Bradford Metropolitan District Council
A658 Harrogate Road/A657 New Line Junction Modelling

Aimsun Modelling Report

10 June 2014
Version 0.1
Draft

Contents

Appendices

1 Introduction

1.1 Background

City of Bradford Metropolitan District Council (CBMDC) is developing proposals for the A658 Harrogate Road/A657 New Line junction aimed at reducing congestion and facilitating development in the Greengates area. Fore Consulting Limited (Fore) have been commissioned to finalise an Aimsun base model that was initially developed by CBMDC and to test options for improving the junction. The validation of the 2014 base year model is presented in in the Fore report titled "A658 *Harrogate Road/A657 New Line Aimsun Model Validation Report*" and dated June 2014.

Three preferred options for the junction have been identified by the council as follows:

- Option 5 – "Crossroads"
- Option 8 – "Small P-Loop"; and
- Option 9 – "Large P-Loop".

The above options have been coded into the base model and the performance of each option has been reported.

1.2 Report Purpose

This report details the specification and results of the Aimsun modelling of the options described above. It is intended for use within the council to aid in the decision making process concerning the selection and development of a preferred option.

1.3 Report Structure

The remainder of this report is structured as follows:

- Chapter 2 describes the Aimsun Base Model, the assumptions made to develop future year scenarios and Key Performance Indicators;
- Chapter 3 describes the option coding;
- Chapter 4 presents the Aimsun modelling results;
- Chapter 5 presents a summary and conclusions to the report.

2 Aimsun Modelling

2.1 Introduction

This section of the report describes the Aimsun modelling undertaken to simulate the future year proposals.

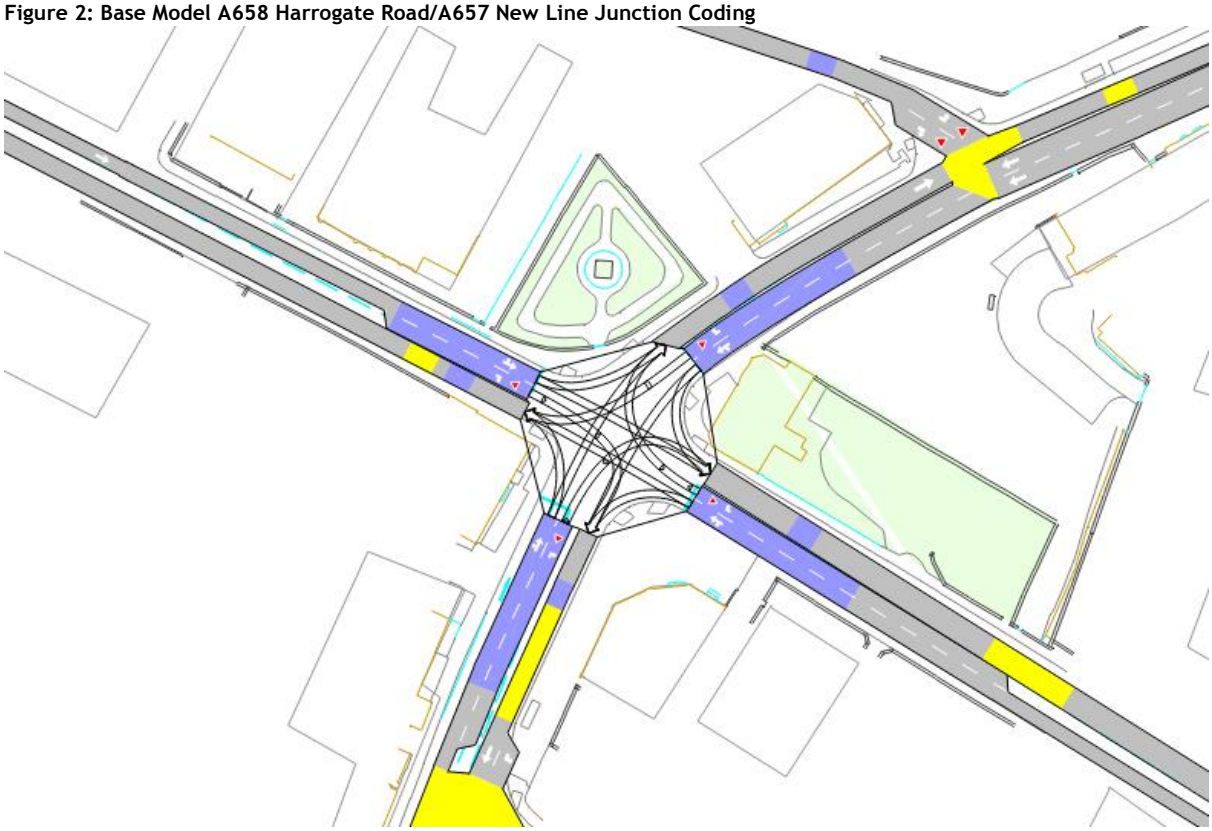
2.2 Method

2.2.1 Base Model

The options have been coded into the recently developed 2014 Base Model. Figure 1 shows the Base Model network. The Base Model has been fully calibrated and validated using 2014 traffic counts and journey times. A closer view of the coding of the existing arrangement at the A658 Harrogate Road/A657 New Line junction is shown in Figure 2.

Figure 1: Aimsun Base Model

Figure 2: Base Model A658 Harrogate Road/A657 New Line Junction Coding



2.2.2 Network Statistics

Network statistics for the base model and options have been extracted for comparison and the following information is presented in this report:

- **Total Flow** – this is calculated as the total number of vehicles passing through the network.
- **Average Delay** - delay time is calculated as the difference between travel time and free flow travel time. The average delay time is calculated as the mean delay time experienced by modelled vehicles as they travel through the network.
- **Average Speed** – this is calculated by averaging the speed of every vehicle in the network.
- **Total travelled time** – this calculated as the total travel time experienced by each modelled vehicle as it travels through the network.
- **Total vehicle travelled distance** – this is calculated as the distance matrix multiplied by the demand.

2.2.3 Origin-Destination Statistics

In addition to the global model statistics, the times taken to traverse the network for each origin-destination pair are presented in matrix format.

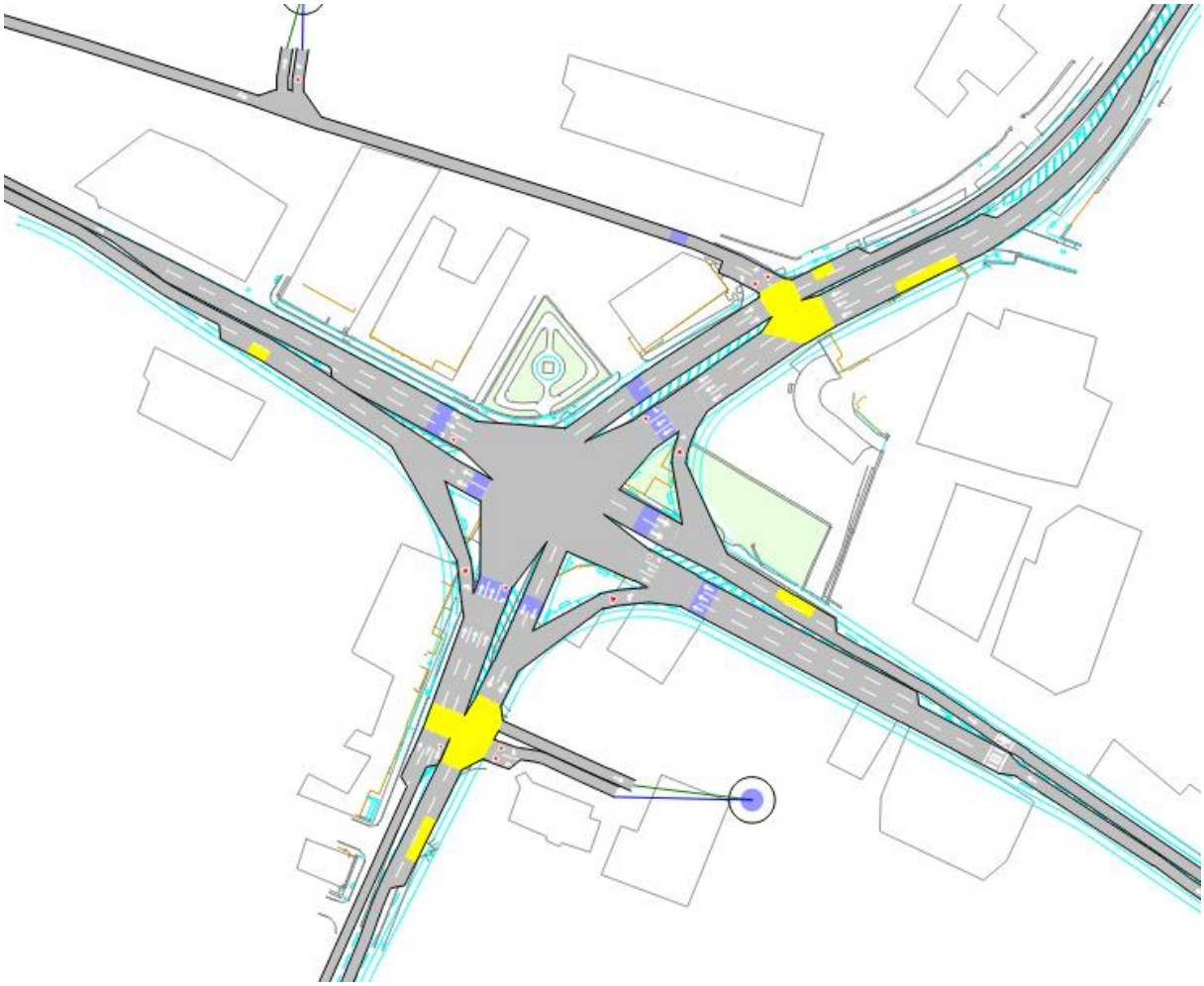
3 Option Coding

3.1 Option 5 – Crossroads

Option 5 is similar in layout to the existing arrangement but with additional lanes on all approaches to provide two ahead lanes, which subsequently merge into single lanes after the junction. Left turn lanes are also provided on the A658 Harrogate Road and A657 New Line (East) approaches together with signal controlled pedestrian crossing facilities. The network coding is shown in Figure 3.

Traffic signal timings have been based on fixed timings with a 90s cycle time. Green splits have been optimised by observing the behaviour of traffic in the model.

Figure 3: Option 5 -Crossroads



3.2 Option 8 – Small P-Loop

Option 8 removes some right turning conflicts from the junction by routing traffic around a one-way "P-loop". From the A658 Harrogate Road (north), only ahead movements are possible through the crossroads with left and right turning movements being facilitated by the use of the P-loop. Similarly, vehicles approaching from A658 Harrogate Road (south) can only travel ahead and left, with right turning traffic having to use the P-loop. The A657 New Line approaches to the junction are unchanged, except for the new junction to the east with the P-loop. The network coding is shown in Figure 4.

Traffic signal timings have been based on fixed timings with a 90s cycle time. Green splits have been optimised by observing the behaviour of traffic in the model.

Figure 4: Option 8 – Small P-Loop

3.3 Option 9 – Large P-Loop

Option 9 is similar to Option 8 but includes an additional lane on the A657 New Line in both directions for traffic going ahead. The network coding can be seen in Figure 5.

Traffic signal timings have been based on fixed timings with a 90s cycle time. Green splits have been optimised by observing the behaviour of traffic in the model.

Figure 5: Option 9 – Large P-Loop

4 Aimsun Model Results

4.1 Network Statistics

The network statistics derived from the Aimsun modelling for each option are presented in Table 1 and Table 2 for the AM and PM peak hours respectively.

Table 1: Aimsun Modelling Results AM Peak Hour

Key Performance Indicator	2014 Base	Option 5	Option 8	Option 9	Units
Total Flow	3,500	3,539	3,517	3,528	veh/h
Average Delay	95	40	68	41	sec/km
Mean Queue	105	30	70	33	veh
Average Speed	28	36	30	36	km/h
Total Travel Time	435	272	354	273	h
Total Travelled Distance	9,076	9,165	9,137	9,162	km

Table 2: Aimsun Modelling Results PM Peak Hour

Key Performance Indicator	2014 Base	Option 5	Option 8	Option 9	Units
Total Flow	3,608	3,720	3,686	3,707	veh/h
Average Delay	114	40	68	43	sec/km
Mean Queue	137	31	74	39	veh
Average Speed	26	36	30	35	km/h
Total Travel Time	503	287	372	295	h
Total Travelled Distance	9,388	9,701	9,632	9,692	km

The above tables show the following:

- The base scenario has significant queuing due to inadequate capacity at the junction.
- The network statistics Options 5 and 9 show minimal queuing and delays. Traffic flows well through these options, of which Option 5 performs best.
- Although Option 8 shows an improvement relative to the base, it still operates at, or slightly over capacity, because compared to Options 5 and 9, Option 8 has significantly higher delays and total travel time.

4.2 Visual Assessment

Analysis of the options has also been undertaken using the animated simulations from the model.

4.2.1 Option 5

As discussed above, Option 5 performs the best with no significant delays, as shown in Figure 6 and Figure 7.

Figure 6: Operation of Option 5 in the AM Peak

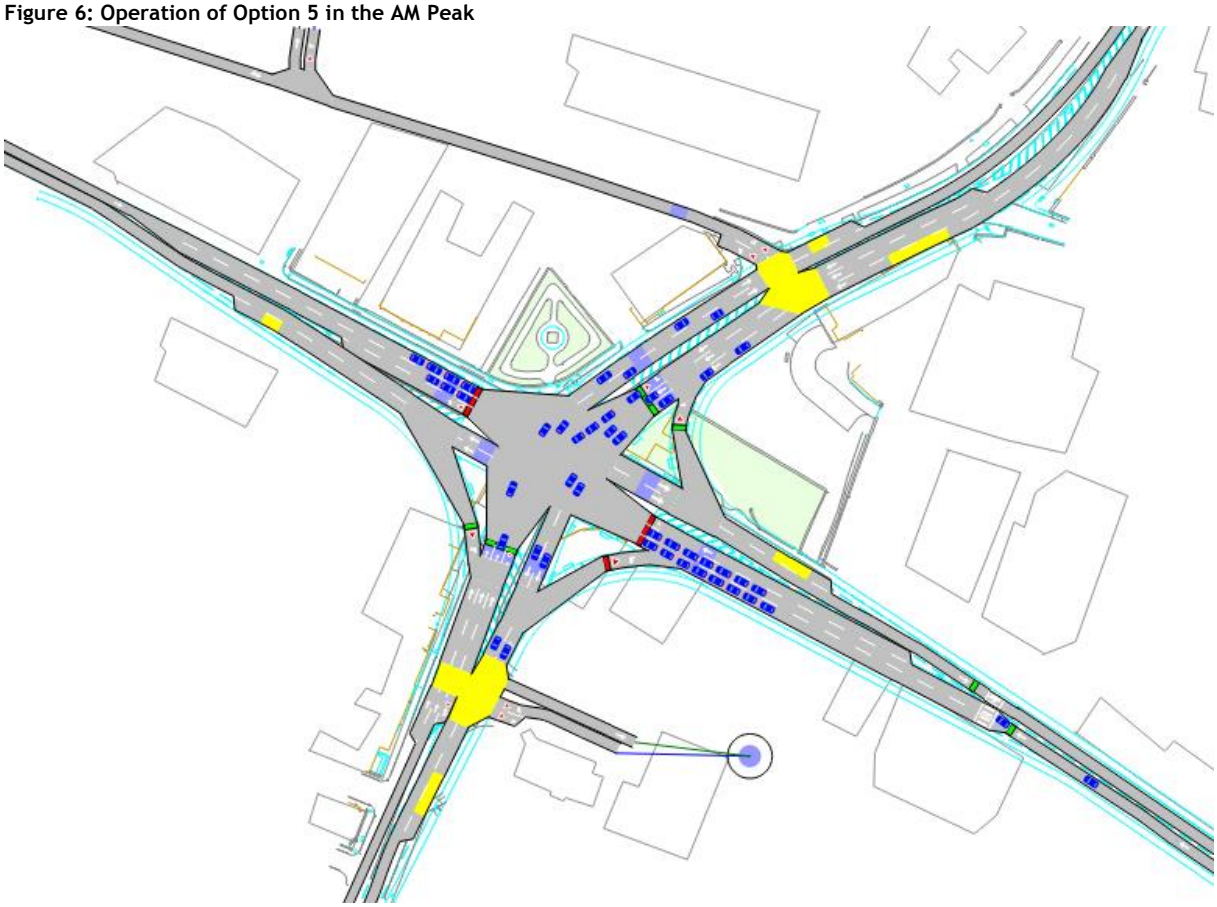
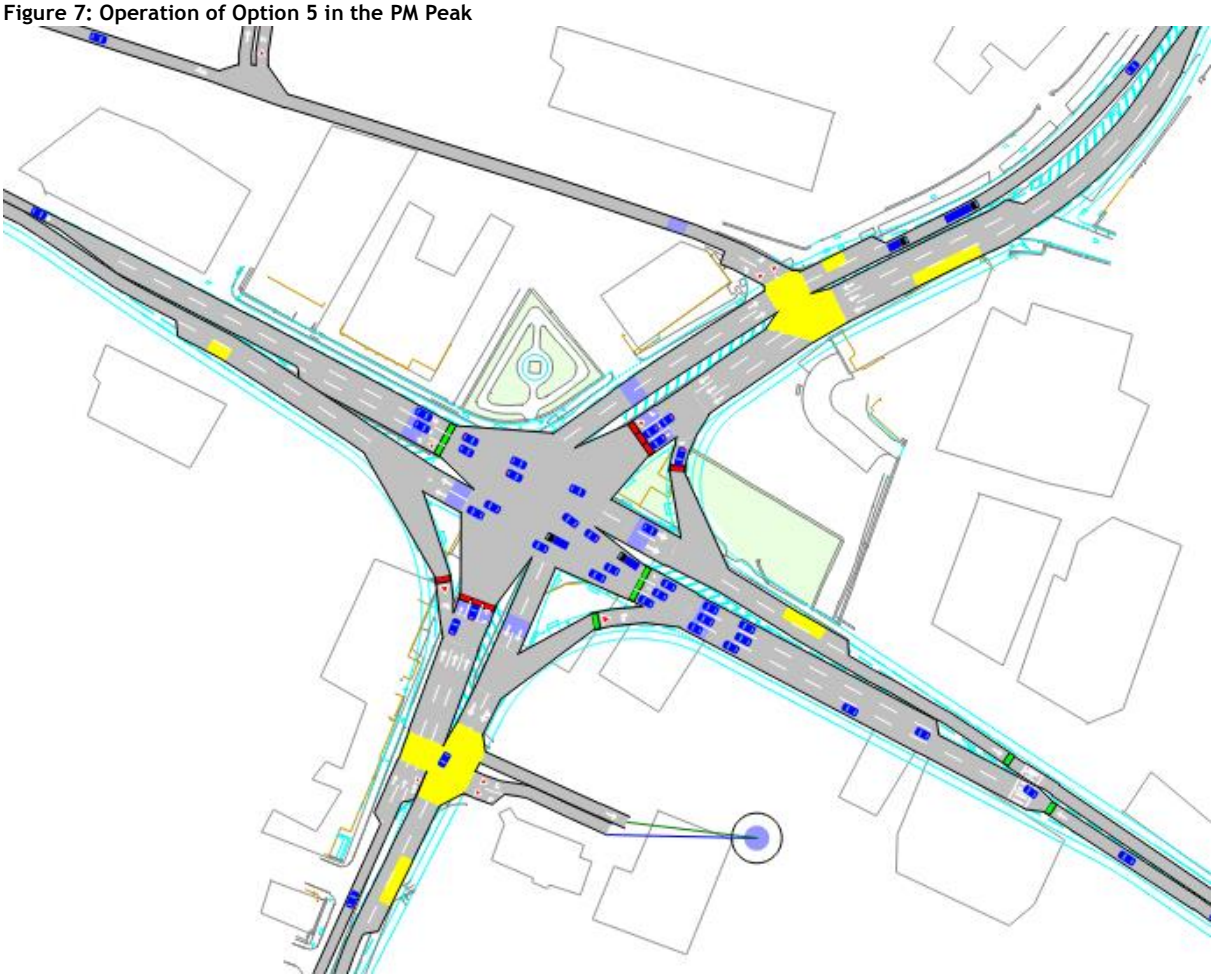


Figure 7: Operation of Option 5 in the PM Peak



4.2.2 Option 8

Figure 8 and Figure 9 show the typical operation of the Option 8 proposals in the AM and PM peak hours, respectively, and confirms that the junction is operating over capacity. Figure 8 shows an example of queuing on the A657 New Line (east) approach to the junction in the AM peak period. However, it should be noted that the queue seen here is not present at the start, and dissipates before the end, of the simulation. The PM peak period, as shown in Figure 9, shows similar issues.

Figure 8: Operation of Option 8 in the AM Peak

Figure 9: Operation of Option 8 in the PM Peak

4.2.3 Option 9

Option 9 is similar to Option 8, but the extra capacity afforded by the additional lane eliminates the significant queuing on the A657 New Line (east) approach to the junction. Figure 8 and Figure 11 show the junction in the AM and PM peak periods, respectively, and show how the junction would operate with minimal queuing and delay.

Figure 10: Operation of Option 9 in the AM Peak

Figure 11: Operation of Option 9 in the PM Peak

4.3 Origin-Destination Statistics

4.3.1 Introduction

The average travel time between each origin and destination for the base and each option are presented in Appendix A. The difference in average travel times compared to those in the base model has been calculated for each option and the results are presented and discussed in the rest of this section.

4.3.2 Option 5

Option 5 shows the most consistent and significant improvements with almost all O-D pairs experiencing an improvement in journey time. Table 3 and Table 4 show the differences in the AM and PM peaks respectively.

Table 3: Option 5 Average Journey Time Comparison with the Base Model in the AM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		-20	-11			-19		-27
New Line E	-101		-97	-110	-92	-107	-145	-131
KFC	0							-5
Albion Rd W		-86				1		
Albion Rd E		-138				-18		
New Line W	-112	-109	-85	0	-1			-32
Tenterfields	-109	-118				-114		1
Harrogate Rd N	-181	-185	-228			-174		

Table 4: Option 5 Average Journey Time Comparison with the Base Model in the PM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		-53	-38			-53		-67
New Line E	-190		-174	-181	-182	-197	-290	-247
KFC	4							3
Albion Rd W		-121				0		
Albion Rd E		-192				-50		
New Line W	-134	-111	-140	0	-1			-35
Tenterfields	-112	-125				-125		0
Harrogate Rd N	-157	-174	-187			-157	-81	

4.3.3 Option 8

Table 5 and Table 6 show the differences in travel time for each O-D pair in the AM and PM peaks, respectively, with Option 8 in place. This shows that the option provides journey time benefits for some routes but disbenefits for others with the largest disbenefit being for vehicles that have to negotiate the P-loop to turn right from Harrogate Road (south). It should be noted that the distribution of benefits between O-D pairs could be altered by changing the signal timings. For example, the disbenefits for A658 Harrogate Road (south) could be eliminated at the expense of benefits for A657 New Line (east).

Table 5: Option 8 Average Journey Time Comparison with the Base Model in the AM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		94	5			20		31
New Line E	-12		-15	-11	-9	-9	-44	-54
KFC	16							56
Albion Rd W		-87				1		
Albion Rd E		-143				-18		
New Line W	-115	-112	-77	1	-2			-37
Tenterfields	-32	-24				20		1
Harrogate Rd N	-128	-117	-177			-64		

Table 6: Option 8 Average Journey Time Comparison with the Base Model in the PM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		68	-12			-12		-24
New Line E	-99		-87	-97	-97	-103	-215	-204
KFC	23							19
Albion Rd W		-116				1		
Albion Rd E		-190				-50		
New Line W	-132	-109	-132	0	-2			-40
Tenterfields	-15	-1				32		2
Harrogate Rd N	-94	-83	-114			-40	-81	

4.3.4 Option 9

The improved capacity on the A657 New Line (east) approach in Option 9 eliminates most of the journey time disbenefits that are seen with Option 8, with any remaining disbenefits being negligible. Table 7 and Table 8 show the differences in the AM and PM peaks, respectively.

Table 7: Option 9 Average Journey Time Comparison with the Base Model in the AM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		16	-4			-12		-1
New Line E	-102		-89	-109	-93	-107	-157	-147
KFC	16							18
Albion Rd W		-92				1		
Albion Rd E		-147				-16		
New Line W	-112	-118	-64	1	-1			-38
Tenterfields	-87	-70				-26		1
Harrogate Rd N	-202	-201	-247			-153		

Table 8: Option 9 Average Journey Time Comparison with the Base Model in the PM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		24	-34			-49		-59
New Line E	-186		-167	-178	-178	-190	-304	-269
KFC	21							-1
Albion Rd W		-124				1		
Albion Rd E		-194				-50		
New Line W	-119	-115	-129	1	-1			-40
Tenterfields	-103	-86				-51		0
Harrogate Rd N	-165	-153	-186			-101	-79	

5 Summary and Conclusions

5.1 Introduction

CBMDC is developing proposals for the A658 Harrogate Road/A657 New Line junction aimed at reducing congestion and facilitating development in the Greengates area. Fore have been commissioned to finalise an Aimsun base model that was initially developed by CBMDC and to test options for improving the junction. The validation of the 2014 base year model is presented in in the Fore report titled "A658 *Harrogate Road/A657 New Line Aimsun Model Validation Report*" and dated June 2014.

Three preferred options for the junction have been identified by the council as follows:

- Option 5 – "Crossroads"
- Option 8 – "Small P-Loop"; and
- Option 9 – "Large P-Loop".

The above options have been coded into the base model and the performance of each option has been reported.

5.2 Results and Conclusions

Network and origin-destination statistics have been outputted from the model to determine the relative performance of each of the options relative to the 2014 base year. The statistics show that Option 5 would provide the best overall improvements with journey time benefits for virtually all origin-destination pairs. Whilst Option 8 would provide journey time and capacity improvements relative to the 2014 base year, it would still operate over capacity for some of the peak periods with significant queuing on the A657 New Line (east) approach to the junction. Option 9 eliminates the queuing on the A657 New Line (east) approach and provides similar overall benefits to Option 5.

Appendix A

Origin-Destination Statistics

Origin Destination Matrices with Journey Times (seconds)

Base AM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		183	49			129		154
New Line E	262		230	297	272	294	324	342
KFC	38							115
Albion Rd W		280				19		
Albion Rd E		340				70		
New Line W	249	302	188	20	49			182
Tenterfields	235	287				248		75
Harrogate Rd N	336	389	349			343		

Base PM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		221	77			165		201
New Line E	349		296	368	360	380	477	471
KFC	38							117
Albion Rd W		317				19		
Albion Rd E		393				105		
New Line W	268	302	241	18	49			189
Tenterfields	245	298				261		81
Harrogate Rd N	306	371	298			321	160	

Option 5 AM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		162	37			110		127
New Line E	161		133	187	180	187	179	211
KFC	38							111
Albion Rd W		195				19		
Albion Rd E		203				52		
New Line W	136	193	103	20	48			150
Tenterfields	126	168				133		75
Harrogate Rd N	155	204	120			169		

Option 5 PM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		167	39			112		135
New Line E	159		122	187	177	184	187	224
KFC	42							120
Albion Rd W		196				19		
Albion Rd E		201				55		
New Line W	134	190	101	19	48			155
Tenterfields	134	173				136		81
Harrogate Rd N	149	197	111			164	79	

Option 8 AM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		276	54			148		185
New Line E	250		215	286	264	285	280	288
KFC	54							172
Albion Rd W		193				19		
Albion Rd E		197				52		
New Line W	134	189	111	21	47			145
Tenterfields	203	262				268		76
Harrogate Rd N	208	272	172			278		

Option 8 PM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		289	64			153		177
New Line E	250		209	271	263	278	261	267
KFC	61							136
Albion Rd W		201				19		
Albion Rd E		203				55		
New Line W	136	193	109	19	48			149
Tenterfields	230	298				293		84
Harrogate Rd N	212	288	185			281	79	

Option 9 AM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		199	45			117		153
New Line E	160		141	188	179	188	168	195
KFC	54							133
Albion Rd W		188				20		
Albion Rd E		194				54		
New Line W	137	184	124	22	48			144
Tenterfields	148	216				221		75
Harrogate Rd N	135	188	102			190		

Option 9 PM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		245	43			116		142
New Line E	163		129	189	181	191	172	202
KFC	59							116
Albion Rd W		193				20		
Albion Rd E		199				55		
New Line W	149	187	112	19	49			150
Tenterfields	142	212				209		81
Harrogate Rd N	141	217	112			219	81	

Origin Destination Matrices with Journey Time Differences (seconds)

Option 5 - Base AM Peak

	Harrogate Rd S	New Line E	KFC	Albion Rd W	Albion Rd E	New Line W	Tenterfields	Harrogate Rd N
Harrogate Rd S		-20	-11			-19		-27
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New Line W	-119	-115	-129	1	-1			-40
Tenterfields	-103	-86				-51		0
Harrogate Rd N	-165	-153	-186			-101	-79	

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