national highways

Lower Thames Crossing

9.15 Localised Traffic Modelling Appendix B - Orsett Cock VISSIM Local Model Validation Report

Infrastructure Planning (Examination Procedure) Rules 2010

Volume 9

DATE: July 2023
DEADLINE: 1

Planning Inspectorate Scheme Ref: TR010032
Examination Document Ref: TR010032/EXAM/9.15

VERSION: 1.0

Lower Thames Crossing

9.15 Localised Traffic Modelling Appendix B - Orsett Cock VISSIM Local Model Validation Report

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1 Introduction

1.1 Purpose of document

1.1.1 The purpose of this document is to present the local VISSIM model validation report for the network including the Orsett Cock junction, the A13/ A1089 junction and the junction of A1013 Stanford Road/ Rectory Road.

1.2 Modelling software

1.2.1 Road traffic micro-simulation models represent individual vehicles travelling within the road network, providing realistic driver behaviour such as lane changing and overtaking. The micro-simulation software selected for the Lower Thames Crossing is VISSIM. The model has been developed in VISSIM version 2020 (SP13).

1.3 The Project

1.3.1 The A122 Lower Thames Crossing (the Project) would provide a connection between the A2 and M2 in Kent, south-east of Gravesend, crossing under the River Thames through a tunnel, before joining the M25 south of junction 29. The Project route is presented in Plate 1.1.

1.3.2 The A122 would be approximately 23km long, 4.25km of which would be in tunnel. On the south side of the River Thames, the Project route would link the tunnel to the A2 and M2. On the north side, it would link to the A13, M25 junction 29 and the M25 south of junction 29. The tunnel entrances would be located to the east of the village of Chalk on the south of the River Thames and to the west of East Tilbury on the north side.

1.3.3 Junctions are proposed at the following locations:

a. New junction with the A2 to the south-east of Gravesend

b. Modified junction with the A13/A1089 in Thurrock

c. New junction with the M25 between junctions 29 and 30

1.3.4 To align with NPSNN policy and to help the Project meet the Scheme Objectives, it is proposed that road user charges would be levied in line with the Dartford Crossing. Vehicles would be charged for using the new tunnel.

1.3.5 The Project route would be three lanes in both directions, except for:

a. link roads

b. stretches of the carriageway through junctions

c. the southbound carriageway from the M25 to the junction with the A13/A1089, which would be two lanes

1.3.6 In common with most A-roads, the A122 would operate with no hard shoulder but would feature a 1m hard strip on either side of the carriageway. It would also feature technology including stopped vehicle and incident detection, lane

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control, variable speed limits and electronic signage and signalling. The A122 design outside of the tunnel would include emergency areas. The tunnel would include a range of enhanced systems and response measures instead of emergency areas.

1.3.7 The A122 would be classified as an ‘all-purpose trunk road’ with green signs. For safety reasons, walkers, cyclists, horse-riders and slow-moving vehicles would be prohibited from using it.

1.3.8 The Project would include adjustment to a number of local roads. There would also be changes to a number of public rights of way, used by walkers, cyclists and horse riders. Construction of the Project would also require the installation and diversion of a number of utilities, including gas mains, overhead electricity powerlines and underground electricity cables, as well as water supplies and telecommunications assets and associated infrastructure.

1.3.9 The Project has been developed to avoid or minimise significant effects on the environment. Some of the measures adopted include landscaping, noise mitigation, green bridges, floodplain compensation, new areas of ecological habitat and two new parks.

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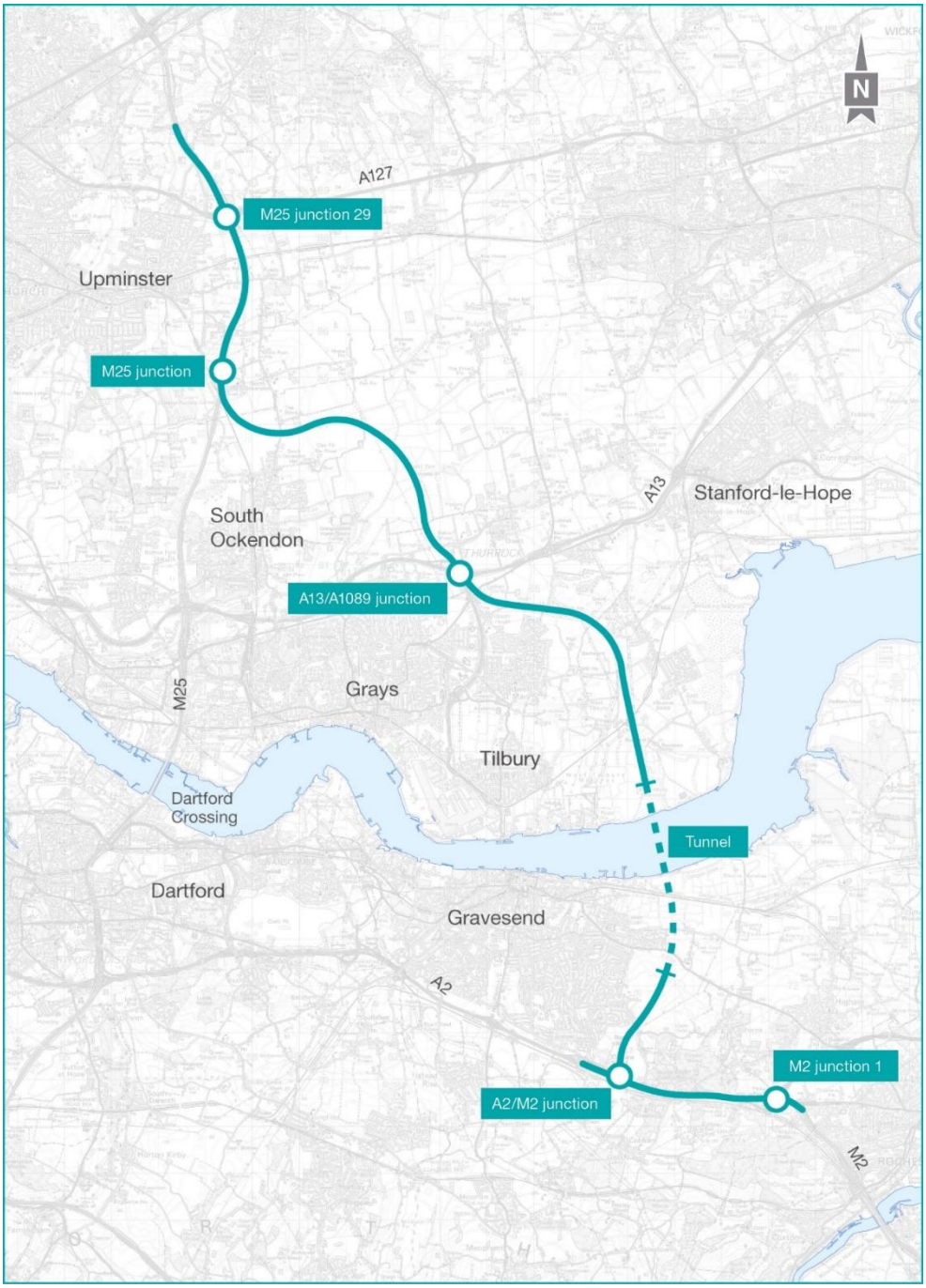
Plate 1.1 Lower Thames Crossing route



1.4 Structure of this report

1.4.1 The report summarises the methodology of the modelling process including:

a. Chapter 2: Study Area Justification;

a. Chapter 3: Traffic Data Analysis;

b. Chapter 4: Technical Guidelines;

c. Chapter 5: VISSIM Model Calibration;

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d. Chapter 6: Model Validation Results; and

e. Chapter 7: Conclusions.

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2 Modelling scope

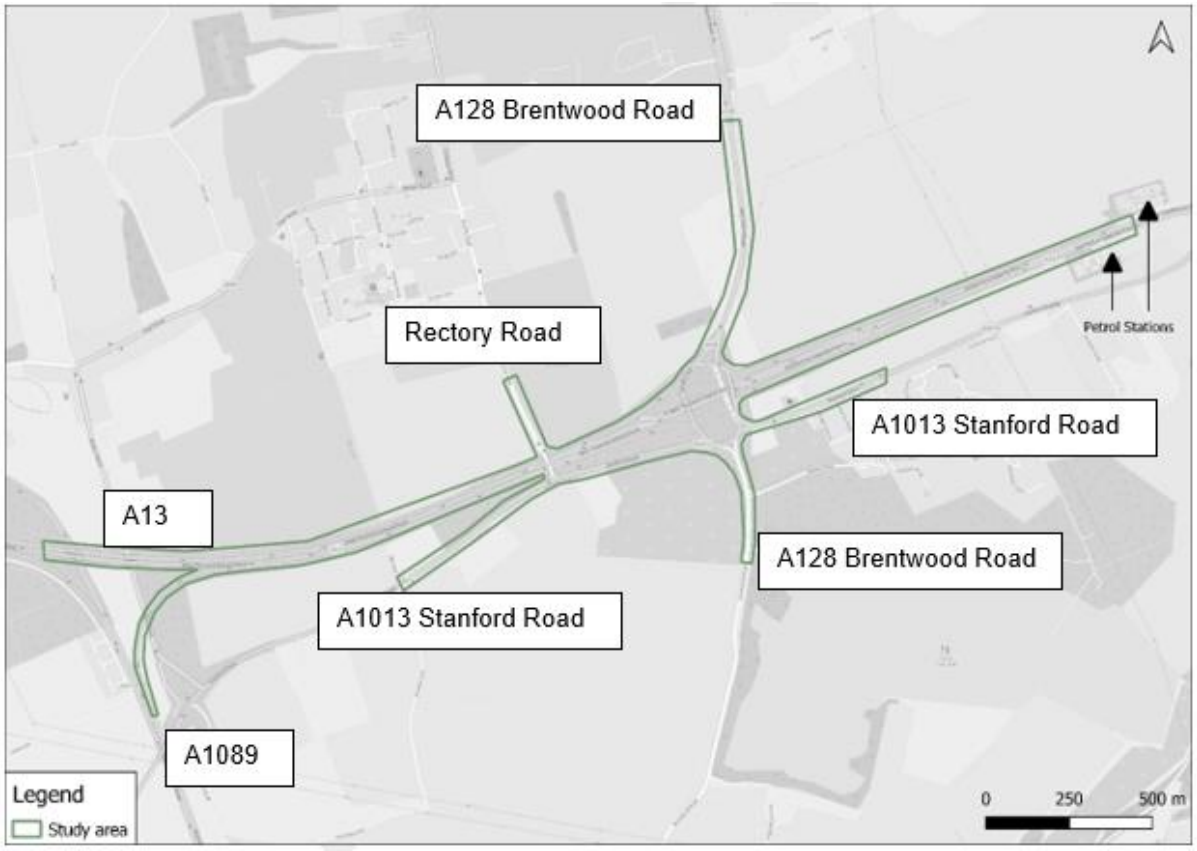
2.1.1 The model extent, modelling years and time periods have been defined based on discussion and agreement with Thurrock Council and their consultants during a workshop on 14 December 2021.

2.1.2 The study area is located to the north-east of Grays and Plate 2.1 shows the extent of the study area covered by the VISSIM model. The section of the A13 in this area and the Orsett Cock junction itself is, at the time of writing this report, under construction as part of the A13 Widening Scheme between Orsett Cock and the Manorway being undertaken by Thurrock Council. The VISSIM base year model reflects the road network and traffic condition in 2016, before the construction work commenced.

2.1.3 The Orsett Cock junction in 2016 was an unsignalised, grade-separated roundabout with two circulatory lanes. The A13 had three lanes in each direction west of the junction and two lanes east of the Orsett Cock junction. The area of interest also extends to the westbound diverge from the A13/A1089 onto the A1089 in order to capture the anticipated changes proposed around the A13/A1089 in the Project.

2.1.4 The model also includes the A1013 Stanford Road/ Rectory Road unsignalised T- Junction, located just to the west of the Orsett Cock junction.

Plate 2.1 Traffic Operations Study Area



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3 Traffic data analysis

3.1 Traffic count data

3.1.1 This section covers the existing traffic count data available for use in the development of this model. The locations of the existing count data are displayed in Plate 3.1.

Plate 3.1 Traffic Count Locations

3.1.2 The traffic demand for the A13 and Orsett Cock junction was based upon the Manual Classified Junction and Link Counts collected on 11 October 2016 (Tuesday).

3.1.3 Traffic flow at the A1013 Stanford Road and Rectory Road junction was based on the Manual Classified Junction Count from 17 May 2018 (Thursday). The flows on the A1013 were factored to match the 2016 data at the Orsett Cock junction.

3.1.4 There were no traffic counts available for the A13 westbound diverge with the A1089. The proportions of A13 westbound traffic travelling to the A1089 were derived using outputs from the base year of the Project's transport model (LR_N108R1_2016). Plate 3.2 to Plate 3.4 show the total hourly turning flows during the AM (07:00 – 08:00 and 08:00 – 09:00) and PM (17:00 – 18:00) peak hours respectively.

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Plate 3.2 Traffic Volumes 07:00 to 08:00 in Veh/hr

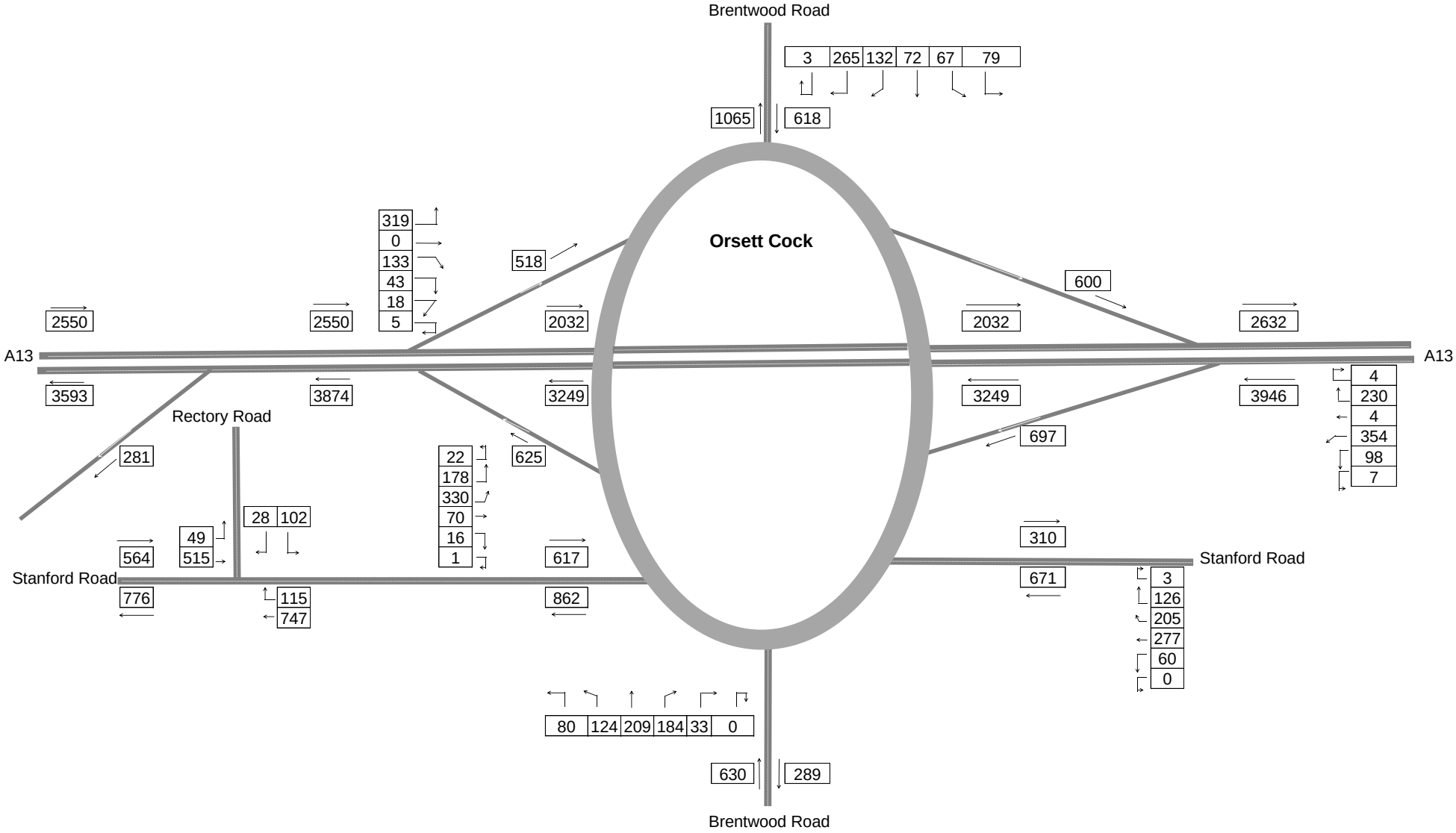

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Plate 3.3 Traffic Volumes 08:00 to 09:00 in Veh/hr

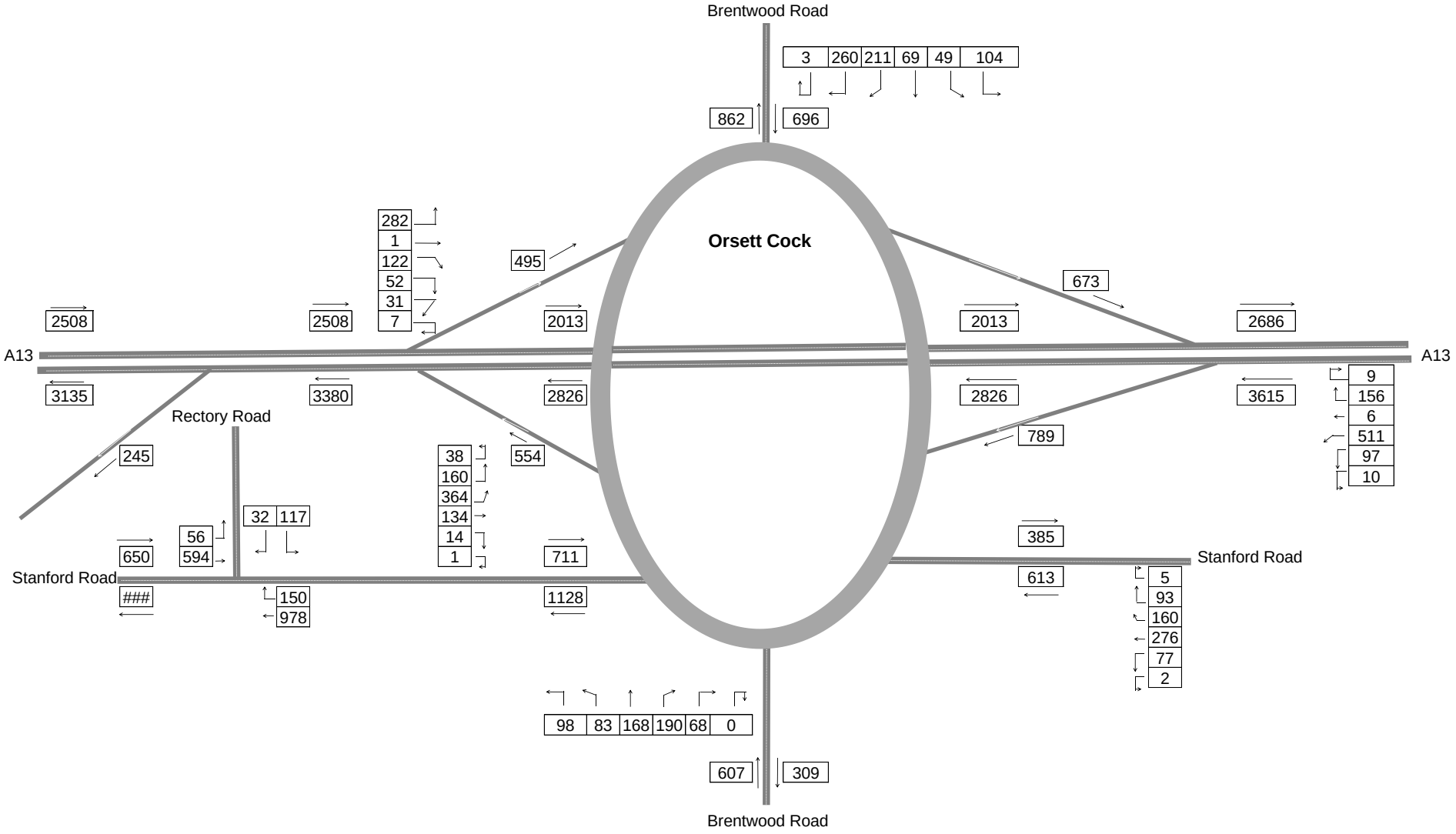

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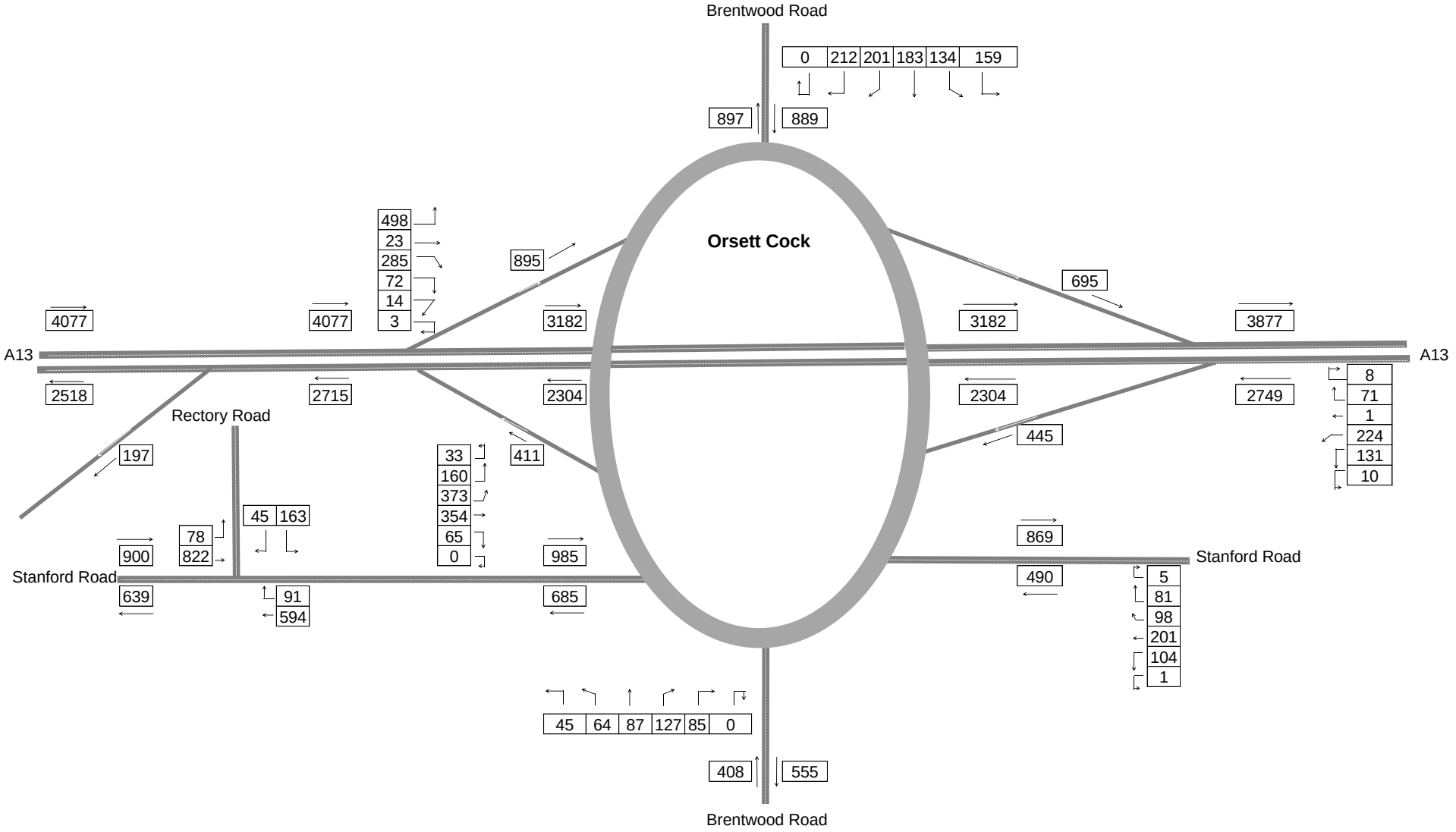
Plate 3.4 Traffic Volumes 17:00 to 18:00 in Veh/hr



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3.3 Journey time data

3.3.1 The journey time data for the model validation was extracted from the TrafficMaster data supplied by DfT for all neutral weekdays (Tue, Wed & Thu) in October 2016. It excluded the half-term school holidays from 24 to 28 October. Taking the journey time data from multiple days over the same month of the traffic counts increases the sample size as there were no data for some links on the day of the traffic counts.

3.3.2 The data was aggregated into journey time routes through the area covered by the modelled network. The routes and the observed journey time used for model validation are listed in Table 3.1 to Table 3.3 and covers all movements between the seven origin and seven destinations illustrated in Plate 3.5.

Plate 3.5 Journey Time Start and End Locations

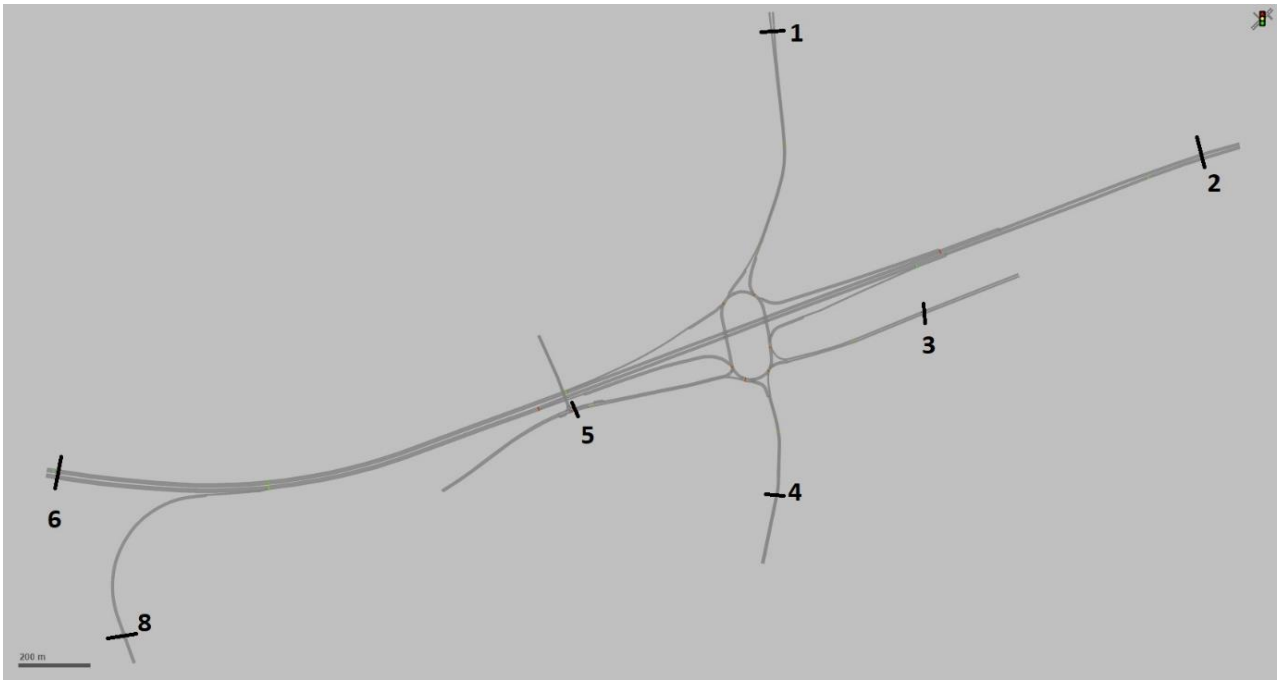

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Table 3.1 Zone to zone Journey Times and Distances AM1

Peak	Route	Name	Distance [m]	JT [s]	Average Speed [mph]
AM 07:00-08:00	1-->2	A128 Brentwood Rd (North) to A13 EB mainline	2,083	108	43.2
	1-->3	A128 Brentwood Rd (North) to A1013 Stanford Rd (East)	1,377	97	31.6
	1-->4	A128 Brentwood Rd (North) to A128 Brentwood Rd (South)	1,332	91	32.9
	1-->5	A128 Brentwood Rd (North) to A1013 Stanford Rd (West)	1,554	106	32.9
	1-->6	A128 Brentwood Rd (North) to A13 WB mainline	3,045	159	42.7
	1-->8	A128 Brentwood Rd (North) to A13 WB off-slip to A1089	3,197	171	41.8
	2-->1	A13 WB mainline to A128 Brentwood Rd (North)	2,364	153	34.6
	2-->3	A13 WB mainline to A1013 Stanford Rd (East)	1,652	109	33.8
	2-->4	A13 WB mainline to A128 Brentwood Rd (South)	1,606	102	35.1
	2-->5	A13 WB mainline to A1013 Stanford Rd (West)	1,828	117	34.8
	2-->6	A13 WB mainline to A13 WB mainline	3,193	134	53.3
	2-->8	A13 WB mainline to A13 WB off-slip to A1089	3,344	146	51.3
	3-->1	A1013 Stanford Rd (East) to A128 Brentwood Rd (North)	1,572	126	27.8
	3-->2	A1013 Stanford Rd (East) to A13 EB mainline	2,195	140	35.1
	3-->4	A1013 Stanford Rd (East) to A128 Brentwood Rd (South)	814	76	24.0
	3-->5	A1013 Stanford Rd (East) to A1013 Stanford Rd (West)	1,036	91	25.5
	3-->6	A1013 Stanford Rd (East) to A13 WB mainline	2,528	145	39.1
	3-->8	A1013 Stanford Rd (East) to A13 WB off-slip to A1089	2,680	156	38.3
	4-->1	A128 Brentwood Rd (South) to A128 Brentwood Rd (North)	1,403	108	29.0

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Peak	Route	Name	Distance [m]	JT [s]	Average Speed [mph]
	4-->2	A128 Brentwood Rd (South) to A13 EB mainline	2,027	121	37.3
	4-->3	A128 Brentwood Rd (South) to A1013 Stanford Rd (East)	1,321	111	26.6
	4-->5	A128 Brentwood Rd (South) to A1013 Stanford Rd (West)	868	73	26.8
	4-->6	A128 Brentwood Rd (South) to A13 WB mainline	2,360	126	41.8
	4-->8	A128 Brentwood Rd (South) to A13 WB off-slip to A1089	2,511	138	40.7
	5-->1	A1013 Stanford Rd (West) to A128 Brentwood Rd (North)	1,460	119	27.6
	5-->2	A1013 Stanford Rd (West) to A13 EB mainline	2,084	132	35.3
	5-->3	A1013 Stanford Rd (West) to A1013 Stanford Rd (East)	1,378	121	25.4
	5-->4	A1013 Stanford Rd (West) to A128 Brentwood Rd (South)	1,332	115	26.0
	5-->6	A1013 Stanford Rd (West) to A13 WB mainline	2,417	137	39.5
	5-->8	A1013 Stanford Rd (West) to A13 WB off-slip to A1089	2,568	149	38.7
	6-->1	A13 EB mainline to A128 Brentwood Rd (North)	2,784	151	41.4
	6-->2	A13 EB mainline to A13 EB mainline	3,371	112	67.5
	6-->3	A13 EB mainline to A1013 Stanford Rd (East)	2,702	153	39.4
	6-->4	A13 EB mainline to A128 Brentwood Rd (South)	2,656	147	40.6
	6-->5	A13 EB mainline to A1013 Stanford Rd (West)	2,878	162	39.9
	6-->8	A13 EB mainline to A13 WB off-slip to A1089	3,889	199	43.8

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Table 3.2 Zone to zone Journey Times and Distances AM2

Peak	Route	Name	Distance [m]	JT [s]	Average Speed [mph]
AM 08:00-09:00	1-->2	A128 Brentwood Rd (North) to A13 EB mainline	2,083	106	44.1
	1-->3	A128 Brentwood Rd (North) to A1013 Stanford Rd (East)	1,377	98	31.3
	1-->4	A128 Brentwood Rd (North) to A128 Brentwood Rd (South)	1,332	97	30.8
	1-->5	A128 Brentwood Rd (North) to A1013 Stanford Rd (West)	1,554	106	32.8
	1-->6	A128 Brentwood Rd (North) to A13 WB mainline	3,045	152	44.7
	1-->8	A128 Brentwood Rd (North) to A13 WB off-slip to A1089	3,197	162	44.2
	2-->1	A13 WB mainline to A128 Brentwood Rd (North)	2,364	140	37.9
	2-->3	A13 WB mainline to A1013 Stanford Rd (East)	1,652	101	36.8
	2-->4	A13 WB mainline to A128 Brentwood Rd (South)	1,606	99	36.3
	2-->5	A13 WB mainline to A1013 Stanford Rd (West)	1,828	108	37.9
	2-->6	A13 WB mainline to A13 WB mainline	3,193	121	58.8
	2-->8	A13 WB mainline to A13 WB off-slip to A1089	3,344	131	57.2
	3-->1	A1013 Stanford Rd (East) to A128 Brentwood Rd (North)	1,572	182	19.3
	3-->2	A1013 Stanford Rd (East) to A13 EB mainline	2,195	197	24.9
	3-->4	A1013 Stanford Rd (East) to A128 Brentwood Rd (South)	814	141	12.9
	3-->5	A1013 Stanford Rd (East) to A1013 Stanford Rd (West)	1,036	150	15.4
	3-->6	A1013 Stanford Rd (East) to A13 WB mainline	2,528	197	28.7
	3-->8	A1013 Stanford Rd (East) to A13 WB off-slip to A1089	2,680	206	29.0
	4-->1	A128 Brentwood Rd (South) to A128 Brentwood Rd (North)	1,403	262	12.0
	4-->2	A128 Brentwood Rd (South) to A13 EB mainline	2,027	277	16.3

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Peak	Route	Name	Distance [m]	JT [s]	Average Speed [mph]
	4-->3	A128 Brentwood Rd (South) to A1013 Stanford Rd (East)	1,321	270	10.9
	4-->5	A128 Brentwood Rd (South) to A1013 Stanford Rd (West)	868	231	8.4
	4-->6	A128 Brentwood Rd (South) to A13 WB mainline	2,360	277	19.0
	4-->8	A128 Brentwood Rd (South) to A13 WB off-slip to A1089	2,511	287	19.6
	5-->1	A1013 Stanford Rd (West) to A128 Brentwood Rd (North)	1,460	136	24.1
	5-->2	A1013 Stanford Rd (West) to A13 EB mainline	2,084	151	30.9
	5-->3	A1013 Stanford Rd (West) to A1013 Stanford Rd (East)	1,378	143	21.5
	5-->4	A1013 Stanford Rd (West) to A128 Brentwood Rd (South)	1,332	142	21.0
	5-->6	A1013 Stanford Rd (West) to A13 WB mainline	2,417	151	35.9
	5-->8	A1013 Stanford Rd (West) to A13 WB off-slip to A1089	2,568	160	35.9
	6-->1	A13 EB mainline to A128 Brentwood Rd (North)	2,784	166	37.5
	6-->2	A13 EB mainline to A13 EB mainline	3,371	114	66.0
	6-->3	A13 EB mainline to A1013 Stanford Rd (East)	2,702	174	34.7
	6-->4	A13 EB mainline to A128 Brentwood Rd (South)	2,656	172	34.5
	6-->5	A13 EB mainline to A1013 Stanford Rd (West)	2,878	182	35.5
	6-->8	A13 EB mainline to A13 WB off-slip to A1089	4,521	238	42.6

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Table 3.3 Zone to zone Journey Times and Distances PM

Peak	Route	Name	Distance [m]	JT [s]	Average Speed [mph]
PM 17:00-18:00	1-->2	A128 Brentwood Rd (North) to A13 EB mainline	2,083	183	25.5
	1-->3	A128 Brentwood Rd (North) to A1013 Stanford Rd (East)	1,377	148	20.8
	1-->4	A128 Brentwood Rd (North) to A128 Brentwood Rd (South)	1,332	145	20.6
	1-->5	A128 Brentwood Rd (North) to A1013 Stanford Rd (West)	1,554	159	21.9
	1-->6	A128 Brentwood Rd (North) to A13 WB mainline	3,045	204	33.5
	1-->8	A128 Brentwood Rd (North) to A13 WB off-slip to A1089	3,197	215	33.3
	2-->1	A13 WB mainline to A128 Brentwood Rd (North)	2,364	191	27.7
	2-->3	A13 WB mainline to A1013 Stanford Rd (East)	1,652	148	24.9
	2-->4	A13 WB mainline to A128 Brentwood Rd (South)	1,606	145	24.8
	2-->5	A13 WB mainline to A1013 Stanford Rd (West)	1,828	159	25.7
	2-->6	A13 WB mainline to A13 WB mainline	3,193	111	64.4
	2-->8	A13 WB mainline to A13 WB off-slip to A1089	3,344	122	61.4
	3-->1	A1013 Stanford Rd (East) to A128 Brentwood Rd (North)	1,572	108	32.5
	3-->2	A1013 Stanford Rd (East) to A13 EB mainline	2,195	146	33.6
	3-->4	A1013 Stanford Rd (East) to A128 Brentwood Rd (South)	814	63	29.0
	3-->5	A1013 Stanford Rd (East) to A1013 Stanford Rd (West)	1,036	77	30.3
	3-->6	A1013 Stanford Rd (East) to A13 WB mainline	2,528	121	46.6
	3-->8	A1013 Stanford Rd (East) to A13 WB off-slip to A1089	2,680	132	45.3
	4-->1	A128 Brentwood Rd (South) to A128 Brentwood Rd (North)	1,403	94	33.5
	4-->2	A128 Brentwood Rd (South) to A13 EB mainline	2,027	132	34.4

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Peak	Route	Name	Distance [m]	JT [s]	Average Speed [mph]
	4-->3	A128 Brentwood Rd (South) to A1013 Stanford Rd (East)	1,321	97	30.6
	4-->5	A128 Brentwood Rd (South) to A1013 Stanford Rd (West)	868	62	31.2
	4-->6	A128 Brentwood Rd (South) to A13 WB mainline	2,360	107	49.3
	4-->8	A128 Brentwood Rd (South) to A13 WB off-slip to A1089	2,511	118	47.6
	5-->1	A1013 Stanford Rd (West) to A128 Brentwood Rd (North)	1,460	112	29.1
	5-->2	A1013 Stanford Rd (West) to A13 EB mainline	2,084	150	31.1
	5-->3	A1013 Stanford Rd (West) to A1013 Stanford Rd (East)	1,378	115	26.8
	5-->4	A1013 Stanford Rd (West) to A128 Brentwood Rd (South)	1,332	112	26.6
	5-->6	A1013 Stanford Rd (West) to A13 WB mainline	2,417	125	43.1
	5-->8	A1013 Stanford Rd (West) to A13 WB off-slip to A1089	2,568	136	42.2
	6-->1	A13 EB mainline to A128 Brentwood Rd (North)	2,784	326	19.1
	6-->2	A13 EB mainline to A13 EB mainline	3,371	247	30.5
	6-->3	A13 EB mainline to A1013 Stanford Rd (East)	2,702	329	18.4
	6-->4	A13 EB mainline to A128 Brentwood Rd (South)	2,656	326	18.2
	6-->5	A13 EB mainline to A1013 Stanford Rd (West)	2,878	340	19.0
	6-->8	A13 EB mainline to A13 WB off-slip to A1089	4,521	395	25.6

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4 Technical guidelines

4.1.1 The traffic modelling on the Lower Thames Crossing project complies with the requirements set out in National Highways' technical documentation and DfT Transport Appraisal Guidance (TAG). Guidance on methodology and reporting relevant for micro-simulation models can be found in the following:

a. Design Manual for Roads and Bridges (DMRB).

b. Guidelines for the Use of Microsimulation Software, Highways Agency (now withdrawn).

4.1.2 A new issue of the DMRB was released early 2020. The new issue of the DMRB no longer includes the Traffic Appraisal of Roads Schemes (Volume 12). Instead, most of the guidance is now available in TAG.

4.1.3 TAG has little guidance specific to microsimulation models and the key chapters in the previous DMRB date from the early 1990s. Therefore, in accordance with industry best practise, this document references the Transport for London (TfL) modelling guidelines which cover microsimulation models, in particular:

a. Traffic Modelling Guidelines, TfL, Version 4.0 (September 2021); and

b. Model Auditing Process (MAP) – Traffic Schemes in London Urban Network, TfL, Version 3.5 (March 2017).

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5 VISSIM model calibration

5.1 Flow profile & peak hour identification

5.1.1 An analysis of all observed traffic volumes was undertaken to determine the hour with the busiest total traffic flows for each peak period.

5.1.2 This analysis showed that the busiest hours at this location are 07:00 to 08:00 and 08:00 to 09:00 for the AM peak, and 17:00-18:00 for the PM peak. The total traffic volume in each hour is shown in Table 5.1, with the busiest hours identified in bold.

5.1.3 The morning peak period has been modelled as a two-hour period to capture the peak hour for the A13 (07:00–08:00) and the peak hour of the junction (08:00–09:00) as presented in Plate 5.1 and Plate 5.2. The PM flow comparison presented in Plate 5.3 and Plate 5.4 which shows that the peak hour for both the A13 and at the junction is 17:00–18:00.

Table 5.1 AM/PM Peak Hour Analysis

Hour starting	Total flows	Peak hour
06:00:00	7,662	
07:00:00	**10,492**	AM
08:00:00	**10,349**	AM
09:00:00	7,657	
10:00:00	6,791	
11:00:00	6,747	
12:00:00	7,065	
13:00:00	7,333	
14:00:00	8,326	
15:00:00	9,423	
16:00:00	10,486	
17:00:00	**10,921**	PM
18:00:00	8,005	

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Plate 5.1 AM Flow Comparison at junction approaches

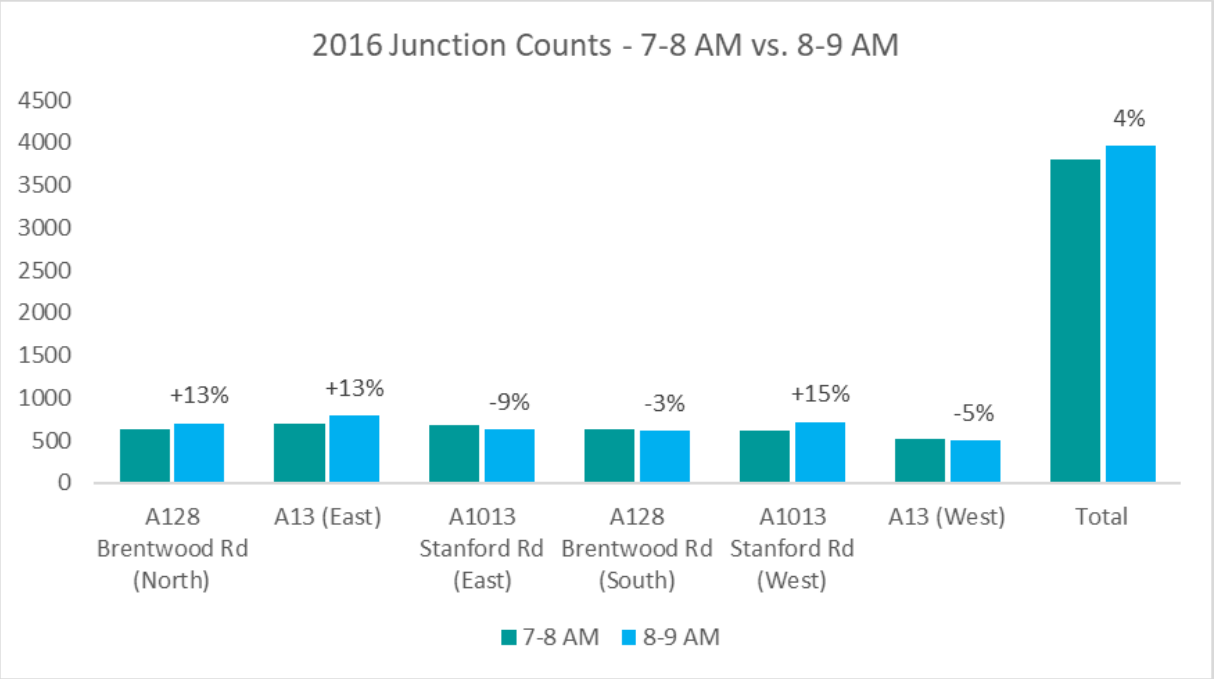

Plate 5.2 AM Flow Comparison at A13

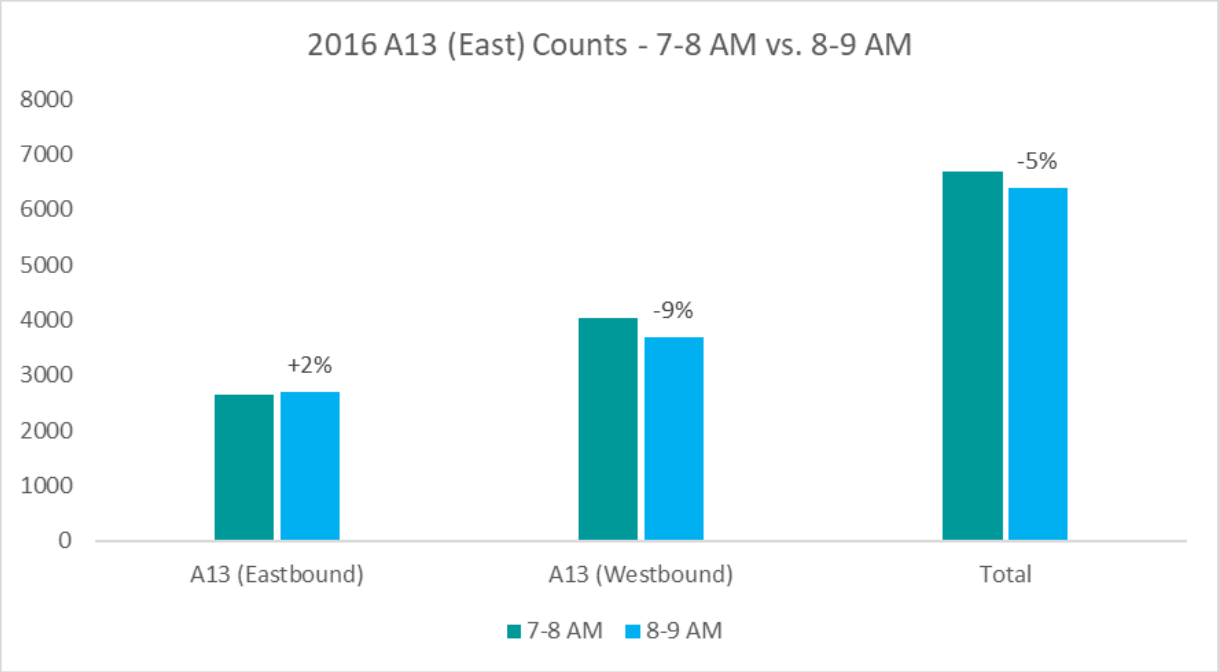

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Plate 5.3 PM Flow Comparison at junction approaches

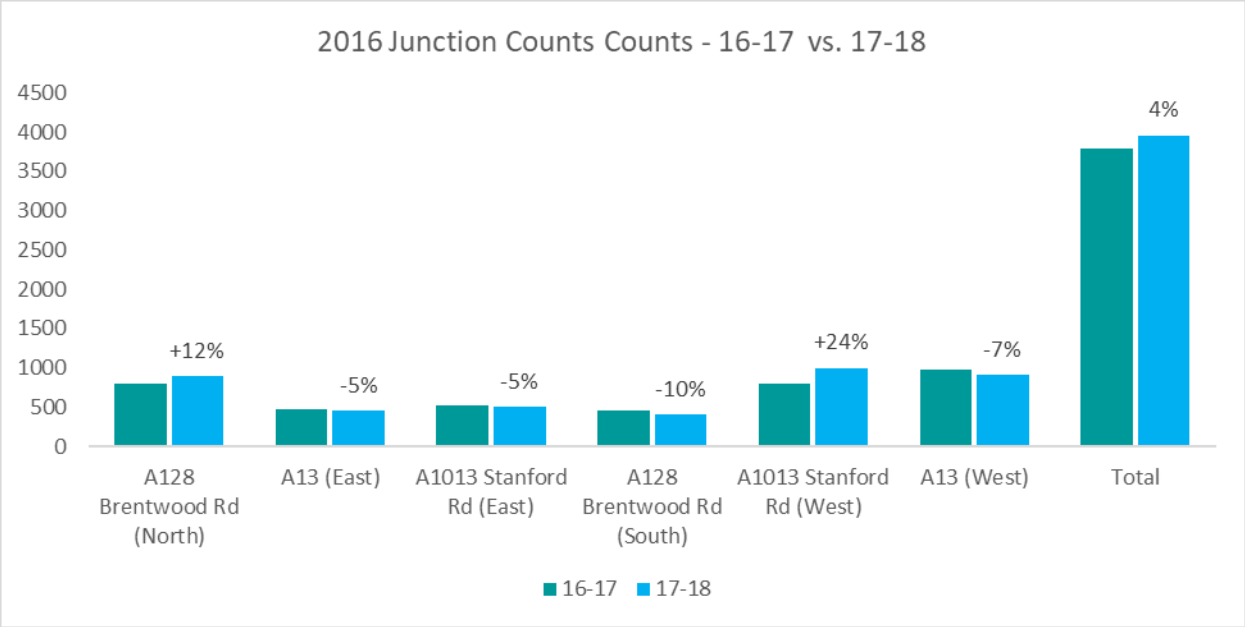
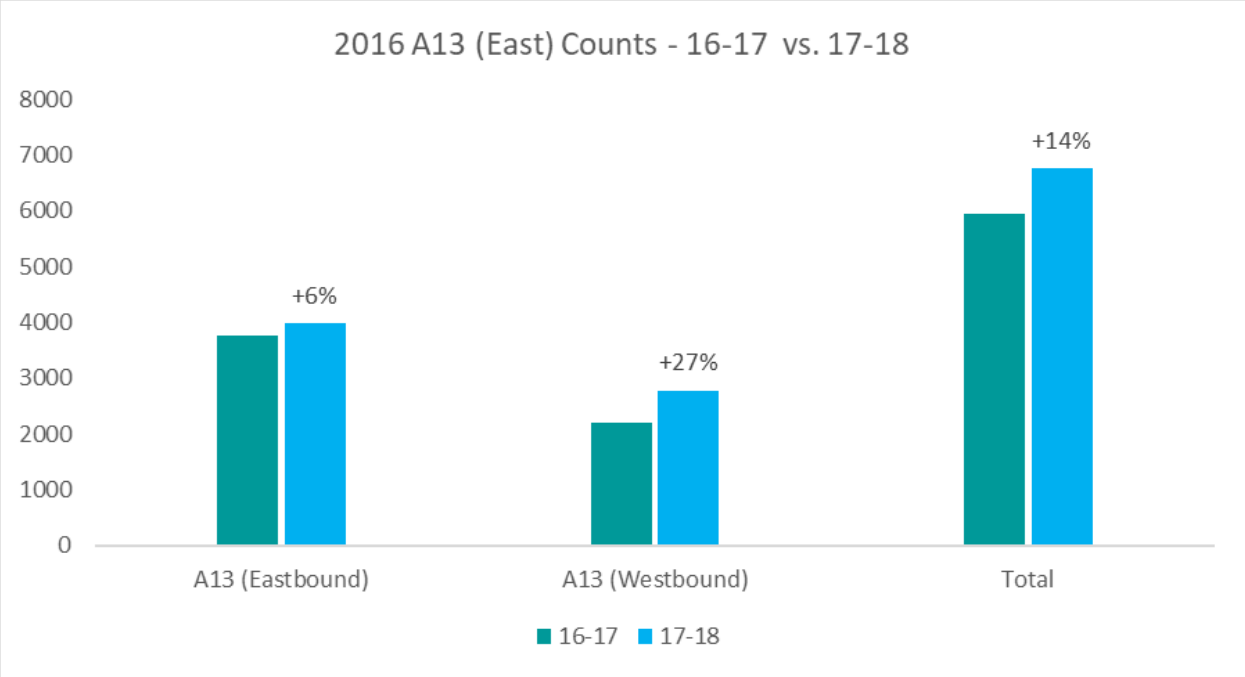


Plate 5.4 PM Flow Comparison at A13



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5.1.4 A 30-minute warm-up and cool-down period have been included at both ends of the modelling peak period. The modelling peak periods are as follows:

a. Weekday AM Peak (07:00 to 09:00); and

b. Weekday PM Peak (17:00 to 18:00).

5.2 Network

5.2.1 The network structure such as link lengths, lane connectors, number of lanes, lane utilisation and bus stop locations have been coded to match the road layout. The main data source was Ordnance Survey Base AutoCAD drawings supplemented by online mapping.

5.2.2 Reduced speed areas have been set up on all turning movements, with tighter turns having lower reduced speed values. VISSIM's 'desired speed decision points' have been used to allocate desired speeds to the vehicles on entry to the network and where there is a change in the posted speed limit. Vehicles attempt to travel in the model at this constant desired speed and will only adjust this speed if they approach a queue or are performing a lane change.

5.2.3 Priority rules have been used where one traffic movement has to give way to another traffic movement at Orsett Cock junction and at the A1013 Stanford Road and Rectory Road junction. The default values of a five-metre headway and three second gap time were adjusted based upon considerations of geometry, position and the types of vehicles stopping. Gap time and headway values were reviewed and updated as part of the model calibration process to replicate conditions on site. The gap times for heavy vehicles (bus and HGV) are longer compared to light vehicles. This reflects the fact that large vehicles have to wait for larger gaps in traffic than a car.

5.3 Link types and driving behaviour

5.3.1 The car-following model in VISSIM controls the way vehicles interact with other vehicles in front of them. (In VISSIM, vehicles do not adjust their behaviour to vehicles behind them, except for lane change behaviour).

5.3.2 The local roads including the Orsett Cock junction in the model are set to driving the 'Wiedemann 74' behaviour model which is the default for urban roads. The A13 adopts the freeway Wiedemann 99 behaviour model which is the default for motorway type roads.

5.4 Acceleration and deceleration functions

5.4.1 The acceleration and deceleration functions define the rates of vehicle acceleration and deceleration. The default settings in VISSIM have been adjusted to match the settings recommended by TfL.

5.5 Calibration of merges on the A13

5.5.1 The merge on the A13 eastbound is a taper merge with a long taper of 200m. This type of merge is particularly difficult to code in VISSIM as drivers' behaviour changes depending on the level of congestion on the mainline. When the A13 is under free-flowing conditions, more vehicles from the slip road can

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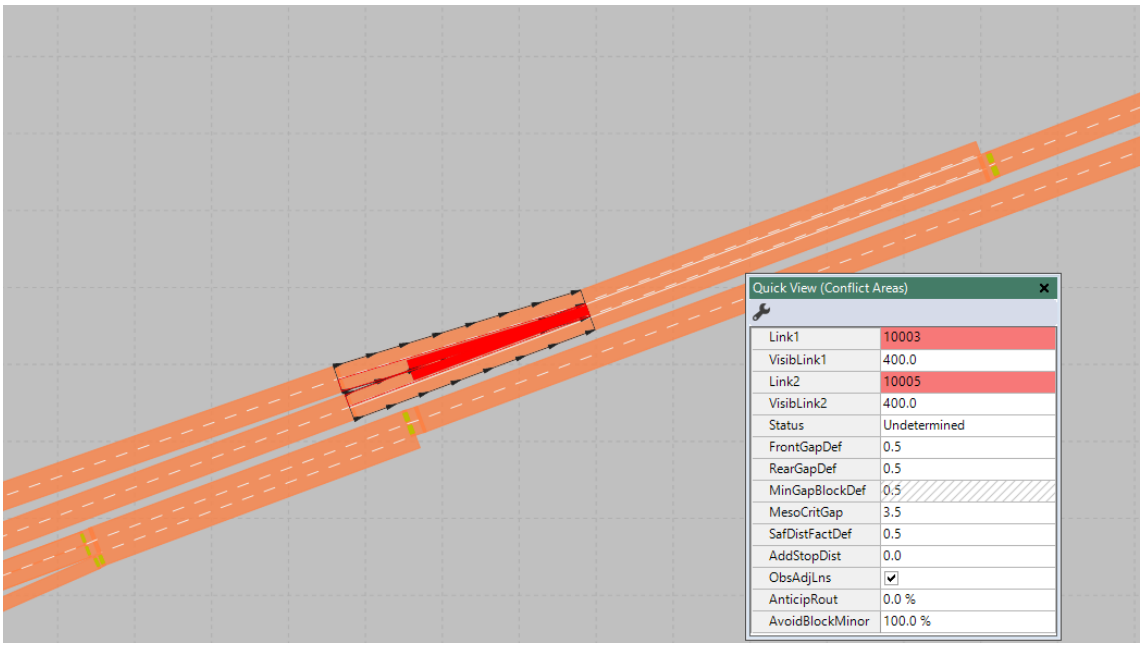
merge early and when the A13 mainline is congested, most vehicles from the slip road will use the full length of the taper.

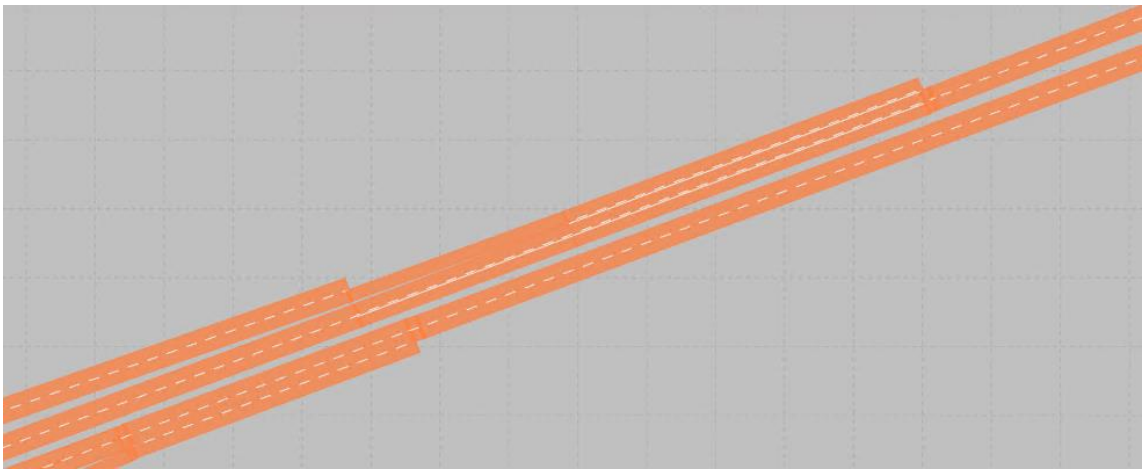
5.5.2 PTV, the software provider, suggested two methods for coding this type of merge in VISSIM. One method uses a two-lane merge coded as both a taper merge for one lane for vehicles merging early and a parallel merge for the other lane. The taper merge conflict between vehicles is managed using a conflict area as shown in Plate 5.5.

Plate 5.5 Two-lane Merge with Conflict Areas



5.5.3 The second method is a parallel merge as shown in Plate 5.6 that includes an auxiliary lane, enabling VISSIM driving behaviour rules to manage vehicle to vehicle interactions for the lane change without the need for additional conflict markers.

Plate 5.6 Parallel Merge Coding



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5.5.4 Observations during the simulation showed the first method (two-lane merge with conflict area) was unrealistically prioritising the slip road over the mainline with vehicles on the mainline sometimes stopping completely at the conflict area to let more than one vehicle from the slip road to merge. In response to this, the parallel merge method was adopted. In addition, the “Freeway” driving behaviour for the A13 was adjusted with an increased standstill distance (CC0) of 6.0m to reflect that vehicles on the mainline often leave bigger gaps during congested condition to allow vehicles from the slip road to merge.

5.6 Traffic demand matrices

5.6.1 The Orsett Cock VISSIM model applies traffic demand in 15-minute intervals to capture the build-up and cool-down of congestion. 15-minute matrices have been prepared using the available traffic data described in Chapter 3 for the following vehicle classes:

a. Cars

b. LGVs

c. HGVs

5.7 Public transport

5.7.1 The following bus routes have been included in the model:

a. 475

b. 5A

c. 5B

d. 5X

e. 11

f. 100

g. Z4

h. 27

5.7.2 Bus routes 5X and 475 have been excluded from the PM peak model as they do not run during the this hour.

5.7.3 Bus routes have been coded separately from general traffic. Bus routes were coded using the VISSIM public transport lines feature, with a public transport line set up for each bus route. Bus route and frequency information was derived from publicly available 2022 bus timetable information. For all bus stops, a dwell time of 20 seconds with a two second standard deviation has been modelled at each bus stop.

5.7.4 A summary of the modelled bus routes and their frequency is presented in Table 5.2.

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Table 5.2 Modelled Bus Routes and Frequency

Bus Route	AM (07:00 – 08:00)	AM (08:00 – 09:00)	PM (17:00 – 18:00)
475	1 per hour	0	0
5A (EB)	0	1 per hour	1 per hour
5A (WB)	1 per hour	1 per hour	1 per hour
5B (EB)	2 per hour	1 per hour	1 per hour
5B (WB)	1 per hour	1 per hour	1 per hour
5X	0	1 per hour	0
11 (NB)	0	1 per hour	0
11 (SB)	1 per hour	0	1 per hour
100 (WB)	4 per hour	3 per hour	3 per hour
100 (EB)	3 per hour	3 per hour	3 per hour
Z4 (NB)	0	0	1 per hour
Z4 (SB)	1 per hour	0	1 per hour
27 (NB)	0	1 per hour	0

5.8 Traffic assignment

5.8.1 Traffic is assigned using ‘dynamic assignment’. Dynamic assignment allows traffic to choose their preferred route at the time they enter the simulation. The route choice of each vehicle is based on the “cost” of all accessible options; distance and travel time are the most important factors in determining cost.

5.9 Convergence

5.9.1 Convergence is determined by the level of stability of the model whereby trip routing does not change significantly between iterations of the same model. Before any results from a traffic model are used to influence a decision, it should be confirmed that the model has reached an acceptable level of stability.

5.9.2 A high level of convergence for the highway assignment is particularly important because inadequate convergence is likely to result in unstable and unreliable forecasts.

5.9.3 According to Transport for London (TfL) Traffic Modelling Guidelines on VISSIM modelling, convergence is deemed to have been satisfactorily achieved when the following criteria have been met over the modelled peak hour:

a. 95% of travel times on all paths change by less than 20% for at least four consecutive iterations; and

b. 95% of all path traffic volumes change by less than 5% for at least four consecutive iterations.

5.9.4 The convergence performance can be seen in Plate 5.7 to Plate 5.10 for both the AM and PM peaks.

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Plate 5.7 AM Base Model Journey Time Convergence

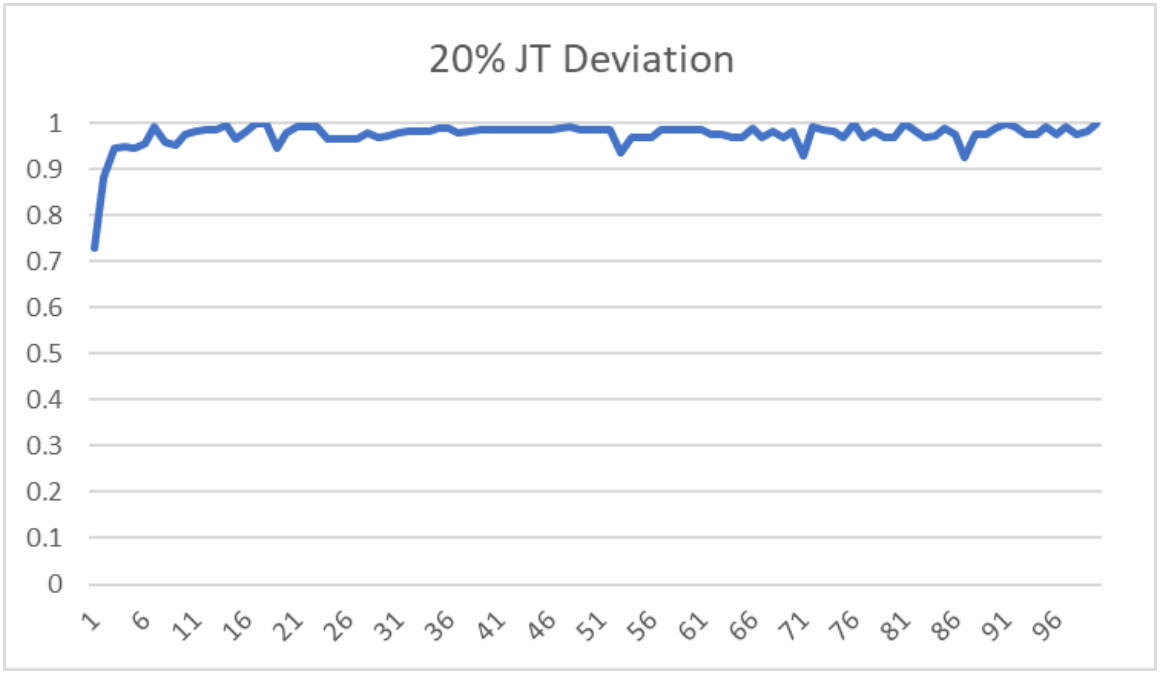

Plate 5.8 AM Base Model Traffic Volume Convergence

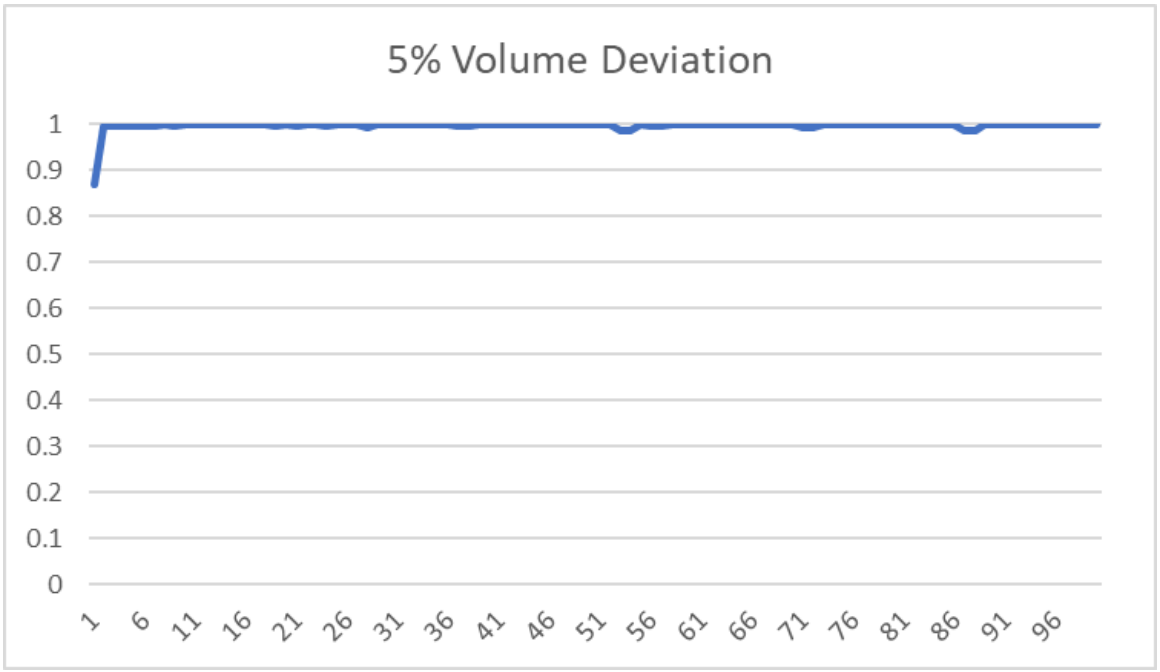

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Plate 5.9 PM Base Model Journey Time Convergence

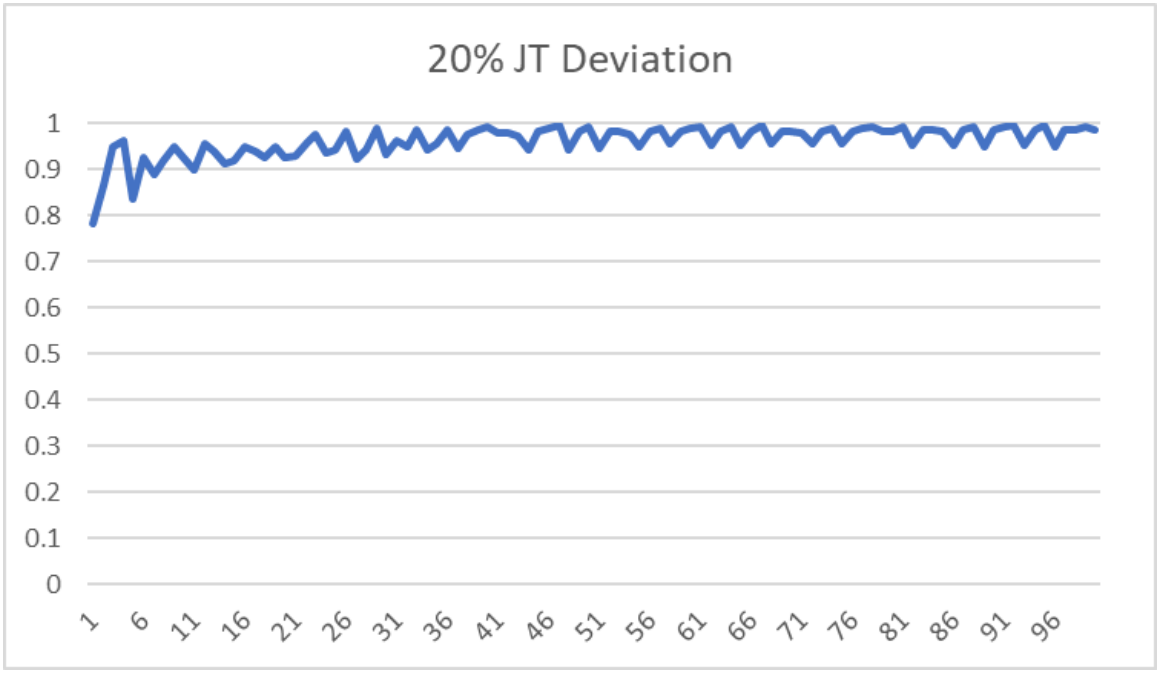
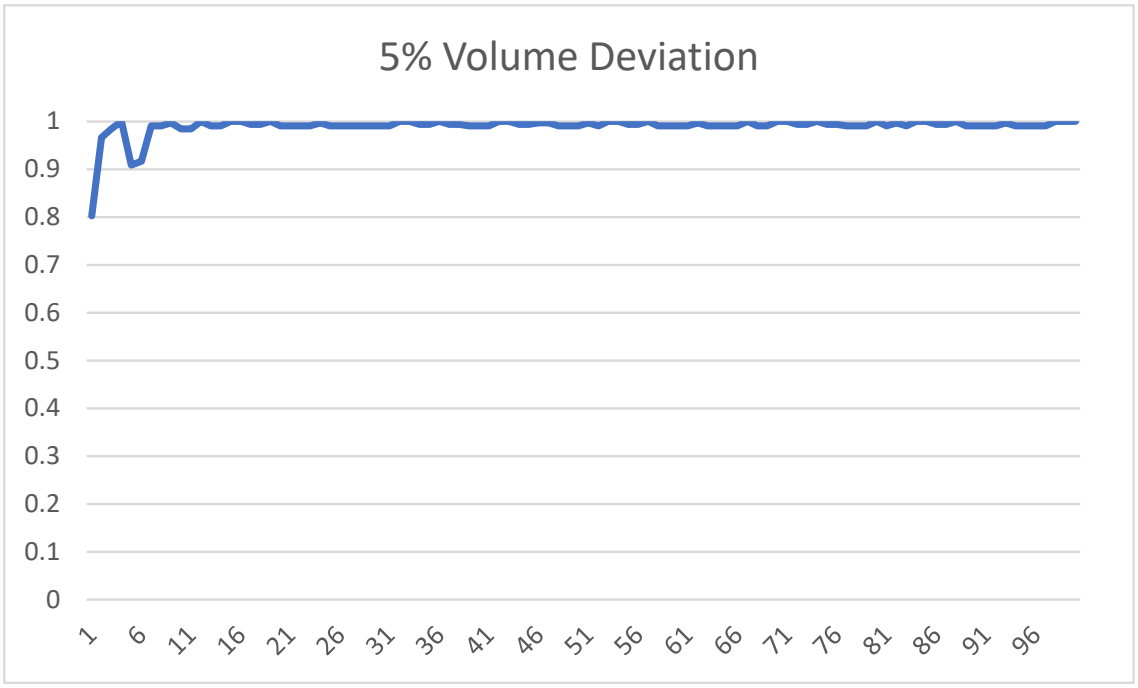


Plate 5.10 PM Base Model Traffic Volume Convergence



5.9.5 As can be seen on the Plates above, the convergence criteria of journey time changes were met well. The percentages of journey times which have less than a 20% difference are high and stable at around 95% in both AM and PM peaks. These figures show that the journey time changes are relatively small for at least four consecutive model runs, which indicates that the models are stable. The Plates also show that the models are producing stable traffic flow results with volume deviation of less than 5% on nearly all paths after the 10th iteration.

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5.9.6 The convergence performance indicates that the models are suitable to test the scheme as they are producing stable results.

5.9.7 Table 5.3 and Table 5.4 present the convergence results for the last 10 runs in the AM peak and PM peak models respectively.

Table 5.3 AM Base Model Traffic Volume Convergence – Last 10 runs

Run	20% JT Deviation	5% Volume Deviation
91	1.00	1.00
92	0.99	1.00
93	0.97	1.00
94	0.97	1.00
95	0.99	1.00
96	0.98	1.00
97	0.99	1.00
98	0.98	1.00
99	0.98	1.00
100*	1.00	1.00

** Cost and path files were taken from the last run (ID 100)*

Table 5.4 PM Base Model Traffic Volume Convergence – Last 10 runs

Run	20% JT Deviation	5% Volume Deviation
91	0.99	0.99
92	1.00	0.99
93	0.95	1.00
94	0.99	0.99
95	1.00	0.99
96	0.95	0.99
97	0.99	0.99
98	0.99	1.00
99	0.99	1.00
100*	0.99	1.00

** Cost and path files were taken from the last run (ID 100)*

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5.10 Number of random seed records

5.10.1 Traffic conditions on the road are variable. They vary because of changes in:

a. **Overall traffic volumes**, accounted for in VISSIM by selecting a representative peak hour.

b. **Traffic flow profiles**, corresponding to the variation in short-term flow rate within a modelled period, accounted for in VISSIM by profiling the traffic inputs into 15 minutes time periods; and

c. **Random Driver Behaviours,** Traffic conditions vary day-to-day as a result of random driver behaviours such as speed selection, lane changing, route choice and bus dwell times. The stochastic microsimulation traffic model in Vissim attempts to replicate this day-to-day random variability by altering individual driver decisions based on random numbers. The set of random numbers is generated from an initial 'seed' value specified at the start of a simulation run. A single set of random numbers, generated by a single seed value, therefore represents one potential outcome, or one particular day of traffic operation. The actual value of the seed has no significance; however, the seeds from different runs must be different from each other to produce different outcomes. Based on UK modelling guidelines, the recommended number of random seed runs is:

i. A minimum of 20 *(TfL Traffic Modelling Guidelines, Version 4.0)*

ii. Typically recommended being 10 (Section 5.5.2 - Guidelines for the Use of Microsimulation Software, Highways Agency).

5.10.2 The above number of runs in the guidelines, however, is indicative and the number of random seeds should be set based on the variability of the travel time results.

5.10.3 Model outputs based on 20 runs with different random seeds have therefore been used in the Orsett Cock VISSIM model.

5.11 Traffic flow calibration

5.11.1 For the validation process, each model time period has been run 20 times using a different random seed for each run. This method is representative of the variation that is observed on a day-to-day basis. The final model output data used in the validation tables are the averages of all 20 seed runs, and this has been compared against observed data.

5.11.2 The scope of the traffic flow comparison process is to verify that the total flows and traffic movements generated by the model are comparable with the observed flows.

5.11.3 For VISSIM, Traffic Modelling Guidelines from TfL recommends the use of the GEH statistic to demonstrate that the traffic flows within the model match observed counts to an acceptable level of accuracy. The GEH statistic gives

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greater weighting to higher flows, highlighting differences that are more significant. This statistic is a derivative of the Chi-squared statistic, and is defined as:

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

where: GEH is the GEH statistic;
M is the modelled flow; and
C is the observed flow.

5.11.4 Modelled flows should be averaged over multiple runs with different seeds. It is recommended that, for a model to be considered validated, the GEH statistic for turns/links should be:

a. Less than 5 for at least 85% of turns/ links; and

b. Less than 3 for all important/critical links.

5.11.5 TAG also recommends modelled link flows should:

a. Be within 100 vehicles per hour of observed flows, where those observed flows are less than 700 vehicles per hour;

b. Be within 15% of observed flows where those observed flows are between 700 vehicles per hour and 2,700 vehicles per hour; and

c. Be within 400 vehicles per hour of observed flows where those observed flows are greater than 2,700 vehicles per hour.

5.11.6 The modelled flows are extracted from VISSIM using Node Evaluation for turns and data collection points on links and are available separately by vehicle type. Table 5.5 provides a summary of the percentage of movements meeting the above criteria. It demonstrates that nearly all of the turning movements in the model pass the required validation thresholds.

5.11.7 Appendix A provides a more detailed summary of the validation status of each turning movement.

Table 5.5 Orsett Cock junction GEH Flow Validation

Peak	Number of Counts	% of movements within a GEH<5	% Satisfying TAG Flow Criteria
AM 7.00 - 8.00	51	100%	100%
AM 8.00 - 9.00	51	100%	100%
PM 17.00 - 18.00	51	98%	100%

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5.11.8 The results show that 100% of AM turning counts and 98% of PM turning counts have GEH < 5. The only movement not meeting the GEH criteria is the movement from the A13 West to A13 East via the Orsett Cock junction which exceeded the flow validation threshold in the PM. This is traffic on the A13 eastbound leaving the mainline via the off-slip and re-joining the A13 mainline again from the eastbound on-slip, an unusual movement, with an observed total of only 27 vehicles.

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6 Model validation results

6.1 Journey time validation

6.1.1 Validation of the Orsett Cock VISSIM model has been carried out following TAG and TfL's Traffic modelling guidelines.

6.1.2 For the validation process, each model time period has been run 20 times each with a different random seed. The final journey time output data used in the validation tables are the averages of all 20 seed runs.

6.1.3 For VISSIM TfL's Modelling Guidelines and TAG recommend modelled journey times should be within 15% of surveyed values or within one minute for routes longer than 3km.

6.1.4 Journey time measurements have been undertaken within the models along the same route sections as those extracted from the TrafficMaster data. Table 6.1 summarises the journey time validation. The table shows that journey time validation in the AM and PM against TrafficMaster data for 85% of routes satisfy the validation criteria, validating to within 15% of observed values.

6.1.5 Tables showing the full journey time validation for each route are shown in Appendix B.

6.1.6 More detailed journey time results, with each route broken down into a number of timing points along each route are presented in the form of cumulative distance and time graphs, and can be found in Appendix C.

Table 6.1 Orsett Cock Junction Journey Time Summary Table

Peak	Validation (all routes)	Average Speed [mph]	
	<15%	Observed	Modelled
AM 07:00-08:00	86%	36.8	35.0
AM 08:00-09:00	100%	31.4	29.7
PM 17:00-18:00	100%	32.2	31.7

6.1.7 In the first hour of the AM peak (07:00–08:00), five journey time routes exceed the 15% validation threshold when compared to observed data. These routes originate from the A1013 Stanford Road (East) and A128 Brentwood Road (South) arms and the cumulative distance time graphs indicate the model has slightly more delay on these approaches compared to the observed data. These discrepancies are small (less than 30 seconds when compared against the observed monthly averages) which is well within acceptable daily variations and will not impact on the accuracy of the assessment in the future years as traffic conditions are expected to change in the future years due to the junction improvement scheme being implemented.

6.1.8 For the AM (08:00–09:00) hour and the PM peak, all routes validated within the 15% threshold.

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6.1.9 Overall, the journey time validation demonstrates a good match against the observed data and the model is considered to provide a good representation of traffic condition in 2016.

6.2 Queue length analysis

6.2.1 Queue length is not a validation criterion for VISSIM due to the subjective nature of queue measurement, but the models have been visually sense-checked to ensure that it accurately reflects location-specific delays and capacity bottlenecks. This was further confirmed by breaking down the journey time routes into shorter segments, as shown in Appendix C. The relative delay plots shown in Appendix D, shows that the location-specific delays are replicated accurately.

6.3 Error logs

6.3.1 Following a review of the error log files no significant errors were identified.

6.4 Network performance

6.4.1 In addition to the flow and journey time validation results, some general statistics are also provided for the model. These are not part of the calibration/validation process but supply some general metrics about the network performance and are a good baseline to compare against when evaluating the future year forecasts.

Table 6.2 Network Performance Statistics

Statistic	AM (7-8)	AM (8-9)	PM (17-18)
Average Delay [sec]	26	44	84
Average Stops	1	2	3
Average Speed [mph]	47	41	32.0
Total Distance [km]	26.9	26.2	28.4
Total Travel Time [h]	358	401	547
Total Vehicles [veh]	8936	8978	9622
Latent Demand [veh]	31	2	59

6.4.2 Table 6.2 shows the network performance statistics. In the PM peak, the average delay is 40 seconds higher than in the AM and average speed is 9 mph slower, which suggests that the network is relatively more congested in the PM.

6.4.3 Latent demand is the number of vehicles not being able to deploy in the network within the evaluation period because of congestion. It is typically the total difference between the demand flow and the modelled flow on all the entry links. A small number of vehicles were unable to deploy in 07:00-08:00 and these vehicles have been deployed at the beginning of the 08:00-09:00 period instead. The PM has higher latent demand of 59 vehicles (less than. 1% of the total vehicles in the network). These vehicles were unable to deploy from the entry on the A13 West during the peak hour due to congestions on the

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eastbound off-slip and on the eastbound mainline and have been deployed in the cool down period instead.

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7 Conclusion

7.1.1 The calibration and validation processes show a good correlation between the modelled and observed traffic flows and journey times within the study area.

7.1.2 The journey time validations indicate the model has slightly more delay on the A1013 East and A128 South approaches in 07:00–08:00 when compared with the observed condition. These discrepancies are small (less than 30 seconds when compared against the observed monthly averages) which is well within acceptable daily variations and will not impact on the accuracy of the assessment in the future years as traffic conditions are expected to change in the future years due to the junction improvement scheme being implemented.

7.1.3 With this in mind and given the limitations and constraints described in this note as well as the required level of accuracy for this study, the models are considered fit-for-purpose in providing a robust representation of the existing situation and can be used with confidence to test the performance of the network with future traffic forecasts.

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Transport for London (September 2021). Traffic Modelling Guidelines Version 4.0.

https://content.tfl.gov.uk/traffic-modelling-guidelines.pdf

Transport for London (March 2017). Model Auditing Process (MAP) Version 3.5. Engineer Guide for Design Engineer (DE), Checking Engineer (CE) and Model Auditing Engineer (MAE).

https://content.tfl.gov.uk/map-v3-5-engineer-guide.pdf

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Glossary

Term	Explanation
ANPR	Automatic Number Plate Recognition
ATC	Automatic Traffic Count
DCO	Development Consent Order - Means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects (NSIPs)
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges: A comprehensive manual which contains requirements, advice and other published documents relating to works on motorway and all-purpose trunk roads for which one of the Overseeing Organisations (National Highways, Transport Scotland, the Welsh Government or the Department for Regional Development (Northern Ireland)) is the highway authority. For the Lower Thames Crossing, the Overseeing Organisation is National Highways.
Do Minimum	A future year scenario which includes changes to the road network and planned development that is forecast to go ahead, but not the Lower Thames Crossing.
Do Something	A future year scenario which includes changes to the road network and planned development that is forecast to go ahead, and the Lower Thames Crossing.
EB	Eastbound
GEH	A formula used to compare two traffic volumes, named after its originator, Geoff E. Havers. It is similar to a chi-squared test.
HGV	Heavy Goods Vehicle
LGV	Light Goods Vehicle
LinSig	A Design and Assessment Tool for Traffic Signal Junctions and Urban Networks
LMVR	Local Model Validation Report
LTC	Lower Thames Crossing
NB	Northbound
OS	Ordnance Survey
PTV	German for Planning Transport and Traffic Software package
SATURN	Simulation and Assignment of Traffic to Urban Networks
SB	Southbound
TAG	Transport Analysis Guidance published by DfT
TfL	Transport for London - The integrated body responsible for London's transport system

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Term	Explanation
VISSIM	Micro-simulation software developed by PTV. Verkehr In Städten - SIMulationsmodell (German for "Traffic in cities - simulation model)
WB	Westbound

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Appendix A Traffic flow comparison

Table A.1 07.00 – 08.00 Flow Comparison

Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
Orsett Cock	A128 Brentwood Rd (North)	A13 (East)	47	24	8	79	51	24	8	82	1	0	0	0	PASS
		A1013 Stanford Rd (East)	42	16	9	67	42	16	9	67	0	0	0	0	PASS
		A128 Brentwood Rd (South)	58	12	2	72	60	12	2	74	0	0	0	0	PASS
		A1013 Stanford Rd (West)	110	17	5	132	113	17	5	135	0	0	0	0	PASS
		A13 (West)	185	48	32	265	192	48	32	271	1	0	0	0	PASS
		A128 Brentwood Rd (North)	2	0	1	3	2	0	1	3	0	0	0	0	PASS
	A13 (East)	A1013 Stanford Rd (East)	3	3	1	7	3	3	1	7	0	0	0	0	PASS
		A128 Brentwood Rd (South)	78	19	1	98	77	19	1	97	0	0	0	0	PASS
		A1013 Stanford Rd (West)	296	50	8	354	286	50	8	343	1	0	0	1	PASS
		A13 (West)	3	1	0	4	0	0	0	0	2	1	0	3	PASS
		A128 Brentwood Rd (North)	159	50	21	230	156	48	21	225	0	0	0	0	PASS
		A13 (East)	3	1	0	4	3	1	0	4	0	0	0	0	PASS
	A1013 Stanford Rd (East)	A128 Brentwood Rd (South)	50	7	3	60	49	7	3	59	0	0	0	0	PASS
		A1013 Stanford Rd (West)	233	36	8	277	221	36	8	268	1	0	0	1	PASS
		A13 (West)	137	35	33	205	135	35	31	201	0	0	0	0	PASS
		A128 Brentwood Rd (North)	96	25	5	126	95	24	5	124	0	0	0	0	PASS
		A13 (East)	3	0	0	3	3	0	0	3	0	0	0	0	PASS

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Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
		A1013 Stanford Rd (East)	0	0	0	0	0	0	0	0	0	0	0	0	PASS
	A128 Brentwood Rd (South)	A1013 Stanford Rd (West)	72	8	0	80	67	8	0	75	1	0	0	1	PASS
		A13 (West)	97	22	5	124	93	22	5	120	0	0	0	0	PASS
		A128 Brentwood Rd (North)	165	42	2	209	158	40	2	199	1	0	0	1	PASS
		A13 (East)	135	45	4	184	129	43	4	176	1	0	0	1	PASS
		A1013 Stanford Rd (East)	29	1	3	33	27	1	2	30	0	0	1	1	PASS
		A128 Brentwood Rd (South)	0	0	0	0	0	0	0	0	0	0	0	0	PASS
	A1013 Stanford Rd (West)	A13 (West)	13	6	3	22	10	6	3	18	1	0	0	1	PASS
		A128 Brentwood Rd (North)	149	23	6	178	144	22	8	174	0	0	1	0	PASS
		A13 (East)	275	47	8	330	264	46	9	319	1	0	0	1	PASS
		A1013 Stanford Rd (East)	48	18	4	70	45	18	4	72	0	0	0	0	PASS
		A128 Brentwood Rd (South)	13	3	0	16	13	4	0	17	0	1	0	0	PASS
		A1013 Stanford Rd (West)	0	0	1	1	0	0	0	0	0	0	1	1	PASS
	A13 (West)	A128 Brentwood Rd (North)	186	42	91	319	178	41	87	306	1	0	0	1	PASS
		A13 (East)	0	0	0	0	0	0	0	0	0	0	0	0	PASS
		A1013 Stanford Rd (East)	76	23	34	133	74	23	35	132	0	0	0	0	PASS
		A128 Brentwood Rd (South)	32	9	2	43	30	9	2	41	0	0	0	0	PASS
		A1013 Stanford Rd (West)	12	1	5	18	11	1	5	17	0	0	0	0	PASS

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Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
		A13 (West)	2	1	2	5	2	1	2	5	0	0	0	0	PASS
A1013 Stanford Road / Rectory Road	Rectory Rd	Stanford Rd (East)	77	21	6	104	76	22	9	109	0	0	1	0	PASS
		Stanford Rd (West)	22	6	0	28	21	5	0	26	0	0	0	0	PASS
	Stanford Rd (East)	Stanford Rd (West)	630	94	23	746	605	93	24	724	1	0	0	1	PASS
		Rectory Rd	93	18	5	116	89	19	2	110	0	0	1	1	PASS
	Stanford Rd (West)	Rectory Rd	44	2	0	47	43	2	0	46	0	0	0	0	PASS
		Stanford Rd (East)	421	76	17	513	416	77	15	511	0	0	0	0	PASS
Link flows	A128 Brentwood Rd (North) SB		508	134	65	707	465	117	57	639	2	1	1	3	PASS
	A128 Brentwood Rd (North) NB		753	181	125	1060	729	174	123	1026	1	1	0	1	PASS
	A13 (East) WB		2865	840	241	3946	2840	835	239	3914	0	0	0	1	PASS
	A13 (East) EB		1943	449	240	2632	1901	443	241	2585	1	0	0	1	PASS
	A1013 Stanford Rd (East) WB		558	111	53	721	519	104	49	678	2	1	1	2	PASS
	A1013 Stanford Rd (East) EB		201	62	52	315	188	61	51	305	1	0	0	1	PASS
	A13 (West) EB		1788	408	354	2550	1787	408	354	2549	0	0	0	0	PASS
	A13 (West) WB		2553	770	269	3592	2519	775	265	3559	1	0	0	1	PASS
	A13 diverge to A1089 SB		207	59	16	282	205	60	14	279	0	0	0	0	PASS

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Table A.2 08.00 – 09.00 Flow Comparison

Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
Orsett Cock	A128 Brentwood Rd (North)	A13 (East)	63	18	23	104	63	18	23	104	0	0	0	0	PASS
		A1013 Stanford Rd (East)	32	12	5	49	32	12	5	49	0	0	0	0	PASS
		A128 Brentwood Rd (South)	57	10	2	69	57	10	2	70	0	0	0	0	PASS
		A1013 Stanford Rd (West)	186	17	8	211	184	17	8	210	0	0	0	0	PASS
		A13 (West)	172	49	39	260	173	48	39	260	0	0	0	0	PASS
		A128 Brentwood Rd (North)	0	3	0	3	0	3	0	3	0	0	0	0	PASS
	A13 (East)	A1013 Stanford Rd (East)	6	3	1	10	6	3	1	9	0	0	0	0	PASS
		A128 Brentwood Rd (South)	78	15	4	97	78	15	4	97	0	0	0	0	PASS
		A1013 Stanford Rd (West)	459	39	13	511	459	39	13	511	0	0	0	0	PASS
		A13 (West)	4	2	0	6	0	0	0	0	3	2	0	3	PASS
		A128 Brentwood Rd (North)	114	26	16	156	117	29	17	163	0	1	0	1	PASS
		A13 (East)	5	4	0	9	5	4	0	8	0	0	0	0	PASS
	A1013 Stanford Rd (East)	A128 Brentwood Rd (South)	62	15	0	77	62	15	1	78	0	0	1	0	PASS
		A1013 Stanford Rd (West)	245	27	4	276	254	28	4	291	1	0	0	1	PASS
		A13 (West)	95	22	43	160	99	23	44	165	0	0	0	0	PASS
		A128 Brentwood Rd (North)	74	14	5	93	76	15	5	95	0	0	0	0	PASS
		A13 (East)	2	0	3	5	2	0	3	5	0	0	0	0	PASS
		A1013 Stanford Rd (East)	2	0	0	2	2	0	0	2	0	0	0	0	PASS

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Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
	A128 Brentwood Rd (South)	A1013 Stanford Rd (West)	83	12	3	98	83	12	3	98	0	0	0	0	PASS
		A13 (West)	65	12	6	83	65	12	6	83	0	0	0	0	PASS
		A128 Brentwood Rd (North)	136	27	5	168	137	29	5	170	0	0	0	0	PASS
		A13 (East)	166	22	2	190	163	23	2	188	0	0	0	0	PASS
		A1013 Stanford Rd (East)	63	3	2	68	63	3	2	69	0	0	0	0	PASS
		A128 Brentwood Rd (South)	0	0	0	0	0	0	0	0	0	0	0	0	PASS
	A1013 Stanford Rd (West)	A13 (West)	29	4	5	38	25	4	4	34	1	0	0	1	PASS
		A128 Brentwood Rd (North)	127	26	7	160	129	26	8	164	0	0	0	0	PASS
		A13 (East)	322	32	10	364	327	33	11	371	0	0	0	0	PASS
		A1013 Stanford Rd (East)	113	15	6	134	113	15	7	139	0	0	0	0	PASS
		A128 Brentwood Rd (South)	11	1	2	14	11	1	3	16	0	0	1	1	PASS
		A1013 Stanford Rd (West)	1	0	0	1	0	0	0	0	1	0	0	1	PASS
	A13 (West)	A128 Brentwood Rd (North)	178	34	70	282	183	35	72	290	0	0	0	0	PASS
		A13 (East)	0	0	1	1	0	0	0	0	0	0	1	1	PASS
		A1013 Stanford Rd (East)	64	28	30	122	66	28	28	122	0	0	0	0	PASS
		A128 Brentwood Rd (South)	38	7	7	52	39	7	6	52	0	0	0	0	PASS
		A1013 Stanford Rd (West)	21	4	6	31	20	4	6	30	0	0	0	0	PASS
		A13 (West)	2	0	5	7	2	0	5	7	0	0	0	0	PASS

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Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
A1013 Stanford Road / Rectory Road	Rectory Rd	Stanford Rd (East)	137	13	13	163	133	13	14	161	0	0	0	0	PASS
		Stanford Rd (West)	43	1	0	45	43	1	0	44	0	0	0	0	PASS
	Stanford Rd (East)	Stanford Rd (West)	816	84	30	929	819	87	32	943	0	0	0	0	PASS
		Rectory Rd	179	15	4	199	180	14	2	198	0	0	1	0	PASS
	Stanford Rd (West)	Rectory Rd	60	5	4	70	60	5	1	66	0	0	2	0	PASS
		Stanford Rd (East)	466	65	17	548	465	66	19	554	0	0	0	0	PASS
Link flows	A128 Brentwood Rd (North) SB		546	117	82	746	511	109	77	697	2	1	1	2	PASS
	A128 Brentwood Rd (North) NB		610	126	100	836	645	137	106	888	1	1	1	2	PASS
	A13 (East) WB		2802	534	279	3615	2827	540	281	3649	0	0	0	1	PASS
	A13 (East) EB		2038	369	279	2686	2051	373	279	2703	0	0	0	0	PASS
	A1013 Stanford Rd (East) WB		466	76	53	595	480	78	55	618	1	0	0	1	PASS
	A1013 Stanford Rd (East) EB		282	62	44	388	281	60	42	389	0	0	0	0	PASS
	A13 (West) EB		1783	366	359	2508	1783	366	359	2508	0	0	0	0	PASS
	A13 (West) WB		2315	496	324	3135	2348	509	327	3184	1	1	0	1	PASS
	A13 diverge to A1089 SB		188	38	19	245	191	37	18	246	0	0	0	0	PASS

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Table A.3 17.00 – 18.00 Flow Comparison

Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
Orsett Cock	A128 Brentwood Rd (North)	A13 (East)	120	27	12	159	114	27	12	153	1	0	0	0	PASS
		A1013 Stanford Rd (East)	118	15	1	134	111	16	1	127	1	0	0	1	PASS
		A128 Brentwood Rd (South)	154	29	0	183	148	29	0	177	0	0	0	0	PASS
		A1013 Stanford Rd (West)	176	21	4	201	168	21	4	192	1	0	0	1	PASS
		A13 (West)	161	31	20	212	154	30	19	204	1	0	0	1	PASS
		A128 Brentwood Rd (North)	0	0	0	0	0	0	0	0	0	0	0	0	PASS
	A13 (East)	A1013 Stanford Rd (East)	10	0	0	10	10	0	0	10	0	0	0	0	PASS
		A128 Brentwood Rd (South)	106	24	1	131	106	24	1	130	0	0	0	0	PASS
		A1013 Stanford Rd (West)	203	20	1	224	200	20	1	221	0	0	0	0	PASS
		A13 (West)	1	0	0	1	0	0	0	0	1	0	0	1	PASS
		A128 Brentwood Rd (North)	45	13	13	71	44	13	14	70	0	0	0	0	PASS
		A13 (East)	7	1	0	8	7	1	0	8	0	0	0	0	PASS
	A1013 Stanford Rd (East)	A128 Brentwood Rd (South)	92	12	0	104	92	12	0	105	0	0	0	0	PASS
		A1013 Stanford Rd (West)	180	19	2	201	180	20	3	208	0	0	0	0	PASS
		A13 (West)	77	19	2	98	79	19	2	100	0	0	0	0	PASS
		A128 Brentwood Rd (North)	63	12	6	81	63	12	6	82	0	0	0	0	PASS
		A13 (East)	5	0	0	5	5	0	0	5	0	0	0	0	PASS
		A1013 Stanford Rd (East)	1	0	0	1	1	0	0	1	0	0	0	0	PASS

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Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
	A128 Brentwood Rd (South)	A1013 Stanford Rd (West)	44	1	0	45	44	1	0	45	0	0	0	0	PASS
		A13 (West)	52	11	1	64	53	11	1	65	0	0	0	0	PASS
		A128 Brentwood Rd (North)	68	15	4	87	69	15	4	88	0	0	0	0	PASS
		A13 (East)	105	21	1	127	106	21	1	128	0	0	0	0	PASS
		A1013 Stanford Rd (East)	69	16	0	85	69	16	0	84	0	0	0	0	PASS
		A128 Brentwood Rd (South)	0	0	0	0	0	0	0	0	0	0	0	0	PASS
	A1013 Stanford Rd (West)	A13 (West)	29	3	1	33	26	3	1	30	1	0	0	1	PASS
		A128 Brentwood Rd (North)	152	7	1	160	152	8	1	161	0	0	0	0	PASS
		A13 (East)	330	41	2	373	331	41	2	374	0	0	0	0	PASS
		A1013 Stanford Rd (East)	326	28	0	354	327	28	0	360	0	0	0	0	PASS
		A128 Brentwood Rd (South)	63	2	0	65	61	2	0	63	0	0	0	0	PASS
		A1013 Stanford Rd (West)	0	0	0	0	0	0	0	0	0	0	0	0	PASS
	A13 (West)	A128 Brentwood Rd (North)	389	60	49	498	357	62	48	467	2	0	0	1	PASS
		A13 (East)	15	5	3	23	0	0	0	0	5	3	3	7	PASS
		A1013 Stanford Rd (East)	228	44	13	285	204	41	11	256	2	0	0	2	PASS
		A128 Brentwood Rd (South)	60	11	1	72	54	10	1	65	1	0	0	1	PASS
		A1013 Stanford Rd (West)	14	0	0	14	12	0	0	12	1	0	0	1	PASS
		A13 (West)	1	2	0	3	1	2	0	2	0	0	0	1	PASS

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Junction	Approach	To	Observed				Modelled				GEH<5				FC
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	
A1013 Stanford Road / Rectory Road	Rectory Rd	Stanford Rd (East)	169	27	1	198	166	26	2	195	0	0	0	0	PASS
		Stanford Rd (West)	104	10	0	113	105	10	0	115	0	0	0	0	PASS
	Stanford Rd (East)	Stanford Rd (West)	527	51	7	585	519	53	8	583	0	0	0	0	PASS
		Rectory Rd	90	10	0	100	85	9	1	97	0	0	0	0	PASS
	Stanford Rd (West)	Rectory Rd	57	8	0	66	57	7	0	64	0	0	0	0	PASS
		Stanford Rd (East)	731	54	3	787	729	56	2	791	0	0	0	0	PASS
Link flows	A128 Brentwood Rd (North) SB		714	120	36	871	708	123	37	869	0	0	0	0	PASS
	A128 Brentwood Rd (North) NB		668	100	68	836	683	111	73	867	1	1	1	1	PASS
	A13 (East) WB		2333	291	125	2749	2333	291	125	2749	0	0	0	0	PASS
	A13 (East) EB		3089	633	155	3877	3045	620	156	3821	1	1	1	1	PASS
	A1013 Stanford Rd (East) WB		416	62	10	487	418	63	11	498	0	0	0	0	PASS
	A1013 Stanford Rd (East) EB		661	90	12	763	718	101	12	836	2	1	1	3	PASS
	A13 (West) EB		3214	660	203	4077	3259	651	200	4110	1	0	0	1	PASS
	A13 (West) WB		2144	247	124	2515	2131	246	125	2501	0	0	0	0	PASS
	A13 diverge to A1089 SB		138	52	10	200	137	53	10	200	0	0	0	0	PASS

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Appendix B Journey time validation

Table B.1 07.00 – 08.00 Journey Time Validation

Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
1-->2	A128 Brentwood Rd (North) to A13 EB mainline	2083	2085	108	109	2	1%	PASS	43.2	42.6
1-->3	A128 Brentwood Rd (North) to A1013 Stanford Rd (East)	1377	1381	97	99	1	1%	PASS	31.6	31.3
1-->4	A128 Brentwood Rd (North) to A128 Brentwood Rd (South)	1332	1341	91	90	-1	-1%	PASS	32.9	33.4
1-->5	A128 Brentwood Rd (North) to A1013 Stanford Rd (West)	1554	1555	106	107	1	1%	PASS	32.9	32.5
1-->6	A128 Brentwood Rd (North) to A13 WB mainline	3045	3052	159	151	-8	-5%	PASS	42.7	45.2
1-->8	A128 Brentwood Rd (North) to A13 WB off-slip to A1089	3197	3190	171	164	-7	-4%	PASS	41.8	43.5
2-->1	A13 WB mainline to A128 Brentwood Rd (North)	2364	2344	153	146	-7	-5%	PASS	34.6	36.0
2-->3	A13 WB mainline to A1013 Stanford Rd (East)	1652	1629	109	99	-10	-9%	PASS	33.8	36.7
2-->4	A13 WB mainline to A128 Brentwood Rd (South)	1606	1588	102	90	-12	-12%	PASS	35.1	39.4
2-->5	A13 WB mainline to A1013 Stanford Rd (West)	1828	1803	117	107	-10	-9%	PASS	34.8	37.6

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Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
2-->6	A13 WB mainline to A13 WB mainline	3193	3177	134	119	-15	-11%	PASS	53.3	59.7
2-->8	A13 WB mainline to A13 WB off-slip to A1089	3344	3315	146	132	-14	-9%	PASS	51.3	56.2
3-->1	A1013 Stanford Rd (East) to A128 Brentwood Rd (North)	1572	1563	126	152	26	20%	FAIL	27.8	23.0
3-->2	A1013 Stanford Rd (East) to A13 EB mainline	2195	2177	140	161	21	15%	PASS	35.1	30.3
3-->4	A1013 Stanford Rd (East) to A128 Brentwood Rd (South)	814	808	76	97	21	28%	FAIL	24.0	18.7
3-->5	A1013 Stanford Rd (East) to A1013 Stanford Rd (West)	1036	1022	91	114	23	25%	FAIL	25.5	20.1
3-->6	A1013 Stanford Rd (East) to A13 WB mainline	2528	2518	145	158	13	9%	PASS	39.1	35.7
3-->8	A1013 Stanford Rd (East) to A13 WB off-slip to A1089	2680	2656	156	171	15	9%	PASS	38.3	34.8
4-->1	A128 Brentwood Rd (South) to A128 Brentwood Rd (North)	1403	1397	108	129	20	19%	FAIL	29.0	24.3
4-->2	A128 Brentwood Rd (South) to A13 EB mainline	2027	2011	121	137	15	13%	PASS	37.3	32.9
4-->3	A128 Brentwood Rd (South) to A1013 Stanford Rd (East)	1321	1307	111	126	15	14%	PASS	26.6	23.1
4-->5	A128 Brentwood Rd (South) to A1013 Stanford Rd (West)	868	856	73	90	18	24%	FAIL	26.8	21.2
4-->6	A128 Brentwood Rd (South) to A13 WB mainline	2360	2352	126	134	8	6%	PASS	41.8	39.2

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Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
4-->8	A128 Brentwood Rd (South) to A13 WB off-slip to A1089	2511	2490	138	147	9	7%	**PASS**	40.7	37.8
5-->1	A1013 Stanford Rd (West) to A128 Brentwood Rd (North)	1460	1453	119	137	18	15%	**PASS**	27.6	23.8
5-->2	A1013 Stanford Rd (West) to A13 EB mainline	2084	2067	132	145	13	10%	**PASS**	35.3	31.8
5-->3	A1013 Stanford Rd (West) to A1013 Stanford Rd (East)	1378	1363	121	135	13	11%	**PASS**	25.4	22.6
5-->4	A1013 Stanford Rd (West) to A128 Brentwood Rd (South)	1332	1322	115	126	11	10%	**PASS**	26.0	23.5
5-->6	A1013 Stanford Rd (West) to A13 WB mainline	2417	2408	137	143	6	4%	**PASS**	39.5	37.8
5-->8	A1013 Stanford Rd (West) to A13 WB off-slip to A1089	2568	2546	149	156	7	5%	**PASS**	38.7	36.6
6-->1	A13 EB mainline to A128 Brentwood Rd (North)	2784	2768	151	172	22	15%	**PASS**	41.4	35.9
6-->2	A13 EB mainline to A13 EB mainline	3371	3345	112	121	10	9%	**PASS**	67.5	61.7
6-->3	A13 EB mainline to A1013 Stanford Rd (East)	2702	2678	153	170	17	11%	**PASS**	39.4	35.2
6-->4	A13 EB mainline to A128 Brentwood Rd (South)	2656	2637	147	161	15	10%	**PASS**	40.6	36.6
6-->5	A13 EB mainline to A1013 Stanford Rd (West)	2878	2852	162	178	17	10%	**PASS**	39.9	35.8
6-->8	A13 EB mainline to A13 WB off-slip to A1089	3889	3763	199	202	3	1%	**PASS**	43.8	41.7
								86%	36.8	35.0

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Table B.2 08.00 – 09.00 Journey Time Validation

Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
1-->2	A128 Brentwood Rd (North) to A13 EB mainline	2083	2085	106	120	14	13%	PASS	44.1	38.9
1-->3	A128 Brentwood Rd (North) to A1013 Stanford Rd (East)	1377	1381	98	109	11	11%	PASS	31.3	28.3
1-->4	A128 Brentwood Rd (North) to A128 Brentwood Rd (South)	1332	1341	97	99	3	3%	PASS	30.8	30.2
1-->5	A128 Brentwood Rd (North) to A1013 Stanford Rd (West)	1554	1555	106	119	13	12%	PASS	32.8	29.4
1-->6	A128 Brentwood Rd (North) to A13 WB mainline	3045	3052	152	161	8	6%	PASS	44.7	42.4
1-->8	A128 Brentwood Rd (North) to A13 WB off-slip to A1089	3197	3190	162	174	12	7%	PASS	44.2	41.0
2-->1	A13 WB mainline to A128 Brentwood Rd (North)	2364	2344	140	157	17	12%	PASS	37.9	33.4
2-->3	A13 WB mainline to A1013 Stanford Rd (East)	1652	1629	101	112	12	12%	PASS	36.8	32.4

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Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
2-->4	A13 WB mainline to A128 Brentwood Rd (South)	1606	1588	99	102	3	3%	PASS	36.3	34.7
2-->5	A13 WB mainline to A1013 Stanford Rd (West)	1828	1803	108	122	14	13%	PASS	37.9	33.2
2-->6	A13 WB mainline to A13 WB mainline	3193	3177	121	118	-3	-3%	PASS	58.8	60.1
2-->8	A13 WB mainline to A13 WB off-slip to A1089	3344	3315	131	131	0	0%	PASS	57.2	56.4
3-->1	A1013 Stanford Rd (East) to A128 Brentwood Rd (North)	1572	1563	182	199	17	10%	PASS	19.3	17.5
3-->2	A1013 Stanford Rd (East) to A13 EB mainline	2195	2177	197	210	13	7%	PASS	24.9	23.1
3-->4	A1013 Stanford Rd (East) to A128 Brentwood Rd (South)	814	807	141	145	4	2%	PASS	12.9	12.5
3-->5	A1013 Stanford Rd (East) to A1013 Stanford Rd (West)	1036	1022	150	164	14	9%	PASS	15.4	13.9
3-->6	A1013 Stanford Rd (East) to A13 WB mainline	2528	2518	197	206	9	5%	PASS	28.7	27.3
3-->8	A1013 Stanford Rd (East) to A13 WB off-slip to A1089	2680	2656	206	220	13	6%	PASS	29.0	27.1

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Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
4-->1	A128 Brentwood Rd (South) to A128 Brentwood Rd (North)	1403	1397	262	292	30	11%	PASS	12.0	10.7
4-->2	A128 Brentwood Rd (South) to A13 EB mainline	2027	2011	277	303	26	9%	PASS	16.3	14.8
4-->3	A128 Brentwood Rd (South) to A1013 Stanford Rd (East)	1321	1307	270	293	23	8%	PASS	10.9	10.0
4-->5	A128 Brentwood Rd (South) to A1013 Stanford Rd (West)	868	856	231	257	26	11%	PASS	8.4	7.5
4-->6	A128 Brentwood Rd (South) to A13 WB mainline	2360	2352	277	299	22	8%	PASS	19.0	17.6
4-->8	A128 Brentwood Rd (South) to A13 WB off-slip to A1089	2511	2490	287	312	26	9%	PASS	19.6	17.8
5-->1	A1013 Stanford Rd (West) to A128 Brentwood Rd (North)	1460	1453	136	150	14	10%	PASS	24.1	21.7
5-->2	A1013 Stanford Rd (West) to A13 EB mainline	2084	2067	151	161	10	7%	PASS	30.9	28.8
5-->3	A1013 Stanford Rd (West) to A1013 Stanford Rd (East)	1378	1363	143	150	7	5%	PASS	21.5	20.3

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Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
5-->4	A1013 Stanford Rd (West) to A128 Brentwood Rd (South)	1332	1323	142	140	-2	-1%	PASS	21.0	21.1
5-->6	A1013 Stanford Rd (West) to A13 WB mainline	2417	2408	151	157	6	4%	**PASS**	35.9	34.4
5-->8	A1013 Stanford Rd (West) to A13 WB off-slip to A1089	2568	2546	160	170	10	6%	**PASS**	35.9	33.5
6-->1	A13 EB mainline to A128 Brentwood Rd (North)	2784	2768	166	170	4	2%	**PASS**	37.5	36.4
6-->2	A13 EB mainline to A13 EB mainline	3371	3345	114	122	7	7%	**PASS**	66.0	61.4
6-->3	A13 EB mainline to A1013 Stanford Rd (East)	2702	2678	174	171	-3	-2%	**PASS**	34.7	35.1
6-->4	A13 EB mainline to A128 Brentwood Rd (South)	2656	2637	172	161	-12	-7%	**PASS**	34.5	36.7
6-->5	A13 EB mainline to A1013 Stanford Rd (West)	2878	2852	182	180	-2	-1%	**PASS**	35.5	35.4
6-->8	A13 EB mainline to A13 WB off-slip to A1089	4521	4486	238	236	-2	-1%	**PASS**	42.6	42.6
								100%	31.4	29.7

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Table B.3 17.00 – 18.00 Journey Time Validation

Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
1-->2	A128 Brentwood Rd (North) to A13 EB mainline	2083	2085	183	160	-23	-12%	PASS	25.5	29.1
1-->3	A128 Brentwood Rd (North) to A1013 Stanford Rd (East)	1377	1381	148	140	-8	-5%	PASS	20.8	22.0
1-->4	A128 Brentwood Rd (North) to A128 Brentwood Rd (South)	1332	1341	145	127	-17	-12%	PASS	20.6	23.5
1-->5	A128 Brentwood Rd (North) to A1013 Stanford Rd (West)	1554	1555	159	144	-15	-10%	PASS	21.9	24.2
1-->6	A128 Brentwood Rd (North) to A13 WB mainline	3045	3052	204	187	-17	-8%	PASS	33.5	36.6
1-->8	A128 Brentwood Rd (North) to A13 WB off-slip to A1089	3197	3190	215	200	-15	-7%	PASS	33.3	35.7
2-->1	A13 WB mainline to A128 Brentwood Rd (North)	2364	2344	191	189	-1	-1%	PASS	27.7	27.7
2-->3	A13 WB mainline to A1013 Stanford Rd (East)	1652	1628	148	149	1	1%	PASS	24.9	24.4
2-->4	A13 WB mainline to A128 Brentwood Rd (South)	1606	1588	145	137	-9	-6%	PASS	24.8	26.0

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Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
2-->5	A13 WB mainline to A1013 Stanford Rd (West)	1828	1803	159	153	-6	-4%	PASS	25.7	26.4
2-->6	A13 WB mainline to A13 WB mainline	3193	3177	111	113	2	2%	PASS	64.4	62.8
2-->8	A13 WB mainline to A13 WB off-slip to A1089	3344	3315	122	126	4	4%	PASS	61.4	58.7
3-->1	A1013 Stanford Rd (East) to A128 Brentwood Rd (North)	1572	1563	108	125	16	15%	PASS	32.5	28.0
3-->2	A1013 Stanford Rd (East) to A13 EB mainline	2195	2177	146	150	3	2%	PASS	33.6	32.6
3-->4	A1013 Stanford Rd (East) to A128 Brentwood Rd (South)	814	807	63	72	9	14%	PASS	29.0	25.2
3-->5	A1013 Stanford Rd (East) to A1013 Stanford Rd (West)	1036	1022	77	88	11	15%	PASS	30.3	26.0
3-->6	A1013 Stanford Rd (East) to A13 WB mainline	2528	2518	121	131	10	8%	PASS	46.6	43.0
3-->8	A1013 Stanford Rd (East) to A13 WB off-slip to A1089	2680	2656	132	144	12	9%	PASS	45.3	41.2
4-->1	A128 Brentwood Rd (South) to A128 Brentwood Rd (North)	1403	1397	94	99	5	5%	PASS	33.5	31.7
4-->2	A128 Brentwood Rd (South) to A13 EB mainline	2027	2011	132	123	-8	-6%	PASS	34.4	36.4
4-->3	A128 Brentwood Rd (South) to A1013 Stanford Rd (East)	1321	1307	97	103	7	7%	PASS	30.6	28.3

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Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
4-->5	A128 Brentwood Rd (South) to A1013 Stanford Rd (West)	868	856	62	62	0	-1%	PASS	31.2	31.0
4-->6	A128 Brentwood Rd (South) to A13 WB mainline	2360	2352	107	105	-2	-2%	PASS	49.3	50.1
4-->8	A128 Brentwood Rd (South) to A13 WB off-slip to A1089	2511	2490	118	118	0	0%	PASS	47.6	47.1
5-->1	A1013 Stanford Rd (West) to A128 Brentwood Rd (North)	1460	1452	112	117	5	4%	PASS	29.1	27.8
5-->2	A1013 Stanford Rd (West) to A13 EB mainline	2084	2066	150	142	-8	-5%	PASS	31.1	32.6
5-->3	A1013 Stanford Rd (West) to A1013 Stanford Rd (East)	1378	1362	115	122	7	6%	PASS	26.8	25.0
5-->4	A1013 Stanford Rd (West) to A128 Brentwood Rd (South)	1332	1321	112	109	-3	-3%	PASS	26.6	27.1
5-->6	A1013 Stanford Rd (West) to A13 WB mainline	2417	2407	125	123	-2	-1%	PASS	43.1	43.6
5-->8	A1013 Stanford Rd (West) to A13 WB off-slip to A1089	2568	2545	136	137	0	0%	PASS	42.2	41.7

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Route	Name	Distance [m]		JT [s]		Difference		Validation	Average Speed [mph]	
		Observed	Modelled	Observed	Modelled	Total [s]	%	<15% or <60s	Observed	Modelled
6-->1	A13 EB mainline to A128 Brentwood Rd (North)	2784	2768	326	342	16	5%	PASS	19.1	18.1
6-->2	A13 EB mainline to A13 EB mainline	3371	3345	247	265	17	7%	PASS	30.5	28.3
6-->3	A13 EB mainline to A1013 Stanford Rd (East)	2702	2678	329	347	18	6%	PASS	18.4	17.3
6-->4	A13 EB mainline to A128 Brentwood Rd (South)	2656	2637	326	334	9	3%	PASS	18.2	17.7
6-->5	A13 EB mainline to A1013 Stanford Rd (West)	2878	2852	340	350	11	3%	PASS	19.0	18.2
6-->8	A13 EB mainline to A13 WB off-slip to A1089	4521	4486	395	407	11	3%	PASS	25.6	24.7
								100%	32.2	31.7

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Appendix C Journey time validation charts

Plate C.1 Journey Time Validation Charts AM (07.00 – 08.00)

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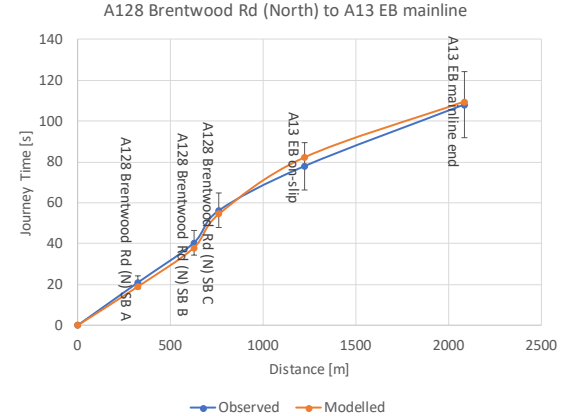

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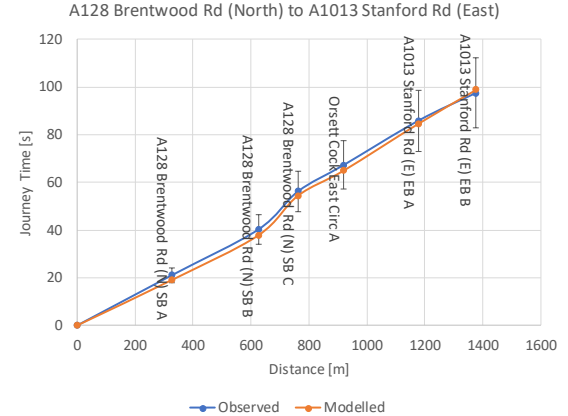

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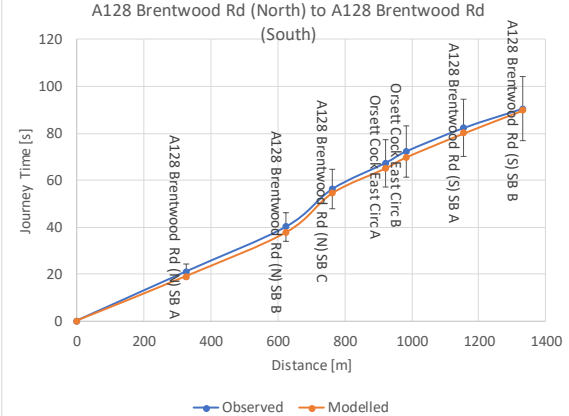

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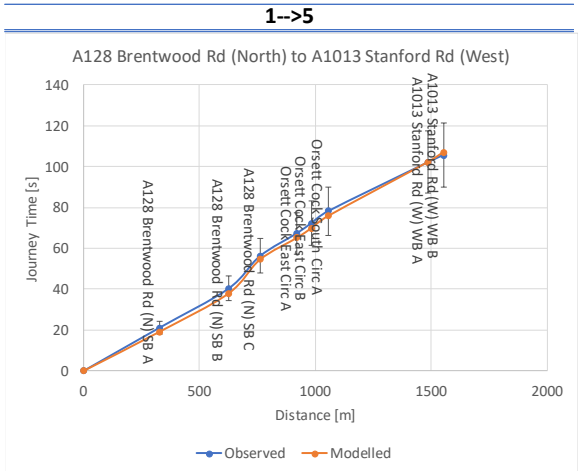

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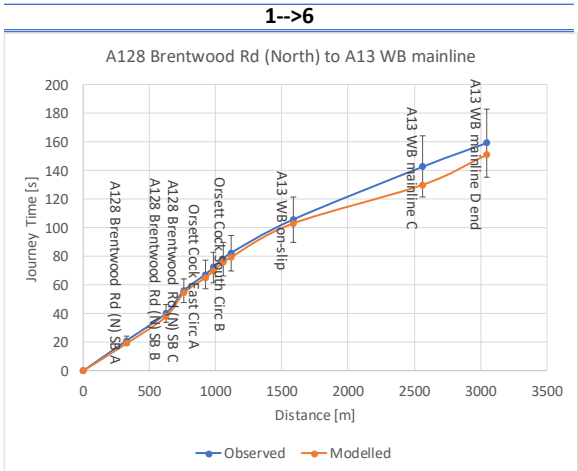

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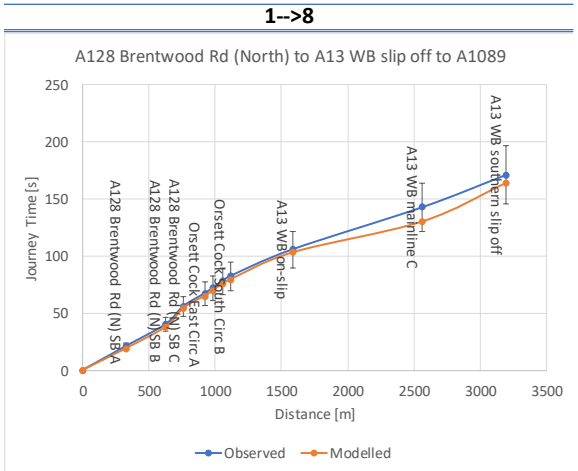

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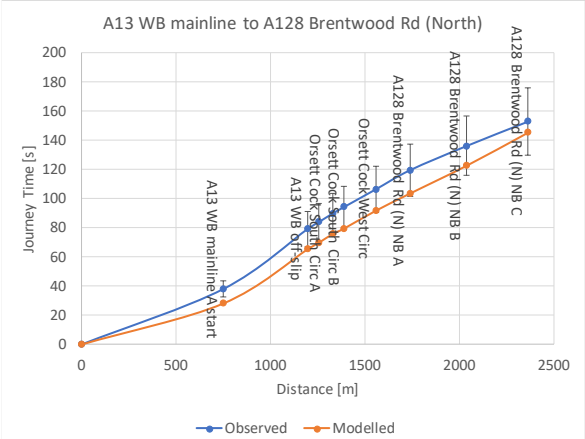

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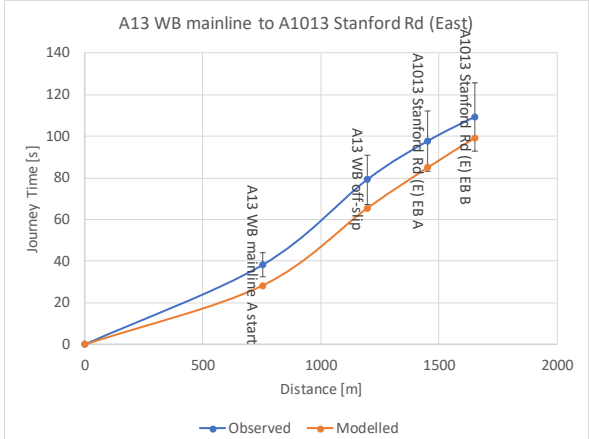

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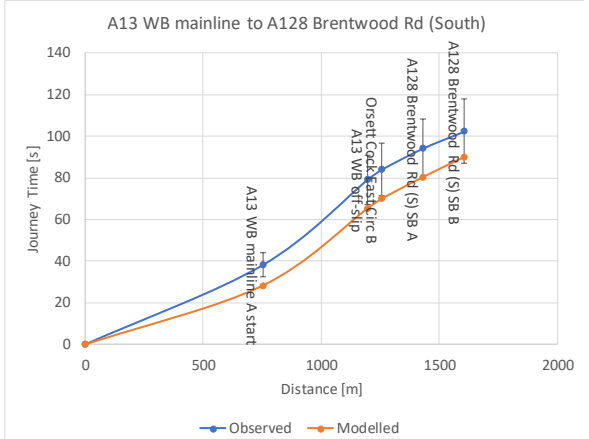

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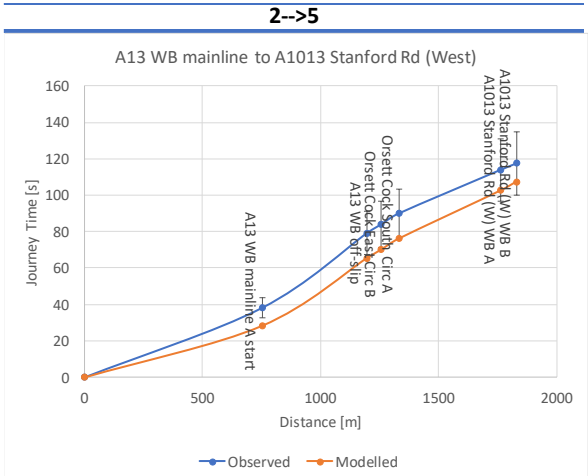

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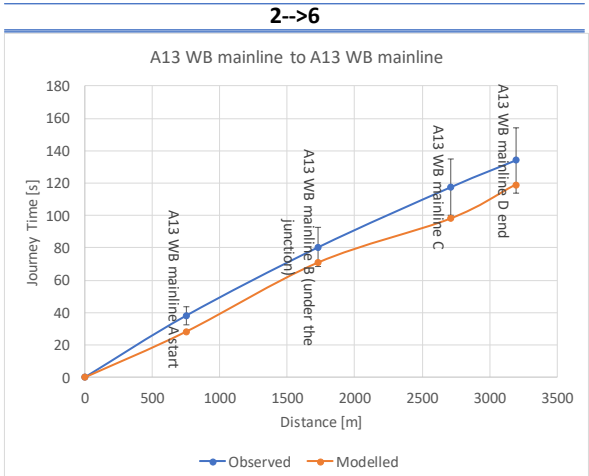

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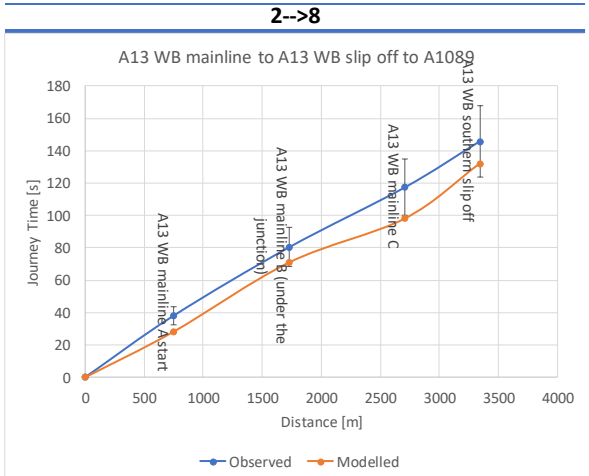

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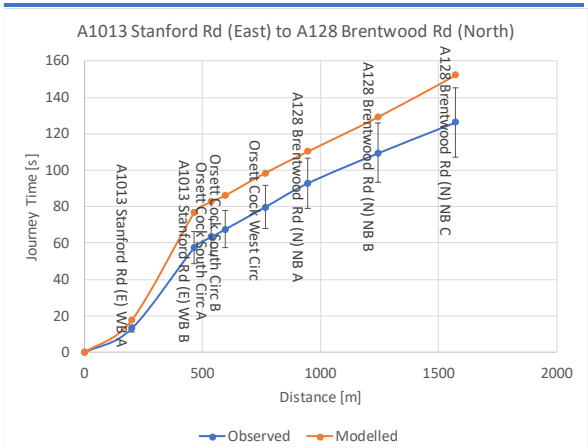

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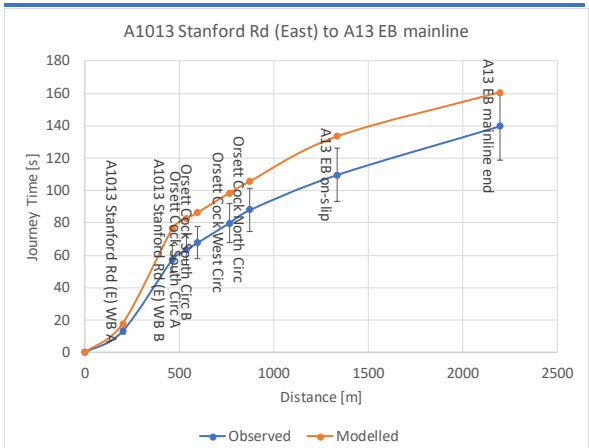

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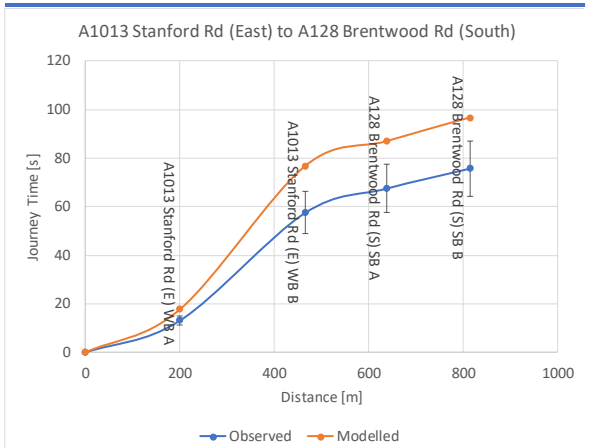

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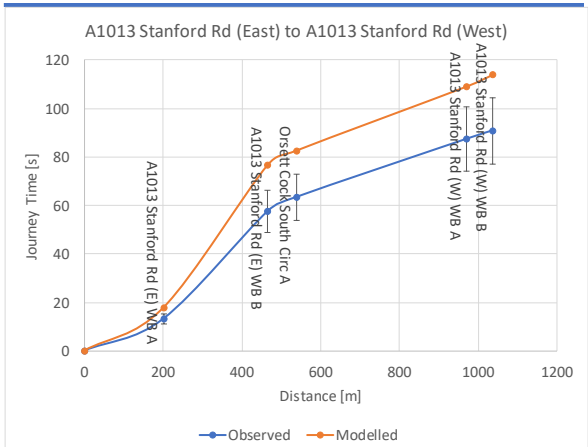

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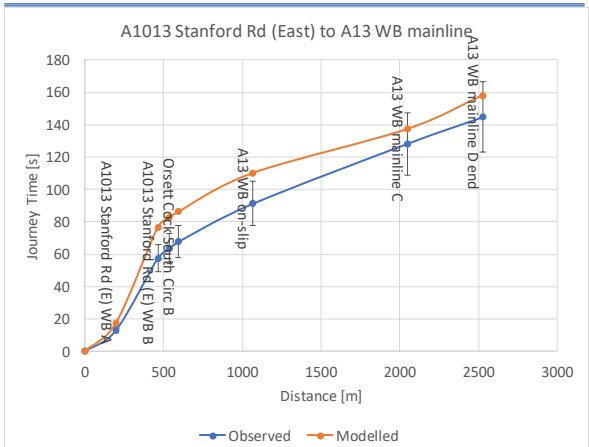

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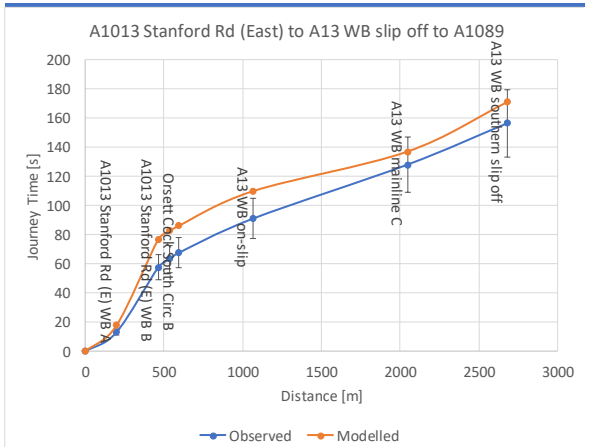

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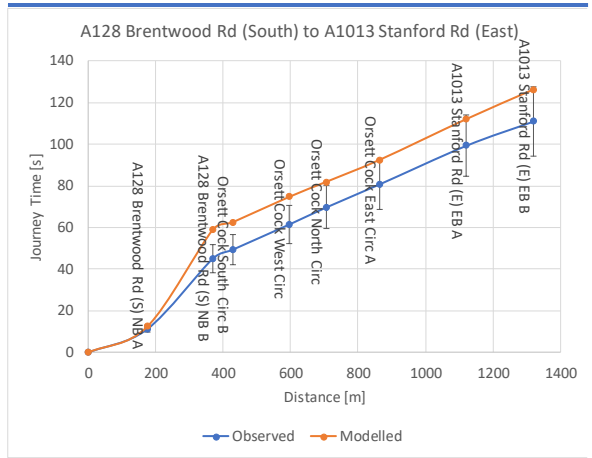

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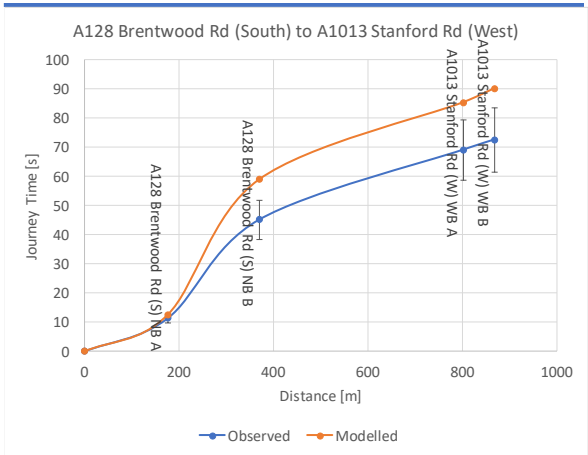

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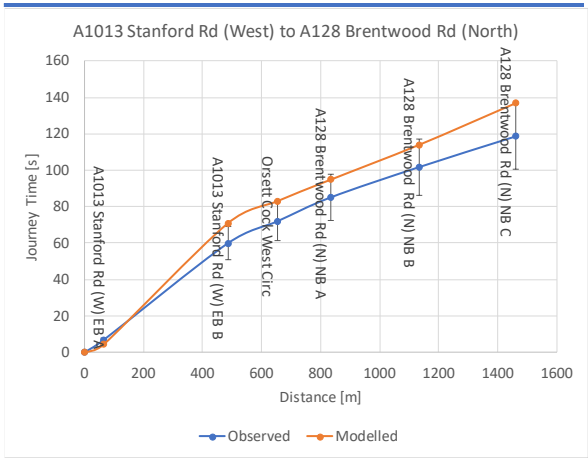

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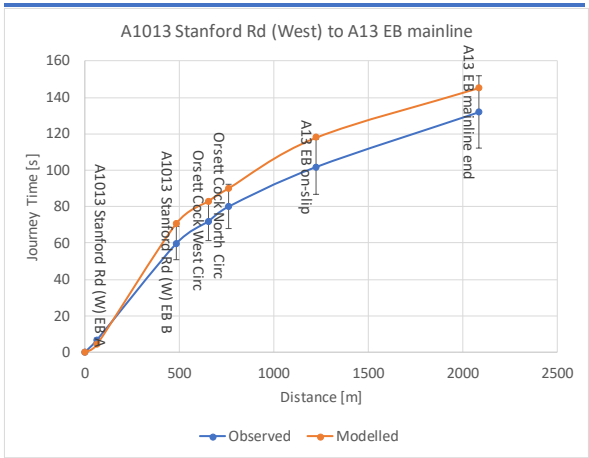

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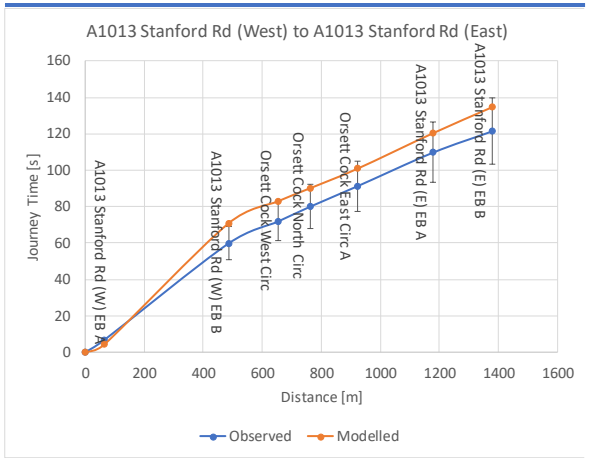

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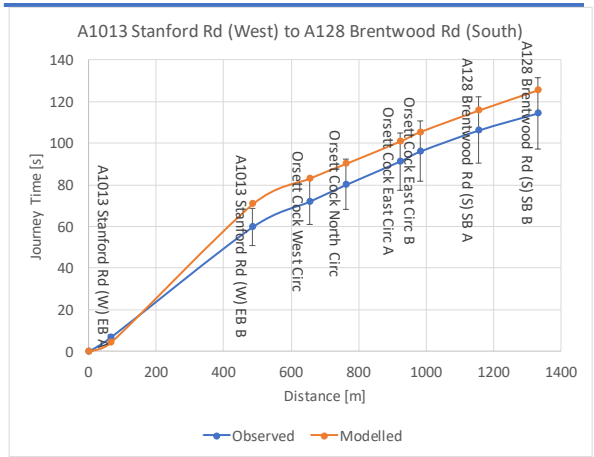

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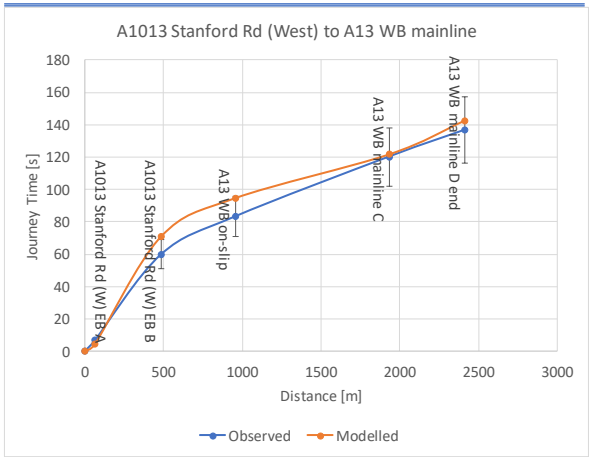

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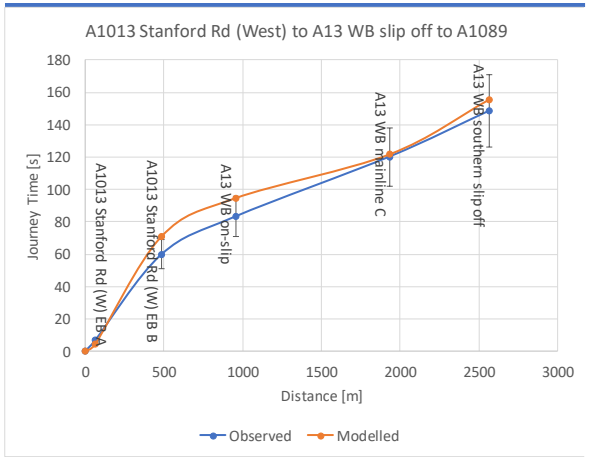

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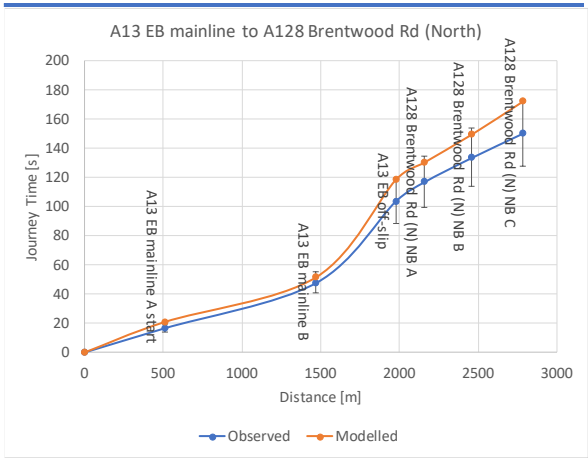

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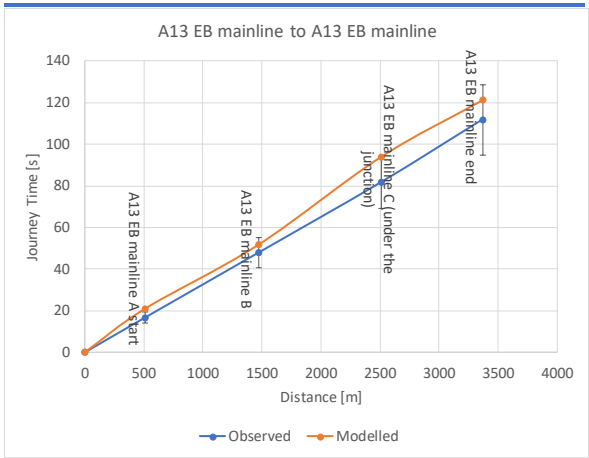

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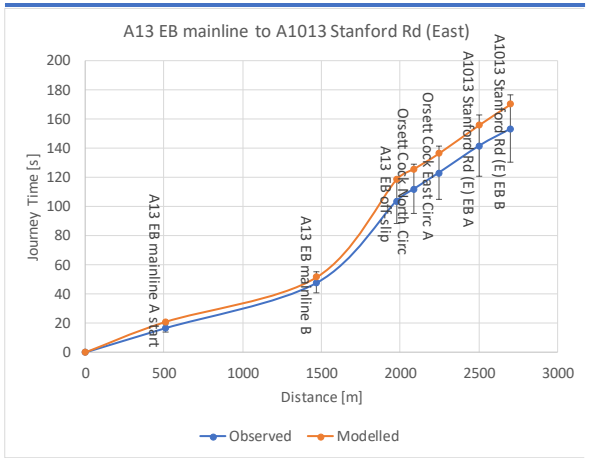

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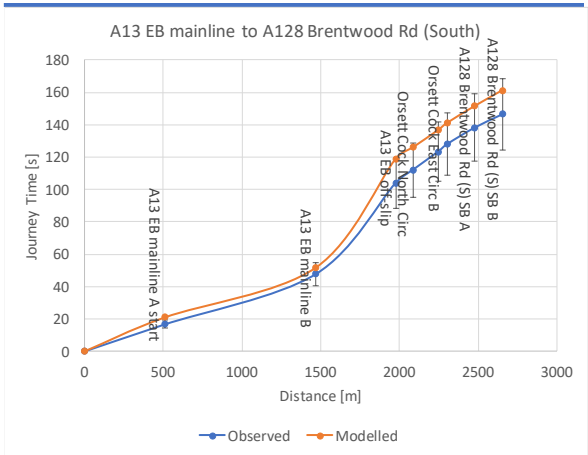

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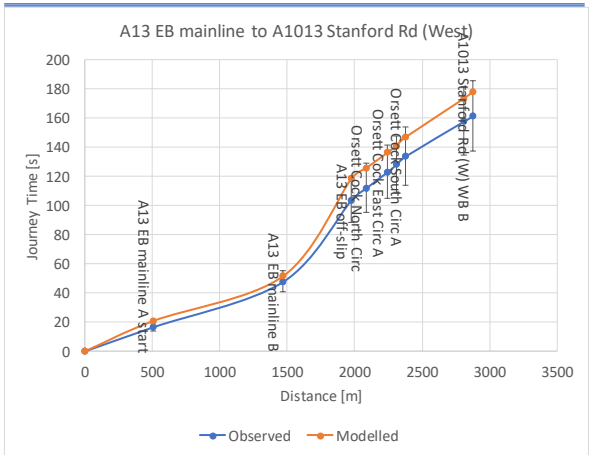

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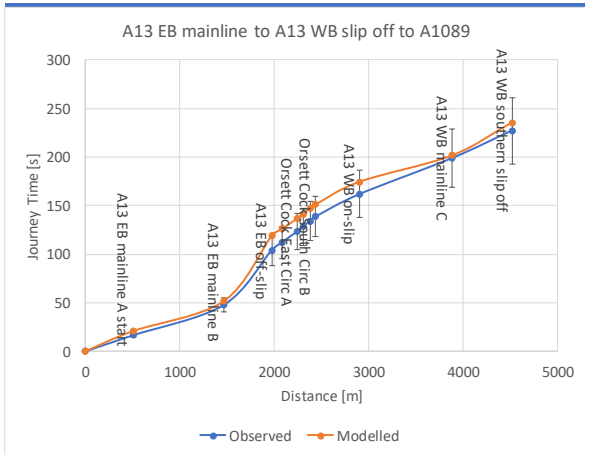

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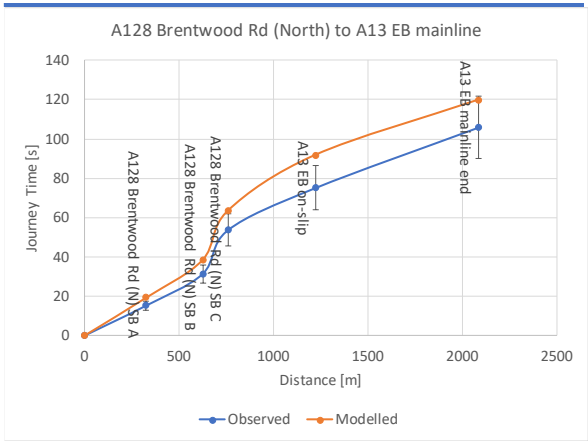
Plate C.2 Journey Time Validation Charts AM (08.00 – 09.00)

1-->2



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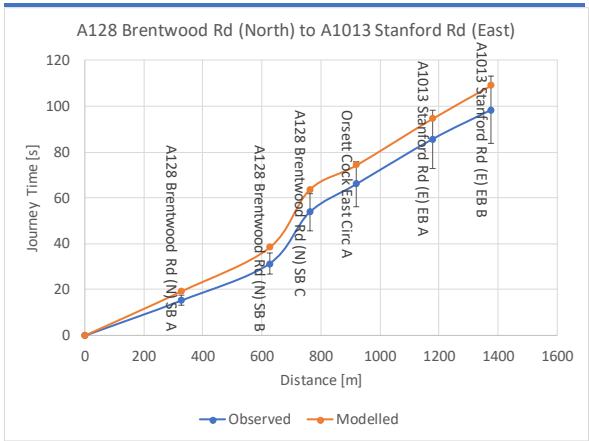

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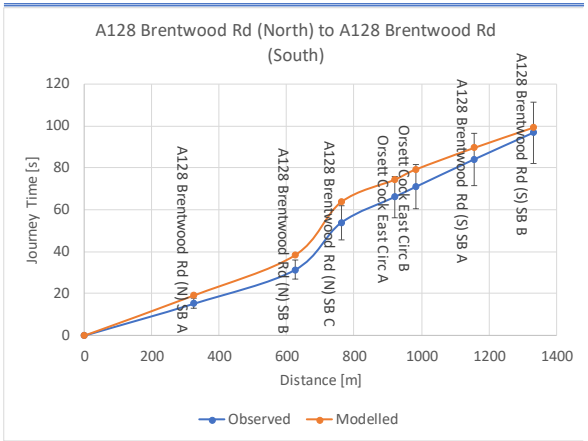

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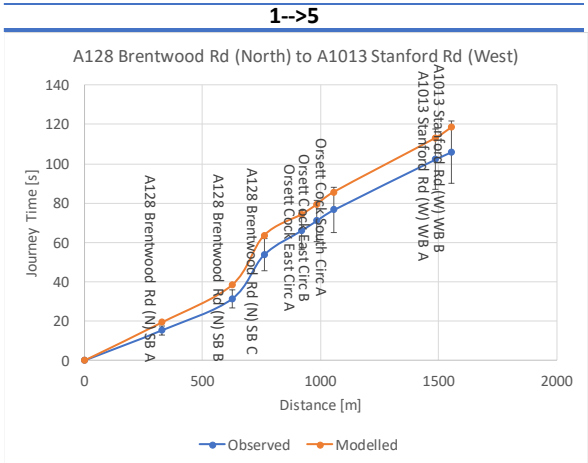

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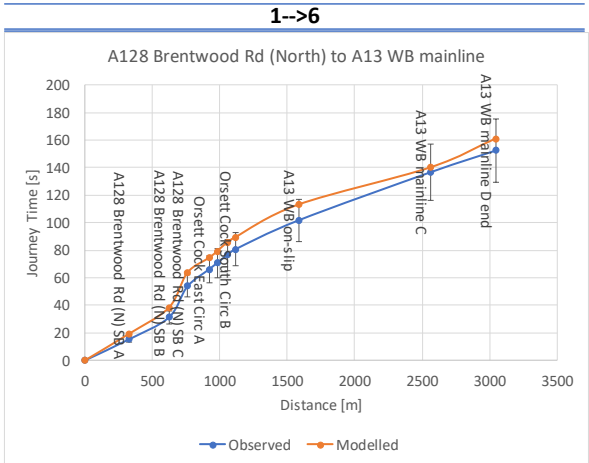

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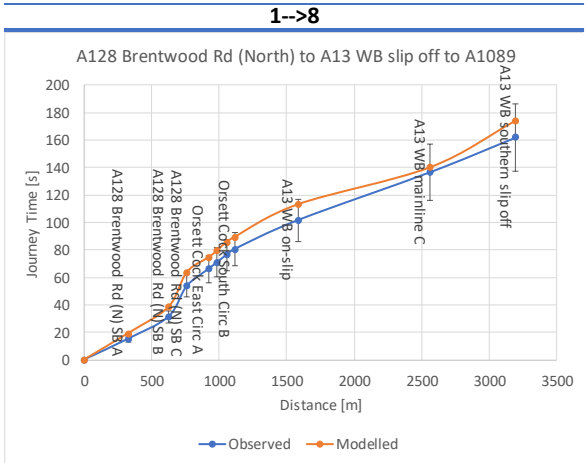

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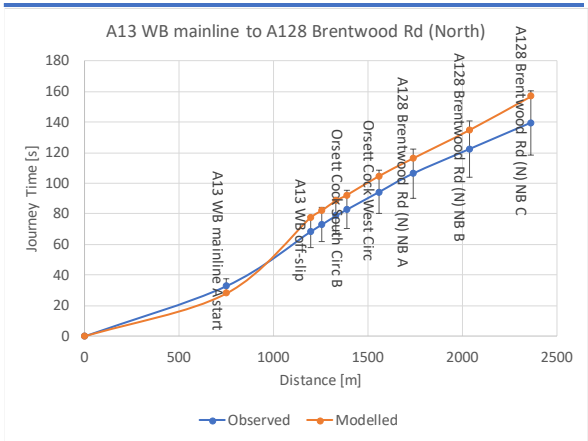

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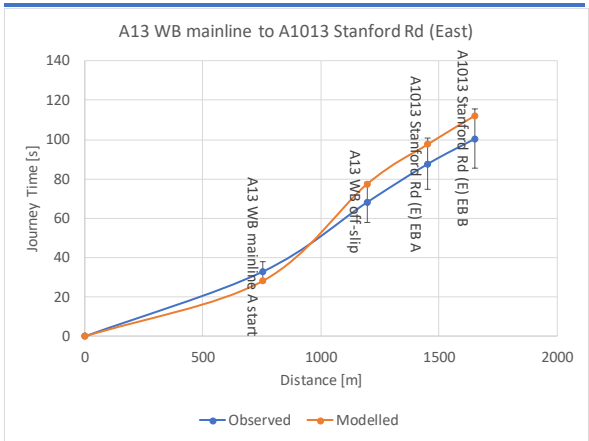

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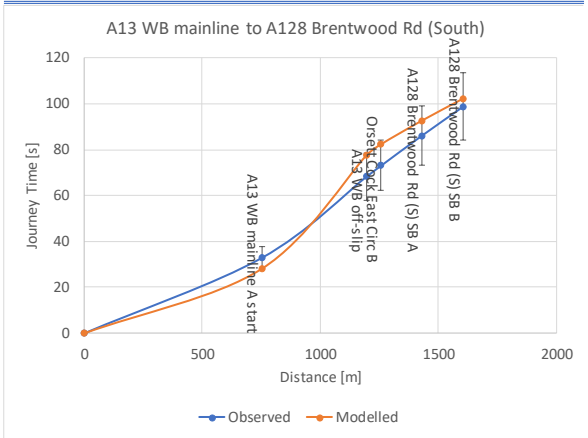

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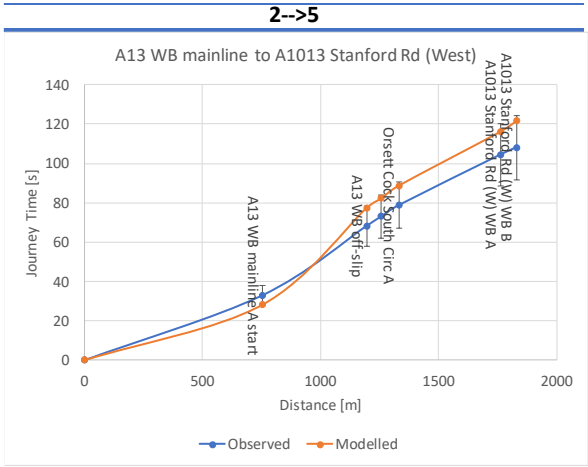

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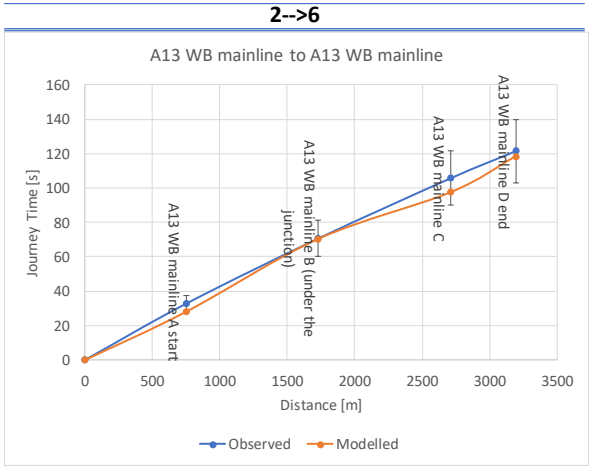

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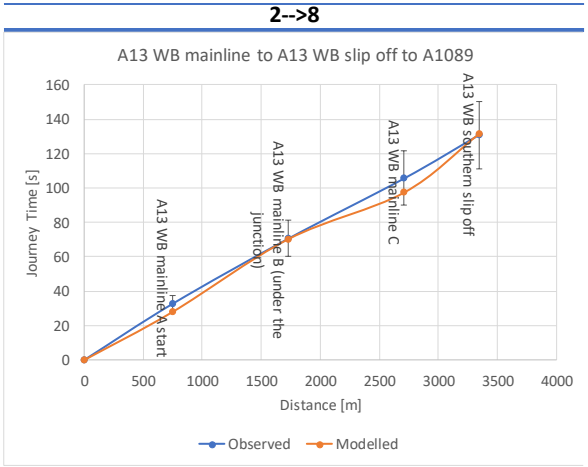

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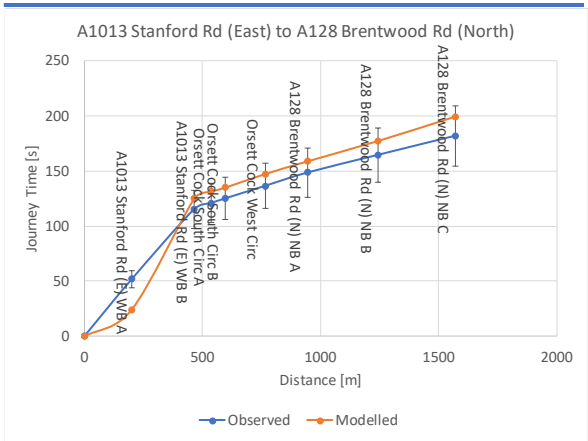

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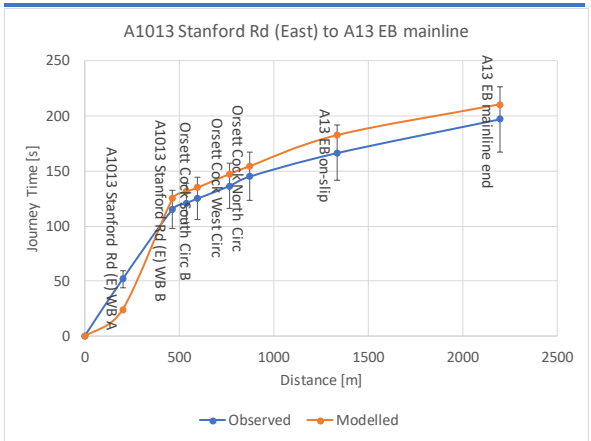

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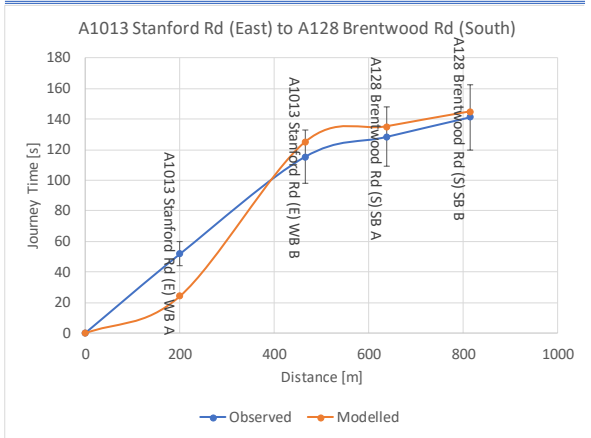

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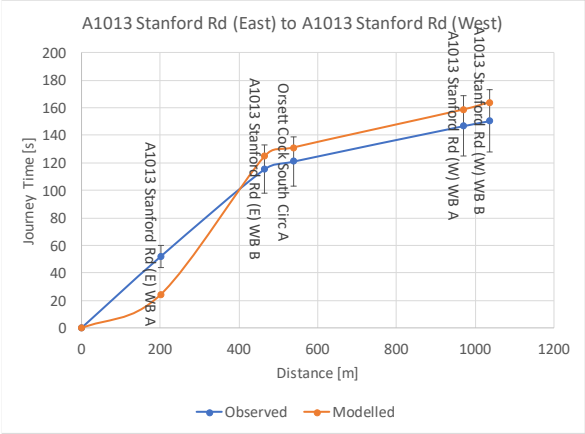

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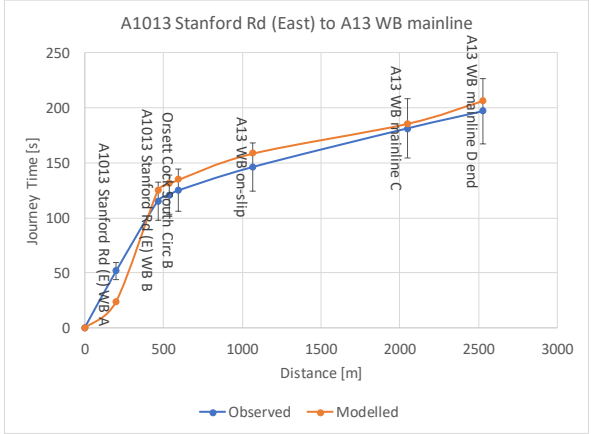

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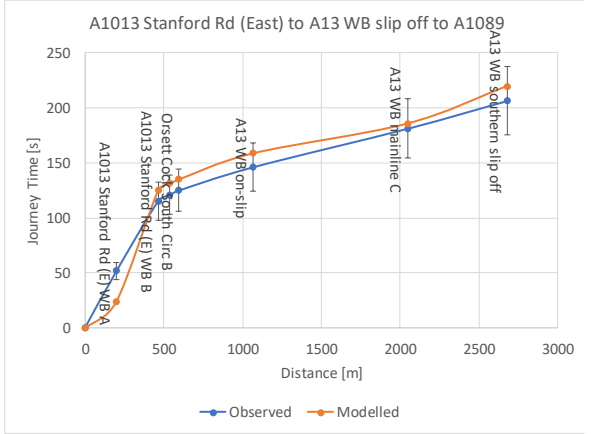

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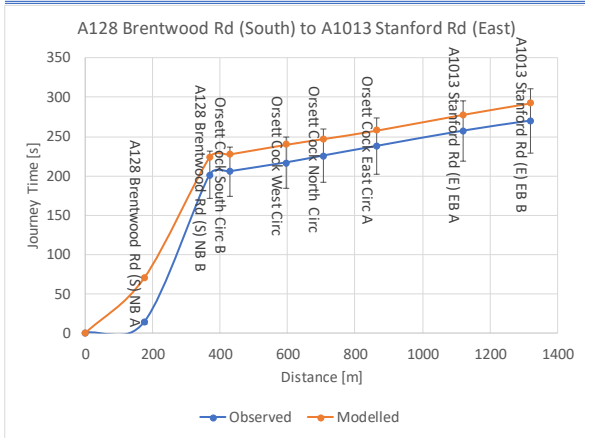

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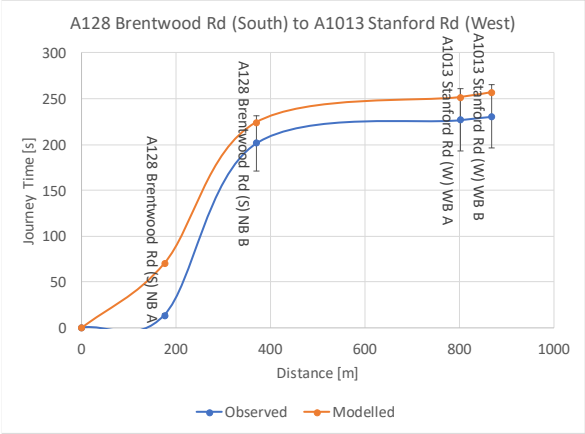

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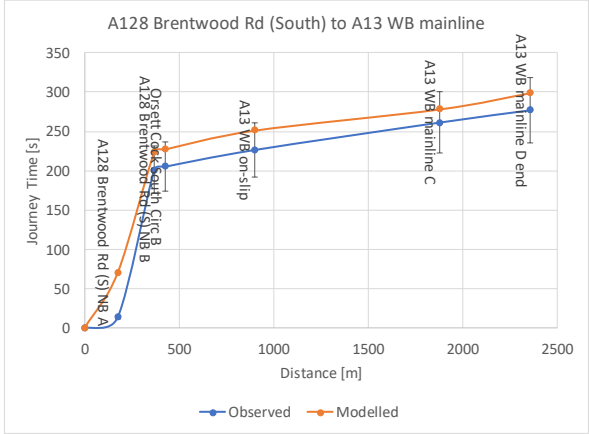

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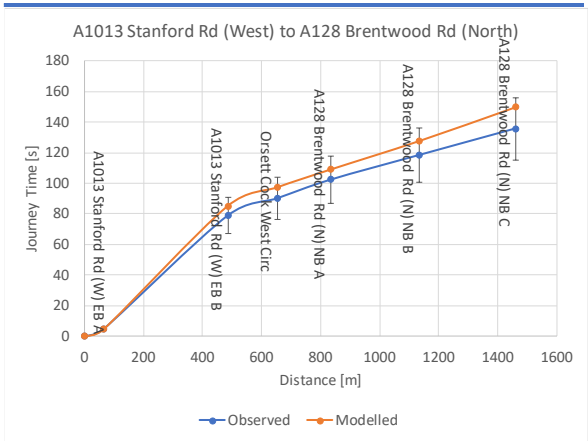

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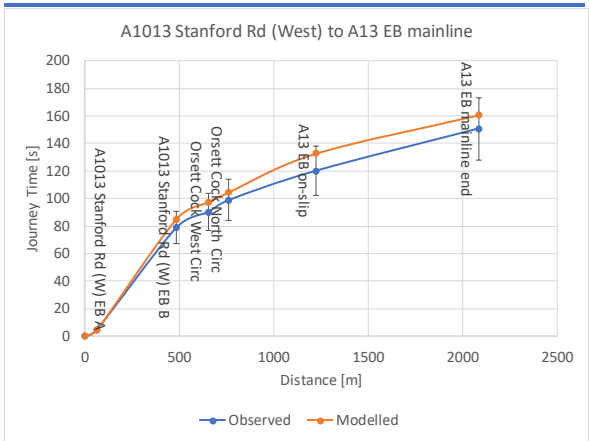

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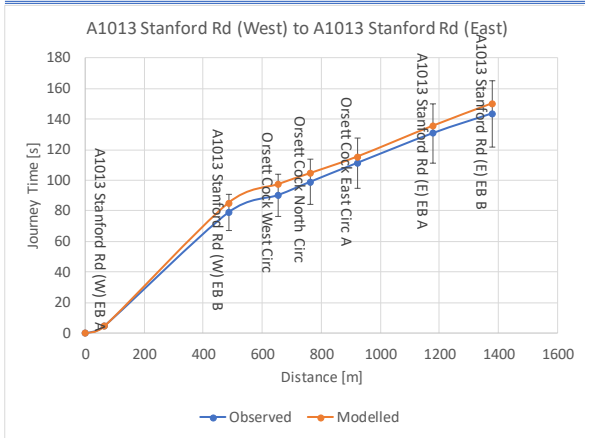

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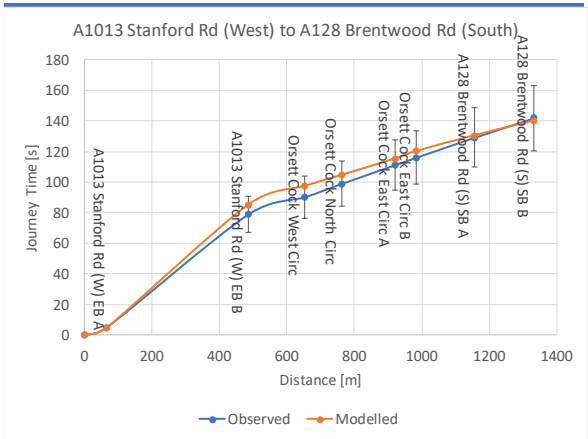

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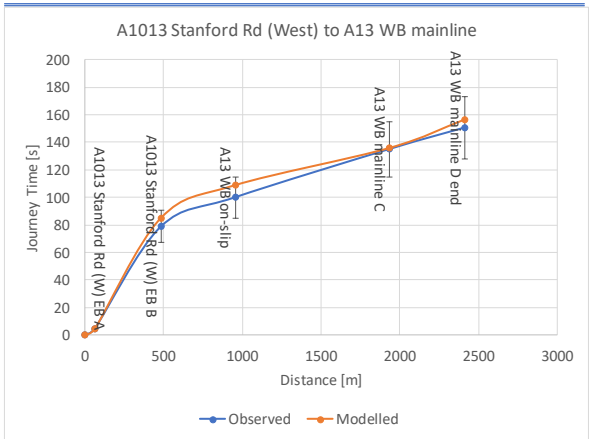

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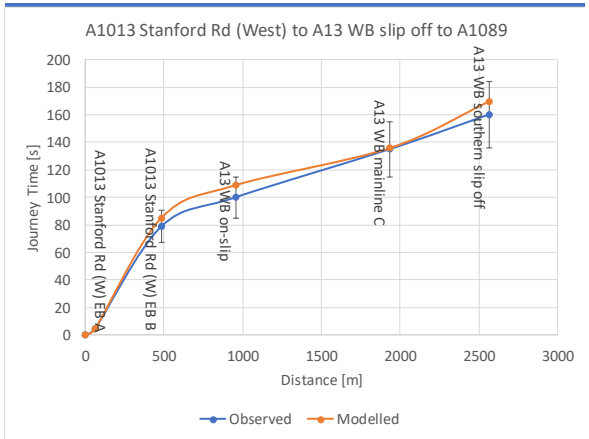

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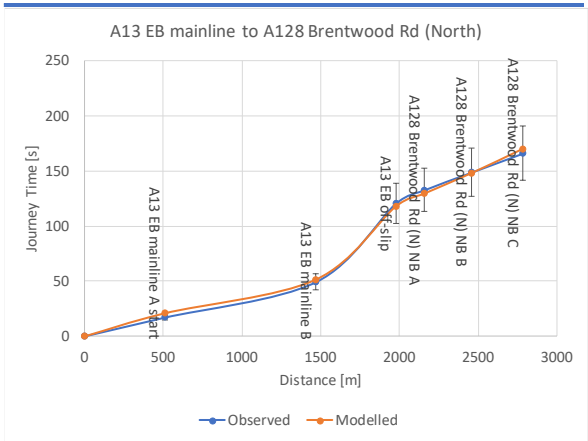

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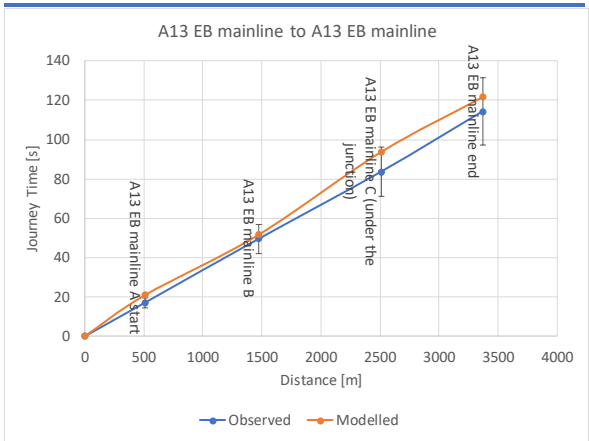

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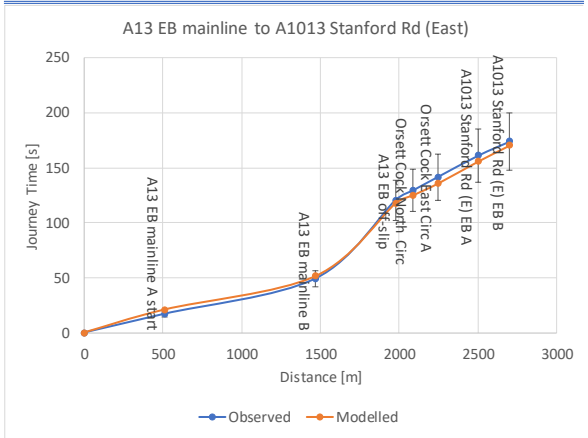

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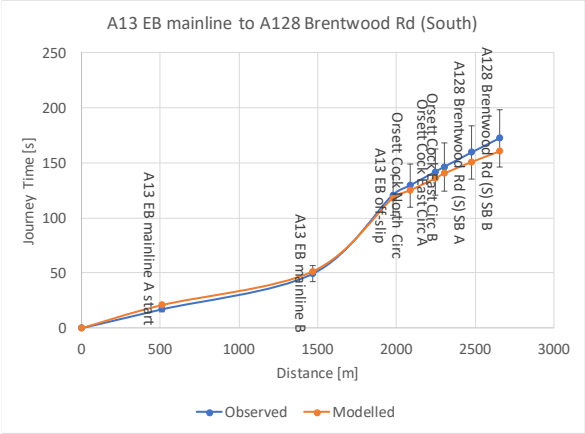

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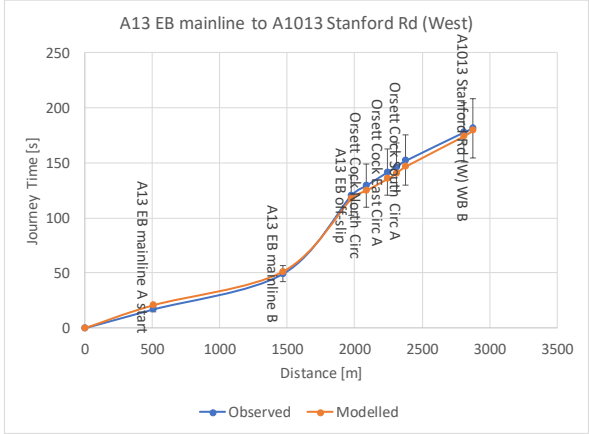

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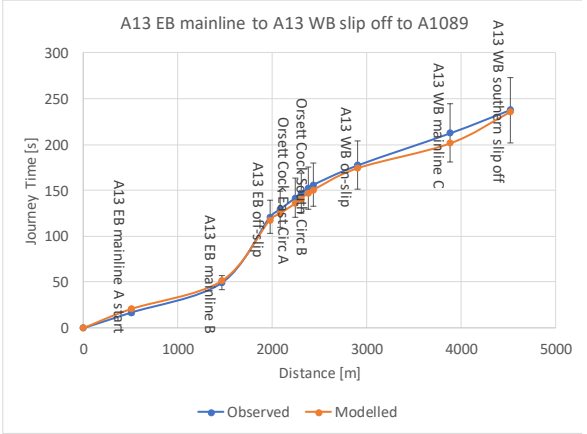

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Plate C.3 Journey Time Validation Charts PM (17.00 – 18.00)

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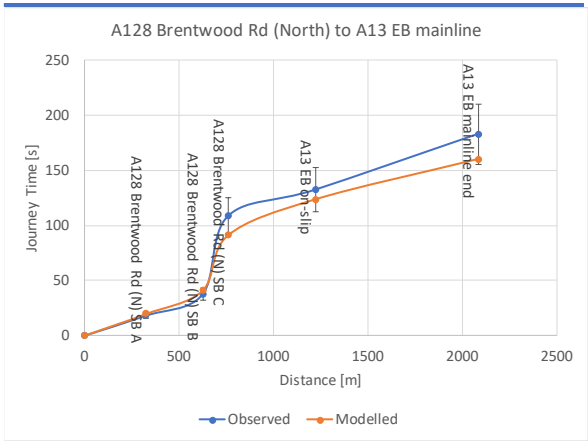

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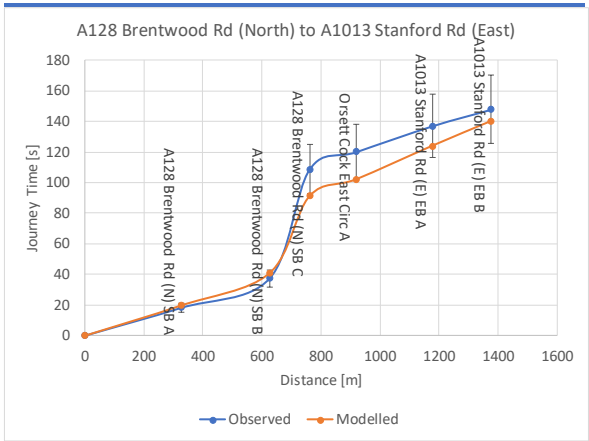

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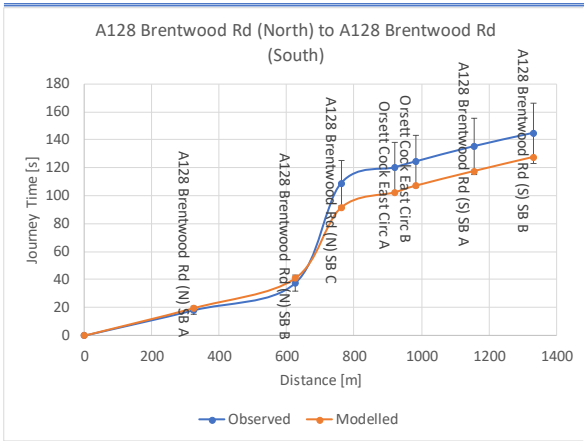

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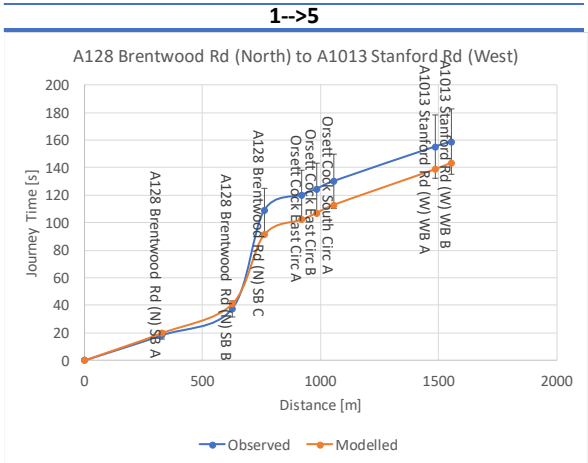

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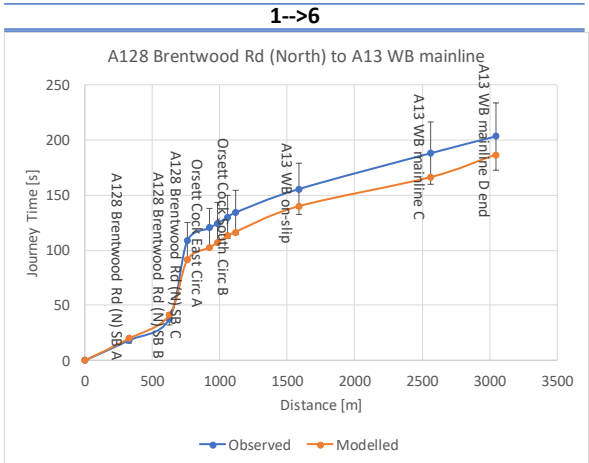

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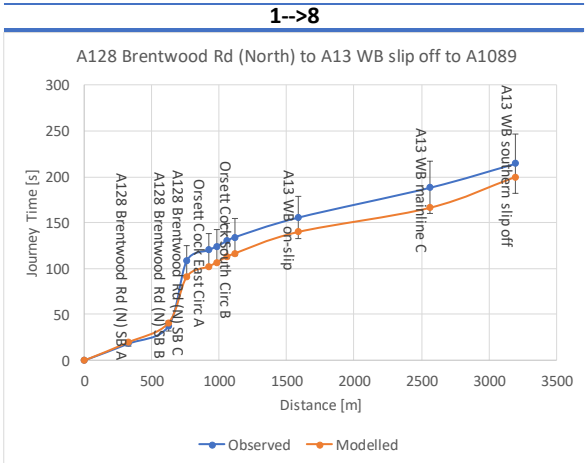

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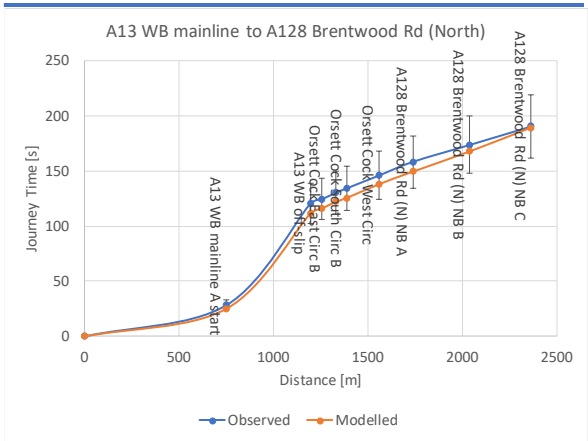

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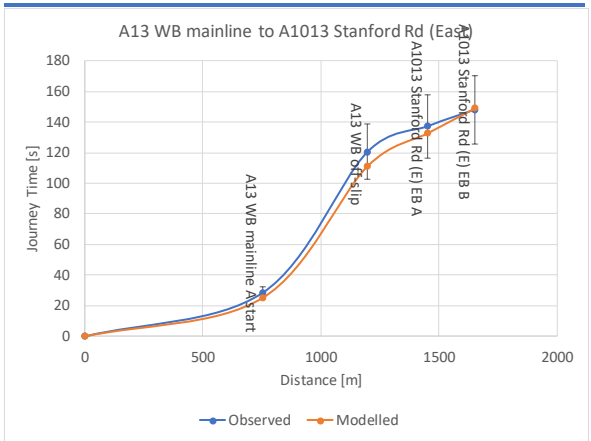

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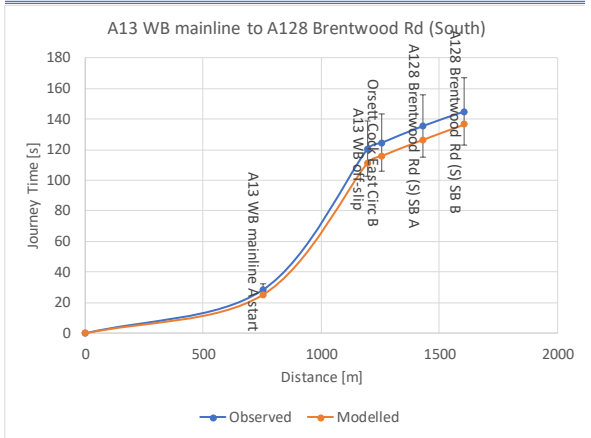

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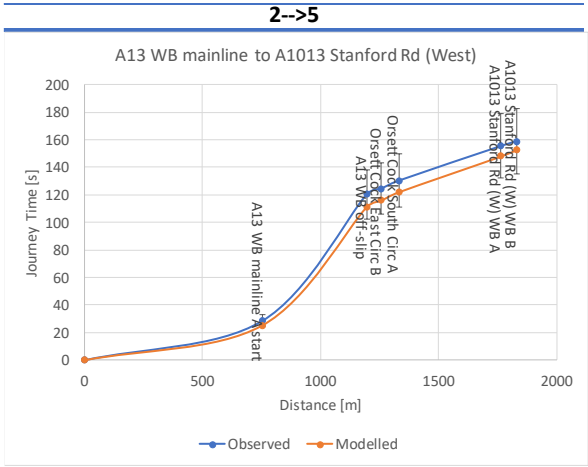

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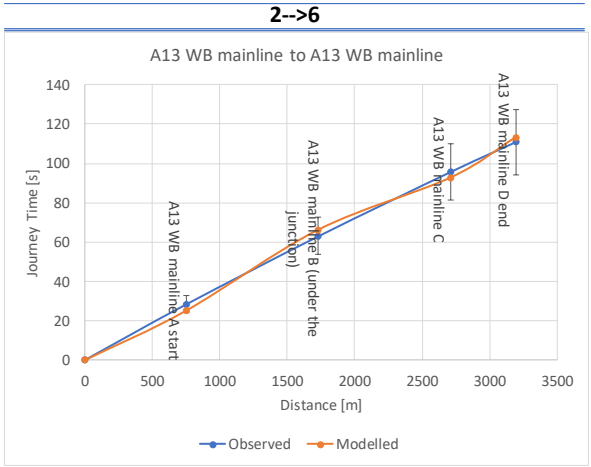

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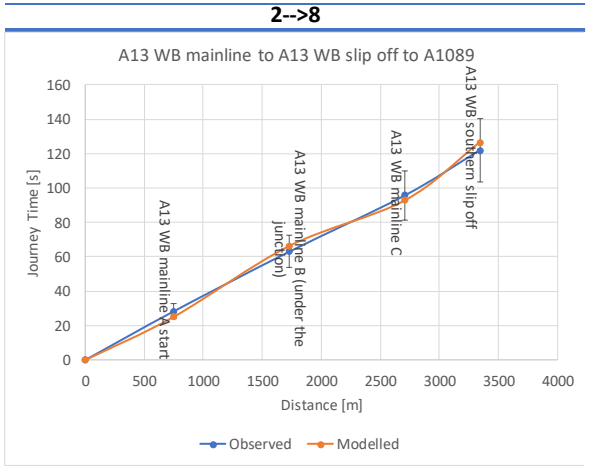

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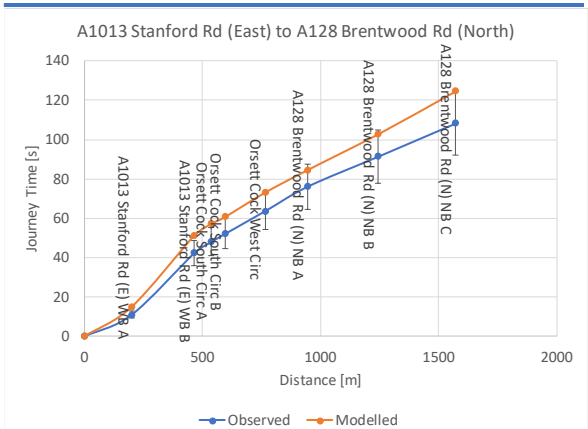

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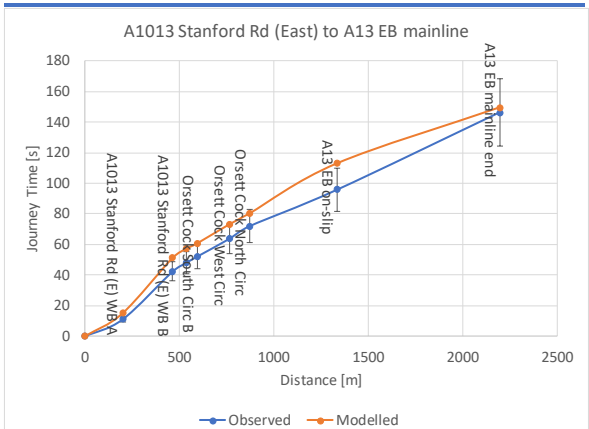

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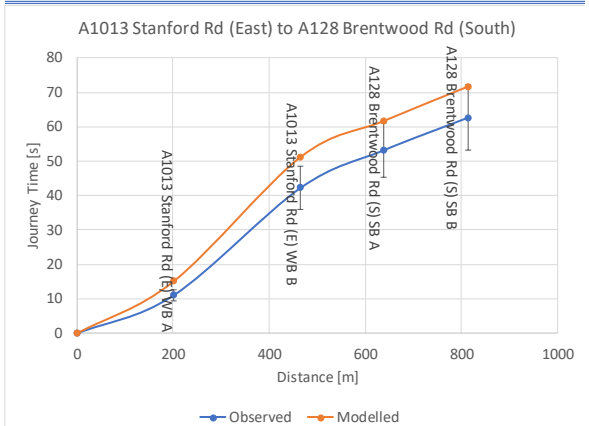

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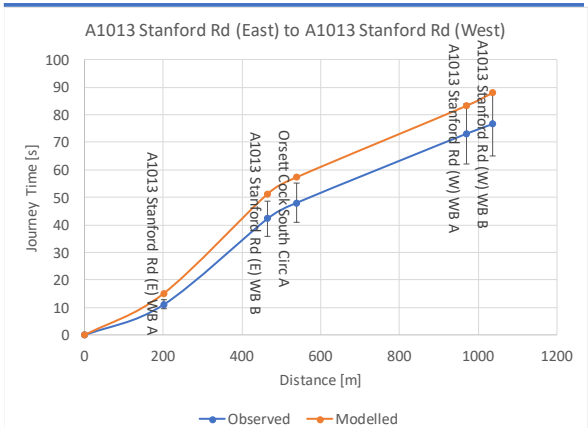

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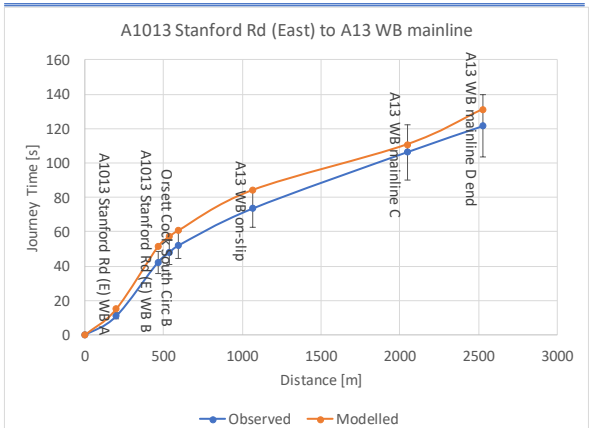

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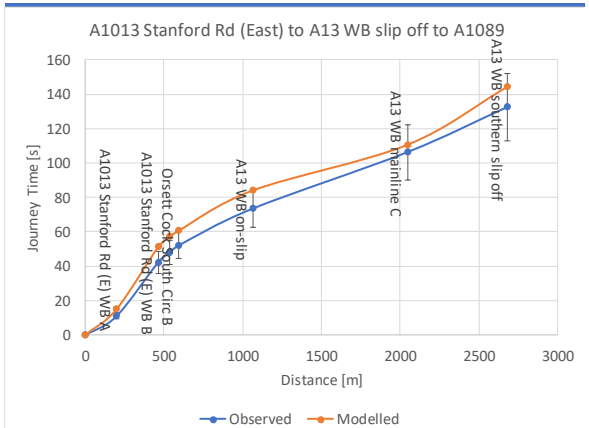

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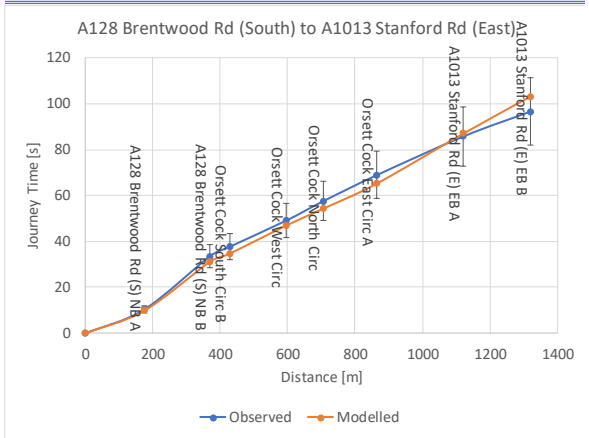

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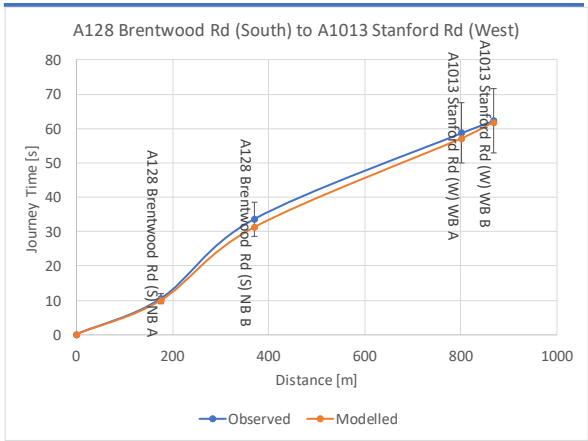

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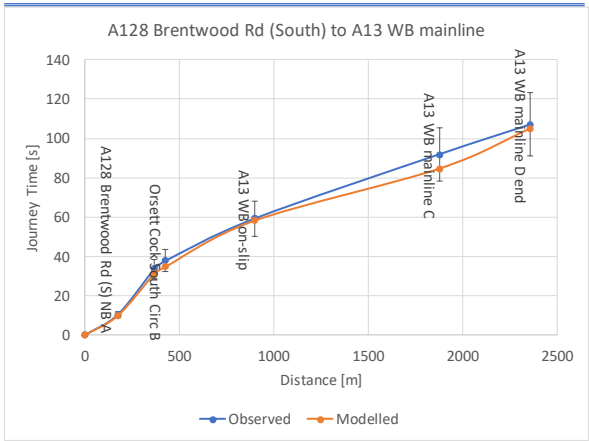

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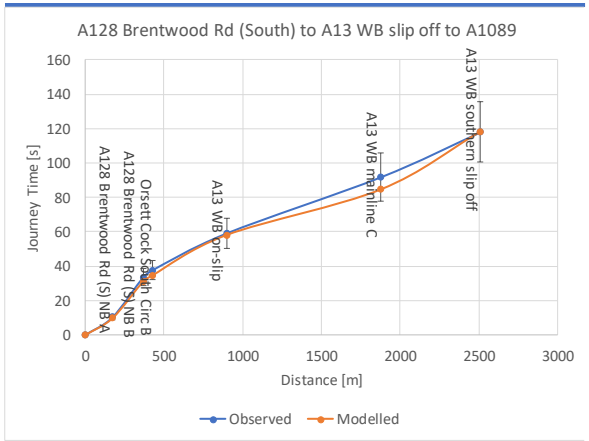

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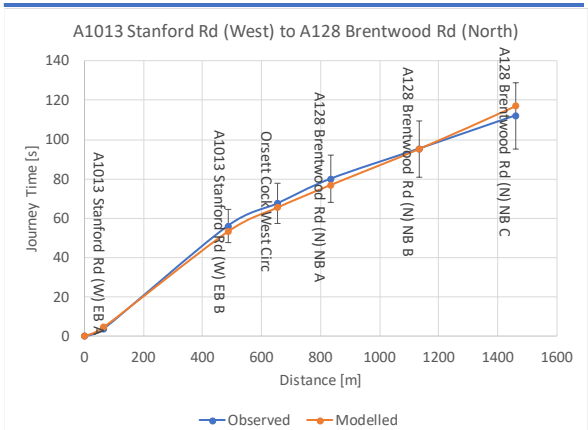

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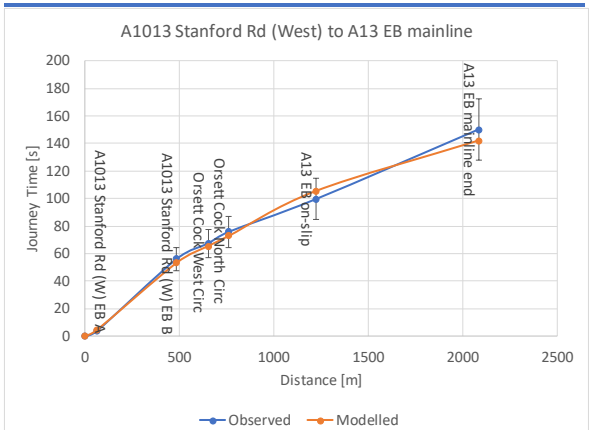

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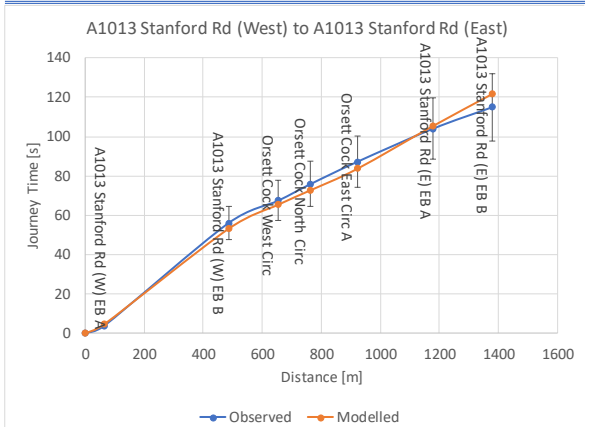

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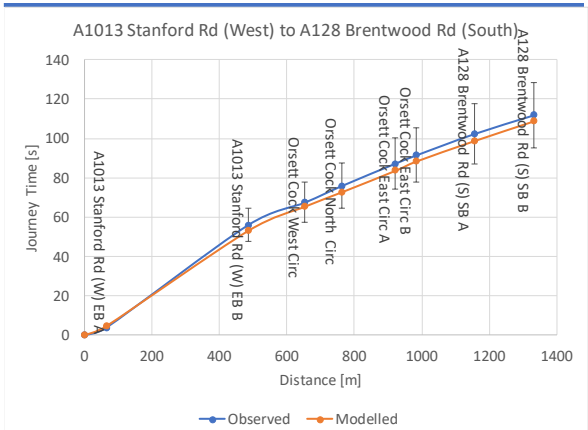

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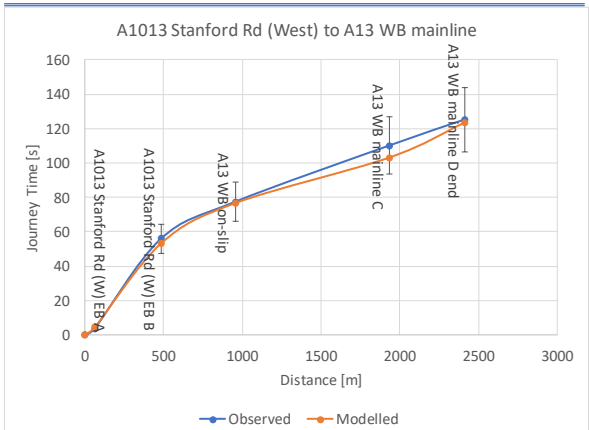

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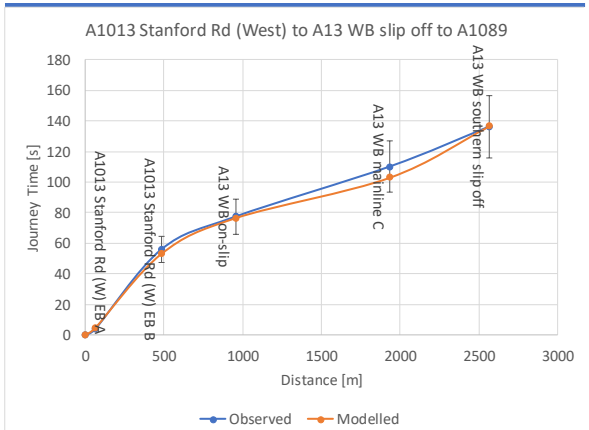

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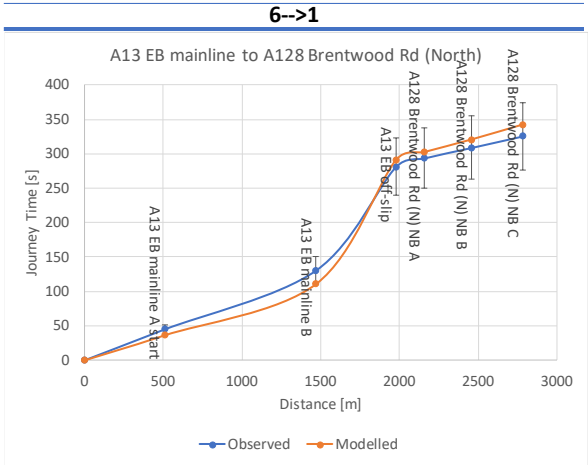

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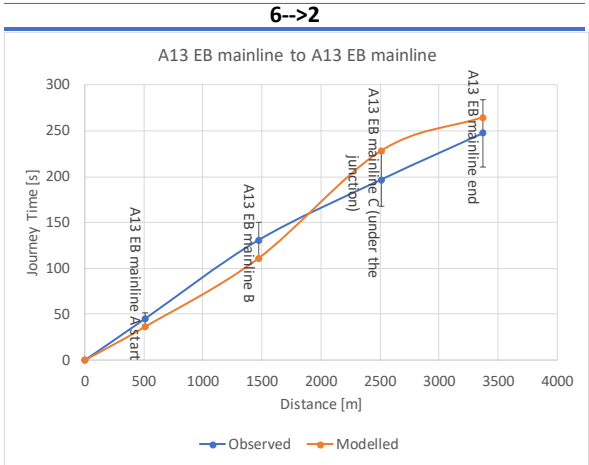

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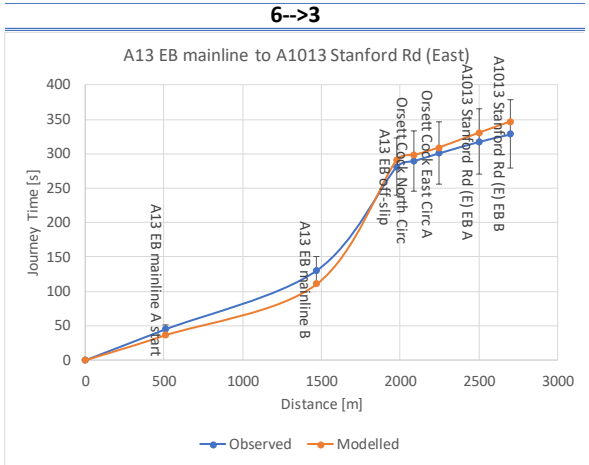

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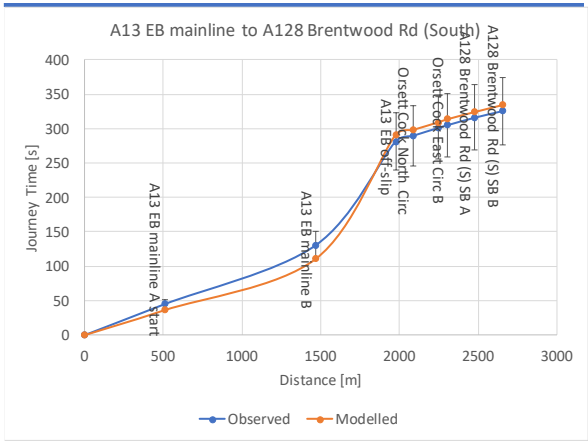

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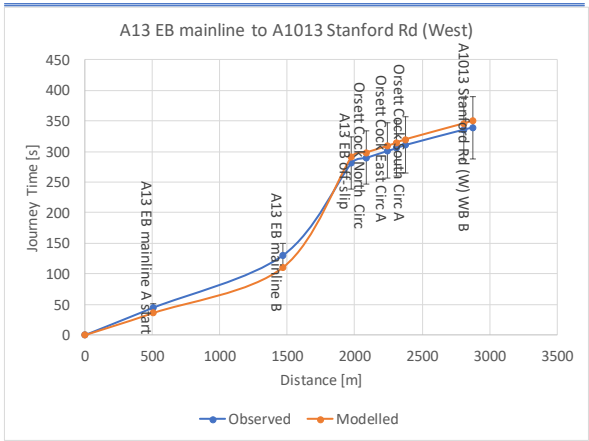

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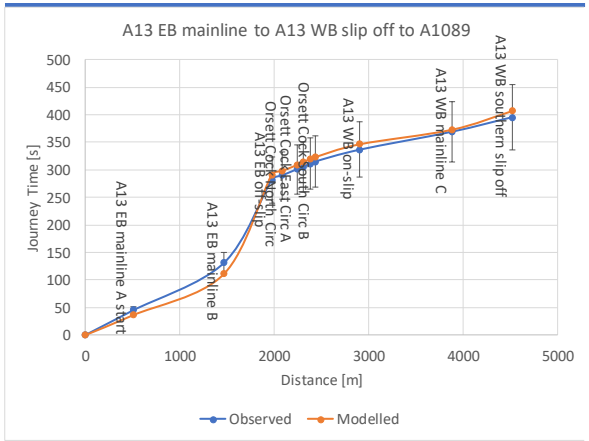

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Appendix D Relative delay plots

Plate D.1 Relative Delay Plot AM (07.00 – 08.00)

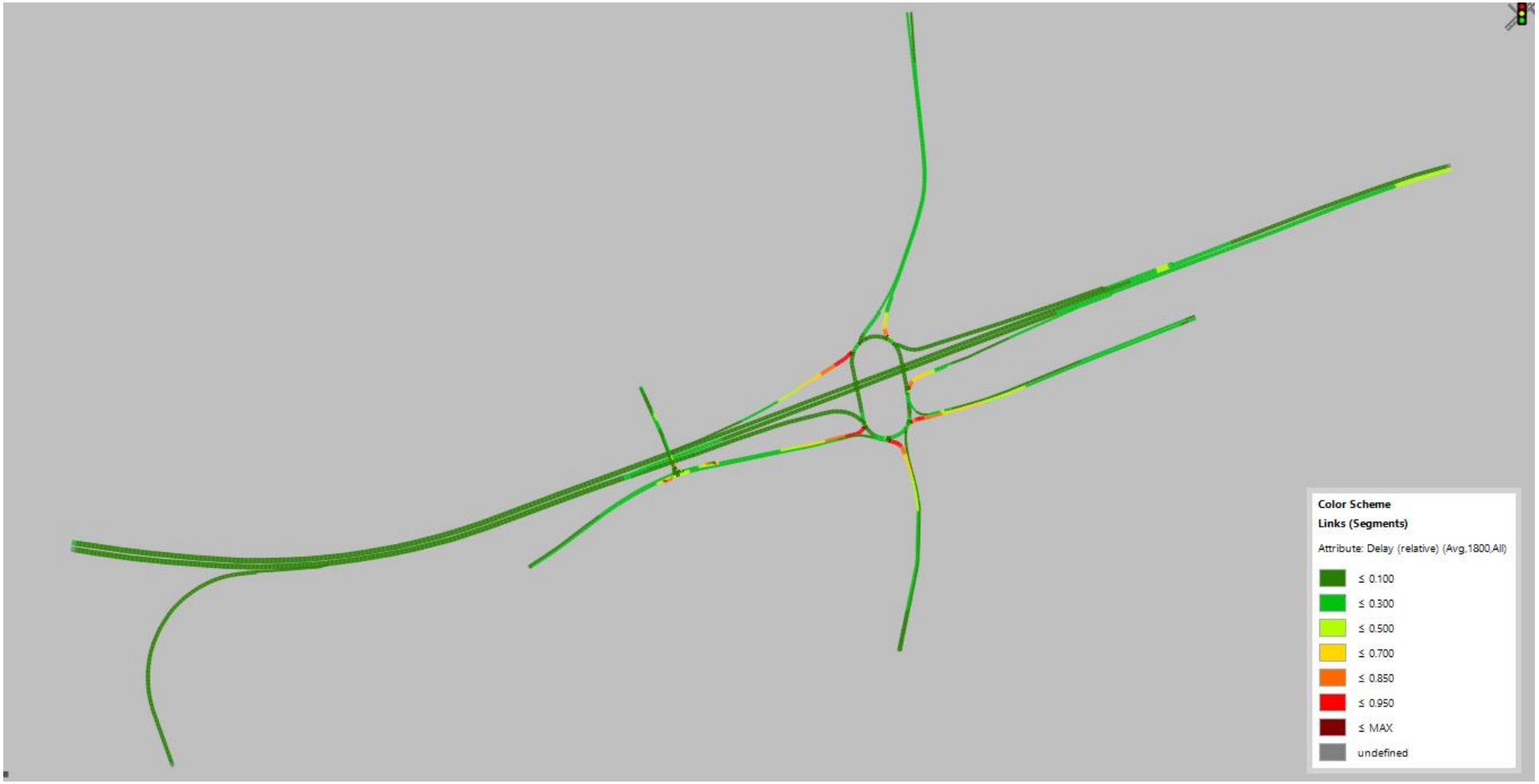

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Plate D.2 Relative Delay Plot AM (08.00 – 09.00)

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Plate D.3 Relative Delay Plot PM (17.00 – 18.00)

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