Welsh Government

# M4 Junction J28 Improvement

Local Model Validation Report

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# 1 Introduction

## 1.1 Study Overview

M4 Junction 28 is a key interchange on both the local and strategic highway networks. It provides access to West Newport, a major employments area, the M4 motorway and Newport Southern Distributor (SDR) from the western valleys.

Bassaleg Roundabout to the north is linked to Junction 28 via the A467 Forge Road. To the east, Pont Ebbw Roundabout is linked to Junction 28 via the SDR. Junction 28 and Pont Ebbw Roundabouts are part-time signal controlled, triggered by traffic flow and queuing thresholds, such that the junctions are signalised during the AM and PM peak periods but operate as roundabouts during off-peak periods.

The Welsh Government's aim (as set out in the project document 'Volume 2 Works Information') is to provide strategic capacity improvements and alleviate congestion throughout this key corridor – and hence improvements are planned at the A48/A4072/M4 Tredegar Park junction, at the A4072 Bassaleg roundabout to the north, and at the A48 Pont Ebbw roundabout to the east.

Highway traffic models of the existing local road network operating under normal traffic conditions has been prepared. This report summarises the model validation results for the individual junction models (LinSig and ARCADY) and the VISSIM of the existing conditions for the study Following the satisfactory validation of the base models, a modified form of the models (with junction improvements) can then be utilised to deduce the traffic capacity of the modified road layout and hence assist in design development, and assess the economic benefits. The Report details results of the validation process for the 2014 base year model.

The 'base' situation has been modelled in two separate processes, initially using traffic capacity software (LinSig, Arcady), and also using microsimulation modelling (VISSIM); the role of each model type is further explained in Section 2.

## 1.2 Model Outputs

The models (LinSig, Arcady and VISSIM) are stored in the form of electronic files, and can be provided to the client organisation as necessary for checking / approval processes. In particular, the VISSIM microsimulation 'movie' outputs can be provided for review purposes.

## 1.3 Report Structure

This report summarises the development of the base year transport model and its subsequent validation.

Following this introduction, the report structure is as follows:

Section 2 provides an overview of the study area and the modelling approach;

Section 3 describes the data used in the model development;

Section 4 provides the Queuing validation for LinSig and Arcady modelling;

Section 5 provides the Queuing validation for VISSIM modelling;

Section 6 discusses the LinSig & VISSIM Journey Time validation;

Section 7 details the VISSIM Model Traffic Flow validation;

Section 8 contains concluding comments.

# 2 Approach to LMVR Modelling

## 2.1 Modelling Area

Copyright GoogleMaps


**Figure 2.1: M4 Junction 28 Traffic Model Area**

**Note:** LinSig modelling does not include A48 / Pencarn Way Junction

This Report provides evidential data to show that separate LinSig and Arcady models, and a single VISSIM microsimulation model, correlate well with the actual traffic conditions, and hence can be reasonably described as validated models for existing (2014) traffic conditions. The model area is shown in Figure 2.1.

## 2.2 Modelling Process

A brief description of the basis and role of the validated LinSig and VISSIM models is as follows (and as illustrated in Figure 2.2):

- **LinSig capacity modelling:** LinSig models (using Version 3.2.22) have been produced for each of the three junctions for 2014 traffic conditions. LinSig modelling utilises detailed signal timings, in respect of cycle times, signal staging, intergreens, and offsets between each signal installation. The 2014 Do Nothing LinSig model will then be used as the modelling basis of testing options for improving the junction layouts and operations, to assist in design development.

- **VISSIM micro-simulation modelling:** A comprehensive micro-simulation VISSIM model (Version 7.00.07) has been produced for 2014 traffic conditions, which includes within a single model the three main junctions, plus the A48 / Pencarn Way junction just south of Junction 28, as well as signalised crossings at the Pont Ebbw and Bassaleg junctions. VISSIM modelling allows the potential impact of queuing and blocking back to be assessed. The VISSIM model adopts a 'Dynamic' modelling approach which allows route and lane choice for journeys within the network – although in this case the modelled network does not include alternative routes. In respect of Vehicle Classification, the VISSIM model includes for modelling buses , and also distinguishes between light (cars and LGVs) and heavy (HGV) vehicles. The development of the demand matrices are is described in Section 3. The 2014 validated VISSIM microsimulation model will then be used as the basis for testing the preferred improvement options (for all three junctions).

The LinSig and VISSIM validated base year models cover the AM, Interpeakand PM peak hours.

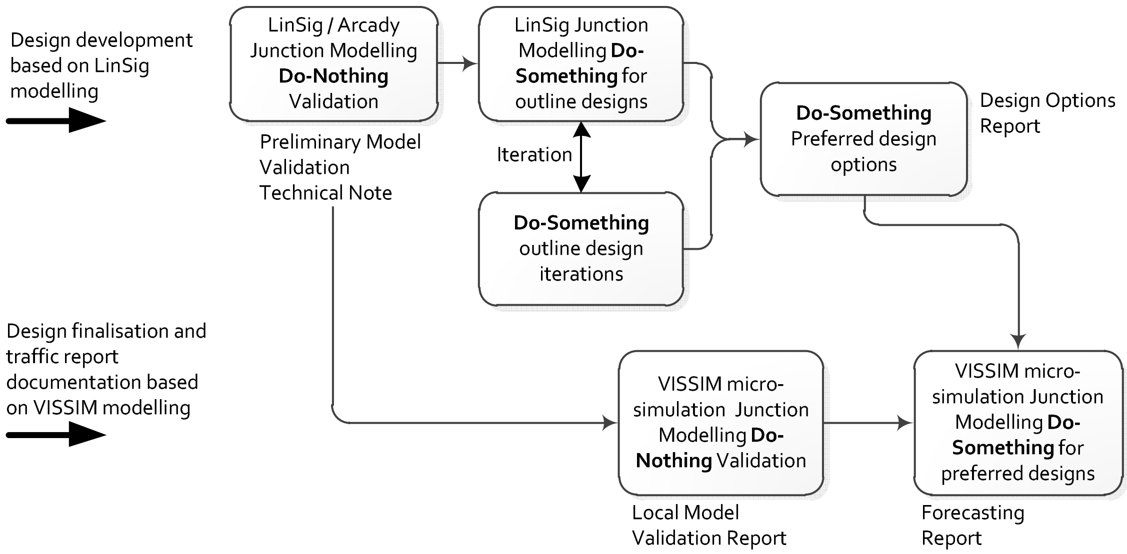


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**Figure 2.2: LinSig/Arcady & VISSIM Validation Modelling Context**

## 2.3 Traffic Data

Traffic data collected through surveys undertaken in 2014 has been input to the LinSig and VISSIM models. The traffic data is described in detail in the Traffic Surveys Report (02.02.2015). The processing of the traffic data to form demand matrices for the VISSIM model is described in Section 3.

## 2.4 Approach to Validation

Validation of the models have been carried out for the following model outputs:

1. Validation of journey time across the local road network – for both the LinSig/Arcady and the VISSIM models;
2. Validation of queues on the junctions – for both the LinSig/Arcady and the VISSIM models.
3. For the VISSIM model only, flows on each of the internal network links are assigned within the model according to the input 'matrix' of origin/destination movements. The validation, in accordance with DfT TAG Unit M3.1 guidance, hence includes a check that the assigned flows correspond well with the surveyed flows.

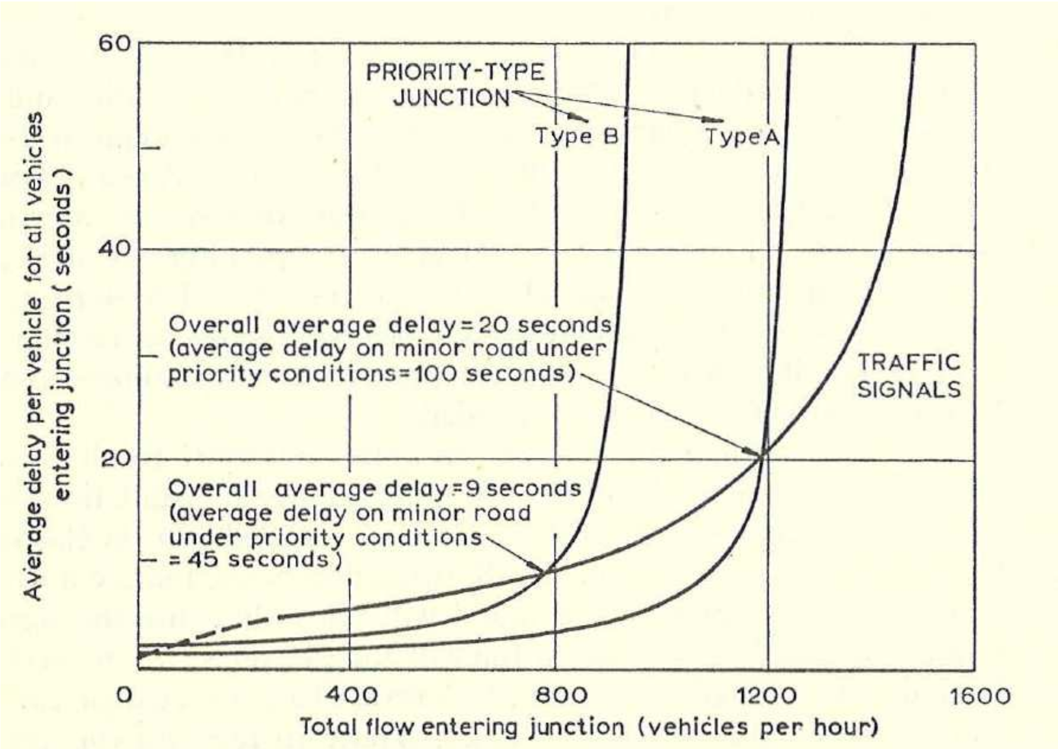


**Figure 2.3: Typical Junction Flow / Delay Relationship Graph**

For queuing and journey time validation, it is relevant that the junctions in the study area are generally operating under congested conditions in the AM and PM peak periods. When a junction reaches 90-100% capacity, queues and delay grow exponentially, and hence validating to an exact queue length or journey time is not realistic. The diagram in Figure 2.3 (which is an extract from Webster and Cobbe, 'Traffic Signals', Road Research Technical Paper 56) shows the typical relationship between flows and delays at busy junctions. For example, the diagram indicates that for a give-way junction at or near saturation, a 5% increase in traffic can engender a 200% increase in delay, and for a traffic signal junction, a 5% increase in traffic can result in a 50% increase in delay. Therefore, for validation of the relatively small network in this case, the approach to validating queues is based on achieving a good fit to the observed range of queue lengths i.e. 'short' queues of up to 20 vehicles, 'medium' queues of around 20-40 vehicles, or 'long' queues at around 50 (or over) vehicles.

## 2.5 Impact of Blocking Back

LinSig and Arcady junction analysis does not directly model 'blocking back' between junctions, since the 'existing' (Do Nothing) LinSig and Arcady models have been built as stand-alone models for each junction. On the other hand, the VISSIM microsimulation model presents all three junctions within a single comprehensive model, and consequently includes traffic interactions between the three junctions, and hence the impact of blocking back of queues between junctions can be modelled.

In respect of modelling (in VISSIM) the occurrence of blocking back, it is noted that the three junctions are subject to variable congestion impacts since the traffic flows fluctuate each hour/day (as is the case for any junction). In particular it is relevant that video records (for two separate days) show that blocking back between the Pont Ebbw and Tredegar Park junction occurs on one of the survey days, but not on the other. The one set of the videos was recorded during the collection of the queue survey data, and the other was recorded during the collection of the traffic count data. Furthermore, blocking back, when it occurs, only occurs intermittently. The approach taken to validation is thus:

- To validate queuing and travel time in respect of a range of observed measurements
- To supplement the numerical validation with a 'visual' sensitivity test of the occurrence of blocking back when small incremental increases in the modelled traffic flows. This allows the effect of daily variation in traffic demand to be considered in relation to the resultant queuing.

The validated model is thus seeking to represent the typical present situation on the local network whereby the junctions are consistently saturated, and often 'tip over' to local grid-lock – but it is not intended that the VISSIM model represents a situation with constant blocking back between junctions (as this is not the case in practice).

## 2.6 Model Calibration Process

During the calibration process, the network has been comprehensively scrutinised and checked through an internal audit process. Adjustments have been made as necessary to remove any errors, and to improve the overall performance of the model based on comparisons with the observed data.

# 3 Model Inputs

## 3.1 Junction 28 Model Inputs

For development of a Base 2014 model of the existing situation at M4 Junction 28, the lane widths, lengths, and lane allocations have been determined from orthorectified aerial photography, with site visits and video footage used to determine the operation of the junction. The existing configuration is shown on Figure 3.1.

**Figure 3.1: Aerial Photo of Junction 28**

The traffic demand data has been determined from the classified turning counts undertaken on Tuesday 13 May 2014, and has been validated against the queue surveys undertaken during the week commencing Monday 13 October 2014.

CCTV footage from Tuesday 14 October 2014 of the junction has been used to determine cycle times, green times for the junction as a whole, and the give way parameters for the Southern Distributer Road (SDR) arm. The footage was analysed in five minute 'chunks' across the peak hours of 8-9am and 5-6pm looking at the A467 entry, the M4/A48 entry, the M4 Off Slip and the SDR. The cycle times were determined using the average observed cycles from each of the three signalled arms of the roundabout – with 70 seconds in the AM Peak and 75 seconds in the PM Peak used in the modelling. Minimum green times were determined from the observed minimum times from the footage for each arm with average time used where appropriate. The SDR give way parameters have been determined by counting the flow of PCUs from the gyratory and the SDR by lane. This has been used to determine the individual coefficients and the maximum flows whilst giving way for each entry lane on the SDR.

The 'yellow box' markings have modelled in VISSIM using conflict areas, with the parameters calibrated to match the observed driver behaviour. It should be noted that in many cases drivers do not observe the rules of the yellow box markings, in particular on the A48/M4 West entry to the gyratory.

## 3.2 Pont Ebbw Model Inputs

A Base model of the existing situation at Pont Ebbw junction has been developed in LinSig 3.2.22. Lane widths, lengths, and lane allocations have been determined from orthorectified aerial photography, with site visits and video footage used to determine the operation of the junction. The existing configuration is shown on Figure 3.2.

**Figure 3.2: Aerial Photo of Pont Ebbw Junction**

The traffic demand data has been determined from the classified turning counts undertaken on Tuesday 13 May 2014, and has been validated against the queue surveys undertaken during the week commencing Monday 13 October 2014.

As with Junction 28, peak hour CCTV footage from Tuesday 14 October 2014 has been used to determine the cycle time and green times at Pont Ebbw. The observed average cycle times are 60 seconds in the AM Peak and 70 seconds in the PM Peak. The dedicated bus lane (from ONS) operates every other cycle in the model to replicate the typical operation observed on site.

Pont Ebbw is operated using part time signals that have been observed to be on for the entire PM Peak hour and the majority of the AM Peak and interpeak hours. For modelling purposes it has been assumed that the signals are on for the entire hour in both the AM and PM peaks and the interpeak.

The ‘yellow box’ markings have modelled in VISSIM using conflict areas, with the parameters calibrated to match the observed driver behaviour. It should be noted that in many cases drivers do not observe the rules of the yellow box markings, in particular on the IPO/ONS/IR entry to the gyratory.

## 3.3 Bassaleg Junction Model Inputs

A model of Bassaleg junction has been developed in ARCADY 8 (a component of Junctions 8.0.4). The geometry has been determined from orthorectified aerial photography and Ordnance Survey mapping, with site visits and video footage used to determine the operation of the junction. The existing configuration is shown on Figure 3.3.

**Figure 3.3: Aerial Photo of Bassaleg Junction**

The traffic demand data has been determined from the classified turning counts undertaken on Tuesday 13 May 2014, and has been validated against the queue surveys undertaken during the week commencing Monday 13 October 2014.

Although lane allocations are not marked on the approaches to the junction, video footage was scrutinised to determine the established existing lane usage. The Entry Lane Simulation function of ARCADY 8 was then used to consider the effects of these.

## 3.4 VISSIM Demand Matrices

In order to combine the turning counts for the four individual junctions into an OD Matrix for use in the VISSIM model, a modified furness process was used. Matrices were produced for Light vehicles (Cars and LGVs) and Heavy vehicles (HGVs) for the AM, Interpeak, and PM peak hours using the following process:

1. A cordon was placed in the base 2012 SATURN model representing the extent of the VISSIM model network, and a cordoned matrix was extracted. This matrix formed the basis for the following steps.
2. The traffic demand for individual OD pairs in the matrix that had been directly observed in the traffic surveys collected in 2014 were replaced with the observed values

3. The 2014 total surveyed traffic demand for each origin and destination was set as the furness target total for the corresponding row or column totals
4. The matrix was furnessed in the normal manner, but with the values of the directly observed OD pairs fixed at their observed values.

In order to more accurately represent the variation in demand over the course of the modelled period, matrices were created for each 15 minute period of the model, taking the hourly matrices described above, and applying a factor to match the variation in observed demand in 15 minute intervals from the traffic surveys.

As the VISSIM models include the modelled hour, a one hour ‘warm up period’ and a half hour ‘cool down’ period, a total of 10 matrices were produced for each vehicle class, for each of the AM, Interpeak, and PM peak models. In total the modelled period in the VISSIM model was 2.5 hours, representing the following periods:

AM Peak: 07:00 to 09:30

Interpeak: 11:00 to 13:30

PM Peak: 16:00 to 18:30

Bus demand was not included in the matrices, however bus services were individually coded using static routes in the model using data from published bus timetables.

# 4 Queuing Model Validation

## 4.1 Basis for Queue Validation

As discussed in Section 2.4, for this local network of junctions operating at or near capacity, the approach to validating queues is based on achieving a good fit to the observed range of queue lengths i.e. ‘short’ queues of up to 20 vehicles, ‘medium’ queues of around 20-40 vehicles, or ‘long’ queues at around 50 (or over) vehicles.

## 4.2 J28 LinSig Queuing Validation

The present situation has been modelled using LinSig, and a screen shot of the model is presented as Figure 4.1.

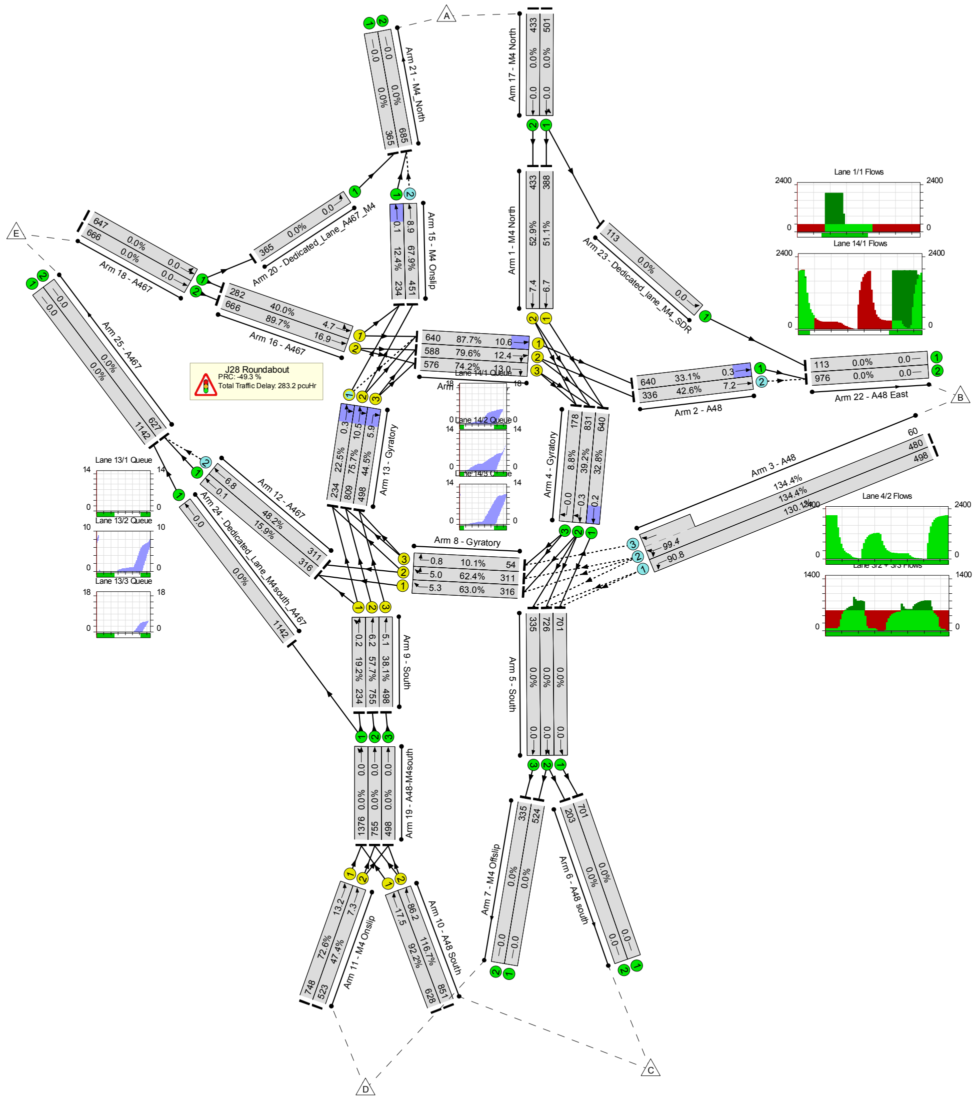


**Figure 4.1: Screenshot of the Junction 28 LinSig model**

The traffic analysis results for the AM, Interpeak and PM peak hours at Junction 28 are summarised in Tables 4.1, 4.2 and 4.3 respectively in terms of queues, and comparison with observed queues on the approaches to the junction. Due to the transient nature of queuing on the circulatory carriageway, it would not be appropriate to quantitatively compare observed queues to the modelled queues on these links, and these links were not recorded in the surveys provided in the Works Information.

**Table 4.1: Junction 28 Model Queue Validation AM Peak 2014**

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| M4 East | 1733 | 100.5% | 28 | 26 | 11 | 45 | Medium/ Medium |
| M4 East Gyratory | 2022 | 52.0% | 1 | - | - | - | - |
| A48 East (SDR) | 850 | 155.6% | 90 | 27 | 18 | 36 | Long / Medium |
| A48 East Gyratory | 563 | 68.3% | 9 | - | - | - | - |
| A48/M4 West | 1147/ 1278 | 53.9% | 7 | 16 | 10 | 20 | Short / Short |
| A48/M4 West Gyratory | 1774 | 80.1% | 14 | - | - | - | - |
| A467 Forge Road | 1233 | 119.2% | 34 | 31 | 35+ | 35+ | Medium/Medium |
| A467 Forge Rd Gyratory | 2114 | 94.9% | 11 | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

**Table 4.2: Junction 28 Model Queue Validation Interpeak 2014**

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| M4 East | 629 | 38.4% | 5 | 5 | 0 | 18 | Short / Short |
| M4 East Gyratory | 1387 | 37.7% | 0 | - | - | - | - |
| A48 East (SDR) | 1053 | 95.5% | 16 | 13 | 0 | 44 | Short / Short |
| A48 East Gyratory | 689 | 86.3% | 12 | - | - | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A48/M4 West | 991/790 | 60.9% | 10 | 8 | 0 | 15 | Short / Short |
| A48/M4 West Gyratory | 1422 | 48.9% | 10 | - | - | - | - |
| A467 Forge Road | 1201 | 79.4% | 10 | 14 | 3 | 18 | Short / Short |
| A467 Forge Rd Gyratory | 1878 | 74.3% | 9 | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

**Table 4.3: Junction 28 Model Queue Validation PM Peak 2014**

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| M4 East | 934 | 52.9% | 7 | 7 | 2 | 15 | Medium/ Medium |
| M4 East Gyratory | 1387 | 37.7% | 0 | - | - | - | - |
| A48 East (SDR) | 1038 | 134.4% | 95 | 50+ | 50+ | 50+ | Long / Long |
| A48 East Gyratory | 689 | 86.3% | 12 | - | - | - | - |
| A48/M4 West | 1479/ 1271 | 57.2% | 4 | 18 | 9 | 21 | Short / Short |
| A48/M4 West Gyratory | 1422 | 48.9% | 10 | - | - | - | - |
| A467 Forge Road | 1313 | 89.7% | 11 | 16 | 8 | 25 | Short / Short |
| A467 Forge Rd Gyratory | 1878 | 74.3% | 9 | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

The observed queues on the SDR are identified as 50+ in both peak hours. The queue length data does not provide any more detail as to the length of these queues. As shown in Section 3, CCTV footage shows the queue on the SDR on occasion backing through the Pont Ebbw Roundabout. Pont Ebbw is approximately 860m from Junction 28, the equivalent of 150 PCUs but for much of the peak hour the queue is shorter than this, and thus an average modelled queue of around 90 vehicles is considered to be acceptable for the validation of the model.

**Queue validation conclusion for Arcady Model of Junction 28:** In conclusion, review of the observed and modelled queue lengths show that the LinSig model of Junction 28 is a valid representation of the existing conditions, and thus can be developed to consider the future operation and improvement options.

## 4.3 Pont Ebbw LinSig Queuing Validation

A screen shot of the model is presented as Figure 4.2, and the queue length results for the AM, Interpeak and PM peak hours are summarised in Tables 4.4, 4.5 and 4.6 respectively, along with the observed queues.

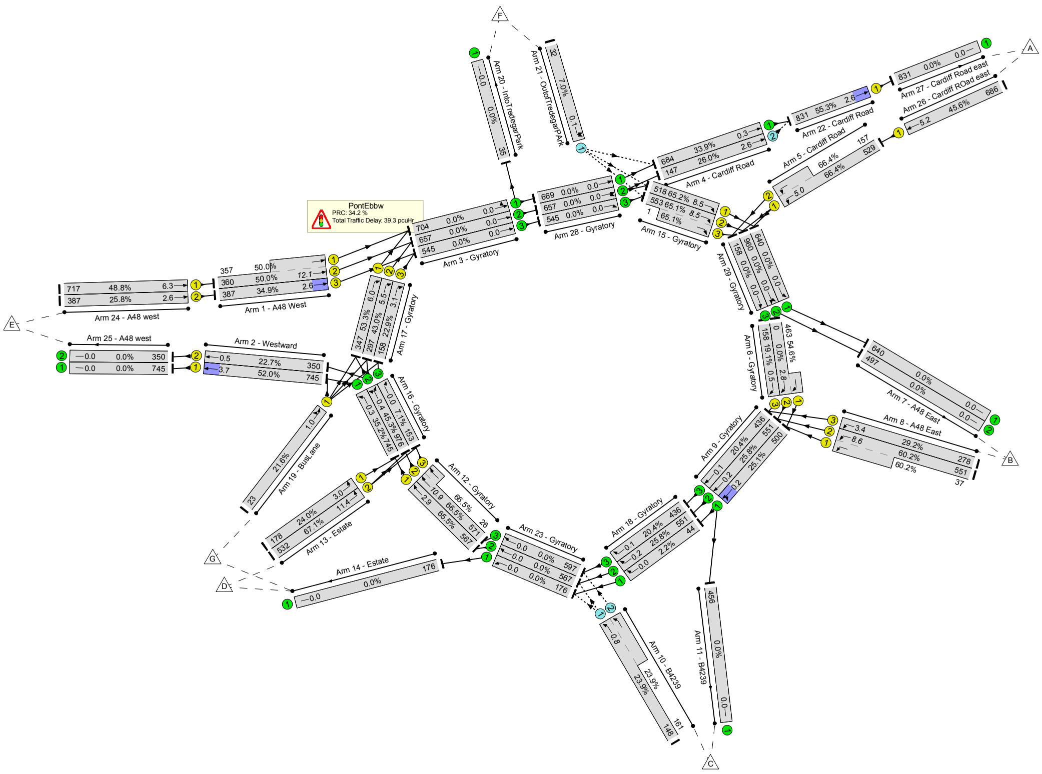


**Figure 4.2: Screenshot of the Pont Ebbw LinSig model**

The traffic analysis results for the AM, Interpeak and PM peak hours at Pont Ebbw are summarised in Tables 4.4, 4.5 and 4.6 respectively in terms of queues, and comparison with observed queues on the approaches to the junction. Due to the transient nature of queuing on the circulatory carriageway, it would not be appropriate to quantitatively compare observed queues to the modelled queues on these links, and these links were not recorded in the surveys provided in the works information.

In the PM peak, the queue from Junction 28 occasionally backs up as far as Pont Ebbw as presented in the Report of Traffic Surveys, and this queuing affects the operation of the junction, as shown in the CCTV screen captures shown below as Figures 4.3 to 4.5. These blocking back effects cannot be modelled in LinSig, leading to the differences between the modelled and observed queues on the Cardiff Road arm in the PM Peak (but is considered in the VISSIM microsimulation modelling). Additionally, in the PM Peak, the queue on the ONS arm of the junction extends into the small internal roundabout serving International Rectifier and the ONS/IPO, affecting its operation, as seen on the

CCTV footage and presented in the Report of Traffic Surveys. This effect is not considered in the LinSig modelling, but is included in the VISSIM model.

**Table 4.4: Pont Ebbw Model Queue Validation AM Peak 2014**

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| B4237 Cardiff Rd | 675 | 81.2% | 11 | 29 | 19 | 36 | Short / Medium |
| B4237 Cardiff Rd Gyratory | 2162 | 78.3% | 9 | - | - | - | - |
| A48 East (SDR) | 1120 | 69.1% | 7 | 5 | 2 | 8 | Short / Short |
| A48 East (SDR) Gyratory | 2065 | 56.7% | 1 | - | - | - | - |
| B4239 | 609 | 53.4% | 1 | 6 | 2 | 10 | Short / Short |
| B4239 Gyratory | 2253 | 57.6% | 5 | - | - | - | - |
| ONS Access | 204 | 46.7% | 2 | 1 | 0 | 3 | Short / Short |
| ONS Access Gyratory | 1462 | 59.2% | 5 | - | - | - | - |
| A48 West | 1738 | 62.6% | 11 | 6 | 2 | 14 | Short / Short |
| A48 West Gyratory | 2332 | - | - | - | - | - | - |
| Tredegar Park | 6 | 1.8% | 0 | 0 | 0 | 0 | Short / Short |
| Tredegar Park Gyratory | 2319 | 80.8% | 7 | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

### Table 4.5: Pont Ebbw Model Queue Validation Interpeak 2014

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| B4237 Cardiff Rd | 654 | 62.0% | 4 | 4 | 0 | 14 | Short / Short |
| B4237 Cardiff Rd Gyratory | 1597 | 49.1% | 2 | - | - | - | - |
| A48 East (SDR) | 904 | 46.3% | 5 | 5 | 0 | 11 | Short / Short |
| A48 East (SDR) Gyratory | 1488 | 27.9% | 0 | - | - | - | - |
| B4239 | 322 | 38.8% | 1 | 1 | 0 | 9 | Short / Short |
| B4239 Gyratory | 1572 | 61.3% | 7 | - | - | - | - |
| ONS Access | 154 | 34.3% | 2 | 2 | 0 | 4 | Short / Short |
| ONS Access Gyratory | 1568 | 42.4% | 4 | - | - | - | - |
| A48 West | 1155 | 45.0% | 12 | 12 | 0 | 21 | Short / Short |
| A48 West Gyratory | 1591 | - | - | - | - | - | - |
| Tredegar Park | 20 | 4.0% | 0 | 0 | 0 | 0 | Short / Short |
| Tredegar Park Gyratory | 1574 | 63.2% | 4 | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

### Table 4.6: Pont Ebbw Model Queue Validation PM Peak 2014

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| B4237 Cardiff Rd | 686 | 66.4% | 5 | 17 | 10 | 27 | Short / Short |
| B4237 Cardiff Rd Gyratory | 1758 | 56.1% | 3 | - | - | - | - |
| A48 East (SDR) | 866 | 60.2% | 9 | 10 | 4 | 16 | Short / Short |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A48 East (SDR) Gyratory | 1487 | 25.1% | 0 | - | - | - | - |
| B4239 | 309 | 23.9% | 2 | 4 | 2 | 7 | Short / Short |
| B4239 Gyratory | 1340 | 67.7% | 10 | - | - | - | - |
| ONS Access | 733 | 67.1% | 6 | 6 | 2 | 11 | Short / Short |
| ONS Access Gyratory | 1874 | 53.6% | 6 | - | - | - | - |
| A48 West | 1104 | 50.0% | 7 | 6 | 0 | 15 | Short / Short |
| A48 West Gyratory | 1906 | - | - | - | - | - | - |
| Tredegar Park | 32 | 7.0% | 0 | 0 | 0 | 0 | Short / Short |
| Tredegar Park Gyratory | 1903 | 68.7% | - | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

**Queue validation conclusion for Arcady Model of Pont Ebbw junction:** It is concluded that the LinSig model of Pont Ebbw is a valid representation of the existing conditions, and thus can be developed to consider the future operation and improvement options.

**Figure 4.3: CCTV image of A48 towards J28 (bottom right of image) Pont Ebbw**

**Figure 4.4: CCTV image of exit to ONS (bottom right of image) Pont Ebbw**


**Figure 4.5: CCTV image of exit to B4239 (on right of image) Pont Ebbw**


## 4.4 Bassaleg ARCADY Queuing Validation

A screen shot of the model is presented as Figure 4.6, and the results for the AM, Interpeak and PM peak hours are summarised in Tables 4.7, 4.8 and 4.9 respectively, along with the observed queues.

In the AM Peak in particular, queuing on the A468 exit of the junction blocks back onto the circulatory carriageway and affects the operation of the junction, as shown in Figure 4.7. This is largely due to the interaction with school traffic and the pedestrian crossing. Similarly, the occasional slow moving traffic on the exit towards Junction 28 causes blocking back onto the circulatory carriageway, as shown in Figure 4.8. These effects cannot be modelled in ARCADY, leading to the differences between the modelled and observed queues in the AM Peak, but is considered in the VISSIM microsimulation.

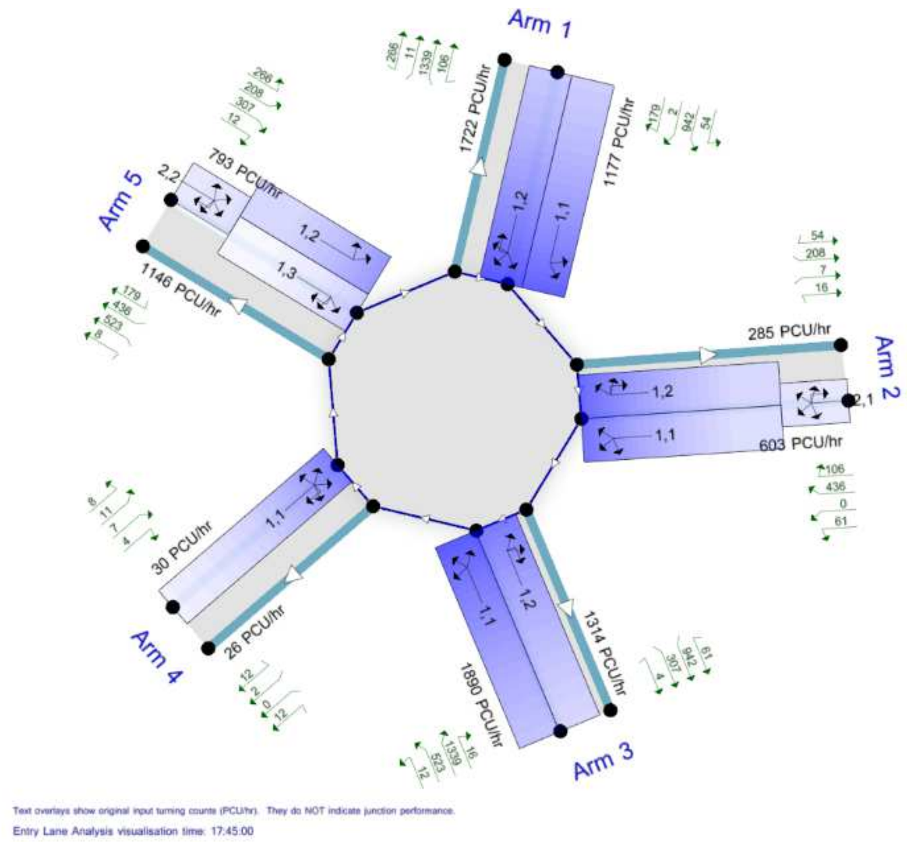


**Figure 4.6: Screenshot of the Bassaleg ARCADY model**

The traffic analysis results for the AM and PM peak hours at Bassaleg are summarised in Tables 4.5 and 4.6 respectively in terms of queues, and comparison with observed queues.

**Table 4.7: Bassaleg Model Queue Validation AM Peak 2014**

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| A467 North | 1239 | F | 36 | 89 | 24 | 100+ | Medium / Long |
| A467 North Gyratory | 1963 | - | - | - | - | - | - |
| Park View | 326 | A | 1 | 4 | 1 | 9 | Short / Short |
| Park View Gyratory | 1576 | - | - | - | - | - | - |
| A467 South | 1272 | A | 2 | 7 | 1 | 19 | Short / Short |
| A467 South Gyratory | 1818 | - | - | - | - | - | - |
| Court Crescent | 116 | C | 1 | 3 | 0 | 8 | Short / Short |
| Court Crescent Gyratory | 1707 | - | - | - | - | - | - |
| A468 | 983 | C | 5 | 5 | 1 | 13 | Short / Short |
| A468 Gyratory | 1826 | - | - | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

**Table 4.8: Bassaleg Model Queue Validation Interpeak 2014**

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| A467 North | 973 | A | 3 | 3 | 0 | 29 | Short / Short |
| A467 North Gyratory | 1427 | - | - | - | - | - | - |
| Park View | 270 | A | 1 | 1 | 0 | 8 | Short / Short |
| Park View Gyratory | 1382 | - | - | - | - | - | - |
| A467 South | 1035 | A | 1 | 0 | 0 | 7 | Short / Short |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A467 South Gyratory | 1318 | - | - | - | - | - | - |
| Court Crescent | 20 | A | 0 | 0 | 0 | 2 | Short / Short |
| Court Crescent Gyratory | 1208 | - | - | - | - | - | - |
| A468 | 620 | A | 0 | 0 | 0 | 11 | Short / Short |
| A468 Gyratory | 1280 | - | - | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

### Table 4.6: Bassaleg Model Queue Validation PM Peak 2014

| Arm | Flow (PCUs) | DoS | Modelled Queue (PCUs) | Observed Queue (PCUs) | | | Comparison of Modelled and Observed Queue |
|---|---|---|---|---|---|---|---|
| | | | | Avge Q | Min Q | Max Q | |
| A467 North | 1177 | C | 8 | 5 | 1 | 16 | Short / Short |
| A467 North Gyratory | 1669 | - | - | - | - | - | - |
| Park View | 603 | D | 5 | 6 | 3 | 10 | Short / Short |
| Park View Gyratory | 1893 | - | - | - | - | - | - |
| A467 South | 1890 | C | 9 | 9 | 0 | 32 | Short / Short |
| A467 South Gyratory | 2547 | - | - | - | - | - | - |
| Court Crescent | 30 | F | 1 | 1 | 0 | 5 | Short / Short |
| Court Crescent Gyratory | 2366 | - | - | - | - | - | - |
| A468 | 793 | B | 3 | 6 | 3 | 10 | Short / Short |
| A468 Gyratory | 2129 | - | - | - | - | - | - |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

**Queue validation conclusion for Arcady Model of Bassaleg junction:** The results in Tables 4.5 and 4.6 show that the ARCADY model of Bassaleg is a valid representation of the existing queuing conditions, and thus can be developed to consider the future operation and improvement options.


**Figure 4.7: CCTV image of blocking back from A468 Exit Bassaleg**


**Figure 4.8: CCTV image of blocking back from A467 (South) Exit Bassaleg**

# 5 VISSIM Model Traffic Queue Validation

## 5.1 Basis for Validation

The calibration and validation processes determines if the model satisfies the validation criteria and that it is a true representation of the current conditions in the defined study area.

As discussed in Section 2.4, for this local network of junctions operating at or near capacity, the approach to validating queues is based on achieving a good fit to the observed range of queue lengths i.e. ‘short’ queues of up to 20 vehicles, ‘medium’ queues of around 20-40 vehicles, or ‘long’ queues at around 50 vehicles (or more).

## 5.2 VISSIM Network Queuing Validation

Output results for queue lengths on each approach arm to the three junctions under consideration are set out in Tables 5.1 to 5.3. A comparison of the range of queues are shown in each case. The tabulations show that the modelled and observed queue lengths match well to the Short, Medium and Long criteria. In particular it is noted that the long queues match well on the A467 North (Bassaleg) in the AM peak, and on the SDR East approach to Junction 28 in the PM peak.

**VISSIM Model Traffic Queue Validation Conclusion:** The VISSIM results show that the microsimulation model of the network is a valid representation of the existing queuing conditions, and thus can be developed to consider the future operation and improvement options. A sensitivity test for occurrences of blocking back between junctions is addressed in Section 5.3.

**Table 5.1: VISSIM Model Queue Validation AM Peak Hour 2014**

| Junction | Approach Arm | Average Modelled | | | | Observed AM Peak Hour Q | | | Comparison of Modelled and Observed Queues |
|---|---|---|---|---|---|---|---|---|---|
| | | 08:00 | 08:15 | 08:30 | 08:45 | Avge Q | Min Q | Max Q | |
| Bassaleg | Park View | 0 | 1 | 1 | 1 | 4 | 1 | 9 | Short / Short |
| | A467-N | 137 | 173 | 170 | 174 | 89 | 24 | 100+ | Long / Long |
| | A468 | 5 | 3 | 8 | 5 | 5 | 1 | 13 | Short / Short |
| | Court Cres. | 0 | 0 | 0 | 0 | 3 | 0 | 8 | Short / Short |
| | A467-S | 2 | 1 | 1 | 2 | 7 | 1 | 19 | Short / Short |
| J28 | A467 | 12 | 11 | 9 | 6 | 34 | 31 | 35+ | Short/Medium |
| | M4-N | 9 | 8 | 7 | 14 | 26 | 11 | 45 | Short/Medium |
| | SDR-E | 18 | 27 | 41 | 46 | 27 | 18 | 36 | Medium/Medium |
| | M4-S | 2 | 12 | 17 | 3 | 16 | 10 | 20 | Short / Short |
| Pont Ebbw | SDR-W | 1 | 1 | 1 | 2 | 6 | 2 | 14 | Short / Short |
| | B4237 | 4 | 1 | 5 | 1 | 29 | 19 | 36 | Short/Medium |
| | SDR-E | 1 | 1 | 1 | 1 | 5 | 2 | 8 | Short / Short |
| | B4239 | 2 | 1 | 2 | 1 | 6 | 2 | 10 | Short / Short |
| | ONS | 1 | 1 | 2 | 2 | 1 | 0 | 3 | Short / Short |

**Note:** Validation based on Short queues of around 5-20 vehicles, Medium queues of around 20-40 vehicles, or Long queues at around 50 (or over) vehicles

**Table 5.2: VISSIM Model Queue Validation PM Peak Hour 2014**

| Junction | Approach Arm | Average Modelled | | | | Observed AM Peak Hour Q | | | Comparison of Modelled and Observed Queues |
|---|---|---|---|---|---|---|---|---|---|
| | | 17:00 | 17:15 | 17:30 | 17:45 | Avge Q | Min Q | Max Q | |
| Bassaleg | Park View | 19 | 19 | 20 | 18 | 6 | 3 | 10 | Short / Short |
| | A467-N | 1 | 1 | 1 | 0 | 5 | 1 | 16 | Short / Short |
| | A468 | 9 | 6 | 4 | 2 | 6 | 3 | 10 | Short / Short |
| | Court Cres. | 0 | 0 | 0 | 2 | 1 | 0 | 5 | Short / Short |
| | A467-S | 2 | 2 | 1 | 10 | 9 | 0 | 32 | Short / Medium |
| J28 | A467 | 14 | 11 | 20 | 3 | 16 | 8 | 44 | Medium/Medium |
| | M4-N | 14 | 11 | 17 | 6 | 7 | 2 | 15 | Short / Short |
| | SDR-E | 69 | 94 | 122 | 122 | 50+ | 50+ | 50+ | Long / Long |
| | M4-S | 2 | 5 | 67 | 32 | 18 | 9 | 21 | Short / Short |
| Pont Ebbw | SDR-W | 1 | 1 | 1 | 1 | 6 | 0 | 15 | Short / Short |
| | B4237 | 1 | 2 | 2 | 1 | 17 | 10 | 27 | Short / Short |
| | SDR-E | 1 | 1 | 1 | 1 | 10 | 4 | 16 | Short / Short |
| | B4239 | 0 | 0 | 0 | 0 | 4 | 2 | 7 | Short / Short |
| | ONS | 4 | 3 | 3 | 2 | 6 | 2 | 11 | Short / Short |

**Table 5.3: VISSIM Model Queue Validation Inter Peak Average Hour 2014**

| Junction | Approach Arm | Average Modelled | | | | Observed AM Peak Hour Q | | | Comparison of Modelled and Observed Queues |
|---|---|---|---|---|---|---|---|---|---|
| | | 12:00 | 12:15 | 12:30 | 12:45 | Avge Q | Min Q | Max Q | |
| Bassaleg | Park View | 0 | 0 | 0 | 0 | 2 | 1 | 6 | Short / Short |
| | A467-N | 1 | 0 | 0 | 0 | 5 | 1 | 13 | Short / Short |
| | A468 | 0 | 0 | 0 | 0 | 2 | 0 | 7 | Short / Short |
| | Court Cres. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Short / Short |
| | A467-S | 0 | 0 | 0 | 0 | 1 | 0 | 5 | Short / Short |
| J28 | A467 | 26 | 26 | 27 | 42 | 6 | 4 | 10 | Medium / Short |
| | M4-N | 1 | 2 | 1 | 1 | 4 | 1 | 11 | Short / Short |
| | SDR-E | 1 | 4 | 6 | 2 | 8 | 2 | 19 | Short / Short |
| | M4-S | 2 | 2 | 2 | 2 | 7 | 5 | 10 | Short / Short |
| Pont Ebbw | SDR-W | 0 | 0 | 0 | 0 | 3 | 0 | 8 | Short / Short |
| | B4237 | 1 | 1 | 1 | 1 | 6 | 2 | 11 | Short / Short |
| | SDR-E | 1 | 1 | 1 | 1 | 4 | 2 | 8 | Short / Short |
| | B4239 | 0 | 0 | 0 | 0 | 2 | 0 | 6 | Short / Short |
| | ONS | 1 | 1 | 1 | 2 | 1 | 0 | 3 | Short / Short |

## 5.3 VISSIM Model Movie and Visualisations

A ‘movie’ of the VISSIM network for the AM and PM peak periods has been produced to illustrate the traffic conditions represented in the model [This is provided separately to this Report]. The network performance represented in the ‘movie’ corresponds with the modelled queue lengths presented in Tables 5.1 and 5.2. Figures 5.1 to 5.5 show screen shots from the VISSIM model movie for portions of the network.

**Figure 5.1: VISSIM Movie Screenshot for Bassaleg Junction PM Peak**

**Figure 5.2: VISSIM VISSIM Movie Screenshot for Junction 28**

**Figure 5.3: VISSIM VISSIM Movie Screenshot for Pont Ebbw**

**Figure 5.4: VISSIM VISSIM Movie Screenshot for A4067 between Bassaleg and J28**

**Figure 5.5: VISSIM VISSIM Movie Screenshot for A48 between J28 and Pont Ebbw**

## 5.4 Sensitivity Test for Blocking Back of Queues

For purposes of validation, a sensitivity test of the model has been undertaken in respect of the frequent occurrences of blocking back from Junction 28 to Pont Ebbw (by westbound traffic) for portions of the PM peak hour in particular. This sensitivity test is based on applying small incremental increases in the modelled traffic flows across the whole demand matrix to check whether blocking back does occur.

The purpose of this sensitivity test is to demonstrate that small changes in traffic demand in the model can have a major impact on the operation of the junctions, and as such mirroring the variability in queuing and journey times that are observed on a day to day basis.

For these sensitivity tests the traffic assignment was based on the converged 100% demand model runs. This has the effect that the modelled driver route choice is based on understanding of the network conditions on a typical day, mimicking the real-life situation that a driver would make their decisions based on experience of previous journeys in the network.

It was found that an increase of modelled flows by 3% (on 2014 surveyed flows) led to significant blocking back on the A48 Westbound (at Junction 28), creating gridlock conditions at Pont Ebbw due to vehicles unable to exit the gyratory – which (in the model) has a knock-on effect at the ONS exit lane (with vehicles unable to exit the site and hence queuing back into the car park access road). This modelled situation closely resembles the observed gridlock situation which occurs relatively frequently at Pont Ebbw junction (although it is emphasised that gridlock does not during every peak period and hence is not an ‘average’ scenario).

Figures 5.6 and 5.7 show queues (in the ‘sensitivity test’ model) blocking back from J28 through Pont Ebbw junction (showing the whole of the SDR between J28 and Pont Ebbw in Figure 5.6, and a close-up of queuing through Pont Ebbw junction in Figure 5.7).

The outcome of the sensitivity test of the VISSIM model shows that the model provides a good representation of the variability of the current situation on the local network presented in the traffic survey data collected for this study. The sensitivity test represents the present situation observed on one of the survey days, whereby the junctions are consistently saturated, and small increases in traffic can often ‘tip over’ to local grid-lock. This increase in demand is deemed as daily variation on the network. The analysis shows that the under current conditions, daily variation has a significant impact on the operation of the current network.

**Figure 5.6: VISSIM model screenshot of Pont Ebbw (3% Increase in Modelled Traffic)**

**Figure 5.7: VISSIM model screenshot of SDR (for 3% Increase in Modelled Traffic)**

# 6 LinSig & VISSIM Journey Time Validation

## 6.1 Journey Times Validation Criteria

It is important that modelled journey times match well with actual movements through the local network in order to accurately gauge the impact on travel time of the proposed junction improvements.

For the LinSig and Arcady modelling (see Section 6.2), actual and modelled journey times have been compared and judgements made as to the acceptability or not of the match between the two sets of data.

In respect of the VISSIM network model (see Section 6.3), the criteria set out in DMRB are “Modelled journey times should be within ±15% of observed times (or ± 1 minute) on 85% of routes”. This validation approach for journey times is defined in **Table 6.1**, and a refined validation approach for the VISSIM model at Bassaleg-J28-Pont Ebbw is also set out. This is based on comparing the relevant ranges of modelled and actual journey times – rather than focusing on a single numeric value for journey time.

For this local network at Tredegar Park, ‘actual’ journey time data has been extracted from waze.com which provides a reliable source of data in respect of the time taken by drivers moving through the road network as recorded automatically from anonymised mobile phone data. The waze.com records have been obtained for a number of days and set out as a defined range of minimum and maximum values.

**Table 6.1: VISSIM Journey time validation and criteria**

| DMRB Criteria | Acceptability Guideline | Validation Criteria for J28 VISSIM model |
|---|---|---|
| Modelled times along routes should be within 15% of surveyed times (or 1 minute, if higher than 15%) | > 85% of routes | The modelled journey time is termed as validated if one or more of the modelled journey times at 00 mins, 15mins, 30 mins, 45 mins past the hour are within the Max and Min range of recorded journey times, or within 1 minute of the range of journey times. |

## 6.2 LinSig Model Journey Time Validation

A check has been undertaken of total modelled and observed journey time through the A467/A48 improvement corridor – from the Bassaleg junction to Pont Ebbw (in both the northbound and southbound directions). The assessed journey time matches Routes A and B used for the VISSIM journey time validation, and shown on Figure 6.1 .Table 6.2 shows the modelled junction delay (from the relevant Arcady and LinSig analyses) for the AM and PM peak hour. As can be seen, the majority of delay occurs at Junction 28.

**Table 6.2: LinSig Modelled Delay at Junctions**

| Peak Hour & Dir.[1] | Modelled Delay at Junction, Seconds | | | |
|---|---|---|---|---|
| | Bassaleg [2] | J28 [3] | Pont Ebbw [3] | Total |
| AM, S/B | 84 | 244 | 14 | 343 |
| PM, S/B | 23 | 147 | 13 | 183 |
| AM, N/B | 3 | 506 | 161 | 671 |
| PM, N/B | 16 | 289 | 176 | 491 |

**Note:**
1. N/B = from Pont Ebbw to Bassaleg junctions, S/B = from Bassaleg to Pont Ebbw junctions
2. Arcady model delay; 3. LinSig model delay

Table 6.3 shows the calculated modelled travel time through the corridor – which is based on adding the modelled delay to the observed interpeak journey time (i.e. when delay is minimal), as follows

| Peak Hour Journey Time | = | Observed Inter-peak travel time | + | Linsig/Arcady Junction Delay in Peak Hour |
|---|---|---|---|---|

The interpeak journey time has been used as it represents uncongested journeys through the network, such that adding the modelled junction delay represents the additional delay that could be expected during peak conditions. Comparison is made in Table 6.3 with the observed travel time – taken from mobile phone-based travel time data provided on waze.com, which correlates well with observations on site; that is, the travel time during peak hours (in the 'peak direction') is around 10 minutes.

The comparison of modelled and observed travel time shows a good correlation – with modelled times generally within the range given by the measured 'maximum' and 'average' travel times during peak periods. However, the northbound AM peak journey time correlates less well than other periods, with a higher modelled delay than observed. This difference is likely to be associated with the particular operation of the SDR northbound entry arm at J28 Gyratory, where the entry movement is a 'Give-way' to gyratory traffic which is generally moving in platoons due to signal control at upstream entry arms – and hence there is likely to be a 'surge' of entry movements in between each platoon, with a consequent marginally higher-than-modelled entry capacity. It is considered that this difference between modelled and observed entry delay is not a significant factor in respect of testing and analysing future improvements – since this entry arm is in any case to be modified to signal control, for which standard modelling parameters will apply, with consequent high reliability of the modelled results.

**LinSig Model Journey Time Validation Conclusion:** It is concluded that the ‘base’ 2014 LinSig (and Arcady) models of each of the three relevant junctions validate sufficiently well to be used as a basis for developing junction models of the options for junction improvements.

**Table 6.3: LinSig Modelled & Observed Travel Time (Bassaleg to Pont Ebbw)**

| Peak Hour & Dir.[1] | Modelled Delay [2] | Interpeak Observed Journey Time [3] | Comparison | | Comment on Validation |
|---|---|---|---|---|---|
| | | | Total Modelled Journey Time | Observed Peak Journey Time [3] | |
| AM S/B | 6 | 2 | 8 | 18 (9) | Modelled journey time is within range of average and maximum peak period journey time. Good Validation |
| PM S/B | 3 | 2 | 5 | 4 (3) | Modelled journey time is within 1 minutes of average and maximum peak period journey time. Good Validation |
| AM N/B | 11 | 3 | 14 | 8 (5) | Modelled journey times are much higher than observed. This is likely to be due to the non-signal controlled operation of the n/b SDR entry to J28, which is an unusual operation with priority control within a partially signal-controlled gyratory. However, this entry junction is to be modified to signal control and hence non-validation of its current operation is not a significant risk to testing future improved junction layouts. Acceptable Validation |
| PM N/B | 8 | 3 | 11 | 14 (10) | Modelled journey time is within range of average and maximum peak period journey time. Good Validation |

**Notes:**
1. N/B = from Pont Ebbw to Bassaleg junctions, S/B = from Bassaleg to Pont Ebbw junctions
2. Modelled delays from Table 6.1;
3. Maximum (and Average) Peak Period Journey Time from waze.com

## 6.3 VISSIM Model Journey Time Validation

Journey times have been extracted from VISSIM model outputs for the AM, IP and PM peaks. The journey time routes (A to H) are shown in Figure 6.1 and represent a range of journeys across the network (in all directions).

A comparison of modelled and actual journey times (from waze.com) s provided in Tables 6.4 to 6.6 for the three modelled periods. DfT TAG Unit M3.1 sets out the modelled journey time validation criterion and acceptability guideline as below:

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

However, due to the large variability of the observed journey times in the network around Junction 28, is it more useful to consider the range of journey times and to demonstrate the modelled journey times fall within the observed range.

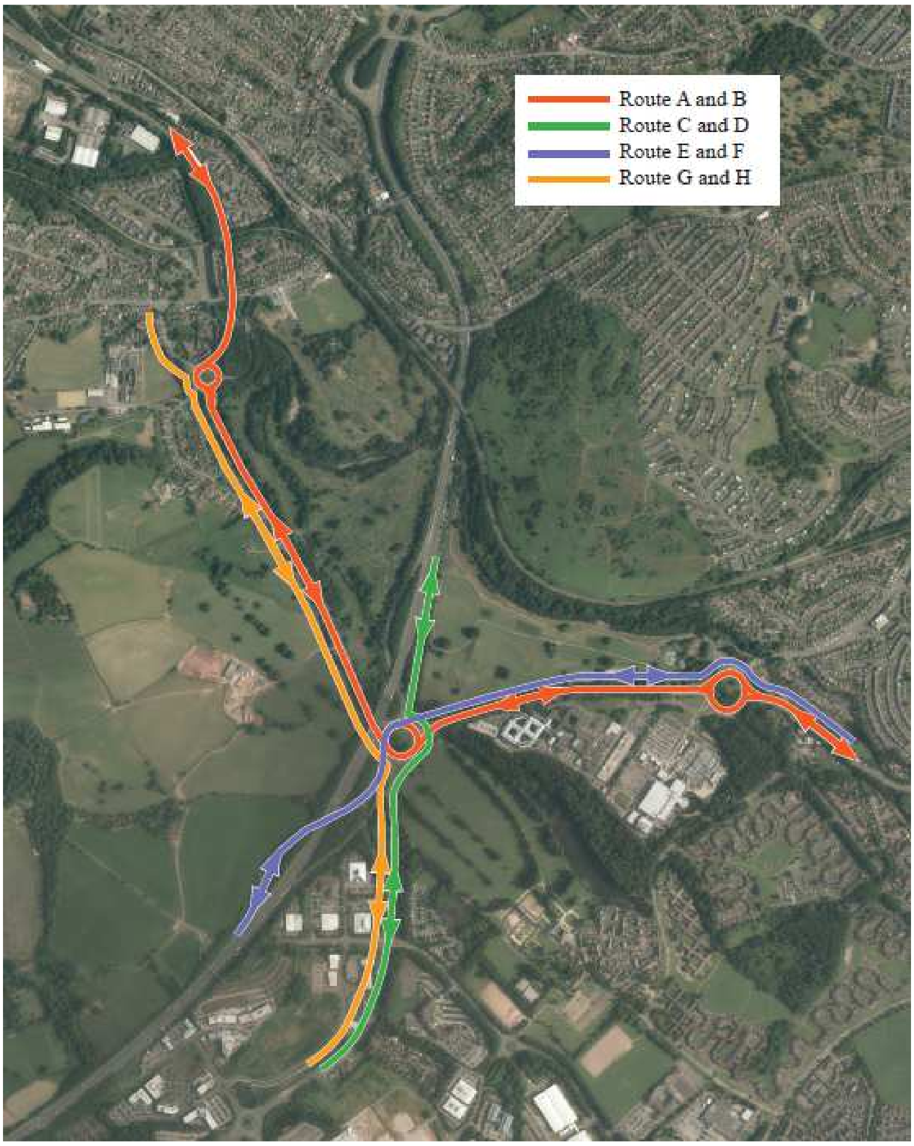


**Figure 6.1: Journey Time Routes**.

**Table 6.4: VISSIM Modelled & Observed Travel Time AM 2014**

| Route | | Journey Time in minutes | | | | | | | | Comment on Validation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Modelled | | | | | Observed (WAZE) | | | |
| | | 08:00 | 08:15 | 08:30 | 08:45 | Avg | Min. | -15% Avg +15% | Max. | |
| A | A467 to SDR Eastbound | 9 | 13 | 16 | 15 | 13 | 9 | 12 \| 14 \| 16 | 18 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |
| B | SDR to A467 westbound | 6 | 6 | 8 | 9 | 7 | 5 | 6 \| 7 \| 8 | 8 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |
| C | A48 Cardiff Road to M4 north slip road | 5 | 5 | 5 | 6 | 5 | 3 | 4 \| 4 \| 5 | 5 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |
| D | M4 north slip road to A48 Cardiff Road | 3 | 3 | 3 | 3 | 3 | 3 | 3 \| 3 \| 3 | 3 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |
| E | M4 west slip road to SDR eastbound | 4 | 4 | 4 | 4 | 4 | 4 | 4 \| 4 \| 5 | 5 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |
| F | SDR to M4 west slip road | 5 | 5 | 5 | 7 | 5 | 3 | 4 \| 5 \| 6 | 6 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |
| G | A468 to M4 Slip road southbound | 4 | 4 | 3 | 3 | 4 | 2 | 7 \| 8 \| 9 | 8 | Average modelled journey time outside acceptable range<br>Modelled journey times all within range of observed journey times.<br>Partially Validated |
| H | M4 slip road to A468 northbound | 2 | 2 | 2 | 2 | 2 | 2 | 2 \| 3 \| 3 | 3 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |

For the AM Peak, 7 out of 8 routes (88%) meet the TAG validation criterion, thus deemed acceptable as greater than 85%. Additionally, 100% of the modelled journey times are within a range of observed journey times.

**Table 6.4: VISSIM Modelled & Observed Travel Time PM 2014**

| Route | | Journey Time in minutes | | | | | | | | Comment on Validation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Modelled | | | | | Observed (WAZE) | | | |
| | | 17:00 | 17:15 | 17:30 | 17:45 | Avg | Min. | -15% Avg +15% | Max. | |
| A | A467 to SDR Eastbound | 4 | 4 | 4 | 4 | 4 | 3 | 3 \| 4 \| 4 | 4 | Average modelled journey time within acceptable range Modelled journey times all within range of observed journey times. Validated |
| B | SDR to A467 westbound | 7 | 9 | 10 | 11 | 9 | 10 | 11 \| 13 \| 14 | 14 | Average modelled journey time outside acceptable range Modelled journey times within 1 minute of observed journey times for 45 mins. of peak hour. Partially Validated |
| C | A48 Cardiff Road to M4 north slip road | 3 | 4 | 4 | 4 | 4 | 4 | 4 \| 5 \| 6 | 6 | Average modelled journey time within acceptable range Modelled journey times all within 1 minute of observed journey times. Validated |
| D | M4 north slip road to A48 Cardiff Road | 3 | 3 | 3 | 3 | 3 | 2 | 2 \| 2 \| 2 | 2 | Average modelled journey time within acceptable range Modelled journey times all within 1 minute of observed journey times. Validated |
| E | M4 west slip road to SDR eastbound | 4 | 4 | 4 | 4 | 4 | 4 | 4 \| 5 \| 5 | 5 | Average modelled journey time within acceptable range Modelled journey times all within range of observed journey times. Validated |
| F | SDR to M4 west slip road | 8 | 9 | 11 | 12 | 10 | 9 | 9 \| 10 \| 12 | 11 | Average modelled journey time within acceptable range Modelled journey times within 1 minute of observed journey times for 45 mins. of peak hour. Validated |
| G | A468 to M4 Slip road southbound | 4 | 3 | 4 | 3 | 3 | 2 | 2 \| 2 \| 2 | 3 | Average modelled journey time within acceptable range Modelled journey times all within 1 minute of observed journey times. Validated |
| H | M4 slip road to A468 northbound | 3 | 3 | 4 | 4 | 3 | 4 | 3 \| 4 \| 5 | 4 | Average modelled journey time within acceptable range Modelled journey times within 1 minute of observed journey times for 45 mins. of peak hour. Validated |

For the PM Peak, 7 out of 8 routes (88%) meet the TAG validation criterion, thus deemed acceptable as greater than 85%. Additionally, 91% of the modelled journey times are within a 1 minute of the range of observed journey times.

## Table 6.5: VISSIM Modelled & Observed Travel Time Interpeak 2014

| Route | | Journey Time in minutes | | | | | | | | Comment on Validation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Modelled | | | | | Observed (WAZE) | | | |
| | | 12:00 | 12:15 | 12:30 | 12:45 | Avg | Min. | -15% \| Avg \| +15% | Max. | |
| A | A467 to SDR Eastbound | 4 | 4 | 6 | 6 | 5 | 3 | 3 \| 4 \| 4 | 4 | Average modelled journey time within acceptable range<br>Modelled journey times within 1 minute of observed journey times for 45 mins. of peak hour.<br>Validated |
| B | SDR to A467 westbound | 4 | 4 | 5 | 4 | 4 | 3 | 3 \| 4 \| 4 | 4 | Average modelled journey time within acceptable range<br>Modelled journey times all within 1 minute of observed journey times.<br>Validated |
| C | A48 Cardiff Road to M4 north slip road | 3 | 2 | 3 | 2 | 2 | 2 | 2 \| 3 \| 3 | 4 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |
| D | M4 north slip road to A48 Cardiff Road | 2 | 2 | 2 | 2 | 2 | 2 | 2 \| 2 \| 2 | 2 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |
| E | M4 west slip road to SDR eastbound | 4 | 4 | 4 | 4 | 4 | 3 | 3 \| 3 \| 3 | 3 | Average modelled journey time within acceptable range<br>Modelled journey times all within 1 minute of observed journey times.<br>Validated |
| F | SDR to M4 west slip road | 3 | 3 | 3 | 3 | 3 | 2 | 2 \| 2 \| 2 | 2 | Average modelled journey time within acceptable range<br>Modelled journey times all within 1 minute of observed journey times.<br>Validated |
| G | A468 to M4 Slip road southbound | 3 | 4 | 6 | 6 | 5 | 2 | 2 \| 2 \| 2 | 2 | Average modelled journey time outside acceptable range<br>Modelled journey times within 1 minute of observed journey times for 15 mins. of peak hour.<br>Partially Validated |
| H | M4 slip road to A468 northbound | 2 | 2 | 2 | 2 | 2 | 2 | 2 \| 2 \| 2 | 2 | Average modelled journey time within acceptable range<br>Modelled journey times all within range of observed journey times.<br>Validated |

For the Intereak, 7 out of 8 routes (88%) meet the TAG validation criterion, thus deemed acceptable as greater than 85%. Additionally, 88% of the modelled journey times are within a 1 minute of the range of observed journey times.

**Journey Time validation conclusion for VISSIM network model:** The tabulated results of journey times show that almost all of the modelled times are fully within the range of actual times, with a limited number of journeys validating for only part of the peak hour.

For each of the modelled time periods, 88% of the journey time routes considered meet the TAG validation criterion, thus deemed acceptable as greater than 85%. Additionally, at least 88% of the modelled journey times are within a 1 minute of the range of observed journey times.

This indicates clearly that the VISSIM model is validated for use in modelling junction improvement scenarios.

# 7 VISSIM Model Traffic Flow Validation

## 7.1 Flows Validation Criteria

DMRB sets out the criteria for the validating modelled flows against observed flows, as follows:

- The GEH 'Goodness of Fit' statistic is used to avoid undue weight being given to large percentage differences between small numbers.
- For hourly traffic flows at individual sites the validation is based on percentage differences

The validation criteria and acceptability guidelines for link flows are defined in Table 7.1.

**Table 7.1: Link flow validation criteria and acceptability guidelines**

| Criteria | Description of Criteria | Acceptability 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 | > 85% of cases |
| | Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h | > 85% of cases |
| 2 | GEH < 5 for individual flows | > 85% of cases |

## 7.2 Production of Modelled Flows

For insertion of flows into VISSIM, the 2014 turning count data at each of the three junctions (plus the junction at A48 / Pencarn Way at Celtic Springs) has initially been furnessed to produce a network-wide turning matrix. The network matrix is 15 Origins x 15 Destinations - which represents all the approach roads which enter and exit the network at its extremities.

Following creation of a furnessed matrix, the matrix data has been assigned in the VISSIM model using the Dynamic Assignment function, and the model run to convergence. At this 'assignment' stage the model takes account of capacity 'bottle-necks' within the network, such that the modelled hourly flow on each link in the network represents a real-time flow (which is then compared to actual measured flow for purposes of validation).

As the surveyed turning counts have been used in the creation of the demand matrices, it would not be appropriate to then use these flows for validation. As such, the validation has been carried out against observed link flows, as per the guidance set out in DfT TAG Unit M3.1.

Section 7.3 provides comparison of surveyed flows and modelled flows (after furnessing and assignment).

## 7.3 Flows Validation

Modelled and surveyed flows for the AM and PM peak hour, and an average Interpeak hour, are set out in Tables 7.2 to 7.4. Each table shows the GEH value for each link, and the percentage difference between observed and modelled flow. As set out in Section 7.2, validation has been carried out against observed link flows as the turning counts have been used in the creation of the demand matrices.

**Table 7.2: Traffic Flows – Observed and VISSIM Modelled – AM Peak Hour 2014**

| Junction | Location | Observed Flow | Model Flow | Flow Diff. % | GEH |
|---|---|---|---|---|---|
| Mainline | M4 north mainline n/b | 4648 | 4467 | -4% | 2.7 |
| Mainline | M4 north mainline s/b | 5483 | 5394 | -2% | 1.2 |
| Mainline | M4 west mainline n/b | 5018 | 4824 | -4% | 2.8 |
| Mainline | M4 west mainline s/b | 4545 | 4318 | -5% | 3.4 |
| J28 | entry from A467 north | 882 | 719 | -18% | 5.8 |
| J28 | entry from SDR east | 708 | 803 | 13% | 3.5 |
| J28 | entry from M4 North | 1282 | 1311 | 2% | 0.8 |
| J28 | exit to M4 North | 478 | 401 | -16% | 3.7 |
| J28 | entry from M4 South | 1611 | 1341 | -17% | 7.0 |
| J28 | exit to M4 South | 2278 | 2013 | -12% | 5.7 |
| Bassaleg | entry from A468 | 941 | 940 | 0% | 0.0 |
| Bassaleg | entry to A468 | 888 | 807 | -9% | 2.8 |
| Bassaleg | exit to A467 north | 988 | 950 | -4% | 1.2 |
| Bassaleg | entry from A467 north | 1133 | 895 | -21% | 7.5 |
| Bassaleg | exit to Park View | 642 | 613 | -5% | 1.2 |
| Bassaleg | entry from Park View | 316 | 309 | -2% | 0.4 |
| Bassaleg | entry from Court Cres | 98 | 90 | -8% | 0.8 |
| Bassaleg | exit to Court Crescent | 95 | 76 | -20% | 2.1 |
| Bassaleg | entry from A467 south | 1108 | 1203 | 9% | 2.8 |
| Pont Ebbw | entry from SDR west | 1612 | 1546 | -4% | 1.7 |
| Pont Ebbw | entry from ONS | 175 | 154 | -12% | 1.6 |
| Pont Ebbw | exit to ONS | 924 | 884 | -4% | 1.3 |
| Pont Ebbw | entry from B4239 | 560 | 543 | -3% | 0.7 |
| Pont Ebbw | exit to B4239 | 390 | 372 | -5% | 0.9 |
| Pont Ebbw | entry from A48 East | 1012 | 1014 | 0% | 0.1 |
| Pont Ebbw | exit to A48 east | 1104 | 1022 | -7% | 2.5 |
| Pont Ebbw | entry from B4237 | 627 | 598 | -5% | 1.2 |
| Pont Ebbw | exit to B4237 | 779 | 735 | -6% | 1.6 |
| Cleppa Park | entry from Cleppa Park | 93 | 110 | 18% | 1.7 |
| Cleppa Park | exit to Cleppa Park | 227 | 215 | -5% | 0.8 |
| Cleppa Park | entry from A48 south | 843 | 843 | 0% | 0.0 |
| Cleppa Park | exit to A48 south | 1049 | 1007 | -4% | 1.3 |
| Cleppa Park | entry from Pencarn W | 553 | 550 | -1% | 0.1 |
| Cleppa Park | exit to Pencarn Way | 854 | 796 | -7% | 2.0 |
| Cleppa Park | entry from A48 south | 1567 | 1494 | -5% | 1.9 |
| Cleppa Park | exit to A48 south | 937 | 952 | 2% | 0.5 |

## Table 7.3: Traffic Flows – Observed and VISSIM Modelled – PM Peak Hour 2014

| Junction | Location | Observed Flow | Model Flow | Flow Diff. % | GEH |
|---|---|---|---|---|---|
| Mainline | M4 north mainline n/b | 4071 | 4472 | 10% | 6.1 |
| Mainline | M4 north mainline s/b | 4282 | 4529 | 6% | 3.7 |
| Mainline | M4 west mainline n/b | 4345 | 4568 | 5% | 3.3 |
| Mainline | M4 west mainline s/b | 4617 | 4615 | 0% | 0.0 |
| J28 | entry from A467 north | 1241 | 1015 | -18% | 6.7 |
| J28 | entry from SDR east | 1004 | 1013 | 1% | 0.3 |
| J28 | entry from M4 North | 761 | 799 | 5% | 1.4 |
| J28 | exit to M4 North | 740 | 877 | 19% | 4.8 |
| J28 | entry from M4 South | 1531 | 1465 | -4% | 1.7 |
| J28 | exit to M4 South | 1854 | 1754 | -5% | 2.4 |
| Bassaleg | entry from A468 | 752 | 738 | -2% | 0.5 |
| Bassaleg | entry to A468 | 1115 | 1094 | -2% | 0.6 |
| Bassaleg | exit to A467 north | 1650 | 1664 | 1% | 0.3 |
| Bassaleg | entry from A467 north | 1118 | 1101 | -2% | 0.5 |
| Bassaleg | exit to Park View | 280 | 281 | 0% | 0.1 |
| Bassaleg | entry from Park View | 596 | 552 | -7% | 1.8 |
| Bassaleg | entry from Court Cres | 30 | 30 | 0% | 0.0 |
| Bassaleg | exit to Court Crescent | 26 | 28 | 8% | 0.4 |
| Bassaleg | entry from A467 south | 1817 | 1841 | 1% | 0.6 |
| Pont Ebbw | entry from SDR west | 1024 | 1077 | 5% | 1.6 |
| Pont Ebbw | entry from ONS | 717 | 700 | -2% | 0.6 |
| Pont Ebbw | exit to ONS | 159 | 145 | -9% | 1.1 |
| Pont Ebbw | entry from B4239 | 296 | 288 | -3% | 0.5 |
| Pont Ebbw | exit to B4239 | 445 | 437 | -2% | 0.4 |
| Pont Ebbw | entry from A48 East | 841 | 822 | -2% | 0.7 |
| Pont Ebbw | exit to A48 east | 1082 | 1096 | 1% | 0.4 |
| Pont Ebbw | entry from B4237 | 676 | 663 | -2% | 0.5 |
| Pont Ebbw | exit to B4237 | 814 | 800 | -2% | 0.5 |
| Cleppa Park | entry from Cleppa Park | 254 | 270 | 6% | 1.0 |
| Cleppa Park | exit to Cleppa Park | 96 | 95 | -1% | 0.1 |
| Cleppa Park | entry from A48 south | 966 | 934 | -3% | 1.0 |
| Cleppa Park | exit to A48 south | 638 | 662 | 4% | 0.9 |
| Cleppa Park | entry from Pencarn W | 718 | 698 | -3% | 0.8 |
| Cleppa Park | exit to Pencarn Way | 507 | 503 | -1% | 0.2 |
| Cleppa Park | entry from A48 south | 817 | 837 | 2% | 0.7 |
| Cleppa Park | exit to A48 south | 1502 | 1473 | -2% | 0.8 |

**Table 7.4: Traffic Flows – Observed and VISSIM Modelled – Inter Peak Hour 2014**

| Junction | Location | Observed Flow | Model Flow | Flow Diff. % | GEH |
|---|---|---|---|---|---|
| Mainline | M4 north mainline n/b | 2870 | 3068 | 7% | 3.6 |
| Mainline | M4 north mainline s/b | 2847 | 2656 | -7% | 3.6 |
| Mainline | M4 west mainline n/b | 3068 | 3300 | 8% | 4.1 |
| Mainline | M4 west mainline s/b | 3052 | 2803 | -8% | 4.6 |
| J28 | entry from A467 north | 757 | 788 | 4% | 1.1 |
| J28 | entry from SDR east | 934 | 1036 | 11% | 3.2 |
| J28 | entry from M4 North | 403 | 399 | -1% | 0.2 |
| J28 | exit to M4 North | 327 | 457 | 40% | 6.6 |
| J28 | entry from M4 South | 820 | 990 | 21% | 5.7 |
| J28 | exit to M4 South | 1214 | 1309 | 8% | 2.7 |
| Bassaleg | entry from A468 | 574 | 557 | -3% | 0.7 |
| Bassaleg | entry to A468 | 569 | 588 | 3% | 0.8 |
| Bassaleg | exit to A467 north | 742 | 758 | 2% | 0.6 |
| Bassaleg | entry from A467 north | 860 | 834 | -3% | 0.9 |
| Bassaleg | exit to Park View | 243 | 236 | -3% | 0.5 |
| Bassaleg | entry from Park View | 266 | 263 | -1% | 0.2 |
| Bassaleg | entry from Court Cres | 20 | 22 | 10% | 0.4 |
| Bassaleg | exit to Court Crescent | 29 | 22 | -24% | 1.4 |
| Bassaleg | entry from A467 south | 912 | 931 | 2% | 0.6 |
| Pont Ebbw | entry from SDR west | 1009 | 1075 | 7% | 2.0 |
| Pont Ebbw | entry from ONS | 141 | 132 | -6% | 0.8 |
| Pont Ebbw | exit to ONS | 129 | 125 | -3% | 0.4 |
| Pont Ebbw | entry from B4239 | 304 | 297 | -2% | 0.4 |
| Pont Ebbw | exit to B4239 | 228 | 224 | -2% | 0.3 |
| Pont Ebbw | entry from A48 East | 807 | 773 | -4% | 1.2 |
| Pont Ebbw | exit to A48 east | 889 | 893 | 0% | 0.1 |
| Pont Ebbw | entry from B4237 | 623 | 609 | -2% | 0.6 |
| Pont Ebbw | exit to B4237 | 603 | 591 | -2% | 0.5 |
| Cleppa Park | entry from Cleppa Park | 111 | 122 | 10% | 1.0 |
| Cleppa Park | exit to Cleppa Park | 138 | 138 | 0% | 0.0 |
| Cleppa Park | entry from A48 south | 478 | 462 | -3% | 0.7 |
| Cleppa Park | exit to A48 south | 412 | 433 | 5% | 1.0 |
| Cleppa Park | entry from Pencarn W | 335 | 328 | -2% | 0.4 |
| Cleppa Park | exit to Pencarn Way | 361 | 354 | -2% | 0.4 |
| Cleppa Park | entry from A48 south | 605 | 614 | 1% | 0.4 |
| Cleppa Park | exit to A48 south | 618 | 590 | -5% | 1.1 |

**Conclusion for Validation of Link Flows for VISSIM model:** The validation results for each time period are as follows:

- For the AM peak, the proportion of links with a GEH of more than 5 is 11% (4 of 36), and 8% of links (3 of 36) are marginally outside the validation criteria.
- For the PM peak, the proportion of links with a GEH of more than 5 is 6% (2 of 36), and 6% of links (2 of 36) are marginally outside the validation criteria.
- For the Interpeak, the proportion of links with a GEH of more than 5 is 6% (2 of 36), and 6% of links (2 of 36) are marginally outside the validation criteria.

Overall therefore, the modelled flows are correlated well to the observed flows, and comply with DMRB validation criteria, which gives confidence that the model is appropriate for testing junction improvements.

# 8 Validation Summary

## 8.1 Validation Conclusions

This Technical Note has described the development and validation of

- LinSig / ARCADY junction models for the existing configurations of junctions at M4 Junction 28, Pont Ebbw and Bassaleg, and a
- Comprehensive VISSIM microsimulation model of the existing local road network.

**LinSig and ARCADY junction models**: The validation process has shown that the LinSig and ARCADY junction models provide a good representation of the existing traffic conditions in respect of queues and travel time through the junctions' corridor, and hence provide a sound basis for design development and junction capacity assessment for improvement options.

**VISSIM model:** The VISSIM model is fully validated in respect of travel time through the network, link flows, and queue lengths – when comparing the modelled and observed conditions.

In particular the VISSIM model has been shown to be able to represent the existing peak hour congested traffic conditions, which leads to the occurrence of occasional blocking back between adjacent junctions. The ability of the 2014 VISSIM model to re-create blocking back and the accompanying 'grid-lock' which occasionally occurs (at Pont Ebbw in particular) is an important aspect of the model, which will ensure that the 'future' VISSIM model (with junction improvements) provides a robust basis for testing and fine-tuning the preferred junction improvement proposals.