36	9	1	0	0	0	46	35	6	1	1	0	1	44	112
12:15	14	4	1	0	0	0	19	38	6	2	0	0	0	46	35	5	3	0	0	0	43	108
12:30	11	2	0	3	0	0	16	35	3	1	0	0	1	40	36	2	2	0	0	0	40	96

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Site 4 - Bannold Road / High Street / Denny End Road

12:45	16	3	1	1	3	0	24	32	10	1	0	1	0	44	26	9	3	2	1	1	42	110
1 Hr	53	18	3	4	3	0	81	141	28	5	0	1	1	176	132	22	9	3	1	2	169	426
13:00	13	4	2	0	0	1	20	27	5	0	0	0	0	32	39	11	2	2	0	0	54	106
13:15	20	2	1	1	0	0	24	32	6	1	0	0	1	40	43	9	1	0	0	2	55	119
13:30	8	2	1	0	1	0	12	34	7	2	0	1	2	46	34	9	1	1	0	1	46	104
13:45	15	2	0	1	0	0	18	31	7	0	0	1	1	40	27	7	2	1	0	0	37	95
1 Hr	56	10	4	2	1	1	74	124	25	3	0	2	4	158	143	36	6	4	0	3	192	424
14:00	12	2	3	1	0	0	18	20	4	2	0	0	0	26	32	9	3	1	0	1	46	90
14:15	18	3	2	1	0	0	24	30	5	0	0	0	0	35	36	10	3	0	0	0	49	108
14:30	16	0	0	0	0	0	16	37	8	0	0	0	1	46	37	10	0	2	0	0	49	111
14:45	23	4	0	2	1	0	30	35	6	1	1	1	0	44	26	10	5	1	0	0	42	116
1 Hr	69	9	5	4	1	0	88	122	23	3	1	1	1	151	131	39	11	4	0	1	186	425
15:00	21	2	1	0	0	0	24	32	4	0	0	0	0	36	27	6	2	0	0	0	35	95
15:15	22	3	1	1	0	0	27	17	2	1	0	0	0	20	32	9	2	1	0	0	44	91
15:30	29	5	1	3	0	0	38	27	3	2	0	1	0	33	51	12	1	0	2	0	66	137
15:45	19	3	1	0	1	0	24	22	10	0	0	1	0	33	56	14	6	3	0	1	80	137
1 Hr	91	13	4	4	1	0	113	98	19	3	0	2	0	122	166	41	11	4	2	1	225	460
16:00	16	1	0	0	0	0	17	35	11	0	0	0	0	46	47	12	1	1	1	0	62	125
16:15	12	3	1	0	0	0	16	41	6	0	0	0	1	48	60	9	1	0	0	0	70	134
16:30	25	1	1	1	0	1	29	60	6	1	0	0	1	68	43	12	1	0	0	1	57	154
16:45	20	2	0	0	1	0	23	42	4	0	0	0	0	46	65	5	2	3	0	0	75	144
1 Hr	73	7	2	1	1	1	85	178	27	1	0	0	2	208	215	38	5	4	1	1	264	557
17:00	15	5	0	0	0	0	20	53	4	0	0	1	1	59	61	4	1	0	0	0	66	145
17:15	36	3	0	0	0	0	39	39	0	0	0	0	0	39	64	11	0	0	0	0	75	153
17:30	36	4	0	0	0	0	40	49	3	1	0	0	0	53	69	5	0	0	1	0	75	168
17:45	33	2	0	0	0	1	36	30	0	0	0	0	0	30	60	5	2	0	1	0	68	134
1 Hr	120	14	0	0	0	1	135	171	7	1	0	1	1	181	254	25	3	0	2	0	284	600
18:00	41	3	0	0	1	0	45	51	5	0	0	1	0	57	51	8	0	0	0	1	60	162
18:15	31	1	1	0	0	0	33	31	3	0	0	0	0	34	43	6	0	0	1	0	50	117
18:30	24	1	0	0	0	0	25	32	1	0	0	0	0	33	40	3	0	0	0	0	43	101
18:45	22	4	0	0	0	0	26	25	1	0	0	0	0	26	43	3	0	0	1	1	48	100
1 Hr	118	9	1	0	1	0	129	139	10	0	0	1	0	150	177	20	0	0	2	2	201	480
Total	858	157	46	39	17	4	1121	1871	267	39	3	23	18	2221	1853	338	77	41	11	13	2333	5675

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Site 5 - Green Side / Chapel Street / Cambridge Road

Origin Arm A Green Side

	Destination : Arm A Green Side							Destination : Arm B Chapel Street							Destination : Arm C Cambridge Road							Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	
07:00	0	0	0	0	0	0	0	5	1	0	0	0	1	7	10	0	3	0	0	0	13	20
07:15	0	0	0	0	0	0	0	1	0	0	0	0	0	1	16	4	1	0	1	0	22	23
07:30	0	0	0	0	0	0	0	6	1	0	0	1	0	8	26	4	0	0	0	1	31	39
07:45	0	0	0	0	0	0	0	5	1	0	0	0	0	6	21	3	0	0	2	1	27	33
1 Hr	0	0	0	0	0	0	0	17	3	0	0	1	1	22	73	11	4	0	3	2	93	115
08:00	0	0	0	0	0	0	0	5	1	0	0	0	0	6	19	3	0	0	1	0	23	29
08:15	0	0	0	0	0	0	0	4	0	1	0	0	0	5	14	3	0	0	3	0	20	25
08:30	0	0	0	0	0	0	0	2	0	0	0	0	0	2	20	1	0	0	0	0	21	23
08:45	0	0	0	0	0	0	0	2	0	0	0	0	0	2	19	0	0	0	1	0	20	22
1 Hr	0	0	0	0	0	0	0	13	1	1	0	0	0	15	72	7	0	0	5	0	84	99
09:00	0	0	0	0	0	0	0	8	0	0	0	0	0	8	15	1	2	0	0	1	19	27
09:15	1	0	0	0	0	0	1	4	1	0	0	0	0	5	15	7	0	0	0	0	22	28
09:30	0	0	0	0	0	0	0	6	2	0	0	1	0	9	13	3	1	0	0	1	18	27
09:45	0	0	0	0	0	0	0	5	0	1	0	0	0	6	15	1	1	0	1	0	18	24
1 Hr	1	0	0	0	0	0	1	23	3	1	0	1	0	28	58	12	4	0	1	2	77	106
10:00	0	0	0	0	0	0	0	4	0	1	0	0	0	5	17	2	2	0	0	0	21	26
10:15	0	0	0	0	0	0	0	0	2	0	0	0	0	2	9	4	0	0	0	0	13	15
10:30	0	0	0	0	0	0	0	4	0	0	0	0	0	4	15	1	1	0	0	0	17	21
10:45	0	0	0	0	0	0	0	4	1	0	0	0	0	5	11	3	0	0	1	0	15	20
1 Hr	0	0	0	0	0	0	0	12	3	1	0	0	0	16	52	10	3	0	1	0	66	82
11:00	0	0	0	0	0	0	0	2	0	0	0	0	0	2	11	2	0	0	0	0	13	15
11:15	0	0	0	0	0	0	0	6	0	0	0	0	0	6	8	4	0	0	0	0	12	18
11:30	0	0	0	0	0	0	0	3	2	1	0	1	0	7	10	1	0	0	0	0	11	18
11:45	0	0	0	0	0	0	0	6	0	0	0	0	0	6	18	3	1	0	1	0	23	29
1 Hr	0	0	0	0	0	0	0	17	2	1	0	1	0	21	47	10	1	0	1	0	59	80
12:00	0	0	0	0	0	0	0	4	0	1	0	0	0	5	14	3	0	0	0	0	17	22
12:15	0	0	0	0	0	0	0	6	2	0	0	0	0	8	15	1	0	0	0	1	17	25
12:30	0	0	0	0	0	0	0	5	0	0	0	0	0	5	15	1	1	0	0	0	17	22
12:45	0	0	0	0	0	0	0	3	0	0	0	0	0	3	11	5	0	0	1	0	17	20
1 Hr	0	0	0	0	0	0	0	18	2	1	0	0	0	21	55	10	1	0	1	1	68	89
13:00	1	0	0	0	0	0	1	2	1	0	0	0	0	3	6	5	0	0	0	0	11	15
13:15	0	0	0	0	0	0	0	6	2	0	0	0	1	9	12	2	0	0	0	0	14	23
13:30	0	0	0	0	0	0	0	3	0	0	0	1	0	4	15	1	1	0	0	0	17	21
13:45	0	0	0	0	0	0	0	5	0	0	0	0	0	5	14	2	1	0	1	0	18	23
1 Hr	1	0	0	0	0	0	1	16	3	0	0	1	1	21	47	10	2	0	1	0	60	82
14:00	0	0	0	0	0	0	0	1	0	0	0	0	0	1	14	3	0	0	0	1	18	19
14:15	0	0	0	0	0	0	0	0	0	1	0	0	0	1	5	2	0	0	0	0	7	8
14:30	0	0	0	0	0	0	0	3	0	0	0	0	0	3	20	1	0	0	0	0	21	24
14:45	1	0	0	0	0	0	1	3	0	0	0	0	0	3	12	2	1	1	1	0	17	21
1 Hr	1	0	0	0	0	0	1	7	0	1	0	0	0	8	51	8	1	1	1	1	63	72
15:00	0	0	0	0	0	0	0	6	0	0	0	0	0	6	13	3	0	0	0	0	16	22
15:15	0	0	0	0	0	0	0	3	0	0	0	0	0	3	12	2	0	0	0	0	14	17
15:30	0	0	0	0	0	0	0	3	2	0	0	0	0	5	17	0	0	0	1	0	18	23
15:45	0	0	0	0	0	0	0	3	0	0	0	0	0	3	18	6	2	0	1	0	27	30
1 Hr	0	0	0	0	0	0	0	15	2	0	0	0	0	17	60	11	2	0	2	0	75	92
16:00	0	0	0	0	0	0	0	4	1	0	0	0	0	5	11	1	1	0	0	0	13	18
16:15	0	0	0	0	0	0	0	1	0	0	0	0	0	1	17	4	0	0	0	2	23	24
16:30	1	0	0	0	0	0	1	6	1	0	0	0	0	7	33	5	0	0	0	0	38	46
16:45	0	0	0	0	0	0	0	7	1	0	0	0	0	8	16	1	0	0	0	0	17	25
1 Hr	1	0	0	0	0	0	1	18	3	0	0	0	0	21	77	11	1	0	0	2	91	113
17:00	0	0	0	0	0	0	0	7	1	0	0	0	0	8	25	2	0	0	1	1	29	37
17:15	0	0	0	0	0	0	0	3	0	0	0	0	0	3	13	0	0	0	0	0	13	16
17:30	0	0	0	0	0	0	0	8	0	0	0	0	0	8	23	1	0	0	0	0	24	32
17:45	0	0	0	0	0	0	0	3	1	0	0	0	0	4	22	1	1	0	0	0	24	28
1 Hr	0	0	0	0	0	0	0	21	2	0	0	0	0	23	83	4	1	0	1	1	90	113
18:00	0	0	0	0	0	0	0	6	1	0	0	0	0	7	18	1	0	0	1	0	20	27
18:15	0	0	0	0	0	0	0	3	0	0	0	0	0	3	10	2	0	0	0	0	12	15
18:30	0	0	0	0	0	0	0	1	0	0	0	0	0	1	12	0	0	0	0	0	12	13
18:45	0	0	0	0	0	0	0	7	0	0	0	0	0	7	19	2	0	0	0	0	21	28
1 Hr	0	0	0	0	0	0	0	17	1	0	0	0	0	18	59	5	0	0	1	0	65	83
Total	4	0	0	0	0	0	4	194	25	6	0	4	2	231	734	109	20	1	18	9	891	1126

Origin Arm B Chapel Street

	Destination : Arm A Green Side							Destination : Arm B Chapel Street							Destination : Arm C Cambridge Road							Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	
07:00	7	1	0	0	0	0	8	1	0	0	0	0	0	1	16	5	0	0	0	0	21	30
07:15	9	0	0	0	0	0	9	0	0	0	0	0	0	0	21	4	0	1	0	1	27	36
07:30	11	3	2	0	0	0	16	0	0	0	0	0	0	0	19	2	0	0	0	0	21	37
07:45	22	10	1	0	0	0	33	0	0	0	0	0	0	0	24	0	2	0	0	0	26	59
1 Hr	49	14	3	0	0	0	66	1	0	0	0	0	0	1	80	11	2	1	0	1	95	162
08:00	23	3	0	0	0	0	26	0	0	0	0	0	0	0	21	4	0	0	0	0	25	51
08:15	22	2	0	0	0	0	24	0	0	0	0	0	0	0	24	4	2	0	0	0	30	54
08:30	26	4	0	0	0	0	30	0	0	0	0	0	0	0	27	3	0	0	0	0	30	60
08:45	25	3	0	0	0	0	28	0	0	0	0	0	0	0	15	5	0	1	0	0	21	49
1 Hr	96	12	0	0	0	0	108	0	0	0	0	0	0	0	87	16	2	1	0	0	106	214
09:00	11	1	1	0	0	0	13	0	0	0	0	0	0	0	17	3	0	0	0	1	21	34
09:15	9	2	0	0	0	0	11	0	0	0	0	0	0	0	30	1	1	0	0	0	32	43
09:30	17	1	0	0	0	0	18	0	0	0	0	0	0	0	21	5	0	0	0	0	26	44
09:45	19	1	1	0	0	0	21	0	0	0	0	0	0	0	17	7	0	0	0	0	24	45
1 Hr	56	5	2	0	0	0	63	0	0	0	0	0	0	0	85	16	1	0	0	1	103	166
10:00	16	2	1	0	0	0	19	0	0	0	0	0	0	0	20	7	0	0	0	0	27	46
10:15	11	2	1	0	0	0	14	0	0	0	0	0	0	0	13	4	0	0	0	0	17	31
10:30	10	2	1	0	0	0	13	0	0	0	0	0	0	0	13	2	1	0	0	0	16	29
10:45	14	4	0	0	0	0	18	0	0	0	0	0	0	0	24	5	1	0	0	0	30	48
1 Hr	51	10	3	0	0	0	64	0	0	0	0	0	0	0	70	18	2	0	0	0	90	154
11:00	19	2	2	0	0	0	23	0	0	0	0	0	0	0	16	1	0	0	0	0	17	40
11:15	12	2	0	0	0	0	14	0	0	0	0	0	0	0	15	1	0	0	0	0	16	30
11:30	20	4	3	0	0	0	27	0	1	0	0	0	0	1	16	1	1	0	0	0	18	46
11:45	16	3	2	0	0	0	21	0	0	0	0	0	0	0	15	1	0	0	0	0	16	37
1 Hr	67	11	7	0	0	0	85	0	1	0	0	0	0	1	62	4	1	0	0	0	67	153
12:00	18	0	0	0	0	0	18	0	0	0	0	0	0	0	16	1	1	0	0	0	18	36
12:15	20	2	0	0	0	0	22	0	0	0	0	0	0	0	23	5	4	0	0	0	32	54
12:30	17	1	1	0	0	0	19	0	0	0	0	0	0	0	19	2	0	0	0	0	21	40
12:45	16	4	1	0	1	0	22	0	0	0	0	0	0	0	15	5	1	0	0	2	23	45

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 5 - Green Side / Chapel Street / Cambridge Road

1 Hr	71	7	2	0	1	0	81	0	0	0	0	0	0	0	73	13	6	0	0	2	94	175
13:00	24	3	0	0	0	0	27	0	0	0	0	0	0	0	10	5	0	0	0	0	15	42
13:15	24	3	1	0	0	0	28	0	0	0	0	0	0	0	15	4	0	0	0	1	20	48
13:30	14	2	0	0	0	0	16	0	0	0	0	0	0	0	13	2	2	1	0	0	18	34
13:45	15	4	1	1	0	0	21	0	0	0	0	0	0	0	19	5	0	0	0	0	24	45
1 Hr	77	12	2	1	0	0	92	0	0	0	0	0	0	0	57	16	2	1	0	1	77	169
14:00	25	4	1	0	0	0	30	0	0	0	0	0	0	0	17	6	1	0	0	0	24	54
14:15	21	4	2	0	0	0	27	0	0	0	0	0	0	0	19	5	0	0	0	0	24	51
14:30	16	6	0	0	0	0	22	0	0	0	0	0	0	0	12	1	0	0	0	0	13	35
14:45	21	7	3	0	0	0	31	0	0	0	0	0	0	0	31	7	0	0	1	0	39	70
1 Hr	83	21	6	0	0	0	110	0	0	0	0	0	0	0	79	19	1	0	1	0	100	210
15:00	14	3	0	0	0	0	17	0	0	0	0	0	0	0	16	2	0	1	0	0	19	36
15:15	19	7	0	0	0	0	26	0	0	0	0	0	0	0	19	2	1	0	0	1	23	49
15:30	29	6	0	0	0	0	35	0	0	0	0	0	0	0	23	8	0	0	0	0	31	66
15:45	42	5	3	0	0	0	50	0	0	0	0	0	0	0	32	7	2	0	0	0	41	91
1 Hr	104	21	3	0	0	0	128	0	0	0	0	0	0	0	90	19	3	1	0	1	114	242
16:00	32	6	0	0	0	0	38	0	0	0	0	0	0	0	23	5	0	0	0	0	28	66
16:15	47	5	0	0	0	1	53	0	0	0	0	0	0	0	15	5	0	0	0	1	21	74
16:30	26	7	1	0	0	0	34	0	0	0	0	0	0	0	19	1	1	0	0	0	21	55
16:45	46	4	1	0	0	0	51	0	0	0	0	0	0	0	22	0	0	0	0	0	22	73
1 Hr	151	22	2	0	0	1	176	0	0	0	0	0	0	0	79	11	1	0	0	1	92	268
17:00	43	4	0	0	0	0	47	0	0	0	0	0	0	0	24	2	0	0	0	0	26	73
17:15	54	4	0	0	0	0	58	0	0	0	0	0	0	0	19	3	0	0	0	0	22	80
17:30	41	2	0	0	1	0	44	0	0	0	0	0	0	0	40	3	0	0	0	0	43	87
17:45	53	3	0	0	0	0	56	0	0	0	0	0	0	0	19	1	1	0	0	0	21	77
1 Hr	191	13	0	0	1	0	205	0	0	0	0	0	0	0	102	9	1	0	0	0	112	317
18:00	30	4	0	0	0	1	35	0	0	0	0	0	0	0	38	1	0	0	1	1	41	76
18:15	32	2	0	0	0	0	34	0	0	0	0	0	0	0	27	1	1	0	0	0	29	63
18:30	27	3	0	0	0	0	30	0	0	0	0	0	0	0	21	3	0	0	0	0	24	54
18:45	28	2	0	0	0	0	30	0	0	0	0	0	0	0	32	1	0	0	0	0	33	63
1 Hr	117	11	0	0	0	1	129	0	0	0	0	0	0	0	118	6	1	0	1	1	127	256
Total	1113	159	30	1	2	2	1307	1	1	0	0	0	0	2	982	158	23	4	2	8	1177	2486

Origin : Arm C Cambridge Road

	Destination : Arm A Green Side						Total	Destination : Arm B Chapel Street						Total	Destination : Arm C Cambridge Road						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	3	2	0	1	0	0	6	24	3	1	0	0	0	28	0	0	0	0	0	0	0	34
07:15	6	5	0	0	0	1	12	26	3	1	1	0	0	31	0	0	0	0	0	0	0	43
07:30	11	4	1	0	0	0	16	33	3	0	0	0	1	37	0	0	0	0	0	0	0	53
07:45	9	6	0	0	0	0	15	30	5	0	0	0	0	35	0	0	1	0	0	0	1	51
1 Hr	29	17	1	1	0	1	49	113	14	2	1	0	1	131	0	0	1	0	0	0	1	181
08:00	19	3	1	0	0	0	23	21	7	0	0	0	0	28	0	0	0	0	0	0	0	51
08:15	11	5	0	0	0	0	16	36	8	0	0	0	0	44	0	0	0	0	0	0	0	60
08:30	16	2	1	0	0	0	19	33	5	1	0	0	0	39	0	0	0	0	0	0	0	58
08:45	10	2	0	0	1	0	13	24	5	1	0	0	0	30	1	0	0	0	0	0	1	44
1 Hr	56	12	2	0	1	0	71	114	25	2	0	0	0	141	1	0	0	0	0	0	1	213
09:00	20	2	4	0	0	0	26	21	4	1	0	0	0	26	0	0	0	0	0	0	0	52
09:15	11	4	0	0	0	0	15	20	3	1	0	0	0	24	0	0	0	0	0	0	0	39
09:30	11	3	0	0	1	0	15	19	5	0	0	0	1	25	0	0	0	0	0	0	0	40
09:45	12	2	0	0	0	0	14	15	0	2	0	0	0	17	0	0	0	0	0	0	0	31
1 Hr	54	11	4	0	1	0	70	75	12	4	0	0	1	92	0	0	0	0	0	0	0	162
10:00	5	2	0	0	0	0	7	12	5	0	1	0	0	18	0	0	0	0	0	0	0	25
10:15	10	2	0	0	0	0	12	15	4	2	0	0	0	21	0	0	0	0	0	0	0	33
10:30	5	0	0	0	0	0	5	11	0	0	0	0	0	11	0	0	0	0	0	0	0	16
10:45	18	2	0	0	0	0	20	16	1	0	0	0	1	18	0	0	0	0	0	0	0	38
1 Hr	38	6	0	0	0	0	44	54	10	2	1	0	1	68	0	0	0	0	0	0	0	112
11:00	12	1	1	0	0	1	15	10	3	1	0	0	0	14	0	0	0	0	0	0	0	29
11:15	17	2	1	0	0	0	20	24	2	1	0	0	0	27	0	0	0	0	0	0	0	47
11:30	8	3	0	1	1	0	13	19	3	1	1	0	0	24	0	0	0	0	0	0	0	37
11:45	16	2	1	0	0	0	19	18	2	0	0	0	0	20	0	0	1	0	0	0	1	40
1 Hr	53	8	3	1	1	1	67	71	10	3	1	0	0	85	0	0	1	0	0	0	1	153
12:00	12	4	0	0	0	0	16	20	2	0	0	0	0	22	0	0	0	0	0	0	0	38
12:15	13	3	1	0	0	0	17	21	3	0	0	0	0	24	0	0	0	0	0	0	0	41
12:30	10	3	0	0	0	0	13	19	3	1	0	0	0	23	0	0	0	0	0	0	0	36
12:45	15	4	2	0	1	0	22	13	5	0	0	0	0	18	0	0	0	0	0	0	0	40
1 Hr	50	14	3	0	1	0	68	73	13	1	0	0	0	87	0	0	0	0	0	0	0	155
13:00	13	5	1	0	0	1	20	18	2	0	0	0	0	20	0	0	0	0	0	0	0	40
13:15	5	3	0	0	0	1	9	9	7	1	1	0	0	18	0	0	0	0	0	0	0	27
13:30	8	1	0	0	0	0	9	20	2	0	0	0	0	22	0	0	0	0	0	0	0	31
13:45	15	4	0	0	0	0	19	20	6	0	0	0	0	26	1	0	0	0	0	0	1	46
1 Hr	41	13	1	0	0	2	57	67	17	1	1	0	0	86	1	0	0	0	0	0	1	144
14:00	11	1	1	0	0	0	13	25	3	1	0	0	0	29	0	0	0	0	0	0	0	42
14:15	15	0	0	0	0	1	16	15	1	0	0	0	0	16	0	0	0	0	0	0	0	32
14:30	11	2	1	0	0	0	14	21	3	0	0	0	0	24	1	0	0	0	0	0	1	39
14:45	19	1	0	0	1	0	21	19	1	0	0	0	0	20	0	0	0	0	0	0	0	41
1 Hr	56	4	2	0	1	1	64	80	8	1	0	0	0	89	1	0	0	0	0	0	1	154
15:00	25	1	0	0	0	0	26	21	0	1	0	0	0	22	0	1	0	0	0	0	1	49
15:15	12	5	1	0	0	0	18	27	6	0	0	0	0	33	0	0	0	0	0	0	0	51
15:30	22	1	0	0	1	0	24	18	3	1	0	2	1	25	0	0	1	0	0	0	1	50
15:45	20	3	1	0	1	0	25	21	5	0	0	0	0	26	0	0	0	0	0	0	0	51
1 Hr	79	10	2	0	2	0	93	87	14	2	0	2	1	106	0	1	1	0	0	0	2	201
16:00	13	3	0	0	1	0	17	31	4	1	0	0	0	36	0	1	1	0	0	0	2	55
16:15	23	7	1	0	0	0	31	26	4	0	0	0	0	30	0	0	0	0	0	0	0	61
16:30	30	3	2	0	0	1	36	27	3	0	0	0	0	30	0	0	0	0	0	0	0	66
16:45	15	4	0	0	1	0	20	22	1	0	0	0	0	23	0	0	0	0	0	0	0	43
1 Hr	81	17	3	0	2	1	104	106	12	1	0	0	0	119	0	1	1	0	0	0	2	225
17:00	18	1	0	0	0	0	19	34	4	0	0	0	0	38	0	0	0	0	0	0	0	57
17:15	22	4	0	0	0	1	27	27	0	0	0	0	1	28	0	0	0	0	0	0	0	55
17:30	33	3	0	0	1	1	38	31	4	0	0	0	0	35	0	0	0	0	0	0	0	73
17:45	25	0	1	0	0	1	27	42	1	1	0	0	0	44	1	0	0	0	0	0	1	72
1 Hr	98	8	1	0	1	3	111	134	9	1	0	0	1	145	1	0	0	0	0	0	1	257
18:00	33	3	1	0	0	0	37	37	5	1	0	0	0	43	0	0	0	0	0	0	0	80
18:15	15	4	0	0	1	0	20	24	2	0	0	0	0	26	0	0	0	0	0	0	0	46
18:30	25	0	0	0	1	0	26	25	0	0	0	0	0	25	0	0	0	0	0	0	0	51
18:45	21	2	0	0	0	0	23	20	1	1	0	0	0	22	0	0	0	0	0	0	0	45
1 Hr	94	9	1	0	2	0	106	106	8	2	0	0	0	116	0	0	0	0	0	0	0	222
Total	729	129	23	2	12	9	904	1080	152	22	4	2	5	1265	4	2	4	0	0	0	10	2179

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3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 5 - Green Side / Chapel Street / Cambridge Road

ORIGIN SUMMARY

	Origin : Arm A Green Side						Total	Origin : Arm B Chapel Street						Total	Origin : Arm C Cambridge Road						Total	Origin Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	15	1	3	0	0	1	20	24	6	0	0	0	0	30	27	5	1	1	0	0	34	84
07:15	17	4	1	0	1	0	23	30	4	0	1	0	1	36	32	8	1	1	0	1	43	102
07:30	32	5	0	0	1	1	39	30	5	2	0	0	0	37	44	7	1	0	0	1	53	129
07:45	26	4	0	0	2	1	33	46	10	3	0	0	0	59	39	11	1	0	0	0	51	143
1 Hr	90	14	4	0	4	3	115	130	25	5	1	0	1	162	142	31	4	2	0	2	181	458
08:00	24	4	0	0	1	0	29	44	7	0	0	0	0	51	40	10	1	0	0	0	51	131
08:15	18	3	1	0	3	0	25	46	6	2	0	0	0	54	47	13	0	0	0	0	60	139
08:30	22	1	0	0	0	0	23	53	7	0	0	0	0	60	49	7	2	0	0	0	58	141
08:45	21	0	0	0	1	0	22	40	8	0	1	0	0	49	35	7	1	0	1	0	44	115
1 Hr	85	8	1	0	5	0	99	183	28	2	1	0	0	214	171	37	4	0	1	0	213	526
09:00	23	1	2	0	0	1	27	28	4	1	0	0	1	34	41	6	5	0	0	0	52	113
09:15	20	8	0	0	0	0	28	39	3	1	0	0	0	43	31	7	1	0	0	0	39	110
09:30	19	5	1	0	1	1	27	38	6	0	0	0	0	44	30	8	0	0	1	1	40	111
09:45	20	1	2	0	1	0	24	36	8	1	0	0	0	45	27	2	2	0	0	0	31	100
1 Hr	82	15	5	0	2	2	106	141	21	3	0	0	1	166	129	23	8	0	1	1	162	434
10:00	21	2	3	0	0	0	26	36	9	1	0	0	0	46	17	7	0	1	0	0	25	97
10:15	9	6	0	0	0	0	15	24	6	1	0	0	0	31	25	6	2	0	0	0	33	79
10:30	19	1	1	0	0	0	21	23	4	2	0	0	0	29	16	0	0	0	0	0	16	66
10:45	15	4	0	0	1	0	20	38	9	1	0	0	0	48	34	3	0	0	0	1	38	106
1 Hr	64	13	4	0	1	0	82	121	28	5	0	0	0	154	92	16	2	1	0	1	112	348
11:00	13	2	0	0	0	0	15	35	3	2	0	0	0	40	22	4	2	0	0	1	29	84
11:15	14	4	0	0	0	0	18	27	3	0	0	0	0	30	41	4	2	0	0	0	47	95
11:30	13	3	1	0	1	0	18	36	6	4	0	0	0	46	27	6	1	2	1	0	37	101
11:45	24	3	1	0	1	0	29	31	4	2	0	0	0	37	34	4	2	0	0	0	40	106
1 Hr	64	12	2	0	2	0	80	129	16	8	0	0	0	153	124	18	7	2	1	1	153	386
12:00	18	3	1	0	0	0	22	34	1	1	0	0	0	36	32	6	0	0	0	0	38	96
12:15	21	3	0	0	0	1	25	43	7	4	0	0	0	54	34	6	1	0	0	0	41	120
12:30	20	1	1	0	0	0	22	36	3	1	0	0	0	40	29	6	1	0	0	0	36	98
12:45	14	5	0	0	1	0	20	31	9	2	0	1	2	45	28	9	2	0	1	0	40	105
1 Hr	73	12	2	0	1	1	89	144	20	8	0	1	2	175	123	27	4	0	1	0	155	419
13:00	9	6	0	0	0	0	15	34	8	0	0	0	0	42	31	7	1	0	0	1	40	97
13:15	18	4	0	0	0	1	23	39	7	1	0	0	1	48	14	10	1	1	0	1	27	98
13:30	18	1	1	0	1	0	21	27	4	2	1	0	0	34	28	3	0	0	0	0	31	86
13:45	19	2	1	0	1	0	23	34	9	1	1	0	0	45	36	10	0	0	0	0	46	114
1 Hr	64	13	2	0	2	1	82	134	28	4	2	0	1	169	109	30	2	1	0	2	144	395
14:00	15	3	0	0	0	1	19	42	10	2	0	0	0	54	36	4	2	0	0	0	42	115
14:15	5	2	1	0	0	0	8	40	9	2	0	0	0	51	30	1	0	0	0	1	32	91
14:30	23	1	0	0	0	0	24	28	7	0	0	0	0	35	33	5	1	0	0	0	39	98
14:45	16	2	1	1	1	0	21	52	14	3	0	1	0	70	38	2	0	0	1	0	41	132
1 Hr	59	8	2	1	1	1	72	162	40	7	0	1	0	210	137	12	3	0	1	1	154	436
15:00	19	3	0	0	0	0	22	30	5	0	1	0	0	36	46	2	1	0	0	0	49	107
15:15	15	2	0	0	0	0	17	38	9	1	0	0	1	49	39	11	1	0	0	0	51	117
15:30	20	2	0	0	1	0	23	52	14	0	0	0	0	66	40	4	2	0	3	1	50	139
15:45	21	6	2	0	1	0	30	74	12	5	0	0	0	91	41	8	1	0	1	0	51	172
1 Hr	75	13	2	0	2	0	92	194	40	6	1	0	1	242	166	25	5	0	4	1	201	535
16:00	15	2	1	0	0	0	18	55	11	0	0	0	0	66	44	8	2	0	1	0	55	139
16:15	18	4	0	0	0	2	24	62	10	0	0	0	2	74	49	11	1	0	0	0	61	159
16:30	40	6	0	0	0	0	46	45	8	2	0	0	0	55	57	6	2	0	0	1	66	167
16:45	23	2	0	0	0	0	25	68	4	1	0	0	0	73	37	5	0	0	1	0	43	141
1 Hr	96	14	1	0	0	2	113	230	33	3	0	0	2	268	187	30	5	0	2	1	225	606
17:00	32	3	0	0	1	1	37	67	6	0	0	0	0	73	52	5	0	0	0	0	57	167
17:15	16	0	0	0	0	0	16	73	7	0	0	0	0	80	49	4	0	0	0	2	55	151
17:30	31	1	0	0	0	0	32	81	5	0	0	1	0	87	64	7	0	0	1	1	73	192
17:45	25	2	1	0	0	0	28	72	4	1	0	0	0	77	68	1	2	0	0	1	72	177
1 Hr	104	6	1	0	1	1	113	293	22	1	0	1	0	317	233	17	2	0	1	4	257	687
18:00	24	2	0	0	1	0	27	68	5	0	0	1	2	76	70	8	2	0	0	0	80	183
18:15	13	2	0	0	0	0	15	59	3	1	0	0	0	63	39	6	0	0	1	0	46	124
18:30	13	0	0	0	0	0	13	48	6	0	0	0	0	54	50	0	0	0	1	0	51	118
18:45	26	2	0	0	0	0	28	60	3	0	0	0	0	63	41	3	1	0	0	0	45	136
1 Hr	76	6	0	0	1	0	83	235	17	1	0	1	2	256	200	17	3	0	2	0	222	561
Total	932	134	26	1	22	11	1126	2096	318	53	5	4	10	2486	1813	283	49	6	14	14	2179	5791

DESTINATION SUMMARY

	Destination : Arm A Green Side						Total	Destination : Arm B Chapel Street						Total	Destination : Arm C Cambridge Road						Total	Dest Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	10	3	0	1	0	0	14	30	4	1	0	0	1	36	26	5	3	0	0	0	34	84
07:15	15	5	0	0	0	1	21	27	3	1	1	0	0	32	37	8	1	1	1	1	49	102
07:30	22	7	3	0	0	0	32	39	4	0	0	1	1	45	45	6	0	0	0	1	52	129
07:45	31	16	1	0	0	0	48	35	6	0	0	0	0	41	45	3	3	0	2	1	54	143
1 Hr	78	31	4	1	0	1	115	131	17	2	1	1	2	154	153	22	7	1	3	3	189	458
08:00	42	6	1	0	0	0	49	26	8	0	0	0	0	34	40	7	0	0	1	0	48	131
08:15	33	7	0	0	0	0	40	40	8	1	0	0	0	49	38	7	2	0	3	0	50	139
08:30	42	6	1	0	0	0	49	35	5	1	0	0	0	41	47	4	0	0	0	0	51	141
08:45	35	5	0	0	1	0	41	26	5	1	0	0	0	32	35	5	0	1	1	0	42	115
1 Hr	152	24	2	0	1	0	179	127	26	3	0	0	0	156	160	23	2	1	5	0	191	526
09:00	31	3	5	0	0	0	39	29	4	1	0	0	0	34	32	4	2	0	0	2	40	113
09:15	21	6	0	0	0	0	27	24	4	1	0	0	0	29	45	8	1	0	0	0	54	110
09:30	28	4	0	0	1	0	33	25	7	0	0	1	1	34	34	8	1	0	0	1	44	111
09:45	31	3	1	0	0	0	35	20	0	3	0	0	0	23	32	8	1	0	1	0	42	100
1 Hr	111	16	6	0	1	0	134	98	15	5	0	1	1	120	143	28	5	0	1	3	180	434
10:00	21	4	1	0	0	0	26	16	5	1	1	0	0	23	37	9	2	0	0	0	48	97
10:15	21	4	1	0	0	0	26	15	6	2	0	0	0	23	22	8	0	0	0	0	30	79
10:30	15	2	1	0	0	0	18	15	0	0	0	0	0	15	28	3	2	0	0	0	33	66
10:45	32	6	0	0	0	0	38	20	2	0	0	0	1	23	35	8	1	0	1	0	45	106
1 Hr	89	16	3	0	0	0	108	66	13	3	1	0	1	84	122	28	5	0	1	0	156	348
11:00	31	3	3	0	0	1	38	12	3	1	0	0	0	16	27	3	0	0	0	0	30	84
11:15	29	4	1	0	0	0	34	30	2	1	0	0	0	33	23	5	0	0	0	0	28	95
11:30	28	7	3	1	1	0	40	22	6	2	1	1	0	32	26	2	1	0	0	0	29	101
11:45	32	5	3	0	0	0	40	24	2	0	0	0	0	26	33	4	2	0	1	0	40	106
1 Hr	120	19	10	1	1	1	152	88	13	4	1	1	0	107	109	14	3	0	1	0	127	386
12:00	30	4	0	0	0	0	34	24	2	1	0	0	0	27	30	4	1	0	0	0	35	96
12:15	33	5	1	0	0	0	39	27	5	0	0	0	0	32	38	6	4	0	0	1	49	120
12:30	27	4	1	0	0	0	32	24	3	1	0	0	0	28	34	3	1	0	0	0	38	98

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Site 5 - Green Side / Chapel Street / Cambridge Road

12:45	31	8	3	0	2	0	44	16	5	0	0	0	0	21	26	10	1	0	1	2	40	105
1 Hr	121	21	5	0	2	0	149	91	15	2	0	0	0	108	128	23	7	0	1	3	162	419
13:00	38	8	1	0	0	1	48	20	3	0	0	0	0	23	16	10	0	0	0	0	26	97
13:15	29	6	1	0	0	1	37	15	9	1	1	0	1	27	27	6	0	0	0	1	34	98
13:30	22	3	0	0	0	0	25	23	2	0	0	1	0	26	28	3	3	1	0	0	35	86
13:45	30	8	1	1	0	0	40	25	6	0	0	0	0	31	34	7	1	0	1	0	43	114
1 Hr	119	25	3	1	0	2	150	83	20	1	1	1	1	107	105	26	4	1	1	1	138	395
14:00	36	5	2	0	0	0	43	26	3	1	0	0	0	30	31	9	1	0	0	1	42	115
14:15	36	4	2	0	0	1	43	15	1	1	0	0	0	17	24	7	0	0	0	0	31	91
14:30	27	8	1	0	0	0	36	24	3	0	0	0	0	27	33	2	0	0	0	0	35	98
14:45	41	8	3	0	1	0	53	22	1	0	0	0	0	23	43	9	1	1	2	0	56	132
1 Hr	140	25	8	0	1	1	175	87	8	2	0	0	0	97	131	27	2	1	2	1	164	436
15:00	39	4	0	0	0	0	43	27	0	1	0	0	0	28	29	6	0	1	0	0	36	107
15:15	31	12	1	0	0	0	44	30	6	0	0	0	0	36	31	4	1	0	0	1	37	117
15:30	51	7	0	0	1	0	59	21	5	1	0	2	1	30	40	8	1	0	1	0	50	139
15:45	62	8	4	0	1	0	75	24	5	0	0	0	0	29	50	13	4	0	1	0	68	172
1 Hr	183	31	5	0	2	0	221	102	16	2	0	2	1	123	150	31	6	1	2	1	191	535
16:00	45	9	0	0	1	0	55	35	5	1	0	0	0	41	34	7	2	0	0	0	43	139
16:15	70	12	1	0	0	1	84	27	4	0	0	0	0	31	32	9	0	0	0	3	44	159
16:30	57	10	3	0	0	1	71	33	4	0	0	0	0	37	52	6	1	0	0	0	59	167
16:45	61	8	1	0	1	0	71	29	2	0	0	0	0	31	38	1	0	0	0	0	39	141
1 Hr	233	39	5	0	2	2	281	124	15	1	0	0	0	140	156	23	3	0	0	3	185	606
17:00	61	5	0	0	0	0	66	41	5	0	0	0	0	46	49	4	0	0	1	1	55	167
17:15	76	8	0	0	0	1	85	30	0	0	0	0	1	31	32	3	0	0	0	0	35	151
17:30	74	5	0	0	2	1	82	39	4	0	0	0	0	43	63	4	0	0	0	0	67	192
17:45	78	3	1	0	0	1	83	45	2	1	0	0	0	48	42	2	2	0	0	0	46	177
1 Hr	289	21	1	0	2	3	316	155	11	1	0	0	1	168	186	13	2	0	1	1	203	687
18:00	63	7	1	0	0	1	72	43	6	1	0	0	0	50	56	2	0	0	2	1	61	183
18:15	47	6	0	0	1	0	54	27	2	0	0	0	0	29	37	3	1	0	0	0	41	124
18:30	52	3	0	0	1	0	56	26	0	0	0	0	0	26	33	3	0	0	0	0	36	118
18:45	49	4	0	0	0	0	53	27	1	1	0	0	0	29	51	3	0	0	0	0	54	136
1 Hr	211	20	1	0	2	1	235	123	9	2	0	0	0	134	177	11	1	0	2	1	192	561
Total	1846	288	53	3	14	11	2215	1275	178	28	4	6	7	1498	1720	269	47	5	20	17	2078	5791

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Site 6 - Green Side / Chapel Street(SE) / Chapel Street(NW)

Origin Arm A Green Side

	Destination : Arm A Green Side						Total	Destination : Arm B Chapel Street(SE)						Total	Destination : Arm C Chapel Street(NW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	0	0	0	0	0	0	0	53	6	0	0	0	1	60	3	0	0	0	0	0	3	63
07:15	0	0	0	0	0	0	0	54	8	0	1	0	0	63	1	1	0	0	0	0	2	65
07:30	0	0	0	0	0	0	0	54	8	2	0	0	1	65	4	2	1	0	0	0	7	72
07:45	0	0	0	0	0	0	0	57	7	1	0	0	0	65	5	1	2	0	0	0	8	73
1 Hr	0	0	0	0	0	0	0	218	29	3	1	0	2	253	13	4	3	0	0	0	20	273
08:00	0	0	0	0	0	0	0	42	9	0	0	0	1	52	3	1	0	0	0	0	4	56
08:15	0	0	0	0	0	0	0	50	6	0	0	0	1	57	6	0	2	0	0	0	8	65
08:30	0	0	0	0	0	0	0	36	3	0	0	0	1	40	3	0	0	0	0	0	3	43
08:45	0	0	0	0	0	0	0	40	2	0	0	0	0	42	3	0	0	1	0	0	4	46
1 Hr	0	0	0	0	0	0	0	168	20	0	0	0	3	191	15	1	2	1	0	0	19	210
09:00	0	0	0	0	0	0	0	32	6	1	0	0	0	39	3	0	0	0	0	0	3	42
09:15	0	0	0	0	0	0	0	33	6	0	0	0	0	39	10	0	1	0	0	0	11	50
09:30	0	0	0	0	0	0	0	21	1	0	0	0	1	23	9	1	0	0	0	0	10	33
09:45	0	0	0	0	0	0	0	26	5	1	0	0	0	32	6	0	0	0	0	0	6	38
1 Hr	0	0	0	0	0	0	0	112	18	2	0	0	1	133	28	1	1	0	0	0	30	163
10:00	0	0	0	0	0	0	0	15	0	0	0	0	0	15	3	0	1	0	0	0	4	19
10:15	0	0	0	0	0	0	0	21	0	0	0	0	0	21	1	0	0	0	0	0	1	22
10:30	0	0	0	0	0	0	0	19	7	0	0	0	0	26	2	0	1	0	0	0	3	29
10:45	0	0	0	0	0	0	0	17	3	0	0	0	1	21	3	0	1	0	0	0	4	25
1 Hr	0	0	0	0	0	0	0	72	10	0	0	0	1	83	9	0	3	0	0	0	12	95
11:00	0	0	0	0	0	0	0	14	3	0	0	0	0	17	3	0	0	0	0	0	3	20
11:15	0	0	0	0	0	0	0	25	2	0	0	0	0	27	2	0	0	0	0	0	2	29
11:30	0	0	0	0	0	0	0	13	3	1	1	0	0	18	4	1	0	0	0	0	5	23
11:45	0	0	0	0	0	0	0	17	2	0	0	0	0	19	3	1	0	0	0	0	4	23
1 Hr	0	0	0	0	0	0	0	69	10	1	1	0	0	81	12	2	0	0	0	0	14	95
12:00	0	0	0	0	0	0	0	17	4	1	0	0	0	22	2	0	1	0	0	0	3	25
12:15	0	0	0	0	0	0	0	19	4	0	0	0	0	23	11	2	1	0	0	0	14	37
12:30	0	0	0	0	0	0	0	16	2	0	0	0	0	18	4	1	0	0	0	0	5	23
12:45	0	0	0	0	0	0	0	18	6	1	0	0	0	25	5	0	0	0	0	0	5	30
1 Hr	0	0	0	0	0	0	0	70	16	2	0	0	0	88	22	3	2	0	0	0	27	115
13:00	0	0	0	0	0	0	0	16	1	0	0	0	0	17	3	0	0	0	0	0	3	20
13:15	0	0	0	0	0	0	0	19	5	0	0	0	0	24	7	0	0	0	0	1	8	32
13:30	0	0	0	0	0	0	0	21	6	0	0	0	1	28	2	0	1	0	0	0	3	31
13:45	0	0	0	0	0	0	0	16	3	0	0	0	0	19	1	2	0	0	0	0	3	22
1 Hr	0	0	0	0	0	0	0	72	15	0	0	0	1	88	13	2	1	0	0	1	17	105
14:00	0	0	0	0	0	0	0	10	2	0	0	0	0	12	1	1	1	0	0	0	3	15
14:15	0	0	0	0	0	0	0	14	2	0	0	0	0	16	3	0	0	0	0	0	3	19
14:30	0	0	0	0	0	0	0	18	4	0	0	0	0	22	5	1	0	0	0	0	6	28
14:45	0	0	0	0	0	0	0	16	4	0	0	0	0	20	3	1	0	0	0	0	4	24
1 Hr	0	0	0	0	0	0	0	58	12	0	0	0	0	70	12	3	1	0	0	0	16	86
15:00	0	0	0	0	0	0	0	17	3	0	0	0	0	20	1	1	0	0	0	0	2	22
15:15	0	0	0	0	0	0	0	8	4	0	0	0	0	12	0	0	0	0	0	0	0	12
15:30	0	0	0	0	0	0	0	19	3	0	0	0	0	22	5	0	0	0	0	0	5	27
15:45	0	0	0	0	0	0	0	16	2	0	0	0	0	18	6	2	2	0	0	0	10	28
1 Hr	0	0	0	0	0	0	0	60	12	0	0	0	0	72	12	3	2	0	0	0	17	89
16:00	0	0	0	0	0	0	0	27	7	0	0	0	0	34	1	1	0	0	0	0	2	36
16:15	0	0	0	0	0	0	0	19	4	0	0	0	0	23	4	1	0	0	0	0	5	28
16:30	0	0	0	0	0	0	0	25	4	1	0	0	0	30	5	0	0	0	0	0	5	35
16:45	0	0	0	0	0	0	0	26	3	0	0	0	0	29	4	0	0	0	0	0	4	33
1 Hr	0	0	0	0	0	0	0	97	18	1	0	0	0	116	14	2	0	0	0	0	16	132
17:00	0	0	0	0	0	0	0	29	3	0	0	0	0	32	3	0	0	0	0	0	3	35
17:15	0	0	0	0	0	0	0	23	0	0	0	0	0	23	4	0	0	0	0	0	4	27
17:30	0	0	0	0	0	0	0	27	1	0	0	0	0	28	5	0	0	0	0	0	5	33
17:45	0	0	0	0	0	0	0	16	0	0	0	0	0	16	2	1	0	0	0	0	3	19
1 Hr	0	0	0	0	0	0	0	95	4	0	0	0	0	99	14	1	0	0	0	0	15	114
18:00	0	0	0	0	0	0	0	23	2	0	0	0	0	25	2	1	0	0	0	0	3	28
18:15	0	0	0	0	0	0	0	20	1	0	0	0	0	21	4	0	0	0	0	0	4	25
18:30	0	0	0	0	0	0	0	20	2	0	0	0	0	22	6	0	0	0	0	0	6	28
18:45	0	0	0	0	0	0	0	6	0	0	0	0	0	6	5	0	0	0	0	0	5	11
1 Hr	0	0	0	0	0	0	0	69	5	0	0	0	0	74	17	1	0	0	0	0	18	92
Total	0	0	0	0	0	0	0	1160	169	9	2	0	8	1348	181	23	15	1	0	1	221	1569

Origin Arm B Chapel Street(SE)

	Destination : Arm A Green Side						Total	Destination : Arm B Chapel Street(SE)						Total	Destination : Arm C Chapel Street(NW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	1	0	0	0	0	0	1	0	0	0	0	0	0	0	19	6	0	0	0	0	25	26
07:15	3	1	0	0	0	0	4	0	0	0	0	0	0	0	28	3	0	1	0	1	33	37
07:30	2	2	0	0	0	0	4	0	0	0	0	0	0	0	28	4	1	0	0	0	33	37
07:45	2	0	0	0	0	0	2	0	0	0	0	0	0	0	37	9	0	0	0	0	46	48
1 Hr	8	3	0	0	0	0	11	0	0	0	0	0	0	0	112	22	1	1	0	1	137	148
08:00	2	0	0	0	0	0	2	0	0	0	0	0	0	0	43	6	0	0	0	0	49	51
08:15	5	1	0	0	0	0	6	0	0	0	0	0	0	0	42	6	0	0	0	0	48	54
08:30	3	0	0	0	0	0	3	0	0	0	0	0	0	0	49	7	0	0	0	0	56	59
08:45	6	0	0	0	0	0	6	0	0	0	0	0	0	0	35	8	0	0	0	0	43	49
1 Hr	16	1	0	0	0	0	17	0	0	0	0	0	0	0	169	27	0	0	0	0	196	213
09:00	4	0	0	0	0	0	4	0	0	0	0	0	0	0	27	3	1	0	0	1	32	36
09:15	5	1	0	0	0	0	6	0	0	0	0	0	0	0	25	4	0	0	0	0	29	35
09:30	2	0	1	0	0	0	3	0	0	0	0	0	0	0	30	7	0	0	0	0	37	40
09:45	3	1	1	0	0	0	5	0	0	0	0	0	0	0	27	7	1	0	0	0	35	40
1 Hr	14	2	2	0	0	0	18	0	0	0	0	0	0	0	109	21	2	0	0	1	133	151
10:00	4	1	0	0	0	0	5	0	1	0	0	0	0	1	33	9	0	0	0	0	42	48
10:15	1	0	0	0	0	0	1	0	0	0	0	0	0	0	23	6	1	0	0	0	30	31
10:30	3	1	0	0	0	1	5	0	0	0	0	0	0	0	21	4	1	0	0	0	26	31
10:45	3	2	0	0	0	0	5	0	0	0	0	0	0	0	37	8	0	0	0	0	45	50
1 Hr	11	4	0	0	0	1	16	0	1	0	0	0	0	1	114	27	2	0	0	0	143	160
11:00	5	0	1	0	0	0	6	0	0	0	0	0	0	0	31	3	2	0	0	0	36	42
11:15	4	0	0	0	0	0	4	0	0	0	0	0	0	0	22	3	0	0	0	0	25	29
11:30	6	2	0	0	0	0	8	0	0	0	0	0	0	0	32	5	4	0	0	0	41	49
11:45	5	1	0	0	0	0	6	0	0	0	0	0	0	0	25	3	2	0	0	0	30	36
1 Hr	20	3	1	0	0	0	24	0	0	0	0	0	0	0	110	14	8	0	0	0	132	156
12:00	4	1	0	0	0	1	6	0	0	0	0	0	0	0	34	1	0	0	0	0	35	41
12:15	8	1	0	0	0	0	9	0	0	0	0	0	0	0	33	4	3	0	0	0	40	49
12:30	2	0	0	0	0	0	2	0	0	0	0	0	0	0	31	2	1	0	0	0	34	36
12:45	3	1	0	0	0	0	4	0	0	0	0	0	0	0	25	9	2	0	1	1	38	42

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 6 - Green Side / Chapel Street(SE) / Chapel Street(NW)

1 Hr	17	3	0	0	0	1	21	0	0	0	0	0	0	0	123	16	6	0	1	1	147	168
13:00	4	4	0	0	0	0	8	0	0	0	0	0	0	0	30	9	0	0	0	0	39	47
13:15	9	2	0	0	0	0	11	0	0	0	0	0	0	0	33	7	1	1	0	0	42	53
13:30	6	2	0	0	0	0	8	0	0	0	0	0	0	0	24	4	1	0	0	0	29	37
13:45	3	1	0	0	0	0	4	0	0	0	0	0	0	0	32	8	1	1	0	0	42	46
1 Hr	22	9	0	0	0	0	31	0	0	0	0	0	0	0	119	28	3	2	0	0	152	183
14:00	3	1	0	0	0	0	4	0	0	0	0	0	0	0	40	9	1	0	0	0	50	54
14:15	5	1	0	0	0	0	6	0	0	0	0	0	0	0	36	9	2	0	0	0	47	53
14:30	5	0	0	0	0	0	5	0	0	0	0	0	0	0	24	6	0	0	0	0	30	35
14:45	7	0	0	0	0	0	7	0	0	0	0	0	0	0	49	12	3	0	1	0	65	72
1 Hr	20	2	0	0	0	0	22	0	0	0	0	0	0	0	149	36	6	0	1	0	192	214
15:00	5	2	0	0	0	0	7	0	0	0	0	0	0	0	30	4	0	1	0	0	35	42
15:15	6	0	0	0	0	0	6	0	0	0	0	0	0	0	38	10	1	0	0	1	50	56
15:30	3	2	0	0	0	0	5	0	0	0	0	0	0	0	45	14	0	0	0	0	59	64
15:45	4	2	2	0	0	1	9	0	0	0	0	0	0	0	67	9	3	0	0	0	79	88
1 Hr	18	6	2	0	0	1	27	0	0	0	0	0	0	0	180	37	4	1	0	1	223	250
16:00	7	0	0	0	0	0	7	0	0	0	0	0	0	0	59	10	0	0	0	0	69	76
16:15	4	2	0	0	0	0	6	0	0	0	0	0	0	0	58	9	0	0	0	1	68	74
16:30	6	4	0	0	0	0	10	0	0	0	0	0	0	0	40	7	2	0	0	1	50	60
16:45	6	2	0	0	0	0	8	0	0	0	0	0	0	0	65	4	1	0	0	0	70	78
1 Hr	23	8	0	0	0	0	31	0	0	0	0	0	0	0	222	30	3	0	0	2	257	288
17:00	8	2	0	0	0	0	10	0	0	0	0	0	0	0	66	5	0	0	0	0	71	81
17:15	13	1	0	0	0	0	14	0	0	0	0	0	0	0	65	9	0	0	0	0	74	88
17:30	4	0	0	0	0	0	4	0	0	0	0	0	0	0	76	4	1	0	1	0	82	86
17:45	5	2	0	0	0	0	7	0	0	0	0	0	0	0	71	2	0	0	0	0	73	80
1 Hr	30	5	0	0	0	0	35	0	0	0	0	0	0	0	278	20	1	0	1	0	300	335
18:00	10	1	0	0	0	0	11	0	0	0	0	0	0	0	70	4	0	0	1	2	77	88
18:15	10	0	0	0	0	0	10	0	0	0	0	0	0	0	57	2	1	0	0	0	60	70
18:30	6	0	0	0	0	0	6	0	0	0	0	0	0	0	38	6	0	0	0	0	44	50
18:45	13	1	0	0	0	1	15	0	0	0	0	0	0	0	56	3	0	0	0	0	59	74
1 Hr	39	2	0	0	0	1	42	0	0	0	0	0	0	0	221	15	1	0	1	2	240	282
Total	238	48	5	0	0	4	295	0	1	0	0	0	0	1	1906	293	37	4	4	8	2252	2548

Origin : Arm C Chapel Street(NW)

	Destination : Arm A Green Side						Total	**Destination :** Arm B Chapel Street(SE)						Total	**Destination :** Arm C Chapel Street(NW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	5	1	1	0	0	0	7	24	2	0	0	0	0	26	0	0	0	0	0	0	0	33
07:15	3	2	0	0	0	0	5	25	1	1	1	0	1	29	0	0	0	0	0	0	0	34
07:30	3	2	0	0	0	0	5	32	2	0	0	1	1	36	0	0	0	0	0	0	0	41
07:45	1	3	0	0	0	0	4	37	3	0	0	0	0	40	0	0	0	0	0	0	0	44
1 Hr	12	8	1	0	0	0	21	118	8	1	1	1	2	131	0	0	0	0	0	0	0	152
08:00	2	0	0	0	0	0	2	26	6	0	0	0	0	32	0	0	0	0	0	0	0	34
08:15	3	1	0	0	0	0	4	39	7	1	0	0	0	47	0	0	0	0	0	0	0	51
08:30	1	1	0	0	0	0	2	35	5	0	0	0	0	40	0	0	0	0	0	0	0	42
08:45	3	0	0	0	0	0	3	22	3	1	0	0	0	26	0	1	0	0	0	0	1	30
1 Hr	9	2	0	0	0	0	11	122	21	2	0	0	0	145	0	1	0	0	0	0	1	157
09:00	3	2	0	0	0	0	5	24	2	2	0	0	0	28	0	0	0	0	0	0	0	33
09:15	4	1	0	0	0	0	5	23	3	1	0	0	0	27	0	0	0	0	0	0	0	32
09:30	1	0	0	0	0	0	1	25	6	0	0	1	1	33	0	0	0	0	0	0	0	34
09:45	3	0	0	0	0	0	3	17	0	3	0	0	0	20	0	0	0	0	0	0	0	23
1 Hr	11	3	0	0	0	0	14	89	11	6	0	1	1	108	0	0	0	0	0	0	0	122
10:00	1	0	0	0	0	0	1	14	5	1	1	0	0	21	0	0	0	0	0	0	0	22
10:15	1	0	1	0	0	0	2	15	4	1	0	0	0	20	0	0	0	0	0	0	0	22
10:30	3	0	0	0	0	0	3	13	0	0	0	0	0	13	0	0	0	0	0	0	0	16
10:45	5	0	0	0	0	0	5	15	1	0	0	0	1	17	0	0	0	0	0	0	0	22
1 Hr	10	0	1	0	0	0	11	57	10	2	1	0	1	71	0	0	0	0	0	0	0	82
11:00	1	0	0	0	0	0	1	11	2	1	0	0	0	14	0	0	0	0	0	0	0	15
11:15	2	1	0	0	0	0	3	27	1	1	0	0	0	29	0	0	0	0	0	0	0	32
11:30	2	0	0	0	0	0	2	20	5	2	1	1	0	29	0	0	0	0	0	0	0	31
11:45	0	1	0	0	0	0	1	24	1	0	0	0	0	25	0	0	0	0	0	0	0	26
1 Hr	5	2	0	0	0	0	7	82	9	4	1	1	0	97	0	0	0	0	0	0	0	104
12:00	3	1	0	0	0	0	4	17	1	1	0	0	0	19	0	0	0	0	0	0	0	23
12:15	4	1	0	0	0	0	5	26	3	0	0	0	0	29	0	1	0	0	0	0	1	35
12:30	1	1	0	0	0	0	2	24	2	1	0	0	0	27	0	0	0	0	0	0	0	29
12:45	1	1	0	0	0	0	2	14	7	0	0	0	0	21	0	0	0	0	0	0	0	23
1 Hr	9	4	0	0	0	0	13	81	13	2	0	0	0	96	0	1	0	0	0	0	1	110
13:00	4	1	0	0	0	0	5	17	3	0	0	0	0	20	0	0	0	0	0	0	0	25
13:15	1	2	0	0	0	0	3	16	8	1	1	0	0	26	0	0	0	0	0	1	1	30
13:30	2	0	0	0	0	0	2	20	3	0	0	1	0	24	0	0	0	0	0	0	0	26
13:45	1	0	0	0	0	0	1	23	6	0	0	0	0	29	0	0	0	0	0	0	0	30
1 Hr	8	3	0	0	0	0	11	76	20	1	1	1	0	99	0	0	0	0	0	1	1	111
14:00	4	0	0	0	0	0	4	21	3	1	0	0	0	25	0	0	0	0	0	0	0	29
14:15	1	0	0	0	0	0	1	16	1	1	0	0	0	18	0	0	0	0	0	0	0	19
14:30	4	0	0	0	0	0	4	20	3	0	0	0	0	23	0	0	0	0	0	0	0	27
14:45	2	1	0	0	0	0	3	18	0	0	0	0	0	18	0	0	0	0	0	0	0	21
1 Hr	11	1	0	0	0	0	12	75	7	2	0	0	0	84	0	0	0	0	0	0	0	96
15:00	1	0	0	0	0	0	1	27	0	1	0	0	0	28	0	0	0	0	0	0	0	29
15:15	4	2	0	0	0	0	6	23	5	0	0	0	0	28	0	0	0	0	0	0	0	34
15:30	2	1	1	0	0	0	4	21	4	0	0	2	1	28	0	0	0	0	0	0	0	32
15:45	2	2	0	0	0	0	4	21	3	0	0	0	0	24	0	0	0	0	0	0	0	28
1 Hr	9	5	1	0	0	0	15	92	12	1	0	2	1	108	0	0	0	0	0	0	0	123
16:00	2	0	0	0	0	0	2	33	5	1	0	0	0	39	1	0	0	0	0	0	1	42
16:15	1	1	0	0	0	0	2	25	3	0	0	0	0	28	0	0	0	0	0	0	0	30
16:30	5	1	0	0	0	0	6	26	4	0	0	0	1	31	0	1	0	0	0	0	1	38
16:45	4	0	0	0	0	0	4	24	1	0	0	0	0	25	0	0	0	0	0	0	0	29
1 Hr	12	2	0	0	0	0	14	108	13	1	0	0	1	123	1	1	0	0	0	0	2	139
17:00	5	2	0	0	0	0	7	35	4	0	0	0	0	39	0	0	0	0	0	0	0	46
17:15	3	0	0	0	0	0	3	29	0	0	0	0	1	30	0	0	0	0	0	0	0	33
17:30	4	2	0	0	0	0	6	36	2	0	0	0	0	38	0	0	0	0	0	0	0	44
17:45	4	0	0	0	0	0	4	40	2	1	0	0	0	43	0	0	0	0	0	0	0	47
1 Hr	16	4	0	0	0	0	20	140	8	1	0	0	1	150	0	0	0	0	0	0	0	170
18:00	7	3	0	0	0	0	10	37	3	1	0	0	0	41	0	0	0	0	0	0	0	51
18:15	5	0	0	0	0	0	5	22	2	0	0	0	0	24	0	0	0	0	0	0	0	29
18:30	3	0	0	0	0	0	3	22	0	0	0	0	0	22	0	0	0	0	0	0	0	25
18:45	7	0	0	0	0	0	7	20	1	1	0	0	0	22	0	0	0	0	0	0	0	29
1 Hr	22	3	0	0	0	0	25	101	6	2	0	0	0	109	0	0	0	0	0	0	0	134
Total	134	37	3	0	0	0	174	1141	138	25	4	6	7	1321	1	3	0	0	0	1	5	1500

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3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 6 - Green Side / Chapel Street(SE) / Chapel Street(NW)

ORIGIN SUMMARY

	Origin : Arm A Green Side							Origin : Arm B Chapel Street(SE)							Origin : Arm C Chapel Street(NW)							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Origin Totals
07:00	56	6	0	0	0	1	63	20	6	0	0	0	0	26	29	3	1	0	0	0	33	122
07:15	55	9	0	1	0	0	65	31	4	0	1	0	1	37	28	3	1	1	0	1	34	136
07:30	58	10	3	0	0	1	72	30	6	1	0	0	0	37	35	4	0	0	1	1	41	150
07:45	62	8	3	0	0	0	73	39	9	0	0	0	0	48	38	6	0	0	0	0	44	165
1 Hr	231	33	6	1	0	2	273	120	25	1	1	0	1	148	130	16	2	1	1	2	152	573
08:00	45	10	0	0	0	1	56	45	6	0	0	0	0	51	28	6	0	0	0	0	34	141
08:15	56	6	2	0	0	1	65	47	7	0	0	0	0	54	42	8	1	0	0	0	51	170
08:30	39	3	0	0	0	1	43	52	7	0	0	0	0	59	36	6	0	0	0	0	42	144
08:45	43	2	0	1	0	0	46	41	8	0	0	0	0	49	25	4	1	0	0	0	30	125
1 Hr	183	21	2	1	0	3	210	185	28	0	0	0	0	213	131	24	2	0	0	0	157	580
09:00	35	6	1	0	0	0	42	31	3	1	0	0	1	36	27	4	2	0	0	0	33	111
09:15	43	6	1	0	0	0	50	30	5	0	0	0	0	35	27	4	1	0	0	0	32	117
09:30	30	2	0	0	0	1	33	32	7	1	0	0	0	40	26	6	0	0	1	1	34	107
09:45	32	5	1	0	0	0	38	30	8	2	0	0	0	40	20	0	3	0	0	0	23	101
1 Hr	140	19	3	0	0	1	163	123	23	4	0	0	1	151	100	14	6	0	1	1	122	436
10:00	18	0	1	0	0	0	19	37	11	0	0	0	0	48	15	5	1	1	0	0	22	89
10:15	22	0	0	0	0	0	22	24	6	1	0	0	0	31	16	4	2	0	0	0	22	75
10:30	21	7	1	0	0	0	29	24	5	1	0	0	1	31	16	0	0	0	0	0	16	76
10:45	20	3	1	0	0	1	25	40	10	0	0	0	0	50	20	1	0	0	0	1	22	97
1 Hr	81	10	3	0	0	1	95	125	32	2	0	0	1	160	67	10	3	1	0	1	82	337
11:00	17	3	0	0	0	0	20	36	3	3	0	0	0	42	12	2	1	0	0	0	15	77
11:15	27	2	0	0	0	0	29	26	3	0	0	0	0	29	29	2	1	0	0	0	32	90
11:30	17	4	1	1	0	0	23	38	7	4	0	0	0	49	22	5	2	1	1	0	31	103
11:45	20	3	0	0	0	0	23	30	4	2	0	0	0	36	24	2	0	0	0	0	26	85
1 Hr	81	12	1	1	0	0	95	130	17	9	0	0	0	156	87	11	4	1	1	0	104	355
12:00	19	4	2	0	0	0	25	38	2	0	0	0	1	41	20	2	1	0	0	0	23	89
12:15	30	6	1	0	0	0	37	41	5	3	0	0	0	49	30	5	0	0	0	0	35	121
12:30	20	3	0	0	0	0	23	33	2	1	0	0	0	36	25	3	1	0	0	0	29	88
12:45	23	6	1	0	0	0	30	28	10	2	0	1	1	42	15	8	0	0	0	0	23	95
1 Hr	92	19	4	0	0	0	115	140	19	6	0	1	2	168	90	18	2	0	0	0	110	393
13:00	19	1	0	0	0	0	20	34	13	0	0	0	0	47	21	4	0	0	0	0	25	92
13:15	26	5	0	0	0	1	32	42	9	1	1	0	0	53	17	10	1	1	0	1	30	115
13:30	23	6	1	0	0	1	31	30	6	1	0	0	0	37	22	3	0	0	1	0	26	94
13:45	17	5	0	0	0	0	22	35	9	1	1	0	0	46	24	6	0	0	0	0	30	98
1 Hr	85	17	1	0	0	2	105	141	37	3	2	0	0	183	84	23	1	1	1	1	111	399
14:00	11	3	1	0	0	0	15	43	10	1	0	0	0	54	25	3	1	0	0	0	29	98
14:15	17	2	0	0	0	0	19	41	10	2	0	0	0	53	17	1	1	0	0	0	19	91
14:30	23	5	0	0	0	0	28	29	6	0	0	0	0	35	24	3	0	0	0	0	27	90
14:45	19	5	0	0	0	0	24	56	12	3	0	1	0	72	20	1	0	0	0	0	21	117
1 Hr	70	15	1	0	0	0	86	169	38	6	0	1	0	214	86	8	2	0	0	0	96	396
15:00	18	4	0	0	0	0	22	35	6	0	1	0	0	42	28	0	1	0	0	0	29	93
15:15	8	4	0	0	0	0	12	44	10	1	0	0	1	56	27	7	0	0	0	0	34	102
15:30	24	3	0	0	0	0	27	48	16	0	0	0	0	64	23	5	1	0	2	1	32	123
15:45	22	4	2	0	0	0	28	71	11	5	0	0	1	88	23	5	0	0	0	0	28	144
1 Hr	72	15	2	0	0	0	89	198	43	6	1	0	2	250	101	17	2	0	2	1	123	462
16:00	28	8	0	0	0	0	36	66	10	0	0	0	0	76	36	5	1	0	0	0	42	154
16:15	23	5	0	0	0	0	28	62	11	0	0	0	1	74	26	4	0	0	0	0	30	132
16:30	30	4	1	0	0	0	35	46	11	2	0	0	1	60	31	6	0	0	0	1	38	133
16:45	30	3	0	0	0	0	33	71	6	1	0	0	0	78	28	1	0	0	0	0	29	140
1 Hr	111	20	1	0	0	0	132	245	38	3	0	0	2	288	121	16	1	0	0	1	139	559
17:00	32	3	0	0	0	0	35	74	7	0	0	0	0	81	40	6	0	0	0	0	46	162
17:15	27	0	0	0	0	0	27	78	10	0	0	0	0	88	32	0	0	0	0	1	33	148
17:30	32	1	0	0	0	0	33	80	4	1	0	1	0	86	40	4	0	0	0	0	44	163
17:45	18	1	0	0	0	0	19	76	4	0	0	0	0	80	44	2	1	0	0	0	47	146
1 Hr	109	5	0	0	0	0	114	308	25	1	0	1	0	335	156	12	1	0	0	1	170	619
18:00	25	3	0	0	0	0	28	80	5	0	0	1	2	88	44	6	1	0	0	0	51	167
18:15	24	1	0	0	0	0	25	67	2	1	0	0	0	70	27	2	0	0	0	0	29	124
18:30	26	2	0	0	0	0	28	44	6	0	0	0	0	50	25	0	0	0	0	0	25	103
18:45	11	0	0	0	0	0	11	69	4	0	0	0	1	74	27	1	1	0	0	0	29	114
1 Hr	86	6	0	0	0	0	92	260	17	1	0	1	3	282	123	9	2	0	0	0	134	508
Total	1341	192	24	3	0	9	1569	2144	342	42	4	4	12	2548	1276	178	28	4	6	8	1500	5617

DESTINATION SUMMARY

	Destination : Arm A Green Side							Destination : Arm B Chapel Street(SE)							Destination : Arm C Chapel Street(NW)							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Dest Totals
07:00	6	1	1	0	0	0	8	77	8	0	0	0	1	86	22	6	0	0	0	0	28	122
07:15	6	3	0	0	0	0	9	79	9	1	2	0	1	92	29	4	0	1	0	1	35	136
07:30	5	4	0	0	0	0	9	86	10	2	0	1	2	101	32	6	2	0	0	0	40	150
07:45	3	3	0	0	0	0	6	94	10	1	0	0	0	105	42	10	2	0	0	0	54	165
1 Hr	20	11	1	0	0	0	32	336	37	4	2	1	4	384	125	26	4	1	0	1	157	573
08:00	4	0	0	0	0	0	4	68	15	0	0	0	1	84	46	7	0	0	0	0	53	141
08:15	8	2	0	0	0	0	10	89	13	1	0	0	1	104	48	6	2	0	0	0	56	170
08:30	4	1	0	0	0	0	5	71	8	0	0	0	1	80	52	7	0	0	0	0	59	144
08:45	9	0	0	0	0	0	9	62	5	1	0	0	0	68	38	9	0	1	0	0	48	125
1 Hr	25	3	0	0	0	0	28	290	41	2	0	0	3	336	184	29	2	1	0	0	216	580
09:00	7	2	0	0	0	0	9	56	8	3	0	0	0	67	30	3	1	0	0	1	35	111
09:15	9	2	0	0	0	0	11	56	9	1	0	0	0	66	35	4	1	0	0	0	40	117
09:30	3	0	1	0	0	0	4	46	7	0	0	1	2	56	39	8	0	0	0	0	47	107
09:45	6	1	1	0	0	0	8	43	5	4	0	0	0	52	33	7	1	0	0	0	41	101
1 Hr	25	5	2	0	0	0	32	201	29	8	0	1	2	241	137	22	3	0	0	1	163	436
10:00	5	1	0	0	0	0	6	29	6	1	1	0	0	37	36	9	1	0	0	0	46	89
10:15	2	0	1	0	0	0	3	36	4	1	0	0	0	41	24	6	1	0	0	0	31	75
10:30	6	1	0	0	0	1	8	32	7	0	0	0	0	39	23	4	2	0	0	0	29	76
10:45	8	2	0	0	0	0	10	32	4	0	0	0	2	38	40	8	1	0	0	0	49	97
1 Hr	21	4	1	0	0	1	27	129	21	2	1	0	2	155	123	27	5	0	0	0	155	337
11:00	6	0	1	0	0	0	7	25	5	1	0	0	0	31	34	3	2	0	0	0	39	77
11:15	6	1	0	0	0	0	7	52	3	1	0	0	0	56	24	3	0	0	0	0	27	90
11:30	8	2	0	0	0	0	10	33	8	3	2	1	0	47	36	6	4	0	0	0	46	103
11:45	5	2	0	0	0	0	7	41	3	0	0	0	0	44	28	4	2	0	0	0	34	85
1 Hr	25	5	1	0	0	0	31	151	19	5	2	1	0	178	122	16	8	0	0	0	146	355
12:00	7	2	0	0	0	1	10	34	5	2	0	0	0	41	36	1	1	0	0	0	38	89
12:15	12	2	0	0	0	0	14	45	7	0	0	0	0	52	44	7	4	0	0	0	55	121
12:30	3	1	0	0	0	0	4	40	4	1	0	0	0	45	35	3	1	0	0	0	39	88

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Site 6 - Green Side / Chapel Street(SE) / Chapel Street(NW)

12:45	4	2	0	0	0	0	6	32	13	1	0	0	0	46	30	9	2	0	1	1	43	95
1 Hr	26	7	0	0	0	1	34	151	29	4	0	0	0	184	145	20	8	0	1	1	175	393
13:00	8	5	0	0	0	0	13	33	4	0	0	0	0	37	33	9	0	0	0	0	42	92
13:15	10	4	0	0	0	0	14	35	13	1	1	0	0	50	40	7	1	1	0	2	51	115
13:30	8	2	0	0	0	0	10	41	9	0	0	1	1	52	26	4	2	0	0	0	32	94
13:45	4	1	0	0	0	0	5	39	9	0	0	0	0	48	33	10	1	1	0	0	45	98
1 Hr	30	12	0	0	0	0	42	148	35	1	1	1	1	187	132	30	4	2	0	2	170	399
14:00	7	1	0	0	0	0	8	31	5	1	0	0	0	37	41	10	2	0	0	0	53	98
14:15	6	1	0	0	0	0	7	30	3	1	0	0	0	34	39	9	2	0	0	0	50	91
14:30	9	0	0	0	0	0	9	38	7	0	0	0	0	45	29	7	0	0	0	0	36	90
14:45	9	1	0	0	0	0	10	34	4	0	0	0	0	38	52	13	3	0	1	0	69	117
1 Hr	31	3	0	0	0	0	34	133	19	2	0	0	0	154	161	39	7	0	1	0	208	396
15:00	6	2	0	0	0	0	8	44	3	1	0	0	0	48	31	5	0	1	0	0	37	93
15:15	10	2	0	0	0	0	12	31	9	0	0	0	0	40	38	10	1	0	0	1	50	102
15:30	5	3	1	0	0	0	9	40	7	0	0	2	1	50	50	14	0	0	0	0	64	123
15:45	6	4	2	0	0	1	13	37	5	0	0	0	0	42	73	11	5	0	0	0	89	144
1 Hr	27	11	3	0	0	1	42	152	24	1	0	2	1	180	192	40	6	1	0	1	240	462
16:00	9	0	0	0	0	0	9	60	12	1	0	0	0	73	61	11	0	0	0	0	72	154
16:15	5	3	0	0	0	0	8	44	7	0	0	0	0	51	62	10	0	0	0	1	73	132
16:30	11	5	0	0	0	0	16	51	8	1	0	0	1	61	45	8	2	0	0	1	56	133
16:45	10	2	0	0	0	0	12	50	4	0	0	0	0	54	69	4	1	0	0	0	74	140
1 Hr	35	10	0	0	0	0	45	205	31	2	0	0	1	239	237	33	3	0	0	2	275	559
17:00	13	4	0	0	0	0	17	64	7	0	0	0	0	71	69	5	0	0	0	0	74	162
17:15	16	1	0	0	0	0	17	52	0	0	0	0	1	53	69	9	0	0	0	0	78	148
17:30	8	2	0	0	0	0	10	63	3	0	0	0	0	66	81	4	1	0	1	0	87	163
17:45	9	2	0	0	0	0	11	56	2	1	0	0	0	59	73	3	0	0	0	0	76	146
1 Hr	46	9	0	0	0	0	55	235	12	1	0	0	1	249	292	21	1	0	1	0	315	619
18:00	17	4	0	0	0	0	21	60	5	1	0	0	0	66	72	5	0	0	1	2	80	167
18:15	15	0	0	0	0	0	15	42	3	0	0	0	0	45	61	2	1	0	0	0	64	124
18:30	9	0	0	0	0	0	9	42	2	0	0	0	0	44	44	6	0	0	0	0	50	103
18:45	20	1	0	0	0	1	22	26	1	1	0	0	0	28	61	3	0	0	0	0	64	114
1 Hr	61	5	0	0	0	1	67	170	11	2	0	0	0	183	238	16	1	0	1	2	258	508
Total	372	85	8	0	0	4	469	2301	308	34	6	6	15	2670	2088	319	52	5	4	10	2478	5617

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Site 7 - Chapel Street / Saint Andrews Hill / Station Road

Origin Arm A Chapel Street

	Destination : Arm A Chapel Street						Total	Destination : Arm B Saint Andrews Hill						Total	Destination : Arm C Station Road						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	0	0	0	0	0	0	0	8	2	1	0	0	0	11	65	7	0	0	0	2	74	85
07:15	0	0	0	0	0	0	0	5	0	0	0	0	0	5	76	9	1	2	0	0	88	93
07:30	0	0	0	0	0	0	0	12	3	0	0	0	0	15	78	8	2	0	1	2	91	106
07:45	0	0	0	0	0	0	0	3	2	0	0	0	0	5	89	7	2	0	0	0	98	103
1 Hr	0	0	0	0	0	0	0	28	7	1	0	0	0	36	308	31	5	2	1	4	351	387
08:00	0	0	0	0	0	0	0	7	1	0	0	0	0	8	57	16	0	0	0	1	74	82
08:15	0	0	0	0	0	0	0	10	1	0	0	0	0	11	78	10	1	0	0	1	90	101
08:30	0	0	0	0	0	0	0	10	1	0	0	0	0	11	60	6	1	0	0	1	68	79
08:45	0	0	0	0	0	0	0	8	0	0	0	0	0	8	53	5	1	0	0	0	59	67
1 Hr	0	0	0	0	0	0	0	35	3	0	0	0	0	38	248	37	3	0	0	3	291	329
09:00	0	1	0	0	0	0	1	7	4	1	0	0	0	12	47	3	1	0	0	0	51	64
09:15	0	0	0	0	0	0	0	7	2	0	0	0	0	9	50	6	1	0	0	0	57	66
09:30	0	0	0	0	0	0	0	8	2	0	0	0	0	10	37	6	0	0	1	2	46	56
09:45	0	0	0	0	0	0	0	7	0	0	0	0	0	7	34	5	3	0	0	0	42	49
1 Hr	0	1	0	0	0	0	1	29	8	1	0	0	0	38	168	20	5	0	1	2	196	235
10:00	0	0	0	0	0	0	0	6	2	0	1	0	0	9	24	3	1	0	0	0	28	37
10:15	0	0	0	0	0	0	0	8	3	1	0	0	0	12	27	3	1	0	0	0	31	43
10:30	0	0	0	0	0	0	0	10	2	0	0	0	0	12	22	5	0	0	0	0	27	39
10:45	0	0	0	0	0	0	0	8	0	0	0	0	0	8	22	5	0	0	0	2	29	37
1 Hr	0	0	0	0	0	0	0	32	7	1	1	0	0	41	95	16	2	0	0	2	115	156
11:00	0	0	0	0	0	0	0	7	2	0	0	0	0	9	19	2	1	0	0	0	22	31
11:15	0	0	0	0	0	0	0	14	0	1	0	0	0	15	37	3	0	0	0	0	40	55
11:30	0	0	0	0	0	0	0	10	0	1	1	0	0	12	22	8	2	1	1	0	34	46
11:45	0	0	0	0	0	0	0	9	2	0	0	0	0	11	30	2	0	0	0	0	32	43
1 Hr	0	0	0	0	0	0	0	40	4	2	1	0	0	47	108	15	3	1	1	0	128	175
12:00	0	0	0	0	0	0	0	12	1	0	0	0	0	13	26	4	2	0	0	0	32	45
12:15	0	0	0	0	0	0	0	16	5	0	0	0	0	21	30	2	0	0	0	0	32	53
12:30	0	1	0	0	0	0	1	10	0	0	0	0	0	10	26	3	0	0	0	0	29	40
12:45	0	0	0	0	0	0	0	19	3	1	0	0	0	23	16	10	1	0	0	0	27	50
1 Hr	0	1	0	0	0	0	1	57	9	1	0	0	0	67	98	19	3	0	0	0	120	188
13:00	0	0	0	0	0	0	0	11	0	0	0	0	0	11	23	3	0	0	0	0	26	37
13:15	0	0	0	0	0	0	0	12	6	1	1	0	0	20	24	7	0	0	0	0	31	51
13:30	0	0	0	0	0	0	0	13	3	0	0	0	0	16	29	6	0	0	1	1	37	53
13:45	0	0	0	0	0	0	0	8	7	0	0	0	0	15	29	3	0	0	0	0	32	47
1 Hr	0	0	0	0	0	0	0	44	16	1	1	0	0	62	105	19	0	0	1	1	126	188
14:00	1	0	0	0	0	0	1	10	1	1	0	0	0	12	19	4	0	0	0	0	23	36
14:15	0	0	0	0	0	0	0	11	0	1	0	0	0	12	20	2	0	0	0	0	22	34
14:30	0	0	0	0	0	0	0	14	1	0	0	0	0	15	24	7	0	0	0	0	31	46
14:45	0	0	0	0	0	0	0	12	0	0	0	0	0	12	23	3	0	0	0	0	26	38
1 Hr	1	0	0	0	0	0	1	47	2	2	0	0	0	51	86	16	0	0	0	0	102	154
15:00	0	0	0	0	0	0	0	17	0	1	0	0	0	18	26	3	0	0	0	0	29	47
15:15	1	0	0	0	0	0	1	14	1	0	0	0	0	15	17	7	0	0	0	0	24	40
15:30	1	0	0	0	0	0	1	19	4	0	0	2	1	26	22	3	0	0	0	0	25	52
15:45	2	0	0	0	0	0	2	17	3	0	0	0	0	20	16	2	0	0	0	0	18	40
1 Hr	4	0	0	0	0	0	4	67	8	1	0	2	1	79	81	15	0	0	0	0	96	179
16:00	1	0	0	0	0	0	1	16	4	0	0	0	0	20	43	9	1	0	0	0	53	74
16:15	0	0	0	0	0	0	0	23	4	0	0	0	0	27	22	2	0	0	0	0	24	51
16:30	0	0	0	0	0	0	0	15	3	0	0	0	0	18	36	5	0	0	0	1	42	60
16:45	0	0	0	0	0	0	0	13	1	0	0	0	0	14	37	3	0	0	0	0	40	54
1 Hr	1	0	0	0	0	0	1	67	12	0	0	0	0	79	138	19	1	0	0	1	159	239
17:00	0	0	0	0	0	0	0	21	2	0	0	0	0	23	42	4	0	0	0	0	46	69
17:15	0	0	0	0	0	0	0	18	0	0	0	0	1	19	35	0	0	0	0	0	35	54
17:30	0	0	0	0	0	0	0	28	1	0	0	0	0	29	35	2	0	0	0	0	37	66
17:45	0	0	0	0	0	0	0	29	0	0	0	0	0	29	28	2	0	0	0	0	30	59
1 Hr	0	0	0	0	0	0	0	96	3	0	0	0	1	100	140	8	0	0	0	0	148	248
18:00	0	0	0	0	0	0	0	31	1	0	0	0	0	32	30	4	1	0	0	0	35	67
18:15	0	0	0	0	0	0	0	12	3	0	0	0	0	15	30	1	0	0	0	0	31	46
18:30	0	0	0	0	0	0	0	20	0	0	0	0	0	20	23	1	0	0	0	0	24	44
18:45	0	0	0	0	0	0	0	11	1	1	0	0	0	13	15	0	0	0	0	0	15	28
1 Hr	0	0	0	0	0	0	0	74	5	1	0	0	0	80	98	6	1	0	0	0	105	185
Total	6	2	0	0	0	0	8	616	84	11	3	2	2	718	1673	221	23	3	4	13	1937	2663

Origin Arm B Saint Andrews Hill

	Destination : Arm A Chapel Street						Total	Destination : Arm B Saint Andrews Hill						Total	Destination : Arm C Station Road						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	10	4	0	0	0	0	14	0	0	0	0	0	0	0	11	1	1	0	0	0	13	27
07:15	13	2	0	1	0	0	16	0	0	0	0	0	0	0	10	2	0	0	0	0	12	28
07:30	14	2	0	0	0	0	16	0	0	0	0	0	0	0	22	2	0	0	0	0	24	40
07:45	15	0	0	0	0	0	15	0	0	0	0	0	0	0	30	0	0	0	0	0	30	45
1 Hr	52	8	0	1	0	0	61	0	0	0	0	0	0	0	73	5	1	0	0	0	79	140
08:00	15	0	0	0	0	0	15	0	0	0	0	0	0	0	25	0	0	0	0	0	25	40
08:15	11	1	0	0	0	0	12	0	0	0	0	0	0	0	23	1	0	0	0	0	24	36
08:30	19	2	0	0	0	0	21	0	0	0	0	0	0	0	25	1	0	0	0	0	26	47
08:45	10	2	0	0	0	0	12	0	0	0	0	0	0	0	19	1	0	0	0	0	20	32
1 Hr	55	5	0	0	0	0	60	0	0	0	0	0	0	0	92	3	0	0	0	0	95	155
09:00	11	2	1	0	0	1	15	0	0	0	0	0	0	0	19	1	0	0	0	0	20	35
09:15	11	1	0	0	0	0	12	0	0	0	0	0	0	0	14	1	1	0	0	0	16	28
09:30	14	4	0	0	0	0	18	0	0	0	0	0	0	0	15	1	1	0	0	0	17	35
09:45	13	2	0	0	0	0	15	0	0	0	0	0	0	0	14	0	2	0	0	0	16	31
1 Hr	49	9	1	0	0	1	60	0	0	0	0	0	0	0	62	3	4	0	0	0	69	129
10:00	13	3	0	0	0	0	16	0	0	0	0	0	0	0	8	2	0	0	0	0	10	26
10:15	9	2	0	0	0	0	11	0	0	0	0	0	0	0	4	1	0	0	0	0	5	16
10:30	8	2	0	0	0	0	10	0	0	0	0	0	0	0	7	1	0	0	0	1	9	19
10:45	14	2	0	0	0	0	16	0	0	0	0	0	0	0	4	1	0	0	0	0	5	21
1 Hr	44	9	0	0	0	0	53	0	0	0	0	0	0	0	23	5	0	0	0	1	29	82
11:00	14	1	0	0	0	0	15	0	0	0	0	0	0	0	5	2	1	0	0	0	8	23
11:15	8	0	0	0	0	0	8	0	0	0	0	0	0	0	10	0	0	0	0	0	10	18
11:30	12	2	1	0	0	0	15	0	0	0	0	0	0	0	8	2	0	0	0	0	10	25
11:45	6	2	0	0	0	0	8	0	0	0	0	0	0	0	3	0	0	0	0	0	3	11
1 Hr	40	5	1	0	0	0	46	0	0	0	0	0	0	0	26	4	1	0	0	0	31	77
12:00	10	0	0	0	0	0	10	0	0	0	0	0	0	0	9	1	0	0	0	0	10	20
12:15	19	1	0	0	0	0	20	0	0	0	0	0	0	0	3	0	0	0	0	0	3	23
12:30	11	1	0	0	0	0	12	0	0	0	0	0	0	0	3	0	0	0	0	0	3	15
12:45	6	1	1	0	0	0	8	0	0	0	0	0	0	0	7	4	0	0	0	0	11	19

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 7 - Chapel Street / Saint Andrews Hill / Station Road

Time	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Arm Totals
1 Hr	46	3	1	0	0	0	50	0	0	0	0	0	0	0	22	5	0	0	0	0	27	77
13:00	13	7	0	0	0	0	20	0	0	0	0	0	0	0	3	0	0	0	0	0	3	23
13:15	9	1	0	1	0	0	11	0	0	0	0	0	0	0	8	0	0	0	0	0	8	19
13:30	11	1	1	0	0	0	13	0	0	0	0	0	0	0	2	1	0	0	0	0	3	16
13:45	11	3	0	1	0	0	15	0	0	0	0	0	0	0	4	1	0	0	0	0	5	20
1 Hr	44	12	1	2	0	0	59	0	0	0	0	0	0	0	17	2	0	0	0	0	19	78
14:00	4	3	1	0	0	0	8	0	0	0	0	0	0	0	6	2	0	0	0	0	8	16
14:15	10	3	0	0	0	0	13	0	0	0	0	0	0	0	6	0	0	0	0	0	6	19
14:30	3	0	1	0	0	0	4	0	0	0	0	0	0	0	6	1	0	0	0	0	7	11
14:45	17	2	0	0	0	0	19	0	0	0	0	0	0	0	12	1	0	0	0	0	13	32
1 Hr	34	8	2	0	0	0	44	0	0	0	0	0	0	0	30	4	0	0	0	0	34	78
15:00	11	1	0	0	0	0	12	0	0	0	0	0	0	0	12	1	0	0	0	0	13	25
15:15	10	2	1	0	0	1	14	0	0	0	0	0	0	0	6	0	0	0	0	0	6	20
15:30	12	4	0	0	0	0	16	0	0	0	0	0	0	0	8	1	0	0	0	0	9	25
15:45	5	4	0	0	0	0	9	0	0	0	0	0	0	0	6	1	0	0	0	0	7	16
1 Hr	38	11	1	0	0	1	51	0	0	0	0	0	0	0	32	3	0	0	0	0	35	86
16:00	19	2	0	0	0	0	21	0	0	0	0	0	0	0	8	2	0	0	0	0	10	31
16:15	6	2	0	0	0	0	8	0	0	0	0	0	0	0	5	0	0	0	0	0	5	13
16:30	11	2	1	0	0	0	14	0	0	0	0	0	0	0	5	0	0	0	0	0	5	19
16:45	9	1	0	0	0	0	10	0	0	0	0	0	0	0	4	0	0	0	0	0	4	14
1 Hr	45	7	1	0	0	0	53	0	0	0	0	0	0	0	22	2	0	0	0	0	24	77
17:00	11	1	0	0	0	0	12	0	0	0	0	0	0	0	4	1	0	0	0	0	5	17
17:15	17	2	0	0	0	0	19	0	0	0	0	0	0	0	13	0	0	0	0	0	13	32
17:30	16	1	0	0	0	0	17	0	0	0	0	0	0	0	7	0	0	0	0	0	7	24
17:45	12	0	0	0	0	0	12	0	0	0	0	0	0	0	5	1	0	0	0	0	6	18
1 Hr	56	4	0	0	0	0	60	0	0	0	0	0	0	0	29	2	0	0	0	0	31	91
18:00	23	1	0	0	0	0	24	0	0	0	0	0	0	0	3	1	0	0	0	0	4	28
18:15	13	1	0	0	0	0	14	0	0	0	0	0	0	0	4	0	0	0	0	0	4	18
18:30	8	1	0	0	0	0	9	0	0	0	0	0	0	0	7	0	1	0	0	0	8	17
18:45	14	1	0	0	0	0	15	0	0	0	0	0	0	0	5	0	0	0	0	0	5	20
1 Hr	58	4	0	0	0	0	62	0	0	0	0	0	0	0	19	1	1	0	0	0	21	83
Total	561	85	8	3	0	2	659	0	0	0	0	0	0	0	447	39	7	0	0	1	494	1153

Origin Arm C Station Road

	Destination : Arm A Chapel Street							**Destination :** Arm B Saint Andrews Hill							**Destination :** Arm C Station Road							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Arm Totals
07:00	11	2	0	0	0	0	13	1	2	0	0	0	0	3	0	0	0	0	0	0	0	16
07:15	17	1	0	0	0	1	19	1	1	0	0	0	0	2	0	0	0	0	0	0	0	21
07:30	19	3	1	0	0	0	23	2	1	0	0	0	0	3	0	0	0	0	0	0	0	26
07:45	24	8	0	0	0	0	32	6	0	0	0	0	0	6	0	0	0	0	0	0	0	38
1 Hr	71	14	1	0	0	1	87	10	4	0	0	0	0	14	0	0	0	0	0	0	0	101
08:00	30	6	0	0	0	0	36	6	0	0	0	0	0	6	0	0	0	0	0	0	0	42
08:15	35	6	0	0	0	0	41	2	0	0	0	0	0	2	0	0	0	0	0	0	0	43
08:30	34	4	0	0	0	0	38	13	0	1	0	0	0	14	0	0	0	0	0	0	0	52
08:45	30	6	0	0	0	0	36	6	1	0	0	0	0	7	0	0	0	0	0	0	0	43
1 Hr	129	22	0	0	0	0	151	27	1	1	0	0	0	29	0	0	0	0	0	0	0	180
09:00	19	0	0	0	0	0	19	6	1	0	0	0	0	7	0	0	0	0	0	0	0	26
09:15	19	4	0	0	0	0	23	2	1	0	0	0	0	3	0	0	0	0	0	0	0	26
09:30	18	2	0	0	0	0	20	7	1	1	0	0	0	9	0	0	0	0	0	0	0	29
09:45	17	6	2	0	0	0	25	4	1	0	0	0	0	5	0	0	0	0	0	0	0	30
1 Hr	73	12	2	0	0	0	87	19	4	1	0	0	0	24	0	0	0	0	0	0	0	111
10:00	24	9	0	0	0	0	33	7	1	0	0	0	0	8	0	0	0	0	0	0	0	41
10:15	13	3	1	0	0	0	17	1	0	1	0	0	0	2	0	0	0	0	0	0	0	19
10:30	17	3	1	0	0	1	22	6	1	0	0	0	0	7	0	0	0	0	0	0	0	29
10:45	22	7	1	0	0	0	30	5	2	0	0	0	0	7	0	0	0	0	0	0	0	37
1 Hr	76	22	3	0	0	1	102	19	4	1	0	0	0	24	0	0	0	0	0	0	0	126
11:00	22	2	2	0	0	0	26	6	0	0	0	0	0	6	0	0	0	0	0	0	0	32
11:15	21	3	0	0	0	0	24	7	0	1	0	0	0	8	0	0	0	0	0	0	0	32
11:30	25	5	3	0	0	0	33	2	3	1	0	0	0	6	0	0	0	0	0	0	0	39
11:45	25	1	2	0	0	0	28	7	0	0	0	0	0	7	0	0	0	0	0	0	0	35
1 Hr	93	11	7	0	0	0	111	22	3	2	0	0	0	27	0	0	0	0	0	0	0	138
12:00	28	3	1	0	0	1	33	6	1	0	0	0	0	7	0	0	0	0	0	0	0	40
12:15	23	4	3	0	0	0	30	9	1	0	0	0	0	10	0	0	0	0	0	0	0	40
12:30	23	2	0	0	0	0	25	6	1	0	0	0	0	7	0	0	0	0	0	0	0	32
12:45	21	9	1	0	1	1	33	8	1	0	0	0	0	9	0	0	0	0	0	0	0	42
1 Hr	95	18	5	0	1	2	121	29	4	0	0	0	0	33	0	0	0	0	0	0	0	154
13:00	23	5	0	0	0	0	28	4	1	0	0	0	0	5	0	0	0	0	0	0	0	33
13:15	34	6	1	0	0	0	41	3	1	1	0	0	0	5	0	0	0	0	0	0	0	46
13:30	17	6	0	0	0	0	23	7	1	0	0	0	0	8	0	0	0	0	0	0	0	31
13:45	25	6	1	0	0	0	32	4	2	0	0	0	0	6	0	0	0	0	0	0	0	38
1 Hr	99	23	2	0	0	0	124	18	5	1	0	0	0	24	0	0	0	0	0	0	0	148
14:00	38	7	0	0	0	0	45	6	3	0	0	0	0	9	0	0	0	0	0	0	0	54
14:15	31	6	2	0	0	0	39	7	0	0	0	0	0	7	0	0	0	0	0	0	0	46
14:30	27	6	0	0	0	0	33	9	0	0	0	0	0	9	0	0	0	0	0	0	0	42
14:45	41	10	2	0	1	0	54	14	0	0	0	0	0	14	0	0	0	0	0	0	0	68
1 Hr	137	29	4	0	1	0	171	36	3	0	0	0	0	39	0	0	0	0	0	0	0	210
15:00	24	5	0	1	0	0	30	12	1	0	0	0	0	13	0	0	0	0	0	0	0	43
15:15	34	8	0	0	0	0	42	10	1	0	0	0	0	11	1	0	0	0	0	0	1	54
15:30	35	12	0	0	0	0	47	7	2	0	0	0	0	9	0	0	0	0	0	0	0	56
15:45	66	6	5	0	0	1	78	13	2	1	0	0	0	16	0	0	0	0	0	0	0	94
1 Hr	159	31	5	1	0	1	197	42	6	1	0	0	0	49	1	0	0	0	0	0	1	247
16:00	45	8	0	0	0	0	53	10	1	0	0	0	0	11	0	0	0	0	0	0	0	64
16:15	56	9	0	0	0	1	66	11	1	0	1	0	0	13	0	0	0	0	0	0	0	79
16:30	38	9	1	0	0	1	49	8	2	0	0	0	0	10	0	0	0	0	0	0	0	59
16:45	62	6	1	0	0	0	69	22	2	1	0	0	0	25	0	0	0	0	0	0	0	94
1 Hr	201	32	2	0	0	2	237	51	6	1	1	0	0	59	0	0	0	0	0	0	0	296
17:00	61	8	0	0	0	0	69	17	1	0	0	0	0	18	1	0	0	0	0	0	1	88
17:15	65	7	0	0	0	0	72	8	1	0	0	0	0	9	0	0	0	0	0	0	0	81
17:30	59	3	1	0	1	0	64	22	2	1	0	0	0	25	0	0	0	0	0	0	0	89
17:45	62	5	0	0	0	0	67	9	0	0	0	0	0	9	0	0	0	0	0	0	0	76
1 Hr	247	23	1	0	1	0	272	56	4	1	0	0	0	61	1	0	0	0	0	0	1	334
18:00	62	2	0	0	1	2	67	12	2	0	0	0	0	14	0	0	0	0	0	0	0	81
18:15	54	1	1	0	0	0	56	11	2	0	0	0	0	13	0	0	0	0	0	0	0	69
18:30	35	5	0	0	0	0	40	10	1	0	0	0	0	11	0	0	0	0	0	0	0	51
18:45	53	3	0	0	0	1	57	17	0	0	0	0	0	17	0	0	0	0	0	0	0	74
1 Hr	204	11	1	0	1	3	220	50	5	0	0	0	0	55	0	0	0	0	0	0	0	275
Total	1584	248	33	1	4	10	1880	379	49	9	1	0	0	438	2	0	0	0	0	0	2	2320

Tracsis plc
Traffic and Data Services

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 7 - Chapel Street / Saint Andrews Hill / Station Road

ORIGIN SUMMARY

	Origin : Arm A Chapel Street						Total	Origin : Arm B Saint Andrews Hill						Total	Origin : Arm C Station Road						Total	Origin Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	73	9	1	0	0	2	85	21	5	1	0	0	0	27	12	4	0	0	0	0	16	128
07:15	81	9	1	2	0	0	93	23	4	0	1	0	0	28	18	2	0	0	0	1	21	142
07:30	90	11	2	0	1	2	106	36	4	0	0	0	0	40	21	4	1	0	0	0	26	172
07:45	92	9	2	0	0	0	103	45	0	0	0	0	0	45	30	8	0	0	0	0	38	186
1 Hr	336	38	6	2	1	4	387	125	13	1	1	0	0	140	81	18	1	0	0	1	101	628
08:00	64	17	0	0	0	1	82	40	0	0	0	0	0	40	36	6	0	0	0	0	42	164
08:15	88	11	1	0	0	1	101	34	2	0	0	0	0	36	37	6	0	0	0	0	43	180
08:30	70	7	1	0	0	1	79	44	3	0	0	0	0	47	47	4	1	0	0	0	52	178
08:45	61	5	1	0	0	0	67	29	3	0	0	0	0	32	36	7	0	0	0	0	43	142
1 Hr	283	40	3	0	0	3	329	147	8	0	0	0	0	155	156	23	1	0	0	0	180	664
09:00	54	8	2	0	0	0	64	30	3	1	0	0	1	35	25	1	0	0	0	0	26	125
09:15	57	8	1	0	0	0	66	25	2	1	0	0	0	28	21	5	0	0	0	0	26	120
09:30	45	8	0	0	1	2	56	29	5	1	0	0	0	35	25	3	1	0	0	0	29	120
09:45	41	5	3	0	0	0	49	27	2	2	0	0	0	31	21	7	2	0	0	0	30	110
1 Hr	197	29	6	0	1	2	235	111	12	5	0	0	1	129	92	16	3	0	0	0	111	475
10:00	30	5	1	1	0	0	37	21	5	0	0	0	0	26	31	10	0	0	0	0	41	104
10:15	35	6	2	0	0	0	43	13	3	0	0	0	0	16	14	3	2	0	0	0	19	78
10:30	32	7	0	0	0	0	39	15	3	0	0	0	1	19	23	4	1	0	0	1	29	87
10:45	30	5	0	0	0	2	37	18	3	0	0	0	0	21	27	9	1	0	0	0	37	95
1 Hr	127	23	3	1	0	2	156	67	14	0	0	0	1	82	95	26	4	0	0	1	126	364
11:00	26	4	1	0	0	0	31	19	3	1	0	0	0	23	28	2	2	0	0	0	32	86
11:15	51	3	1	0	0	0	55	18	0	0	0	0	0	18	28	3	1	0	0	0	32	105
11:30	32	8	3	2	1	0	46	20	4	1	0	0	0	25	27	8	4	0	0	0	39	110
11:45	39	4	0	0	0	0	43	9	2	0	0	0	0	11	32	1	2	0	0	0	35	89
1 Hr	148	19	5	2	1	0	175	66	9	2	0	0	0	77	115	14	9	0	0	0	138	390
12:00	38	5	2	0	0	0	45	19	1	0	0	0	0	20	34	4	1	0	0	1	40	105
12:15	46	7	0	0	0	0	53	22	1	0	0	0	0	23	32	5	3	0	0	0	40	116
12:30	36	4	0	0	0	0	40	14	1	0	0	0	0	15	29	3	0	0	0	0	32	87
12:45	35	13	2	0	0	0	50	13	5	1	0	0	0	19	29	10	1	0	1	1	42	111
1 Hr	155	29	4	0	0	0	188	68	8	1	0	0	0	77	124	22	5	0	1	2	154	419
13:00	34	3	0	0	0	0	37	16	7	0	0	0	0	23	27	6	0	0	0	0	33	93
13:15	36	13	1	1	0	0	51	17	1	0	1	0	0	19	37	7	2	0	0	0	46	116
13:30	42	9	0	0	1	1	53	13	2	1	0	0	0	16	24	7	0	0	0	0	31	100
13:45	37	10	0	0	0	0	47	15	4	0	1	0	0	20	29	8	1	0	0	0	38	105
1 Hr	149	35	1	1	1	1	188	61	14	1	2	0	0	78	117	28	3	0	0	0	148	414
14:00	30	5	1	0	0	0	36	10	5	1	0	0	0	16	44	10	0	0	0	0	54	106
14:15	31	2	1	0	0	0	34	16	3	0	0	0	0	19	38	6	2	0	0	0	46	99
14:30	38	8	0	0	0	0	46	9	1	1	0	0	0	11	36	6	0	0	0	0	42	99
14:45	35	3	0	0	0	0	38	29	3	0	0	0	0	32	55	10	2	0	1	0	68	138
1 Hr	134	18	2	0	0	0	154	64	12	2	0	0	0	78	173	32	4	0	1	0	210	442
15:00	43	3	1	0	0	0	47	23	2	0	0	0	0	25	36	6	0	1	0	0	43	115
15:15	32	8	0	0	0	0	40	16	2	1	0	0	1	20	45	9	0	0	0	0	54	114
15:30	42	7	0	0	2	1	52	20	5	0	0	0	0	25	42	14	0	0	0	0	56	133
15:45	35	5	0	0	0	0	40	11	5	0	0	0	0	16	79	8	6	0	0	1	94	150
1 Hr	152	23	1	0	2	1	179	70	14	1	0	0	1	86	202	37	6	1	0	1	247	512
16:00	60	13	1	0	0	0	74	27	4	0	0	0	0	31	55	9	0	0	0	0	64	169
16:15	45	6	0	0	0	0	51	11	2	0	0	0	0	13	67	10	0	1	0	1	79	143
16:30	51	8	0	0	0	1	60	16	2	1	0	0	0	19	46	11	1	0	0	1	59	138
16:45	50	4	0	0	0	0	54	13	1	0	0	0	0	14	84	8	2	0	0	0	94	162
1 Hr	206	31	1	0	0	1	239	67	9	1	0	0	0	77	252	38	3	1	0	2	296	612
17:00	63	6	0	0	0	0	69	15	2	0	0	0	0	17	79	9	0	0	0	0	88	174
17:15	53	0	0	0	0	1	54	30	2	0	0	0	0	32	73	8	0	0	0	0	81	167
17:30	63	3	0	0	0	0	66	23	1	0	0	0	0	24	81	5	2	0	1	0	89	179
17:45	57	2	0	0	0	0	59	17	1	0	0	0	0	18	71	5	0	0	0	0	76	153
1 Hr	236	11	0	0	0	1	248	85	6	0	0	0	0	91	304	27	2	0	1	0	334	673
18:00	61	5	1	0	0	0	67	26	2	0	0	0	0	28	74	4	0	0	1	2	81	176
18:15	42	4	0	0	0	0	46	17	1	0	0	0	0	18	65	3	1	0	0	0	69	133
18:30	43	1	0	0	0	0	44	15	1	1	0	0	0	17	45	6	0	0	0	0	51	112
18:45	26	1	1	0	0	0	28	19	1	0	0	0	0	20	70	3	0	0	0	1	74	122
1 Hr	172	11	2	0	0	0	185	77	5	1	0	0	0	83	254	16	1	0	1	3	275	543
Total	2295	307	34	6	6	15	2663	1008	124	15	3	0	3	1153	1965	297	42	2	4	10	2320	6136

DESTINATION SUMMARY

	Destination : Arm A Chapel Street						Total	Destination : Arm B Saint Andrews Hill						Total	Destination : Arm C Station Road						Total	Dest Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	21	6	0	0	0	0	27	9	4	1	0	0	0	14	76	8	1	0	0	2	87	128
07:15	30	3	0	1	0	1	35	6	1	0	0	0	0	7	86	11	1	2	0	0	100	142
07:30	33	5	1	0	0	0	39	14	4	0	0	0	0	18	100	10	2	0	1	2	115	172
07:45	39	8	0	0	0	0	47	9	2	0	0	0	0	11	119	7	2	0	0	0	128	186
1 Hr	123	22	1	1	0	1	148	38	11	1	0	0	0	50	381	36	6	2	1	4	430	628
08:00	45	6	0	0	0	0	51	13	1	0	0	0	0	14	82	16	0	0	0	1	99	164
08:15	46	7	0	0	0	0	53	12	1	0	0	0	0	13	101	11	1	0	0	1	114	180
08:30	53	6	0	0	0	0	59	23	1	1	0	0	0	25	85	7	1	0	0	1	94	178
08:45	40	8	0	0	0	0	48	14	1	0	0	0	0	15	72	6	1	0	0	0	79	142
1 Hr	184	27	0	0	0	0	211	62	4	1	0	0	0	67	340	40	3	0	0	3	386	664
09:00	30	3	1	0	0	1	35	13	5	1	0	0	0	19	66	4	1	0	0	0	71	125
09:15	30	5	0	0	0	0	35	9	3	0	0	0	0	12	64	7	2	0	0	0	73	120
09:30	32	6	0	0	0	0	38	15	3	1	0	0	0	19	52	7	1	0	1	2	63	120
09:45	30	8	2	0	0	0	40	11	1	0	0	0	0	12	48	5	5	0	0	0	58	110
1 Hr	122	22	3	0	0	1	148	48	12	2	0	0	0	62	230	23	9	0	1	2	265	475
10:00	37	12	0	0	0	0	49	13	3	0	1	0	0	17	32	5	1	0	0	0	38	104
10:15	22	5	1	0	0	0	28	9	3	2	0	0	0	14	31	4	1	0	0	0	36	78
10:30	25	5	1	0	0	1	32	16	3	0	0	0	0	19	29	6	0	0	0	1	36	87
10:45	36	9	1	0	0	0	46	13	2	0	0	0	0	15	26	6	0	0	0	2	34	95
1 Hr	120	31	3	0	0	1	155	51	11	2	1	0	0	65	118	21	2	0	0	3	144	364
11:00	36	3	2	0	0	0	41	13	2	0	0	0	0	15	24	4	2	0	0	0	30	86
11:15	29	3	0	0	0	0	32	21	0	2	0	0	0	23	47	3	0	0	0	0	50	105
11:30	37	7	4	0	0	0	48	12	3	2	1	0	0	18	30	10	2	1	1	0	44	110
11:45	31	3	2	0	0	0	36	16	2	0	0	0	0	18	33	2	0	0	0	0	35	89
1 Hr	133	16	8	0	0	0	157	62	7	4	1	0	0	74	134	19	4	1	1	0	159	390
12:00	38	3	1	0	0	1	43	18	2	0	0	0	0	20	35	5	2	0	0	0	42	105
12:15	42	5	3	0	0	0	50	25	6	0	0	0	0	31	33	2	0	0	0	0	35	116
12:30	34	4	0	0	0	0	38	16	1	0	0	0	0	17	29	3	0	0	0	0	32	87

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3790-TAD Waterbeach
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Site 7 - Chapel Street / Saint Andrews Hill / Station Road

12:45	27	10	2	0	1	1	41	27	4	1	0	0	0	32	23	14	1	0	0	0	38	111
1 Hr	141	22	6	0	1	2	172	86	13	1	0	0	0	100	120	24	3	0	0	0	147	419
13:00	36	12	0	0	0	0	48	15	1	0	0	0	0	16	26	3	0	0	0	0	29	93
13:15	43	7	1	1	0	0	52	15	7	2	1	0	0	25	32	7	0	0	0	0	39	116
13:30	28	7	1	0	0	0	36	20	4	0	0	0	0	24	31	7	0	0	1	1	40	100
13:45	36	9	1	1	0	0	47	12	9	0	0	0	0	21	33	4	0	0	0	0	37	105
1 Hr	143	35	3	2	0	0	183	62	21	2	1	0	0	86	122	21	0	0	1	1	145	414
14:00	43	10	1	0	0	0	54	16	4	1	0	0	0	21	25	6	0	0	0	0	31	106
14:15	41	9	2	0	0	0	52	18	0	1	0	0	0	19	26	2	0	0	0	0	28	99
14:30	30	6	1	0	0	0	37	23	1	0	0	0	0	24	30	8	0	0	0	0	38	99
14:45	58	12	2	0	1	0	73	26	0	0	0	0	0	26	35	4	0	0	0	0	39	138
1 Hr	172	37	6	0	1	0	216	83	5	2	0	0	0	90	116	20	0	0	0	0	136	442
15:00	35	6	0	1	0	0	42	29	1	1	0	0	0	31	38	4	0	0	0	0	42	115
15:15	45	10	1	0	0	1	57	24	2	0	0	0	0	26	24	7	0	0	0	0	31	114
15:30	48	16	0	0	0	0	64	26	6	0	0	2	1	35	30	4	0	0	0	0	34	133
15:45	73	10	5	0	0	1	89	30	5	1	0	0	0	36	22	3	0	0	0	0	25	150
1 Hr	201	42	6	1	0	2	252	109	14	2	0	2	1	128	114	18	0	0	0	0	132	512
16:00	65	10	0	0	0	0	75	26	5	0	0	0	0	31	51	11	1	0	0	0	63	169
16:15	62	11	0	0	0	1	74	34	5	0	1	0	0	40	27	2	0	0	0	0	29	143
16:30	49	11	2	0	0	1	63	23	5	0	0	0	0	28	41	5	0	0	0	1	47	138
16:45	71	7	1	0	0	0	79	35	3	1	0	0	0	39	41	3	0	0	0	0	44	162
1 Hr	247	39	3	0	0	2	291	118	18	1	1	0	0	138	160	21	1	0	0	1	183	612
17:00	72	9	0	0	0	0	81	38	3	0	0	0	0	41	47	5	0	0	0	0	52	174
17:15	82	9	0	0	0	0	91	26	1	0	0	0	1	28	48	0	0	0	0	0	48	167
17:30	75	4	1	0	1	0	81	50	3	1	0	0	0	54	42	2	0	0	0	0	44	179
17:45	74	5	0	0	0	0	79	38	0	0	0	0	0	38	33	3	0	0	0	0	36	153
1 Hr	303	27	1	0	1	0	332	152	7	1	0	0	1	161	170	10	0	0	0	0	180	673
18:00	85	3	0	0	1	2	91	43	3	0	0	0	0	46	33	5	1	0	0	0	39	176
18:15	67	2	1	0	0	0	70	23	5	0	0	0	0	28	34	1	0	0	0	0	35	133
18:30	43	6	0	0	0	0	49	30	1	0	0	0	0	31	30	1	1	0	0	0	32	112
18:45	67	4	0	0	0	1	72	28	1	1	0	0	0	30	20	0	0	0	0	0	20	122
1 Hr	262	15	1	0	1	3	282	124	10	1	0	0	0	135	117	7	2	0	0	0	126	543
Total	2151	335	41	4	4	12	2547	995	133	20	4	2	2	1156	2122	260	30	3	4	14	2433	6136

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Site 8 - Cody Road / Bannold Road(E) / Bannold Road(WNW)

Origin Arm A Cody Road

	Destination : Arm A Cody Road						Total	Destination : Arm B Bannold Road(E)						Total	Destination : Arm C Bannold Road(WNW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	0	0	0	0	0	0	0	6	1	0	0	0	0	7	11	1	1	0	0	0	13	20
07:15	0	0	0	0	0	0	0	10	1	0	0	0	0	11	15	4	0	0	1	0	20	31
07:30	0	0	0	0	0	0	0	9	0	0	0	0	0	9	20	3	0	0	0	0	23	32
07:45	0	0	0	0	0	0	0	10	0	0	0	0	0	10	17	1	0	0	0	0	18	28
1 Hr	0	0	0	0	0	0	0	35	2	0	0	0	0	37	63	9	1	0	1	0	74	111
08:00	0	0	0	0	0	0	0	14	1	0	0	0	0	15	15	3	1	0	0	0	19	34
08:15	0	0	0	0	0	0	0	15	0	0	0	0	0	15	13	2	1	0	1	0	17	32
08:30	0	0	0	0	0	0	0	25	0	0	0	0	0	25	28	1	0	0	0	0	29	54
08:45	0	0	0	0	0	0	0	11	0	0	0	0	0	11	14	0	1	0	1	0	16	27
1 Hr	0	0	0	0	0	0	0	65	1	0	0	0	0	66	70	6	3	0	2	0	81	147
09:00	0	0	0	0	0	0	0	9	0	0	0	0	0	9	14	0	2	1	0	0	17	26
09:15	0	0	0	0	0	0	0	6	2	2	0	0	0	10	18	1	0	1	0	0	20	30
09:30	0	0	0	0	0	0	0	9	0	0	0	0	0	9	9	1	0	0	1	0	11	20
09:45	0	0	0	0	0	0	0	8	0	0	0	0	0	8	9	0	0	0	2	0	11	19
1 Hr	0	0	0	0	0	0	0	32	2	2	0	0	0	36	50	2	2	2	3	0	59	95
10:00	0	0	0	0	0	0	0	3	0	0	0	0	0	3	19	2	1	0	0	0	22	25
10:15	0	0	0	0	0	0	0	3	2	0	0	0	0	5	8	2	0	0	0	0	10	15
10:30	0	0	0	0	0	0	0	3	1	0	0	0	0	4	5	2	2	1	0	0	10	14
10:45	0	0	0	0	0	0	0	2	0	0	0	0	0	2	9	1	0	0	1	0	11	13
1 Hr	0	0	0	0	0	0	0	11	3	0	0	0	0	14	41	7	3	1	1	0	53	67
11:00	0	0	0	0	0	0	0	4	0	0	0	0	0	4	6	1	0	0	0	0	7	11
11:15	0	0	0	0	0	0	0	3	0	0	0	0	0	3	6	1	0	0	0	0	7	10
11:30	0	0	0	0	0	0	0	5	1	0	0	0	0	6	4	3	0	1	1	0	9	15
11:45	0	0	0	0	0	0	0	8	0	0	0	0	0	8	9	1	1	0	1	0	12	20
1 Hr	0	0	0	0	0	0	0	20	1	0	0	0	0	21	25	6	1	1	2	0	35	56
12:00	0	0	0	0	0	0	0	4	1	0	0	0	0	5	7	1	0	0	0	0	8	13
12:15	0	0	0	0	0	0	0	2	0	0	0	0	0	2	13	2	0	0	0	0	15	17
12:30	0	0	0	0	0	0	0	3	1	0	0	0	0	4	13	1	0	0	0	0	14	18
12:45	0	0	0	0	0	0	0	5	1	0	0	0	0	6	10	4	0	0	2	0	16	22
1 Hr	0	0	0	0	0	0	0	14	3	0	0	0	0	17	43	8	0	0	2	0	53	70
13:00	0	0	0	0	0	0	0	3	2	1	0	0	0	6	9	0	1	1	0	0	11	17
13:15	0	0	0	0	0	0	0	4	0	0	0	0	0	4	3	1	0	0	0	0	4	8
13:30	0	0	0	0	0	0	0	1	1	0	0	0	0	2	7	2	0	0	1	1	11	13
13:45	0	0	0	0	0	0	0	3	0	0	0	0	0	3	8	1	0	0	1	0	10	13
1 Hr	0	0	0	0	0	0	0	11	3	1	0	0	0	15	27	4	1	1	2	1	36	51
14:00	0	0	0	0	0	0	0	4	1	0	0	0	0	5	7	1	0	0	0	0	8	13
14:15	0	0	0	0	0	0	0	2	0	0	0	0	0	2	9	1	0	0	0	0	10	12
14:30	0	0	1	0	0	0	1	1	0	0	0	0	0	1	12	1	0	1	0	0	14	16
14:45	0	0	0	0	0	0	0	12	1	0	0	0	0	13	10	1	1	2	1	0	15	28
1 Hr	0	0	1	0	0	0	1	19	2	0	0	0	0	21	38	4	1	3	1	0	47	69
15:00	0	0	0	0	0	0	0	14	0	0	0	0	0	14	11	1	0	0	0	0	12	26
15:15	0	0	0	0	0	0	0	8	0	0	0	0	0	8	9	1	1	0	0	0	11	19
15:30	0	0	0	0	0	0	0	1	0	0	0	0	0	1	5	3	1	0	1	0	10	11
15:45	0	0	0	0	0	0	0	5	0	0	0	0	0	5	4	6	1	0	1	0	12	17
1 Hr	0	0	0	0	0	0	0	28	0	0	0	0	0	28	29	11	3	0	2	0	45	73
16:00	0	0	0	0	0	0	0	5	0	0	0	0	0	5	9	1	1	0	0	0	11	16
16:15	0	0	0	0	0	0	0	3	1	0	0	0	0	4	13	0	0	0	0	1	14	18
16:30	0	0	0	0	0	0	0	3	0	0	0	0	0	3	9	1	0	0	0	0	10	13
16:45	0	0	0	0	0	0	0	1	0	0	0	0	0	1	8	0	1	1	0	0	10	11
1 Hr	0	0	0	0	0	0	0	12	1	0	0	0	0	13	39	2	2	1	0	1	45	58
17:00	0	0	0	0	0	0	0	4	1	0	0	0	0	5	16	0	1	0	1	0	18	23
17:15	0	0	0	0	0	0	0	4	2	0	0	0	0	6	10	3	0	0	0	0	13	19
17:30	0	0	0	0	0	0	0	7	0	0	0	0	0	7	14	1	0	0	0	0	15	22
17:45	0	0	0	0	0	0	0	5	1	0	0	0	0	6	11	0	0	0	0	0	11	17
1 Hr	0	0	0	0	0	0	0	20	4	0	0	0	0	24	51	4	1	0	1	0	57	81
18:00	0	0	0	0	0	0	0	6	1	0	0	0	0	7	15	5	0	0	1	0	21	28
18:15	0	0	0	0	0	0	0	6	1	0	0	0	0	7	5	0	0	0	0	0	5	12
18:30	0	0	0	0	0	0	0	2	0	0	0	0	0	2	10	0	0	0	0	0	10	12
18:45	0	0	0	0	0	0	0	7	0	0	0	0	0	7	8	0	0	0	0	0	8	15
1 Hr	0	0	0	0	0	0	0	21	2	0	0	0	0	23	38	5	0	0	1	0	44	67
Total	0	0	1	0	0	0	1	288	24	3	0	0	0	315	514	68	18	9	18	2	629	945

Origin Arm B Bannold Road(E)

	Destination : Arm A Cody Road						Total	Destination : Arm B Bannold Road(E)						Total	Destination : Arm C Bannold Road(WNW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	1	0	0	0	0	0	1	0	0	0	0	0	0	0	6	1	0	0	0	0	7	8
07:15	1	0	0	0	0	0	1	0	0	0	0	0	0	0	4	1	0	0	0	0	5	6
07:30	2	1	0	0	0	0	3	0	0	0	0	0	0	0	11	1	0	0	0	0	12	15
07:45	8	1	0	0	0	0	9	0	0	0	0	0	0	0	4	1	0	0	0	0	5	14
1 Hr	12	2	0	0	0	0	14	0	0	0	0	0	0	0	25	4	0	0	0	0	29	43
08:00	4	0	0	0	0	0	4	0	0	0	0	0	0	0	6	0	0	1	0	0	7	11
08:15	4	0	0	0	0	0	4	0	0	0	0	0	0	0	9	1	0	1	0	0	11	15
08:30	7	0	1	0	0	0	8	0	0	0	0	0	0	0	5	1	0	0	0	0	6	14
08:45	10	0	1	0	0	0	11	0	0	0	0	0	0	0	11	1	0	1	0	0	13	24
1 Hr	25	0	2	0	0	0	27	0	0	0	0	0	0	0	31	3	0	3	0	0	37	64
09:00	6	0	1	0	0	0	7	0	0	0	0	0	0	0	5	1	3	2	0	0	11	18
09:15	4	0	0	0	0	0	4	0	0	0	0	0	0	0	2	1	0	1	0	0	4	8
09:30	9	0	0	0	0	0	9	0	0	0	0	0	0	0	5	2	2	2	0	0	11	20
09:45	5	1	0	0	0	0	6	0	0	0	0	0	0	0	1	3	3	1	0	0	8	14
1 Hr	24	1	1	0	0	0	26	0	0	0	0	0	0	0	13	7	8	6	0	0	34	60
10:00	6	2	1	0	0	0	9	0	0	0	0	0	0	0	3	1	0	1	0	0	5	14
10:15	0	1	1	0	0	0	2	0	0	0	0	0	0	0	5	4	1	0	0	0	10	12
10:30	4	1	0	0	0	0	5	0	0	0	0	0	0	0	7	0	0	0	0	0	7	12
10:45	6	0	0	0	0	0	6	0	0	0	0	0	0	0	8	1	0	0	0	0	9	15
1 Hr	16	4	2	0	0	0	22	0	0	0	0	0	0	0	23	6	1	1	0	0	31	53
11:00	2	0	0	0	0	0	2	0	0	0	0	0	0	0	8	5	0	0	0	0	13	15
11:15	7	0	0	0	0	0	7	0	0	0	0	0	0	0	5	2	0	1	0	0	8	15
11:30	6	0	0	0	0	0	6	0	0	0	0	0	0	0	1	1	1	2	0	0	5	11
11:45	5	1	0	0	0	0	6	0	0	0	0	0	0	0	6	1	0	3	0	0	10	16
1 Hr	20	1	0	0	0	0	21	0	0	0	0	0	0	0	20	9	1	6	0	0	36	57
12:00	5	0	0	0	0	0	5	0	0	0	0	0	0	0	6	2	1	1	0	0	10	15
12:15	4	1	0	0	0	0	5	0	0	0	0	0	0	0	7	0	3	0	0	0	10	15
12:30	7	2	0	0	0	0	9	0	0	0	0	0	0	0	3	1	0	0	0	0	4	13
12:45	5	2	0	0	0	0	7	0	0	0	0	0	0	0	7	2	2	2	0	0	13	20

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 8 - Cody Road / Bannold Road(E) / Bannold Road(WNW)

1 Hr	21	5	0	0	0	0	26	0	0	0	0	0	0	0	23	5	6	3	0	0	37	63
13:00	2	0	0	0	0	0	2	0	0	0	0	0	0	0	6	3	0	1	0	0	10	12
13:15	2	0	0	0	0	0	2	0	0	0	0	0	0	0	7	1	0	0	0	0	8	10
13:30	2	0	0	0	0	0	2	0	0	0	0	0	0	0	11	2	1	1	0	0	15	17
13:45	3	0	0	0	0	0	3	0	0	0	0	0	0	0	4	2	1	0	0	0	7	10
1 Hr	9	0	0	0	0	0	9	0	0	0	0	0	0	0	28	8	2	2	0	0	40	49
14:00	1	1	0	0	0	0	2	0	0	0	0	0	0	0	3	7	3	1	0	0	14	16
14:15	4	0	0	0	0	0	4	0	0	0	0	0	0	0	7	4	1	0	0	0	12	16
14:30	6	0	0	0	0	0	6	0	0	0	0	0	0	0	9	6	1	1	0	0	17	23
14:45	7	0	0	0	0	0	7	0	0	0	0	0	0	0	11	1	1	0	0	0	13	20
1 Hr	18	1	0	0	0	0	19	0	0	0	0	0	0	0	30	18	6	2	0	0	56	75
15:00	5	1	0	0	0	0	6	0	0	0	0	0	0	0	7	3	2	0	0	0	12	18
15:15	7	2	0	0	0	0	9	0	0	0	0	0	0	0	7	2	0	1	0	0	10	19
15:30	8	2	0	0	1	0	11	0	0	0	0	0	0	0	13	2	1	0	1	0	17	28
15:45	8	1	0	0	0	0	9	0	0	0	0	0	0	0	13	3	1	3	0	0	20	29
1 Hr	28	6	0	0	1	0	35	0	0	0	0	0	0	0	40	10	4	4	1	0	59	94
16:00	7	1	0	0	0	0	8	0	0	0	0	0	0	0	5	7	0	1	0	0	13	21
16:15	9	2	0	0	0	0	11	0	0	0	0	0	0	0	7	2	0	0	0	0	9	20
16:30	7	2	0	0	0	0	9	0	0	0	0	0	0	0	2	0	0	0	0	0	2	11
16:45	16	1	1	0	0	0	18	0	0	0	0	0	0	0	8	0	0	1	0	0	9	27
1 Hr	39	6	1	0	0	0	46	0	0	0	0	0	0	0	22	9	0	2	0	0	33	79
17:00	5	1	0	0	0	0	6	0	0	0	0	0	0	0	7	0	0	0	0	0	7	13
17:15	4	1	0	0	0	0	5	0	0	0	0	0	0	0	6	1	0	0	0	0	7	12
17:30	19	0	1	0	0	0	20	0	0	0	0	0	0	0	11	0	0	0	0	0	11	31
17:45	9	0	0	0	0	0	9	0	0	0	0	0	0	0	7	1	0	0	0	0	8	17
1 Hr	37	2	1	0	0	0	40	0	0	0	0	0	0	0	31	2	0	0	0	0	33	73
18:00	13	1	0	0	0	0	14	0	0	0	0	0	0	0	6	1	0	0	0	0	7	21
18:15	11	2	0	0	0	0	13	0	0	0	0	0	0	0	8	2	0	0	0	0	10	23
18:30	14	0	0	0	0	0	14	0	0	0	0	0	0	0	6	1	0	0	0	0	7	21
18:45	11	1	0	0	0	0	12	0	0	0	0	0	0	0	6	0	0	0	0	0	6	18
1 Hr	49	4	0	0	0	0	53	0	0	0	0	0	0	0	26	4	0	0	0	0	30	83
Total	298	32	7	0	1	0	338	0	0	0	0	0	0	0	312	85	28	29	1	0	455	793

Origin : Arm C Bannold Road(WNW)

	Destination : Arm A Cody Road						Total	Destination : Arm B Bannold Road(E)						Total	Destination : Arm C Bannold Road(WNW)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	1	3	0	0	0	0	4	5	3	1	1	0	0	10	0	0	0	0	0	0	0	14
07:15	4	0	0	0	1	0	5	11	8	0	1	0	0	20	0	0	0	0	0	0	0	25
07:30	6	1	1	2	0	0	10	10	4	0	0	0	0	14	0	0	0	0	0	0	0	24
07:45	7	1	0	0	0	0	8	7	7	0	1	0	0	15	0	0	0	0	0	0	0	23
1 Hr	18	5	1	2	1	0	27	33	22	1	3	0	0	59	0	0	0	0	0	0	0	86
08:00	10	1	1	0	1	0	13	3	1	1	0	0	0	5	0	0	0	0	0	0	0	18
08:15	9	2	0	0	0	0	11	4	2	0	0	0	0	6	0	0	0	0	0	0	0	17
08:30	8	0	2	0	0	0	10	6	1	2	1	0	0	10	0	0	0	0	0	0	0	20
08:45	8	1	0	1	1	0	11	7	0	1	1	0	0	9	0	0	0	0	0	0	0	20
1 Hr	35	4	3	1	2	0	45	20	4	4	2	0	0	30	0	0	0	0	0	0	0	75
09:00	9	1	1	1	1	0	13	8	0	5	3	0	0	16	1	0	0	0	0	0	1	30
09:15	11	1	2	0	0	0	14	5	0	3	2	0	0	10	0	0	0	0	0	0	0	24
09:30	5	1	0	1	0	1	8	5	1	1	0	0	0	7	0	0	0	0	0	0	0	15
09:45	13	0	0	0	2	0	15	4	2	0	1	0	0	7	0	0	0	0	0	0	0	22
1 Hr	38	3	3	2	3	1	50	22	3	9	6	0	0	40	1	0	0	0	0	0	1	91
10:00	10	4	0	0	0	0	14	5	3	1	0	0	0	9	0	0	0	0	0	0	0	23
10:15	3	2	0	0	0	0	5	4	2	0	2	0	0	8	0	0	0	0	0	0	0	13
10:30	7	2	0	0	1	0	10	6	3	0	0	0	0	9	0	0	0	0	0	0	0	19
10:45	13	2	0	0	1	0	16	5	3	1	0	0	0	9	0	0	0	0	0	0	0	25
1 Hr	33	10	0	0	2	0	45	20	11	2	2	0	0	35	0	0	0	0	0	0	0	80
11:00	1	0	0	0	0	0	1	7	3	0	2	0	0	12	0	0	0	0	0	0	0	13
11:15	16	0	1	1	0	0	18	8	3	0	1	0	0	12	0	0	0	0	0	0	0	30
11:30	6	0	1	0	1	0	8	1	1	1	1	0	0	4	0	0	0	0	0	0	0	12
11:45	19	1	1	0	0	0	21	3	0	1	1	0	0	5	0	0	0	0	0	0	0	26
1 Hr	42	1	3	1	1	0	48	19	7	2	5	0	0	33	0	0	0	0	0	0	0	81
12:00	8	5	0	0	0	0	13	5	4	1	0	0	0	10	0	0	0	0	0	0	0	23
12:15	5	4	1	0	0	0	10	4	0	0	0	0	0	4	0	0	0	0	0	0	0	14
12:30	8	2	0	1	0	0	11	4	1	0	2	0	0	7	0	0	0	0	0	0	0	18
12:45	7	0	0	0	3	0	10	6	3	1	1	0	0	11	0	0	0	0	0	0	0	21
1 Hr	28	11	1	1	3	0	44	19	8	2	3	0	0	32	0	0	0	0	0	0	0	76
13:00	6	2	1	0	0	0	9	1	0	1	0	0	0	2	0	0	0	0	0	0	0	11
13:15	7	1	0	0	0	0	8	9	2	1	1	0	0	13	0	0	0	0	0	0	0	21
13:30	4	2	0	0	0	0	6	4	0	1	0	0	0	5	0	0	0	0	0	0	0	11
13:45	9	0	0	0	1	0	10	2	2	0	1	0	0	5	0	0	0	0	0	0	0	15
1 Hr	26	5	1	0	1	0	33	16	4	3	2	0	0	25	0	0	0	0	0	0	0	58
14:00	4	0	0	1	0	0	5	4	2	2	0	0	0	8	0	0	0	0	0	0	0	13
14:15	10	1	1	0	0	0	12	4	1	1	1	0	0	7	0	0	0	0	0	0	0	19
14:30	7	1	0	0	0	0	8	7	0	0	0	0	0	7	0	0	0	0	0	0	0	15
14:45	16	2	0	0	1	0	19	7	1	0	2	0	0	10	0	0	0	0	0	0	0	29
1 Hr	37	4	1	1	1	0	44	22	4	3	3	0	0	32	0	0	0	0	0	0	0	76
15:00	12	1	1	0	0	0	14	11	2	0	0	0	0	13	0	0	0	0	0	0	0	27
15:15	12	1	1	0	0	0	14	5	0	0	1	0	0	6	0	0	0	0	0	0	0	20
15:30	18	1	1	0	0	0	20	12	3	0	3	0	0	18	0	0	0	0	0	0	0	38
15:45	11	1	1	0	1	0	14	3	0	0	0	0	0	3	0	0	0	0	0	0	0	17
1 Hr	53	4	4	0	1	0	62	31	5	0	4	0	0	40	0	0	0	0	0	0	0	102
16:00	8	1	0	0	0	0	9	4	0	0	0	0	0	4	0	0	0	0	0	0	0	13
16:15	3	3	1	0	0	0	7	2	0	0	0	0	0	2	0	0	0	0	0	0	0	9
16:30	11	0	0	1	0	0	12	6	0	1	0	0	0	7	0	0	0	0	0	0	0	19
16:45	17	0	0	0	1	0	18	3	1	0	0	0	0	4	0	0	0	0	0	0	0	22
1 Hr	39	4	1	1	1	0	46	15	1	1	0	0	0	17	0	0	0	0	0	0	0	63
17:00	6	2	0	0	0	0	8	6	0	0	0	0	0	6	0	0	0	0	0	0	0	14
17:15	17	3	0	0	0	0	20	14	0	0	0	0	0	14	0	0	0	0	0	0	0	34
17:30	24	2	0	0	0	0	26	5	0	0	0	0	0	5	0	0	0	0	0	0	0	31
17:45	22	1	0	0	0	0	23	6	1	0	0	0	0	7	0	0	0	0	0	0	0	30
1 Hr	69	8	0	0	0	0	77	31	1	0	0	0	0	32	0	0	0	0	0	0	0	109
18:00	21	1	0	0	1	0	23	8	1	0	0	0	0	9	0	0	0	0	0	0	0	32
18:15	21	1	0	0	0	0	22	2	0	0	0	0	0	2	0	0	0	0	0	0	0	24
18:30	13	1	0	0	0	0	14	4	0	1	0	0	0	5	0	0	0	0	0	0	0	19
18:45	11	2	0	0	0	0	13	6	2	0	0	0	0	8	0	0	0	0	0	0	0	21
1 Hr	66	5	0	0	1	0	72	20	3	1	0	0	0	24	0	0	0	0	0	0	0	96
Total	484	64	18	9	17	1	593	268	73	28	30	0	0	399	1	0	0	0	0	0	1	993

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 8 - Cody Road / Bannold Road(E) / Bannold Road(WNW)

ORIGIN SUMMARY

Origin : Arm A Cody Road

	Car	LGV	OGV1	OGV2	PSV	MC	Total
07:00	17	2	1	0	0	0	20
07:15	25	5	0	0	1	0	31
07:30	29	3	0	0	0	0	32
07:45	27	1	0	0	0	0	28
1 Hr	98	11	1	0	1	0	111
08:00	29	4	1	0	0	0	34
08:15	28	2	1	0	1	0	32
08:30	53	1	0	0	0	0	54
08:45	25	0	1	0	1	0	27
1 Hr	135	7	3	0	2	0	147
09:00	23	0	2	1	0	0	26
09:15	24	3	2	1	0	0	30
09:30	18	1	0	0	1	0	20
09:45	17	0	0	0	2	0	19
1 Hr	82	4	4	2	3	0	95
10:00	22	2	1	0	0	0	25
10:15	11	4	0	0	0	0	15
10:30	8	3	2	1	0	0	14
10:45	11	1	0	0	1	0	13
1 Hr	52	10	3	1	1	0	67
11:00	10	1	0	0	0	0	11
11:15	9	1	0	0	0	0	10
11:30	9	4	0	1	1	0	15
11:45	17	1	1	0	1	0	20
1 Hr	45	7	1	1	2	0	56
12:00	11	2	0	0	0	0	13
12:15	15	2	0	0	0	0	17
12:30	16	2	0	0	0	0	18
12:45	15	5	0	0	2	0	22
1 Hr	57	11	0	0	2	0	70
13:00	12	2	2	1	0	0	17
13:15	7	1	0	0	0	0	8
13:30	8	3	0	0	1	1	13
13:45	11	1	0	0	1	0	13
1 Hr	38	7	2	1	2	1	51
14:00	11	2	0	0	0	0	13
14:15	11	1	0	0	0	0	12
14:30	13	1	1	1	0	0	16
14:45	22	2	1	2	1	0	28
1 Hr	57	6	2	3	1	0	69
15:00	25	1	0	0	0	0	26
15:15	17	1	1	0	0	0	19
15:30	6	3	1	0	1	0	11
15:45	9	6	1	0	1	0	17
1 Hr	57	11	3	0	2	0	73
16:00	14	1	1	0	0	0	16
16:15	16	1	0	0	0	1	18
16:30	12	1	0	0	0	0	13
16:45	9	0	1	1	0	0	11
1 Hr	51	3	2	1	0	1	58
17:00	20	1	1	0	1	0	23
17:15	14	5	0	0	0	0	19
17:30	21	1	0	0	0	0	22
17:45	16	1	0	0	0	0	17
1 Hr	71	8	1	0	1	0	81
18:00	21	6	0	0	1	0	28
18:15	11	1	0	0	0	0	12
18:30	12	0	0	0	0	0	12
18:45	15	0	0	0	0	0	15
1 Hr	59	7	0	0	1	0	67
Total	802	92	22	9	18	2	945

Origin : Arm B Bannold Road(E)

	Car	LGV	OGV1	OGV2	PSV	MC	Total
07:00	7	1	0	0	0	0	8
07:15	5	1	0	0	0	0	6
07:30	13	2	0	0	0	0	15
07:45	12	2	0	0	0	0	14
1 Hr	37	6	0	0	0	0	43
08:00	10	0	0	1	0	0	11
08:15	13	1	0	1	0	0	15
08:30	12	1	1	0	0	0	14
08:45	21	1	1	1	0	0	24
1 Hr	56	3	2	3	0	0	64
09:00	11	1	4	2	0	0	18
09:15	6	1	0	1	0	0	8
09:30	14	2	2	2	0	0	20
09:45	6	4	3	1	0	0	14
1 Hr	37	8	9	6	0	0	60
10:00	9	3	1	1	0	0	14
10:15	5	5	2	0	0	0	12
10:30	11	1	0	0	0	0	12
10:45	14	1	0	0	0	0	15
1 Hr	39	10	3	1	0	0	53
11:00	10	5	0	0	0	0	15
11:15	12	2	0	1	0	0	15
11:30	7	1	1	2	0	0	11
11:45	11	2	0	3	0	0	16
1 Hr	40	10	1	6	0	0	57
12:00	11	2	1	1	0	0	15
12:15	11	1	3	0	0	0	15
12:30	10	3	0	0	0	0	13
12:45	12	4	2	2	0	0	20
1 Hr	44	10	6	3	0	0	63
13:00	8	3	0	1	0	0	12
13:15	9	1	0	0	0	0	10
13:30	13	2	1	1	0	0	17
13:45	7	2	1	0	0	0	10
1 Hr	37	8	2	2	0	0	49
14:00	4	8	3	1	0	0	16
14:15	11	4	1	0	0	0	16
14:30	15	6	1	1	0	0	23
14:45	18	1	1	0	0	0	20
1 Hr	48	19	6	2	0	0	75
15:00	12	4	2	0	0	0	18
15:15	14	4	0	1	0	0	19
15:30	21	4	1	0	2	0	28
15:45	21	4	1	3	0	0	29
1 Hr	68	16	4	4	2	0	94
16:00	12	8	0	1	0	0	21
16:15	16	4	0	0	0	0	20
16:30	9	2	0	0	0	0	11
16:45	24	1	1	1	0	0	27
1 Hr	61	15	1	2	0	0	79
17:00	12	1	0	0	0	0	13
17:15	10	2	0	0	0	0	12
17:30	30	0	1	0	0	0	31
17:45	16	1	0	0	0	0	17
1 Hr	68	4	1	0	0	0	73
18:00	19	2	0	0	0	0	21
18:15	19	4	0	0	0	0	23
18:30	20	1	0	0	0	0	21
18:45	17	1	0	0	0	0	18
1 Hr	75	8	0	0	0	0	83
Total	610	117	35	29	2	0	793

Origin : Arm C Bannold Road(WNW)

	Car	LGV	OGV1	OGV2	PSV	MC	Total
07:00	6	6	1	1	0	0	14
07:15	15	8	0	1	1	0	25
07:30	16	5	1	2	0	0	24
07:45	14	8	0	1	0	0	23
1 Hr	51	27	2	5	1	0	86
08:00	13	2	2	0	1	0	18
08:15	13	4	0	0	0	0	17
08:30	14	1	4	1	0	0	20
08:45	15	1	1	2	1	0	20
1 Hr	55	8	7	3	2	0	75
09:00	18	1	6	4	1	0	30
09:15	16	1	5	2	0	0	24
09:30	10	2	1	1	0	1	15
09:45	17	2	0	1	2	0	22
1 Hr	61	6	12	8	3	1	91
10:00	15	7	1	0	0	0	23
10:15	7	4	0	2	0	0	13
10:30	13	5	0	0	1	0	19
10:45	18	5	1	0	1	0	25
1 Hr	53	21	2	2	2	0	80
11:00	8	3	0	2	0	0	13
11:15	24	3	1	2	0	0	30
11:30	7	1	2	1	1	0	12
11:45	22	1	2	1	0	0	26
1 Hr	61	8	5	6	1	0	81
12:00	13	9	1	0	0	0	23
12:15	9	4	1	0	0	0	14
12:30	12	3	0	3	0	0	18
12:45	13	3	1	1	3	0	21
1 Hr	47	19	3	4	3	0	76
13:00	7	2	2	0	0	0	11
13:15	16	3	1	1	0	0	21
13:30	8	2	1	0	0	0	11
13:45	11	2	0	1	1	0	15
1 Hr	42	9	4	2	1	0	58
14:00	8	2	2	1	0	0	13
14:15	14	2	2	1	0	0	19
14:30	14	1	0	0	0	0	15
14:45	23	3	0	2	1	0	29
1 Hr	59	8	4	4	1	0	76
15:00	23	3	1	0	0	0	27
15:15	17	1	1	1	0	0	20
15:30	30	4	1	3	0	0	38
15:45	14	1	1	0	1	0	17
1 Hr	84	9	4	4	1	0	102
16:00	12	1	0	0	0	0	13
16:15	5	3	1	0	0	0	9
16:30	17	0	1	1	0	0	19
16:45	20	1	0	0	1	0	22
1 Hr	54	5	2	1	1	0	63
17:00	12	2	0	0	0	0	14
17:15	31	3	0	0	0	0	34
17:30	29	2	0	0	0	0	31
17:45	28	2	0	0	0	0	30
1 Hr	100	9	0	0	0	0	109
18:00	29	2	0	0	1	0	32
18:15	23	1	0	0	0	0	24
18:30	17	1	1	0	0	0	19
18:45	17	4	0	0	0	0	21
1 Hr	86	8	1	0	1	0	96
Total	753	137	46	39	17	1	993

	Origin Totals
07:00	42
07:15	62
07:30	71
07:45	65
1 Hr	240
08:00	63
08:15	64
08:30	88
08:45	71
1 Hr	286
09:00	74
09:15	62
09:30	55
09:45	55
1 Hr	246
10:00	62
10:15	40
10:30	45
10:45	53
1 Hr	200
11:00	39
11:15	55
11:30	38
11:45	62
1 Hr	194
12:00	51
12:15	46
12:30	49
12:45	63
1 Hr	209
13:00	40
13:15	39
13:30	41
13:45	38
1 Hr	158
14:00	42
14:15	47
14:30	54
14:45	77
1 Hr	220
15:00	71
15:15	58
15:30	77
15:45	63
1 Hr	269
16:00	50
16:15	47
16:30	43
16:45	60
1 Hr	200
17:00	50
17:15	65
17:30	84
17:45	64
1 Hr	263
18:00	81
18:15	59
18:30	52
18:45	54
1 Hr	246
Total	2731

DESTINATION SUMMARY

Destination : Arm A Cody Road

	Car	LGV	OGV1	OGV2	PSV	MC	Total
07:00	2	3	0	0	0	0	5
07:15	5	0	0	0	1	0	6
07:30	8	2	1	2	0	0	13
07:45	15	2	0	0	0	0	17
1 Hr	30	7	1	2	1	0	41
08:00	14	1	1	0	1	0	17
08:15	13	2	0	0	0	0	15
08:30	15	0	3	0	0	0	18
08:45	18	1	1	1	1	0	22
1 Hr	60	4	5	1	2	0	72
09:00	15	1	2	1	1	0	20
09:15	15	1	2	0	0	0	18
09:30	14	1	0	1	0	1	17
09:45	18	1	0	0	2	0	21
1 Hr	62	4	4	2	3	1	76
10:00	16	6	1	0	0	0	23
10:15	3	3	1	0	0	0	7
10:30	11	3	0	0	1	0	15
10:45	19	2	0	0	1	0	22
1 Hr	49	14	2	0	2	0	67
11:00	3	0	0	0	0	0	3
11:15	23	0	1	1	0	0	25
11:30	12	0	1	0	1	0	14
11:45	24	2	1	0	0	0	27
1 Hr	62	2	3	1	1	0	69
12:00	13	5	0	0	0	0	18
12:15	9	5	1	0	0	0	15
12:30	15	4	0	1	0	0	20

Destination : Arm B Bannold Road(E)

	Car	LGV	OGV1	OGV2	PSV	MC	Total
07:00	11	4	1	1	0	0	17
07:15	21	9	0	1	0	0	31
07:30	19	4	0	0	0	0	23
07:45	17	7	0	1	0	0	25
1 Hr	68	24	1	3	0	0	96
08:00	17	2	1	0	0	0	20
08:15	19	2	0	0	0	0	21
08:30	31	1	2	1	0	0	35
08:45	18	0	1	1	0	0	20
1 Hr	85	5	4	2	0	0	96
09:00	17	0	5	3	0	0	25
09:15	11	2	5	2	0	0	20
09:30	14	1	1	0	0	0	16
09:45	12	2	0	1	0	0	15
1 Hr	54	5	11	6	0	0	76
10:00	8	3	1	0	0	0	12
10:15	7	4	0	2	0	0	13
10:30	9	4	0	0	0	0	13
10:45	7	3	1	0	0	0	11
1 Hr	31	14	2	2	0	0	49
11:00	11	3	0	2	0	0	16
11:15	11	3	0	1	0	0	15
11:30	6	2	1	1	0	0	10
11:45	11	0	1	1	0	0	13
1 Hr	39	8	2	5	0	0	54
12:00	9	5	1	0	0	0	15
12:15	6	0	0	0	0	0	6
12:30	7	2	0	2	0	0	11

Destination : Arm C Bannold Road(WNW)

	Car	LGV	OGV1	OGV2	PSV	MC	Total
07:00	17	2	1	0	0	0	20
07:15	19	5	0	0	1	0	25
07:30	31	4	0	0	0	0	35
07:45	21	2	0	0	0	0	23
1 Hr	88	13	1	0	1	0	103
08:00	21	3	1	1	0	0	26
08:15	22	3	1	1	1	0	28
08:30	33	2	0	0	0	0	35
08:45	25	1	1	1	1	0	29
1 Hr	101	9	3	3	2	0	118
09:00	20	1	5	3	0	0	29
09:15	20	2	0	2	0	0	24
09:30	14	3	2	2	1	0	22
09:45	10	3	3	1	2	0	19
1 Hr	64	9	10	8	3	0	94
10:00	22	3	1	1	0	0	27
10:15	13	6	1	0	0	0	20
10:30	12	2	2	1	0	0	17
10:45	17	2	0	0	1	0	20
1 Hr	64	13	4	2	1	0	84
11:00	14	6	0	0	0	0	20
11:15	11	3	0	1	0	0	15
11:30	5	4	1	3	1	0	14
11:45	15	2	1	3	1	0	22
1 Hr	45	15	2	7	2	0	71
12:00	13	3	1	1	0	0	18
12:15	20	2	3	0	0	0	25
12:30	16	2	0	0	0	0	18

	Dest Totals
07:00	42
07:15	62
07:30	71
07:45	65
1 Hr	240
08:00	63
08:15	64
08:30	88
08:45	71
1 Hr	286
09:00	74
09:15	62
09:30	55
09:45	55
1 Hr	246
10:00	62
10:15	40
10:30	45
10:45	53
1 Hr	200
11:00	39
11:15	55
11:30	38
11:45	62
1 Hr	194
12:00	51
12:15	46
12:30	49

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Site 8 - Cody Road / Bannold Road(E) / Bannold Road(WNW)

12:45	12	2	0	0	3	0	17	11	4	1	1	0	0	17	17	6	2	2	2	0	29	63
1 Hr	49	16	1	1	3	0	70	33	11	2	3	0	0	49	66	13	6	3	2	0	90	209
13:00	8	2	1	0	0	0	11	4	2	2	0	0	0	8	15	3	1	2	0	0	21	40
13:15	9	1	0	0	0	0	10	13	2	1	1	0	0	17	10	2	0	0	0	0	12	39
13:30	6	2	0	0	0	0	8	5	1	1	0	0	0	7	18	4	1	1	1	1	26	41
13:45	12	0	0	0	1	0	13	5	2	0	1	0	0	8	12	3	1	0	1	0	17	38
1 Hr	35	5	1	0	1	0	42	27	7	4	2	0	0	40	55	12	3	3	2	1	76	158
14:00	5	1	0	1	0	0	7	8	3	2	0	0	0	13	10	8	3	1	0	0	22	42
14:15	14	1	1	0	0	0	16	6	1	1	1	0	0	9	16	5	1	0	0	0	22	47
14:30	13	1	1	0	0	0	15	8	0	0	0	0	0	8	21	7	1	2	0	0	31	54
14:45	23	2	0	0	1	0	26	19	2	0	2	0	0	23	21	2	2	2	1	0	28	77
1 Hr	55	5	2	1	1	0	64	41	6	3	3	0	0	53	68	22	7	5	1	0	103	220
15:00	17	2	1	0	0	0	20	25	2	0	0	0	0	27	18	4	2	0	0	0	24	71
15:15	19	3	1	0	0	0	23	13	0	0	1	0	0	14	16	3	1	1	0	0	21	58
15:30	26	3	1	0	1	0	31	13	3	0	3	0	0	19	18	5	2	0	2	0	27	77
15:45	19	2	1	0	1	0	23	8	0	0	0	0	0	8	17	9	2	3	1	0	32	63
1 Hr	81	10	4	0	2	0	97	59	5	0	4	0	0	68	69	21	7	4	3	0	104	269
16:00	15	2	0	0	0	0	17	9	0	0	0	0	0	9	14	8	1	1	0	0	24	50
16:15	12	5	1	0	0	0	18	5	1	0	0	0	0	6	20	2	0	0	0	1	23	47
16:30	18	2	0	1	0	0	21	9	0	1	0	0	0	10	11	1	0	0	0	0	12	43
16:45	33	1	1	0	1	0	36	4	1	0	0	0	0	5	16	0	1	2	0	0	19	60
1 Hr	78	10	2	1	1	0	92	27	2	1	0	0	0	30	61	11	2	3	0	1	78	200
17:00	11	3	0	0	0	0	14	10	1	0	0	0	0	11	23	0	1	0	1	0	25	50
17:15	21	4	0	0	0	0	25	18	2	0	0	0	0	20	16	4	0	0	0	0	20	65
17:30	43	2	1	0	0	0	46	12	0	0	0	0	0	12	25	1	0	0	0	0	26	84
17:45	31	1	0	0	0	0	32	11	2	0	0	0	0	13	18	1	0	0	0	0	19	64
1 Hr	106	10	1	0	0	0	117	51	5	0	0	0	0	56	82	6	1	0	1	0	90	263
18:00	34	2	0	0	1	0	37	14	2	0	0	0	0	16	21	6	0	0	1	0	28	81
18:15	32	3	0	0	0	0	35	8	1	0	0	0	0	9	13	2	0	0	0	0	15	59
18:30	27	1	0	0	0	0	28	6	0	1	0	0	0	7	16	1	0	0	0	0	17	52
18:45	22	3	0	0	0	0	25	13	2	0	0	0	0	15	14	0	0	0	0	0	14	54
1 Hr	115	9	0	0	1	0	125	41	5	1	0	0	0	47	64	9	0	0	1	0	74	246
Total	782	96	26	9	18	1	932	556	97	31	30	0	0	714	827	153	46	38	19	2	1085	2731

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Site 9 - Bannold Road(E) / Way Lane / Bannold Road(W)

Origin Arm A Bannold Road(E)

	Destination : Arm A Bannold Road(E)						Total	Destination : Arm B Way Lane						Total	Destination : Arm C Bannold Road(W)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	1	0	0	0	0	0	1	2	0	0	0	0	0	2	4	1	0	0	0	0	5	8
07:15	0	0	0	0	0	0	0	3	0	0	1	0	0	4	2	1	0	0	0	0	3	7
07:30	0	0	0	0	0	0	0	1	0	0	0	0	0	1	7	1	0	0	0	0	8	9
07:45	0	0	0	0	0	0	0	4	0	0	0	0	0	4	5	1	0	0	0	0	6	10
1 Hr	1	0	0	0	0	0	1	10	0	0	1	0	0	11	18	4	0	0	0	0	22	34
08:00	0	0	0	0	0	0	0	7	0	0	0	0	0	7	5	0	0	1	0	0	6	13
08:15	0	0	0	0	0	0	0	6	3	0	0	0	0	9	7	1	0	1	0	0	9	18
08:30	0	0	0	0	0	0	0	2	0	0	0	0	0	2	2	1	0	0	0	0	3	5
08:45	0	0	0	0	0	0	0	6	0	0	0	0	0	6	3	1	0	1	0	0	5	11
1 Hr	0	0	0	0	0	0	0	21	3	0	0	0	0	24	17	3	0	3	0	0	23	47
09:00	0	0	0	0	0	0	0	3	0	0	0	0	0	3	2	1	3	2	0	0	8	11
09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2	2
09:30	0	0	0	0	0	0	0	3	0	2	0	0	0	5	5	1	2	2	0	0	10	15
09:45	0	0	0	0	0	0	0	4	1	1	0	0	0	6	1	2	3	1	0	0	7	13
1 Hr	0	0	0	0	0	0	0	10	1	3	0	0	0	14	8	5	8	6	0	0	27	41
10:00	0	0	0	0	0	0	0	2	2	0	0	0	0	4	2	4	1	1	0	0	8	12
10:15	0	0	0	0	0	0	0	3	0	0	0	0	0	3	3	2	2	0	0	0	7	10
10:30	0	0	0	0	0	0	0	3	0	0	0	0	0	3	4	0	0	0	0	0	4	7
10:45	0	0	0	0	0	0	0	3	1	0	0	0	0	4	5	1	0	0	0	0	6	10
1 Hr	0	0	0	0	0	0	0	11	3	0	0	0	0	14	14	7	3	1	0	0	25	39
11:00	0	0	0	0	0	0	0	2	0	1	0	0	0	3	8	5	0	0	0	0	13	16
11:15	0	0	0	0	0	0	0	2	0	1	0	0	0	3	2	2	0	1	0	0	5	8
11:30	0	0	0	0	0	0	0	1	1	0	0	0	0	2	2	1	1	2	0	0	6	8
11:45	0	0	0	0	0	0	0	2	1	0	0	0	0	3	4	1	0	3	0	0	8	11
1 Hr	0	0	0	0	0	0	0	7	2	2	0	0	0	11	16	9	1	6	0	0	32	43
12:00	0	0	0	0	0	0	0	4	0	0	0	0	0	4	3	2	1	1	0	0	7	11
12:15	0	0	0	0	0	0	0	2	0	0	0	0	0	2	4	0	3	0	0	0	7	9
12:30	0	0	0	0	0	0	0	2	0	0	0	0	0	2	3	1	0	0	0	0	4	6
12:45	0	0	0	0	0	0	0	3	2	0	0	0	0	5	4	3	2	2	0	0	11	16
1 Hr	0	0	0	0	0	0	0	11	2	0	0	0	0	13	14	6	6	3	0	0	29	42
13:00	0	0	0	0	0	0	0	0	2	0	0	0	0	2	3	4	0	1	0	0	8	10
13:15	0	0	0	0	0	0	0	2	0	0	0	0	0	2	3	0	0	0	0	0	3	5
13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	1	1	0	0	10	10
13:45	0	0	0	0	0	0	0	1	0	0	0	0	0	1	4	0	1	0	0	0	5	6
1 Hr	0	0	0	0	0	0	0	3	2	0	0	0	0	5	16	6	2	2	0	0	26	31
14:00	0	0	0	0	0	0	0	1	2	0	0	0	0	3	2	8	3	1	0	0	14	17
14:15	0	0	0	0	0	0	0	3	2	0	0	0	0	5	5	4	1	0	0	0	10	15
14:30	0	0	3	0	0	0	3	0	0	0	0	0	0	0	7	5	1	1	0	0	14	17
14:45	0	0	0	0	0	0	0	2	1	0	0	0	0	3	5	1	1	0	0	0	7	10
1 Hr	0	0	3	0	0	0	3	6	5	0	0	0	0	11	19	18	6	2	0	0	45	59
15:00	0	0	0	0	0	0	0	1	1	0	0	0	0	2	4	3	2	0	0	0	9	11
15:15	0	0	0	0	0	0	0	0	4	0	0	0	0	4	1	2	0	1	0	0	4	8
15:30	0	0	0	0	0	0	0	2	2	0	0	0	0	4	3	3	1	0	0	0	7	11
15:45	0	0	0	0	0	0	0	2	3	1	0	0	0	6	9	4	1	3	0	0	17	23
1 Hr	0	0	0	0	0	0	0	5	10	1	0	0	0	16	17	12	4	4	0	0	37	53
16:00	0	0	0	0	0	0	0	1	0	0	0	0	0	1	4	5	0	1	0	0	10	11
16:15	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2	2	0	0	0	0	4	5
16:30	0	0	0	0	0	0	0	5	0	0	0	0	0	5	2	0	0	0	0	0	2	7
16:45	0	0	0	0	0	0	0	1	0	0	0	0	0	1	4	0	0	1	0	0	5	6
1 Hr	0	0	0	0	0	0	0	8	0	0	0	0	0	8	12	7	0	2	0	0	21	29
17:00	0	0	0	0	0	0	0	2	0	0	0	0	0	2	5	1	0	0	0	0	6	8
17:15	0	0	0	0	0	0	0	5	1	0	0	0	0	6	2	1	0	0	0	0	3	9
17:30	0	0	0	0	0	0	0	8	0	0	0	0	0	8	7	0	0	0	0	0	7	15
17:45	0	0	0	0	0	0	0	3	0	0	0	0	0	3	5	1	0	0	0	0	6	9
1 Hr	0	0	0	0	0	0	0	18	1	0	0	0	0	19	19	3	0	0	0	0	22	41
18:00	0	0	0	0	0	0	0	2	0	0	0	0	0	2	6	0	0	0	0	0	6	8
18:15	0	0	0	0	0	0	0	1	0	0	0	0	0	1	3	2	0	0	0	0	5	6
18:30	0	0	0	0	0	0	0	2	0	0	0	0	0	2	3	0	0	0	0	0	3	5
18:45	0	0	0	0	0	0	0	3	0	0	0	0	0	3	1	0	0	0	0	0	1	4
1 Hr	0	0	0	0	0	0	0	8	0	0	0	0	0	8	13	2	0	0	0	0	15	23
Total	1	0	3	0	0	0	4	118	29	6	1	0	0	154	183	82	30	29	0	0	324	482

Origin Arm B Way Lane

	Destination : Arm A Bannold Road(E)						Total	Destination : Arm B Way Lane						Total	Destination : Arm C Bannold Road(W)						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	4	2	1	0	0	0	7	0	0	0	0	0	0	0	3	0	0	0	0	0	3	10
07:15	1	0	0	0	0	0	1	0	0	0	0	0	0	0	3	1	0	0	0	0	4	5
07:30	8	3	0	0	0	0	11	0	0	0	0	0	0	0	5	1	0	0	0	0	6	17
07:45	2	1	0	0	0	0	3	0	0	0	0	0	0	0	7	1	0	0	0	0	8	11
1 Hr	15	6	1	0	0	0	22	0	0	0	0	0	0	0	18	3	0	0	0	0	21	43
08:00	3	0	0	0	0	0	3	0	0	0	0	0	0	0	5	0	0	0	0	0	5	8
08:15	1	0	1	0	0	0	2	0	0	0	0	0	0	0	7	0	0	0	0	0	7	9
08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	1	0	0	0	10	10
08:45	2	0	0	0	0	0	2	0	0	0	0	0	0	0	17	0	0	0	0	0	17	19
1 Hr	6	0	1	0	0	0	7	0	0	0	0	0	0	0	38	0	1	0	0	0	39	46
09:00	1	2	1	0	0	0	4	0	0	0	0	0	0	0	10	0	0	0	0	0	10	14
09:15	1	0	0	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0	0	0	6	7
09:30	1	0	0	0	0	0	1	0	0	0	0	0	0	0	9	1	0	0	0	0	10	11
09:45	2	0	0	0	0	0	2	0	0	0	0	0	0	0	6	0	0	0	0	0	6	8
1 Hr	5	2	1	0	0	0	8	0	0	0	0	0	0	0	31	1	0	0	0	0	32	40
10:00	1	2	1	0	0	0	4	0	0	0	0	0	0	0	5	0	0	0	0	0	5	9
10:15	2	1	0	0	0	0	3	0	0	0	0	0	0	0	2	2	1	0	0	0	5	8
10:30	4	2	0	0	0	0	6	0	0	0	0	0	0	0	6	0	0	0	0	0	6	12
10:45	3	1	0	0	0	0	4	0	0	0	0	0	0	0	9	0	0	0	0	0	9	13
1 Hr	10	6	1	0	0	0	17	0	0	0	0	0	0	0	22	2	1	0	0	0	25	42
11:00	1	1	0	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	0	0	4	6
11:15	2	0	1	0	0	0	3	0	0	0	0	0	0	0	8	0	0	0	0	0	8	11
11:30	2	0	1	0	0	0	3	0	0	0	0	0	0	0	6	1	0	0	0	0	7	10
11:45	4	1	0	0	0	0	5	0	0	0	0	0	0	0	6	1	0	0	0	0	7	12
1 Hr	9	2	2	0	0	0	13	0	0	0	0	0	0	0	24	2	0	0	0	0	26	39
12:00	3	2	0	0	0	0	5	0	0	0	0	0	0	0	7	0	0	0	0	0	7	12
12:15	2	1	0	0	0	0	3	0	0	0	0	0	0	0	8	1	0	0	0	0	9	12
12:30	2	1	0	0	0	0	3	0	0	0	0	0	0	0	7	1	0	0	0	0	8	11
12:45	1	0	0	0	0	0	1	0	0	0	0	0	0	0	7	1	0	0	0	0	8	9

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 9 - Bannold Road(E) / Way Lane / Bannold Road(W)

	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Arm Totals
1 Hr	8	4	0	0	0	0	12	0	0	0	0	0	0	0	29	3	0	0	0	0	32	44
13:00	5	0	0	0	0	0	5	0	0	0	0	0	0	0	4	0	0	0	0	0	4	9
13:15	1	2	0	0	0	0	3	0	0	0	0	0	0	0	5	1	0	0	0	0	6	9
13:30	1	0	0	0	0	0	1	0	0	0	0	0	0	0	7	0	0	0	0	0	7	8
13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	5	5
1 Hr	7	2	0	0	0	0	9	0	0	0	0	0	0	0	19	3	0	0	0	0	22	31
14:00	5	3	2	0	0	0	10	0	0	0	0	0	0	0	2	0	0	0	0	0	2	12
14:15	3	0	1	0	0	0	4	0	0	0	0	0	0	0	6	0	0	0	0	0	6	10
14:30	2	1	0	0	0	0	3	0	0	0	0	0	0	0	8	1	0	0	0	0	9	12
14:45	2	0	1	0	0	0	3	0	0	0	0	0	0	0	13	0	0	0	0	0	13	16
1 Hr	12	4	4	0	0	0	20	0	0	0	0	0	0	0	29	1	0	0	0	0	30	50
15:00	4	0	0	0	0	0	4	0	0	0	0	0	0	0	7	1	0	0	0	0	8	12
15:15	4	1	0	0	0	0	5	0	0	0	0	0	0	0	12	2	0	0	0	0	14	19
15:30	5	3	0	0	0	1	9	0	0	0	0	0	0	0	18	1	0	0	2	0	21	30
15:45	2	2	0	0	0	0	4	0	0	0	0	0	0	0	10	0	0	0	0	0	10	14
1 Hr	15	6	0	0	0	1	22	0	0	0	0	0	0	0	47	4	0	0	2	0	53	75
16:00	1	0	0	0	0	0	1	0	0	0	0	0	0	0	9	3	0	0	0	0	12	13
16:15	6	0	0	1	0	0	7	0	0	0	0	0	0	0	14	2	0	0	0	0	16	23
16:30	2	1	0	0	0	0	3	0	0	0	0	0	0	0	7	2	0	0	0	0	9	12
16:45	2	1	0	0	0	0	3	0	0	0	0	0	0	0	20	1	1	0	0	0	22	25
1 Hr	11	2	0	1	0	0	14	0	0	0	0	0	0	0	50	8	1	0	0	0	59	73
17:00	4	1	0	0	0	0	5	0	0	0	0	0	0	0	7	0	0	0	0	0	7	12
17:15	8	0	0	0	0	0	8	1	0	0	0	0	0	1	8	1	0	0	0	0	9	18
17:30	5	1	0	0	0	0	6	0	0	0	0	0	0	0	23	0	1	0	0	0	24	30
17:45	8	0	0	0	0	0	8	0	0	0	0	0	0	0	11	0	0	0	0	0	11	19
1 Hr	25	2	0	0	0	0	27	1	0	0	0	0	0	1	49	1	1	0	0	0	51	79
18:00	4	0	0	0	0	0	4	0	0	0	0	0	0	0	15	2	0	0	0	0	17	21
18:15	3	0	0	0	0	0	3	0	0	0	0	0	0	0	15	2	0	0	0	0	17	20
18:30	0	3	0	0	0	0	3	0	0	0	0	0	0	0	17	1	0	0	0	0	18	21
18:45	5	0	0	0	0	0	5	0	0	0	0	0	0	0	16	1	0	0	0	0	17	22
1 Hr	12	3	0	0	0	0	15	0	0	0	0	0	0	0	63	6	0	0	0	0	69	84
Total	135	39	10	1	0	1	186	1	0	0	0	0	0	1	419	34	4	0	2	0	459	646

Origin : Arm C Bannold Road(W)

	Destination : Arm A Bannold Road(E)							Destination : Arm B Way Lane							Destination : Arm C Bannold Road(W)							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Arm Totals
07:00	3	4	1	1	0	0	9	8	0	0	0	0	0	8	0	0	0	0	0	0	0	17
07:15	11	8	0	1	0	0	20	10	1	0	0	0	0	11	0	0	0	0	0	0	0	31
07:30	6	3	0	0	0	0	9	12	0	0	0	0	0	12	0	0	0	0	0	0	0	21
07:45	3	6	0	1	0	0	10	13	1	0	0	0	0	14	0	0	0	0	0	0	0	24
1 Hr	23	21	1	3	0	0	48	43	2	0	0	0	0	45	0	0	0	0	0	0	0	93
08:00	0	1	1	0	0	0	2	17	1	0	0	0	0	18	0	0	0	0	0	0	0	20
08:15	2	2	0	0	0	0	4	17	0	0	0	0	0	17	0	0	0	0	0	0	0	21
08:30	1	1	1	1	0	0	4	27	0	0	0	0	0	27	1	0	0	0	0	0	1	32
08:45	2	1	2	1	0	0	6	16	0	1	0	0	0	17	0	0	0	0	0	0	0	23
1 Hr	5	5	4	2	0	0	16	77	1	1	0	0	0	79	1	0	0	0	0	0	1	96
09:00	1	0	1	5	0	0	7	17	0	1	0	0	0	18	0	0	1	0	0	0	1	26
09:15	3	0	5	1	0	0	9	8	2	1	0	0	0	11	0	0	0	0	0	0	0	20
09:30	3	1	1	0	0	0	5	8	0	0	0	0	0	8	0	0	0	0	0	0	0	13
09:45	1	1	0	0	0	0	2	14	1	0	0	0	0	15	0	0	0	0	0	0	0	17
1 Hr	8	2	7	6	0	0	23	47	3	2	0	0	0	52	0	0	1	0	0	0	1	76
10:00	5	3	1	0	0	0	9	3	0	0	0	0	0	3	0	0	0	0	0	0	0	12
10:15	2	3	0	2	0	0	7	4	1	0	0	0	0	5	1	0	0	0	0	0	1	13
10:30	4	3	0	0	0	0	7	5	1	0	0	0	0	6	0	0	0	0	0	0	0	13
10:45	4	2	1	0	0	0	7	2	1	0	0	0	0	3	0	0	0	0	0	0	0	10
1 Hr	15	11	2	2	0	0	30	14	3	0	0	0	0	17	1	0	0	0	0	0	1	48
11:00	7	3	0	2	0	0	12	5	0	0	0	0	0	5	0	0	0	0	0	0	0	17
11:15	1	3	0	0	0	0	4	10	0	0	0	0	0	10	0	0	0	0	0	0	0	14
11:30	0	0	1	2	0	0	3	7	2	0	0	0	0	9	0	0	0	0	0	0	0	12
11:45	2	0	1	1	0	0	4	8	0	0	0	0	0	8	0	0	0	0	0	0	0	12
1 Hr	10	6	2	5	0	0	23	30	2	0	0	0	0	32	0	0	0	0	0	0	0	55
12:00	6	3	1	0	0	0	10	2	1	0	0	0	0	3	0	0	0	0	0	0	0	13
12:15	3	0	0	0	0	0	3	3	1	0	0	0	0	4	0	0	0	0	0	0	0	7
12:30	2	1	0	2	0	0	5	6	0	0	0	0	0	6	0	1	0	0	0	0	1	12
12:45	5	2	1	1	0	0	9	5	2	0	0	0	0	7	0	0	0	0	0	0	0	16
1 Hr	16	6	2	3	0	0	27	16	4	0	0	0	0	20	0	1	0	0	0	0	1	48
13:00	1	1	2	0	0	0	4	3	2	0	0	0	0	5	0	0	0	0	0	0	0	9
13:15	5	2	1	1	0	0	9	5	0	0	0	0	0	5	1	0	0	0	0	0	1	15
13:30	2	1	1	0	0	0	4	2	0	0	0	0	0	2	0	0	0	0	0	0	0	6
13:45	1	2	0	1	0	0	4	4	0	0	0	0	0	4	0	0	0	0	0	0	0	8
1 Hr	9	6	4	2	0	0	21	14	2	0	0	0	0	16	1	0	0	0	0	0	1	38
14:00	2	3	1	0	0	0	6	3	0	1	0	0	0	4	0	0	0	0	0	0	0	10
14:15	3	1	1	1	0	0	6	3	0	0	0	0	0	3	0	0	0	0	0	0	0	9
14:30	5	0	0	0	0	0	5	4	1	0	0	0	0	5	0	0	0	0	0	0	0	10
14:45	5	1	0	2	0	0	8	13	1	0	0	0	0	14	0	0	0	0	0	0	0	22
1 Hr	15	5	2	3	0	0	25	23	2	1	0	0	0	26	0	0	0	0	0	0	0	51
15:00	1	2	0	0	0	0	3	24	0	0	0	0	0	24	1	0	0	0	0	0	1	28
15:15	2	0	0	1	0	0	3	10	0	0	0	0	0	10	1	0	0	0	0	0	1	14
15:30	6	1	0	3	0	0	10	7	1	0	0	0	0	8	0	0	0	0	0	0	0	18
15:45	1	0	0	0	0	0	1	7	0	0	0	0	0	7	0	0	0	0	0	0	0	8
1 Hr	10	3	0	4	0	0	17	48	1	0	0	0	0	49	2	0	0	0	0	0	2	68
16:00	2	0	0	0	0	0	2	7	0	0	0	0	0	7	0	0	0	0	0	0	0	9
16:15	2	0	0	0	0	0	2	3	1	0	0	0	0	4	0	0	0	0	0	0	0	6
16:30	7	0	0	0	0	0	7	1	0	1	0	0	0	2	0	0	0	0	0	0	0	9
16:45	2	1	0	0	0	0	3	2	0	0	0	0	0	2	0	0	0	0	0	0	0	5
1 Hr	13	1	0	0	0	0	14	13	1	1	0	0	0	15	0	0	0	0	0	0	0	29
17:00	3	0	0	0	0	0	3	7	1	0	0	0	0	8	0	0	0	0	0	0	0	11
17:15	7	1	0	0	0	0	8	11	1	0	0	0	0	12	0	0	0	0	0	0	0	20
17:30	4	0	0	0	0	0	4	8	0	0	0	0	0	8	0	0	0	0	0	0	0	12
17:45	6	1	0	0	0	0	7	6	1	0	0	0	0	7	0	0	0	0	0	0	0	14
1 Hr	20	2	0	0	0	0	22	32	3	0	0	0	0	35	0	0	0	0	0	0	0	57
18:00	6	1	0	0	0	0	7	8	1	0	0	0	0	9	0	0	0	0	0	0	0	16
18:15	2	0	0	0	0	0	2	6	1	0	0	0	0	7	0	0	0	0	0	0	0	9
18:30	4	0	0	0	0	0	4	1	0	1	0	0	0	2	0	0	0	0	0	0	0	6
18:45	5	1	0	0	0	0	6	8	0	0	0	0	0	8	0	0	0	0	0	0	0	14
1 Hr	17	2	0	0	0	0	19	23	2	1	0	0	0	26	0	0	0	0	0	0	0	45
Total	161	70	24	30	0	0	285	380	26	6	0	0	0	412	5	1	1	0	0	0	7	704

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3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 9 - Bannold Road(E) / Way Lane / Bannold Road(W)

ORIGIN SUMMARY

	Origin : Arm A Bannold Road(E)							Origin : Arm B Way Lane							Origin : Arm C Bannold Road(W)							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Origin Totals
07:00	7	1	0	0	0	0	8	7	2	1	0	0	0	10	11	4	1	1	0	0	17	35
07:15	5	1	0	1	0	0	7	4	1	0	0	0	0	5	21	9	0	1	0	0	31	43
07:30	8	1	0	0	0	0	9	13	4	0	0	0	0	17	18	3	0	0	0	0	21	47
07:45	9	1	0	0	0	0	10	9	2	0	0	0	0	11	16	7	0	1	0	0	24	45
1 Hr	29	4	0	1	0	0	34	33	9	1	0	0	0	43	66	23	1	3	0	0	93	170
08:00	12	0	0	1	0	0	13	8	0	0	0	0	0	8	17	2	1	0	0	0	20	41
08:15	13	4	0	1	0	0	18	8	0	1	0	0	0	9	19	2	0	0	0	0	21	48
08:30	4	1	0	0	0	0	5	9	0	1	0	0	0	10	29	1	1	1	0	0	32	47
08:45	9	1	0	1	0	0	11	19	0	0	0	0	0	19	18	1	3	1	0	0	23	53
1 Hr	38	6	0	3	0	0	47	44	0	2	0	0	0	46	83	6	5	2	0	0	96	189
09:00	5	1	3	2	0	0	11	11	2	1	0	0	0	14	18	0	3	5	0	0	26	51
09:15	0	1	0	1	0	0	2	7	0	0	0	0	0	7	11	2	6	1	0	0	20	29
09:30	8	1	4	2	0	0	15	10	1	0	0	0	0	11	11	1	1	0	0	0	13	39
09:45	5	3	4	1	0	0	13	8	0	0	0	0	0	8	15	2	0	0	0	0	17	38
1 Hr	18	6	11	6	0	0	41	36	3	1	0	0	0	40	55	5	10	6	0	0	76	157
10:00	4	6	1	1	0	0	12	6	2	1	0	0	0	9	8	3	1	0	0	0	12	33
10:15	6	2	2	0	0	0	10	4	3	1	0	0	0	8	7	4	0	2	0	0	13	31
10:30	7	0	0	0	0	0	7	10	2	0	0	0	0	12	9	4	0	0	0	0	13	32
10:45	8	2	0	0	0	0	10	12	1	0	0	0	0	13	6	3	1	0	0	0	10	33
1 Hr	25	10	3	1	0	0	39	32	8	2	0	0	0	42	30	14	2	2	0	0	48	129
11:00	10	5	1	0	0	0	16	5	1	0	0	0	0	6	12	3	0	2	0	0	17	39
11:15	4	2	1	1	0	0	8	10	0	1	0	0	0	11	11	3	0	0	0	0	14	33
11:30	3	2	1	2	0	0	8	8	1	1	0	0	0	10	7	2	1	2	0	0	12	30
11:45	6	2	0	3	0	0	11	10	2	0	0	0	0	12	10	0	1	1	0	0	12	35
1 Hr	23	11	3	6	0	0	43	33	4	2	0	0	0	39	40	8	2	5	0	0	55	137
12:00	7	2	1	1	0	0	11	10	2	0	0	0	0	12	8	4	1	0	0	0	13	36
12:15	6	0	3	0	0	0	9	10	2	0	0	0	0	12	6	1	0	0	0	0	7	28
12:30	5	1	0	0	0	0	6	9	2	0	0	0	0	11	8	2	0	2	0	0	12	29
12:45	7	5	2	2	0	0	16	8	1	0	0	0	0	9	10	4	1	1	0	0	16	41
1 Hr	25	8	6	3	0	0	42	37	7	0	0	0	0	44	32	11	2	3	0	0	48	134
13:00	3	6	0	1	0	0	10	9	0	0	0	0	0	9	4	3	2	0	0	0	9	28
13:15	5	0	0	0	0	0	5	6	3	0	0	0	0	9	11	2	1	1	0	0	15	29
13:30	6	2	1	1	0	0	10	8	0	0	0	0	0	8	4	1	1	0	0	0	6	24
13:45	5	0	1	0	0	0	6	3	2	0	0	0	0	5	5	2	0	1	0	0	8	19
1 Hr	19	8	2	2	0	0	31	26	5	0	0	0	0	31	24	8	4	2	0	0	38	100
14:00	3	10	3	1	0	0	17	7	3	2	0	0	0	12	5	3	2	0	0	0	10	39
14:15	8	6	1	0	0	0	15	9	0	1	0	0	0	10	6	1	1	1	0	0	9	34
14:30	7	5	4	1	0	0	17	10	2	0	0	0	0	12	9	1	0	0	0	0	10	39
14:45	7	2	1	0	0	0	10	15	0	1	0	0	0	16	18	2	0	2	0	0	22	48
1 Hr	25	23	9	2	0	0	59	41	5	4	0	0	0	50	38	7	3	3	0	0	51	160
15:00	5	4	2	0	0	0	11	11	1	0	0	0	0	12	26	2	0	0	0	0	28	51
15:15	1	6	0	1	0	0	8	16	3	0	0	0	0	19	13	0	0	1	0	0	14	41
15:30	5	5	1	0	0	0	11	23	4	0	0	2	1	30	13	2	0	3	0	0	18	59
15:45	11	7	2	3	0	0	23	12	2	0	0	0	0	14	8	0	0	0	0	0	8	45
1 Hr	22	22	5	4	0	0	53	62	10	0	0	2	1	75	60	4	0	4	0	0	68	196
16:00	5	5	0	1	0	0	11	10	3	0	0	0	0	13	9	0	0	0	0	0	9	33
16:15	3	2	0	0	0	0	5	20	2	0	1	0	0	23	5	1	0	0	0	0	6	34
16:30	7	0	0	0	0	0	7	9	3	0	0	0	0	12	8	0	1	0	0	0	9	28
16:45	5	0	0	1	0	0	6	22	2	1	0	0	0	25	4	1	0	0	0	0	5	36
1 Hr	20	7	0	2	0	0	29	61	10	1	1	0	0	73	26	2	1	0	0	0	29	131
17:00	7	1	0	0	0	0	8	11	1	0	0	0	0	12	10	1	0	0	0	0	11	31
17:15	7	2	0	0	0	0	9	17	1	0	0	0	0	18	18	2	0	0	0	0	20	47
17:30	15	0	0	0	0	0	15	28	1	1	0	0	0	30	12	0	0	0	0	0	12	57
17:45	8	1	0	0	0	0	9	19	0	0	0	0	0	19	12	2	0	0	0	0	14	42
1 Hr	37	4	0	0	0	0	41	75	3	1	0	0	0	79	52	5	0	0	0	0	57	177
18:00	8	0	0	0	0	0	8	19	2	0	0	0	0	21	14	2	0	0	0	0	16	45
18:15	4	2	0	0	0	0	6	18	2	0	0	0	0	20	8	1	0	0	0	0	9	35
18:30	5	0	0	0	0	0	5	17	4	0	0	0	0	21	5	0	1	0	0	0	6	32
18:45	4	0	0	0	0	0	4	21	1	0	0	0	0	22	13	1	0	0	0	0	14	40
1 Hr	21	2	0	0	0	0	23	75	9	0	0	0	0	84	40	4	1	0	0	0	45	152
Total	302	111	39	30	0	0	482	555	73	14	1	2	1	646	546	97	31	30	0	0	704	1832

DESTINATION SUMMARY

	Destination : Arm A Bannold Road(E)							Destination : Arm B Way Lane							Destination : Arm C Bannold Road(W)							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Dest Totals
07:00	8	6	2	1	0	0	17	10	0	0	0	0	0	10	7	1	0	0	0	0	8	35
07:15	12	8	0	1	0	0	21	13	1	0	1	0	0	15	5	2	0	0	0	0	7	43
07:30	14	6	0	0	0	0	20	13	0	0	0	0	0	13	12	2	0	0	0	0	14	47
07:45	5	7	0	1	0	0	13	17	1	0	0	0	0	18	12	2	0	0	0	0	14	45
1 Hr	39	27	2	3	0	0	71	53	2	0	1	0	0	56	36	7	0	0	0	0	43	170
08:00	3	1	1	0	0	0	5	24	1	0	0	0	0	25	10	0	0	1	0	0	11	41
08:15	3	2	1	0	0	0	6	23	3	0	0	0	0	26	14	1	0	1	0	0	16	48
08:30	1	1	1	1	0	0	4	29	0	0	0	0	0	29	12	1	1	0	0	0	14	47
08:45	4	1	2	1	0	0	8	22	0	1	0	0	0	23	20	1	0	1	0	0	22	53
1 Hr	11	5	5	2	0	0	23	98	4	1	0	0	0	103	56	3	1	3	0	0	63	189
09:00	2	2	2	5	0	0	11	20	0	1	0	0	0	21	12	1	4	2	0	0	19	51
09:15	4	0	5	1	0	0	10	8	2	1	0	0	0	11	6	1	0	1	0	0	8	29
09:30	4	1	1	0	0	0	6	11	0	2	0	0	0	13	14	2	2	2	0	0	20	39
09:45	3	1	0	0	0	0	4	18	2	1	0	0	0	21	7	2	3	1	0	0	13	38
1 Hr	13	4	8	6	0	0	31	57	4	5	0	0	0	66	39	6	9	6	0	0	60	157
10:00	6	5	2	0	0	0	13	5	2	0	0	0	0	7	7	4	1	1	0	0	13	33
10:15	4	4	0	2	0	0	10	7	1	0	0	0	0	8	6	4	3	0	0	0	13	31
10:30	8	5	0	0	0	0	13	8	1	0	0	0	0	9	10	0	0	0	0	0	10	32
10:45	7	3	1	0	0	0	11	5	2	0	0	0	0	7	14	1	0	0	0	0	15	33
1 Hr	25	17	3	2	0	0	47	25	6	0	0	0	0	31	37	9	4	1	0	0	51	129
11:00	8	4	0	2	0	0	14	7	0	1	0	0	0	8	12	5	0	0	0	0	17	39
11:15	3	3	1	0	0	0	7	12	0	1	0	0	0	13	10	2	0	1	0	0	13	33
11:30	2	0	2	2	0	0	6	8	3	0	0	0	0	11	8	2	1	2	0	0	13	30
11:45	6	1	1	1	0	0	9	10	1	0	0	0	0	11	10	2	0	3	0	0	15	35
1 Hr	19	8	4	5	0	0	36	37	4	2	0	0	0	43	40	11	1	6	0	0	58	137
12:00	9	5	1	0	0	0	15	6	1	0	0	0	0	7	10	2	1	1	0	0	14	36
12:15	5	1	0	0	0	0	6	5	1	0	0	0	0	6	12	1	3	0	0	0	16	28
12:30	4	2	0	2	0	0	8	8	0	0	0	0	0	8	10	3	0	0	0	0	13	29

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Site 9 - Bannold Road(E) / Way Lane / Bannold Road(W)

12:45	6	2	1	1	0	0	10	8	4	0	0	0	0	12	11	4	2	2	0	0	19	41
1 Hr	24	10	2	3	0	0	39	27	6	0	0	0	0	33	43	10	6	3	0	0	62	134
13:00	6	1	2	0	0	0	9	3	4	0	0	0	0	7	7	4	0	1	0	0	12	28
13:15	6	4	1	1	0	0	12	7	0	0	0	0	0	7	9	1	0	0	0	0	10	29
13:30	3	1	1	0	0	0	5	2	0	0	0	0	0	2	13	2	1	1	0	0	17	24
13:45	1	2	0	1	0	0	4	5	0	0	0	0	0	5	7	2	1	0	0	0	10	19
1 Hr	16	8	4	2	0	0	30	17	4	0	0	0	0	21	36	9	2	2	0	0	49	100
14:00	7	6	3	0	0	0	16	4	2	1	0	0	0	7	4	8	3	1	0	0	16	39
14:15	6	1	2	1	0	0	10	6	2	0	0	0	0	8	11	4	1	0	0	0	16	34
14:30	7	1	3	0	0	0	11	4	1	0	0	0	0	5	15	6	1	1	0	0	23	39
14:45	7	1	1	2	0	0	11	15	2	0	0	0	0	17	18	1	1	0	0	0	20	48
1 Hr	27	9	9	3	0	0	48	29	7	1	0	0	0	37	48	19	6	2	0	0	75	160
15:00	5	2	0	0	0	0	7	25	1	0	0	0	0	26	12	4	2	0	0	0	18	51
15:15	6	1	0	1	0	0	8	10	4	0	0	0	0	14	14	4	0	1	0	0	19	41
15:30	11	4	0	3	0	1	19	9	3	0	0	0	0	12	21	4	1	0	2	0	28	59
15:45	3	2	0	0	0	0	5	9	3	1	0	0	0	13	19	4	1	3	0	0	27	45
1 Hr	25	9	0	4	0	1	39	53	11	1	0	0	0	65	66	16	4	4	2	0	92	196
16:00	3	0	0	0	0	0	3	8	0	0	0	0	0	8	13	8	0	1	0	0	22	33
16:15	8	0	0	1	0	0	9	4	1	0	0	0	0	5	16	4	0	0	0	0	20	34
16:30	9	1	0	0	0	0	10	6	0	1	0	0	0	7	9	2	0	0	0	0	11	28
16:45	4	2	0	0	0	0	6	3	0	0	0	0	0	3	24	1	1	1	0	0	27	36
1 Hr	24	3	0	1	0	0	28	21	1	1	0	0	0	23	62	15	1	2	0	0	80	131
17:00	7	1	0	0	0	0	8	9	1	0	0	0	0	10	12	1	0	0	0	0	13	31
17:15	15	1	0	0	0	0	16	17	2	0	0	0	0	19	10	2	0	0	0	0	12	47
17:30	9	1	0	0	0	0	10	16	0	0	0	0	0	16	30	0	1	0	0	0	31	57
17:45	14	1	0	0	0	0	15	9	1	0	0	0	0	10	16	1	0	0	0	0	17	42
1 Hr	45	4	0	0	0	0	49	51	4	0	0	0	0	55	68	4	1	0	0	0	73	177
18:00	10	1	0	0	0	0	11	10	1	0	0	0	0	11	21	2	0	0	0	0	23	45
18:15	5	0	0	0	0	0	5	7	1	0	0	0	0	8	18	4	0	0	0	0	22	35
18:30	4	3	0	0	0	0	7	3	0	1	0	0	0	4	20	1	0	0	0	0	21	32
18:45	10	1	0	0	0	0	11	11	0	0	0	0	0	11	17	1	0	0	0	0	18	40
1 Hr	29	5	0	0	0	0	34	31	2	1	0	0	0	34	76	8	0	0	0	0	84	152
Total	297	109	37	31	0	1	475	499	55	12	1	0	0	567	607	117	35	29	2	0	790	1832

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Site 10 - Clayhithe Road(NW) / Clayhithe Road(SE) / Parking

Origin Arm A Clayhithe Road(NW)

	Destination : Arm A Clayhithe Road(NW)						Total	**Destination :** Arm B Clayhithe Road(SE)						Total	**Destination :** Arm C Parking						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	0	0	0	0	0	0	0	85	10	1	0	0	2	98	1	0	0	0	0	0	1	99
07:15	0	0	0	0	0	0	0	67	11	1	2	0	0	81	13	0	0	0	0	0	13	94
07:30	0	0	0	0	0	0	0	97	12	2	0	1	1	113	6	0	0	0	0	0	6	119
07:45	0	0	0	0	0	0	0	93	7	1	0	0	1	102	12	0	0	0	0	0	12	114
1 Hr	0	0	0	0	0	0	0	342	40	5	2	1	4	394	32	0	0	0	0	0	32	426
08:00	0	0	0	0	0	0	0	76	10	0	0	0	1	87	7	0	0	0	0	0	7	94
08:15	0	0	0	0	0	0	0	87	7	1	0	0	1	96	8	0	0	0	0	0	8	104
08:30	0	0	0	0	0	0	0	91	5	1	0	0	1	98	1	0	0	0	0	0	1	99
08:45	0	0	0	0	0	0	0	67	6	1	0	0	0	74	5	0	0	0	0	0	5	79
1 Hr	0	0	0	0	0	0	0	321	28	3	0	0	3	355	21	0	0	0	0	0	21	376
09:00	0	0	0	0	0	0	0	60	3	1	0	0	0	64	2	0	0	0	0	0	2	66
09:15	0	0	0	0	0	0	0	57	7	2	0	0	0	66	3	0	0	0	0	0	3	69
09:30	0	0	0	0	0	0	0	48	2	1	0	1	2	54	2	0	0	0	0	0	2	56
09:45	0	0	0	0	0	0	0	43	5	2	0	0	0	50	4	0	0	0	0	0	4	54
1 Hr	0	0	0	0	0	0	0	208	17	6	0	1	2	234	11	0	0	0	0	0	11	245
10:00	0	0	0	0	0	0	0	28	3	2	0	0	0	33	1	0	0	0	0	0	1	34
10:15	0	0	0	0	0	0	0	31	1	0	0	0	0	32	2	0	0	0	0	0	2	34
10:30	0	0	0	0	0	0	0	27	4	0	0	0	0	31	0	0	0	0	0	0	0	31
10:45	0	0	0	0	0	0	0	24	7	0	0	0	2	33	0	0	0	0	0	0	0	33
1 Hr	0	0	0	0	0	0	0	110	15	2	0	0	2	129	3	0	0	0	0	0	3	132
11:00	0	0	0	0	0	0	0	27	4	2	0	0	0	33	0	0	0	0	0	0	0	33
11:15	1	0	0	0	0	0	1	45	3	0	0	0	0	48	0	0	0	0	0	0	0	49
11:30	0	0	0	0	0	0	0	33	5	1	0	1	0	40	2	0	0	0	0	0	2	42
11:45	0	0	0	0	0	0	0	27	3	0	0	0	0	30	0	0	0	0	0	0	0	30
1 Hr	1	0	0	0	0	0	1	132	15	3	0	1	0	151	2	0	0	0	0	0	2	154
12:00	0	0	0	0	0	0	0	34	5	2	0	0	0	41	0	0	0	0	0	0	0	41
12:15	0	0	0	0	0	0	0	30	1	0	0	0	0	31	0	0	0	0	0	0	0	31
12:30	0	0	0	0	0	0	0	25	5	0	0	0	0	30	2	0	0	0	0	0	2	32
12:45	0	0	0	0	0	0	0	22	10	1	0	0	0	33	1	0	0	0	0	0	1	34
1 Hr	0	0	0	0	0	0	0	111	21	3	0	0	0	135	3	0	0	0	0	0	3	138
13:00	0	0	0	0	0	0	0	25	3	0	0	0	0	28	0	0	0	0	0	0	0	28
13:15	0	0	0	0	0	0	0	30	6	0	0	0	0	36	0	0	0	0	0	0	0	36
13:30	0	0	0	0	0	0	0	27	7	0	0	1	1	36	1	0	0	0	0	0	1	37
13:45	0	0	0	0	0	0	0	30	2	0	0	0	0	32	0	0	0	0	0	0	0	32
1 Hr	0	0	0	0	0	0	0	112	18	0	0	1	1	132	1	0	0	0	0	0	1	133
14:00	0	0	0	0	0	0	0	21	6	0	0	0	0	27	0	0	0	0	0	0	0	27
14:15	0	0	0	0	0	0	0	26	2	0	0	0	0	28	1	0	0	0	0	0	1	29
14:30	0	0	0	0	0	0	0	24	4	0	0	0	0	28	2	0	0	0	0	0	2	30
14:45	0	0	0	0	0	0	0	32	6	0	0	0	0	38	0	0	0	0	0	0	0	38
1 Hr	0	0	0	0	0	0	0	103	18	0	0	0	0	121	3	0	0	0	0	0	3	124
15:00	0	0	0	0	0	0	0	35	3	0	0	0	0	38	2	0	0	0	0	0	2	40
15:15	0	0	0	0	0	0	0	18	4	0	0	0	0	22	1	0	0	0	0	0	1	23
15:30	0	0	0	0	0	0	0	30	2	0	0	0	0	32	0	0	0	0	0	0	0	32
15:45	0	0	0	0	0	0	0	17	2	0	0	0	0	19	3	0	0	0	0	0	3	22
1 Hr	0	0	0	0	0	0	0	100	11	0	0	0	0	111	6	0	0	0	0	0	6	117
16:00	1	0	0	0	0	0	1	31	7	1	0	0	0	39	3	0	0	0	0	0	3	43
16:15	0	0	0	0	0	0	0	26	4	0	0	0	0	30	3	0	0	0	0	0	3	33
16:30	1	0	0	0	0	0	1	24	3	0	0	0	1	28	4	0	0	0	0	0	4	33
16:45	0	0	0	0	0	0	0	41	1	0	0	0	0	42	1	0	0	0	0	0	1	43
1 Hr	2	0	0	0	0	0	2	122	15	1	0	0	1	139	11	0	0	0	0	0	11	152
17:00	0	0	0	0	0	0	0	32	3	0	0	0	0	35	3	0	0	0	0	0	3	38
17:15	1	0	0	0	0	0	1	42	4	0	0	0	0	46	3	0	0	0	0	0	3	50
17:30	0	0	0	0	0	0	0	36	1	1	0	0	0	38	3	0	0	0	0	0	3	41
17:45	0	0	0	0	0	0	0	23	2	0	0	0	0	25	4	0	0	0	0	0	4	29
1 Hr	1	0	0	0	0	0	1	133	10	1	0	0	0	144	13	0	0	0	0	0	13	158
18:00	0	0	0	0	0	0	0	29	2	0	0	0	0	31	1	0	0	0	0	0	1	32
18:15	0	0	0	0	0	0	0	27	2	0	0	0	0	29	4	0	0	0	0	0	4	33
18:30	0	0	0	0	0	0	0	20	1	0	0	0	0	21	6	0	0	0	0	0	6	27
18:45	0	0	0	0	0	0	0	16	0	1	0	0	0	17	0	0	0	0	0	0	0	17
1 Hr	0	0	0	0	0	0	0	92	5	1	0	0	0	98	11	0	0	0	0	0	11	109
Total	4	0	0	0	0	0	4	1886	213	25	2	4	13	2143	117	0	0	0	0	0	117	2264

Origin Arm B Clayhithe Road(SE)

	Destination : Arm A Clayhithe Road(NW)						Total	**Destination :** Arm B Clayhithe Road(SE)						Total	**Destination :** Arm C Parking						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	8	4	0	0	0	0	12	0	0	0	0	0	0	0	1	0	0	0	0	0	1	13
07:15	14	2	0	0	0	1	17	0	0	0	0	0	0	0	1	0	0	0	0	0	1	18
07:30	12	6	1	0	0	0	19	0	0	0	0	0	0	0	1	0	0	0	0	0	1	20
07:45	23	6	1	0	0	0	30	0	0	0	0	0	0	0	1	0	0	0	0	0	1	31
1 Hr	57	18	2	0	0	1	78	0	0	0	0	0	0	0	4	0	0	0	0	0	4	82
08:00	23	7	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
08:15	25	6	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
08:30	30	3	1	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
08:45	31	5	1	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37
1 Hr	109	21	2	0	0	0	132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	132
09:00	21	1	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
09:15	20	4	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
09:30	17	1	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
09:45	17	5	2	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
1 Hr	75	11	2	0	0	0	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88
10:00	24	7	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
10:15	14	4	1	0	0	0	19	0	0	0	0	0	0	0	3	0	0	0	0	0	3	22
10:30	19	5	0	0	0	1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
10:45	21	6	1	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28
1 Hr	78	22	2	0	0	1	103	0	0	0	0	0	0	0	3	0	0	0	0	0	3	106
11:00	26	1	4	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
11:15	25	4	0	0	0	0	29	0	0	0	0	0	0	0	1	0	0	0	0	0	1	30
11:30	29	4	3	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
11:45	31	1	2	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
1 Hr	111	10	9	0	0	0	130	0	0	0	0	0	0	0	1	0	0	0	0	0	1	131
12:00	31	3	1	0	0	1	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
12:15	29	4	3	0	0	0	36	0	0	0	0	0	0	0	1	0	0	0	0	0	1	37
12:30	26	3	0	0	0	0	29	0	0	0	0	0	0	0	1	0	0	0	0	0	1	30
12:45	29	6	1	0	1	1	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 10 - Clayhithe Road(NW) / Clayhithe Road(SE) / Parking

1 Hr	115	16	5	0	1	2	139	0	0	0	0	0	0	0	2	0	0	0	0	0	2	141
13:00	30	5	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
13:15	30	5	2	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37
13:30	30	5	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
13:45	21	7	1	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
1 Hr	111	22	3	0	0	0	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	136
14:00	44	8	0	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52
14:15	37	6	2	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
14:30	24	6	2	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
14:45	44	11	2	0	1	0	58	0	0	0	0	0	0	0	1	0	0	0	0	0	1	59
1 Hr	149	31	6	0	1	0	187	0	0	0	0	0	0	0	1	0	0	0	0	0	1	188
15:00	41	8	0	0	0	0	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49
15:15	38	7	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
15:30	37	11	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48
15:45	74	8	4	0	0	1	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87
1 Hr	190	34	4	0	0	1	229	0	0	0	0	0	0	0	0	0	0	0	0	0	0	229
16:00	46	6	0	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52
16:15	59	6	0	1	0	1	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67
16:30	42	10	2	0	0	1	55	0	0	0	0	0	0	0	1	0	0	0	0	0	1	56
16:45	70	6	0	0	0	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76
1 Hr	217	28	2	1	0	2	250	0	0	0	0	0	0	0	1	0	0	0	0	0	1	251
17:00	75	8	0	0	0	0	83	0	0	0	0	0	0	0	1	0	0	0	0	0	1	84
17:15	71	6	0	0	0	0	77	1	0	0	0	0	0	1	0	0	0	0	0	0	0	78
17:30	67	6	3	0	1	0	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77
17:45	68	3	0	0	0	0	71	0	0	0	0	0	0	0	1	0	0	0	0	0	1	72
1 Hr	281	23	3	0	1	0	308	1	0	0	0	0	0	1	2	0	0	0	0	0	2	311
18:00	52	3	0	0	1	2	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58
18:15	54	5	0	0	0	0	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59
18:30	41	3	0	0	0	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44
18:45	48	3	0	0	0	1	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52
1 Hr	195	14	0	0	1	3	213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	213
Total	1688	250	40	1	4	10	1993	1	0	0	0	0	0	1	14	0	0	0	0	0	14	2008

Origin : Arm C Parking

	Destination : Arm A Clayhithe Road(NW)						Total	Destination : Arm B Clayhithe Road(SE)						Total	Destination : Arm C Parking						Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		Car	LGV	OGV1	OGV2	PSV	MC		
07:00	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
07:15	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
07:30	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
07:45	5	0	0	0	0	0	5	2	0	0	0	0	0	2	0	0	0	0	0	0	0	7
1 Hr	12	0	0	0	0	0	12	2	0	0	0	0	0	2	0	0	0	0	0	0	0	14
08:00	6	0	0	0	0	0	6	2	0	0	0	0	0	2	0	0	0	0	0	0	0	8
08:15	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
08:30	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
08:45	2	0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	3
1 Hr	10	0	0	0	0	0	10	3	0	0	0	0	0	3	0	0	0	0	0	0	0	13
09:00	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
09:15	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
09:30	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
09:45	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	9	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
10:00	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10:15	2	0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	3
10:30	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2
10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	4	0	0	0	0	0	4	2	0	0	0	0	0	2	0	0	0	0	0	0	0	6
11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	2
12:45	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2
1 Hr	1	0	0	0	0	0	1	3	0	0	0	0	0	3	0	0	0	0	0	0	0	4
13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 Hr	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30	6	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	6	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
15:30	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
15:45	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1 Hr	6	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
16:00	3	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
16:15	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
16:30	5	0	0	0	0	0	5	1	0	0	0	0	0	1	0	0	0	0	0	0	0	6
16:45	5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
1 Hr	15	1	0	0	0	0	16	1	0	0	0	0	0	1	0	0	0	0	0	0	0	17
17:00	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
17:15	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1 Hr	7	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
18:00	16	0	0	0	0	0	16	2	0	0	0	0	0	2	0	0	0	0	0	0	0	18
18:15	8	0	0	0	0	0	8	2	0	0	0	0	0	2	0	0	0	0	0	0	0	10
18:30	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
18:45	10	0	0	0	0	0	10	2	0	0	0	0	0	2	0	0	0	0	0	0	0	12
1 Hr	36	0	0	0	0	0	36	6	0	0	0	0	0	6	0	0	0	0	0	0	0	42
Total	108	1	0	0	0	0	109	17	0	0	0	0	0	17	0	0	0	0	0	0	0	126

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 10 - Clayhithe Road(NW) / Clayhithe Road(SE) / Parking

ORIGIN SUMMARY

	Origin : Arm A Clayhithe Road(NW)							Origin : Arm B Clayhithe Road(SE)							Origin : Arm C Parking							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Origin Totals
07:00	86	10	1	0	0	2	99	9	4	0	0	0	0	13	1	0	0	0	0	0	1	113
07:15	80	11	1	2	0	0	94	15	2	0	0	0	1	18	3	0	0	0	0	0	3	115
07:30	103	12	2	0	1	1	119	13	6	1	0	0	0	20	3	0	0	0	0	0	3	142
07:45	105	7	1	0	0	1	114	24	6	1	0	0	0	31	7	0	0	0	0	0	7	152
1 Hr	374	40	5	2	1	4	426	61	18	2	0	0	1	82	14	0	0	0	0	0	14	522
08:00	83	10	0	0	0	1	94	23	7	0	0	0	0	30	8	0	0	0	0	0	8	132
08:15	95	7	1	0	0	1	104	25	6	0	0	0	0	31	1	0	0	0	0	0	1	136
08:30	92	5	1	0	0	1	99	30	3	1	0	0	0	34	1	0	0	0	0	0	1	134
08:45	72	6	1	0	0	0	79	31	5	1	0	0	0	37	3	0	0	0	0	0	3	119
1 Hr	342	28	3	0	0	3	376	109	21	2	0	0	0	132	13	0	0	0	0	0	13	521
09:00	62	3	1	0	0	0	66	21	1	0	0	0	0	22	3	0	0	0	0	0	3	91
09:15	60	7	2	0	0	0	69	20	4	0	0	0	0	24	2	0	0	0	0	0	2	95
09:30	50	2	1	0	1	2	56	17	1	0	0	0	0	18	3	0	0	0	0	0	3	77
09:45	47	5	2	0	0	0	54	17	5	2	0	0	0	24	1	0	0	0	0	0	1	79
1 Hr	219	17	6	0	1	2	245	75	11	2	0	0	0	88	9	0	0	0	0	0	9	342
10:00	29	3	2	0	0	0	34	24	7	0	0	0	0	31	1	0	0	0	0	0	1	66
10:15	33	1	0	0	0	0	34	17	4	1	0	0	0	22	3	0	0	0	0	0	3	59
10:30	27	4	0	0	0	0	31	19	5	0	0	0	1	25	2	0	0	0	0	0	2	58
10:45	24	7	0	0	0	2	33	21	6	1	0	0	0	28	0	0	0	0	0	0	0	61
1 Hr	113	15	2	0	0	2	132	81	22	2	0	0	1	106	6	0	0	0	0	0	6	244
11:00	27	4	2	0	0	0	33	26	1	4	0	0	0	31	0	0	0	0	0	0	0	64
11:15	46	3	0	0	0	0	49	26	4	0	0	0	0	30	0	0	0	0	0	0	0	79
11:30	35	5	1	0	1	0	42	29	4	3	0	0	0	36	0	0	0	0	0	0	0	78
11:45	27	3	0	0	0	0	30	31	1	2	0	0	0	34	1	0	0	0	0	0	1	65
1 Hr	135	15	3	0	1	0	154	112	10	9	0	0	0	131	1	0	0	0	0	0	1	286
12:00	34	5	2	0	0	0	41	31	3	1	0	0	1	36	0	0	0	0	0	0	0	77
12:15	30	1	0	0	0	0	31	30	4	3	0	0	0	37	0	0	0	0	0	0	0	68
12:30	27	5	0	0	0	0	32	27	3	0	0	0	0	30	2	0	0	0	0	0	2	64
12:45	23	10	1	0	0	0	34	29	6	1	0	1	1	38	2	0	0	0	0	0	2	74
1 Hr	114	21	3	0	0	0	138	117	16	5	0	1	2	141	4	0	0	0	0	0	4	283
13:00	25	3	0	0	0	0	28	30	5	0	0	0	0	35	0	0	0	0	0	0	0	63
13:15	30	6	0	0	0	0	36	30	5	2	0	0	0	37	0	0	0	0	0	0	0	73
13:30	28	7	0	0	1	1	37	30	5	0	0	0	0	35	0	0	0	0	0	0	0	72
13:45	30	2	0	0	0	0	32	21	7	1	0	0	0	29	1	0	0	0	0	0	1	62
1 Hr	113	18	0	0	1	1	133	111	22	3	0	0	0	136	1	0	0	0	0	0	1	270
14:00	21	6	0	0	0	0	27	44	8	0	0	0	0	52	0	0	0	0	0	0	0	79
14:15	27	2	0	0	0	0	29	37	6	2	0	0	0	45	0	0	0	0	0	0	0	74
14:30	26	4	0	0	0	0	30	24	6	2	0	0	0	32	6	0	0	0	0	0	6	68
14:45	32	6	0	0	0	0	38	45	11	2	0	1	0	59	0	0	0	0	0	0	0	97
1 Hr	106	18	0	0	0	0	124	150	31	6	0	1	0	188	6	0	0	0	0	0	6	318
15:00	37	3	0	0	0	0	40	41	8	0	0	0	0	49	0	0	0	0	0	0	0	89
15:15	19	4	0	0	0	0	23	38	7	0	0	0	0	45	1	0	0	0	0	0	1	69
15:30	30	2	0	0	0	0	32	37	11	0	0	0	0	48	2	0	0	0	0	0	2	82
15:45	20	2	0	0	0	0	22	74	8	4	0	0	1	87	3	0	0	0	0	0	3	112
1 Hr	106	11	0	0	0	0	117	190	34	4	0	0	1	229	6	0	0	0	0	0	6	352
16:00	35	7	1	0	0	0	43	46	6	0	0	0	0	52	3	1	0	0	0	0	4	99
16:15	29	4	0	0	0	0	33	59	6	0	1	0	1	67	2	0	0	0	0	0	2	102
16:30	29	3	0	0	0	1	33	43	10	2	0	0	1	56	6	0	0	0	0	0	6	95
16:45	42	1	0	0	0	0	43	70	6	0	0	0	0	76	5	0	0	0	0	0	5	124
1 Hr	135	15	1	0	0	1	152	218	28	2	1	0	2	251	16	1	0	0	0	0	17	420
17:00	35	3	0	0	0	0	38	76	8	0	0	0	0	84	3	0	0	0	0	0	3	125
17:15	46	4	0	0	0	0	50	72	6	0	0	0	0	78	2	0	0	0	0	0	2	130
17:30	39	1	1	0	0	0	41	67	6	3	0	1	0	77	0	0	0	0	0	0	0	118
17:45	27	2	0	0	0	0	29	69	3	0	0	0	0	72	2	0	0	0	0	0	2	103
1 Hr	147	10	1	0	0	0	158	284	23	3	0	1	0	311	7	0	0	0	0	0	7	476
18:00	30	2	0	0	0	0	32	52	3	0	0	1	2	58	18	0	0	0	0	0	18	108
18:15	31	2	0	0	0	0	33	54	5	0	0	0	0	59	10	0	0	0	0	0	10	102
18:30	26	1	0	0	0	0	27	41	3	0	0	0	0	44	2	0	0	0	0	0	2	73
18:45	16	0	1	0	0	0	17	48	3	0	0	0	1	52	12	0	0	0	0	0	12	81
1 Hr	103	5	1	0	0	0	109	195	14	0	0	1	3	213	42	0	0	0	0	0	42	364
Total	2007	213	25	2	4	13	2264	1703	250	40	1	4	10	2008	125	1	0	0	0	0	126	4398

DESTINATION SUMMARY

	Destination : Arm A Clayhithe Road(NW)							Destination : Arm B Clayhithe Road(SE)							Destination : Arm C Parking							
	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Car	LGV	OGV1	OGV2	PSV	MC	Total	Dest Totals
07:00	9	4	0	0	0	0	13	85	10	1	0	0	2	98	2	0	0	0	0	0	2	113
07:15	17	2	0	0	0	1	20	67	11	1	2	0	0	81	14	0	0	0	0	0	14	115
07:30	15	6	1	0	0	0	22	97	12	2	0	1	1	113	7	0	0	0	0	0	7	142
07:45	28	6	1	0	0	0	35	95	7	1	0	0	1	104	13	0	0	0	0	0	13	152
1 Hr	69	18	2	0	0	1	90	344	40	5	2	1	4	396	36	0	0	0	0	0	36	522
08:00	29	7	0	0	0	0	36	78	10	0	0	0	1	89	7	0	0	0	0	0	7	132
08:15	26	6	0	0	0	0	32	87	7	1	0	0	1	96	8	0	0	0	0	0	8	136
08:30	31	3	1	0	0	0	35	91	5	1	0	0	1	98	1	0	0	0	0	0	1	134
08:45	33	5	1	0	0	0	39	68	6	1	0	0	0	75	5	0	0	0	0	0	5	119
1 Hr	119	21	2	0	0	0	142	324	28	3	0	0	3	358	21	0	0	0	0	0	21	521
09:00	24	1	0	0	0	0	25	60	3	1	0	0	0	64	2	0	0	0	0	0	2	91
09:15	22	4	0	0	0	0	26	57	7	2	0	0	0	66	3	0	0	0	0	0	3	95
09:30	20	1	0	0	0	0	21	48	2	1	0	1	2	54	2	0	0	0	0	0	2	77
09:45	18	5	2	0	0	0	25	43	5	2	0	0	0	50	4	0	0	0	0	0	4	79
1 Hr	84	11	2	0	0	0	97	208	17	6	0	1	2	234	11	0	0	0	0	0	11	342
10:00	25	7	0	0	0	0	32	28	3	2	0	0	0	33	1	0	0	0	0	0	1	66
10:15	16	4	1	0	0	0	21	32	1	0	0	0	0	33	5	0	0	0	0	0	5	59
10:30	20	5	0	0	0	1	26	28	4	0	0	0	0	32	0	0	0	0	0	0	0	58
10:45	21	6	1	0	0	0	28	24	7	0	0	0	2	33	0	0	0	0	0	0	0	61
1 Hr	82	22	2	0	0	1	107	112	15	2	0	0	2	131	6	0	0	0	0	0	6	244
11:00	26	1	4	0	0	0	31	27	4	2	0	0	0	33	0	0	0	0	0	0	0	64
11:15	26	4	0	0	0	0	30	45	3	0	0	0	0	48	1	0	0	0	0	0	1	79
11:30	29	4	3	0	0	0	36	33	5	1	0	1	0	40	2	0	0	0	0	0	2	78
11:45	32	1	2	0	0	0	35	27	3	0	0	0	0	30	0	0	0	0	0	0	0	65
1 Hr	113	10	9	0	0	0	132	132	15	3	0	1	0	151	3	0	0	0	0	0	3	286
12:00	31	3	1	0	0	1	36	34	5	2	0	0	0	41	0	0	0	0	0	0	0	77
12:15	29	4	3	0	0	0	36	30	1	0	0	0	0	31	1	0	0	0	0	0	1	68
12:30	26	3	0	0	0	0	29	27	5	0	0	0	0	32	3	0	0	0	0	0	3	64

Tracsis plc
Traffic and Data Services

Return To Dashboard
Convert to PCU

3790-TAD Waterbeach
Junction Turning Count
11/07/2017

Site 10 - Clayhithe Road(NW) / Clayhithe Road(SE) / Parking

12:45	30	6	1	0	1	1	39	23	10	1	0	0	0	34	1	0	0	0	0	0	1	74
1 Hr	116	16	5	0	1	2	140	114	21	3	0	0	0	138	5	0	0	0	0	0	5	283
13:00	30	5	0	0	0	0	35	25	3	0	0	0	0	28	0	0	0	0	0	0	0	63
13:15	30	5	2	0	0	0	37	30	6	0	0	0	0	36	0	0	0	0	0	0	0	73
13:30	30	5	0	0	0	0	35	27	7	0	0	1	1	36	1	0	0	0	0	0	1	72
13:45	22	7	1	0	0	0	30	30	2	0	0	0	0	32	0	0	0	0	0	0	0	62
1 Hr	112	22	3	0	0	0	137	112	18	0	0	1	1	132	1	0	0	0	0	0	1	270
14:00	44	8	0	0	0	0	52	21	6	0	0	0	0	27	0	0	0	0	0	0	0	79
14:15	37	6	2	0	0	0	45	26	2	0	0	0	0	28	1	0	0	0	0	0	1	74
14:30	30	6	2	0	0	0	38	24	4	0	0	0	0	28	2	0	0	0	0	0	2	68
14:45	44	11	2	0	1	0	58	32	6	0	0	0	0	38	1	0	0	0	0	0	1	97
1 Hr	155	31	6	0	1	0	193	103	18	0	0	0	0	121	4	0	0	0	0	0	4	318
15:00	41	8	0	0	0	0	49	35	3	0	0	0	0	38	2	0	0	0	0	0	2	89
15:15	39	7	0	0	0	0	46	18	4	0	0	0	0	22	1	0	0	0	0	0	1	69
15:30	39	11	0	0	0	0	50	30	2	0	0	0	0	32	0	0	0	0	0	0	0	82
15:45	77	8	4	0	0	1	90	17	2	0	0	0	0	19	3	0	0	0	0	0	3	112
1 Hr	196	34	4	0	0	1	235	100	11	0	0	0	0	111	6	0	0	0	0	0	6	352
16:00	50	7	0	0	0	0	57	31	7	1	0	0	0	39	3	0	0	0	0	0	3	99
16:15	61	6	0	1	0	1	69	26	4	0	0	0	0	30	3	0	0	0	0	0	3	102
16:30	48	10	2	0	0	1	61	25	3	0	0	0	1	29	5	0	0	0	0	0	5	95
16:45	75	6	0	0	0	0	81	41	1	0	0	0	0	42	1	0	0	0	0	0	1	124
1 Hr	234	29	2	1	0	2	268	123	15	1	0	0	1	140	12	0	0	0	0	0	12	420
17:00	78	8	0	0	0	0	86	32	3	0	0	0	0	35	4	0	0	0	0	0	4	125
17:15	74	6	0	0	0	0	80	43	4	0	0	0	0	47	3	0	0	0	0	0	3	130
17:30	67	6	3	0	1	0	77	36	1	1	0	0	0	38	3	0	0	0	0	0	3	118
17:45	70	3	0	0	0	0	73	23	2	0	0	0	0	25	5	0	0	0	0	0	5	103
1 Hr	289	23	3	0	1	0	316	134	10	1	0	0	0	145	15	0	0	0	0	0	15	476
18:00	68	3	0	0	1	2	74	31	2	0	0	0	0	33	1	0	0	0	0	0	1	108
18:15	62	5	0	0	0	0	67	29	2	0	0	0	0	31	4	0	0	0	0	0	4	102
18:30	43	3	0	0	0	0	46	20	1	0	0	0	0	21	6	0	0	0	0	0	6	73
18:45	58	3	0	0	0	1	62	18	0	1	0	0	0	19	0	0	0	0	0	0	0	81
1 Hr	231	14	0	0	1	3	249	98	5	1	0	0	0	104	11	0	0	0	0	0	11	364
Total	1800	251	40	1	4	10	2106	1904	213	25	2	4	13	2161	131	0	0	0	0	0	131	4398

Tracsis plc
Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 1
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM A - Ely Road (NNW)		ARM B - Denny End Road		ARM C - Ely Road(SSE)	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
07:00	10	55	0	5	35	25
07:05	10	55	5	70	20	25
07:10	5	75	0	25	30	20
07:15	0	40	0	5	5	15
07:20	10	45	0	5	0	10
07:25	10	65	0	20	45	32.5
07:30	5	90	5	20	5	52.5
07:35	5	72.5	0	35	0	45
07:40	15	60	0	30	35	30
07:45	15	65	10	25	5	45
07:50	5	70	0	10	35	20
07:55	0	30	0	15	45	0
08:00	5	45	0	25	0	15
08:05	0	75+	0	35+	0	10
08:10	0	70	0	15	40	30
08:15	10	65	0	20	0	10
08:20	10	75+	0	30	0	25
08:25	10	70	0	20	0	30
08:30	0	15	0	17.5	10	60
08:35	0	0	0	25	0	30
08:40	0	2.5	0	35	5	10
08:45	15	65	0	45	25	30
08:50	5	55	0	0	25	50
08:55	0	50	0	40	45	45
09:00	0	35	5	10	10	15
09:05	30	55	0	0	0	30
09:10	5	75+	0	25	35	15
09:15	0	70	0	20	40	10
09:20	0	50	0	20	0	5
09:25	15	30	0	15	0	10
09:30	5	30	0	5	0	15
09:35	5	40	0	45	0	10
09:40	0	0	0	10	10	10
09:45	5	70	0	25	45	10
09:50	0	65	0	10	25	40
09:55	5	55	0	35	40	25
15:00	0	10	0	15	10	5
15:05	0	60	0	15	65+	20
15:10	5	30	0	40	45+	5
15:15	0	35	0	35	35	15
15:20	0	15	0	25	0	10
15:25	0	75+	0	30	40	15
15:30	0	70	10	5	60+	0
15:35	0	75+	0	40	35+	40
15:40	15	75+	0	10	50	5
15:45	0	25	0	20	25	5
15:50	0	70	0	27.5	35	5
15:55	0	75+	0	40+	15	15

Tracsis plc
Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 2
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM C - Waterbeach Road		ARM C - Central reservation	ARM A - A10 Ely Road (right turn across central reservation)
	Lane 1	Lane 2	Lane 1	Lane 1
07:00	0	0	0	0
07:05	0	0	0	0
07:10	0	5	0	0
07:15	0	0	0	0
07:20	0	0	0	0
07:25	0	0	0	0
07:30	0	0	0	0
07:35	0	20	10	5
07:40	5	0	0	0
07:45	0	15	5	0
07:50	0	0	0	0
07:55	0	5	5	0
08:00	0	10	0	0
08:05	0	0	0	0
08:10	0	0	0	0
08:15	0	0	0	0
08:20	0	0	0	0
08:25	0	0	0	0
08:30	0	0	0	0
08:35	0	0	0	0
08:40	0	0	0	0
08:45	5	5	0	0
08:50	0	20	5	0
08:55	0	5	5	0
09:00	0	0	0	0
09:05	0	0	0	0
09:10	0	10	0	0
09:15	0	0	0	0
09:20	0	0	0	0
09:25	0	0	0	0
09:30	0	0	0	0
09:35	0	0	0	0
09:40	0	0	0	0
09:45	0	0	10	0
09:50	0	0	0	0
09:55	0	0	0	0
15:00	0	0	0	0
15:05	0	5	0	0
15:10	0	5	5	0
15:15	0	5	0	0
15:20	0	0	0	0
15:25	0	5	0	0
15:30	0	0	0	0
15:35	0	0	0	0
15:40	10	0	0	0
15:45	0	0	0	0
15:50	0	0	0	0
15:55	0	0	0	0

Tracsis plc
Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 3
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM B - Car Dyke Road		ARM B Car Dyke Road - right turn at Central reservation	ARM C A10 Ely Road - right turn at Central reservation
	Lane 1	Lane 2	Lane 1	Lane 1
07:00	0	0	0	0
07:05	0	5	0	5
07:10	10	0	0	5
07:15	0	0	0	0
07:20	10	0	0	0
07:25	5	0	0	0
07:30	0	10	0	10
07:35	0	5	0	0
07:40	15	0	0	5
07:45	10	0	0	5
07:50	5	0	0	0
07:55	0	2.5	2.5	10
08:00	0	15	0	5
08:05	0	0	0	0
08:10	10	5	0	0
08:15	0	5	0	0
08:20	5	0	0	0
08:25	5	0	0	0
08:30	5	0	5	0
08:35	5	0	0	0
08:40	0	0	0	0
08:45	0	0	0	0
08:50	0	0	0	5
08:55	5	0	0	0
09:00	0	0	0	0
09:05	0	0	0	0
09:10	0	0	2.5	0
09:15	15	0	0	10
09:20	0	5	5	0
09:25	5	0	5	0
09:30	10	0	0	0
09:35	35	0	0	10
09:40	0	0	0	0
09:45	15	0	0	0
09:50	0	0	0	0
09:55	5	0	0	0
15:00	0	5	0	0
15:05	0	0	0	0
15:10	5	25	0	0
15:15	0	0	0	0
15:20	5	0	0	0
15:25	0	0	0	0
15:30	0	0	0	0
15:35	0	0	0	0
15:40	5	0	0	0
15:45	0	0	0	0
15:50	10	10	0	5
15:55	0	0	0	0

Tracsis plc
Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 4
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM A - Bannold Road	
	Lane 1	Lane 2
07:00	0	0
07:05	0	0
07:10	5	0
07:15	0	0
07:20	0	0
07:25	0	0
07:30	0	0
07:35	0	0
07:40	0	0
07:45	5	0
07:50	0	0
07:55	0	5
08:00	0	0
08:05	0	0
08:10	0	0
08:15	0	0
08:20	0	0
08:25	0	5
08:30	0	0
08:35	0	0
08:40	0	0
08:45	0	0
08:50	0	0
08:55	0	0
09:00	0	15
09:05	0	0
09:10	0	10
09:15	0	0
09:20	0	0
09:25	0	0
09:30	0	0
09:35	0	0
09:40	0	0
09:45	0	0
09:50	0	0
09:55	0	0
15:00	0	0
15:05	0	0
15:10	0	0
15:15	0	0
15:20	0	0
15:25	0	0
15:30	0	5
15:35	0	0
15:40	0	0
15:45	0	0
15:50	0	0
15:55	0	0

Tracsis plc
Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 5
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM A - Green side	
	Lane 1	Lane 2
07:00	0	0
07:05	0	0
07:10	0	0
07:15	0	0
07:20	0	0
07:25	0	0
07:30	0	0
07:35	0	0
07:40	0	0
07:45	5	0
07:50	0	0
07:55	0	0
08:00	0	0
08:05	0	0
08:10	0	0
08:15	0	0
08:20	0	0
08:25	5	0
08:30	0	0
08:35	0	0
08:40	0	0
08:45	0	0
08:50	0	0
08:55	0	0
09:00	0	0
09:05	0	0
09:10	0	0
09:15	0	0
09:20	0	0
09:25	0	0
09:30	0	0
09:35	0	0
09:40	0	0
09:45	0	0
09:50	0	0
09:55	0	0
15:00	5	0
15:05	0	0
15:10	0	0
15:15	0	0
15:20	0	0
15:25	0	0
15:30	0	0
15:35	0	0
15:40	0	0
15:45	0	0
15:50	5	0
15:55	0	0

Tracsis plc
Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 6
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM A - Green side	
	Lane 1	Lane 2
07:00	0	0
07:05	0	0
07:10	0	0
07:15	0	0
07:20	0	0
07:25	0	0
07:30	0	0
07:35	0	0
07:40	0	0
07:45	5	0
07:50	0	0
07:55	0	0
08:00	0	0
08:05	0	0
08:10	0	0
08:15	0	0
08:20	0	0
08:25	0	0
08:30	0	0
08:35	0	0
08:40	0	0
08:45	0	0
08:50	0	0
08:55	0	0
09:00	0	0
09:05	0	0
09:10	0	0
09:15	0	0
09:20	0	0
09:25	0	5
09:30	0	0
09:35	0	0
09:40	10	0
09:45	0	0
09:50	0	0
09:55	0	0
15:00	0	0
15:05	0	0
15:10	0	0
15:15	0	0
15:20	0	0
15:25	0	0
15:30	0	0
15:35	0	0
15:40	0	0
15:45	0	0
15:50	0	0
15:55	0	0

Tracsis plc
Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 7
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM B - St Andrews Hill	
	Lane 1	Lane 2
07:00	0	0
07:05	0	0
07:10	0	0
07:15	0	5
07:20	0	0
07:25	0	0
07:30	0	5
07:35	0	0
07:40	0	0
07:45	0	0
07:50	0	0
07:55	0	5
08:00	0	0
08:05	0	0
08:10	5	0
08:15	0	0
08:20	0	5
08:25	0	0
08:30	0	5
08:35	0	0
08:40	0	0
08:45	0	0
08:50	0	0
08:55	0	0
09:00	0	0
09:05	0	0
09:10	0	0
09:15	0	0
09:20	0	0
09:25	0	0
09:30	0	0
09:35	10	0
09:40	0	0
09:45	0	0
09:50	0	0
09:55	0	0
15:00	0	0
15:05	0	0
15:10	0	5
15:15	0	0
15:20	0	0
15:25	0	5
15:30	0	5
15:35	0	0
15:40	0	0
15:45	0	0
15:50	0	0
15:55	0	5

Tracsis plc Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 8
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM A - Cody Road	
	Lane 1	Lane 2
07:00	0	0
07:05	0	0
07:10	0	0
07:15	0	0
07:20	0	0
07:25	0	0
07:30	0	0
07:35	0	0
07:40	0	0
07:45	0	0
07:50	0	0
07:55	0	0
08:00	0	0
08:05	0	0
08:10	0	0
08:15	0	0
08:20	0	0
08:25	0	0
08:30	0	20
08:35	0	0
08:40	0	0
08:45	0	0
08:50	0	0
08:55	0	0
09:00	0	0
09:05	0	0
09:10	0	0
09:15	0	0
09:20	0	0
09:25	0	0
09:30	0	0
09:35	0	0
09:40	0	0
09:45	5	0
09:50	0	0
09:55	0	0
15:00	0	0
15:05	0	0
15:10	5	0
15:15	0	0
15:20	0	0
15:25	0	5
15:30	0	0
15:35	0	0
15:40	0	0
15:45	0	0
15:50	0	0
15:55	0	0

Tracsis plc
Traffic and Data Services

Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 9
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

Lane 1 is nearside. Queues are recorded in metres.

Time	ARM B - Way Lane	
	Lane 1	Lane 2
07:00	0	0
07:05	0	0
07:10	0	0
07:15	0	0
07:20	0	0
07:25	0	0
07:30	0	0
07:35	0	0
07:40	0	0
07:45	0	0
07:50	0	0
07:55	0	0
08:00	0	0
08:05	0	0
08:10	0	0
08:15	0	0
08:20	0	0
08:25	0	0
08:30	0	0
08:35	0	0
08:40	0	0
08:45	0	0
08:50	0	0
08:55	0	0
09:00	0	0
09:05	0	0
09:10	0	0
09:15	0	0
09:20	0	0
09:25	0	0
09:30	0	0
09:35	0	0
09:40	0	0
09:45	0	0
09:50	0	0
09:55	0	0
15:00	0	0
15:05	0	0
15:10	0	0
15:15	0	0
15:20	0	0
15:25	0	0
15:30	0	0
15:35	0	0
15:40	0	0
15:45	0	0
15:50	0	0
15:55	0	0

Tracsis plc
Traffic and Data Services

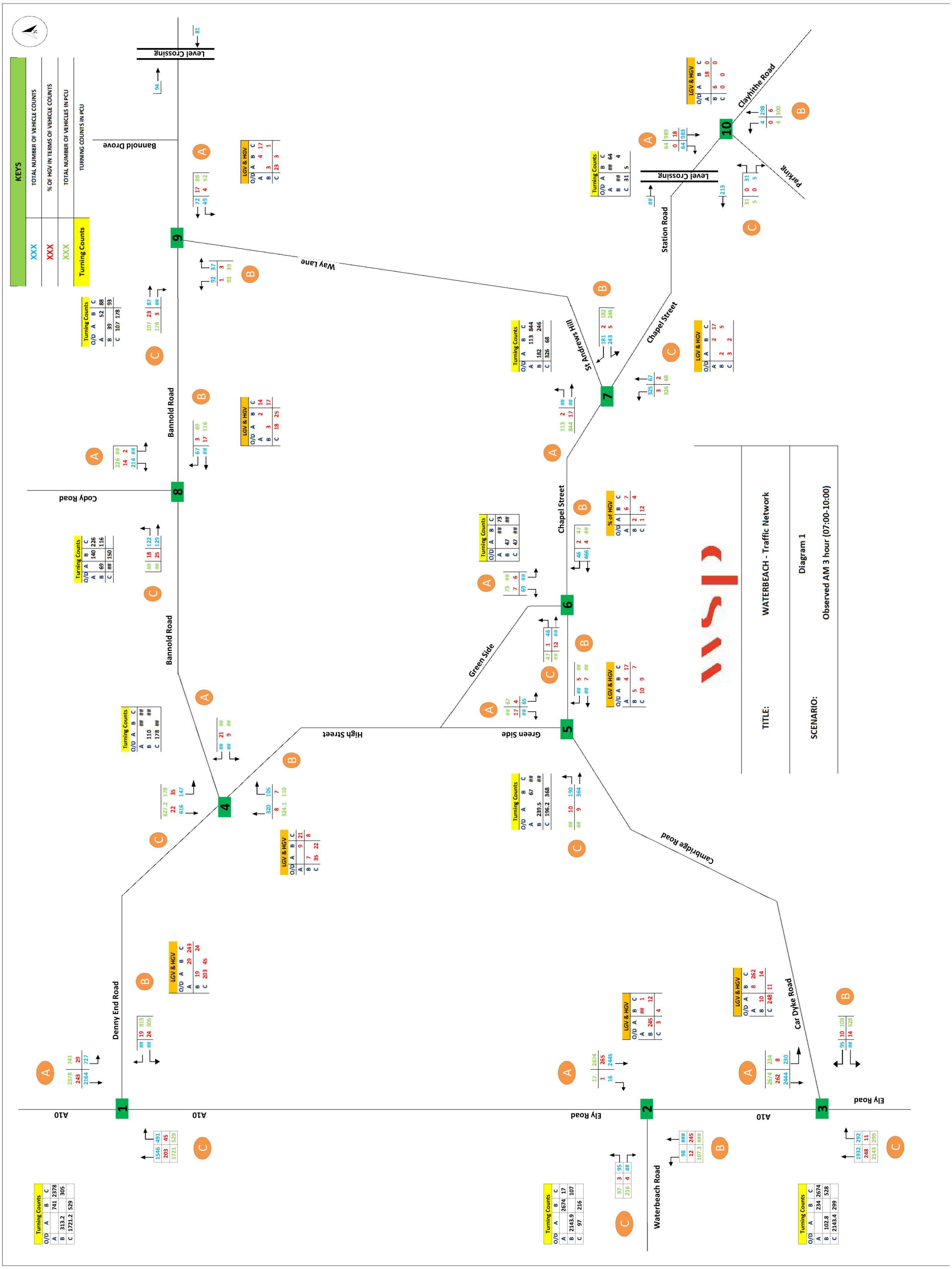
Client : WSP
Project : 3790-Tad Waterbeach
Site : Site 10
Date : 11th July 2017
Queue Method : Snap
Queue Lengths : Vehicle Metres

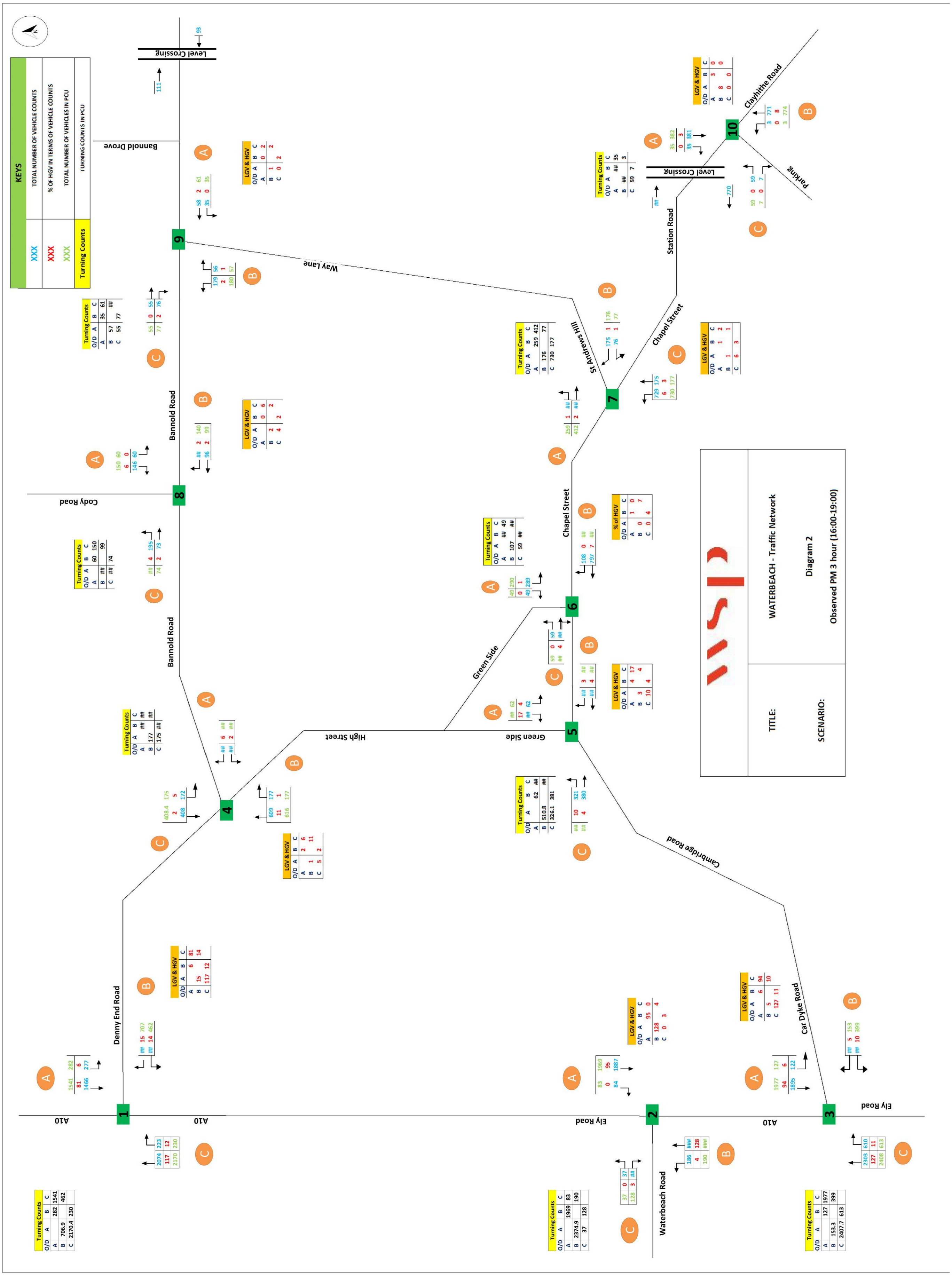
Vehicle	Number
PC, MC *	0.5
LV	1
OGV1	2
OGV2	3
Bus	3

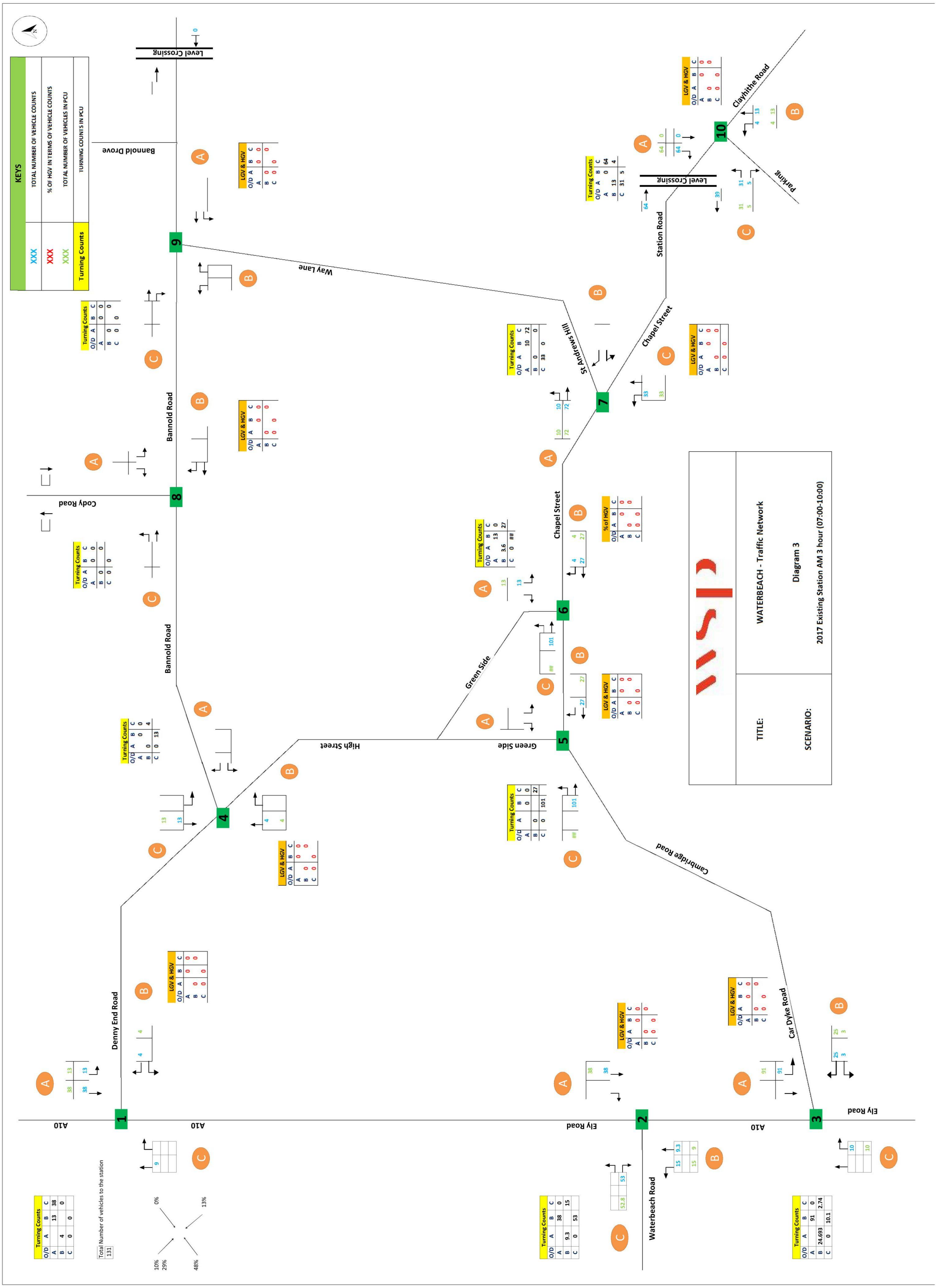
Lane 1 is nearside. Queues are recorded in metres.

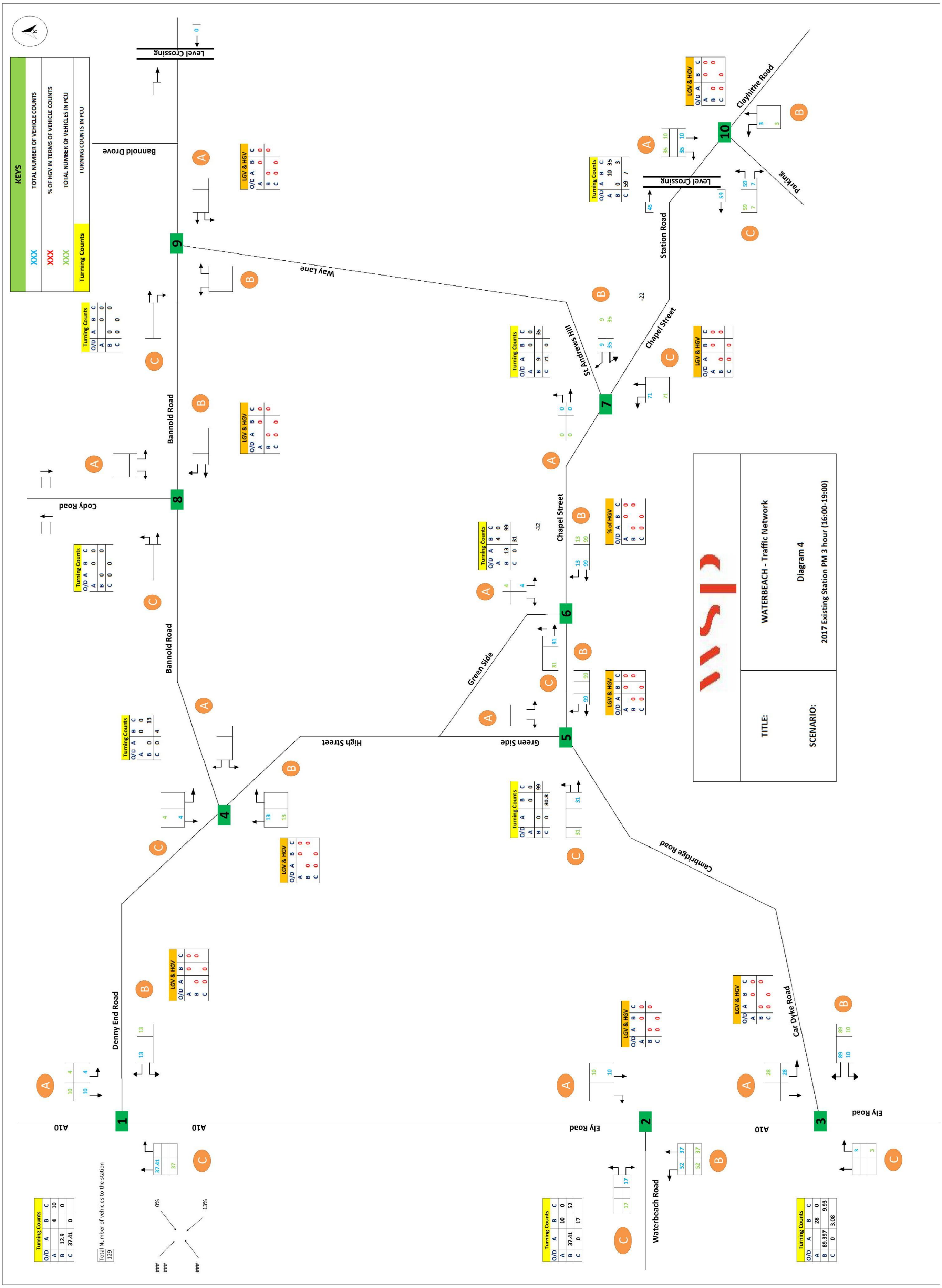
Time	ARM C - Parking	
	Lane 1	Lane 2
07:00	0	0
07:05	0	0
07:10	0	0
07:15	0	0
07:20	0	0
07:25	0	0
07:30	0	0
07:35	0	0
07:40	5	0
07:45	0	0
07:50	0	0
07:55	0	0
08:00	0	0
08:05	0	0
08:10	0	0
08:15	0	0
08:20	0	0
08:25	0	0
08:30	0	0
08:35	0	0
08:40	0	0
08:45	0	0
08:50	0	0
08:55	0	0
09:00	0	0
09:05	0	0
09:10	0	0
09:15	0	0
09:20	0	0
09:25	0	0
09:30	0	0
09:35	0	0
09:40	0	0
09:45	0	0
09:50	0	0
09:55	0	0
15:00	0	0
15:05	0	0
15:10	0	0
15:15	0	0
15:20	0	0
15:25	0	0
15:30	0	0
15:35	0	0
15:40	0	0
15:45	0	0
15:50	0	0
15:55	0	0

Appendix L – Traffic Flow Diagrams

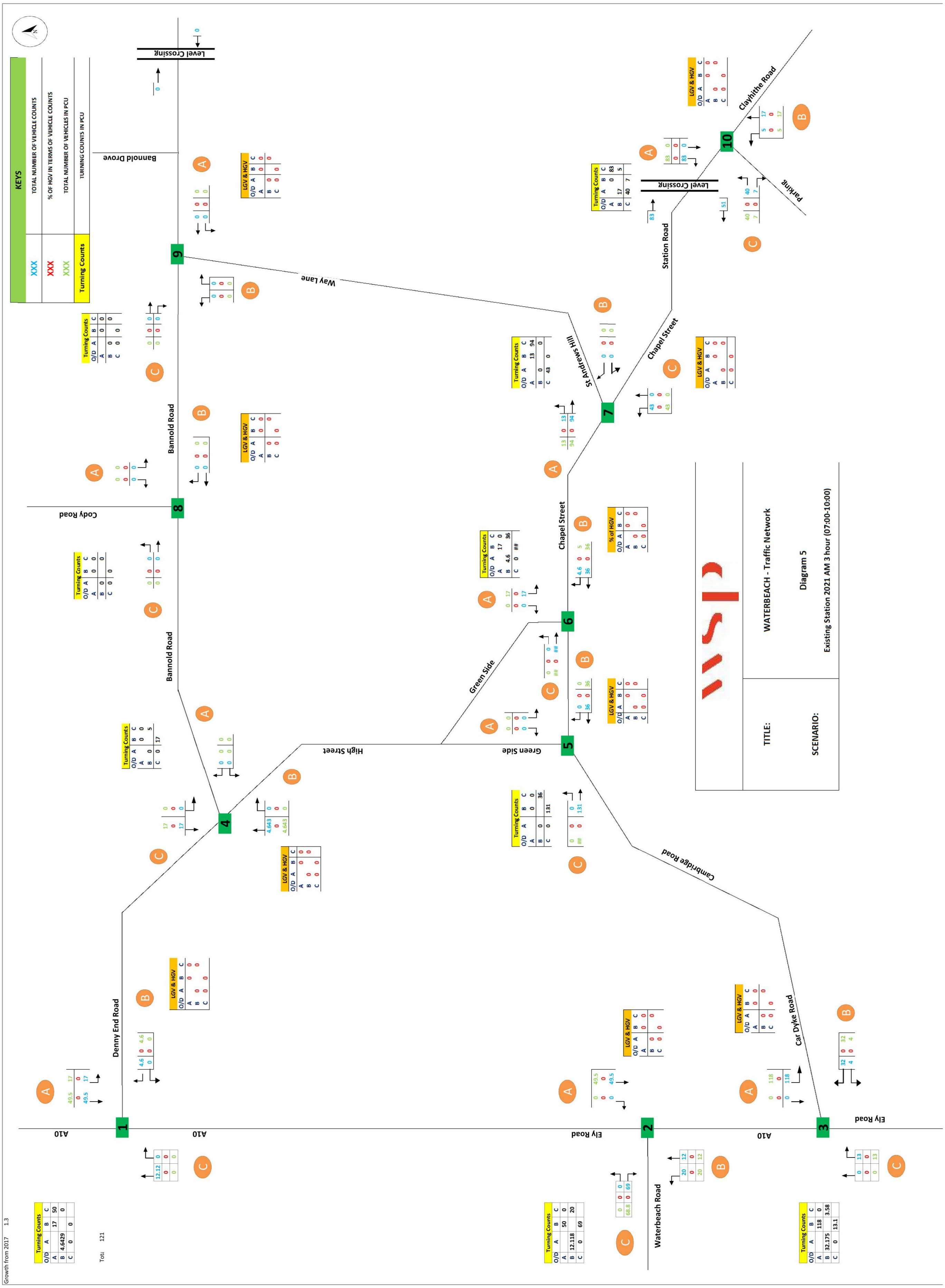

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
WSP
TITLE:
WATERBEACH - Traffic Network
Diagram 1
SCENARIO:
Observed AM 3 hour (07:00-10:00)
A10
Denny End Road
Bannold Road
Bannold Drove
Cody Road
Level Crossing
Way Lane
High Street
Green Side
Chapel Street
St Andrews Hill
Station Road
Clayhithe Road
Parking
Cambridge Road
Car Dyke Road
Ely Road
Waterbeach Road

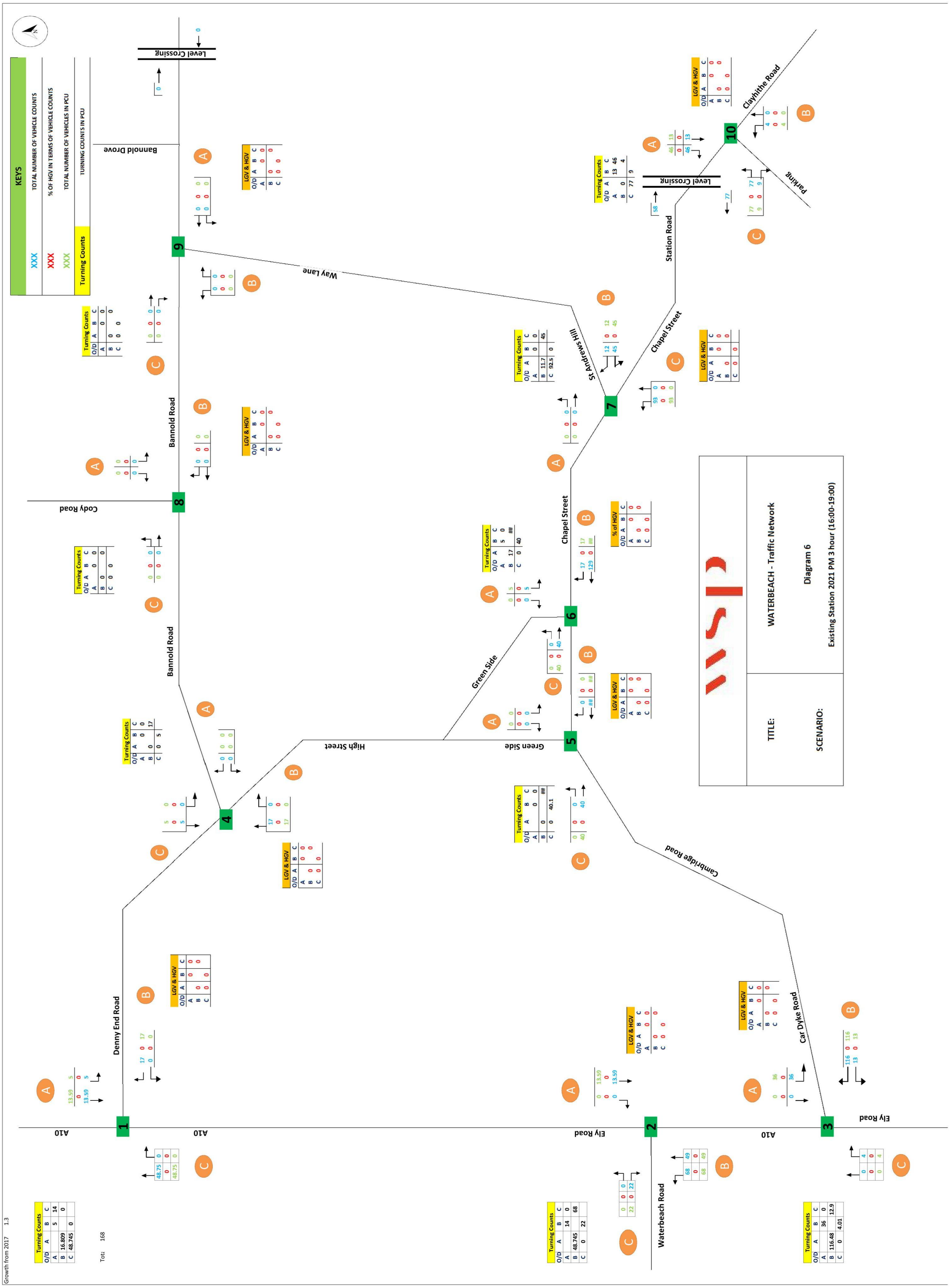

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
Level Crossing
Bannold Drove
Bannold Road
Way Lane
Cody Road
High Street
Green Side
Chapel Street
St Andrews Hill
Station Road
Claythithe Road
Parking
Cambridge Road
Denny End Road
Car Dyke Road
A10
Ely Road
Waterbeach Road
TITLE:
WATERBEACH - Traffic Network
Diagram 2
SCENARIO:
Observed PM 3 hour (16:00-19:00)

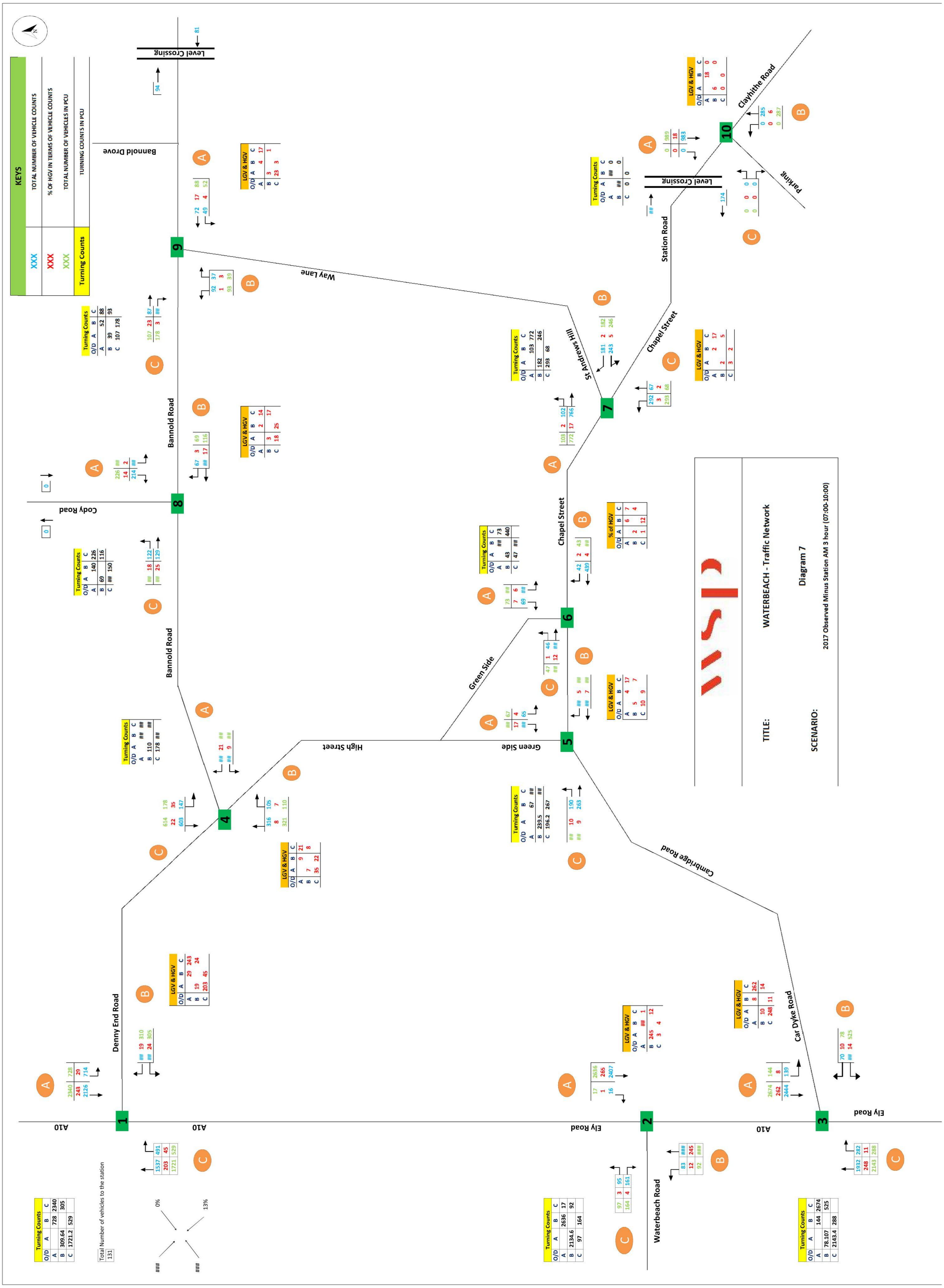

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
TITLE:
WATERBEACH - Traffic Network
Diagram 3
SCENARIO:
2017 Existing Station AM 3 hour (07:00-10:00)
A10
Ely Road
Waterbeach Road
Car Dyke Road
Cambridge Road
Denny End Road
Bannold Road
Bannold Drove
Cody Road
Way Lane
High Street
Green Side
Chapel Street
St Andrews Hill
Station Road
Level Crossing
Clayhithe Road
Parking
Total Number of vehicles to the station
131

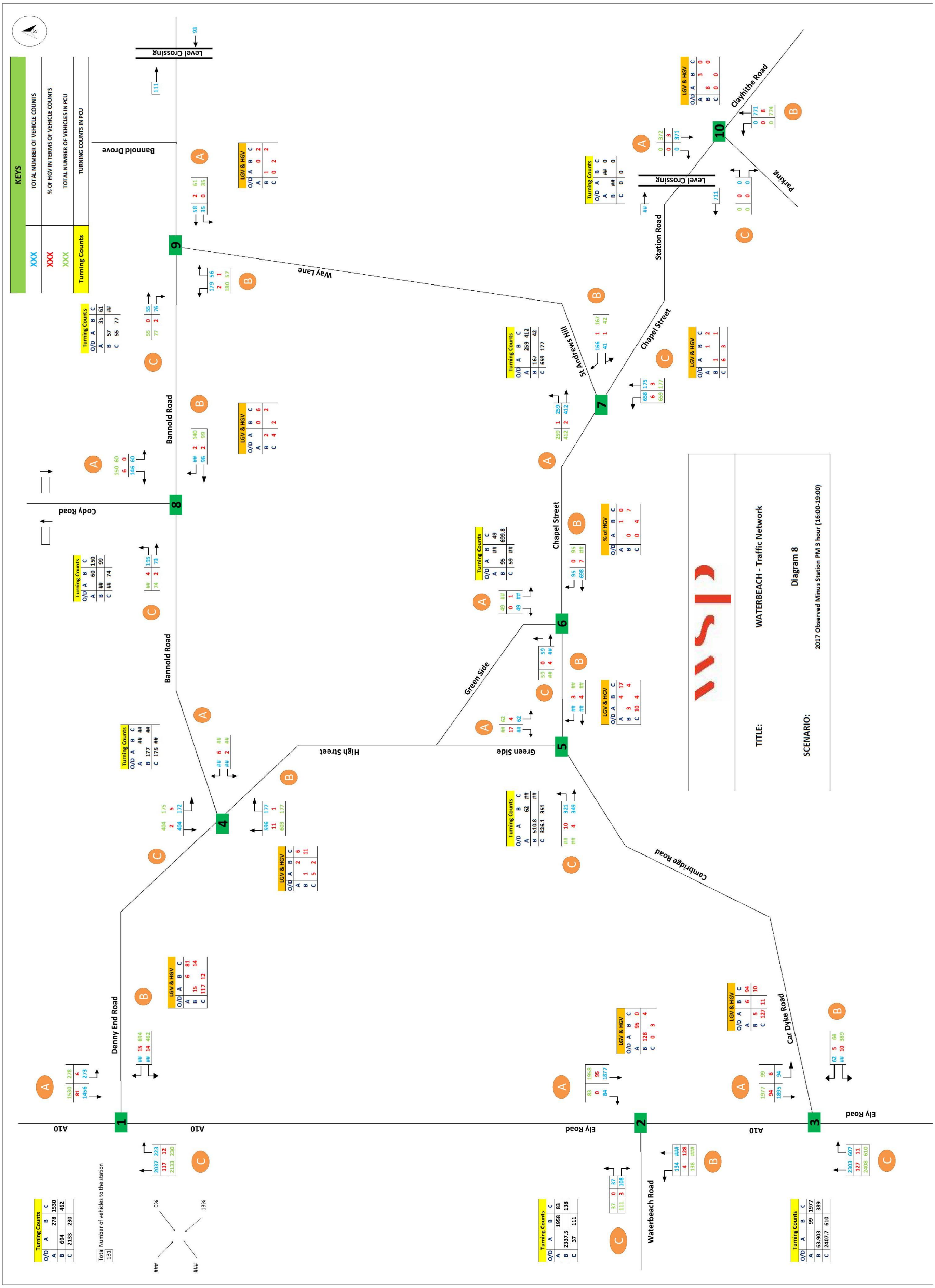


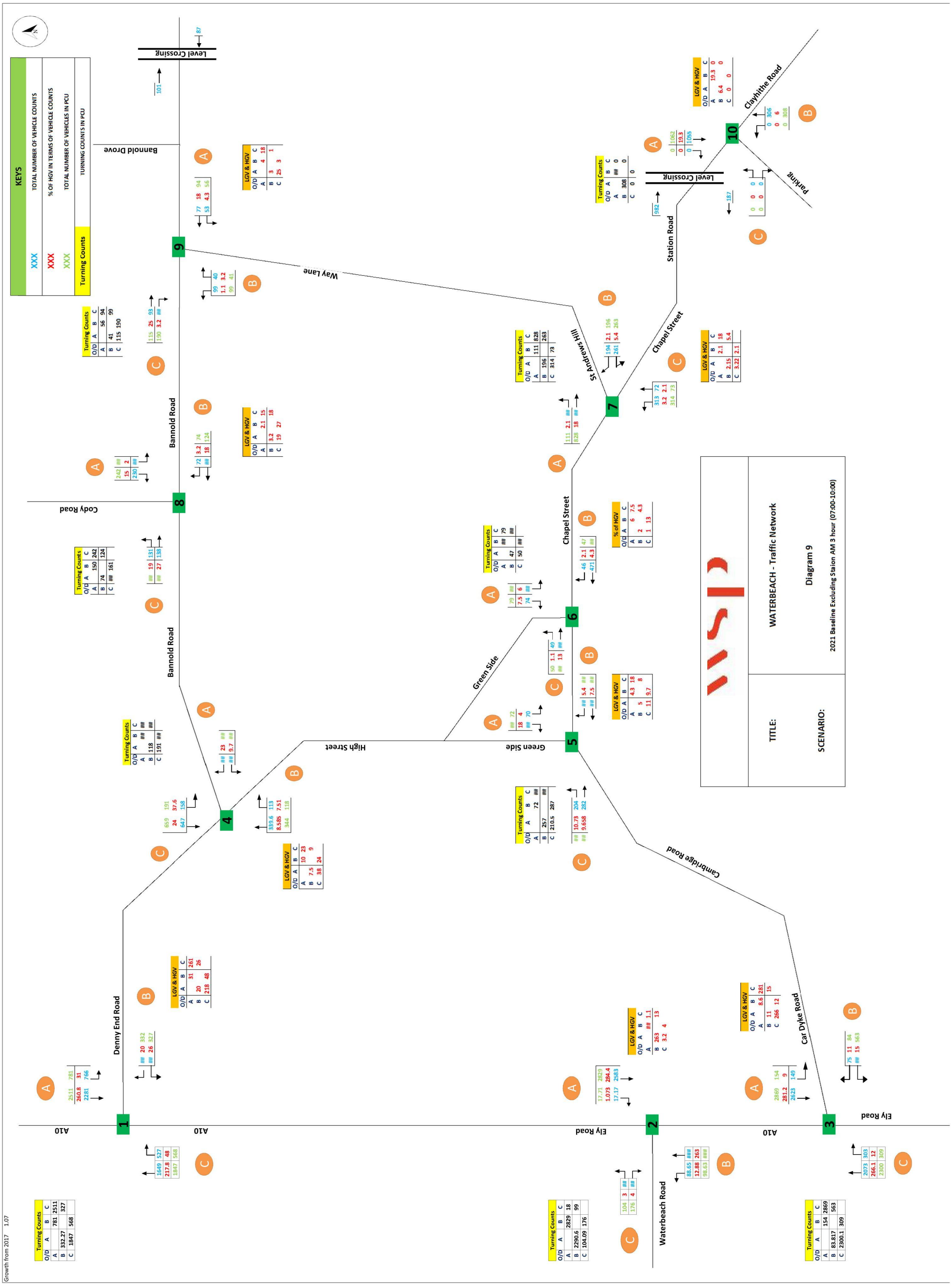
KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
Level Crossing
Bannold Drove
Bannold Road
Way Lane
Cody Road
St Andrews Hill
Chapel Street
Station Road
Clayhithe Road
Parking
Green Side
High Street
Cambridge Road
Denny End Road
Car Dyke Road
A10
Ely Road
Waterbeach Road
TITLE:
WATERBEACH - Traffic Network
Diagram 4
SCENARIO:
2017 Existing Station PM 3 hour (16:00-19:00)

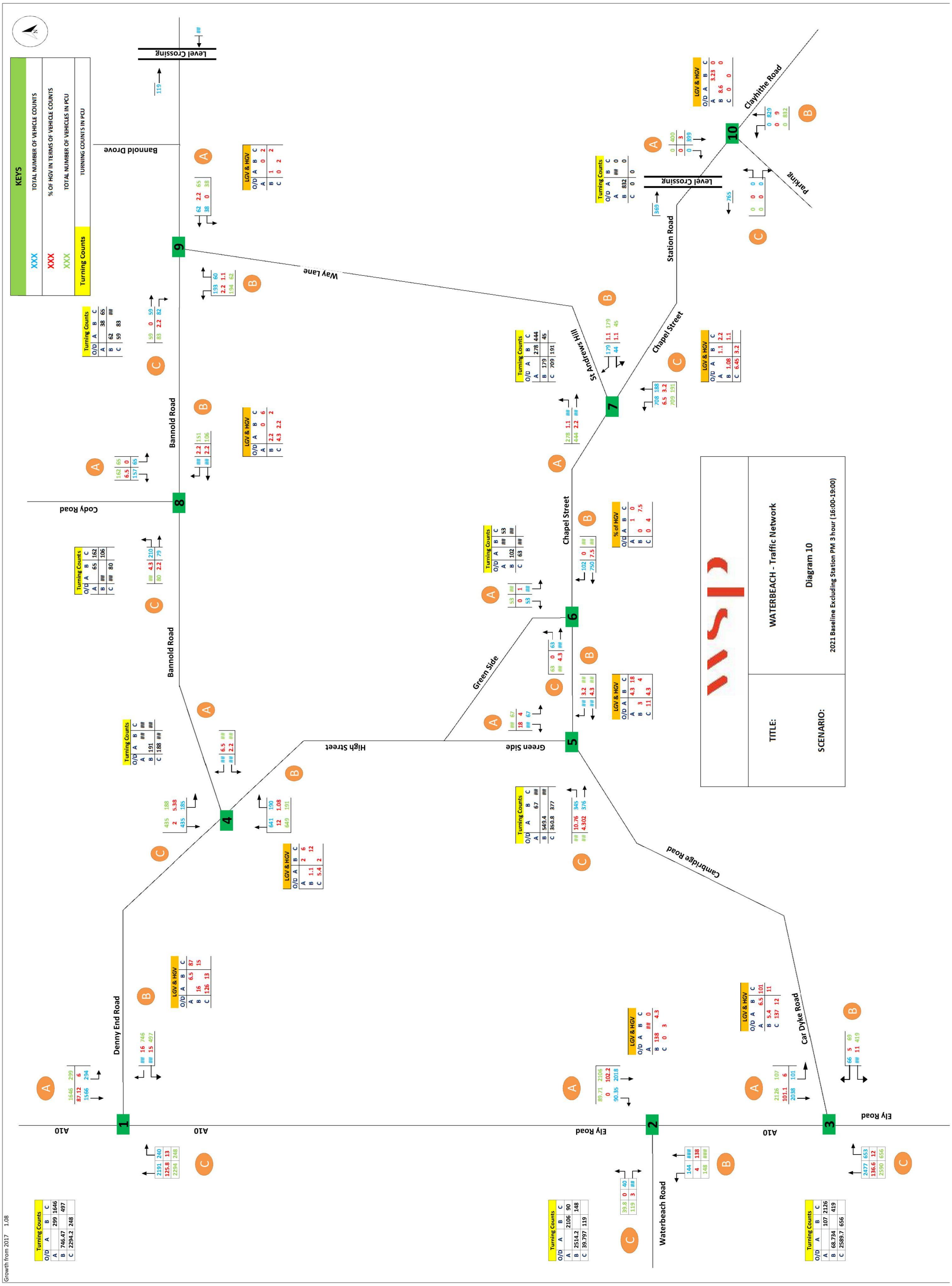

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
TITLE:
WATERBEACH - Traffic Network
Diagram 5
SCENARIO:
Existing Station 2021 AM 3 hour (07:00-10:00)
A10
Ely Road
Waterbeach Road
Car Dyke Road
Cambridge Road
Green Side
High Street
Denny End Road
Bannold Road
Cody Road
Bannold Drove
Level Crossing
Way Lane
St Andrews Hill
Chapel Street
Station Road
Clayhithe Road
Parking

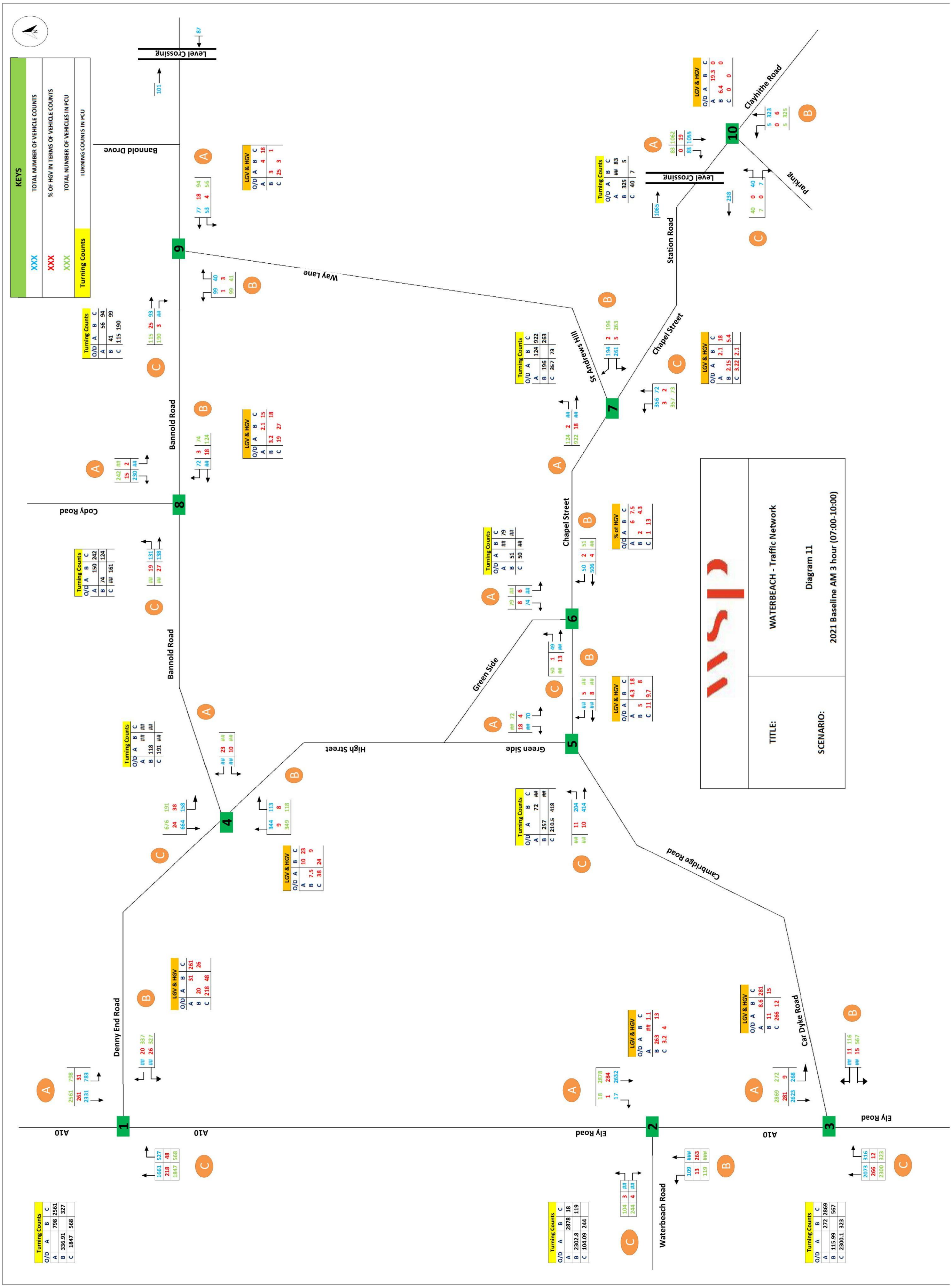

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
TITLE:
WATERBEACH - Traffic Network
Diagram 6
SCENARIO:
Existing Station 2021 PM 3 hour (16:00-19:00)
Level Crossing
Bannold Drove
Way Lane
Bannold Road
Cody Road
St Andrews Hill
Station Road
Chapel Street
Clayhithe Road
Parking
Green Side
High Street
Cambridge Road
Car Dyke Road
Denny End Road
A10
Ely Road
Waterbeach Road
Growth from 2017

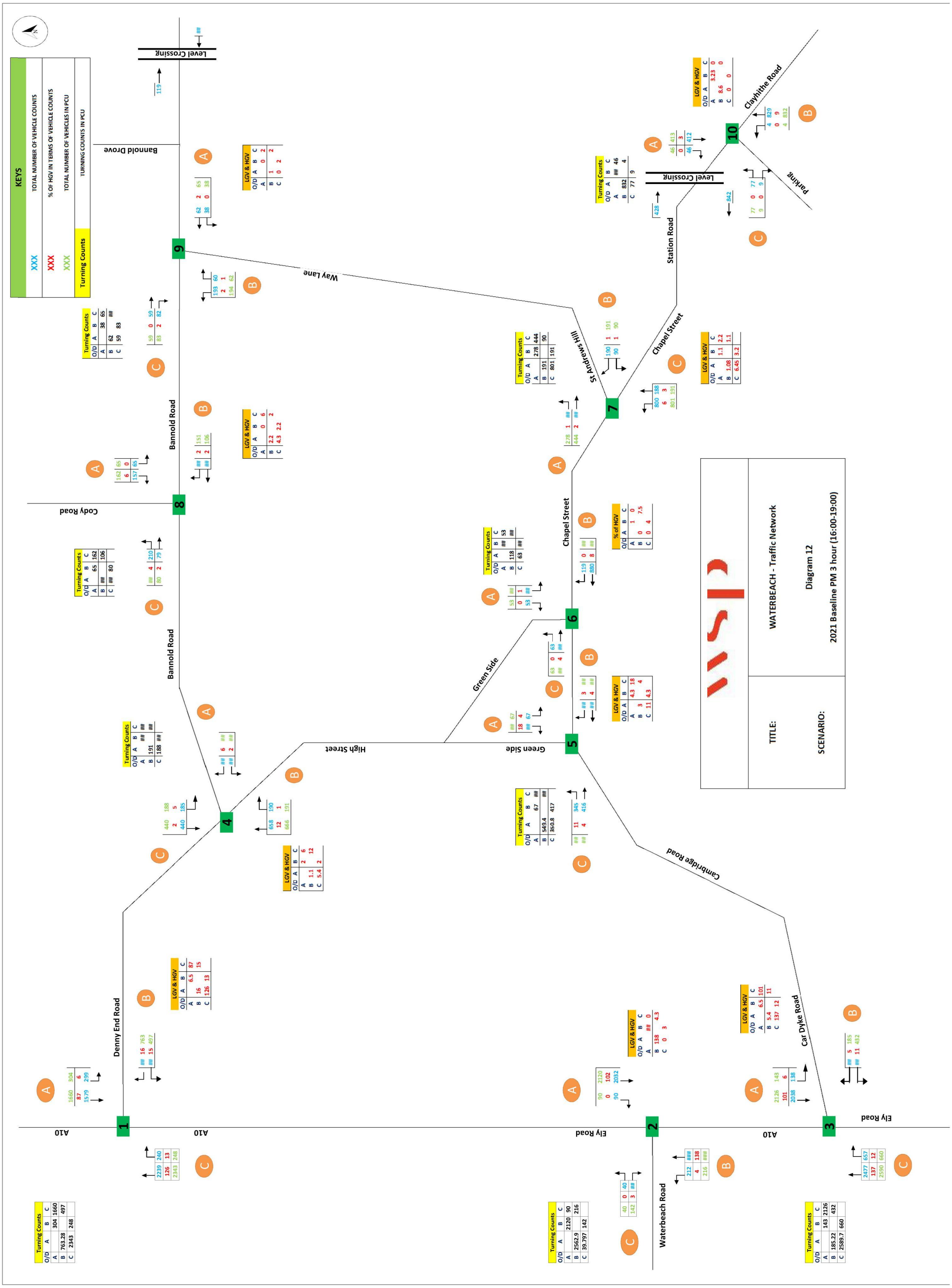

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
Level Crossing
Bannold Drove
Bannold Road
Way Lane
Cody Road
St Andrews Hill
Chapel Street
Station Road
Clayhithe Road
Parking
Green Side
High Street
Cambridge Road
Car Dyke Road
Denny End Road
Waterbeach Road
Ely Road
A10
TITLE: WATERBEACH - Traffic Network
Diagram 7
SCENARIO: 2017 Observed Minus Station AM 3 hour (07:00-10:00)
Total Number of vehicles to the station

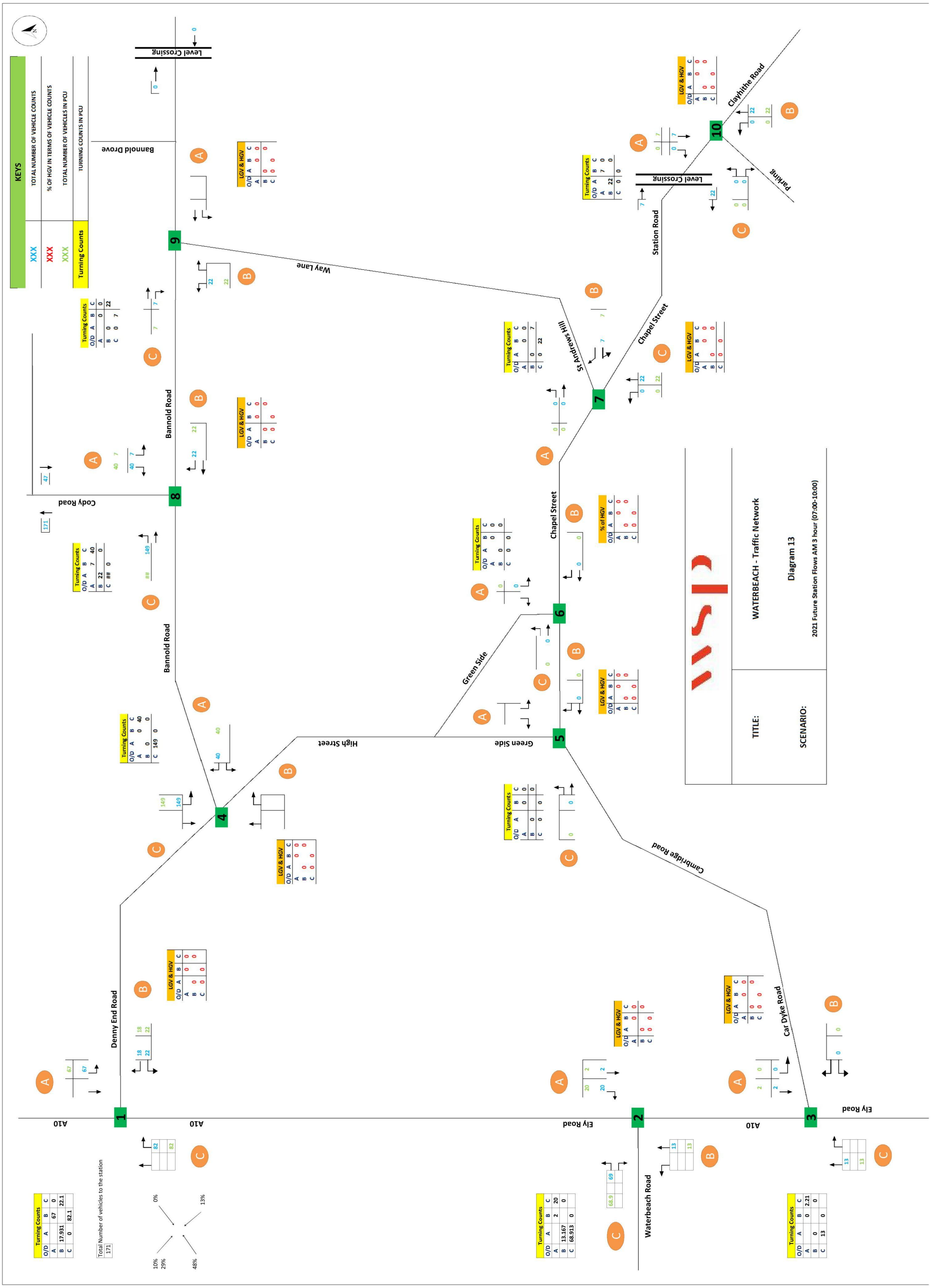

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
Level Crossing
Bannold Drove
Bannold Road
Way Lane
Cody Road
High Street
Green Side
Chapel Street
St Andrews Hill
Station Road
Clayhithe Road
Parking
Cambridge Road
Car Dyke Road
Denny End Road
A10
Ely Road
Waterbeach Road
Total Number of vehicles to the station
TITLE:
WATERBEACH - Traffic Network
Diagram 8
SCENARIO:
2017 Observed Minus Station PM 3 hour (16:00-19:00)

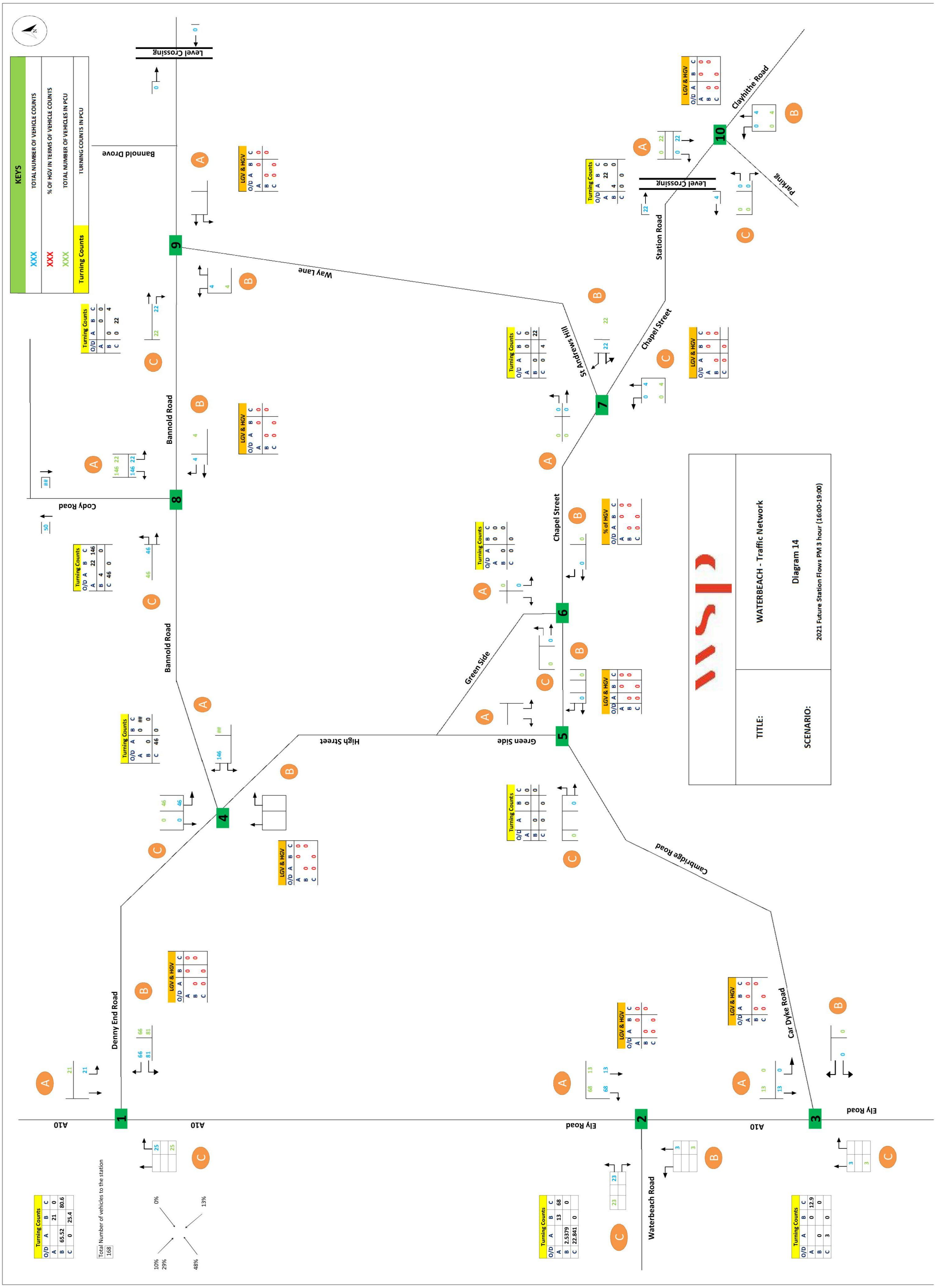

TITLE:
WATERBEACH - Traffic Network
Diagram 9
SCENARIO:
2021 Baseline Excluding Station AM 3 hour (07:00-10:00)
KEYS
Turning Counts
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Bannold Drove
Bannold Road
Cody Road
Way Lane
St Andrews Hill
Chapel Street
Station Road
Clayhithe Road
Parking
Level Crossing
Green Side
High Street
Cambridge Road
Denny End Road
A10
Ely Road
Waterbeach Road
Car Dyke Road

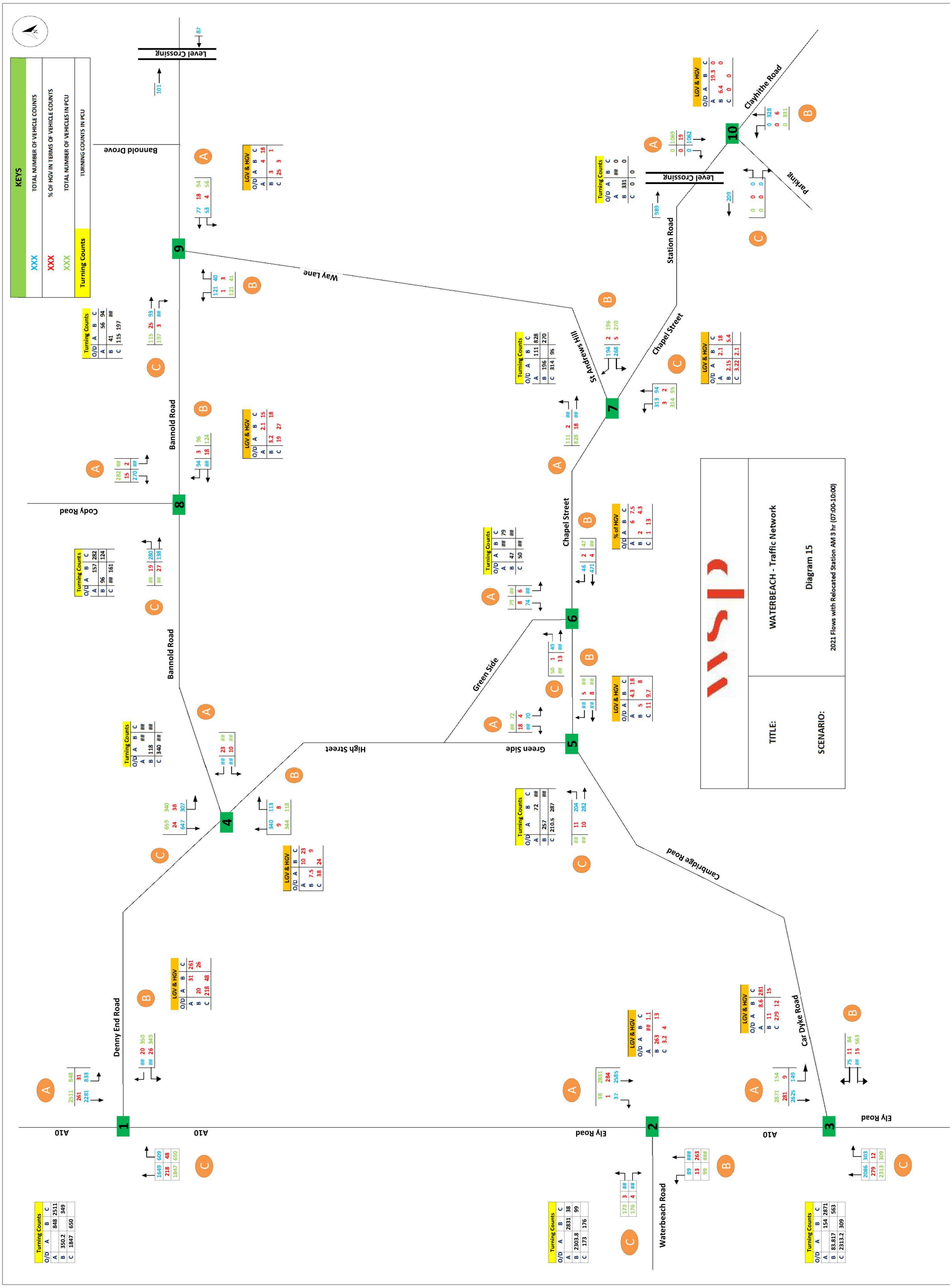

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
LGV & HGV
% of HGV
Level Crossing
Bannold Drove
Bannold Road
Way Lane
Cody Road
St Andrews Hill
Chapel Street
Station Road
Clayhithe Road
Parking
Green Side
High Street
Cambridge Road
Denny End Road
Car Dyke Road
Ely Road
A10
Waterbeach Road
WATERBEACH - Traffic Network
Diagram 10
2021 Baseline Excluding Station PM 3 hour (16:00-19:00)
TITLE:
SCENARIO:
Growth from 2017 1.08

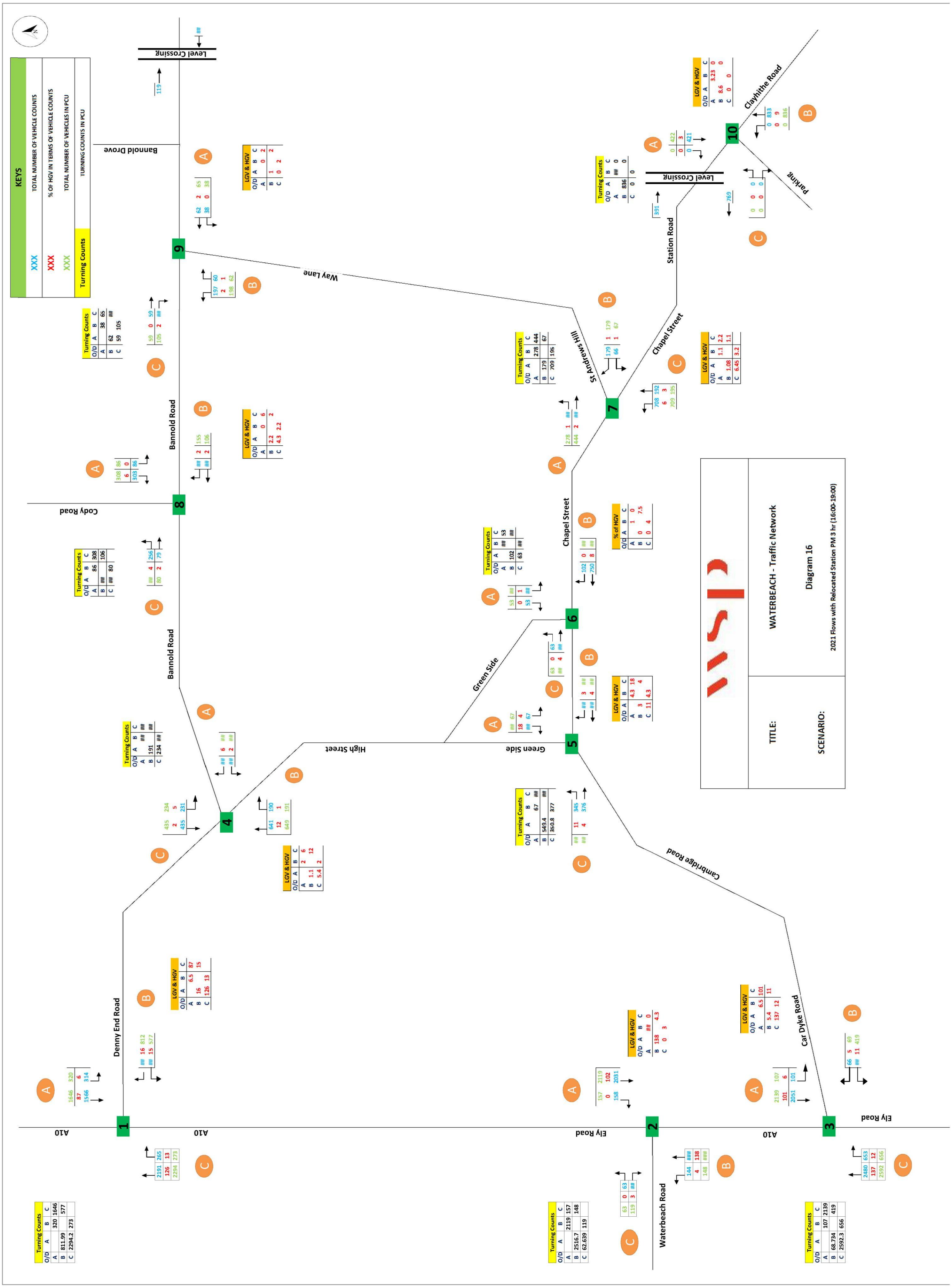

KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
LGV & HGV
% of HGV
Level Crossing
Bannold Drove
Bannold Road
Cody Road
Way Lane
St Andrews Hill
Chapel Street
Station Road
Clayhithe Road
Parking
Green Side
High Street
Cambridge Road
Denny End Road
Car Dyke Road
Waterbeach Road
Ely Road
A10
TITLE:
WATERBEACH - Traffic Network
Diagram 11
SCENARIO:
2021 Baseline AM 3 hour (07:00-10:00)


KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
Level Crossing
Bannold Drove
Bannold Road
Cody Road
Way Lane
St Andrews Hill
Chapel Street
Station Road
Clayhithe Road
Parking
Green Side
High Street
Cambridge Road
Denny End Road
A10
Ely Road
Waterbeach Road
Car Dyke Road
LGV & HGV
% of HGV
TITLE:
WATERBEACH - Traffic Network
Diagram 12
SCENARIO:
2021 Baseline PM 3 hour (16:00-19:00)


KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
WSP
TITLE:
WATERBEACH - Traffic Network
Diagram 13
SCENARIO:
2021 Future Station Flows AM 3 hour (07:00-10:00)
Bannold Road
Bannold Drove
Way Lane
Cody Road
Station Road
Chapel Street
Green Side
High Street
Cambridge Road
Denny End Road
Car Dyke Road
Ely Road
A10
Waterbeach Road
Clayhithe Road
Parking
Level Crossing
St Andrews Hill


KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
LGV & HGV
% of HGV
Level Crossing
Bannold Drove
Bannold Road
Way Lane
Cody Road
St Andrews Hill
Chapel Street
Station Road
Claythithe Road
Parking
Green Side
High Street
Cambridge Road
Denny End Road
A10
Ely Road
Waterbeach Road
Car Dyke Road
Total Number of vehicles to the station
168
TITLE:
WATERBEACH - Traffic Network
Diagram 14
SCENARIO:
2021 Future Station Flows PM 3 hour (16:00-19:00)


KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
Level Crossing
Bannold Drove
Bannold Road
Cody Road
Way Lane
St Andrews Hill
Chapel Street
Station Road
Clayhithe Road
Parking
Green Side
High Street
Cambridge Road
Denny End Road
A10
Ely Road
Waterbeach Road
Car Dyke Road
WATERBEACH - Traffic Network
Diagram 15
2021 Flows with Relocated Station AM 3 hr (07:00-10:00)
TITLE:
SCENARIO:


KEYS
TOTAL NUMBER OF VEHICLE COUNTS
% OF HGV IN TERMS OF VEHICLE COUNTS
TOTAL NUMBER OF VEHICLES IN PCU
TURNING COUNTS IN PCU
Turning Counts
Level Crossing
Bannold Drove
Bannold Road
Way Lane
Cody Road
High Street
Green Side
Chapel Street
St Andrews Hill
Station Road
Clayhithe Road
Parking
Cambridge Road
Car Dyke Road
Ely Road
A10
Denny End Road
Waterbeach Road
LGV & HGV
% of HGV
TITLE:
WATERBEACH - Traffic Network
Diagram 16
SCENARIO:
2021 Flows with Relocated Station PM 3 hr (16:00-19:00)

Appendix M – Indicative Improvements to Way Lane

REV	DATE	BY	DESCRIPTION	CHK	APP
E	21/02/2018	PCLK	NOTED AMENDED. ISSUED FOR PLANNING	PCLK	PCLK
D	19/02/2018	PCLK	ISSUED PLANNING	PCLK	PCLK
C	15/02/2018	HM	REVISED TO SUIT CLIENTS' COMMENTS	P.JC	P.JC
B	09/02/2018	JFD	REVISED TO SUIT CLIENTS' COMMENTS	P.JC	P.JC
A	31/01/2018	JFD	FIRST ISSUE	P.JC	P.JC

DRAWING STATUS: FOR F

wsp
62-64 Hills Road
Cambridge
CB2 1LA, UK
T+ 44 (0) 1223 558 050 F+ 44 (0) 1223 558 051
wsp.com

CLIENT: RLW ESTATES LTD

ARCHITECT: LDA

PROJECT: WATERBEACH STATION RELOCATION

TITLE: PROPOSED WAY LANE TRAFFIC CALMING

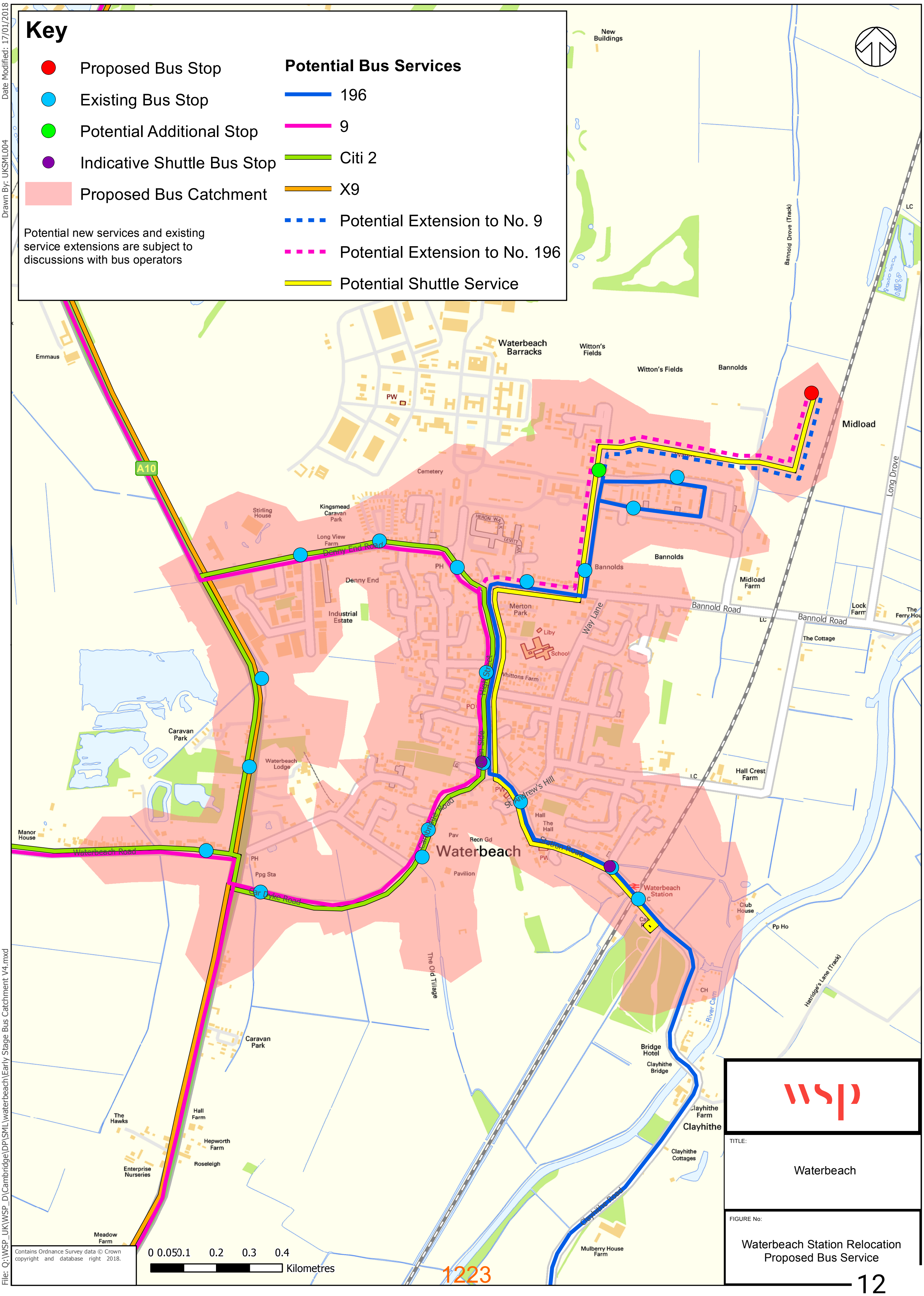
SCALE @ A1:	CHECKED:	APPROVED:
1:1,000	PJC	PJC

PROJECT No:	DESIGNED:	DRAWN:	DATE:
70024709	JFD	JFD	February 18

DRAWING No: 70024709-WSP-DEV-DRG-0105 E — REV: E

File name: \\SER02\COL2UK\PROJECTS\70000773 - DENNY ST FRANCIS\RAIL WATERBEACH STATION\MODELS AND DRAWINGS\DEVELOPMENT\70024709-WSP-DEV-DRG-0105 E.DWG, printed on 21 February 2018 12:18:01 by Clark, Philip

Appendix N – Bus and Shuttle Service Options Plan


Key
Proposed Bus Stop
Existing Bus Stop
Potential Additional Stop
Indicative Shuttle Bus Stop
Proposed Bus Catchment
Potential new services and existing service extensions are subject to discussions with bus operators
Potential Bus Services
196
9
Citi 2
X9
Potential Extension to No. 9
Potential Extension to No. 196
Potential Shuttle Service
Date Modified: 17/01/2018
Drawn By: UKSML004
File: Q:\WSP_UK\WSP_D\Cambridge\DP\SML\waterbeach\Early Stage Bus Catchment V4.mxd
Waterbeach Barracks
Witton's Fields
Bannolds
Midload
Midload Farm
Bannold Road
Long Drove
Bannold Drove (Track)
Lock Farm
The Cottage
Hall Crest Farm
Emmaus
A10
Cemetery
Stirling House
Kingsmead Caravan Park
Long View Farm
Denny End Road
Denny End
Industrial Estate
Merton Park
Way Lane
Whittons Farm
School
Caravan Park
Waterbeach Lodge
Manor House
Waterbeach Road
Car Dyke Road
Ppg Sta
Cambridge Road
St Andrew's Hill
Station Road
Hall
The Hall
Recn Gd
Waterbeach
Pavilion
Waterbeach Station
Club House
River Cam
Bridge Hotel
Clayhithe Bridge
Clayhithe Farm
Clayhithe
Clayhithe Cottages
Clayhithe Road
Mulberry House Farm
Harridge's Lane (Track)
The Old Tillage
Caravan Park
The Hawks
Hall Farm
Hepworth Farm
Roseleigh
Enterprise Nurseries
Meadow Farm
Contains Ordnance Survey data © Crown copyright and database right 2018.
0 0.05 0.1 0.2 0.3 0.4
Kilometres
wsp
TITLE:
Waterbeach
FIGURE No:
Waterbeach Station Relocation Proposed Bus Service

62-64 Hills Road
Cambridge
CB2 1LA

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