Portishead Branch Line (MetroWest Phase 1) Environmental Impact Assessment

Transport Assessment Appendix P: Ashton Vale Road/Winterstoke Road VISSIM Model Development and Assessment

Prepared for

West of England Councils

September 2017

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Document History

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This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
01	September 2017	FINAL	SC	LT	HS

MetroWest Phase 1: Winterstoke Road/Ashton Vale Road VISSIM Model Development and Assessment

Prepared for

North Somerset Council

September 2017

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Document history

Reference: 674946.BC.28.01

Client: North Somerset Council

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
1	04.07.2017	Draft report	S C	L T	H S
2	10.07.2017	Client comments included	S C	L T	H S
3	01.08.2017	Sensitivity Test added	S C	L T	H S
4	07.08.2017	Client comments included	S C	L T	H S
5	04.09.2017	Client comments included	S C	L T	H S

Contents

Executive Summary

This report has been prepared by CH2M on behalf of North Somerset (NSC) to assess the impact of the MetroWest Phase 1 scheme on the performance of the Winterstoke Road/Ashton Vale Road junction and adjacent level crossing, and to understand the benefit of measures aimed at mitigating the impacts of the scheme. The report details the development of a 2017 Winterstoke Road/Ashton Vale Road junction and Ashton Vale level crossing VISSIM base model. The models have been calibrated and validated to turning movement and travel times, respectively, with the results meeting acceptability criteria results in accordance with the standards set out in WebTAG and DMRB.

A range of rail service scenarios, from hourly to 45-minute interval services (sensitivity test), have been considered which vary in terms of the number of passenger and freight rail movements as well as the time between successive level crossing closures. These scenarios include allowance of an increased level of freight train operations (above the existing average volume) based on existing commercial rights held by Bristol Port. This approach has provided a robust basis for the assessment of the impacts of the MetroWest Phase 1 proposals on the level crossing and its users.

Modelling of these scenarios during the weekday AM and PM peak periods in VISSIM shows that queuing and delay are expected to increase significantly on affected arms, namely Winterstoke Road northbound and Ashton Vale Road. To address these potential impacts, following mitigation has been identified:

- An extension of the length of the left turn flare lane on Winterstoke Road northbound,
- An upgrade of the mode of control of the signals to 'MOVA', and
- Installation of a ramp to the north of the level crossing to connect pedestrians and cyclists to Ashton Road and the existing network of at grade and subway footpaths and cycle paths.

The modelling assessment demonstrates that, with all of these mitigation measures implemented, there will be no overall detriment to the highway level of service within the local network, for both the hourly and 45-minute rail service. The results show that with a level crossing barrier down times of up to approximately four minutes, and assuming the Worst-Case number and timing of rail movements, traffic on Winterstoke Road queuing to turn left into Ashton Vale Road can do so without blocking the main northbound ahead traffic flow during the AM period when the left turn flow into Ashton Vale Road is dominant.

With respect of traffic queuing to exit Ashton Vale Road, the model shows that with the same level crossing barrier down times and the Worst-Case rail number and timing of rail movements, (for both the hourly and 45-minute rail service), traffic queues show only a modest increase compared to baseline levels, but return to these levels within two to three minutes during the critical PM peak period when large volumes are exiting the industrial estate.

The level crossing barriers will be down over the highway for up to approximately 12 ½ minutes per hour in total, consequently the barriers will be up for approximately 47 ½ minutes or more per hour. For the 45-minute interval rail service the crossing barrier will be down for up to approximately 16 ½ minutes. For both the hourly and 45-minute rail scenarios (sensitivity test), the modelling showed that the proposed mitigation will provide an extended green signal phase for traffic entering and exiting Ashton Vale Road when the level crossing barriers are up. This is without detriment to other approach arms to the junction.

The overall position is the increased green signal phase for 47½ minutes or more per hour is greater than the time the traffic signals are red, when the barriers are down. This together with the relatively short periods for traffic conditions to return to normal conditions (after the level crossing barriers are lifted) shows that the proposed mitigation more than off-sets the impact of the increased cycles of the level crossing barriers.

The modelling assessment demonstrates that it will not be necessary to provide alternative highway access for Stage B of the scheme and that there is no technical case for its delivery for Stage B.

However, in the medium term after the delivery of Stage B, should funding for Stage C be identified, and subject to further technical work and separate processes and consents (business case, planning consent, voluntary/compulsory acquisition of land etc.) it is likely that alternative highway access will need to be considered.

SECTION 1

Introduction & Modelling Overview

1.1 Study Background

MetroWest is an ambitious programme to improve local rail services across the West of England, including both infrastructure and service enhancement. The programme is being jointly promoted and developed by the four West of England councils (Bath & North East Somerset, Bristol City, North Somerset and South Gloucestershire Councils). MetroWest is being delivered in two main phases:

- Phase 1 includes the re-opening of the line to Portishead, providing new stations at Portishead and Pill, along with additional services on existing lines; the Severn Beach Line and for local stations between Bristol and Bath.
- Phase 2 includes re-opening of the Henbury line, with new stations at Henbury and North Filton and a new station at Ashley Down on the Filton Bank, coupled with an additional service between Yate and Bristol.

Potential subsequent phases may be developed to add more new stations to the network. Currently, the Outline Business Case (OBC), is being developed for MetroWest Phase 1, and preparations made to submit an application for a Development Consent Order (DCO) for capital elements. A staged approach is being considered that would initially implement a reduced service level to Portishead, as follows:

- Stage A – includes an hourly Avonmouth to Bristol Temple Meads service plus an hourly Severn Beach to Bath Spa service (providing a 2 train per hour services on the Severn Beach Line and at Bath Spa line local stations). There are no Portishead line services in this stage.
- Stage B – introduces Portishead line service with new stations at Pill and Portishead (no further changes to Severn Beach Line and Bath Spa line local services). One train per hour shuttle service calling at Bristol Temple Meads, Bedminster, Parson Street, Pill and Portishead.
- Stage C – increase Portishead line services to 2 trains per hour at a later date, both provided as shuttle services from Bristol Temple Meads (again no further changes to Severn Beach Line and Bath Spa line local services).

1.2 Purpose of Report

This report outlines the methodology used to create a base VISSIM microsimulation model of the Winterstoke Road/Ashton Vale Road signal controlled junction and adjacent Ashton Vale level crossing. It presents the results of an assessment of the impact of increased level crossing closures times on the signals associated with the MetroWest scheme and tests a range of measures aimed at mitigating the impact of longer and more frequent closures.

This transport modelling work is part of wider transport assessment which will be reported as a Transport Assessment as part of the Development Consent Order for the MetroWest Phase 1 scheme.

The purpose of this report is to explain the methodology and assumptions used in the development of a weekday morning (AM) and evening (PM) peak base-year VISSIM models and to present the results of the calibration and validation exercise. Critically, the report presents the results of the assessment of the impact of a range of MetroWest Phase 1 rail scenarios on operational conditions within the local highway network and tests a series of measures aimed at mitigating these impacts.

1.3 Structure of Report

The remainder of the report is structure into the following sections:

- Section 2 – Traffic Input Data. This section outlines the survey data collected;
- Section 3 - Model Development. This section describes the various parameters and assumptions used in the development of the model network;
- Section 4 – Base Model Calibration and Validation. This section explains the base model calibration process and includes results of turning count checks. It also sets out the validation criteria employed and include journey time comparison with observed data;
- Section 5 – Option Assessment. This section assesses the impact of longer and more frequent level crossing closures and tests a range of mitigation measures and presents the results from the assessment; and
- Section 6 – Summary and Conclusions. This section included a summary of the base model development undertaken are suitable for their intended purposes.

Traffic Input Data

2.1 General

To provide data for the development of the VISSIM model, traffic count information was collected at the junction at various locations as detailed in **Figure 2.1**. The data collected included classified turning counts, journey time information and pedestrian counts. These were all collected on 9th May 2017. The classified turning counts were collected on all the approaches of the junction between 07:00 and 19:00.

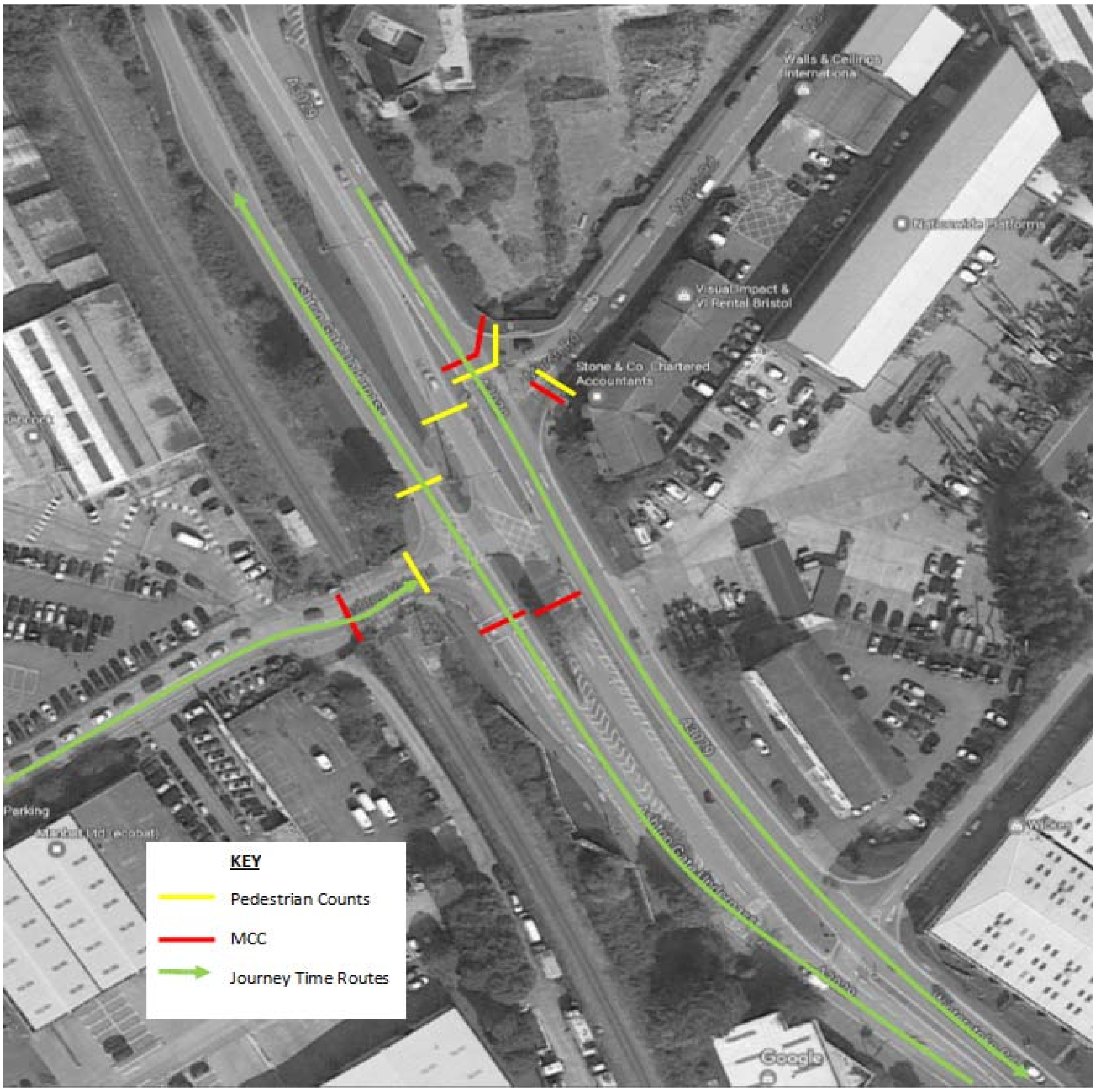


Figure 2.1 Data Collection Locations

Due to traffic management at the junction associated with the Ashton Vale to Temple Meads MetroBus scheme bridge construction, the left turn filter lane for Ashton Vale Road on the Winterstoke Road northbound carriageway was closed. Consequently, traffic entering Ashton Vale Road shared the 'ahead' lane for Ashton Vale Underpass. This will have impacted on queue lengths and journey times for vehicles on this arm. However, enumerators carrying the survey were of the view that any effect of this was likely marginal and that conditions were not significantly different from the norm.

Additionally, due to the traffic management mentioned above, the footway on the northbound carriageway south of Ashton Vale Road was closed. Therefore, pedestrians wishing to go southbound along this route would have needed to cross A3029 and then proceed south along the southbound carriageway and then cross back over further down the road. This will have impacted on pedestrian movements at the site and hence demand for various crossing movements. Again, this is unlikely to have any significant impact on the model.

2.2 Traffic Survey Data

2.2.1 Classified Turning Count Data

Turning Count Data at the modelled signalised junction was collected on the day of the surveys as mentioned above. This data was collected in 15 minute periods between 07:00 and 19:00 and classified into the following vehicle types: Cars, LGV, HGV, Bus, Pedestrians, Pedal cycle and Motor cycle. This information was required in order to develop the traffic demand for the model and was used in the calibration of the VISSIM model.

Using the information collected, the peak periods of network operation were determined as 07:00-10:00 for the weekday morning (‘AM’) peak and 16:00 to 19:00 for the weekday evening (‘PM’) peak.

Figure 2.2 presents the observed traffic profile in the area by summing flows on all junction arms in the model. The profile demonstrates that the AM peak period (red) and PM peak period (green) selected are suitable since they represent the periods of maximum flow conditions.

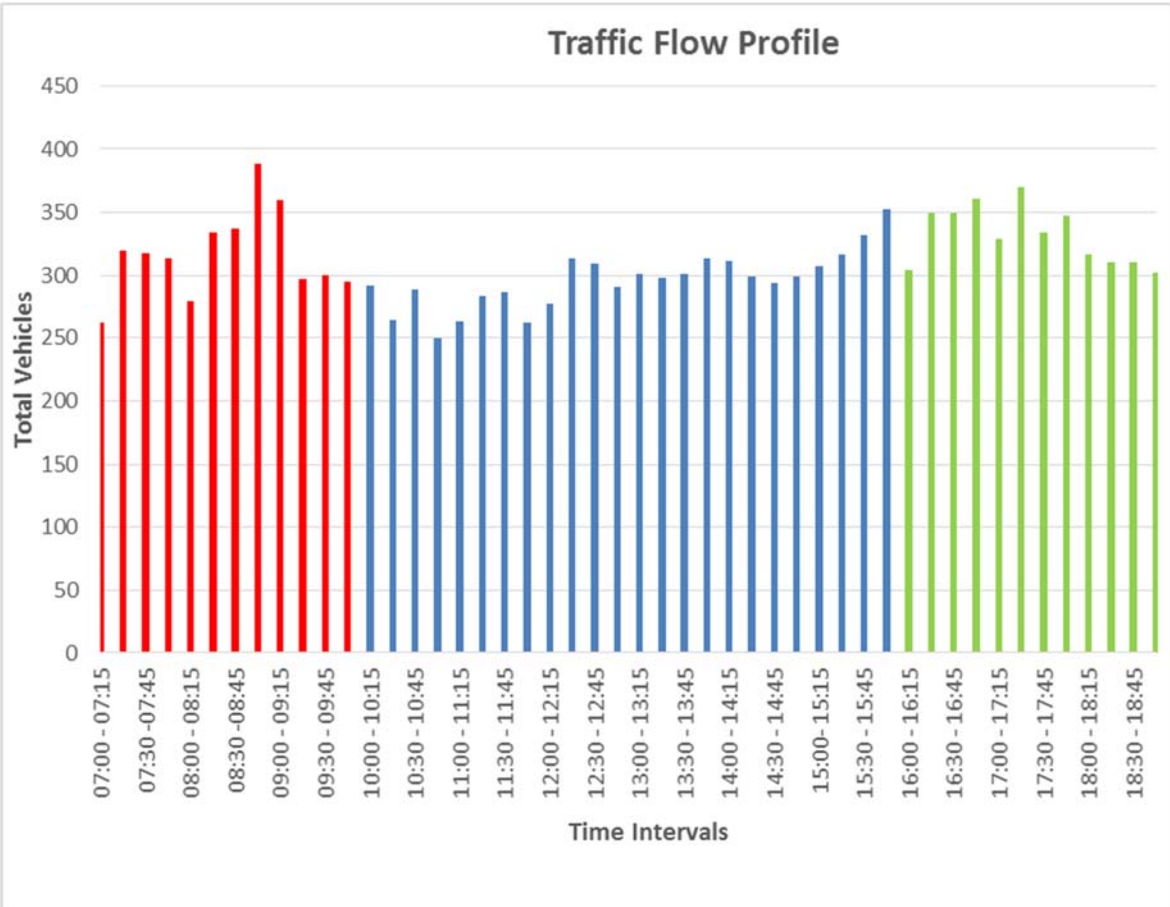


Figure 2.2 Junction Traffic Profile

2.2.2 Journey Time Data

In order to obtain journey time data, moving car surveys were carried out along a number of routes. This was carried out within the AM and PM peak periods. In all 3 routes were used for the AM and PM peak. The routes used are shown in **Table 2.1**.

Table 2.1: Journey Time Routes

Routes	Directions	Description
1	Northbound	From A3029 Sainsbury's Rbt to Ashton Gate Underpass, passing Paxton Drive
2	Southbound	From A370 Brunel Way to A3029 Stadium
3	Eastbound	From Ashton Vale Road to A3029 Junction stop line

2.2.3 Pedestrian, Bicycle and Public Transport Data

Pedestrian counts were undertaken at the junction. The crossings are currently signalled controlled and the corresponding count data has been surveyed to provide pedestrian flows for the crossing.

Bus movements have been taken from the Manual Classified Counts and input as heavy vehicles. There are no bus stops included within the model extents. Bicycle movements were included in the pedestrian crossing counts.

Base Model Development

3.1 Network Development

The first step of the study was to develop base year models which replicate current traffic conditions at the junction. These models can then be used to assess operational conditions following the introduction of MetroWest Phase 1 and longer and more frequent level crossing closures.

The Winterstoke Road/Ashton Vale Road and adjacent level crossing has been modelled using VISSIM micro-simulation software (Version 8). VISSIM is an ideal tool for assessing such situations as it is capable of modelling complex interactions with highway networks including blocking and lane starvations. It can also model in real time the impact of the level crossing.

3.1.1 Modelled Network Extent

The study area of the VISSIM model is shown in **Figure 3.1**. The Winterstoke Road/Ashton Vale Road junction includes Marsh Road, Aston Vale Road, Ashton Vale underpass and the A3029.

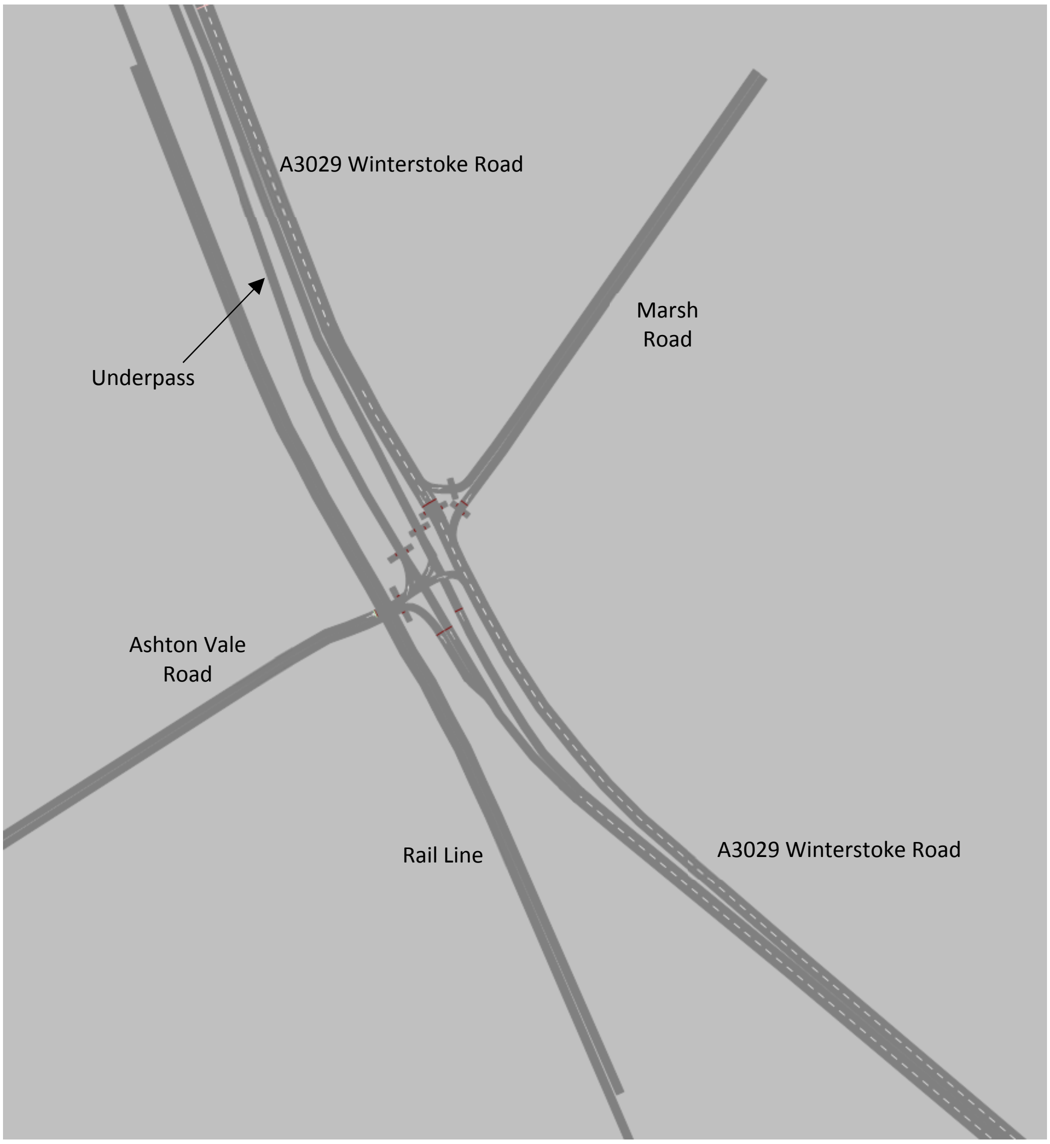


Figure 3.1 Model Network Extent

3.1.2 Model Parameters

The 'urban' link type has been applied to all links within the models. The link type includes modifications to the default driver behaviour parameters as detailed in **Table 3.1**.

Table 3.1: Model Urban Link Type Behaviour Parameter Changes

Parameter	Value	Comments
Average Standstill Distance	1.5m	The average standstill distance defines the average desired distance between stopped vehicles. It has a variation between -1.0 m and +1.0 m which is normally distributed. The value of 1.5m represents a reduction from the default 2.0m in line with micro-simulation best-practice guidelines published by Highways England.
Number of Observed Vehicles	10	The number of observed vehicles determines how well drivers predict the movement of others and react accordingly. The value of 10 represents an increase from the default value of 4 to allow for more accurate modelling of network operation.
Reaction to Red/Amber at Signals	Stop	To account for the fact that VISSIM treats the red-amber periods at signal as green time, an adjustment to the default has been made. Doing so ensures that vehicle behaviour will more accurately reflect actual reaction times of drivers as they receive red-amber followed by green.
Waiting time before diffusion	90s	The removal of vehicles from the network (a phenomenon called 'diffusion' in VISSIM) occurs when a vehicle is unable to change lanes within a specified time due to a lack of adequate gaps. Due to traffic signal cycle times, often being in excess of 60 seconds, the default time of 60 seconds has been increased.

3.1.3 Geometry

The network was created using aerial photography which was scaled to the necessary level. Aerial photography acted as a base mapping, which allowed junction geometry to be checked to ensure that the network incorporated in the model was representative. Lane widths and flare lengths have been checked using the base mapping, together with site visit photos and Google Streetview.

3.1.4 Vehicular Parameters

Within the network geometry having no effect on vehicular speed in VISSIM, it is necessary to code a range of desired speed decisions and reduced speed areas throughout the model.

Speed limits have been obtained from site visits and google maps and entered in to the model, with vehicles having a desired speed determined from a distribution around the speed limit.

At points where vehicles slow down due to network geometry (for example approaching signals and stop lines), reduced speed area have been coded to reflect these reductions in speed. These are adjusted in the calibration process to ensure they accurately reflect diver behaviour.

These reduced speed areas were positioned within the model on approached to the junction and on turning movements to better replicate the slowing down of vehicles as they approach and pass through the junction. A number total of reduced speed areas have been used on the junction.

3.1.5 Modelled Time Periods

Weekday AM (07:00-10:00) and PM (16:00-19:00) peak period models were built for the Winterstoke Road/Ashton Vale Road junction and nearby level crossing. The matrices were built in 15-minute time-slices, for light vehicles (cars and Light Good vehicle (LGV's), and heavy vehicles (Heavy Goods vehicle (HGV's) and Buses). The peak hours and 15-minute time profiles were calculated from an aggregation of the turning count data to give a representative view of the whole study period.

3.1.6 Traffic Signals

A signal controller has been included within the model in order to replicate the existing signalised junction. To model the operation of the signals, signal specification was obtained from Bristol City Council for the junction, including signal controller specification which provides signal controller parameters such as minimum and maximum green times, inter-stage timings and phase-stage allocations. The signals within the model have been coded as vehicle actuated (VA) using VISVAP in order to accurately simulate the Vehicle Actuated (VA) model of control in operation at the site.

3.2 Matrix Development

This section describes the development of the demand matrices used in the Winterstoke Road/Ashton Vale Road signals VISSIM micro-simulation model.

3.2.1 Demand Flow Construction Methodology

The flows used in the model have been derived through the collection, analysis and subsequent assembly of classified count data surveyed at the junction. The sum of the entry flows (from the turning counts) for each VISSIM entry point were apportioned by these turning percentage to derive the flows for use in the model. The approach ensures that any differences in traffic arrival profile and turning proportions over the modelled period are fully reflected in the model.

3.2.2 Assignment

The Ashton Vale Level Crossing junction VISSIM model uses static assignment. Static assignment allows traffic, based on route movements, to be allocated a turning movement at the time they enter the simulation.

There is no route choice within the model network and so no need to run the models to achieve assignment convergence criteria. Note that whilst vehicles have no choice of the route they take from origin to destination they are still free to select different lanes on multi-lane sections.

Base Model Calibration and Validation

4.1 General

In order to provide a robust basis for testing, model calibration and validation are necessary. Calibration is the process of adjusting the model network and input traffic demand such that it reflects observed driving behaviour and traffic levels. Validation is the comparison of model outputs to a different set of observed data to check that the model is a robust representation of the network.

The model was calibrated to link and turn flows and validated to journey times. The results were assessed against WebTAG acceptability criteria and reported against the target WebTAG guidelines. The model was run for ten random seeds and the average of the results presented. The guideline criteria of calibration and validation can be seen in the following sections.

4.2 Model Calibration

The VISSIM model was run multiple times in order to produce a set of average outputs. To enable a robust assessment, the results used in the model calibration and validation represent an average of 10 simulation runs, for each of the AM and PM peaks, using different random seeds.

4.2.1 Calibration Methodology

The Design Manual for Roads and Bridges (DMRB), Volume 12, provides guidance on the acceptability criteria when comparing modelled link flows against observed counts. For this assessment, the link flow criteria have also been applied for the turning movement calibration, as required in TAG Unit M3.1 – Highway Assignment Modelling.

Table 4.1 shows the acceptability criteria for the use with model calibration and validation checks. If comparisons of observed and modelled output meet the acceptable criteria shown in **Table 4.1** the model is deemed to be ‘technically’ calibrated and validated.

Table 4.1: DMRB Calibration and Validation Acceptability Criteria

	Criteria and Measure	Acceptability Guidelines	
	Flow difference Criteria		
1	Total screenline flows (normally > 5 links) to be within +/- 5%	All (or nearly all) screenline	
2	Observed (individual) link flow < 700vph	Modelled flow within +/- 100vph	> 85% of links
	Observed (individual) link flow < 700vph	Modelled flow within +/- 15%	> 85% of links
	Observed (individual) link flow > 2700vph	Modelled flow within +/- 400vph	> 85% of links
	GEH Criteria		
3	GEH statistic for individual link flows <5		> 85% of links
	Journey Time Validation		
4	Modelled times along routes should be within 15% (or 1 minute if higher)		> 85% of links

Traffic flow calibration was carried out across all approaches to the Winterstoke Road/Ashton Vale Road junction. The arm naming convention for the approaches used for calibration can be seen in **Figure 4.1** below.

Figure 4.1 Flow Calibration Sites

4.2.2 Calibration Results

Tables 4.2 to 4.5 present the calibration results comparing observed and modelled link and turning flows for the modelled weekday AM peak period. The results demonstrate that the modelled link flows represent a high correlation to the observed traffic data. The link and turn count flow criteria exceeded the guidelines, with 100% of link flows and 100% of turns had a GEH<5.

The linear regression of the modelled total flows and observed total flows was also analysed. A high co-efficient correlation (R2) was achieved and the results are shown in **Figure 4.2**. The value of R2 =1 implies a perfect match while R2=0 an imperfect match between the observed and modelled flows. The resulting value of R2 provides further confirmation that the traffic movements at the junction are comparable with observed data to a reasonably high degree.

Table 4.6 to 4.9 show the calibration results for the PM peak period model. The results demonstrate that the modelled link flows represent a high correlation to the observed traffic data. The link and turn count flow criteria exceeded the guidelines, with 100% of link flows, (Lights and Heavy's) and 100% of turns had a GEH<5 (Lights) and 96% (Heavy's).

The linear regression of the modelled total flows and observed total flows was also analysed. A high co-efficient correlation (R2) was achieved and the results are shown in **Figure 4.3**. The value of R2 =1 implies a perfect match while R2=0 an imperfect match between the observed and modelled flows. Again, the resulting value of R2 provides further confirmation that the traffic movements at the junction are comparable with observed data to a reasonably high degree during this period.

Table 4.2: AM Flow Calibration (Light vehicles) - Links

Junction Name	Time Periods	From Arm	Observed	Model Flow	Diff	% Diff	GEH <5	DMRB Flow
Ashton Vale Level Crossing	07:00-08:00	A3029 North	1154	1117	-37	-3%	✓	✓
		Marsh Road	159	153	-6	-4%	✓	✓
		A3029 South	1167	1128	-39	-3%	✓	✓
		Ashton Vale Road	36	40	4	11%	✓	✓
	08:00-09:00	A3029 North	1239	1159	-80	-6%	✓	✓
		Marsh Road	183	187	4	2%	✓	✓
		A3029 South	1072	1067	-5	0%	✓	✓
		Ashton Vale Road	50	49	-1	-2%	✓	✓
	09:00-10:00	A3029 North	1149	1016	-133	-12%	✓	✓
		Marsh Road	87	86	-1	-1%	✓	✓
		A3029 South	966	964	-2	0%	✓	✓
		Ashton Vale Road	70	71	1	1%	✓	✓

Table 4.3: AM Flow Calibration (Heavy's vehicles) - Links

Junction Name	Time Periods	From Arm	Observed	Model Flow	Diff	% Diff	GEH <5	DMRB Flow
Ashton Vale Level Crossing	07:00-08:00	A3029 North	60	64	4	7%	✓	✓
		Marsh Road	6	7	1	17%	✓	✓
		A3029 South	101	95	-6	-6%	✓	✓
		Ashton Vale Road	36	35	-1	-3%	✓	✓
	08:00-09:00	A3029 North	101	109	8	8%	✓	✓
		Marsh Road	12	11	-1	-8%	✓	✓
		A3029 South	92	101	9	10%	✓	✓
		Ashton Vale Road	27	27	0	0%	✓	✓
	09:00-10:00	A3029 North	103	89	-14	-14%	✓	✓
		Marsh Road	7	7	0	0%	✓	✓
		A3029 South	97	102	5	5%	✓	✓
		Ashton Vale Road	35	35	0	0%	✓	✓

Table 4.4: AM Flow Calibration (Light vehicles) - Turns

Junction Name	Time Period		From Arm	Observed	Model Flow	Diff	% Diff	GEH <5	DMRB Flow
Ashton Vale Level Crossing	07:00-08:00	A3029 North	Marsh Road	201	226	25	12%	✓	✓
			A3029 South	953	891	-62	-7%	✓	✓
		Marsh Road	A3029 South	159	153	-6	-4%	✓	✓
		A3029 South	Ashton Vale Road	172	169	-3	-2%	✓	✓
			A3029 Underpass	666	638	-28	-4%	✓	✓
			A3029 North	329	321	-8	-2%	✓	✓
		Ashton Vale Road	A3029 Underpass	18	22	4	22%	✓	✓
			A3029 North	4	6	2	50%	✓	✓
			A3029 South	14	12	-2	-14%	✓	✓
	08:00-09:00	A3029 North	Marsh Road	275	233	-42	-15%	✓	✓
			A3029 South	964	926	-38	-4%	✓	✓
		Marsh Road	A3029 South	183	187	4	2%	✓	✓
		A3029 South	Ashton Vale Road	142	156	14	10%	✓	✓
			A3029 Underpass	623	612	-11	-2%	✓	✓
			A3029 North	307	299	-8	-3%	✓	✓
		Ashton Vale Road	A3029 Underpass	24	23	-1	-4%	✓	✓
			A3029 North	6	7	1	17%	✓	✓
			A3029 South	20	19	-1	-5%	✓	✓
	09:00-10:00	A3029 North	Marsh Road	233	207	-26	-11%	✓	✓
			A3029 South	916	809	-107	-12%	✓	✓
		Marsh Road	A3029 South	87	86	-1	-1%	✓	✓
		A3029 South	Ashton Vale Road	137	147	10	7%	✓	✓
			A3029 Underpass	556	547	-9	-2%	✓	✓
			A3029 North	273	270	-3	-1%	✓	✓
		Ashton Vale Road	A3029 Underpass	31	35	4	13%	✓	✓
			A3029 North	8	10	2	25%	✓	✓
			A3029 South	31	26	-5	-16%	✓	✓

Table 4.5: AM Flow Calibration (Heavy's vehicles) - Turns

Junction Name	Time Period		From Arm	Observed	Model Flow	Diff	% Diff	GEH <5	DMRB Flow
Ashton Vale Level Crossing	07:00-08:00	A3029 North	Marsh Road	5	11	6	120%	✓	✓
			A3029 South	55	53	-2	-4%	✓	✓
		Marsh Road	A3029 South	6	7	1	17%	✓	✓
		A3029 South	Ashton Vale Road	14	13	-1	-7%	✓	✓
			A3029 Underpass	58	58	0	0%	✓	✓
			A3029 North	29	24	-5	-17%	✓	✓
		Ashton Vale Road	A3029 Underpass	22	18	-4	-18%	✓	✓
			A3029 North	7	5	-2	-29%	✓	✓
			A3029 South	7	12	5	71%	✓	✓
	08:00-09:00	A3029 North	Marsh Road	19	23	4	21%	✓	✓
			A3029 South	82	86	4	5%	✓	✓
		Marsh Road	A3029 South	12	11	-1	-8%	✓	✓
		A3029 South	Ashton Vale Road	32	17	-15	-47%	✓	✓
			A3029 Underpass	41	53	12	29%	✓	✓
			A3029 North	19	31	12	63%	✓	✓
		Ashton Vale Road	A3029 Underpass	15	14	-1	-7%	✓	✓
			A3029 North	4	3	-1	-25%	✓	✓
			A3029 South	8	10	2	25%	✓	✓
	09:00-10:00	A3029 North	Marsh Road	10	19	9	90%	✓	✓
			A3029 South	93	70	-23	-25%	✓	✓
		Marsh Road	A3029 South	7	7	0	0%	✓	✓
		A3029 South	Ashton Vale Road	34	14	-20	-59%	✓	✓
			A3029 Underpass	42	59	17	40%	✓	✓
			A3029 North	21	29	8	38%	✓	✓
		Ashton Vale Road	A3029 Underpass	22	16	-6	-27%	✓	✓
			A3029 North	7	6	-1	-14%	✓	✓
			A3029 South	6	13	7	117%	✓	✓

Table 4.6: PM Flow Calibration (Light vehicles) - Links

Junction Name	Time Periods	From Arm	Observed	Model Flow	Diff	% Diff	GEH <5	DMRB Flow
Ashton Vale Level Crossing	16:00-17:00	A3029 North	1286	1229	-57	-4%	✓	✓
		Marsh Road	116	114	-2	-2%	✓	✓
		A3029 South	1039	972	-67	-6%	✓	✓
		Ashton Vale Road	208	188	-20	-10%	✓	✓
	17:00-18:00	A3029 North	1357	1356	-1	0%	✓	✓
		Marsh Road	132	132	0	0%	✓	✓
		A3029 South	1133	1093	-40	-4%	✓	✓
		Ashton Vale Road	219	174	-45	-21%	✓	✓
	18:00-19:00	A3029 North	1222	1239	17	1%	✓	✓
		Marsh Road	86	87	1	1%	✓	✓
		A3029 South	906	895	-11	-1%	✓	✓
		Ashton Vale Road	86	90	4	5%	✓	✓

Table 4.7: PM Flow Calibration (Heavy's vehicles) - Links

Junction Name	Time Periods	From Arm	Observed	Model Flow	Diff	% Diff	GEH <5	DMRB Flow
Ashton Vale Level Crossing	16:00-17:00	A3029 North	79	86	7	9%	✓	✓
		Marsh Road	5	5	0	0%	✓	✓
		A3029 South	68	65	-3	-4%	✓	✓
		Ashton Vale Road	14	12	-2	-14%	✓	✓
	17:00-18:00	A3029 North	23	33	10	43%	✓	✓
		Marsh Road	2	2	0	0%	✓	✓
		A3029 South	30	45	15	50%	✓	✓
		Ashton Vale Road	5	4	-1	-20%	✓	✓
	18:00-19:00	A3029 North	18	15	-3	-17%	✓	✓
		Marsh Road	0	0	0	0%	✓	✓
		A3029 South	20	20	0	0%	✓	✓
		Ashton Vale Road	4	5	1	25%	✓	✓

Table 4.8: PM Flow Calibration (Light vehicles) - Turns

Junction Name	Time Period		From Arm	Observed	Model Flow	Diff	% Diff	GEH <5	DMRB Flow
Ashton Vale Level Crossing	07:00-08:00	A3029 North	Marsh Road	305	309	4	1%	✓	✓
			A3029 South	981	920	-61	-6%	✓	✓
		Marsh Road	A3029 South	116	114	-2	-2%	✓	✓
		A3029 South	Ashton Vale Road	29	19	-10	-34%	✓	✓
			A3029 Underpass	667	627	-40	-6%	✓	✓
			A3029 North	343	326	-17	-5%	✓	✓
		Ashton Vale Road	A3029 Underpass	86	86	0	0%	✓	✓
			A3029 North	29	30	1	3%	✓	✓
			A3029 South	93	72	-21	-23%	✓	✓
	08:00-09:00	A3029 North	Marsh Road	374	342	-32	-9%	✓	✓
			A3029 South	983	1014	31	3%	✓	✓
		Marsh Road	A3029 South	132	132	0	0%	✓	✓
		A3029 South	Ashton Vale Road	19	17	-2	-11%	✓	✓
			A3029 Underpass	736	712	-24	-3%	✓	✓
			A3029 North	378	364	-14	-4%	✓	✓
		Ashton Vale Road	A3029 Underpass	106	79	-27	-25%	✓	✓
			A3029 North	36	27	-9	-25%	✓	✓
			A3029 South	77	68	-9	-12%	✓	✓
	09:00-10:00	A3029 North	Marsh Road	294	315	21	7%	✓	✓
			A3029 South	928	924	-4	0%	✓	✓
		Marsh Road	A3029 South	86	87	1	1%	✓	✓
		A3029 South	Ashton Vale Road	14	17	3	21%	✓	✓
			A3029 Underpass	589	583	-6	-1%	✓	✓
			A3029 North	303	295	-8	-3%	✓	✓
		Ashton Vale Road	A3029 Underpass	43	42	-1	-2%	✓	✓
			A3029 North	15	14	-1	-7%	✓	✓
			A3029 South	28	34	6	21%	✓	✓

Table 4.9: PM Flow Calibration (Heavy's vehicles) - Turns

Junction Name	Time Period		From Arm	Observed	Model Flow	Diff	% Diff	GEH <5	DMRB Flow
Ashton Vale Level Crossing	07:00-08:00	A3029 North	Marsh Road	6	20	14	233%	✓	✓
			A3029 South	73	66	-7	-10%	✓	✓
		Marsh Road	A3029 South	5	5	0	0%	✓	✓
		A3029 South	Ashton Vale Road	26	1	-25	-96%	✗	✓
			A3029 Underpass	28	44	16	57%	✓	✓
			A3029 North	14	20	6	43%	✓	✓
		Ashton Vale Road	A3029 Underpass	8	5	-3	-38%	✓	✓
			A3029 North	3	2	-1	-33%	✓	✓
			A3029 South	3	5	2	67%	✓	✓
	08:00-09:00	A3029 North	Marsh Road	3	7	4	133%	✓	✓
			A3029 South	20	26	6	30%	✓	✓
		Marsh Road	A3029 South	2	2	0	0%	✓	✓
		A3029 South	Ashton Vale Road	6	1	-5	-83%	✓	✓
			A3029 Underpass	16	31	15	94%	✓	✓
			A3029 North	8	13	5	63%	✓	✓
		Ashton Vale Road	A3029 Underpass	4	2	-2	-50%	✓	✓
			A3029 North	1	1	0	0%	✓	✓
			A3029 South	0	1	1	0%	✓	✓
	09:00-10:00	A3029 North	Marsh Road	2	4	2	100%	✓	✓
			A3029 South	16	11	-5	-31%	✓	✓
		Marsh Road	A3029 South	0	0	0	0%	✓	✓
		A3029 South	Ashton Vale Road	6	0	-6	-100%	✓	✓
			A3029 Underpass	9	14	5	56%	✓	✓
			A3029 North	5	6	1	20%	✓	✓
		Ashton Vale Road	A3029 Underpass	3	2	-1	-33%	✓	✓
			A3029 North	0	1	1	0%	✓	✓
			A3029 South	1	2	1	100%	✓	✓

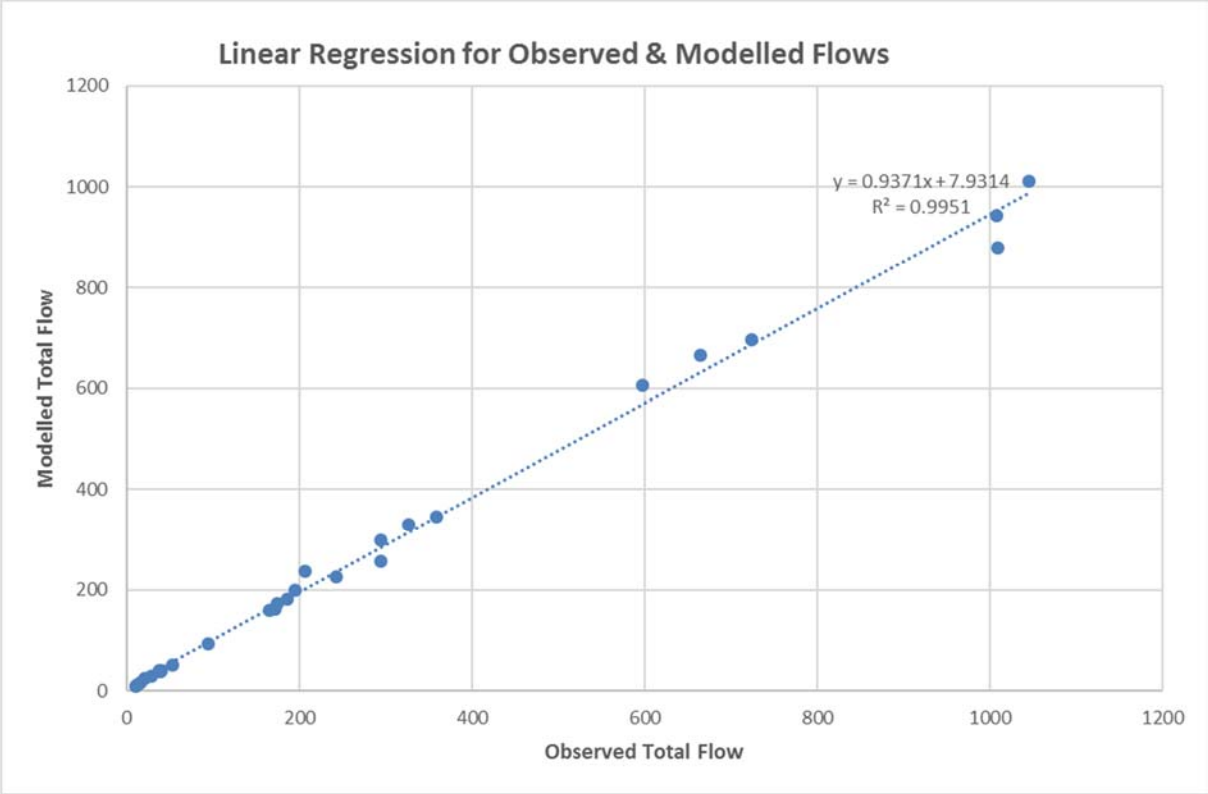


Figure 4.2 Linear Regression for Observed and Modelled Flows of the Base Model – AM Peak

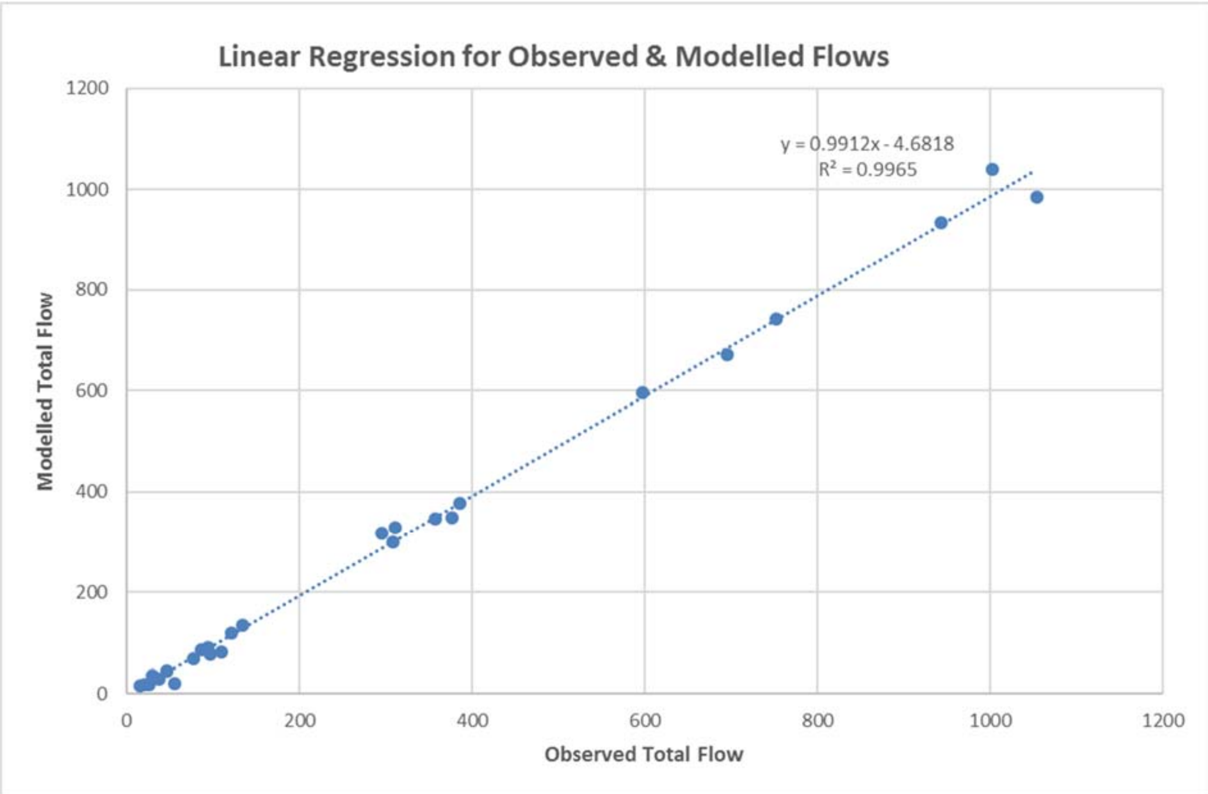


Figure 4.3 Linear Regression for Observed and Modelled Flows of the Base Model – PM Peak

4.3 Model Validation

4.3.1 Validation Methodology

Validation is the process whereby modelled outputs are compared against independently collected observed data. This assignment validation was also carried out in accordance with DMRB Volume 12a, Section 11.4 and WebTag Unit M3.1. The observed and modelled journey times were compared for the junction in accordance with the criteria in **Table 4.1**. Journey time validation were surveyed using the car-follower method for the journey time described in **Table 2.1**.

Acceptable guidelines set out in WebTAG/DMRB recommend the average modelled travel times should be within 15% of the corresponding observed values (or within 1 minute of higher), in at least 85% of cases.

4.3.2 Validation Results

Table 4.10 compares observed and modelled journey times from the AM peak period. The results show that the modelled and observed journey time profiles are sufficiently close and meet the DMRB validation criteria.

Table 4.11 shows the journey time validation results for the PM peak period. Again, the results show that 100% of modelled journey time validate to DMRB criteria when compared against the observed route timings. This shows that the model meets the desired DMRB level of validation.

4.3.3 Model Development Summary

The calibration and validation results for the AM and PM peak base year (2017) Winterstoke Road/Aston Vale Road VISSIM models demonstrate that traffic flows and operational conditions observed in reality are well reflected within the models.

The model has been validated using the guidance, measures and criteria recommended in TAG M3.1. The following comparisons between modelled and observed data have been reported:

- Traffic flows on individual links
- Turning counts; and
- Journey times along a range of routes

The models meet WebTAG calibration and validation acceptability criteria. Consequently, it is considered that the Winterstoke Road/Ashton Vale Road junction and level crossing VISSIM model provides a robust base for use in assessing the impact of MetroWest Phase 1 and testing measures aimed at mitigating the impact of longer and more frequent level crossing closures.

Table 4.10: Journey Time Validation results – AM Peak

Road Name	Route	Dir	Time Period	Observed Mean Journey Time (s)	Modelled Mean Journey Time (s)	Diff (s)	% Diff	Pass/ Fail
A3029 Winterstoke Road	1	NB	0700-0800	191	145	-45.3	-24%	Pass
	1	NB	0800-0900	227	175	-52.3	-23%	Pass
	1	NB	0900-1000	177	135	-41.4	-23%	Pass
A3029 Winterstoke Road	2	SB	0700-0800	99	89	-10.6	-11%	Pass
	2	SB	0800-0900	121	99	-21.7	-18%	Pass
	2	SB	0900-1000	102	81	-20.5	-20%	Pass
Ashton Vale Road	3	EB	0700-0800	77	95	18.1	23%	Pass
	3	EB	0800-0900	96	120	24.2	25%	Pass
	3	EB	0900-1000	N/A	86	N/A	N/A	N/A

Table 4.11: Journey Time Validation results – PM Peak

Road Name	Route	Dir	Time Period	Observed Mean Journey Time (s)	Modelled Mean Journey Time (s)	Diff (s)	% Diff	Pass/ Fail
A3029 Winterstoke Road	1	NB	1600-1700	112	153	40.6	36%	Pass
	1	NB	1700-1800	190	164	-25.7	-14%	Pass
	1	NB	1800-1900	99	134	35.0	35%	Pass
A3029 Winterstoke Road	2	SB	1600-1700	121	98	-23.2	-19%	Pass
	2	SB	1700-1800	137	97	-39.9	-29%	Pass
	2	SB	1800-1900	93	79	-13.8	-15%	Pass
Ashton Vale Road	3	EB	1600-1700	132	175	43.3	33%	Pass
	3	EB	1700-1800	106	152	46.3	44%	Pass
	3	EB	1800-1900	62	102	40.8	66%	Pass

Option Assessment

5.1 Railway Operational Context

While MetroWest Phase 1 will only change rail movements at Ashton Vale Road level crossing by seeing passenger trains pass through the Ashton Vale Road level crossing at regular intervals, in considering the impact of these new passenger services, passage of the level crossing by freight trains to/from Bristol Port at Portbury also needs to be taken into account. However, the amount of freight train traffic is variable. Indeed, Network Rail's General Permitted Development rights for the existing operational freight railway to the port enable an unlimited number of freight train movements across the level crossing, without the need for any planning consent.

Hence, for the purposes of transparency, all the rail operation scenarios and highway options assessed as in highway impact modelling include freight train operations over the level crossing. Three rail operations scenarios have been incorporated into the VISSIM modelling; these are set out in the next section (5.2) of this chapter.

It should be noted that the three scenarios relate to the possible future use of the Portbury freight line for trains to/from the port in the future, and not the current level of usage. For instance, Bristol Port has commercial agreements in place that would allow up to 20 trains per day per direction to use the Portbury freight line to access the port. This is broadly equivalent to 1 train per hour per direction on weekdays, and is a key determinant in the derivation of the 'worst case' level crossing closure scenarios (and in particular '1 Unit B' below).

In practice, the current level of freight traffic to the port is significantly lower than this, averaging around 5-10 trains per week (though this represents a lower level of use than has been seen in the past). As such, MetroWest services will represent a regular use of the level crossing that currently does not occur, but could do so if the Port's traffic requirements increased to the maximum that commercial agreements for the line will allow.

For further information on the wider rail operational context, **Appendix A** sets out a brief account of the current and future use of the Portbury freight line, and puts it into the context of MetroWest Phase 1 services.

5.2 Scenarios Modelled

5.2.1 Level Crossing Rail Operations

There are a range of potential rail scenarios involving movements of both MetroWest Phase 1 passenger trains and freight trains that currently use the railway that passes through the level crossing. Three rail scenarios have been used to provide level crossing timings in the VISSIM model, which differ in terms of their impact on level crossing closures. These are based on options assessed in RailSys operational analysis by Network Rail, and consist of:

- 1 Unit B, which is 1 passenger train and 1 freight train in each direction in each hour;
- 1 Unit CU, which consists of 1 passenger train in each direction and 1 freight train in one direction only (up from Portbury) in each hour; and
- 1 Unit CD, which consists of 1 passenger train in each direction and 1 freight train in one direction only (down to Portbury) in each hour.

5.2.2 Level Crossing Highway Options

The three rail service scenarios were tested with a number of different highway networks reflecting the existing layout and operation of the Winterstoke Road/Ashton Vale Road signalled junction, as well as a range of mitigation measures, as follows:

- 'Do-Nothing' Scenario, which consists of the existing junction layout and traffic signal operation;
- 'Ext Lt Lane' Scenario, which includes the extension of the Winterstoke Road northbound left turn lane into Ashton Vale Road to 150 metres; and
- 'MOVA Ext Lt Lane' Scenario, which includes the extension of the Winterstoke Road northbound left turn flare with the VISVAP file modified to provide extra green time to movements affected by the level crossing thereby emulating longer green times which would be provided under MOVA control.

Network Rail has supplied rail closure timings for the three scenarios to be tested. From this an average closure time of four minutes was modelled within VISSIM. This represents a worst case since some closure times are likely to be slightly shorter. The full Network Rail data can be seen in more detailed in **Appendix B**.

The above scenarios were tested with base year (2017) traffic flows and no forecasting of future volumes has been carried out. MetroWest Phase 1 will be 'live' by 2019 and traffic flows are not expected to materially grow over the intervening period. Critical volumes going to and coming from the industrial estate serviced by Ashton Vale Road are also likely to be static as the estate is fully built out

The resulting scenarios tested using the Winterstoke Road/Ashton Vale Road junction VISSIM are summarised in **Table 5.1**.

Table 5.1: Summary of Scenarios Assessed

Level Crossing Highway Scenarios	Level Crossing Rail Operations							
	Base / Do-Nothing		1 Unit B		1 Unit CU		1 Unit CD	
	AM	PM	AM	PM	AM	PM	AM	PM
Do Nothing	S1	S2	S3	S4	S5	S6	S7	S8
Ext Left Lane	n/a	n/a	S9	S10	S11	S12	S13	S14
Ext Left Lane / MOVA	n/a	n/a	S15	S16	S17	S18	S19	S20

These scenarios have been tested with base year (2017) traffic flows and no forecasting of future volumes has been carried out. MetroWest Phase 1 will be 'live' by 2019 and traffic flows are not expected to materially grow over the intervening period. Critical volumes going to and coming from the industrial estate serviced by Ashton Vale Road are also likely to be static as the estate is fully built out.

5.3 Assessment Outputs

5.3.1 Observations from Simulation

The validated VISSIM model was used to assess future scenarios for the Ashton Vale Level Crossing signalised junction.

Do-Nothing

Within the Do-Nothing network, it was observed that the operational conditions within the modelled network were severely congestions in all three rail scenarios. It was observed that queueing traffic on the Winterstoke Road northbound heading towards Ashton Vale Road blocks trips wanting to go northbound to the A370 underpass and the A3029 (see Figure 5.1), even when there is green time for these movements. Additionally, heavy queueing traffic was observed on Ashton Vale Road when the level crossing barrier is down, particularly during the evening peak period when traffic volumes on this arm are more dominant (see Figure 5.2).

Figure 5.1 VISSIM Model Do-Nothing Scenario 3 (1 Unit B) – Winterstoke Road Queuing AM

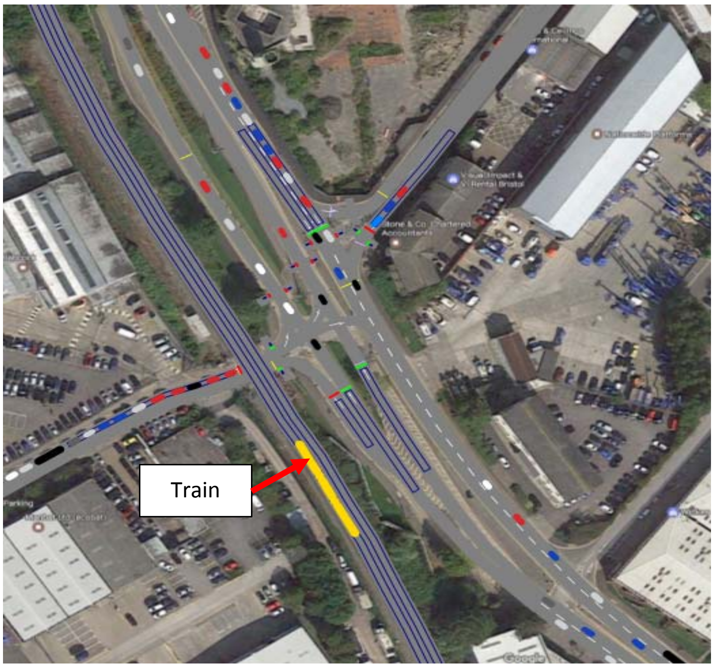


Figure 5.2 VISSIM Model Do-Nothing Scenario 4 (1 Unit B) – Aston Vale Road Queuing PM

With Extended Left Turn Lane

These scenarios consist of an extended left lane turn from the Winterstoke Road northbound towards Ashton Vale Road under the three rail scenarios being tested for both the AM and PM peak periods.

It was observed that the signalised junction operated largely within capacity in all future scenarios during the AM peak period. As a result of the improvements, in each of the scenarios modelled, queues on the Winterstoke Road northbound left turn into Ashton Vale Road rarely impeded other movements through the network (see Figure 5.3). However, notable queuing on Ashton Vale Road was still noted particularly during the PM peak period following a level crossing closure (see Figure 5.4).

Figure 5.3 VISSIM Model Ext LT Lane Scenario 9 (1 Unit B) – Improved Queuing on Winterstoke Road AM

Figure 5.4 VISSIM Model Ext LT Lane Scenario 10 (1 Unit B) – Ashton Vale Road Queuing PM

With Extended Left Turn Lane and MOVA

These scenarios consist of an extended left lane turn on Winterstoke Road northbound and adjustments to the signal operation within the model in order to simulate MOVA control. These changes were tested under the three rail scenarios within the AM and PM peak periods. The extended left turn flare on Winterstoke Road northbound was effective in containing queuing without blocking the adjacent ahead movement during the AM (see Figure 5.5).

During the PM, whilst queue lengths built to high levels on Ashton Vale Road during level crossing closures (see Figure 5.6), they were well managed following the re-opening of the level crossing and with the additional green cleared relatively quickly (two to three minutes) following a level crossing closure.

Figure 5.5 VISSIM Model Ext LT Lane MOVA Scenario 15 (1 Unit B) – Improved Queuing Winterstoke Road AM

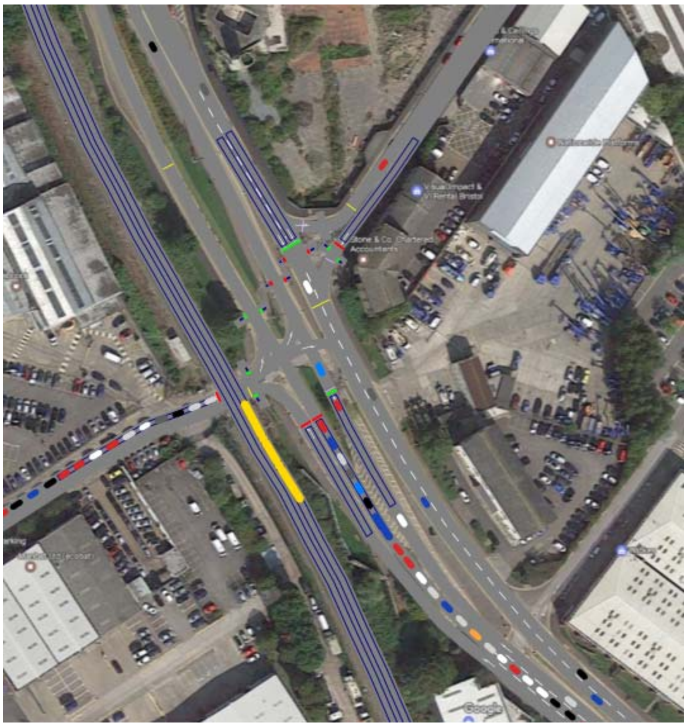


Figure 5.6 VISSIM Model Ext LT Lane and MOVA Scenario 16 (1 Unit B) – Ashton Vale Road Queuing PM

5.3.2 Network Performance Evaluation

To quantify the overall operational conditions arising in each of the modelled scenarios, network performance indicators were extracted from the model. **Tables 5.2 to 5.7** summarise the overall network conditions and key performance indicators for each of the rail scenarios during the AM and PM peak periods.

The tables clearly show that during the AM peak period the inclusion of the left turn lane from the A3029 towards Ashton vale Road mitigates the impact of MetroWest highlighted in the Do-Nothing scenario. Indeed, most of the performance indicators show that network performance under all rail scenarios is, in fact, better than in the base situation.

The network performance results for the PM peak period clearly show that the increased level crossing closures have a negative impact with no mitigation at the junction under the Do-Nothing scenario. These impacts mitigated with the inclusion of the extended left turn lane and introduction of MOVA control with the resulting operational conditions comparable to those under the base situation.

Table 5.2: Performance Indicators for Rail Scenario 1 Unit B, AM Peak, 2017

Network Performance Indicators	Time Period	Base	Do-Nothing	Ex Lt 1	MOVA Ex Lt Ln
Total Number of Vehicles (Arrived)	07:00-10:00	2744	2745	2746	2746
Total Distance (mi)	07:00-10:00	2272	2618	2621	2621
Total Travel Time (s)	07:00-10:00	401913	766658	418839	424193
Average Speed (mph)	07:00-10:00	21	13	23	22
Total Delay (secs)	07:00-10:00	97467	423655	79674	85030
Average Delay Time per Vehicle (secs)	07:00-10:00	33	143	28	29
Total Stopped Delay (secs)	07:00-10:00	65694	292343	54521	58528
Average Stopped Delay per Vehicles (secs)	07:00-10:00	23	99	19	20
Number of Stops	07:00-10:00	2580	13462	1836	1927
Average Number of Stops per Vehicles (secs)	07:00-10:00	1	5	1	1

Table 5.3: Performance Indicators for Rail Scenario 1 Unit CU, AM Peak, 2017

Network Performance Indicators	Time Period	Base	Do-Nothing	Ex Lt 1	MOVA Ex Lt Ln
Total Number of Vehicles (Arrived)	07:00-10:00	2744	2744	2746	2745
Total Distance (mi)	07:00-10:00	2272	2618	2620	2620
Total Travel Time (s)	07:00-10:00	401913	600195	418683	422341
Average Speed (mph)	07:00-10:00	21	17	23	22
Total Delay (secs)	07:00-10:00	97467	257343	79759	83405
Average Delay Time per Vehicle (secs)	07:00-10:00	33	87	28	29
Total Stopped Delay (secs)	07:00-10:00	65694	175509	54375	56709
Average Stopped Delay per Vehicles (secs)	07:00-10:00	23	60	19	20
Number of Stops	07:00-10:00	2580	7801	1856	1958
Average Number of Stops per Vehicles (secs)	07:00-10:00	1	3	1	1

Table 5.4: Performance Indicators for Rail Scenario 1 Unit CD, AM Peak, 2017

Network Performance Indicators	Time Period	Base	Do-Nothing	Ex Lt 1	MOVA Ex Lt Ln
Total Number of Vehicles (Arrived)	07:00-10:00	2744	2746	2745	2745
Total Distance (mi)	07:00-10:00	2272	2618	2620	2620
Total Travel Time (s)	07:00-10:00	401913	573107	419753	423824
Average Speed (mph)	07:00-10:00	21	17	23	22
Total Delay (secs)	07:00-10:00	97467	230099	80795	84871
Average Delay Time per Vehicle (secs)	07:00-10:00	33	78	28	29
Total Stopped Delay (secs)	07:00-10:00	65694	155813	55015	58050
Average Stopped Delay per Vehicles (secs)	07:00-10:00	23	53	19	20
Number of Stops	07:00-10:00	2580	7032	1896	1969
Average Number of Stops per Vehicles (secs)	07:00-10:00	1	2	1	1

Table 5.5: Performance Indicators for Rail Scenario 1 Unit B, PM Peak, 2017

Network Performance Indicators	Time Period	Base	Do-Nothing	Ex Lt 1	MOVA Ex Lt Ln
Total Number of Vehicles (Arrived)	16:00-19:00	2836	2837	2838	2838
Total Distance (mi)	16:00-19:00	2292	2603	2604	2604
Total Travel Time (s)	16:00-19:00	424041	504072	499816	450537
Average Speed (mph)	16:00-19:00	20	19	19	21
Total Delay (secs)	16:00-19:00	121046	165139	164186	114975
Average Delay Time per Vehicle (secs)	16:00-19:00	40	54	54	38
Total Stopped Delay (secs)	16:00-19:00	88889	134166	133021	83357
Average Stopped Delay per Vehicles (secs)	16:00-19:00	29	44	44	28
Number of Stops	16:00-19:00	2553	2482	2483	2410
Average Number of Stops per Vehicles (secs)	16:00-19:00	1	1	1	1

Table 5.6: Performance Indicators for Rail Scenario 1 Unit CU, PM Peak, 2017

Network Performance Indicators	Time Period	Base	Do-Nothing	Ex Lt 1	MOVA Ex Lt Ln
Total Number of Vehicles (Arrived)	16:00-19:00	2836	2836	2837	2837
Total Distance (mi)	16:00-19:00	2292	2602	2603	2602
Total Travel Time (s)	16:00-19:00	424041	476669	471405	452779
Average Speed (mph)	16:00-19:00	20	20	20	21
Total Delay (secs)	16:00-19:00	121046	137989	136060	117485
Average Delay Time per Vehicle (secs)	16:00-19:00	40	45	45	39
Total Stopped Delay (secs)	16:00-19:00	88889	106467	104358	84966
Average Stopped Delay per Vehicles (secs)	16:00-19:00	29	35	34	28
Number of Stops	16:00-19:00	2553	2462	2499	2483
Average Number of Stops per Vehicles (secs)	16:00-19:00	1	1	1	1

Table 5.7: Performance Indicators for Rail Scenario 1 Unit CD, PM Peak, 2017

Network Performance Indicators	Time Period	Base	Do-Nothing	Ex Lt 1	MOVA Ex Lt Ln
Total Number of Vehicles (Arrived)	16:00-19:00	2836	2837	2837	2837
Total Distance (mi)	16:00-19:00	2292	2602	2603	2603
Total Travel Time (s)	16:00-19:00	424041	476866	467007	453957
Average Speed (mph)	16:00-19:00	20	20	20	21
Total Delay (secs)	16:00-19:00	121046	138162	131598	118595
Average Delay Time per Vehicle (secs)	16:00-19:00	40	45	43	39
Total Stopped Delay (secs)	16:00-19:00	88889	107912	100903	86152
Average Stopped Delay per Vehicles (secs)	16:00-19:00	29	35	33	28
Number of Stops	16:00-19:00	2553	2373	2392	2479
Average Number of Stops per Vehicles (secs)	16:00-19:00	1	1	1	1

For an indication of the congestion and delay predicted for the future year scenarios, overall network performance indices were run for each scenario, as mentioned above. From the results, above, **Figure 5.7 to 5.12** shows the average delay per vehicle (s), the Total delay time and the total travel time on the network for the base and all future modelled scenarios. The graphs clearly show the scale of the increase and decrease in congestion and delay predicted from the VISSIM modelling of the future scenarios.

Figures 5.7-5.9 indicate that the inclusion of the left turn lane from the A3029 has highly beneficial impact on the junction when compared to the Do-Nothing. The results show that the addition of MOVA does not provide any further benefit to the network during this period.

Figures 5.10-12 indicate that the inclusion of the left turn lane from the A3029 has beneficial impact on overall network operation when compared to the Do-Nothing. The results show that the introduction of MOVA provides additional benefit over and above when the extended left turn lane is introduced in isolation.

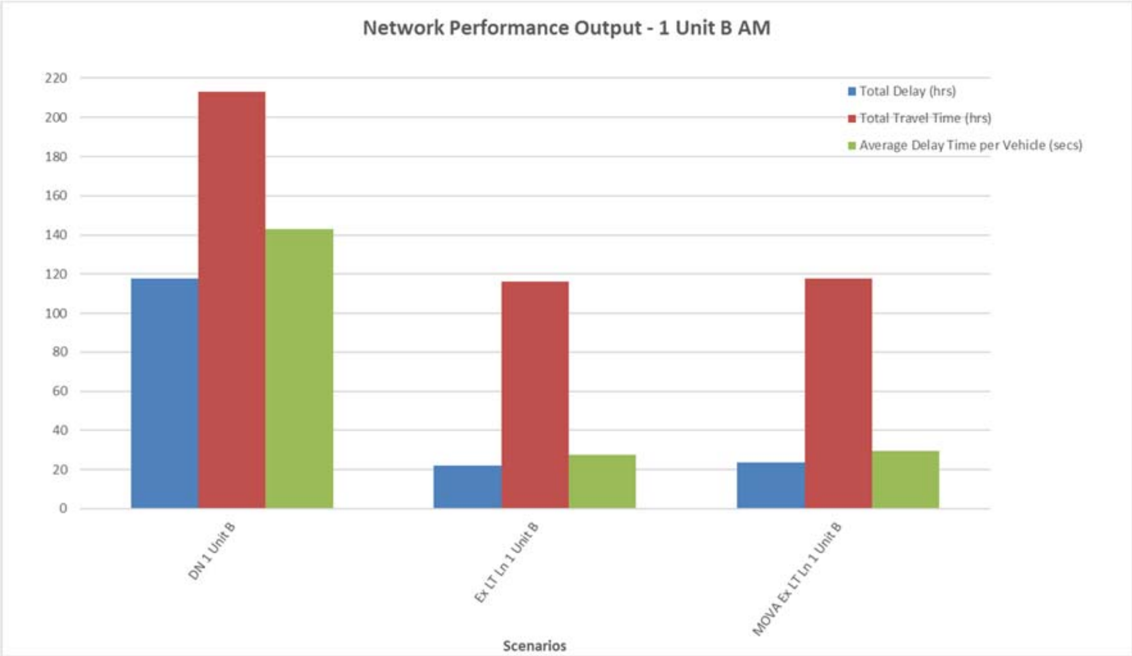


Figure 5.7 Network Performance Outputs for VISSIM Model Scenarios 1 Unit B – AM

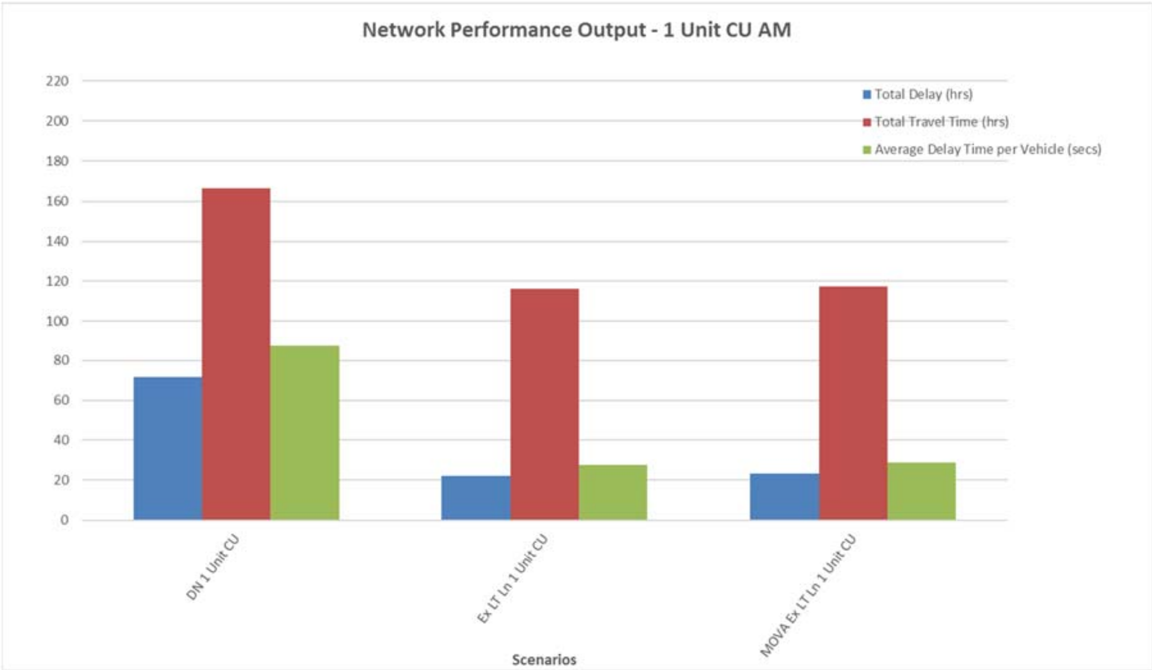


Figure 5.8 Network Performance Outputs for VISSIM Model Scenarios 1 Unit CU – AM

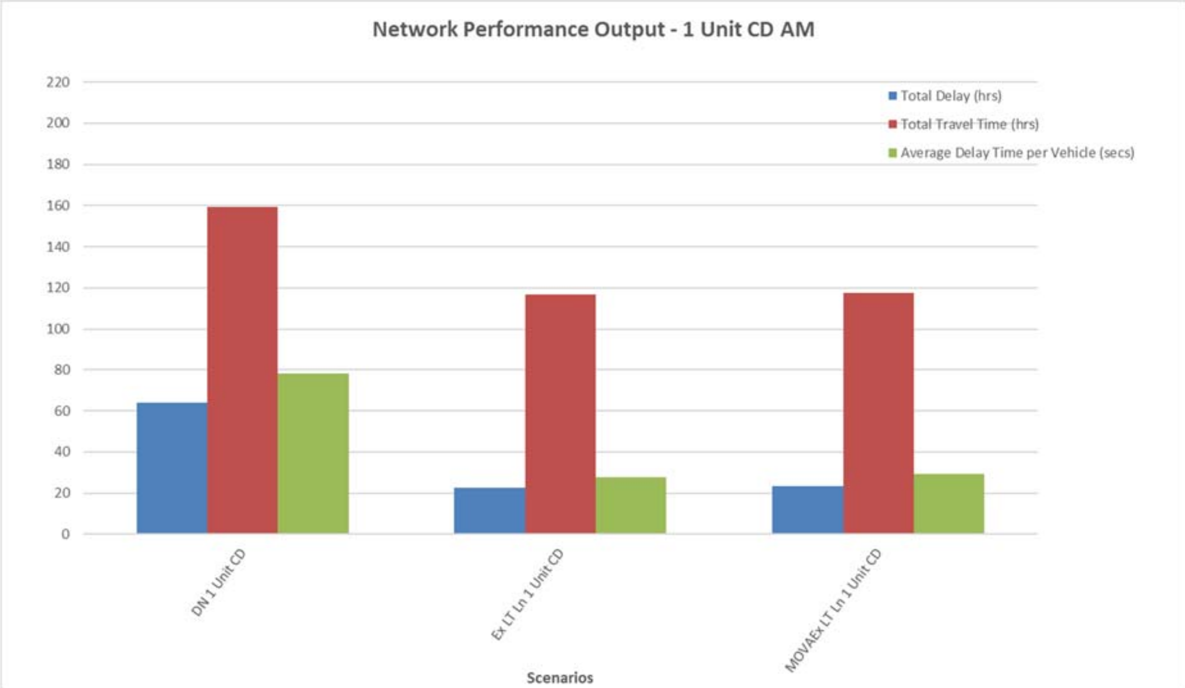


Figure 5.9 Network Performance Outputs for VISSIM Model Scenarios 1 Unit CD – AM

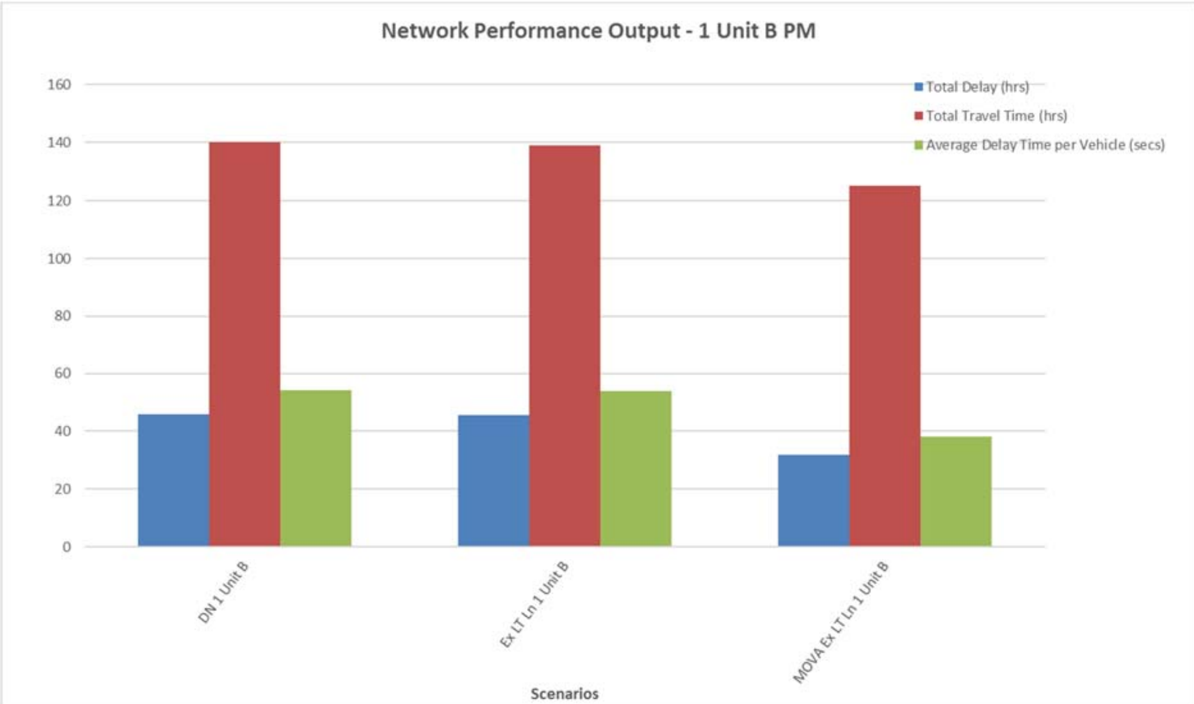


Figure 5.10 Network Performance Outputs for VISSIM Model Scenarios 1 Unit B – PM

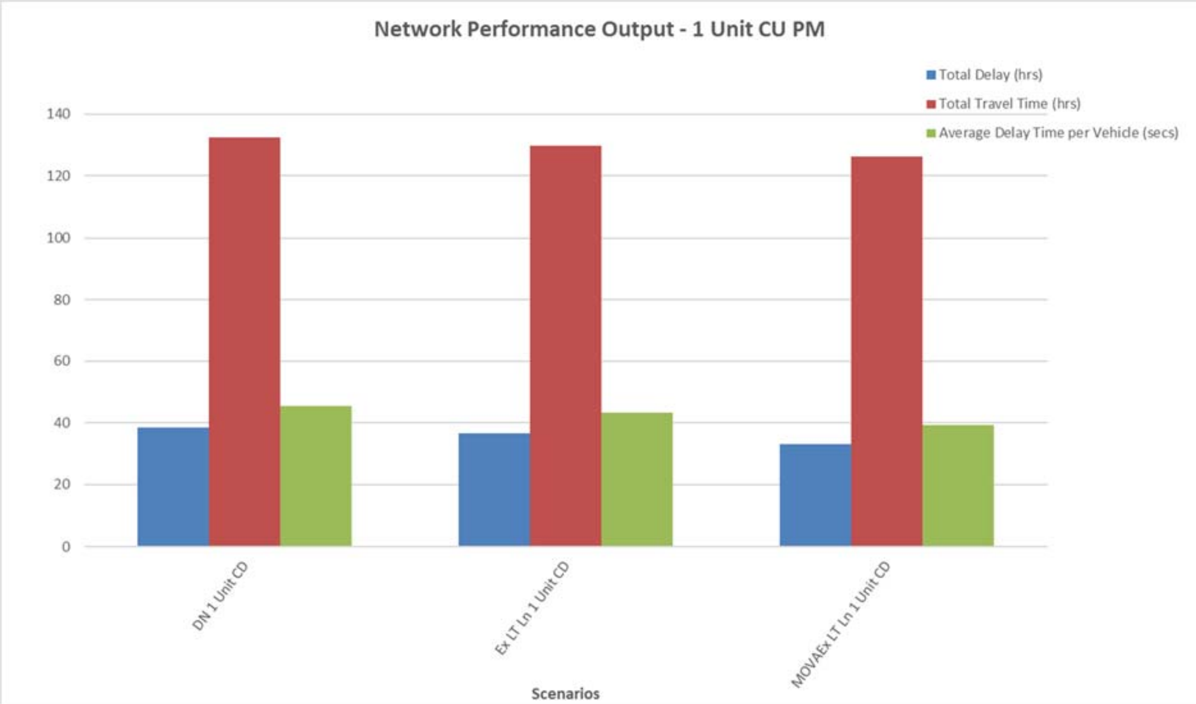


Figure 5.11 Network Performance Outputs for VISSIM Model Scenarios 1 Unit CU - PM

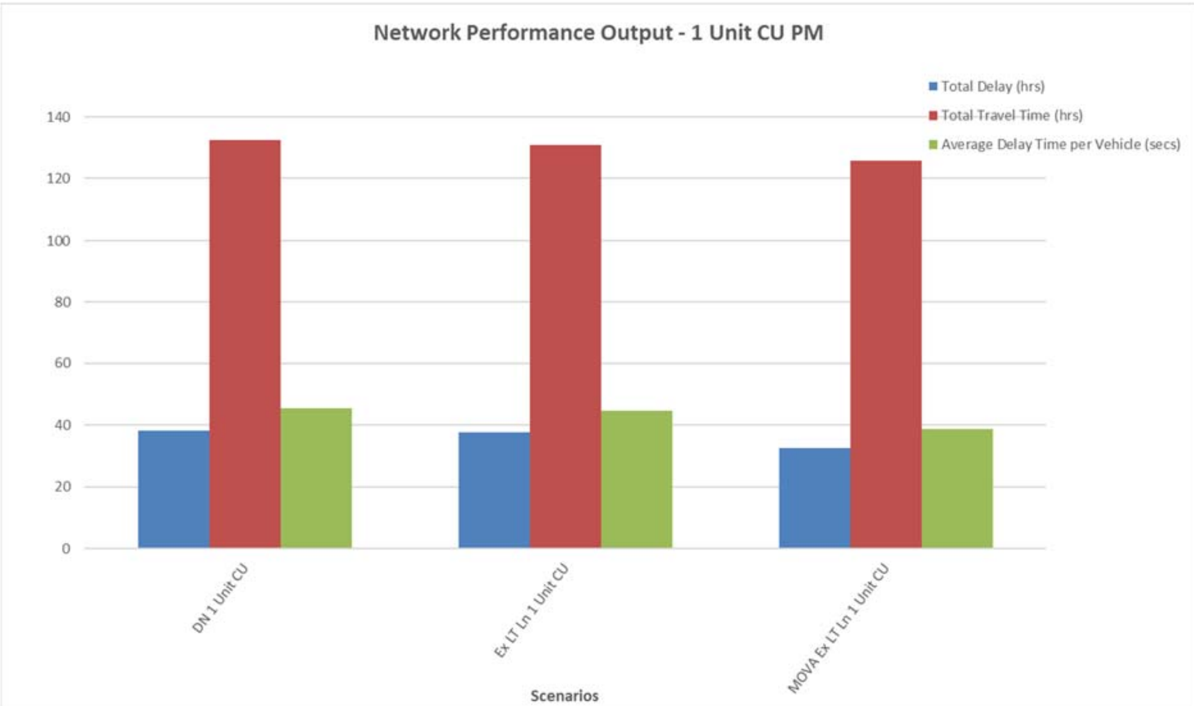


Figure 5.12 Network Performance Outputs for VISSIM Model Scenarios 1 Unit CD - PM

5.3.3 Queue Lengths

The scenarios were run to obtain queue length profiles throughout the simulation period. **Figures 5.13 to 5.18** compare the Winterstoke Road northbound left turn and Ashton Vale Road queue length profiles within each of the rail scenarios for the AM peak period. The base queue length profile is also shown within these in order to provide a benchmark for comparison. Queue graphs for other approaches to the junction are provided in in **Appendix C.**

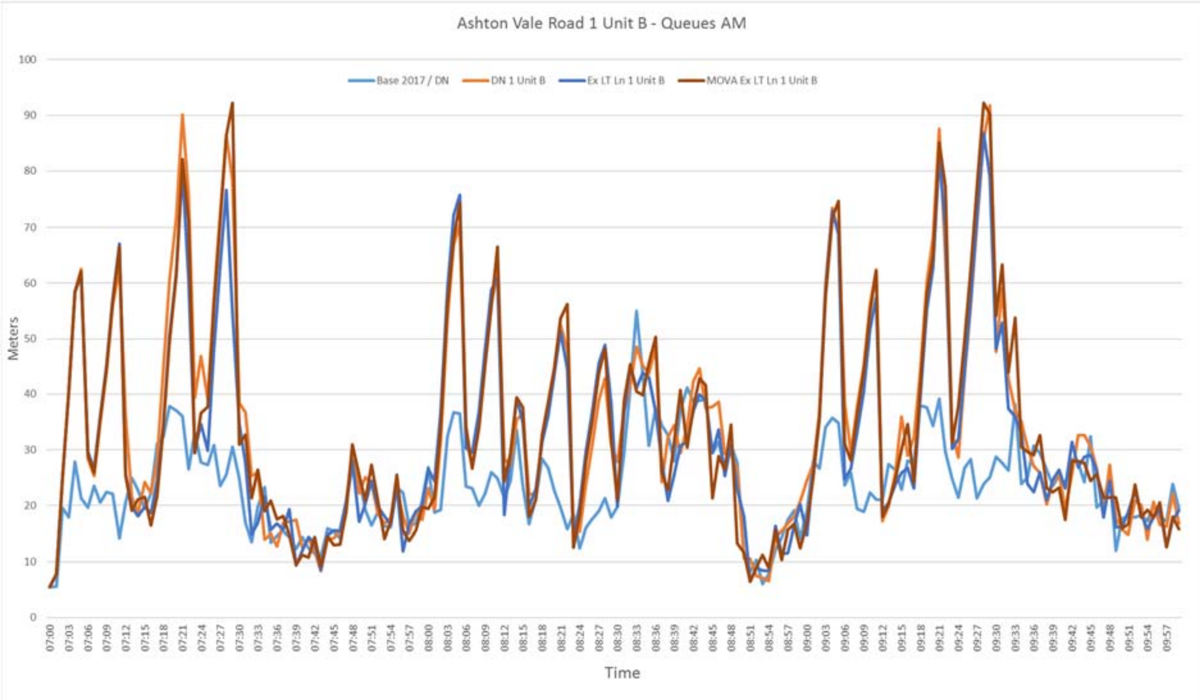


Figure 5.13 Ashton Vale Road, Queue Length Profile - Rail Scenario 1 Unit B - AM

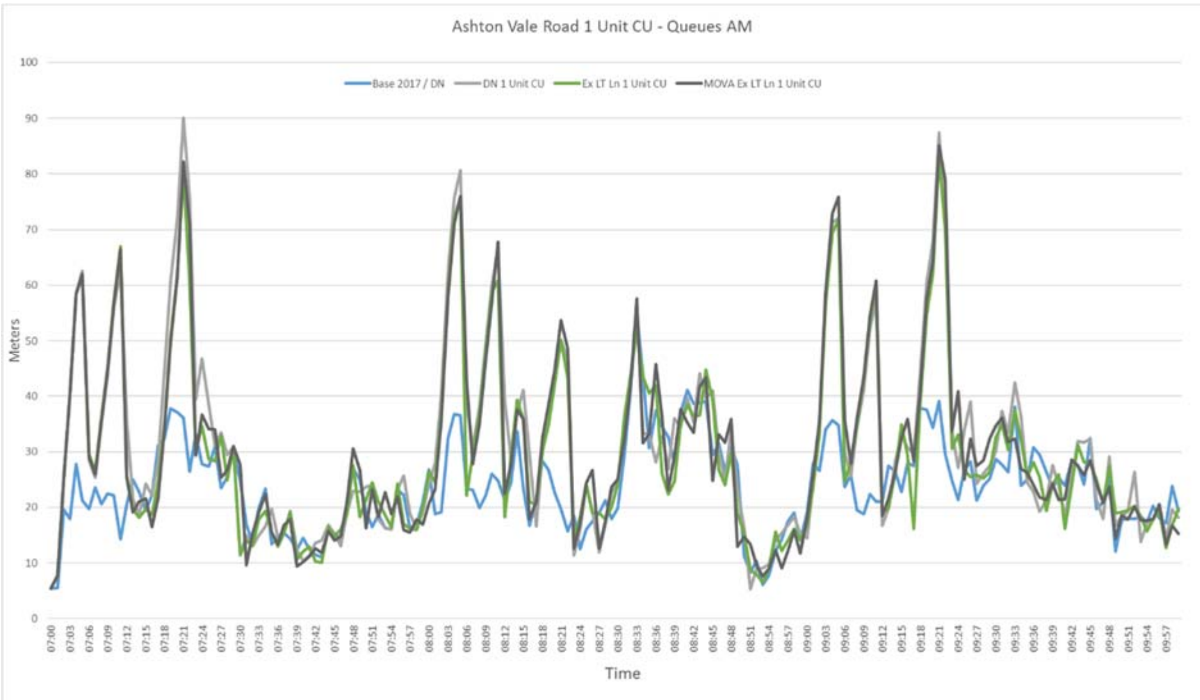


Figure 5.14 Ashton Vale Road, Queue Length Profile - Rail Scenario 1 Unit CU - AM

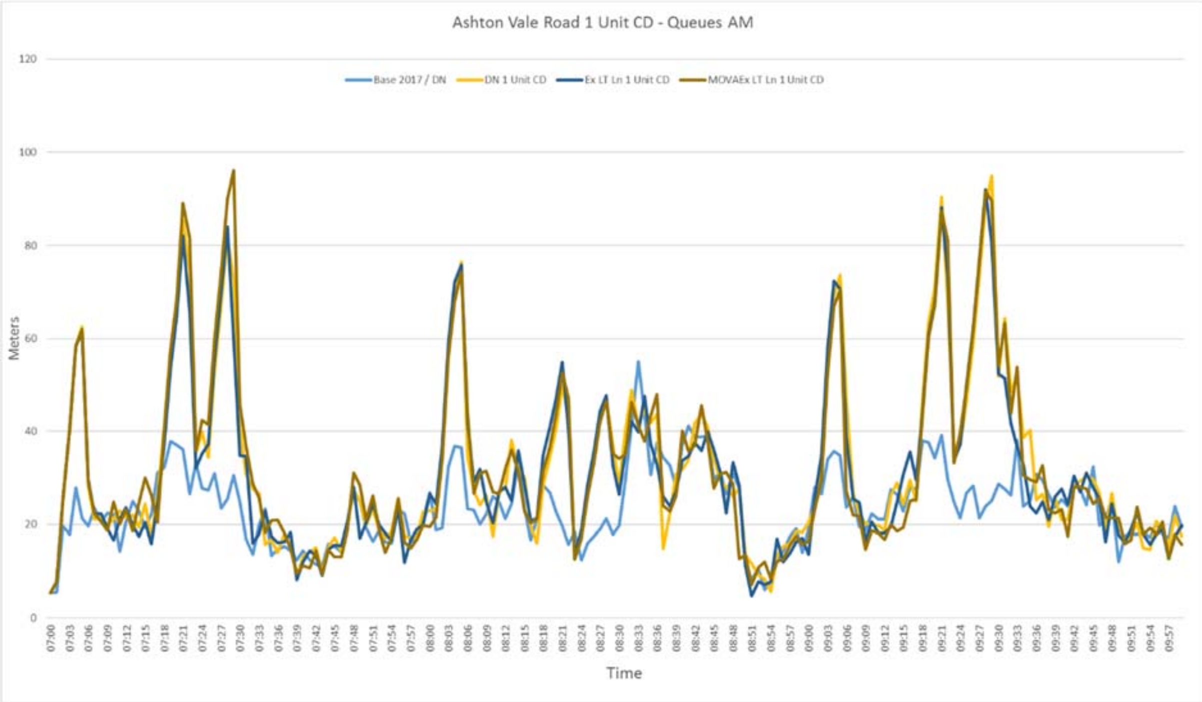


Figure 5.15 Ashton Vale Road, Queue Length Profile - Rail Scenario 1 Unit CD - AM

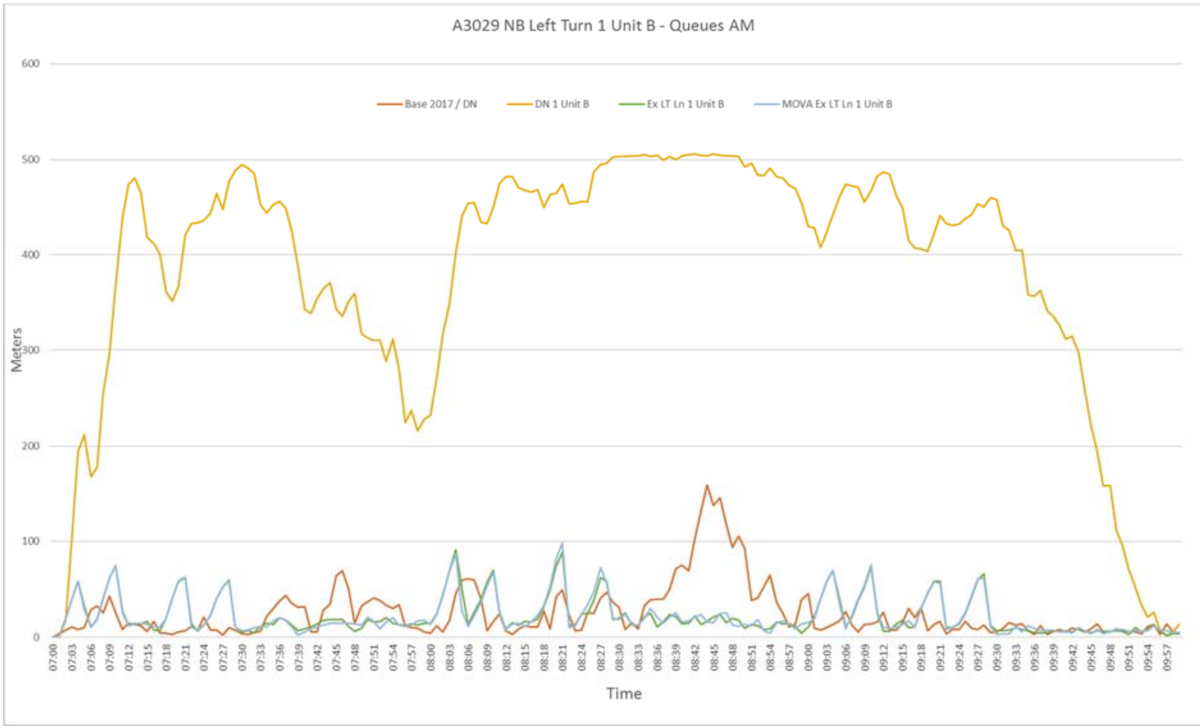


Figure 5.16 Winterstoke Road n/b Left Turn, Queue Length Profile - Rail Scenario 1 Unit CB - AM

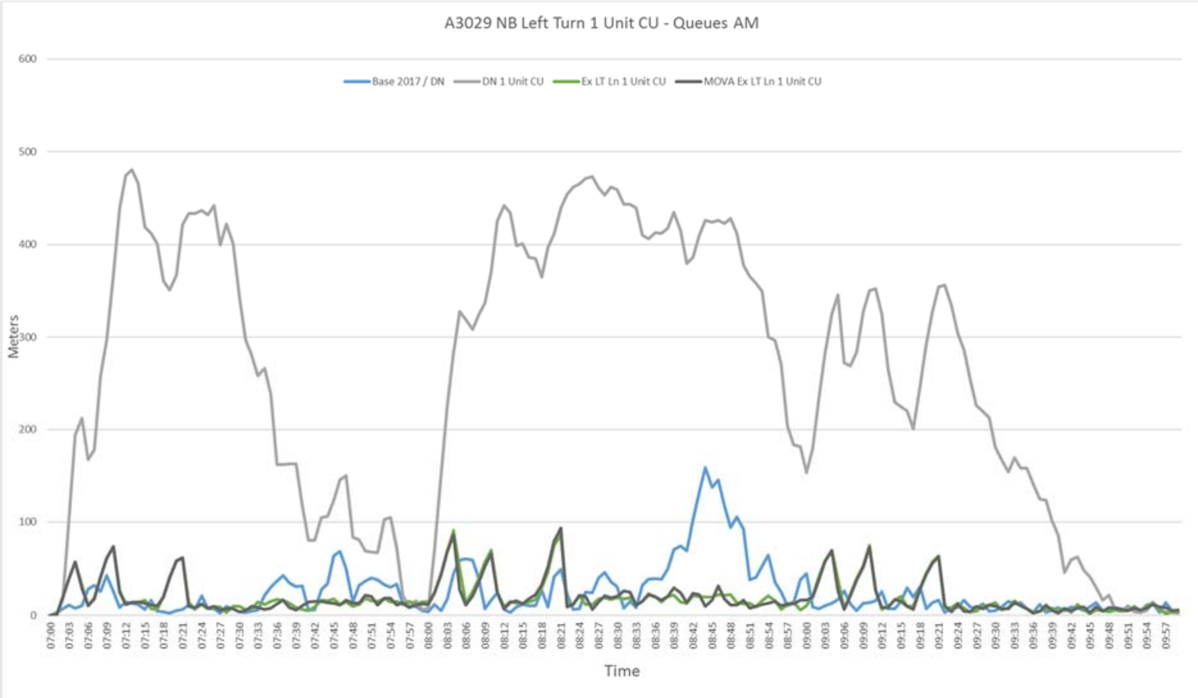


Figure 5.17 Winterstoke Road n/b Left Turn, Queue Length Profile - Rail Scenario 1 Unit CU - AM

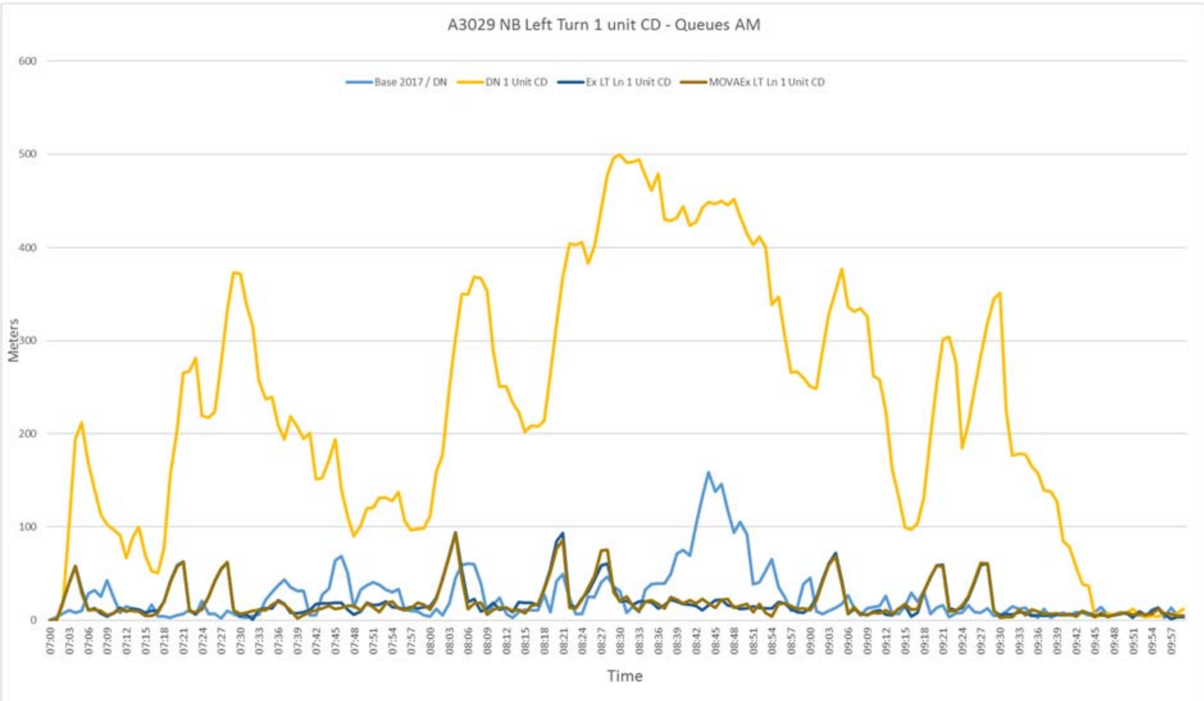


Figure 5.18 Winterstoke Road n/b Left Turn, Queue Length Profile - Rail Scenario 1 Unit CD - AM

Examination of the queue length profiles during the AM peak shows that without mitigation there is a significant increase in queuing on the Winterstoke Road northbound left turn which is persistent throughout much of the AM peak. The results show that the proposed extension of the left turn flare mitigates this impact to baseline levels.

With regard to Ashton Vale Road, the queue profiles highlight short spikes in queuing associated with level crossing closures. However, these spikes are relatively short with queue lengths returning to baseline levels within two to three minutes.

Figures **5.19 to 5.24** compare the Winterstoke Road northbound left turn and Ashton Vale Road modelled queue length profiles for all scenarios for the PM peak period. As before, the base queue length profile is also shown within these in order to provide a benchmark for comparison. Queue graphs for other approaches to the junction are provided in in **Appendix C**.

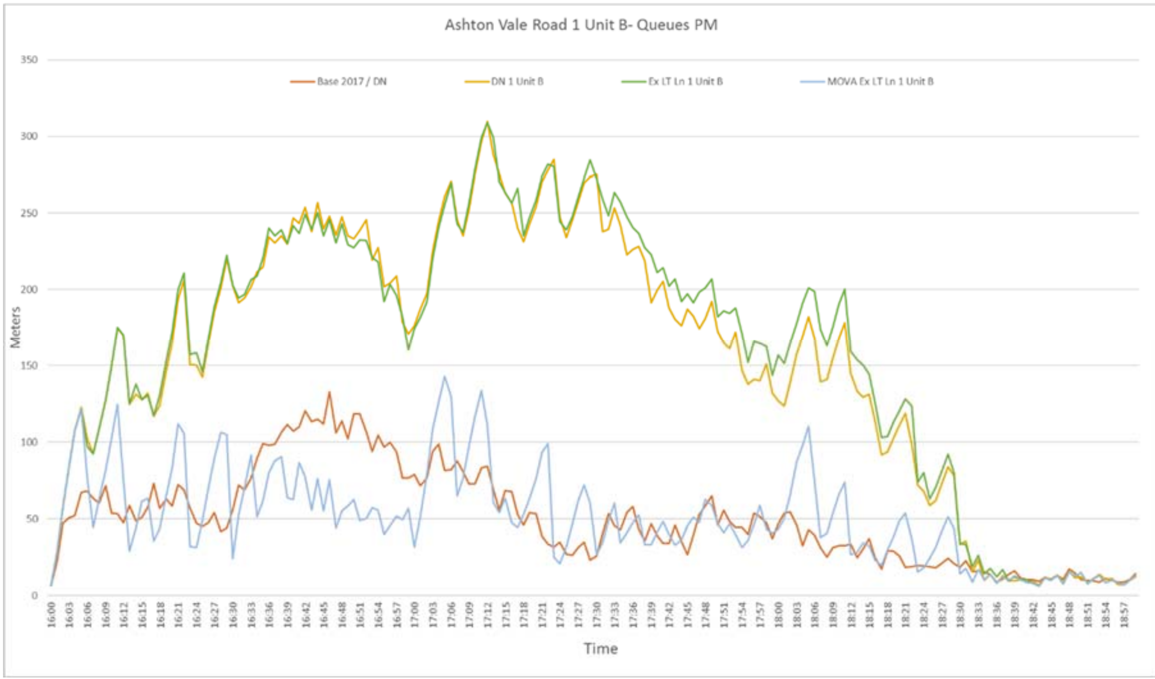


Figure 5.19 Ashton Vale Road, Queue Length Profile - Scenarios 1 Unit B - PM

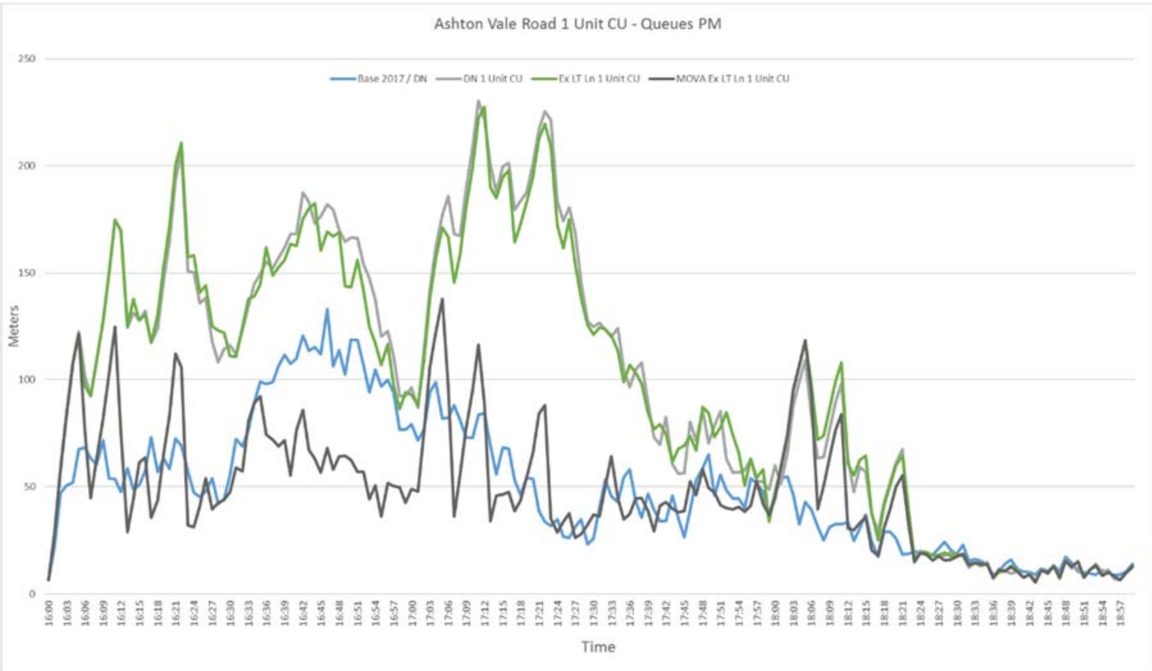


Figure 5.20 Ashton Vale Road, Queue Length Profile - Scenarios 1 Unit CU - PM

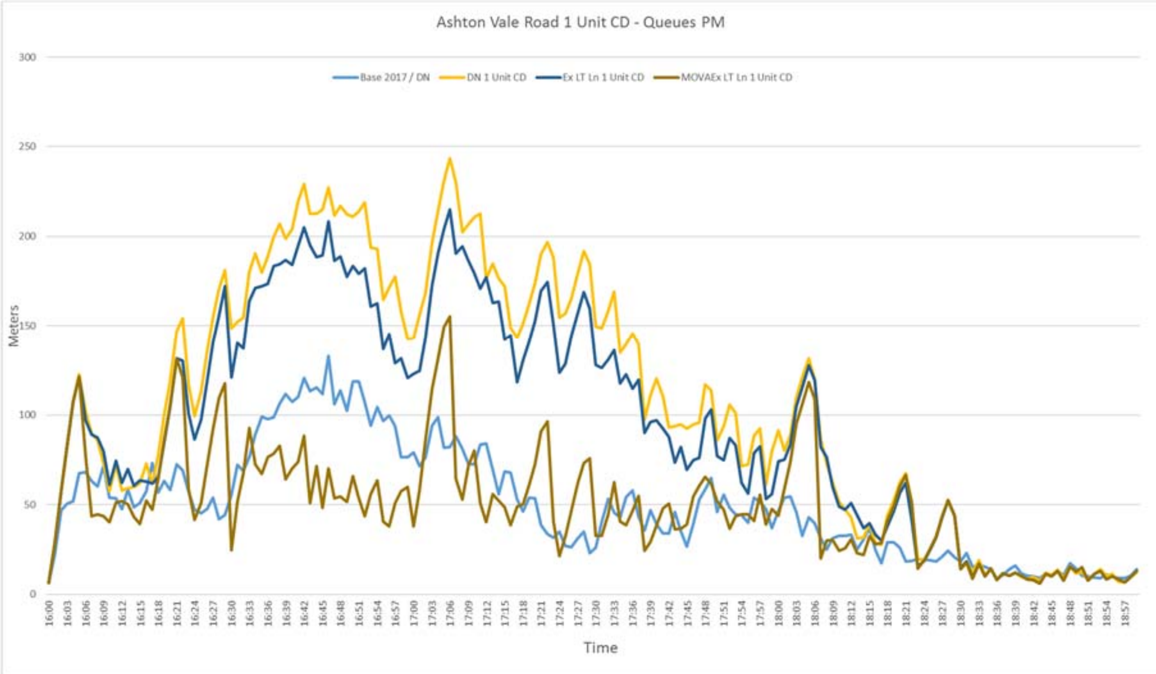


Figure 5.21 Ashton Vale Road, Queue Length Profile - Scenarios 1 Unit - PM

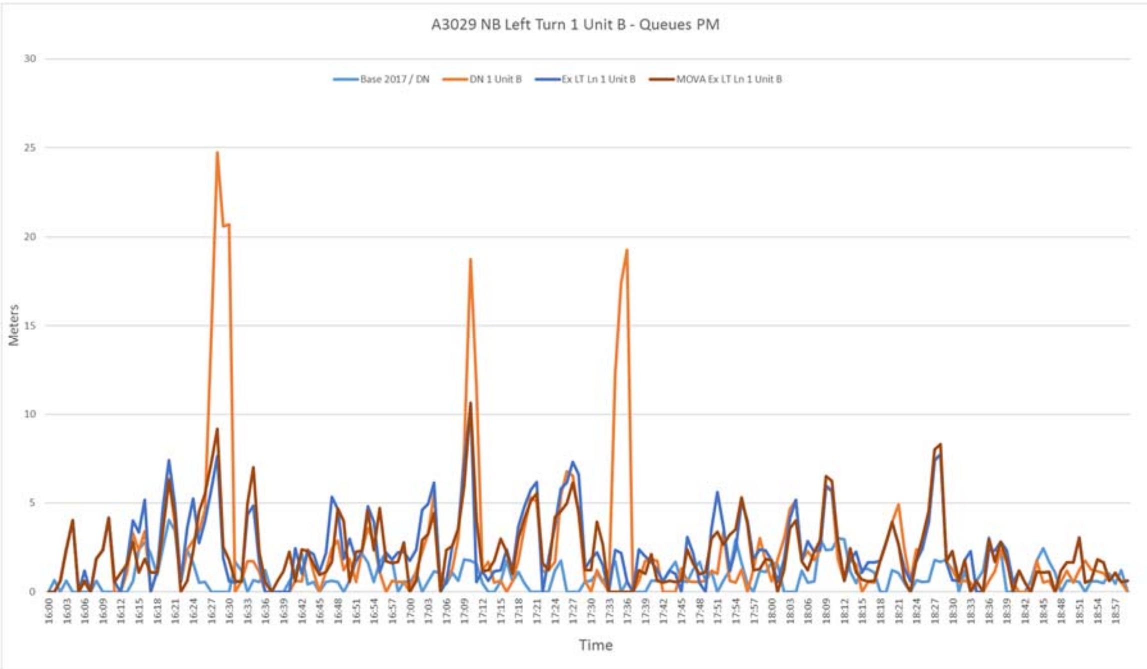


Figure 5.22 Winterstoke Road n/b Left Turn, Queue Length Profile – Rail Scenario 1 Unit - PM

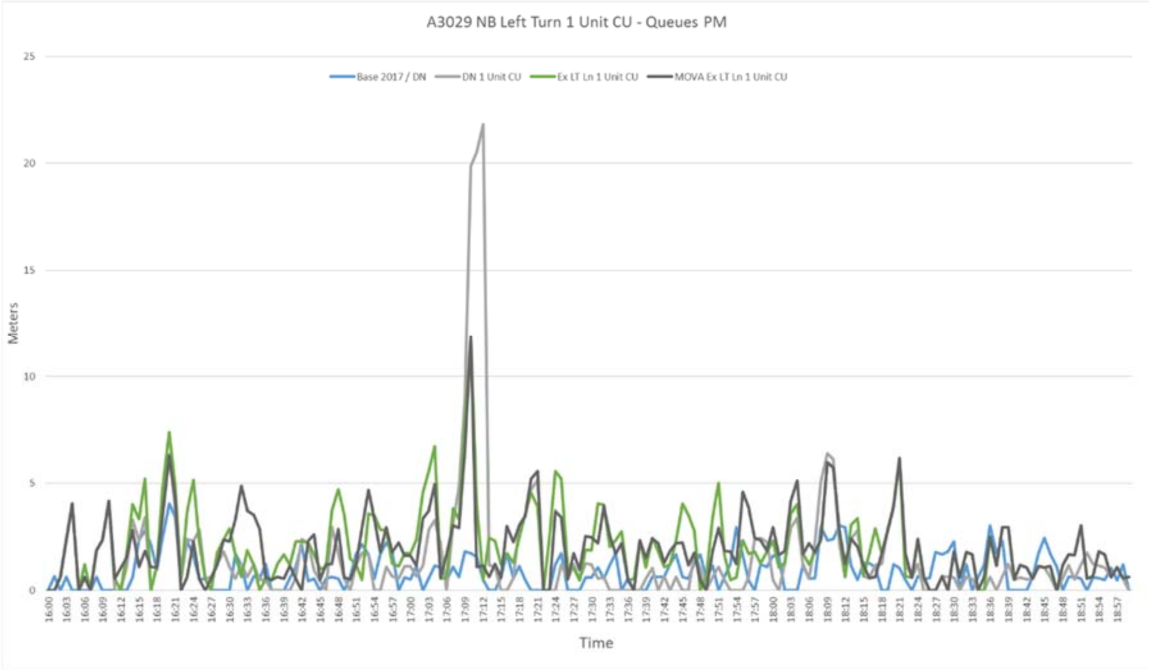


Figure 5.23 Winterstoke Road n/b Left Turn, Queue Length Profile – Rail Scenario 1 Unit - PM

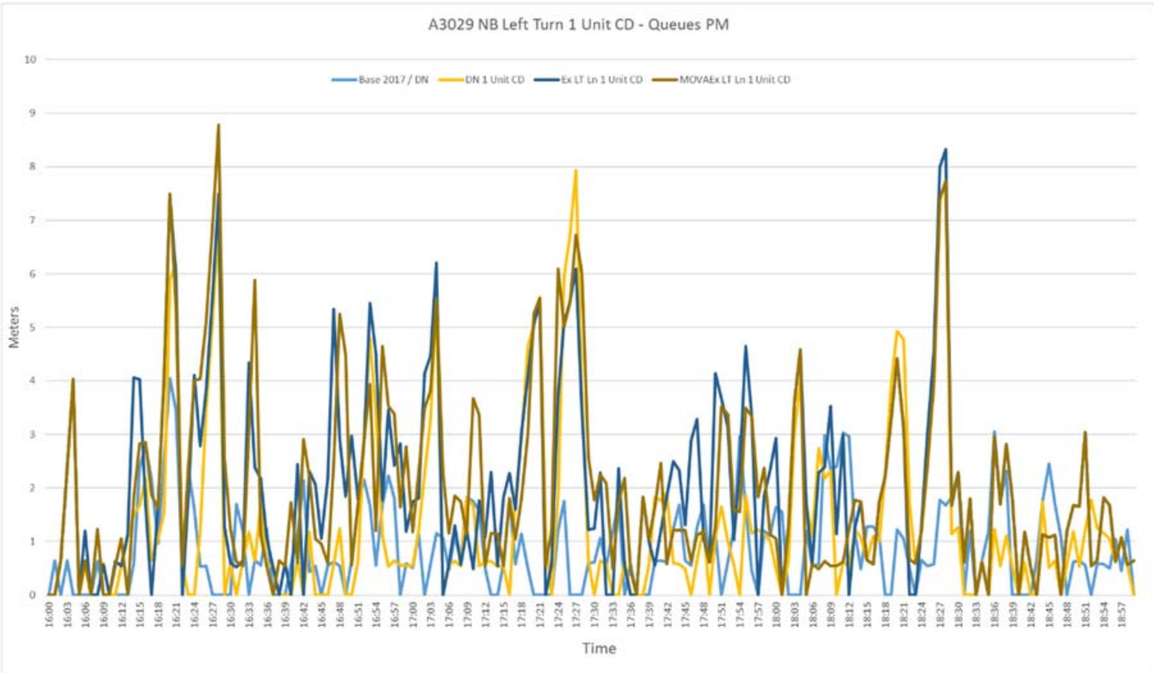


Figure 5.24 Winterstoke Road n/b Left Turn, Queue Length Profile – Rail Scenario 1 Unit - PM

Examination of the queue length profile graphs shows that without mitigation queue lengths on Ashton Vale Road greatly increase compared to the base situation. Unsurprisingly, the extension of the Winterstoke Road left turn flare does little to resolve this. However, the introduction of MOVA is shown to reduce overall queuing to baseline model levels.

5.3.4 Travel Times

Figures 5.25 to 5.30 compare modelled travel times for the three potential network configurations (Do-Nothing, Extended Left Turn and Extended Left Turn with MOVA within each of the three rail scenarios for the AM peak hour (08:00-09:00). Again, the results from the base model are included for reference.

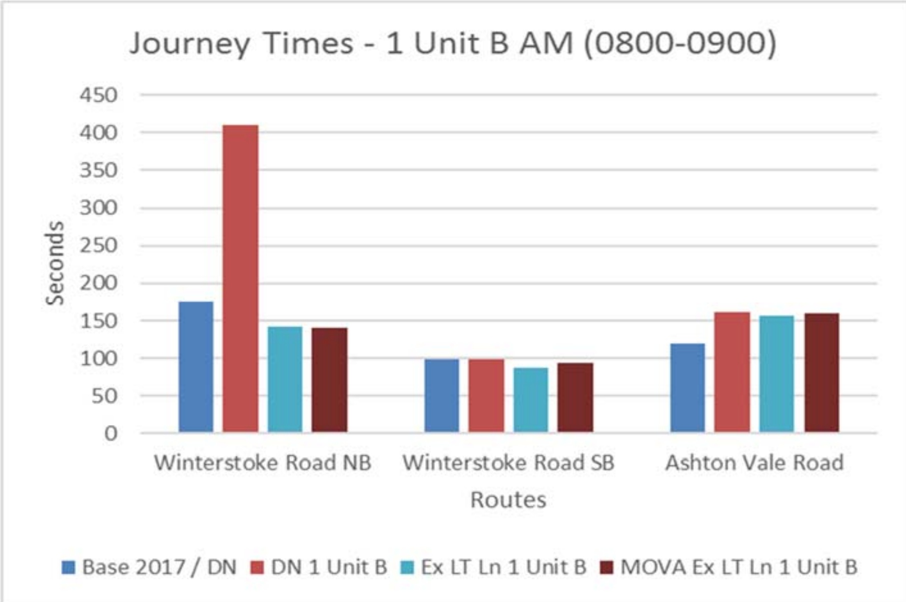


Figure 5.25 Modelled Journey Time Comparison, Rail Scenario 1 Unit B – AM

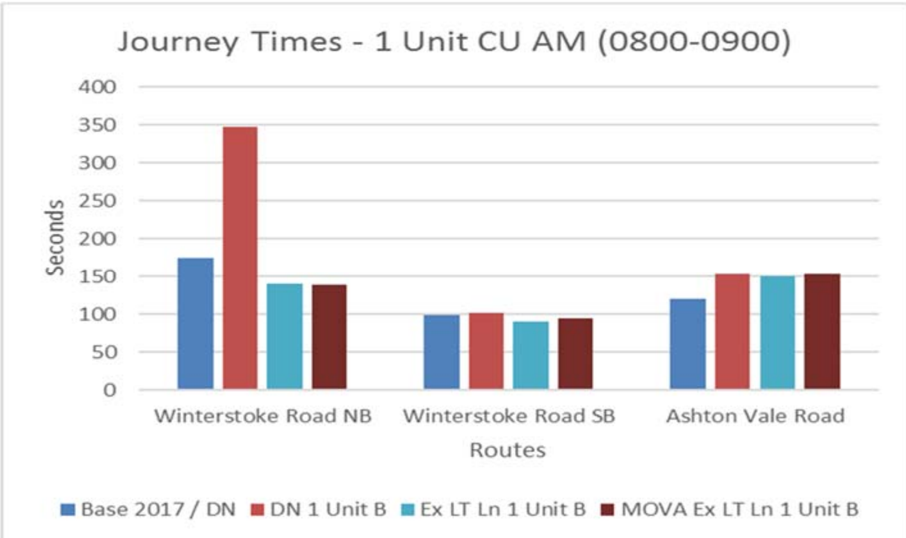


Figure 5.26 Modelled Journey Time Comparison, Rail Scenario 1 Unit CU - AM

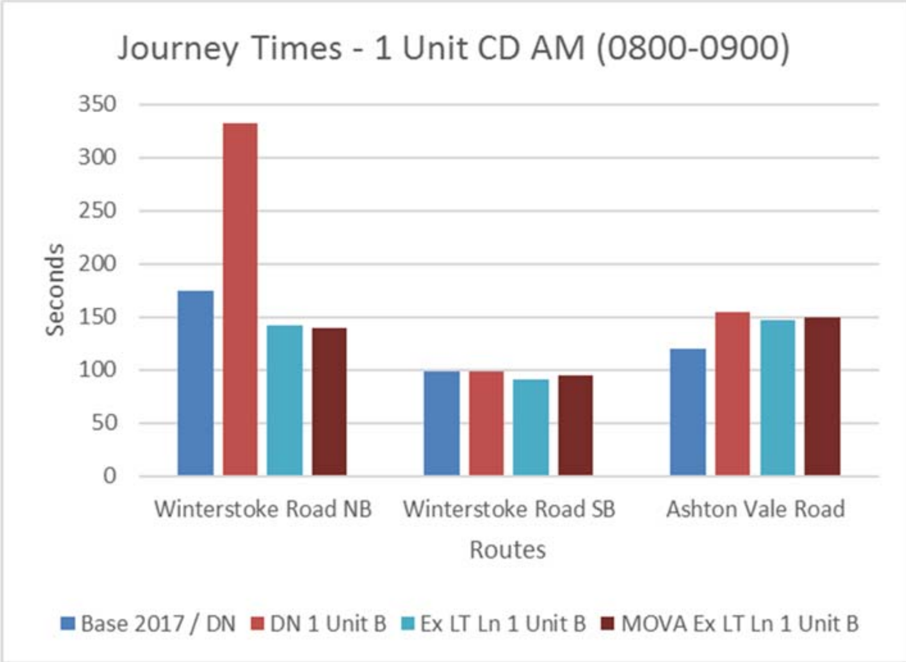


Figure 5.27 Modelled Journey Time Comparison, Rail Scenario 1 Unit CD - AM

The graphs highlight large increases in journey time during the AM peak hour on Winterstoke Road northbound under the Do-Nothing scenario, particularly under the Worst Case 1 Unit B rail scenario. The graphs also show, however, that the impact of MetroWest, even under this worst-case rail scenario, are completely mitigated by the extension of the Winterstoke Road left turn flare.

Figures 5.28 to 5.30 compare modelled travel times for the three potential network configurations (Do-Nothing, Extended Left Turn and Extended Left Turn with MOVA within each of the three rail scenarios for the PM peak hour 17:00-18:00). Again, the results from the base model are included for reference.

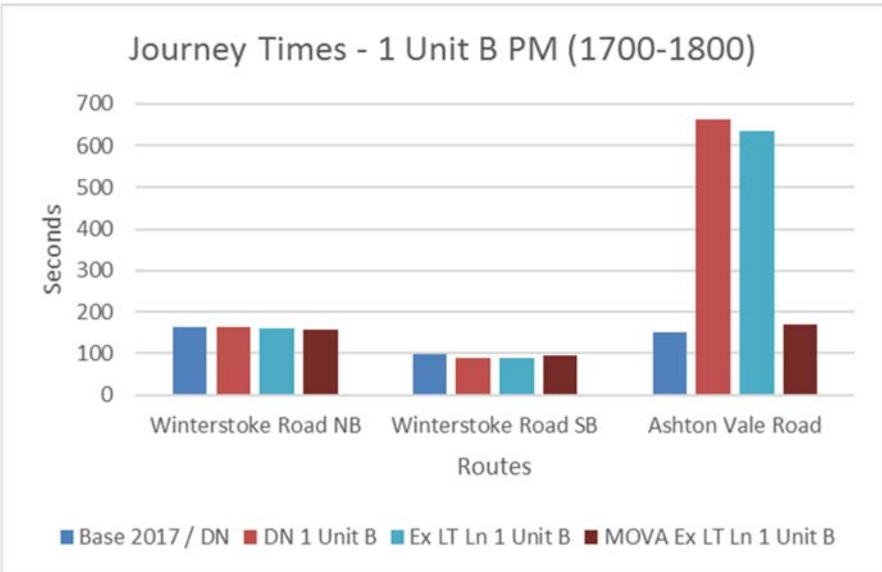


Figure 5.28 Modelled Journey Time Comparison, Rail Scenario 1 Unit B - PM

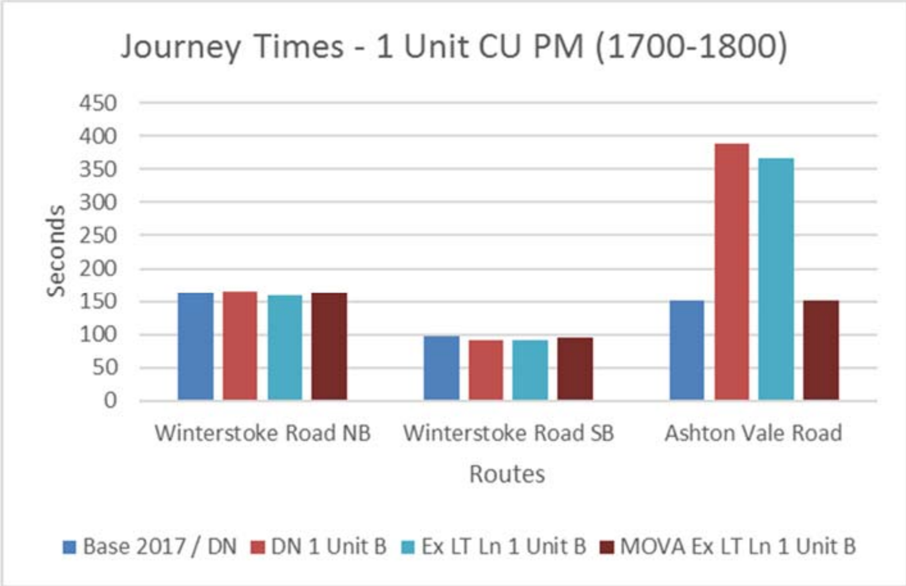


Figure 5.29 Modelled Journey Time Comparison, Rail Scenario 1 Unit CU - PM

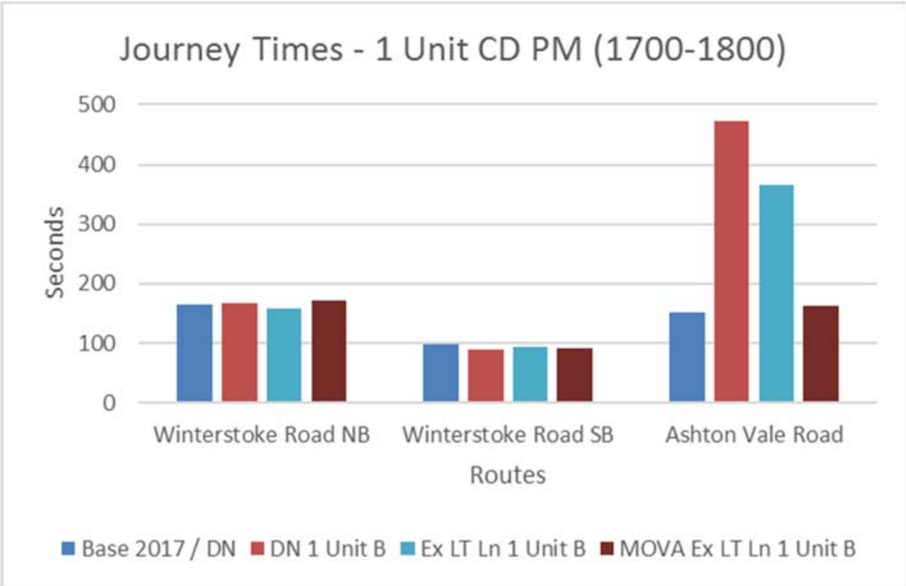


Figure 5.30 Modelled Journey Time Comparison, Rail Scenario 1 Unit CD - PM

Examination of the journey time results for PM modelled scenarios highlights that without mitigation MetroWest is expected to lead to significant increases in journey time for vehicles seeking to exit the industrial estate via Ashton Vale Road. The graphs show that the introduction of the extended left turn on Winterstoke Road will do little to alleviate this increase. The introduction of MOVA and an assumed increase in green time to this arm is predicted to fully mitigate this impact with overall mean journey times for the PM peak comparable to baseline levels.

Sensitivity Test

6.1 Scenarios Modelled

Network Rail has supplied an additional rail scenario reflecting a 45-minute interval rail scenario. This has been tested in VISSIM over the three-hour model period during the AM and PM peaks. As with the previous testing, these rail timings were tested in three different networks. Theses being:

- 'Do-Nothing' Scenario;
- 'Ext Lt Lane' Scenario; and
- 'MOVA Ext Lt Lane' Scenario.

6.2 Assessment Outputs

6.2.1 Observations from Simulation

As before, within the Do-Nothing network, it was observed that the operational conditions within the modelled network were highly congested with queuing on Winterstoke Road northbound during the AM (Figure 6.1) and Ashton Vale Road during the PM (Figure 6.2) appearing worse than under the previous testing because of the more frequent level crossing closures.

Figure 6.1 VISSIM Model Do-Nothing 45 Minute Service – Winterstoke Road Queuing AM

Figure 6.2 VISSIM Model Do-Nothing 45 Minute Service – Aston Vale Road Queuing PM

With Extended Left Turn Lane

With the extended left lane turn from the Winterstoke Road northbound, it was observed that the signalised junction operated well during the AM peak period. As before, queues on the Winterstoke Road northbound left turn into Ashton Vale Road were contained within the extended flare (see Figure 6.3). However, notable queuing on Ashton Vale Road was still noted particularly during the PM peak period following a level crossing closure (see Figure 6.4).

Figure 6.3 VISSIM Model Ext LT Lane 45 Minute Service – Improved Queuing on Winterstoke Road AM

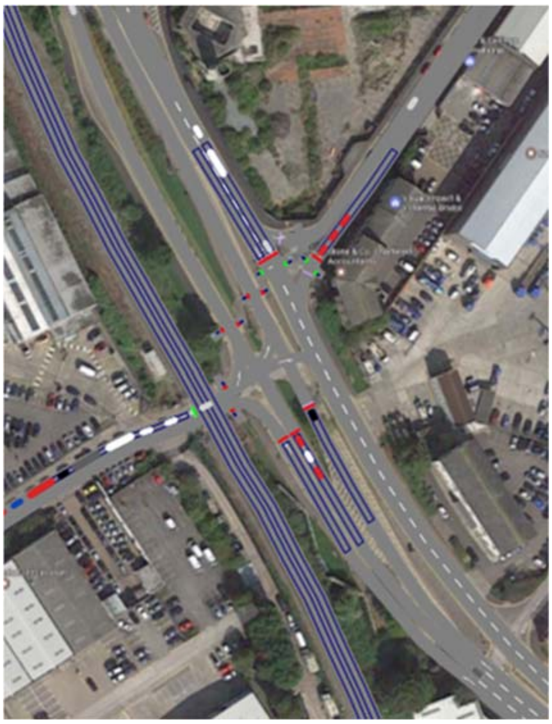


Figure 6.4 VISSIM Model Ext LT Lane 45 Minute Service – Ashton Vale Road Queuing PM

With Extended Left Turn Lane and MOVA

With the introduction of all mitigation measures, queue lengths were once again well managed on Ashton Vale Road following level crossing closures (see Figure 6.6) with the additional green time clearing queues relatively quickly (two to three minutes) following a level crossing closure.

Figure 6.5 VISSIM Model Ext LT Lane MOVA 45 Minute Service – Improved Queuing on Winterstoke Road AM

Figure 6.6 VISSIM Model Ext LT Lane and MOVA 45 Minute Service – Ashton Vale Road Queuing PM

6.2.2 Network Performance Evaluation

To quantify the overall operational conditions arising in each of the 45-minute interval rail modelled scenarios, network performance indicators were extracted from the model. **Table 6.1 and 6.2** summarise the overall network conditions and key performance indicators for each of the scenarios during the AM and PM peak periods.

Table 6.1: Performance Indicators for Rail Scenario 45 Minute Service, AM Peak, 2017

Network Performance Indicators	Time Period	Base	Do-Nothing	Ex Lt Ln	MOVA Ex Lt Ln
Total Number of Vehicles (Arrived)	07:00-10:00	2744	2695	2747	2746
Total Distance (mi)	07:00-10:00	2272	2585	2622	2622
Total Travel Time (s)	07:00-10:00	401913	1034849	422787	425354
Average Speed (mph)	07:00-10:00	21	10	22	22
Total Delay (secs)	07:00-10:00	97467	701219	83330	85921
Average Delay Time per Vehicle (secs)	07:00-10:00	33	233	29	30
Total Stopped Delay (secs)	07:00-10:00	65694	501821	58231	60831
Average Stopped Delay per Vehicles (secs)	07:00-10:00	23	167	20	21
Number of Stops	07:00-10:00	2580	21750	1812	1800
Average Number of Stops per Vehicles (secs)	07:00-10:00	1	7	1	1

The table above clearly show that during the AM peak period the inclusion of the left turn lane from the A3029 towards Ashton vale Road is still capable of mitigating the impact of MetroWest with a 45-minute service interval highlighted in the Do-Nothing scenario.

Table 6.2: Performance Indicators for Rail Scenario 45 Minute Service, PM Peak, 2017

Network Performance Indicators	Time Period	Base	Do-Nothing	Ex Lt Ln	MOVA Ex Lt Ln
Total Number of Vehicles (Arrived)	16:00-19:00	2836	2839	2839	2839
Total Distance (mi)	16:00-19:00	2292	2605	2605	2605
Total Travel Time (s)	16:00-19:00	424041	539949	542060	450618
Average Speed (mph)	16:00-19:00	20	18	18	21
Total Delay (secs)	16:00-19:00	121046	203994	206114	114782
Average Delay Time per Vehicle (secs)	16:00-19:00	40	67	68	38
Total Stopped Delay (secs)	16:00-19:00	88889	172482	174673	83975
Average Stopped Delay per Vehicles (secs)	16:00-19:00	29	56	57	28
Number of Stops	16:00-19:00	2553	2584	2566	2328
Average Number of Stops per Vehicles (secs)	16:00-19:00	1	1	1	1

The network performance results for the PM peak period clearly show that introduction of MOVA control yields operational conditions comparable to those under the base situation under the sensitivity test rail scenario (45-minute interval services).

For an indication of the congestion and delay predicted for the future year scenarios, for the 45-minute interval rail service, overall network performance indices were run for each scenario. From the results, above, **Figure 6.7 to 6.8** shows the average delay per vehicle (s), the Total delay time and the total travel time on the network for the base and all future modelled scenarios.

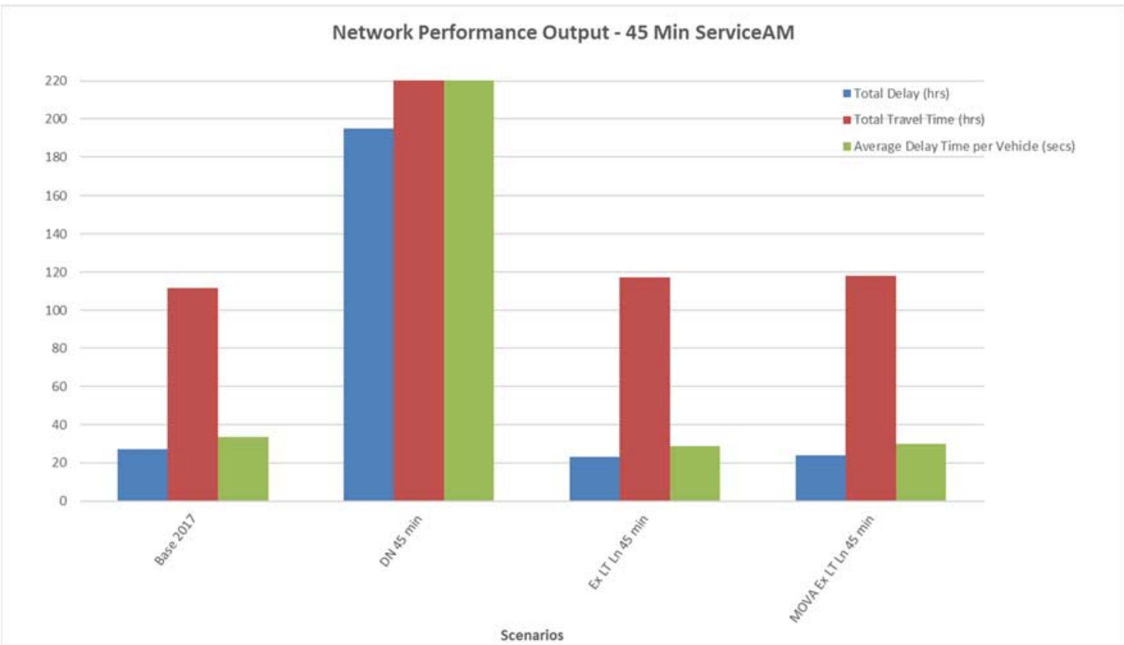


Figure 6.7 Network Performance Outputs for VISSIM Model Scenarios 45 Minute Service – AM

The figure above indicates that the inclusion of the left turn lane from the A3029 still has a highly beneficial impact on the junction when compared to the Do-Nothing. The results show that the addition of MOVA does not provide any further benefit to the network during this period.

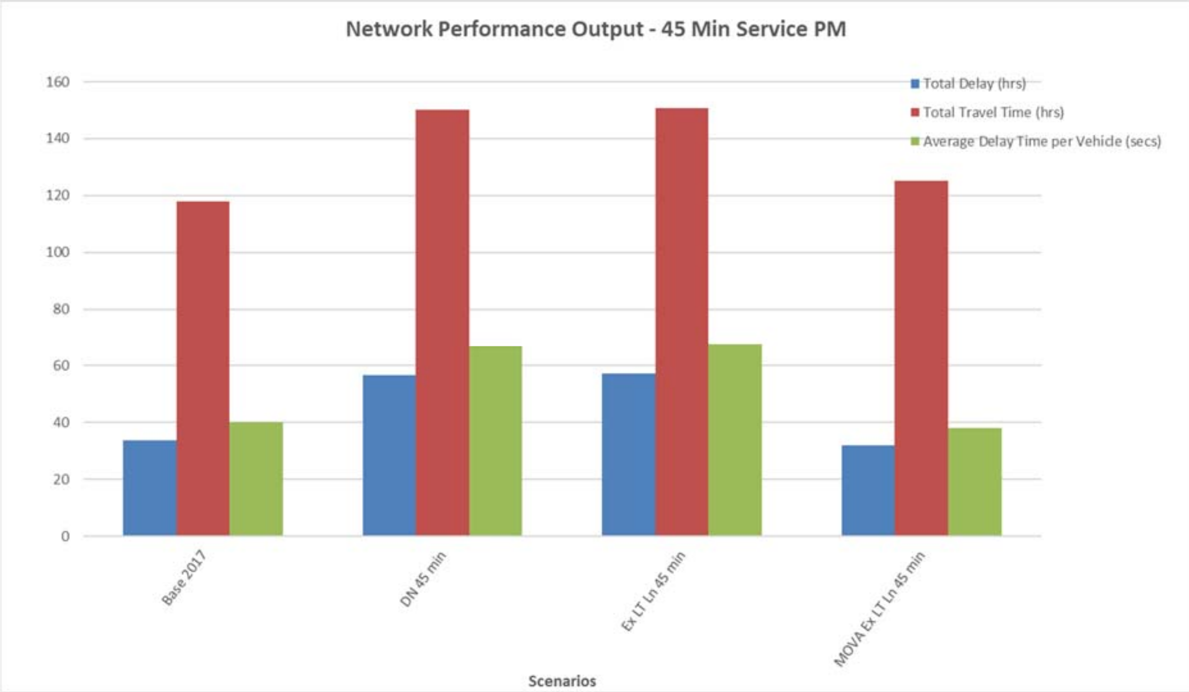


Figure 6.8 Network Performance Outputs for VISSIM Model Scenarios 45 Minute Service - PM

Again, the results show that the introduction of MOVA is expected to mitigate the impact of MetroWest, even with the higher frequency 45-minute service interval.

6.2.3 Queue Lengths

Figures 6.9 to 6.10 compare the Winterstoke Road northbound left turn and Ashton Vale Road queue length profiles for the 45-minute interval rail scenario for the AM peak period. Queue graphs for other approaches to the junction are provided in in **Appendix D.**

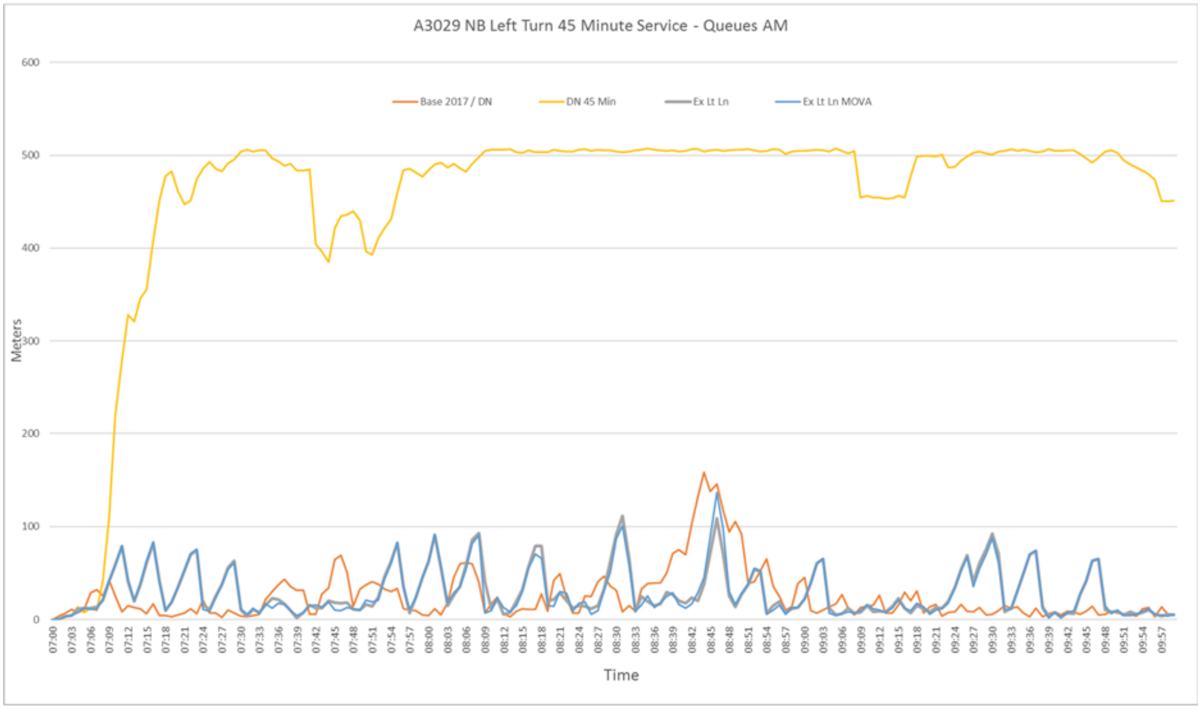


Figure 6.9 Winterstoke Road n/b Left Turn, Queue Length Profile - Rail Scenario 45 Minute Service - AM

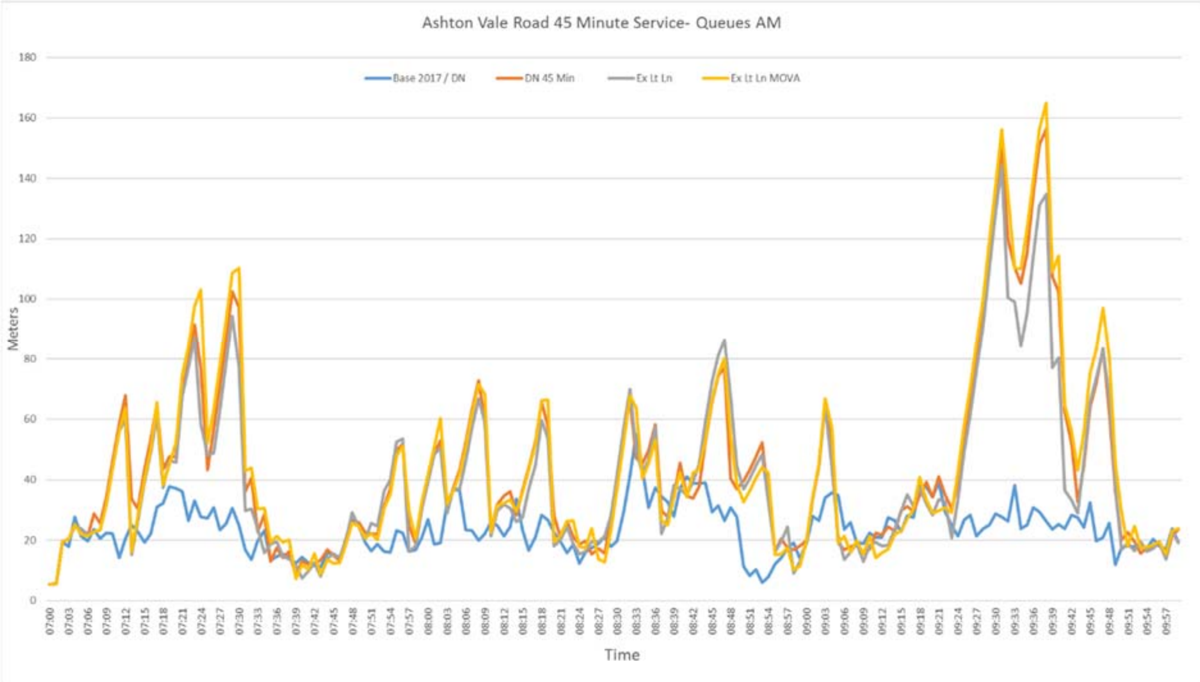


Figure 6.10 Ashton Vale Road, Queue Length Profile - Rail Scenario 45 Minute Service - AM

The results show that the proposed extension of the left turn flare mitigates the impact of MetroWest under the sensitivity test rail scenario. On Ashton Vale Road, the graph highlights short spikes in queuing although queue return to baseline levels within two to three minutes.

Figures **6.11 to 6.12** compare the Winterstoke Road northbound left turn and Ashton Vale Road modelled queue length profiles for the PM peak period. As before, the base queue length profile is also shown within these in order to provide a benchmark for comparison. Queue graphs for other approaches to the junction are provided in in **Appendix D**.

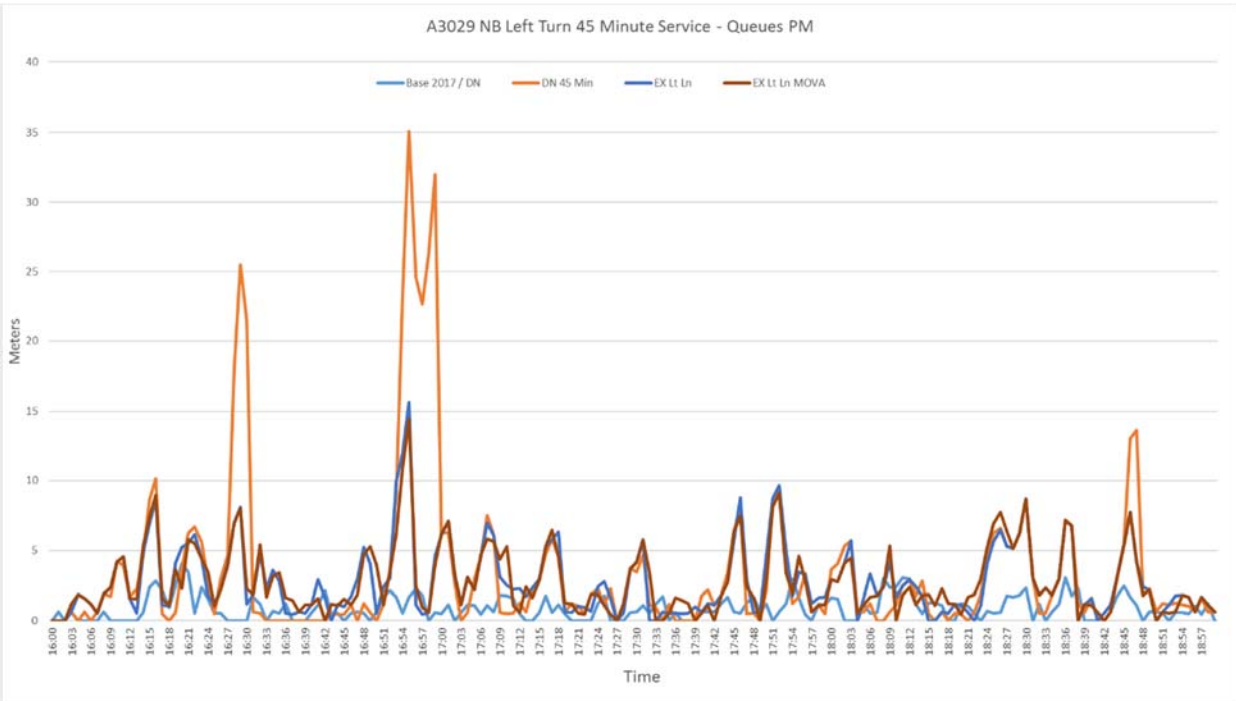


Figure 6.11 Winterstoke Road n/b Left Turn, Queue Length Profile – Rail Scenario 45 Minute Service – PM

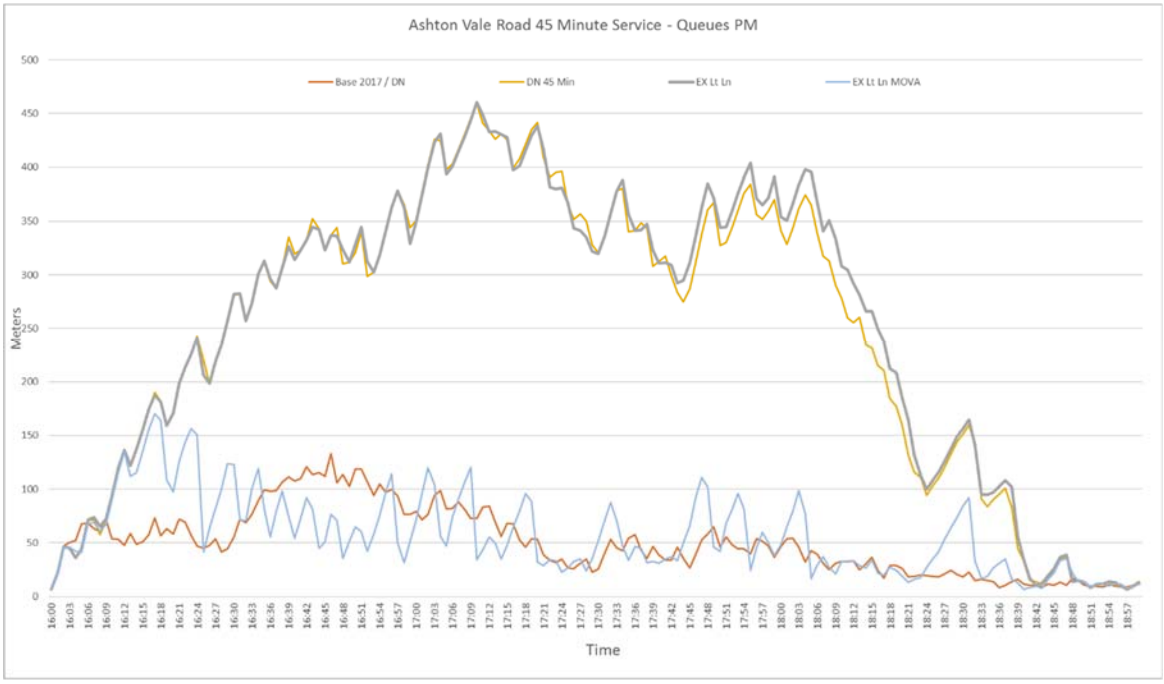


Figure 6.12 Ashton Vale Road, Queue Length Profile - Scenarios 45 Minute Service - PM

Examination of the queue length profile graphs shows that without mitigation queue lengths on Ashton Vale Road greatly increase compared to the base situation. Once again, the introduction of MOVA is required to reduce overall queuing to baseline model levels.

6.2.4 Travel Times

Figure 6.13 compare modelled travel times for the three potential network configurations (Do-Nothing, Extended Left Turn and Extended Left Turn with MOVA with the 45-minute interval rail service scenario for the AM peak hour (08:00-09:00).

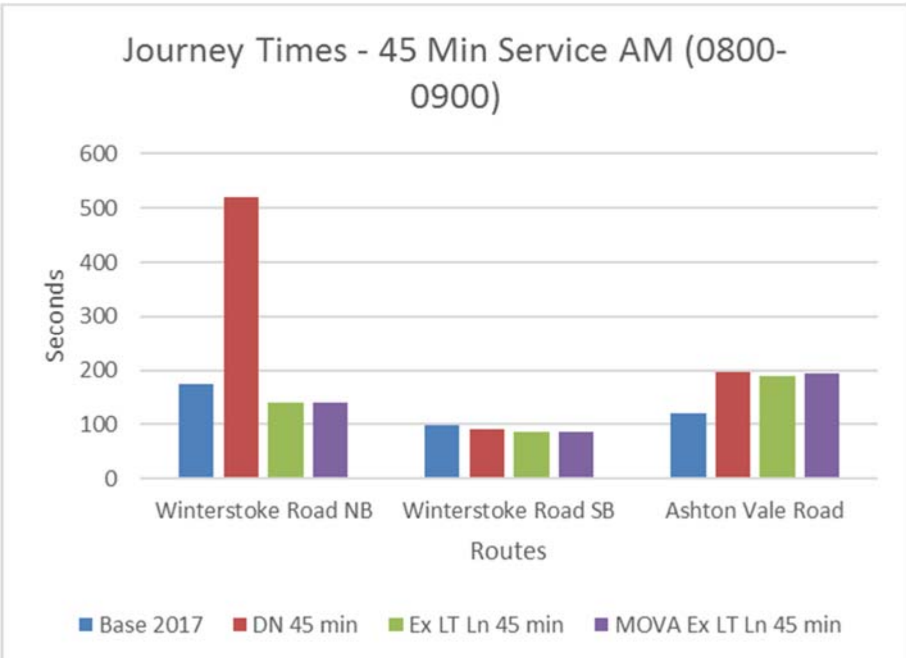


Figure 6.13 Modelled Journey Time Comparison, Rail Scenario 45 Minute Service – AM

As before, the graph also shows that the impact of MetroWest, are completely mitigated by the extension of the Winterstoke Road left turn flare.

Figure 6.14 compares modelled travel times for the three potential network configurations (Do-Nothing, Extended Left Turn and Extended Left Turn with MOVA for the 45-minute interval rail service scenario for the PM peak hour 17:00-18:00).

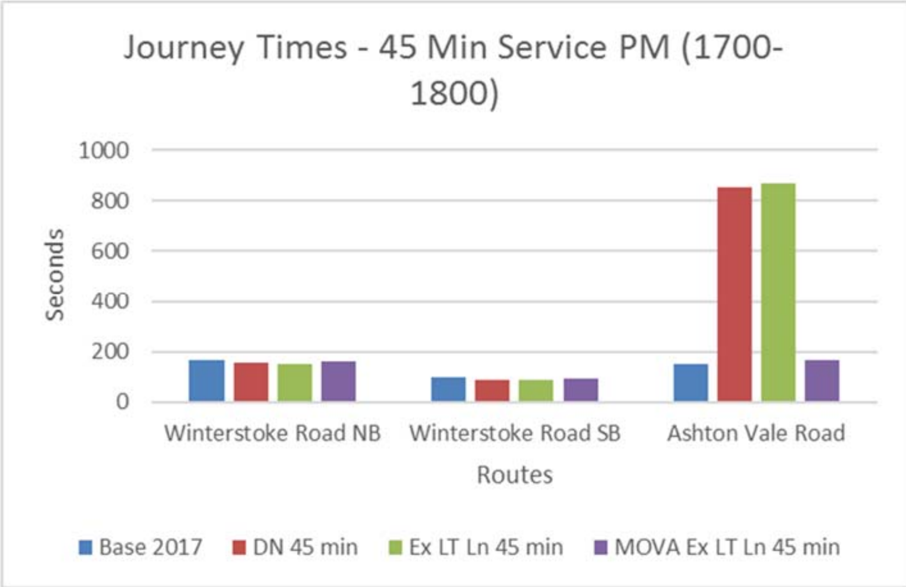


Figure 6.14 Modelled Journey Time Comparison, Rail Scenario 45 Minute Service - PM

Examination of the journey time results for PM modelled scenario highlights that without mitigation MetroWest with a 45-minute service interval is expected to lead to significant increases in journey time for vehicles seeking to exit the industrial estate via Ashton Vale Road. The graphs show that the introduction of MOVA is still predicted to mitigate this impact with overall mean journey times for the PM peak comparable to baseline levels.

Summary and Conclusions

7.1 Summary

This report has presented the results of an assessment of the impact of MetroWest Phase 1 proposals on operational conditions within the local highway network on the approaches to the Winterstoke Road/Ashton Vale Road traffic signals and adjacent level crossing. MetroWest Phase 1 will result in greater use of the railway line leading to potentially longer and more frequent level crossing closures during which traffic on Winterstoke Road turning left into Ashton Vale Road, and on Ashton Vale Road are held on red whilst train services clear the level crossing.

The assessment has been carried out using a VISSIM micro-simulation traffic model which has been developed for the Winterstoke Road/Ashton Vale Road junction and adjacent level crossing. This model has been calibrated using recent turning count data collected during 2017 and validated to moving car observer journey times also collected during 2017. The calibration and validation checks meet and exceed the required acceptability criteria and demonstrate that the model is fit for purpose of assessing the impact of MetroWest and testing associated mitigation.

A series of three different rail scenarios have been tested which differ in terms of the number and frequency of level crossing closures. A standard closure time of approximately four minutes has been assumed in all scenarios representing a worst case based on rail service information supplied by Network Rail.

The results of scenario testing show that there will be a significant increase in queuing and delay on the Winterstoke Road northbound mainline and on Ashton Vale Road under the various MetroWest rail scenarios without any mitigation under all rail scenarios. The worst-case impacts occur under rail scenario 1 Unit B during which level crossing closures in quick succession lead to a notable deterioration in network conditions compared to base scenario.

Two options for mitigation of these impacts were tested using the VISSIM model. The first involved the extension of the Winterstoke Road northbound left turn flare to a length of circa 150 metres in order to try to store traffic queuing to the level crossing and prevent it from impeding the main through movement. The second mitigation package tested included the extension of the left turn flare along with changes to the signals to simulate MOVA control providing more green to the Winterstoke Road left turn and the Ashton Vale Road phases.

The assessment results show that the extension of the left turn flare on Winterstoke Road mitigates against the impact of longer and more frequent level crossing closures even under the worst case 1 Unit B rail scenario during the AM peak, when traffic volumes are their highest. Examination of queue lengths show that vehicles waiting to turn left into the industrial estate can be stored within the extended lane and so will not block the dominant ahead movements towards the A370.

Consequently, aggregate network conditions and journey times for through movements on Winterstoke Road northbound during the AM peak hour are predicted to be comparable to base model conditions, that is, with no level crossing closures assumed.

Whilst the assessment highlights that the extended left turn flare is effective at mitigating the potential impact of MetroWest on Winterstoke Road, the modelling shows that queues and delays are expected to worsen on Ashton Vale Road. The modelling shows, however, that the introduction of MOVA, and the provision of a longer green signal phase to arms affected by the level crossing, is expected to enable the signals to recover much faster with queues returning to 'normal' levels within one to two minutes. The results also show that with MOVA aggregate conditions within the modelled network under all rail scenarios are comparable to the base situation.

A sensitivity test was undertaken to see the likely impact on the junction if a 45-minute interval rail service, over a three-hour period, if it was to be implemented. The results of this testing suggest that the proposed left turn flare extension on Winterstoke Road northbound and the introduction of MOVA at the junction can still mitigate the impact even under a more frequent service pattern.

7.2 Conclusions

The modelling assessment demonstrates that, for both the hourly and 45-minute rail service, with all of the combined mitigation (extension of the left turn and MOVA), there will be no overall detriment to the highway level of service within the local network. The results show that with a level crossing barrier down times of up to four minutes, and assuming the Worst-Case number and timing of rail movements (for both the hourly and 45-minute rail service), traffic on Winterstoke Road queuing to turn left into Ashton Vale Road can do so without blocking the main northbound ahead traffic flow during the AM period when the left turn flow into Ashton Vale Road is dominant.

With respect of traffic queuing to exit Ashton Vale Road, the model shows that with the same level crossing barrier down times and the worst case rail scenario (number and timing of rail movements for both the hourly and 45-minute rail service), traffic queues show only a modest increase compared to baseline levels, but return to these levels within two to three minutes during the critical PM peak period when large volumes are exiting the industrial estate.

The level crossing barriers will be down over the highway for up to approximately 12 ½ minutes per hour in total, consequently the barriers will be up for approximately 47 ½ minutes or more per hour. For the 45-minute interval rail service the crossing barrier will be down for up to approximately 16 ½ minutes. The modelling shows that the proposed mitigation will provide an extended green signal phase for traffic entering and exiting Ashton Vale Road when the level crossing barriers are up. This is without detriment to other approach arms to the junction. This is also apparent for the sensitivity test of a 45-minute interval rail scenario.

The overall position is the increased green signal phase for approximately 47 ½ minutes or more per hour is greater than the time the traffic signals are red, when the barriers are down. This together with the relatively short periods for traffic conditions to return to normal conditions (after the level crossing barriers are lifted) shows that the proposed mitigation more than off-sets the impact of the increased cycles of the level crossing barriers.

The modelling includes allowance of an increased level of freight train operations (above the existing average volume) based on existing commercial rights held by Bristol Port. This approach has provided a robust basis for the assessment of the impacts of the MetroWest Phase 1 proposals on the level crossing and its users. The assessment demonstrates that it will not be necessary to provide alternative highway access for Stage B of the scheme and that there is no technical case for its delivery for Stage B. However, in the medium term after the delivery of Stage B, should funding for Stage C be identified, and subject to further technical work and separate processes and consents (business case, planning consent, voluntary/compulsory acquisition of land etc.) it is likely that alternative highway access will need to be considered.

Appendix A – Portbury Freight Operation

Review of existing Portbury freight operations in the context of MetroWest Phase 1 proposals

The Portbury freight line is a freight only branch line linking Royal Portbury Dock (part of Bristol Port) with the Bristol to Taunton main line, at Parson Street Junction (south of Parson Street station). The Portbury freight line is owned and operated by Network Rail, except for the last 500m of line approaching Royal Portbury Dock Gates which is a siding owned and operated by Bristol Port.

The volume of freight train traffic varies in accordance with national and international supply chain markets. For instance, while the volume of coal being transported by freight train has decreased notably over the last few years, other markets are being explored by the Port and there remains a regular flow of cars/vans and containers on the line. The number of freight train movements currently averages between 5 and 10 freight trains per week, but historically the average has been higher. The Port has commercial rights to operate 20 freight trains in each direction per day (which is broadly one freight train per hour in each direction). Over the working week (Mon-Fri) the Port could operate up to 100 freight trains in each direction (200 freight rains in total), without the need for any new planning consents for the freight line.

MetroWest Phase 1 proposes to operate either 18 or 20 passenger trains in each direction per day (Mon to Saturday) and approximately 10 passenger trains on Sundays, giving a total of up to 130 passenger trains in each direction per week, totalling 260 passenger trains per week. Taking account of the existing average of up to 10 freight trains per week the total number of trains (passenger and freight) per week would be approximately 270 trains, see table below.

Table 1 – Based on Existing Freight Train Operations (Average Volume)

Day of Week	Existing Freight Train Operations (Average Volume)	Proposed MetroWest Phase 1 passenger Trains	Total
Mon - Friday	Average up to 10 freight trains (5-day total)	18 or 20 passenger trains in each direction	Up to 40 passenger trains per day x 5 days = 200 trains, plus 10 freight trains (5-day total)
Sat	Only operated occasionally in very early hours (Sat AM)	18 or 20 passenger trains in each direction	Up to 40 passenger trains per day
Sun	Only operated occasionally in very late hours (Sun PM)	10 passenger trains in each direction	Up to 20 passenger trains per day
Total Per Week	Average up to 10 freight trains (5-day total)	130 passenger trains in each direction per week (260 in total)	Up to 270 trains per week in total

This would result in a net increase of 70 trains per week in comparison with the existing commercial rights to operate up to 200 train per week.

However, to provide a robust basis for assessment of impact on the level crossing and its users, growth of freight train operations up to the maximum commercial rights has to be considered, as the number of freight trains thus operated could increase significantly beyond the existing volume. Assessment in this report has taken account of the following freight train volume scenarios:

- 20 freight trains one freight train in one direction per hour (hourly in one direction), giving a weekly total of 100 freight trains (ref model run 1 Unit CU and 1 Unit CD) and
- 20 freight trains in each direction per hour (hourly in each direction), giving weekly total of 200 freight trains (Ref model run 1 Unit B).

Taking account of the proposed MetroWest Phase 1 passenger train service with up to 260 passenger trains per week, and operating up to 100 freight trains per week (half the maximum commercial rights) this assessment included 360 trains per week for model run 1 Unit CU and 1 Unit CD, see table below.

Table 2 – Based on Existing Freight Train Operations (Half of Maximum Commercial Rights)

Day of Week	**Future Freight Train Operations (Half of Maximum Commercial Rights)**	**Proposed MetroWest Phase 1 passenger Trains**	**Total**
Mon - Friday	Commercial rights to operate up to 20 trains in one direction only	18 or 20 passenger trains in each direction	Up to 40 passenger trains per day x 5 days = 200 trains, plus 20 freight trains per day
Sat	Only operated occasionally in very early hours (Sat AM)	18 or 20 passenger trains in each direction	Up to 40 passenger trains per day
Sun	Only operated occasionally in very late hours (Sun PM)	10 passenger trains in each direction	Up to 20 passenger trains per day
Total Per Week	100 freight trains per week	130 passenger trains in each direction per week (260 in total)	Up to 360 trains per week in total

Taking account of the proposed MetroWest Phase 1 passenger train service with up to 260 passenger trains per week, and operating up to 200 freight trains per week (maximum commercial rights) this assessment included 460 trains per week for model run 1 Unit B, see table below.

Table 3 – Based on Existing Freight Train Operations (Half of Maximum Commercial Rights)

Day of Week	**Future Freight Train Operations (Maximum Commercial Rights)**	**Proposed MetroWest Phase 1 passenger Trains**	**Total**
Mon - Friday	Commercial rights to operate up to 20 trains in both directions	18 or 20 passenger trains in each direction	Up to 40 passenger trains per day x 5 days = 200 trains, plus 40 freight trains per day
Sat	Only operated occasionally in very early hours (Sat AM)	18 or 20 passenger trains in each direction	Up to 40 passenger trains per day
Sun	Only operated occasionally in very late hours (Sun PM)	10 passenger trains in each direction	Up to 20 passenger trains per day
Total Per Week	200 freight trains per week	130 passenger trains in each direction per week (260 in total)	Up to 460 trains per week in total

Appendix B – Network Rail Data

Note that this is for a standard hour, so times '09:xx:xx' also apply to other hours

			NO signalling mitigation				WITH signalling mitigation			ROUNDED	WITH signalling mitigation			CALCULATED
			Road closes *time*	Closure duration *min:sec*	Road opens *time*	Min time to next closure *min:sec*	Road closes *time*	Closure duration *min:sec*	Road opens *time*	Min time to next closure *min:sec*	Road closes *time*	Closure duration *min:sec*	Road opens *time*	Min time to next closure *min:sec*

USING 'ROUNDED' TIMES | USING 'CALCULATED' TIMES

1 passenger train per hr per dir - 1 freight train per hr per dir - PILL JUNCTION | **1 hr** – **1 Unit B** | **1 hr** – **1 Unit B**

Pasenger	UP	from Portishead	08:53:30	02:44	08:56:30	10:30	08:53:30	03:00	08:56:30	10:30	08:53:46	02:44	08:56:30	10:46
Freight	UP	from Portbury	09:07:00	02:44	09:10:00	06:00	09:07:00	03:00	09:10:00	08:00	09:07:16	02:44	09:10:00	08:16
Passenger	DOWN	to Portishead	09:16:00	05:14	09:21:30	02:00	09:18:00	03:30	09:21:30	03:30	09:18:16	03:14	09:21:30	03:46
Freight	DOWN	to Portbury	09:23:30	05:14	09:29:00	24:30	09:25:00	04:00	09:29:00	24:30	09:25:16	03:44	09:29:00	24:46
		TOTAL		15:56			TOTAL	13:30			TOTAL	12:26		

1 passenger train per hr per dir - 1 freight train per hr in one direction only (up) - PILL JUNCTION | **1 hr** – **1 Unit CU** | **1 hr** – **1 Unit CU**

Pasenger	UP	from Portishead	08:57:30	02:44	09:00:30	07:30	08:57:30	03:00	09:00:30	07:30	08:57:46	02:44	09:00:30	07:46
Freight	UP	from Portbury	09:08:00	02:44	09:11:00	05:00	09:08:00	03:00	09:11:00	07:00	09:08:16	02:44	09:11:00	07:16
Passenger	DOWN	to Portishead	09:16:00	05:14	09:21:30	36:00	09:18:00	03:30	09:21:30	36:00	09:18:16	03:14	09:21:30	36:16
		TOTAL		10:42			TOTAL	09:30			TOTAL	08:42		

1 passenger train per hr per dir - 1 freight train per hr in one direction only (down) - PILL JUNCTION | **1 hr** – **1 Unit CD** | **1 hr** – **1 Unit CD**

Pasenger	UP	from Portishead	08:57:30	02:44	09:00:30	04:30	08:57:30	03:00	09:00:30	04:30	08:57:46	02:44	09:00:30	04:46
Passenger	DOWN	to Portishead	09:05:00	05:14	09:10:30	05:30	09:05:00	05:30	09:10:30	05:30	09:05:16	05:14	09:10:30	05:46
Freight	DOWN	to Portbury	09:16:00	05:14	09:21:30	36:00	09:16:00	05:30	09:21:30	36:00	09:16:16	05:14	09:21:30	36:16
		TOTAL		13:12			TOTAL	14:00			TOTAL	13:12		

USING 'ROUNDED' TIMES | USING 'CALCULATED' TIMES

45 minute interval passenger services - 3 hour cycle of movements | **3 hours** – **45 minute cycles** | **3 hours** – **45 minute cycles**

Freight	UP	from Portbury	09:08:00	03:00	09:11:00	02:00		09:08:00	03:00	09:11:00	02:00	09:08:16	02:44	09:11:00	02:16
Passenger	UP	from Portishead	09:13:00	03:00	09:16:00	00:30		09:13:00	03:00	09:16:00	02:30	09:13:16	02:44	09:16:00	02:46
Passenger	DOWN	to Portishead	09:16:30	05:30	09:22:00	01:00		09:18:30	03:30	09:22:00	02:30	09:18:46	03:14	09:22:00	02:46
Freight	DOWN	to Portbury	09:23:00	05:30	09:28:30	24:30		09:24:30	04:00	09:28:30	24:30	09:24:46	03:44	09:28:30	24:46
Freight	UP	from Portbury	09:53:00	03:00	09:56:00	02:00		09:53:00	03:00	09:56:00	02:00	09:53:16	02:44	09:56:00	02:16
Passenger	UP	from Portishead	09:58:00	03:00	10:01:00	00:30		09:58:00	03:00	10:01:00	02:30	09:58:16	02:44	10:01:00	02:46
Passenger	DOWN	to Portishead	10:01:30	05:30	10:07:00	05:30		10:03:30	03:30	10:07:00	07:00	10:03:46	03:14	10:07:00	07:16
Freight	DOWN	to Portbury	10:12:30	05:30	10:18:00	10:00		10:14:00	04:00	10:18:00	10:00	10:14:16	03:44	10:18:00	10:16
Freight	UP	from Portbury	10:28:00	03:00	10:31:00	12:00		10:28:00	03:00	10:31:00	12:00	10:28:16	02:44	10:31:00	12:16
Passenger	UP	from Portishead	10:43:00	03:00	10:46:00	00:30		10:43:00	03:00	10:46:00	02:30	10:43:16	02:44	10:46:00	02:46
Passenger	DOWN	to Portishead	10:46:30	05:30	10:52:00	05:30		10:48:30	03:30	10:52:00	07:00	10:48:46	03:14	10:52:00	07:16
Freight	DOWN	to Portbury	10:57:30	05:30	11:03:00	20:00	0	10:59:00	04:00	11:03:00	20:00	10:59:16	03:44	11:03:00	20:16
Freight	UP	from Portbury	11:23:00	03:00	11:26:00	02:00	0	11:23:00	03:00	11:26:00	02:00	11:23:16	02:44	11:26:00	02:16
Passenger	UP	from Portishead	11:28:00	03:00	11:31:00	00:30		11:28:00	03:00	11:31:00	02:30	11:28:16	02:44	11:31:00	02:46
Passenger	DOWN	to Portishead	11:31:30	05:30	11:37:00	05:30		11:33:30	03:30	11:37:00	07:00	11:33:46	03:14	11:37:00	07:16
Freight	DOWN	to Portbury	11:42:30	05:30	11:48:00	20:00		11:44:00	04:00	11:48:00	20:00	11:44:16	03:44	11:48:00	20:16
		TOTAL		1:08:00				TOTAL	54:00			TOTAL	49:44		
		TOTAL /hr		22:40				TOTAL /hr	18:00			TOTAL /hr	16:35		

Bristol East- Portishead

Down

Class 150

Location		2C75	MW D	FR D	2Y16	1v50
Bristol West	arr					
	Line	DM	DM	DM	DM	DM
	dep	09:09:30	09:15:00	09:22:00	09:28:30	09:46:00
Bedminster	arr		09:16:30		09:30:30	
	Line		DM		DM	
	dep		09:17:00		09:31:00	
Parson Street	arr		09:19:00	09:26:30	09:33:00	
	Line	{2}	DM	DM	DM	
	dep		09:19:30	09:26:30	09:33:30	
Parson Street Junction	arr		09:20:00	09:27:00		
	Line					
	dep	09:12:30	09:20:00	09:27:00	09:34:00	09:49:30
Portishead Branch Line			**MW D**	**FR D**		
Ashton Junction	arr		09:21:30	09:29:00		
	Line					
	dep		09:21:30	09:29:00		
Pill	arr		09:33:00	09:40:30		
	Line					
	dep		09:33:30	09:40:30		
Portbury Dock	arr			09:45:00		
	Line					
	dep					
Portishead	arr		09:37:30			
	Line					
	dep					

Up

Class 150

Location		FR U		MW U		
Portishead	arr					
	Line					
	dep			08:40:30		
Portbury Dock	arr					
	Line					
	dep	08:54:30				
Pill	arr			08:45:00		
	Line					
	dep	08:58:30		08:45:30		
Ashton Junction	arr			08:56:30		
	Line					
	dep	09:10:00		08:56:30		
POD Line		**FR U**	**2U14**	**MW U**	**1S47**	**2.00E+62**
Parson Street Junction	arr					
	Line					
	dep	09:11:30	09:16:30	08:58:00	09:24:00	09:49:00
Parson Street	arr		09:17:00	08:58:30	09:24:30	09:49:30
	Line	URL	UM	URL	UM	UM
	dep	09:12:30		08:59:00		09:50:00
Bedminster	arr			09:01:00		09:52:00
	Line			URL		UM
		00:02:00				
	dep			09:01:30		09:52:30
Bristol West	arr	09:17:00	09:19:00	09:03:30	09:27:30	09:54:00
	Line	URL	UM	URL	UM	UM
	dep					

Direction	Time (hh:mm)	Time between previous (hh:mm)	Scenario C service type	Barrier closure sequence time	Platform dwell time	CPT Travel time PSN-Ash Jcn (mm:ss)	Strike In	CPT Travel time BED-PSN (mm:ss)	CPT Travel time Clifton-Ash Jcn (mm:ss)	Road closure total time	**Road closure timings (CALCULATED)** FROM (hh:mm)	TO (hh:mm)	**Road closure timings (ROUNDED)** FROM (hh:mm)	TO (hh:mm)	**MROT**	Comments
UP	08:56:30	00:00:00	Passenger	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	**08:53:46**	**08:56:30**	**09:01:00**	**09:05:00**	**00:00:00**	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
UP	09:10:00	00:13:30	Freight	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	**09:07:16**	**09:10:00**	**09:07:00**	**09:11:00**	**00:02:00**	
DOWN	09:21:30	00:11:30	Passenger	00:00:44	00:00:30	00:02:00	Bedminster track section	00:02:00		00:05:14	**09:16:16**	**09:21:30**	**09:16:00**	**09:21:00**	**00:05:00**	A TRTS can be used @ PSN station as the strike in to trigger the auto lower TAR path.
DOWN	09:29:00	00:07:30	Freight	00:00:44	00:00:00	00:02:30	Bedminster track section	00:02:00		00:05:14	**09:23:46**	**09:29:00**	**09:22:00**	**09:29:00**	**00:01:00**	A timer could be used
									00:20:00	**00:15:56 minutes total closure time at peak hour**						

MITIGATIONS

Signalling Mitigation	Road closure total time	**Road closure timings** FROM (hh:mm)	TO (hh:mm)	**MROT**	Comments
-	**00:02:44**	**09:01:00**	**09:05:00**	**00:00:00**	no change
-	**00:02:44**	**09:07:00**	**09:11:00**	**00:02:00**	no change
TRTS (+ Auto Lower)	**00:03:14**	**09:17:46**	**09:21:00**	**00:06:46**	TRTS = 30s reaction time from signaller + 01:00 travel time + 44s crossing time
timer (+auto lower)	**00:03:44**	**09:24:46**	**09:28:30**	**00:03:46**	3 minute timer could be used. The only issue is if the freight is quicker getting to parson street, it will be delayed waiting for the timer. A get around would be a 44sec timer added to the MAR control at Parson Street. This would allow the MAR control to activate and the crossing sequence to activate. once the crossing is complete, the MAR would also be complete.
00:14:58	**00:12:26**	**minutes total closure time at peak hour**			

TRTS - train ready to start

MROT - mimimum road opening time

Bristol East- Portishead

Down — **Class 150**

Location		2C75	MW D	FR D	2Y16	1v50
Bristol We	arr					
	Line	DM	DM		DM	DM
	dep	09:09:30	09:15:00		09:28:30	09:46:00
Bedminste	arr		09:16:30		09:30:30	
	Line		DM		DM	
	dep		09:17:00		09:31:00	
Parson Str	arr		09:19:00		09:33:00	
	Line	{2}	DM		DM	
	dep		09:19:30		09:33:30	
Parson Str	arr		09:20:00			
	Line					
	dep	09:12:30	09:20:00		09:34:00	09:49:30
Portishead Branch Line			**MW D**			
Ashton Jur	arr		09:21:30			
	Line					
	dep		09:21:30			
Pill	arr		09:33:00			
	Line					
	dep		09:33:30			
Portbury D	arr		09:36:00			
	Line					
	dep					
Portishead	arr		09:40:00			
	Line					
	dep					

Up — **Class 150**

Location		FR U		MW U		
Portishead	arr					
	Line					
	dep			08:43:00		
Portbury D	arr			08:44:30		
	Line					
	dep	08:55:30				
Pill	arr			08:49:00		
	Line					
	dep	08:59:30		08:49:30		
Ashton Jur	arr			09:00:30		
	Line					
	dep	09:11:00		09:00:30		
POD Line		**FR U**	**2U14**	**MW U**	**1S47**	**2.00E+62**
Parson Str	arr					
	Line					
	dep	09:12:30	09:16:30	09:02:00	09:24:00	09:49:00
Parson Str	arr		09:17:00	09:02:30	09:24:30	09:49:30
	Line	URL	UM	URL	UM	UM
	dep	09:13:30		09:03:00		09:50:00
Bedminste	arr			09:05:00		09:52:00
	Line			URL		UM
		00:02:00				
	dep			09:05:30		09:52:30
Bristol We	arr	09:18:00	09:19:00	09:07:30	09:27:30	09:54:00
	Line	URL	UM	URL	UM	UM
	dep					

Direction	Time (hh:mm)	Time between previous (hh:mm)	Scenario C service type	Barrier closure sequence time	Platform dwell time	CPT Travel time PSN-Ash Jcn (mm:ss)	Strike In	CPT Travel time BED-PSN (mm:ss)	CPT Travel time Clifton-Ash Jcn (mm:ss)	Road closure total time	**Road closure timings (CALCULATED)** FROM (hh:mm)	TO (hh:mm)	**Road closure timings (ROUNDED)** FROM (hh:mm)	TO (hh:mm)	**MROT**	Comments
UP	09:00:30	00:00:00	Passenger	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	**08:57:46**	**09:00:30**	**09:01:00**	**09:05:00**	**00:00:00**	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
UP	09:11:00	00:10:30	Freight	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	**09:08:16**	**09:11:00**	**09:07:00**	**09:11:00**	**00:02:00**	freight path has been highlighted for some reason?
DOWN	09:21:30	00:10:30	Passenger	00:00:44	00:00:30	00:02:00	Bedminster track section	00:02:00		00:05:14	**09:16:16**	**09:21:30**	**09:16:00**	**09:21:00**	**00:05:00**	A TRTS can be used @ PSN station as the strike in to trigger the auto lower TAR path.
DOWN	N/A	#VALUE!	Freight	00:00:44	00:00:00	00:02:30	Bedminster track section	00:02:00		00:05:14	**#VALUE!**	**N/A**	**N/A**	**N/A**	**#VALUE!**	NO FREIGHT PATH
									#VALUE!	**00:15:56 minutes total closure time at peak hour**						

MITIGATIONS

Signalling Mitigation	Road closure total time	**Road closure timings** FROM (hh:mm)	TO (hh:mm)	MROT	Comments
-	**00:02:44**	**09:01:00**	**09:05:00**	**00:00:00**	no change
-	**00:02:44**	**09:07:00**	**09:11:00**	**00:02:00**	no change
TRTS (+ Auto Lower)	**00:03:14**	**09:17:46**	**09:21:00**	**00:06:46**	TRTS = 30s reaction time from signaller + 01:00 travel time + 44s crossing time. Putting the TRTS in the TAR path would negate the signaller reaction time as it could be used by ARS, but if ARS was not working and the signaller selects stopping train then the 30 sec reaction time may be useful.
timer (+auto lower)	**00:03:44**	**09:24:46**	**09:28:30**	**00:03:46**	3 minute timer could be used. The only issue is if the freight is quicker getting to parson street, it will be delayed waiting for the timer. A get around would be a 44sec timer added to the MAR control at Parson Street. This would allow the MAR control to activate and the crossing sequence to activate. once the crossing is complete, the MAR would also be complete.
00:14:58	**00:12:26**	**minutes total closure time at peak hour**			

TRTS - train ready to start
MROT - mimimum road opening time

Bristol East- Portishead

Down

Location		2C75	MW D	FR D	2Y16	1v50
			Class 150			
Bristol West	arr					
	Line	DM	DM	DM	DM	DM
	dep	09:09:30	09:15:00	09:03:30	09:28:30	09:46:00
Bedminster	arr		09:16:30		09:30:30	
	Line		DM		DM	
	dep		09:17:00		09:31:00	
Parson Street	arr		09:19:00	09:08:00	09:33:00	
	Line	{2}	DM	DM	DM	
	dep		09:19:30	09:08:00	09:33:30	
Parson Street Junction	arr		09:20:00	09:08:30		
	Line					
	dep	09:12:30	09:20:00	09:08:30	09:34:00	09:49:30
Portishead Branch Line			**MW D**	**FR D**		
Ashton Junction	arr		09:21:30	09:10:30		
	Line					
	dep		09:21:30	09:10:30		
Pill	arr		09:33:00	09:22:00		
	Line					
	dep		09:33:30	09:22:00		
Portbury Dock	arr		09:36:00	09:26:30		
	Line					
	dep					
Portishead	arr		09:40:00			
	Line					
	dep					

Up

Location		FR U		MW U		
				Class 150		
Portishead	arr					
	Line					
	dep			08:43:00		
Portbury Dock	arr			08:44:30		
	Line					
	dep					
Pill	arr			08:49:00		
	Line					
	dep			08:49:30		
Ashton Junction	arr			09:00:30		
	Line					
	dep			09:00:30		
POD Line			**2U14**	**MW U**	**1S47**	**2.00E+62**
Parson Street Junction	arr					
	Line					
	dep		09:16:30	09:02:00	09:24:00	09:49:00
Parson Street	arr		09:17:00	09:02:30	09:24:30	09:49:30
	Line		UM	URL	UM	UM
	dep			09:03:00		09:50:00
Bedminster	arr			09:05:00		09:52:00
	Line			URL		UM
	dep			09:05:30		09:52:30
Bristol West	arr		09:19:00	09:07:30	09:27:30	09:54:00
	Line		UM	URL	UM	UM
	dep					

Direction	Time (hh:mm)	Time between previous (hh:mm)	Scenario C service type	Barrier closure sequence time	Platform dwell time	CPT Travel time PSN-Ash Jcn (mm:ss)	Strike In	CPT Travel time BED-PSN (mm:ss)	CPT Travel time Clifton-Ash Jcn (mm:ss)	Road closure total time	Road closure timings (CALCULATED) FROM (hh:mm)	TO (hh:mm)	Road closure timings (ROUNDED) FROM (hh:mm)	TO (hh:mm)	MROT	Comments	MITIGATIONS Signalling Mitigation	Road closure total time	Road closure timings FROM (hh:mm)	TO (hh:mm)	MROT	Comments
UP		00:00:00	Passenger	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	##########	00:00:00	09:01:00	09:05:00	00:00:00	Standard 30mph approach non stopping trains only 3minutes assumed road closure time	-	00:02:44	09:01:00	09:05:00	00:00:00	no change
UP		00:00:00	Freight	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	##########	00:00:00	09:07:00	09:11:00	00:02:00		-	00:02:44	09:07:00	09:11:00	00:02:00	no change
DOWN	09:21:30	09:21:30	Passenger	00:00:44	00:00:30	00:02:00	Bedminster track section	00:02:00		00:05:14	09:16:16	09:21:30	09:16:00	09:21:00	00:05:00	A TRTS can be used @ PSN station as the strike in to trigger the auto lower TAR path.	TRTS (+ Auto Lower)	00:03:14	09:17:46	09:21:00	00:06:46	TRTS = 30s reaction time from signaller + 01:00 travel time + 44s crossing time
DOWN	09:10:30	#############	Freight	00:00:44	00:00:00	00:02:30	Bedminster track section	00:02:00		00:05:14	09:05:16	09:10:30	09:22:00	09:29:00	00:01:00	A timer could be used	timer (+auto lower)	00:03:44	09:24:46	09:28:30	00:03:46	3 minute timer could be used. The only issue is if the freight is quicker getting to parson street, it will be delayed waiting for the timer. A get around would be a 44sec timer added to the MAR control at Parson Street. This would allow the MAR control to activate and the crossing sequence to activate. once the crossing is complete, the MAR would also be complete.
									00:20:00	**00:15:56 minutes total closure time at peak hour**							00:14:58	**00:12:26**	**minutes total closure time at peak hour**			

Bristol East- Portishead

Down

Location		2C75	MW D	FR D	2Y16	1v50
Bristol West	arr					
	Line	DM	DM	DM	DM	DM
	dep	09.09.30	09.13.30	09.19.30	09.28.30	09.46.00
Bedminster	arr		09.15.30		09.30.30	
	Line		DM		DM	
	dep		09.16.00		09.31.00	
Parson Street	arr		09.17.30	09.25.30	9.33.00	
	Line	{2}	DM	DM	DM	
	dep		09.20.00	09.26.00	09.33.30	
Parson Street Junction	arr					
	Line					
	dep	09.12.30	09.20.30	09.26.30	09.34.00	09.49.30
Portishead Branch Line			**MW D**	**FR D**		
Ashton Junction	arr			09.28.30		
	Line					
	dep		09.22.00	09.28.30		
Pill	arr		09.33.30	09.40.00		
	Line					
	dep		09.34.00	09.40.00		
Portbury Dock	arr			09.44.30		
	Line					
	dep					
Portishead	arr		09.38.00			
	Line					
	dep					

Up

Location		FR U		MW U		
Portishead	arr					
	Line					
	dep			08.59.30		
Portbury Dock	arr					
	Line					
	dep	08.54.30				
Pill	arr			09.04.00		
	Line					
	dep	08.59.30		09.04.30		
Ashton Junction	arr					
	Line					
	dep	09.11.00		09.16.00		
POD Line		**FR U**	**2U14**	**MW U**	**1S47**	**2E+62**
Parson Street Junction	arr					
	Line					
	dep	09.12.30	09.16.30	09.17.30	09.23.30	09.49.00
Parson Street	arr	09.13.00	09.17.00	09.18.00	09.24.00	09.49.30
	Line	URL	UM	URL	UM	UM
	dep		09.17.00	09.23.00		09.50.00
Bedminster	arr			09.25.30		09.52.00
	Line	{2}		URL		UM
	dep			09.26.00		09.52.30
Bristol West	arr	09.18.30	09.19.00	09.28.00	09.27.00	09.54.00
	Line	URL	UM	URL	UM	UM
	dep					

Direction	Time (hh:mm)	Time between previous (hh:mm)	Scenario C service type	Barrier closure sequence time	Platform dwell time	CPT Travel time PSN-Ash Jcn (mm:ss)	Strike In	CPT Travel time BED-PSN (mm:ss)	CPT Travel time Clifton-Ash Jcn (mm:ss)	Road closure total time	**Road closure timings From – To (hh:mm)**	**MROT**	Comments
UP	09:11:00	00:00:00	Freight	44s	-	-	Treadle @ Clifton Bridge	-	02:00	02:44	**09:08 – 09:11**	**00:00**	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
UP	09:16:00	00:05:00	Passenger	44s	-	-	Treadle @ Clifton Bridge	-	02:00	02:44	**09:13 – 09:16**	**02:00**	
DOWN	09:24:00	00:08:00	Passenger	44s	01:30	01:30	Bedminster track section	01:30	-	05:15	**09:18 – 09:24**	**02:00**	A TRTS can be used @ PSN station as the strike in
DOWN	09:28:30	00:04:00	Freight	44s	-	02:00	Bedminster track section	02:00	-	04:44	**09:28 – 09:33**	**04:00**	A timer could be used
											21 minutes total closure time at peak hour		

09:08 09:11
09:13 09:16
09:18 09:24
09:28 09:33

MITIGATIONS

Signalling Mitigation	Road closure total time	**Road closure timings From – To (hh:mm)**	**MROT**	Comments
-	02:44	**09:08 – 09:11**	**00:00**	
-	02:44	**09:13 – 09:16**	**02:00**	
TRTS (+ Auto Lower)	02:44	**09:21 – 09:24**	**05:00**	TRTS = 30s reaction time from signaller + 01:30 travel time + 44s crossing time
01:30 timer once strike in at bedminster	03:15	**09:29 – 09:33**	**05:00**	assumed 30s MAR timer hence 01:30 timer used
13 minutes total closure time at peak hour				

09:08 09:11
09:13 09:16
09:21 09:24
09:29 09:33

Level Crossing Down Time Test

Scenario	Notes
C	2 passenger units, 2 passenger paths (up and down), 2 freight paths (up and down), Stops at Pill
Infill ii	2 passenger units, 3 passenger paths (up,up and down), 2 freight paths (up and down), Stops at Pill
1A	1 passenger unit, 2 passenger paths (up and down), 2 freight paths (up and down), Stops at Pill, Line speed increased to minimum margins
1B	1 passenger unit, 2 passenger paths (up and down), 2 freight paths (up and down), Stops at Pill, Pill Junction installed
1C u	1 passenger unit, 2 passenger paths (up and down), 1 freight paths (up), Stops at Pill
1C d	1 passenger unit, 2 passenger paths (up and down), 1 freight paths (down), Stops at Pill

Bristol East- Portishead

Down Class 150

Location		MW D	FR D	MW D	FR D	MW D	FR D	MW D	FR D
Bristol West	arr								
	Line	DM	DM	DM	DM	DM	DM	DM	DM
	dep	09.13.30	09.19.30	09.58.30	10.04.30	10.43.30	10.49.30	11.28.30	11.34.30
Bedminster	arr	09.15.30		10.00.30		10.45.30		11.30.30	
	Line	DM		DM		DM		DM	
	dep	13.16		10.01		10.46.00		11.31.00	
Parson Street	arr	09.17.30	09.25.30	10.02.30	10.10.30	10.47.30	10.55.30	11.32.30	11.40.30
	Line	DM	DM	DM	DM	DM	DM	DM	DM
	dep	09.20.00	09.26.00	10.05	10.11.00	10.50.00	10.56.00	11.35.00	11.41.00
Parson Street Junction	arr								
	Line								
	dep	09:20:30	09:26:30	10:05:30	10:11:30	10:50:30	10:56:30	11:35:30	11:41:30
Portishead Branch Line		MW D	FR D	MW D	FR D	MW D	FR D	MW D	FR D
Ashton Junction	arr		09.28.30		10.13.30		10.58.30		11.43.30
	Line	3	4	7	8 {4.5}	11	12 {4.5}	15	16 {4.5}
	dep	09:22:00	09:28:30	10:07:00	10:18:00	10:52:00	11:03:00	11:37:00	11:48:00
Pill	arr	09.33.30	09.40.00	10.18.30	10.19.30	11.03.30	11.14.30	11.48.30	11.49.30
	Line								
	dep	09.34.00	09.40.00	10.19.00	10.19.30	11.05.00	11.14.30	11.49.00	11.49.30
Portbury Dock	arr		9.44.30		10.34.00		11.19.00		12.04.00
	Line								
	dep								
Portishead	arr	09.38.00		10.23.00		11.08.00		11.53.00	
	Line								
	dep								

Up Class 150

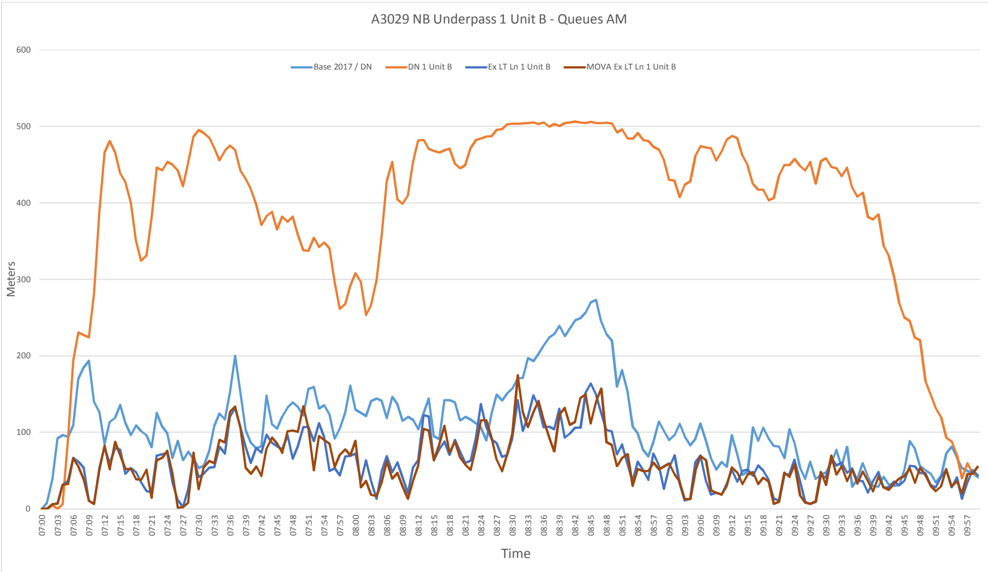
Location		FR U	MW U	FR U	MW U	FR U	MW U	FR U	MW U
Portishead	arr								
	Line								
	dep		08.59.30		09.44.30		10.29.30		11.14.30
Portbury Dock	arr								
	Line								
	dep	08.54.30		09.39.30		10.24.30		11.09.30	
Pill	arr		09.04.00		9.49.00		10.34.00		11.19.00
	Line								
	dep	08.59.30	09.04.30	09.44.30	09.49.30	10.29.30	10.34.30	11.14.30	11.19.30
Ashton Junction	arr								
	Line	1	2	5	6	9	10	13	14
	dep	09:11:00	09:16:00	09:56:00	10:01:00	10:31:00	10:46:00	11:26:00	11:31:00
POD Line		FR U	MW U	FR U	MW U	FR U	MW U	FR U	MW U
Parson Street Junction	arr								
	Line								
	dep	09.12.30	09.17.30	09.57.30	10.02.30	10.42.30	10.47.30	11.27.30	11.32.30
Parson Street	arr	09.13.00	09.18.00	9.58.00	10.03.00	10.43.00	10.48.00	11.28.00	11.33.00
	Line	URL	URL	URL	URL	URL	URL	URL	URL
	dep		09.23.00		10.08.00		10.53.00		11.38.00
Bedminster	arr		09.25.30		10.10.30		10.55.30		11.40.30
	Line	{2}	URL	{2}	URL	{2}	URL	{2}	URL
	dep		09.26.00		10.11.00		10.56.00		11.41.00
Bristol West	arr	09.18.30	09.28.00	09.53.30	10.13.00	10.48.30	10.58.00	11.33.30	11.43.00
	Line	URL	URL	URL	URL	URL	URL	URL	URL
	dep								

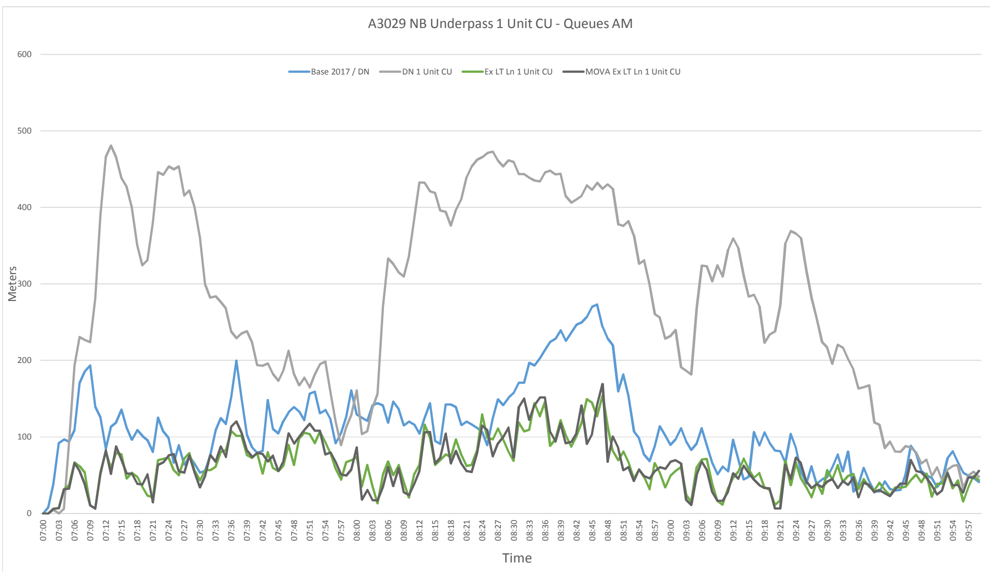
	Direction	Time	Time between previous	service type	Barrier closure sequence time	Platform dwell time	CPT Travel time PSN-Ash Jcn	Strike In	CPT Travel time BED-PSN	CPT Travel time Clifton-Ash Jcn	Road closure total time	Road closure timings (CALCULATED) FROM	TO	Road closure timings (ROUNDED) FROM	TO	MROT	Comments
1	UP	09:11:00	00:00:00	FREIGHT	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	09:08:16	09:11:00	09:08:00	09:11:00		Standard 30mph approach non stopping trains only 3minutes assumed road closure time
2	UP	09:16:00	00:05:00	PASSENGER	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	09:13:16	09:16:00	09:13:00	09:16:00	00:02:00	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
3	DOWN	09:22:00	00:06:00	PASSENGER	00:00:44	00:00:30	00:02:00	Bedminster track section	00:02:00		00:05:14	09:16:46	09:22:00	09:16:30	09:22:00	00:00:30	A TRTS can be used @ PSN station as the strike in to trigger the auto lower TAR path.
4	DOWN	09:28:30	00:06:30	FREIGHT	00:00:44	00:00:00	00:02:30	Bedminster track section	00:02:00		00:05:14	09:23:16	09:28:30	09:23:00	09:28:30	00:01:00	A timer could be used
5	UP	09:56:00	00:27:30	FREIGHT	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	09:53:16	09:56:00	09:53:00	09:56:00	00:24:30	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
6	UP	10:01:00	00:05:00	PASSENGER	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	09:58:16	10:01:00	09:58:00	10:01:00	00:02:00	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
7	DOWN	10:07:00	00:06:00	PASSENGER	00:00:44	00:00:30	00:02:00	Bedminster track section	00:02:00		00:05:14	10:01:46	10:07:00	10:01:30	10:07:00	00:00:30	A TRTS can be used @ PSN station as the strike in to trigger the auto lower TAR path.
8	DOWN	10:18:00	00:11:00	FREIGHT	00:00:44	00:00:00	00:02:30	Bedminster track section	00:02:00		00:05:14	10:12:46	10:18:00	10:12:30	10:18:00	00:05:30	A timer could be used
9	UP	10:31:00	00:13:00	FREIGHT	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	10:28:16	10:31:00	10:28:00	10:31:00	00:10:00	
10	UP	10:46:00	00:15:00	PASSENGER	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	10:43:16	10:46:00	10:43:00	10:46:00	00:12:00	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
11	DOWN	10:52:00	00:06:00	PASSENGER	00:00:44	00:00:30	00:02:00	Bedminster track section	00:02:00		00:05:14	10:46:46	10:52:00	10:46:30	10:52:00	00:00:30	A TRTS can be used @ PSN station as the strike in to trigger the auto lower TAR path.
12	DOWN	11:03:00	00:11:00	FREIGHT	00:00:44	00:00:00	00:02:30	Bedminster track section	00:02:00		00:05:14	10:57:46	11:03:00	10:57:30	11:03:00	00:05:30	A timer could be used
13	UP	11:26:00	00:23:00	FREIGHT	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	11:23:16	11:26:00	11:23:00	11:26:00	00:20:00	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
14	UP	11:31:00	00:05:00	PASSENGER	00:00:44			Treadle @ Clifton Bridge		00:02:00	00:02:44	11:28:16	11:31:00	11:28:00	11:31:00	00:02:00	Standard 30mph approach non stopping trains only 3minutes assumed road closure time
15	DOWN	11:37:00	00:06:00	PASSENGER	00:00:44	00:00:30	00:02:00	Bedminster track section	00:02:00		00:05:14	11:31:46	11:37:00	11:31:30	11:37:00	00:00:30	A TRTS can be used @ PSN station as the strike in to trigger the auto lower TAR path.
16	DOWN	11:48:00	00:11:00	FREIGHT	00:00:44	00:00:00	00:02:30	Bedminster track section	00:02:00		00:05:14	11:42:46	11:48:00	11:42:30	11:48:00	00:05:30	A timer could be used
								minutes total closure time over 3 hour period (CALCULATED)			01:03:44	minutes total closure time over 3 hour period (ROUNDED)			01:08:00		

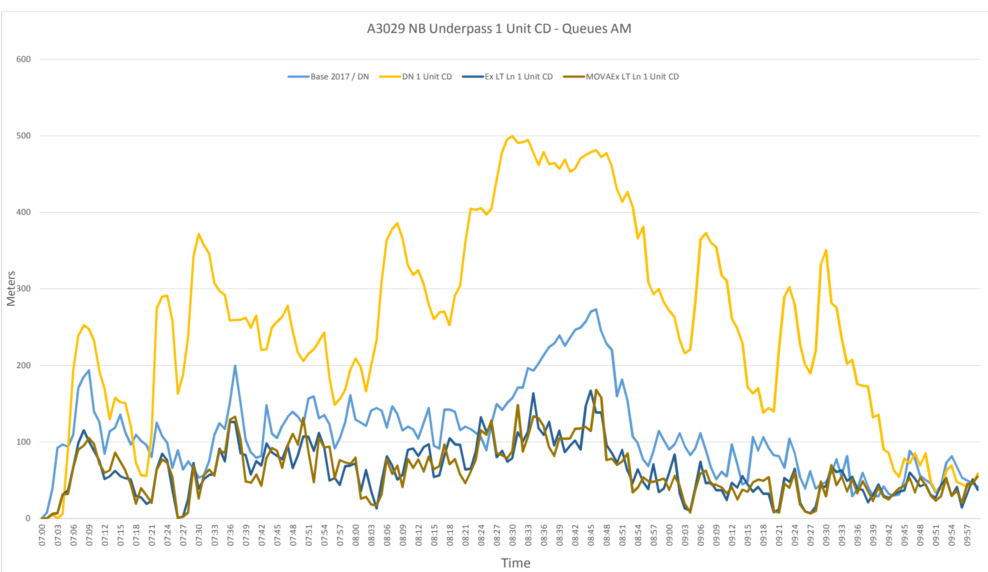
	GAT	Signalling Mitigation	Road closure total time	Road closure timings (CALCULATED) FROM	TO	Road closure timings (ROUNDED) FROM	TO	MROT	Comments
1		-	00:02:44	09:08:16	09:11:00	09:08:00	09:11:00	-	no change
2		-	00:02:44	09:13:16	09:16:00	09:13:00	09:16:00	00:02:00	no change
3		TRTS (+ Auto Lower)	00:03:14	09:18:46	09:22:00	09:18:30	09:22:00	00:02:30	TRTS = 30s reaction time from signaller + 01:00 travel time + 44s crossing time
4		timer (+auto lower)	00:03:44	09:24:46	09:28:30	09:24:30	09:28:30	00:02:30	3 minute timer could be used. The only issue is if the freight is quicker getting to parson street, it will be delayed waiting for the timer. A get around would be a 44sec timer added to the MAR control at Parson Street. This would allow the MAR control to activate and the crossing sequence to activate. once the crossing is complete, the MAR would also be complete.
5		-	00:02:44	09:53:16	09:56:00	09:53:00	09:56:00	00:24:30	no change
6		-	00:02:44	09:58:16	10:01:00	09:58:00	10:01:00	00:02:00	no change
7		TRTS (+ Auto Lower)	00:03:14	10:03:46	10:07:00	10:03:30	10:07:00	00:02:30	TRTS = 30s reaction time from signaller + 01:00 travel time + 44s crossing time
8		timer (+auto lower)	00:03:44	10:14:16	10:18:00	10:14:00	10:18:00	00:07:00	3 minute timer could be used. The only issue is if the freight is quicker getting to parson street, it will be delayed waiting for the timer. A get around would be a 44sec timer added to the MAR control at Parson Street. This would allow the MAR control to activate and the crossing sequence to activate. once the crossing is complete, the MAR would also be complete.
9		-	00:02:44	10:28:16	10:31:00	10:28:00	10:31:00	00:10:00	no change
10		-	00:02:44	10:43:16	10:46:00	10:43:00	10:46:00	00:12:00	no change
11		TRTS (+ Auto Lower)	00:03:14	10:48:46	10:52:00	10:48:30	10:52:00	00:02:30	TRTS = 30s reaction time from signaller + 01:00 travel time + 44s crossing time
12		timer (+auto lower)	00:03:44	10:59:16	11:03:00	10:59:00	11:03:00	00:07:00	3 minute timer could be used. The only issue is if the freight is quicker getting to parson street, it will be delayed waiting for the timer. A get around would be a 44sec timer added to the MAR control at Parson Street. This would allow the MAR control to activate and the crossing sequence to activate. once the crossing is complete, the MAR would also be complete.
13		-	00:02:44	11:23:16	11:26:00	11:23:00	11:26:00	00:20:00	no change
14		-	00:02:44	11:28:16	11:31:00	11:28:00	11:31:00	00:02:00	no change
15		TRTS (+ Auto Lower)	00:03:14	11:33:46	11:37:00	11:33:30	11:37:00	00:02:30	TRTS = 30s reaction time from signaller + 01:00 travel time + 44s crossing time
16		timer (+auto lower)	00:03:44	11:44:16	11:48:00	11:44:00	11:48:00	00:07:00	3 minute timer could be used. The only issue is if the freight is quicker getting to parson street, it will be delayed waiting for the timer. A get around would be a 44sec timer added to the MAR control at Parson Street. This would allow the MAR control to activate and the crossing sequence to activate. once the crossing is complete, the MAR would also be complete.
		minutes total closure time over 3 hour period (CALCULATED)	00:49:44	minutes total closure time over 3 hour period (ROUNDED)			00:54:00		

UP	09:10	00:00	FREIGHT	09:08	09:11	09:08	09:11	09:08	09:11	09:08	09:11
UP	09:15	00:04	PASSENGER	09:13	09:16	09:13	09:16	09:13	09:16	09:13	09:16
DOWN	09:21	00:05	PASSENGER	09:16	09:22	09:16	09:22	09:18	09:22	09:18	09:22
DOWN	09:27	00:05	FREIGHT	09:23	09:28	09:23	09:28	09:24	09:28	09:24	09:28
UP	09:54	00:27	FREIGHT	09:53	09:56	09:53	09:56	09:53	09:56	09:53	09:56
UP	10:00	00:04	PASSENGER	09:58	10:01	09:58	10:01	09:58	10:01	09:58	10:01
DOWN	10:06	00:05	PASSENGER	10:01	10:07	10:01	10:07	10:03	10:07	10:03	10:07
DOWN	10:17	00:10	FREIGHT	10:12	10:18	10:12	10:18	10:14	10:18	10:14	10:18
UP	10:30	00:12	FREIGHT	10:28	10:31	10:28	10:31	10:28	10:31	10:28	10:31
UP	10:45	00:14	PASSENGER	10:43	10:46	10:43	10:46	10:43	10:46	10:43	10:46
DOWN	10:50	00:05	PASSENGER	10:46	10:52	10:46	10:52	10:48	10:52	10:48	10:52
DOWN	11:02	00:10	FREIGHT	10:57	11:03	10:57	11:03	10:59	11:03	10:59	11:03
UP	11:25	00:21	FREIGHT	11:23	11:26	11:23	11:26	11:23	11:26	11:23	11:26
UP	11:29	00:04	PASSENGER	11:28	11:31	11:28	11:31	11:28	11:31	11:28	11:31
DOWN	11:36	00:05	PASSENGER	11:31	11:37	11:31	11:37	11:33	11:37	11:33	11:37
DOWN	11:47	00:10	FREIGHT	11:42	11:48	11:42	11:48	11:44	11:48	11:44	11:48

Appendix C – Queue Length Graphs


A3029 NB Underpass 1 Unit B - Queues AM
Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B
Meters
Time


A3029 NB Underpass 1 Unit CU - Queues AM
Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU
Meters
Time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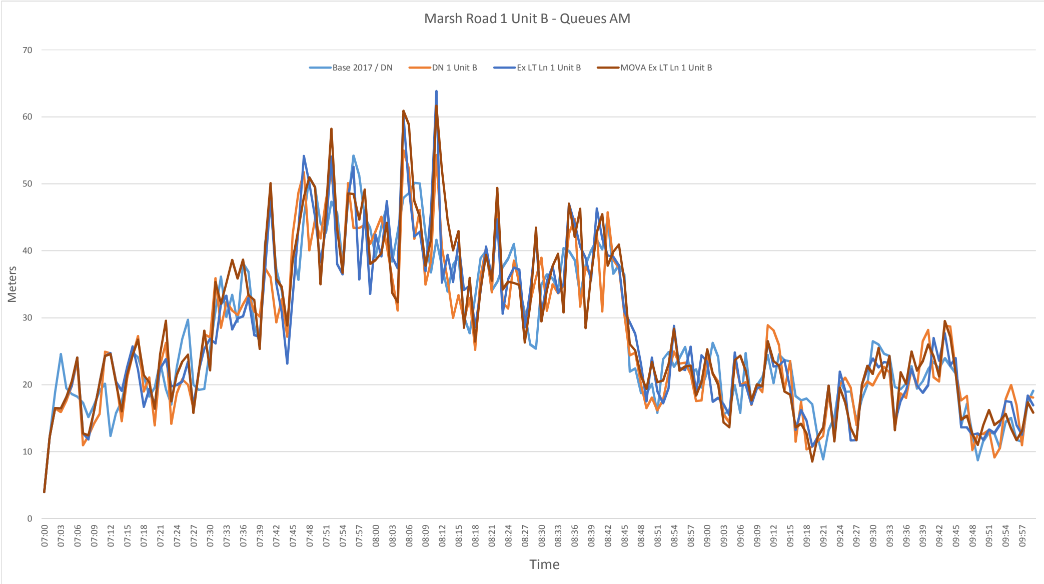
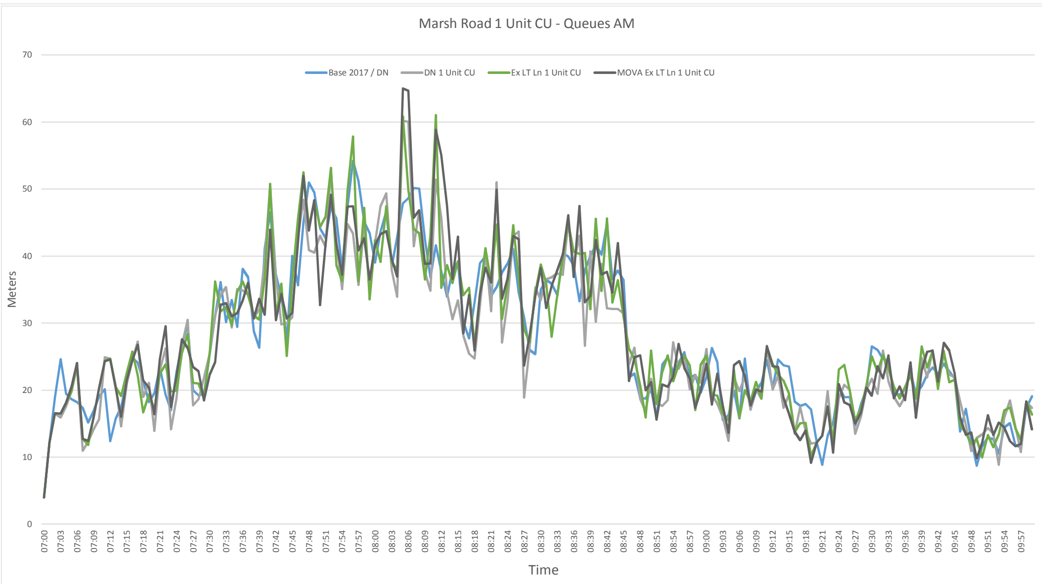
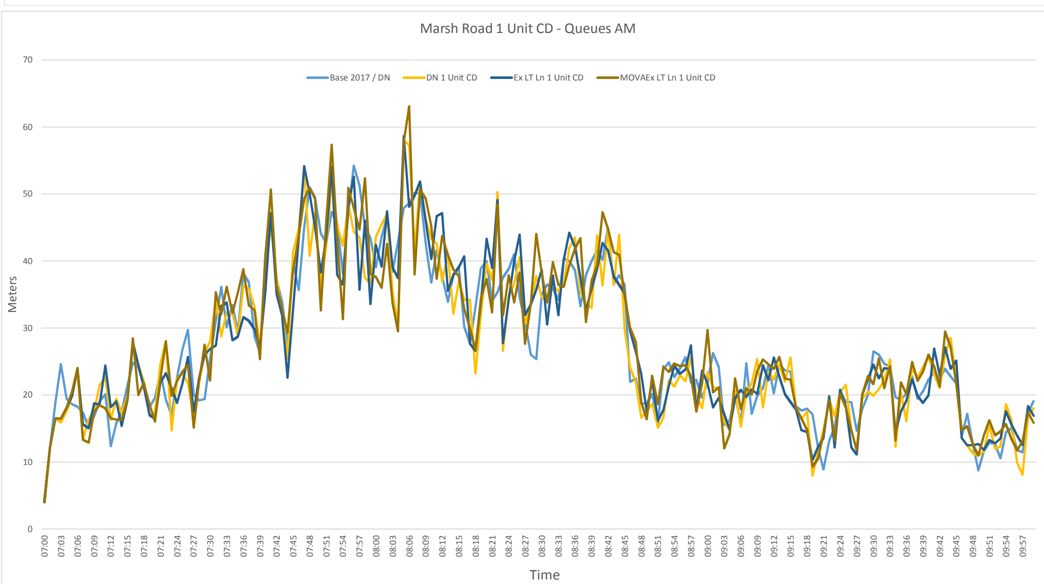
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD
Meters
Time



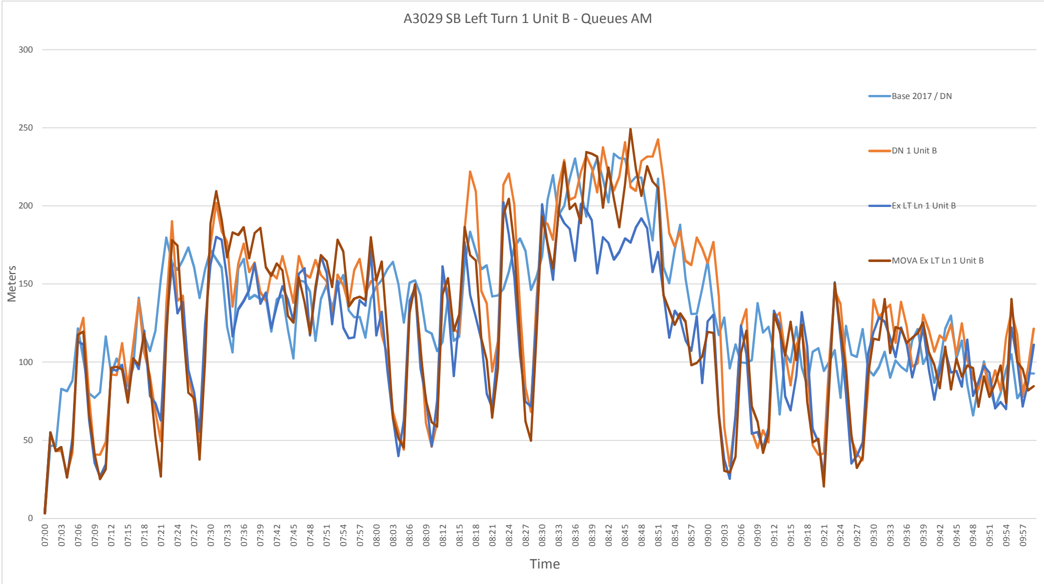
Marsh Road 1 Unit B - Queues AM
Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B
Meters
Time



Marsh Road 1 Unit CU - Queues AM
Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU
Meters
Time



Marsh Road 1 Unit CD - Queues AM
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD
Meters
Time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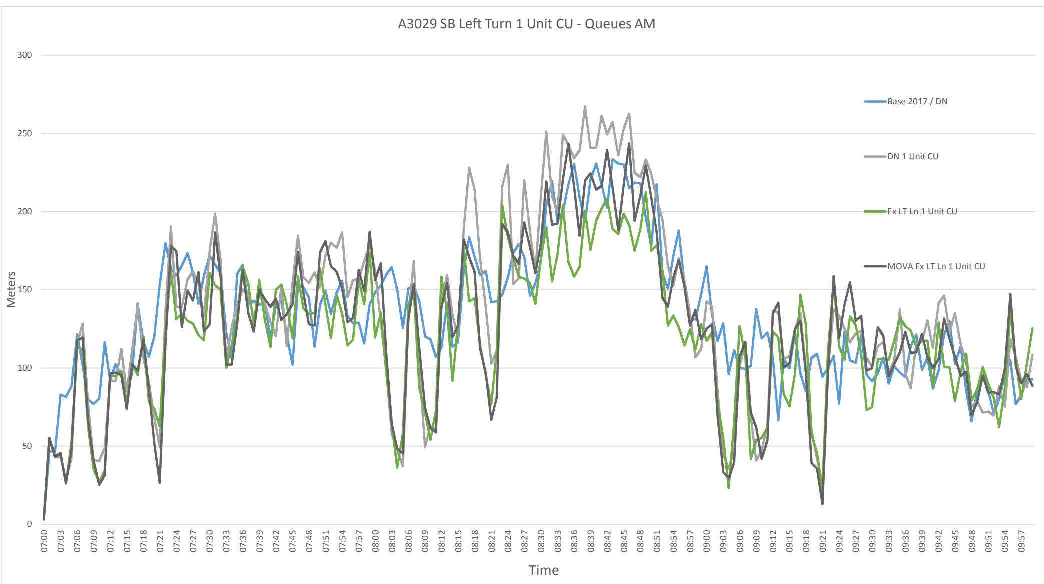
Meters
Time
Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B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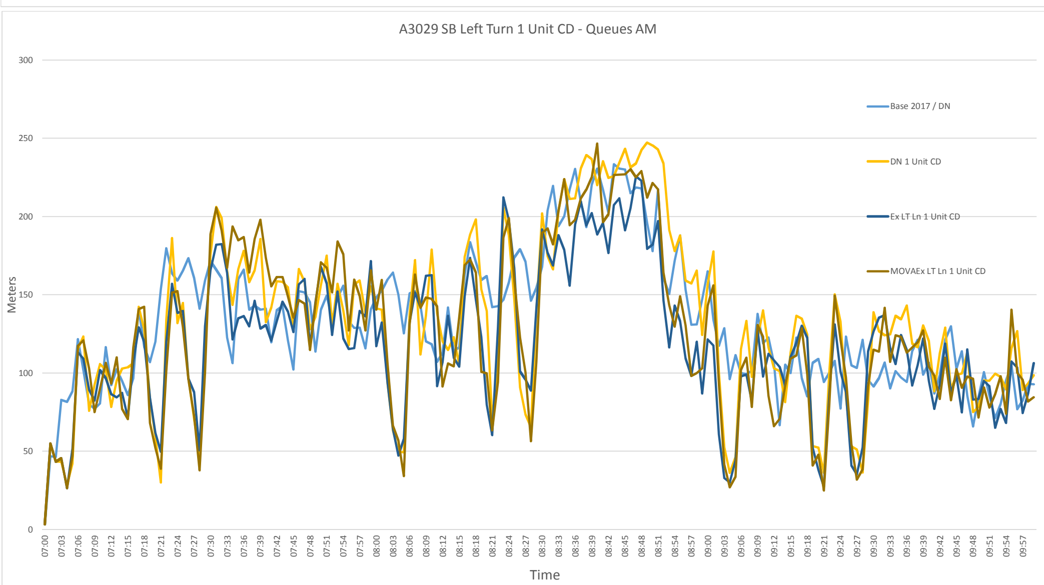
Meters
Time
Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU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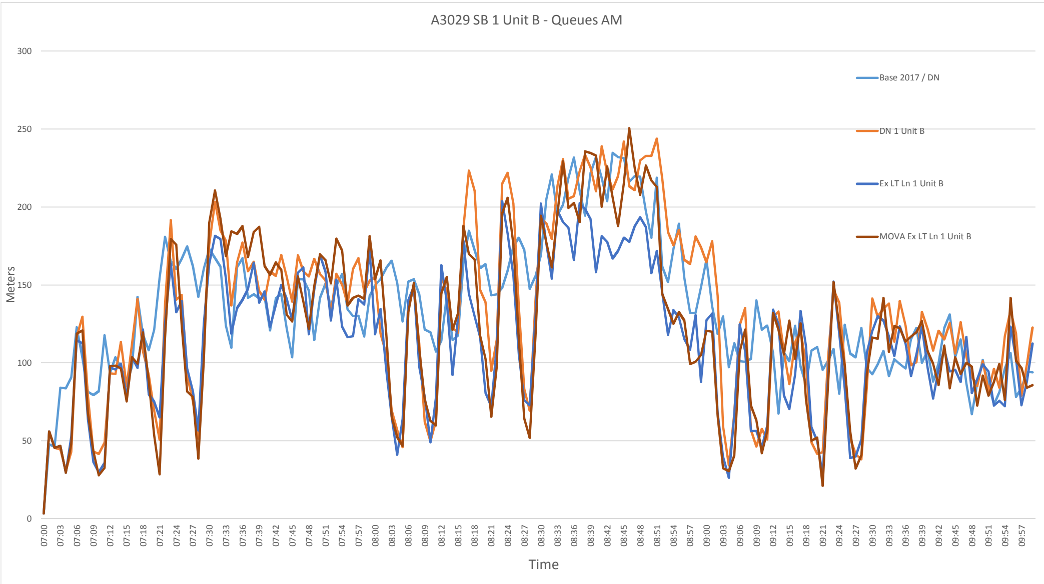
Meters
Time
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD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Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
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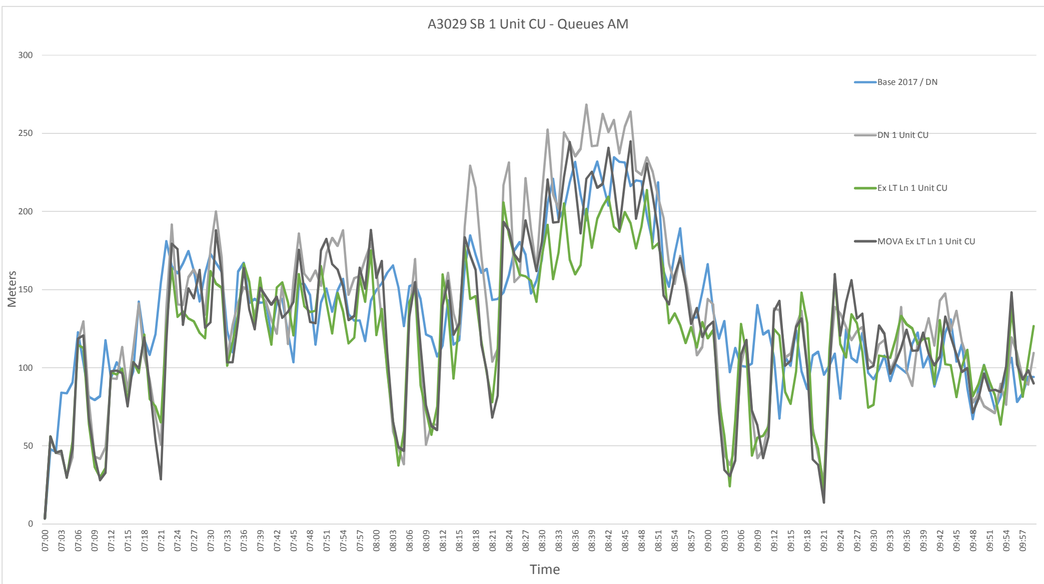
Meters
Time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Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
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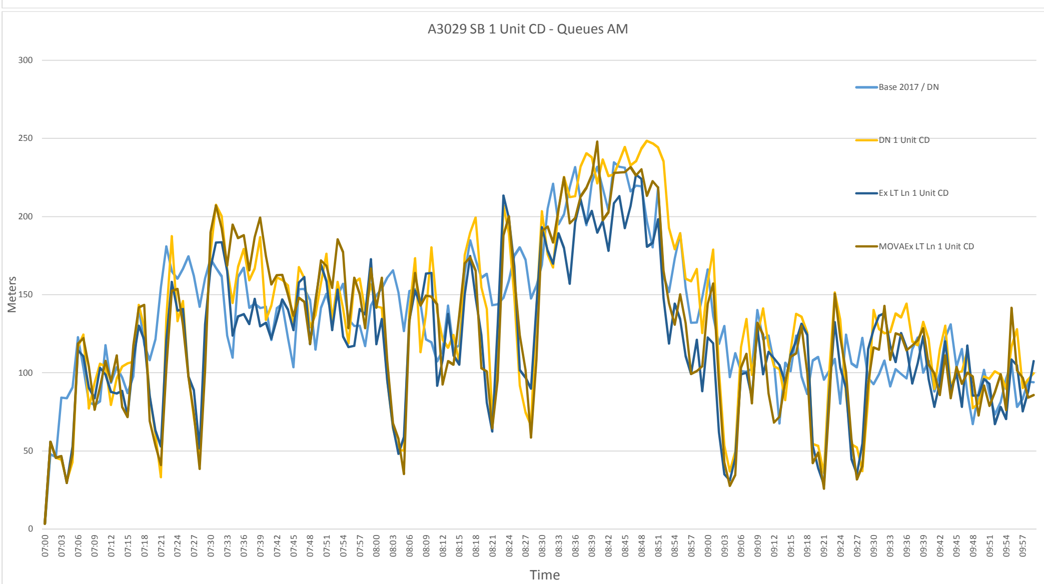
Meters
Time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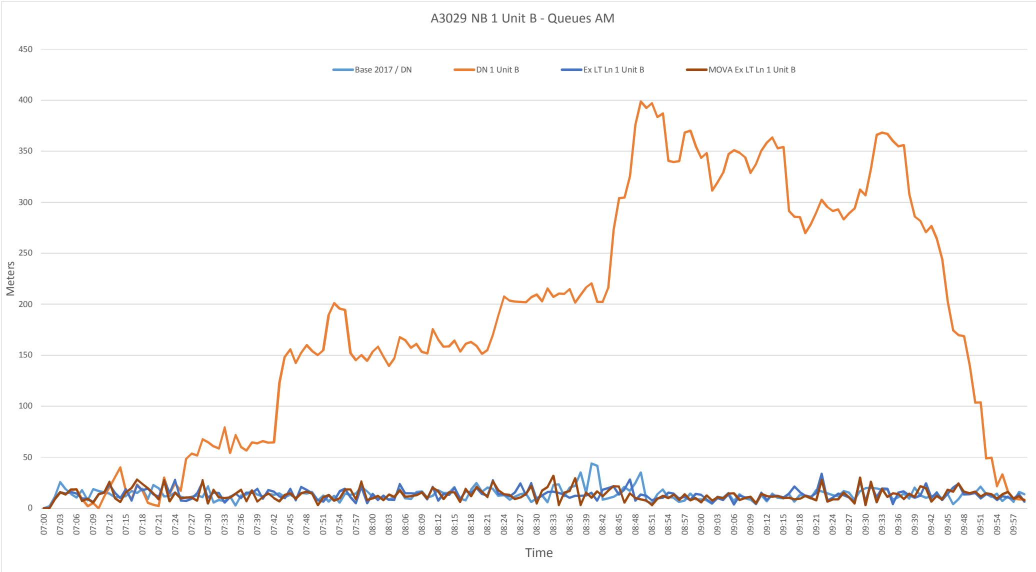
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD
Meters
Time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Base 2017 / DN
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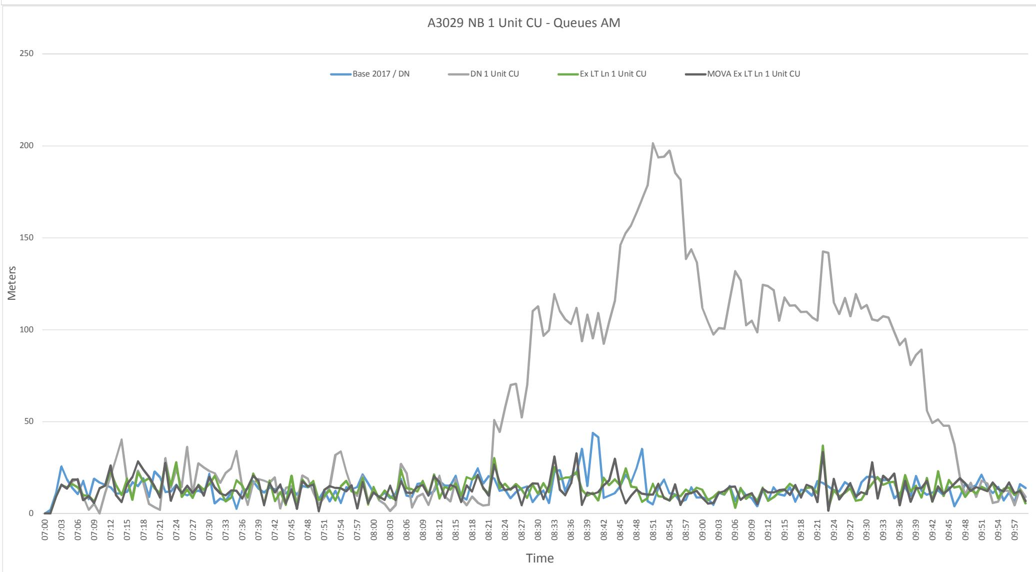
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B
Meters
Time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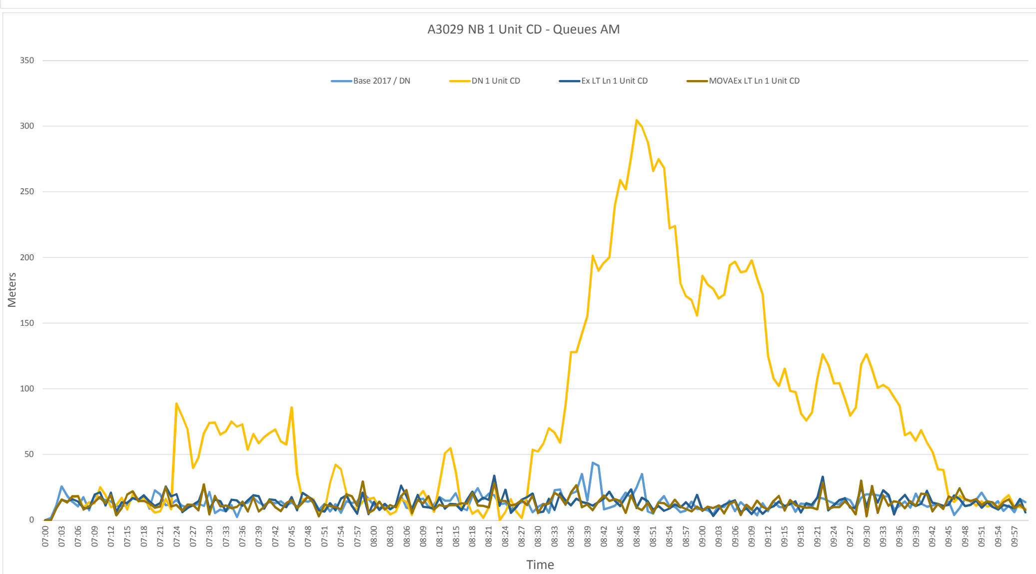
Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU
Meters
Time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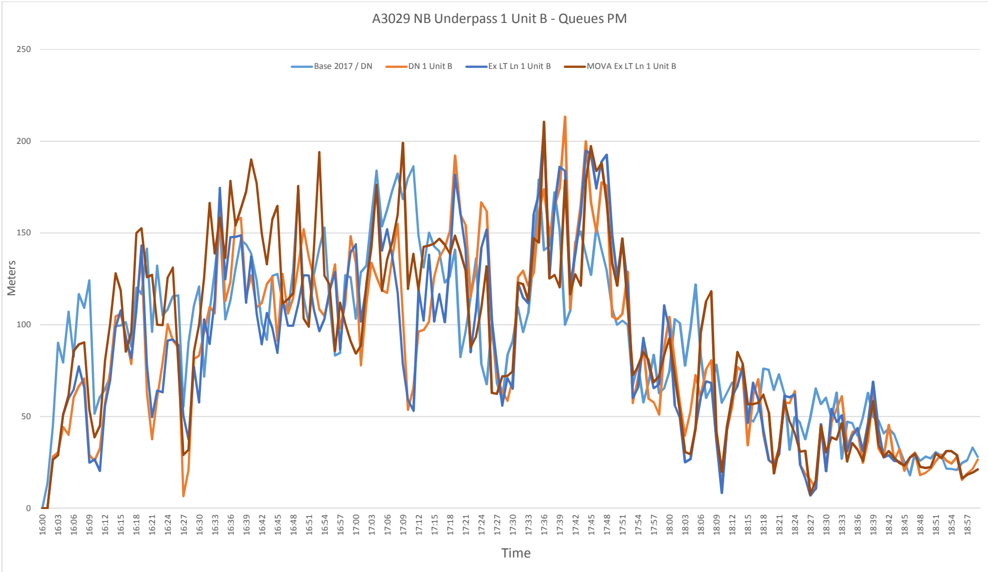
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD
Meters
Time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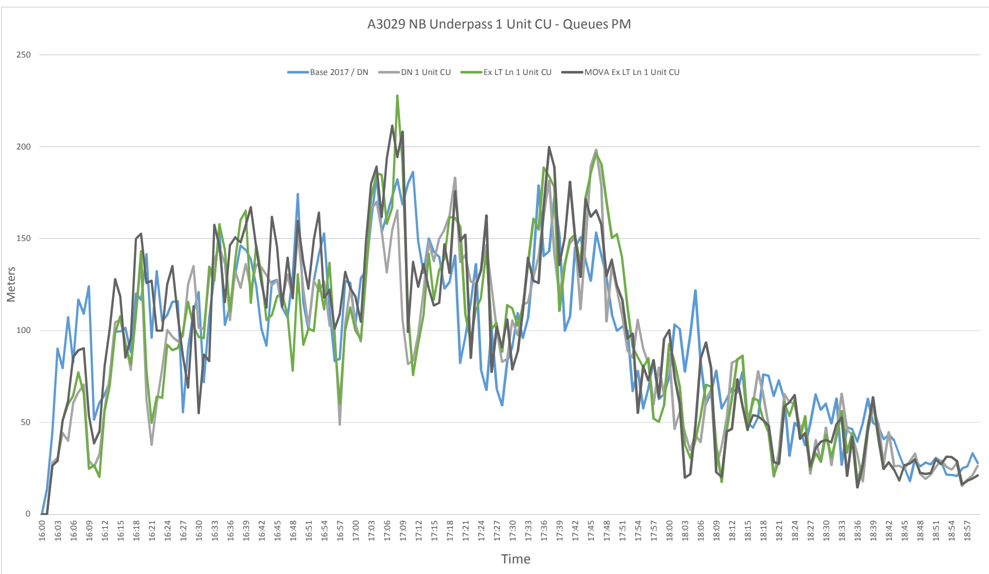
Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B
250
200
150
100
50
0
Meters
Time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Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU
250
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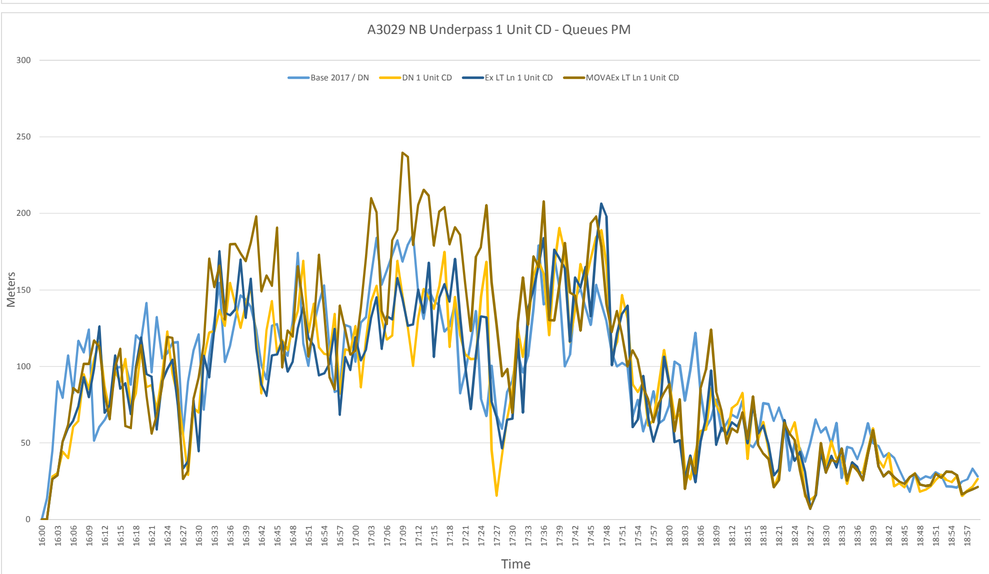
50
0
Meters
Time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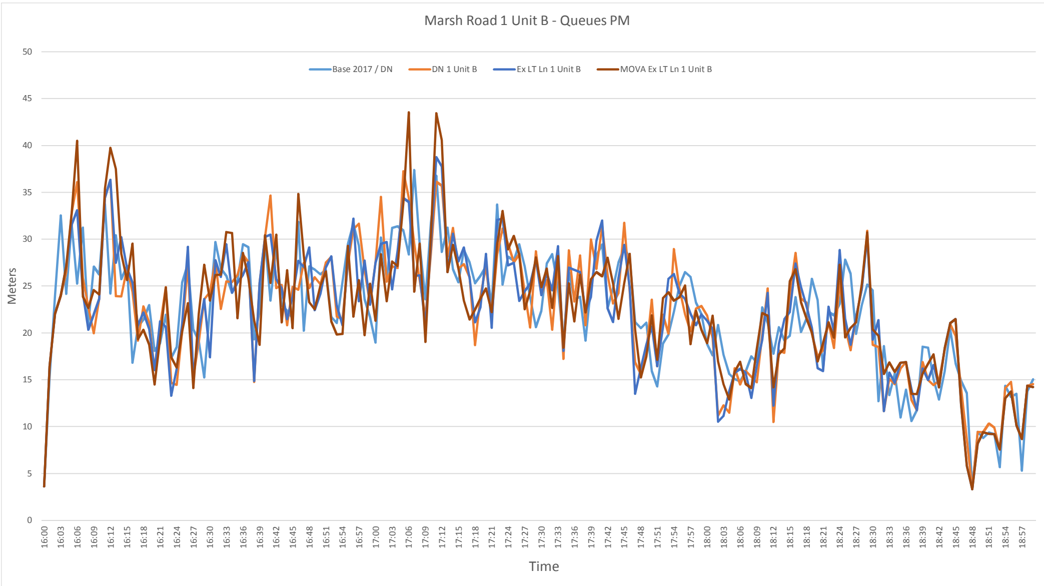
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD
300
250
200
150
100
50
0
Meters
Time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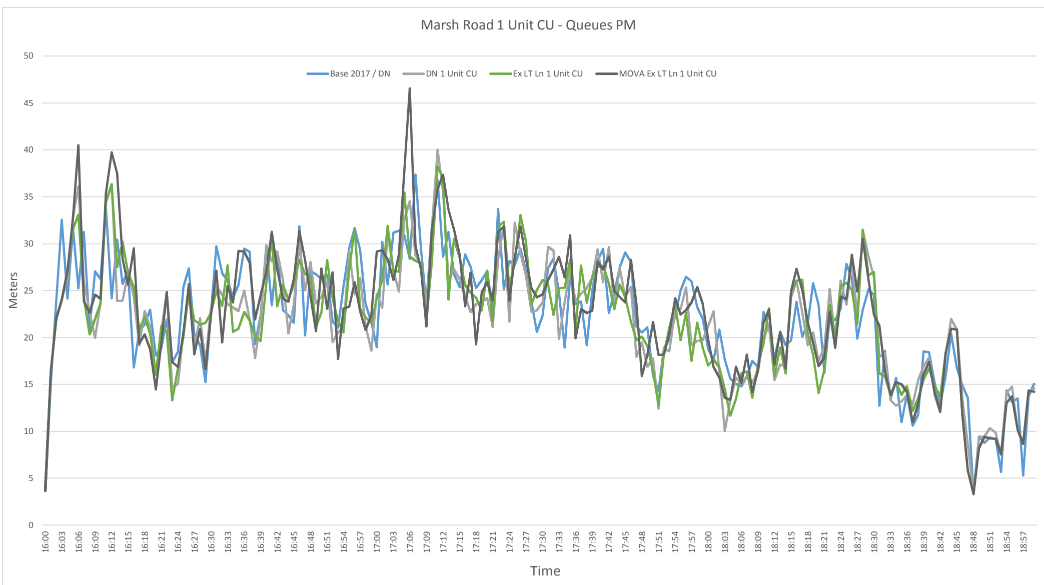
Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B
Meters
Time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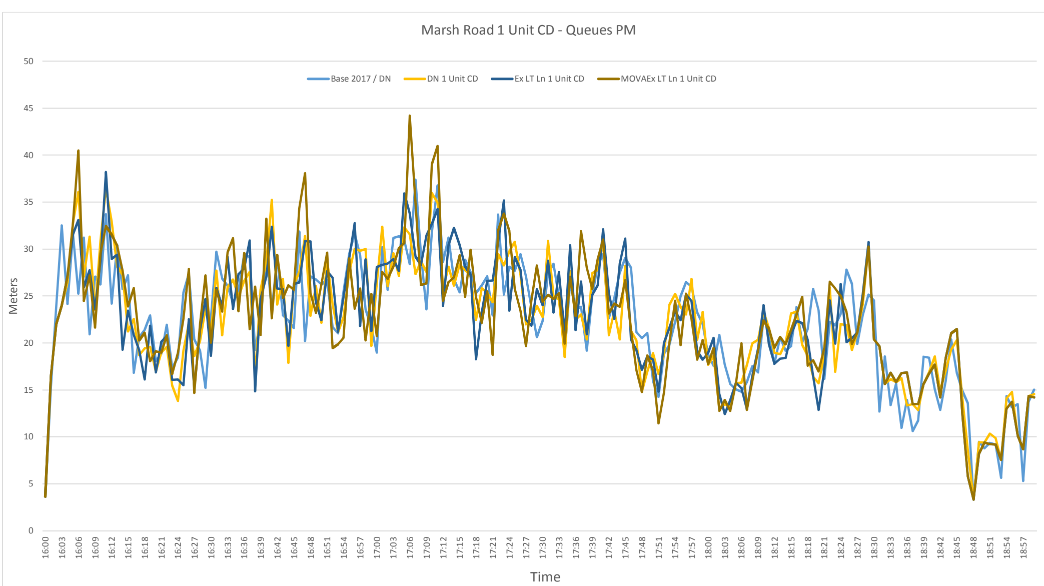
Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU
Meters
Time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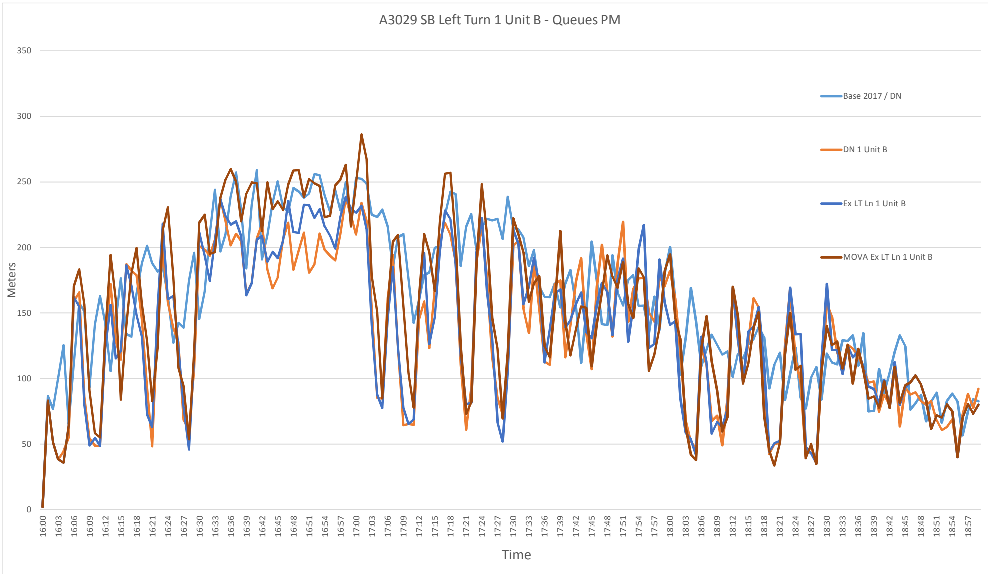
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD
Meters
Time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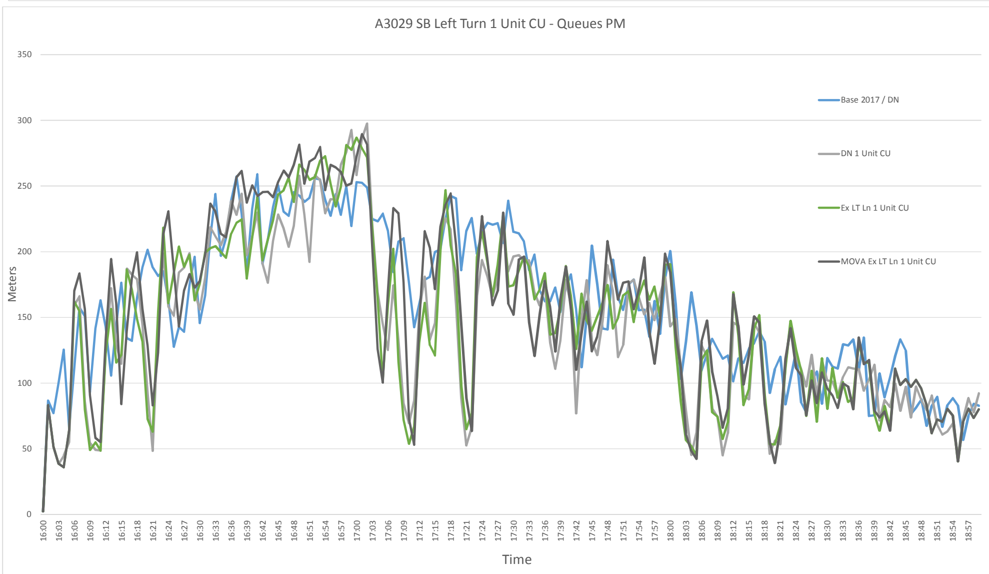
Meters
Time
Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B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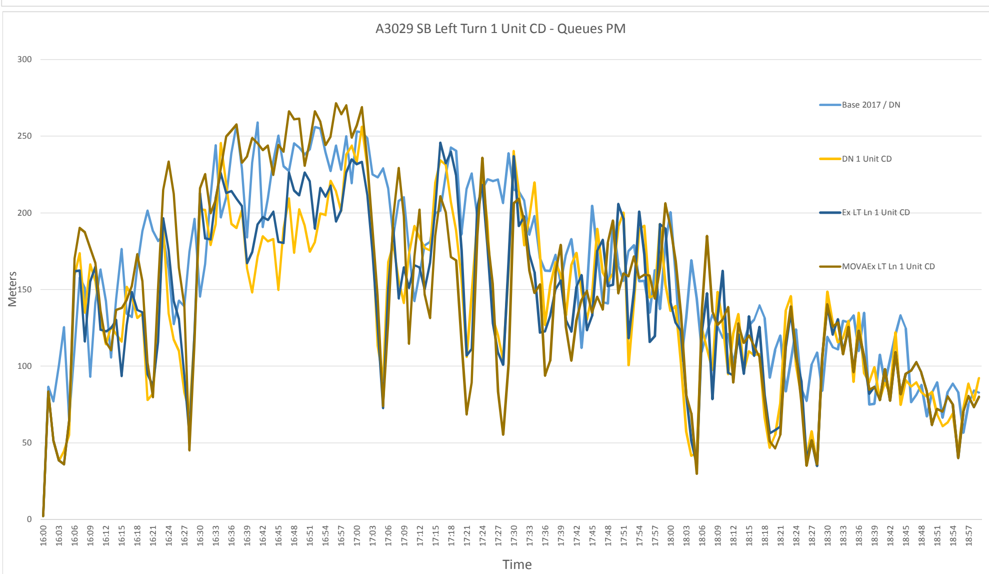
Meters
Time
Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU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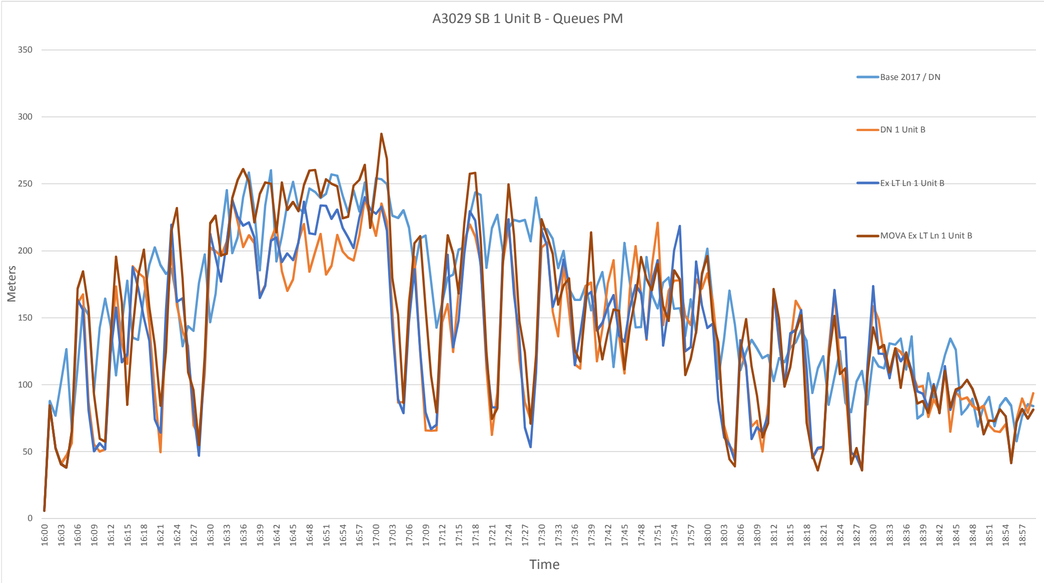
Meters
Time
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD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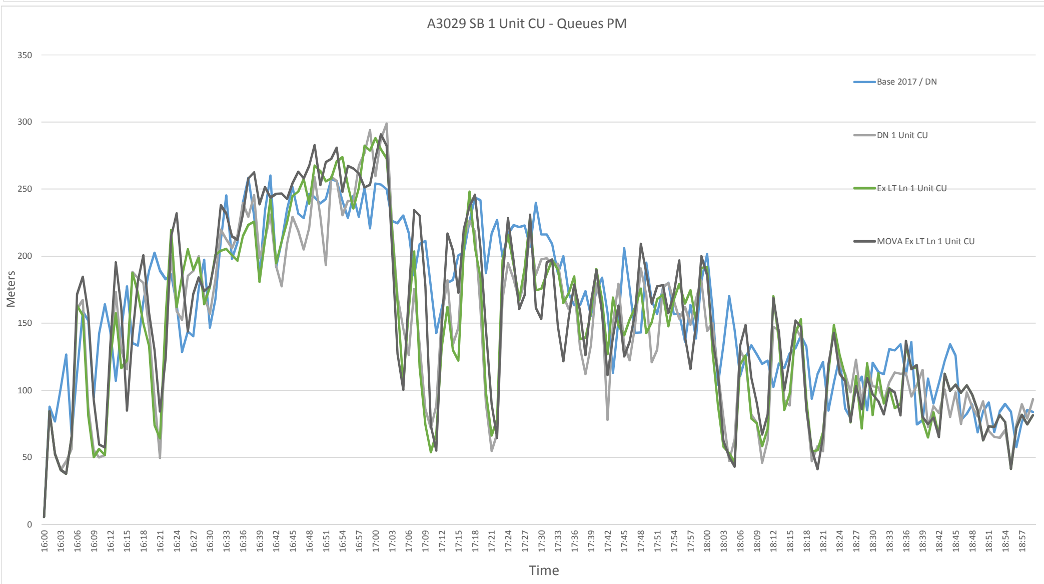
Meters
Time
Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B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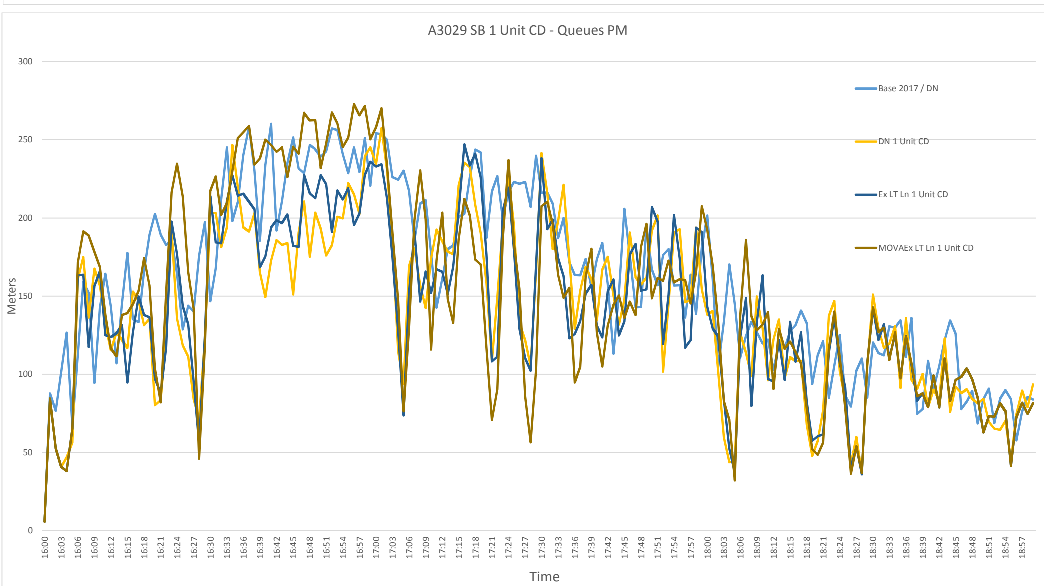
Meters
Time
Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU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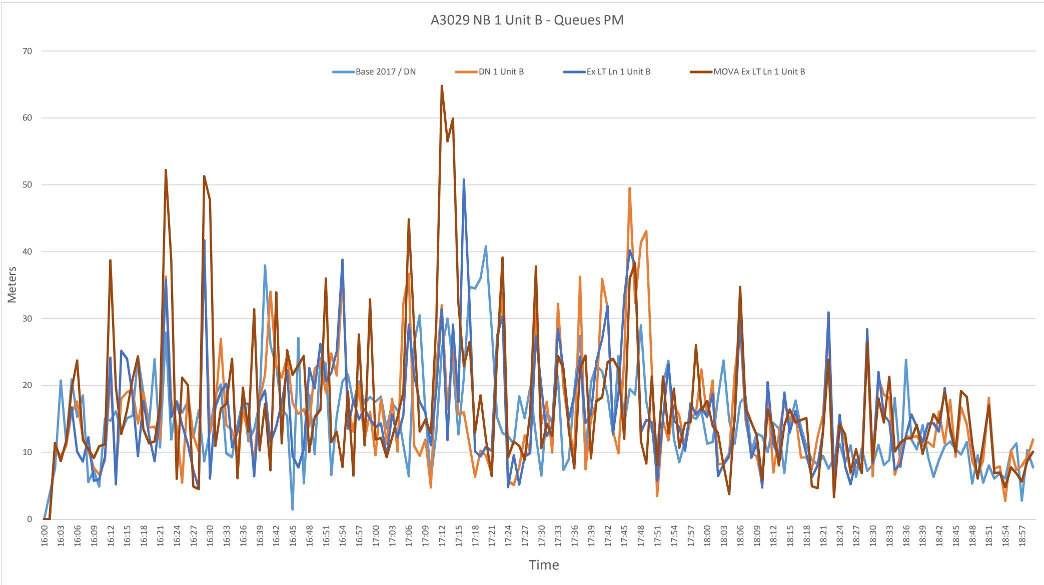
Meters
Time
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD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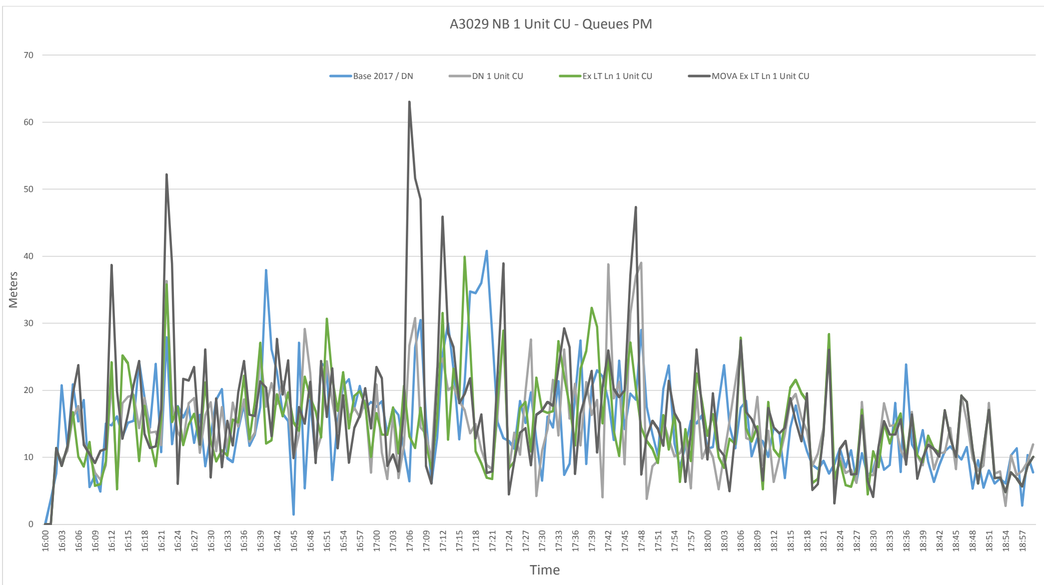
Base 2017 / DN
DN 1 Unit B
Ex LT Ln 1 Unit B
MOVA Ex LT Ln 1 Unit B
Meters
Time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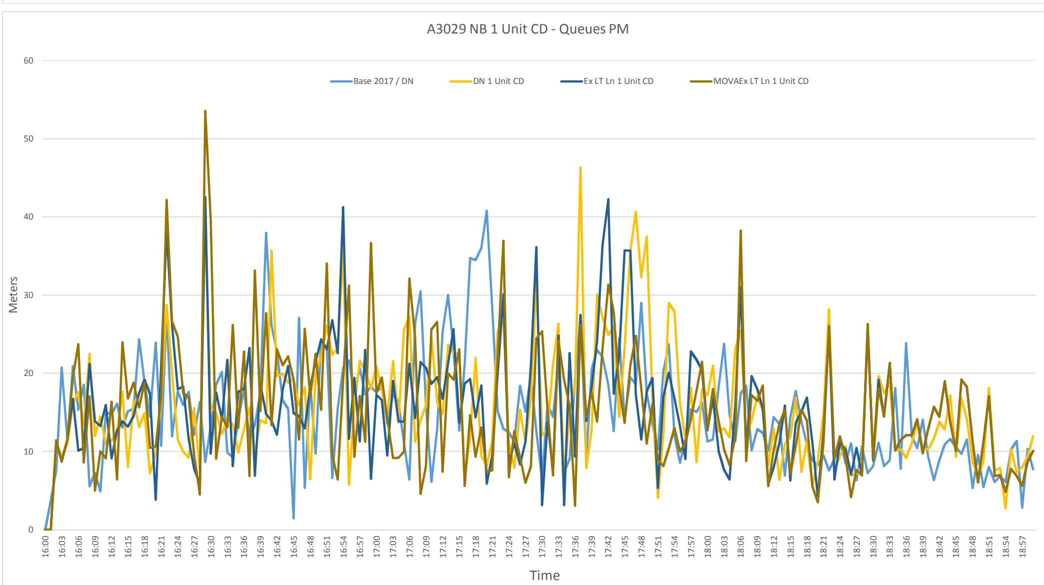
Base 2017 / DN
DN 1 Unit CU
Ex LT Ln 1 Unit CU
MOVA Ex LT Ln 1 Unit CU
Meters
Time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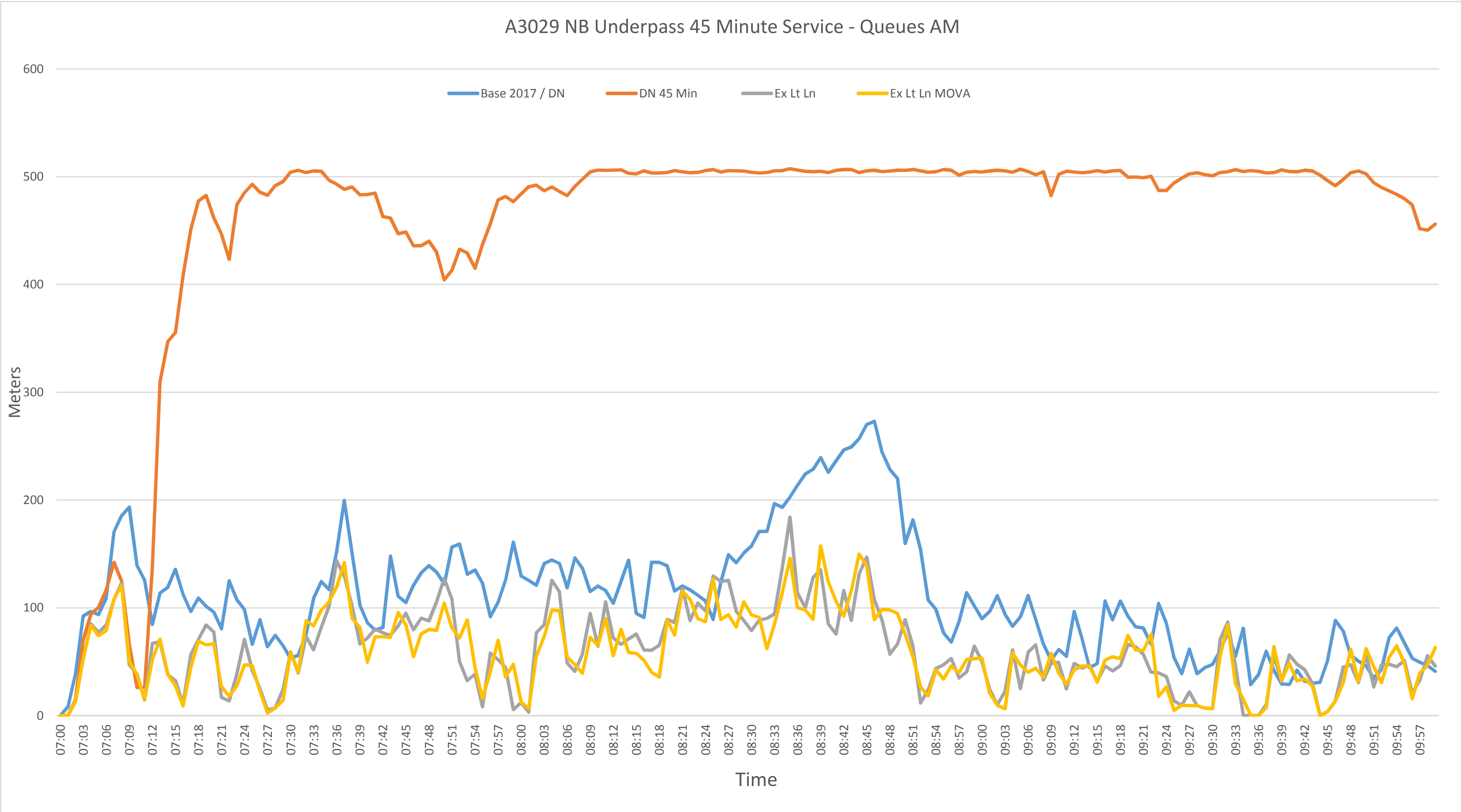
Base 2017 / DN
DN 1 Unit CD
Ex LT Ln 1 Unit CD
MOVAEx LT Ln 1 Unit CD
Meters
Time

Appendix D – Sensitivity Queue Length Graphs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Base 2017 / DN
DN 45 Min
Ex Lt Ln
Ex Lt Ln MOVA
Meters
Time
0
100
200
300
400
500
600
07:00
07:03
07:06
07:09
07:12
07:15
07:18
07:21
07:24
07:27
07:30
07:33
07:36
07:39
07:42
07:45
07:48
07:51
07:54
07:57
08:00
08:03
08:06
08:09
08:12
08:15
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08:24
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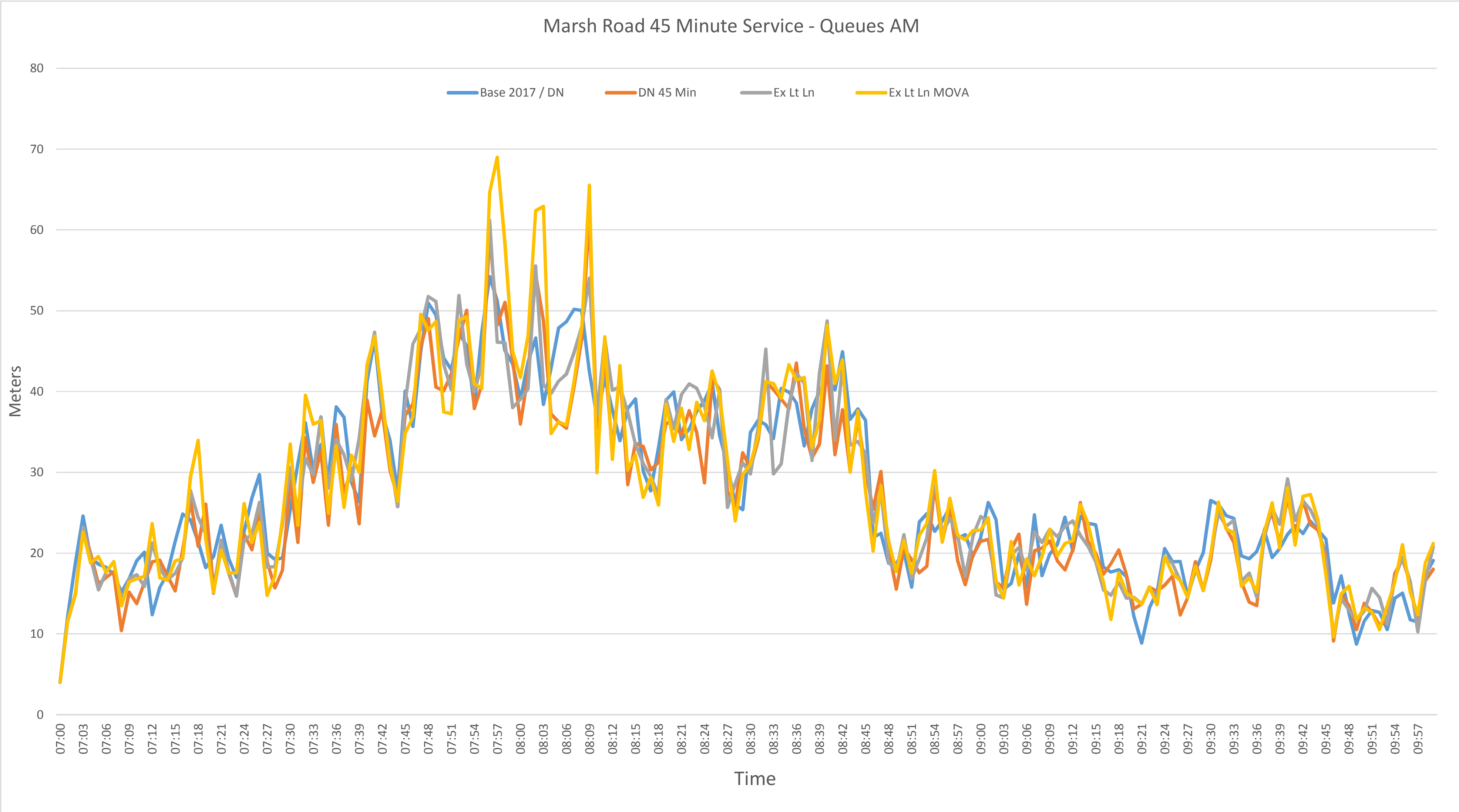
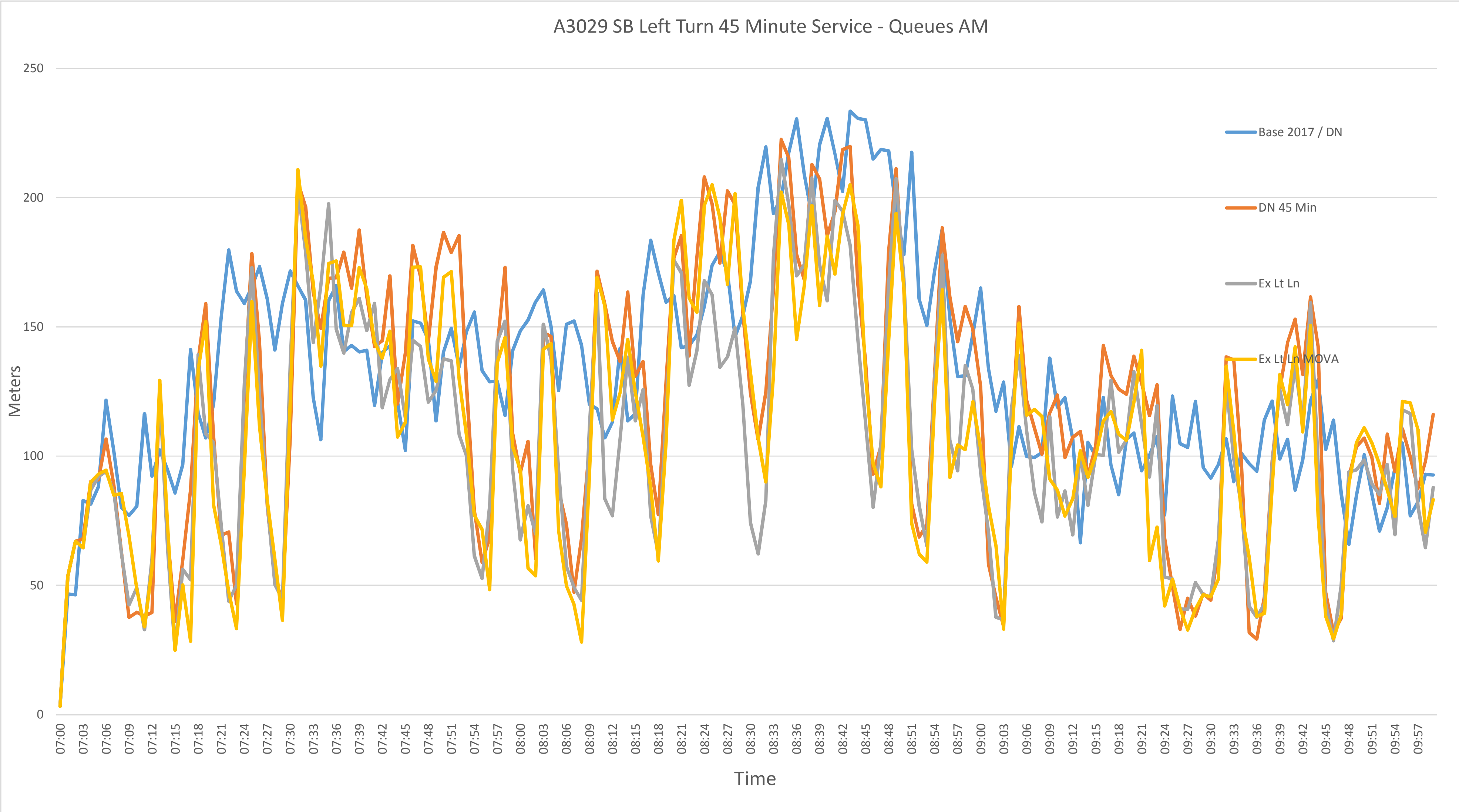


Marsh Road 45 Minute Service - Queues AM
Base 2017 / DN
DN 45 Min
Ex Lt Ln
Ex Lt Ln MOVA
Meters
Time


A3029 SB Left Turn 45 Minute Service - Queues AM
Meters
250
200
150
100
50
0
Time
07:00
07:03
07:06
07:09
07:12
07:15
07:18
07:21
07:24
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09:24
09:27
09:30
09:33
09:36
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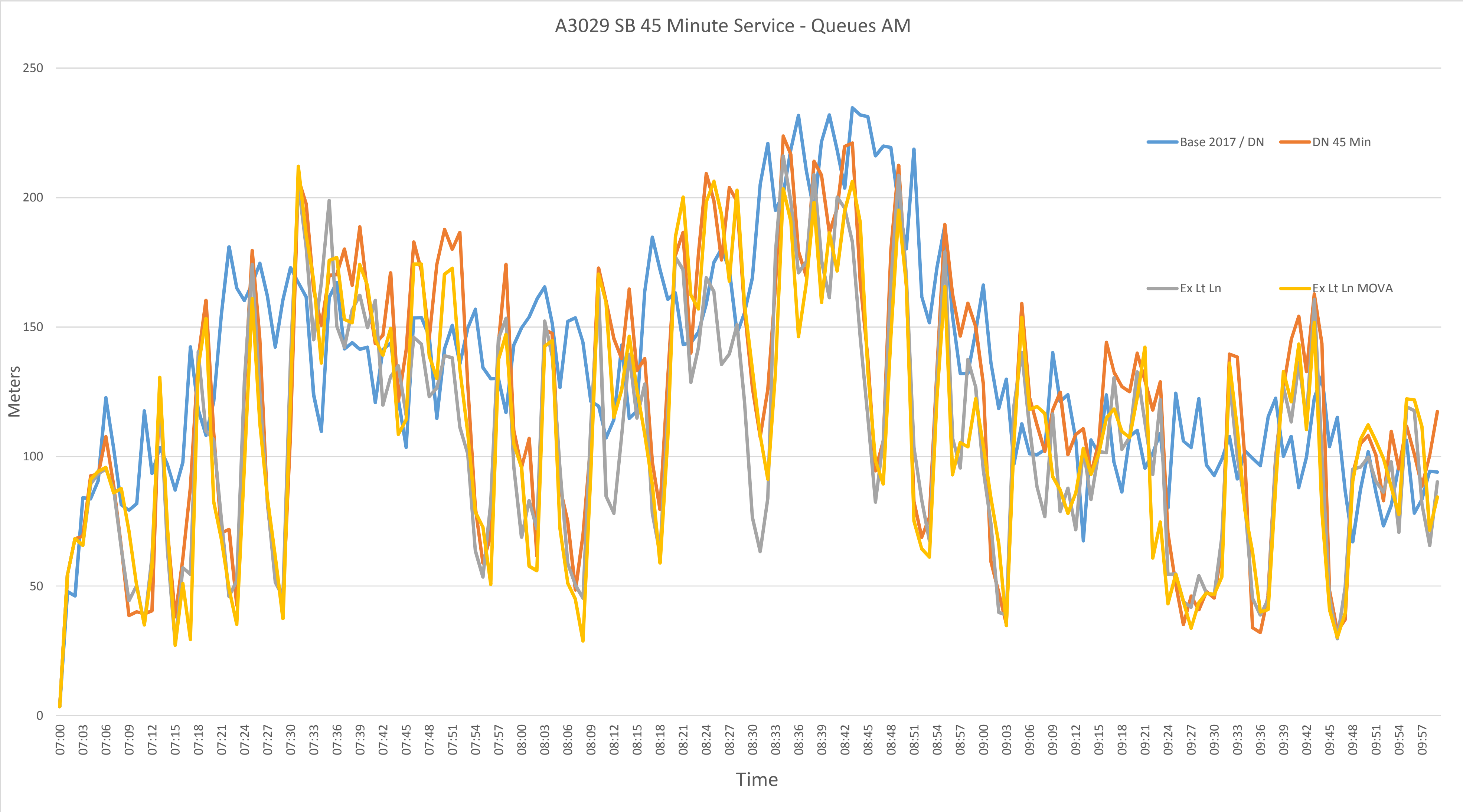
09:45
09:48
09:51
09:54
09:57
Base 2017 / DN
DN 45 Min
Ex Lt Ln
Ex Lt Ln MOVA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Base 2017 / DN
DN 45 Min
Ex Lt Ln
Ex Lt Ln MOVA
Meters
Time
250
200
150
100
50
0
07:00
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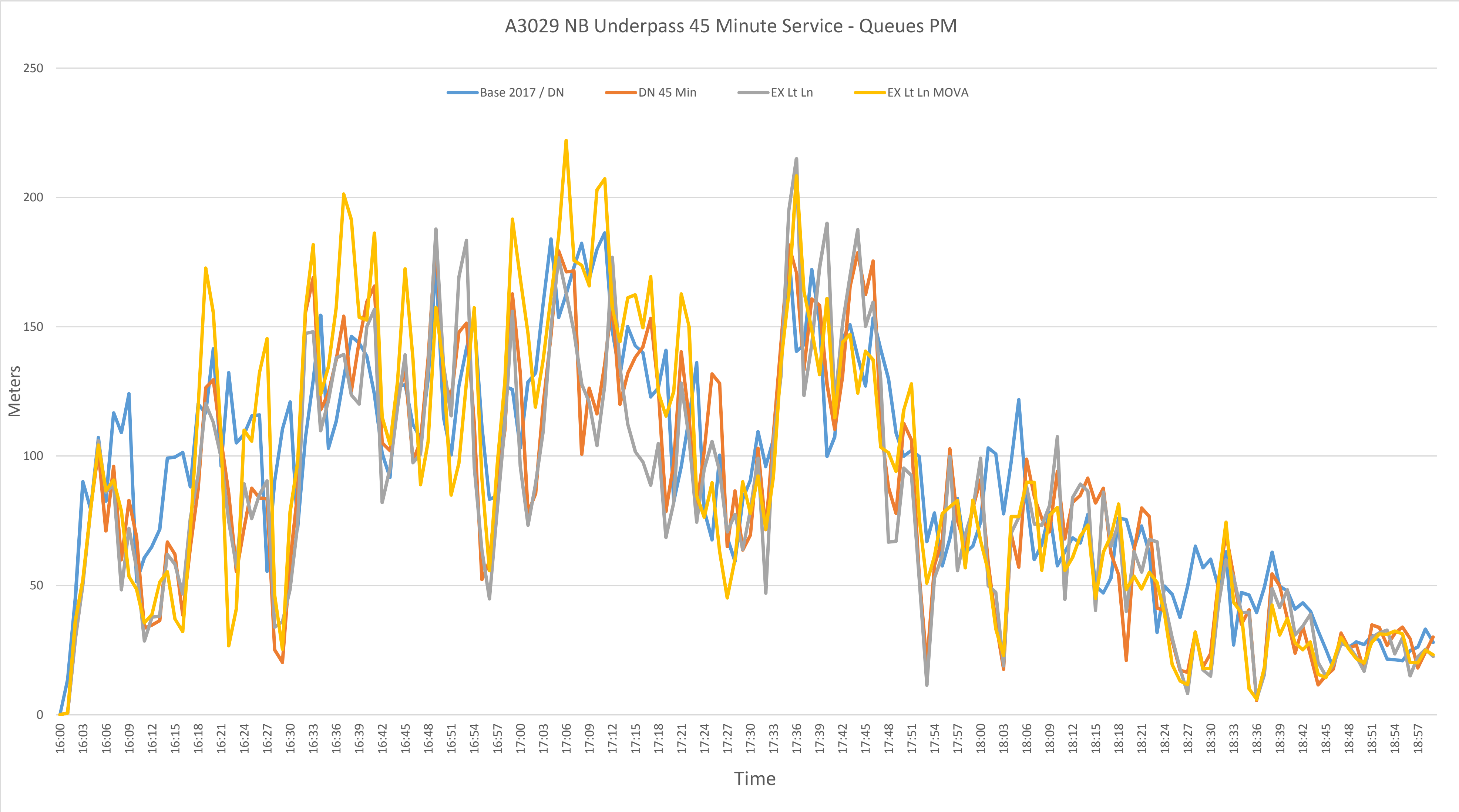

A3029 NB Underpass 45 Minute Service - Queues PM
Base 2017 / DN
DN 45 Min
EX Lt Ln
EX Lt Ln MOVA
Meters
0
50
100
150
200
250
Time
16:00
16:03
16:06
16:09
16:12
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16:21
16:24
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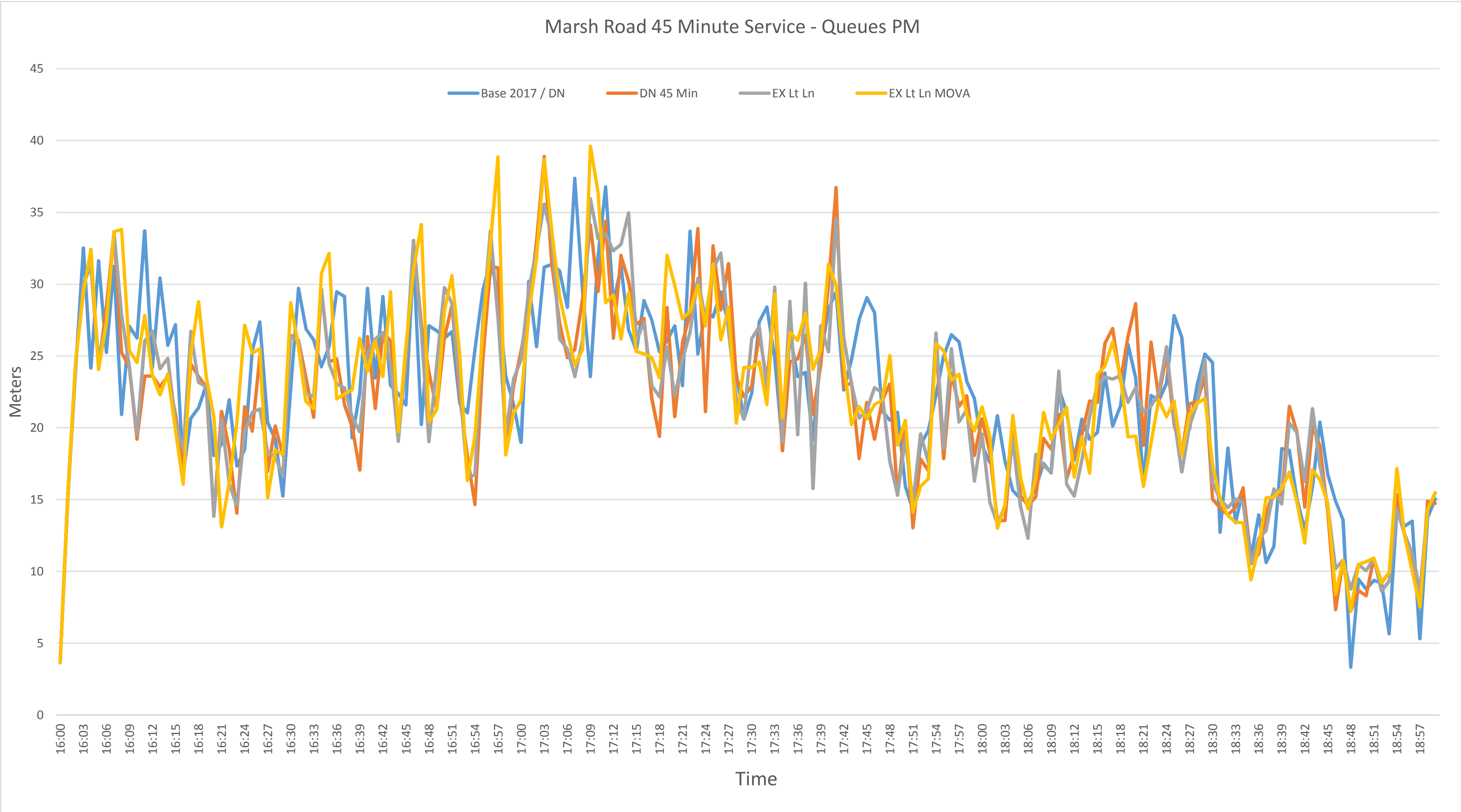

Marsh Road 45 Minute Service - Queues PM
Base 2017 / DN
DN 45 Min
EX Lt Ln
EX Lt Ln MOVA
Meters
Time
45
40
35
30
25
20
15
10
5
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16:00
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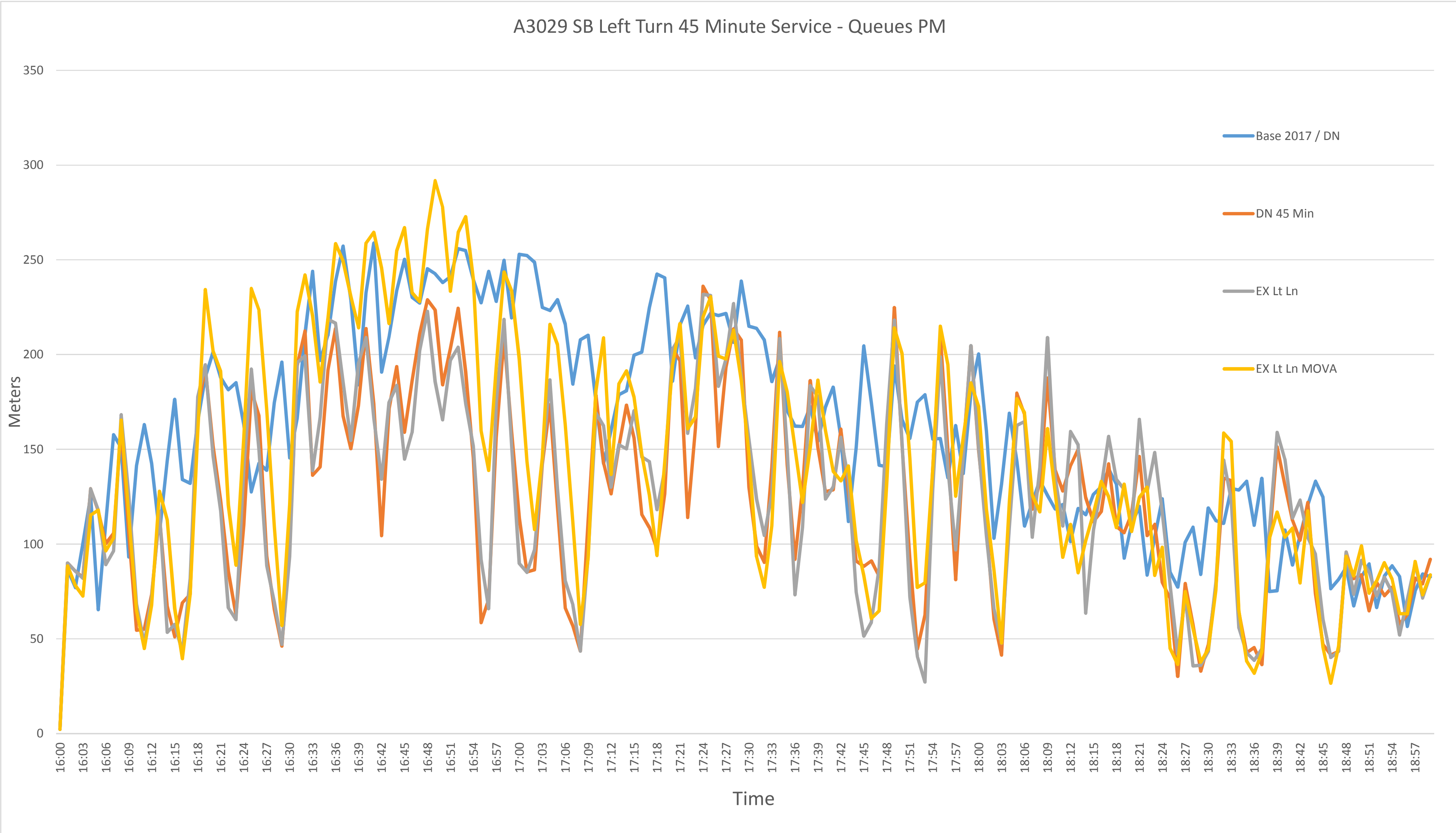
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Meters
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300
250
200
150
100
50
0
Time
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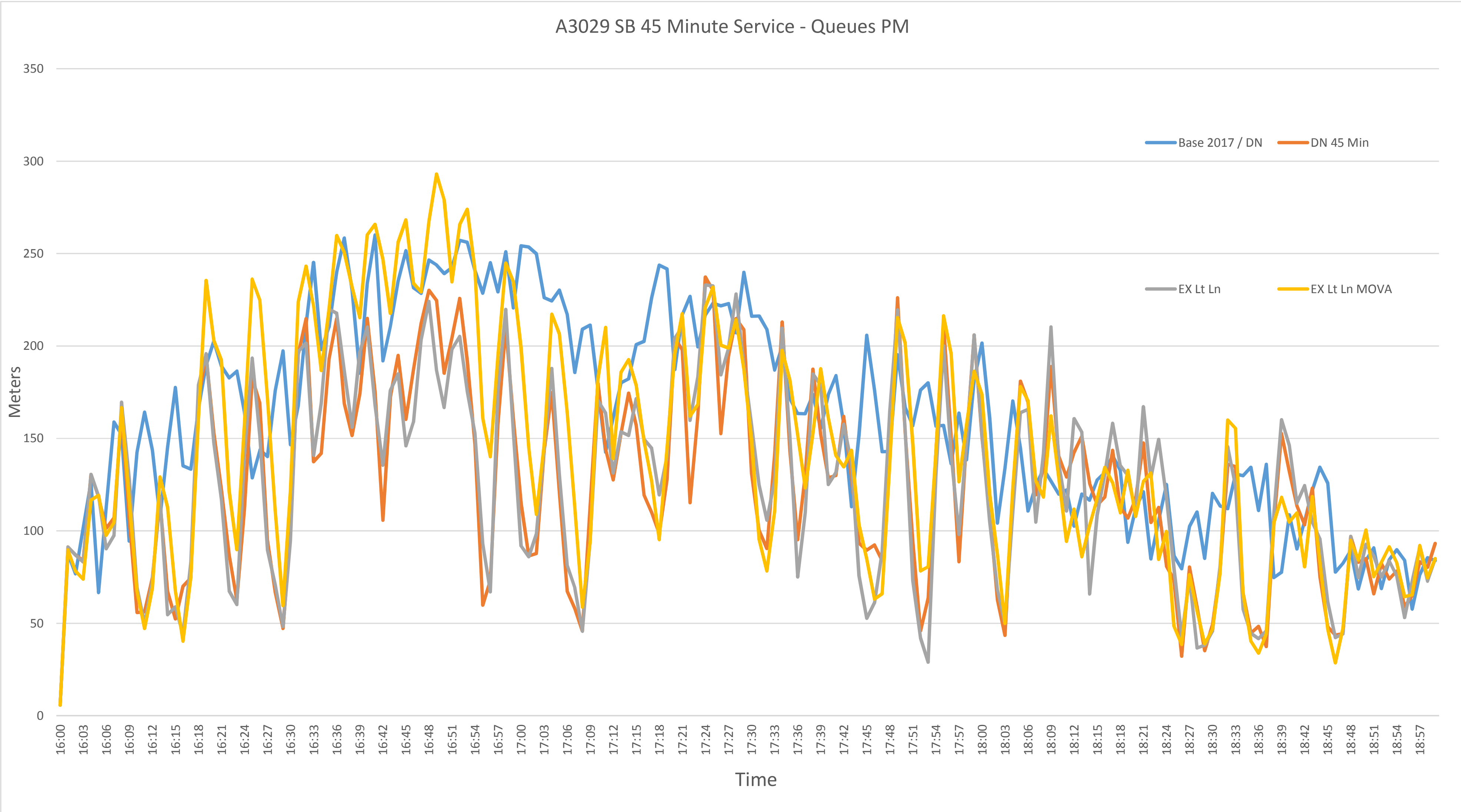
Base 2017 / DN
DN 45 Min
EX Lt Ln
EX Lt Ln MOVA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DN 45 Min
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EX Lt Ln MOVA
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