Memorandum

A30 Chiverton to Carland Cross

Subject:	**Junction Analysis**
To:	
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1 Introduction

1.1.1 The purpose of this Technical Note is to summarise the methodology, modelling approach (geometries) and output results with regards to several junctions on the A30 corridor. The existing junctions will experience significant changes in terms of type, layout and demand, following the implementation of the A30 project.

1.1.2 Four junctions have been assessed, presenting the Base 2015, Do-minimum 2023 and 2038 scenarios which represents the performance of the junctions assuming no changes to layout or additional capacity provision. The analysis also presents the same 2023 and 2038 design year results assuming the implementation of the junction proposals associated with the A30 Chiverton to Carland Cross scheme.

1.1.3 Carland Cross, Chybucca and Chiverton have all been assessed for both neutral month and summer month AM and PM peak hour flows. The summer month flows have been assessed at these junctions as there is a significant increase in traffic passing through these junctions in the summer. With this increase in traffic it is appropriate to assess these junctions with summer flows to gain an understanding as to their performance in these situations.

1.1.4 The junctions have been analysed in terms of queue, Ratio to Flow Capacity (RFC) and delay. The queue for each arm is measured in Passenger Car Unit (PCUs, each PCU is equivalent to 5.75m). RFC is the Ratio of Flow to Capacity for an approach with a maximum acceptable RFC being defined as 0.85. While an RFC of 0.85 is below capacity (RFC < 1.0) at this point the performance of the approach decreases, and becomes less efficient. The delay is the number of extra seconds a vehicle would expect to take through the junction when compared to the free flow situation.

2 Boxheater Priority Junctions – A30/B3285/Fiddlers Green

2.1 Overview

For the purpose of modelling Boxheater junction (Figure 1) in the Junctions 9 programme it was necessary to split this into two separate T-Junctions, Boxheater (West) (Figure 2), and Boxheater (East) (Figure 3) .

Figure 1 - Boxheater Junction

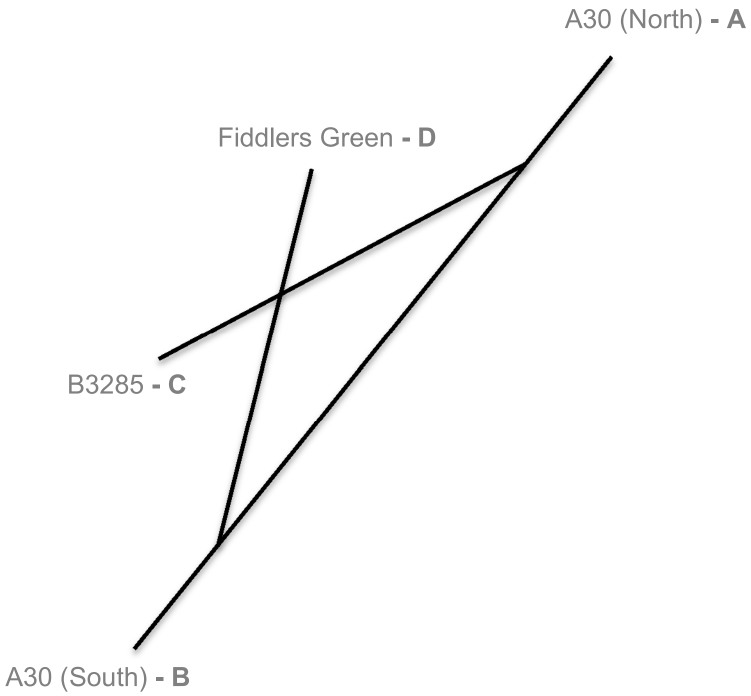


Figure 2 - Boxheater Junction (West)

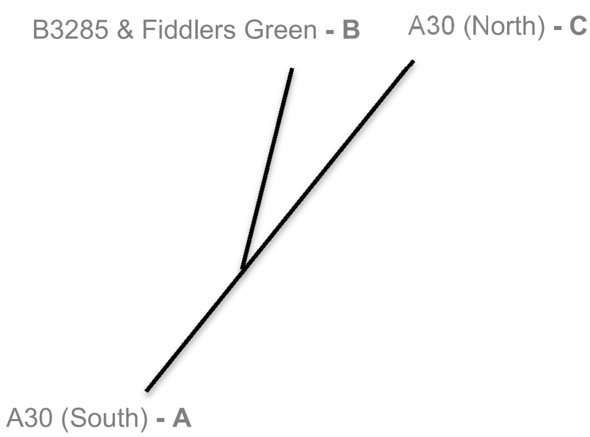
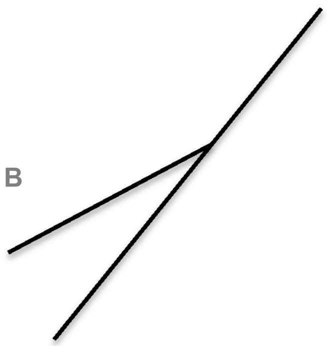


Figure 3 - Boxheater Junction (East)



2.1.1 With reference to Figure 1, the turning movements for the three-arm priority junction in Figure 2 were extracted as in Table 1.

Table 1 - Turning Movement Adjustment

	Arm A	Arm B	Arm C
Arm A	B - B	B - CD	B - A
Arm B	CD - B	CD - CD	CD - A
Arm C	A - B	A - CD	A - A

Since the arms are labelled in the same in Figure 3 as Boxheater (West) (Figure 2), the flows can be extracted in the same way.

2.2 Geometries

2.2.1 The geometries were extracted from an OS map which excluded road markings and therefore the modelling geometries had to be extrapolated from the mapping and aerial photographs.

2.2.2 In the case of the proposed Boxheater layout, the A30 proposals are remote from this junction and therefore no physical changes are planned. However due to the new alignment of the A30, all A30 traffic is reassigned away from these junctions, significantly reducing the mainline traffic demand. The impact from the reduced demands is evident from the output results.

2.3 Results

Table 2 - Boxheater Junction (West) Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	Base 2015					
Fiddlers Green – left turn	7	118.5	0.97	32	413.44	1.37
Fiddlers Green – right turn	3	275.67	0.84	3	623.78	1.22
A30 (N) right turn	0	0	0	0	0	0
	DM 2023					
Fiddlers Green – left turn	12	205.86	1.07	30	393.06	1.35
Fiddlers Green – right turn	4	355.57	0.96	3	605.84	1.2
A30 (N) right turn	0	0	0	0	0	0
	DM 2038					
Fiddlers Green – left turn	100	1666.67	n/a	72	1667.83	n/a
Fiddlers Green – right turn	11	1016.45	n/a	7	997.23	n/a
A30 (N) right turn	0	0	0	0	0	0
	DS 2023					
Fiddlers Green – left turn	0	6.49	0.2	1	7.29	0.3
Fiddlers Green – right turn	0	8.1	0.06	0	8.66	0.04
A30 (N) right turn	0	0	0	0	0	0
	DS 2038					
Fiddlers Green – left turn	1	7.97	0.33	1	8.65	0.41
Fiddlers Green – right turn	0	9.48	0.08	0	8.96	0.04
A30 (N) right turn	0	0	0	0	0	0

Table 3 - Boxheater Junction (East) Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	Base 2015					
B3285 – left turn	98	1701.24	n/a	119	1727.85	n/a
B3285 – right turn	19	1131.88	n/a	9	1303.15	n/a
A30 (N) right turn	2	25.42	0.65	3	40.31	0.76
	DM 2023					
B3285 – left turn	95	1704.1	n/a	120	1735.21	n/a
B3285 – right turn	18	1137.22	n/a	9	1323.06	n/a
A30 (N) right turn	2	27.2	0.66	3	43.91	0.79
	DM 2038					
B3285 – left turn	101	1781.29	n/a	130	3333.52	n/a
B3285 – right turn	11	1366.29	n/a	12	3449.94	n/a
A30 (N) right turn	1	25.64	0.56	4	62.97	0.79
	DS 2023					
B3285 – left turn	0	7.53	0.23	1	8.83	0.35
B3285 – right turn	0	0	0	0	0	0
A30 (N) right turn	0	7.01	0.26	0	7.03	0.26
	DS 2038					
B3285 – left turn	1	9.59	0.38	1	11.14	0.48
B3285 – right turn	0	0	0	0	8.19	0.05
A30 (N) right turn	1	7.84	0.3	0	7.14	0.28

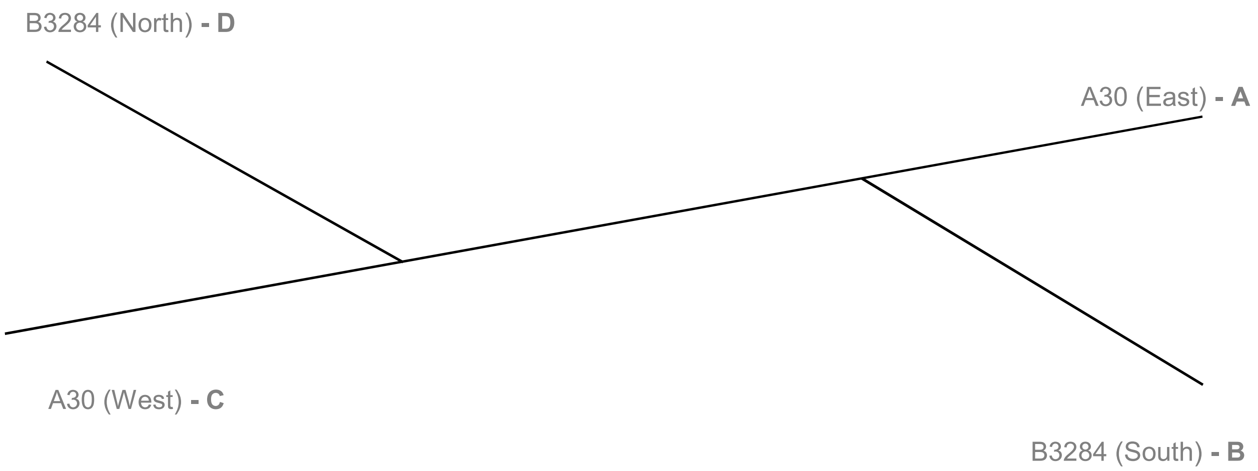
2.3.1 While no physical works are proposed for Boxheater, the removal of A30 demands results in significant improvements to the junction operation.

3 Chybucca Priority Junctions – A30/B3284

3.1 Overview

3.1.1 Similar to the Boxheater junction, this junction is formed of two priority junctions with the demand matrices supplied based on the arm referencing in Figure 4.

Figure 4 – Chybucca Junctions



3.1.2 Given the spacing between the priority junctions (≈350m) it was deemed appropriate to split the junctions for assessment as individual priority junctions, with the arm referencing amended as per Figure 5 and Figure 6.

Figure 5 – Chybucca Junction (West)

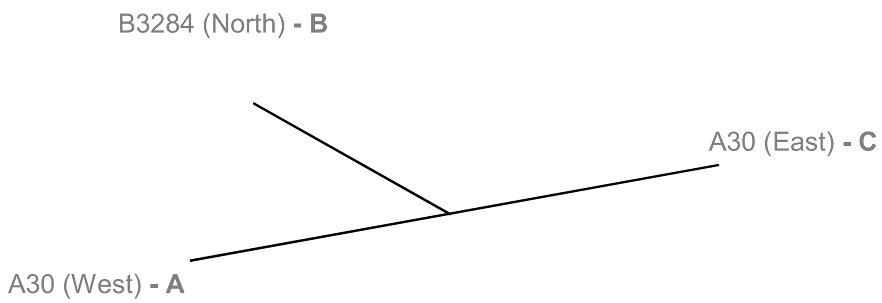
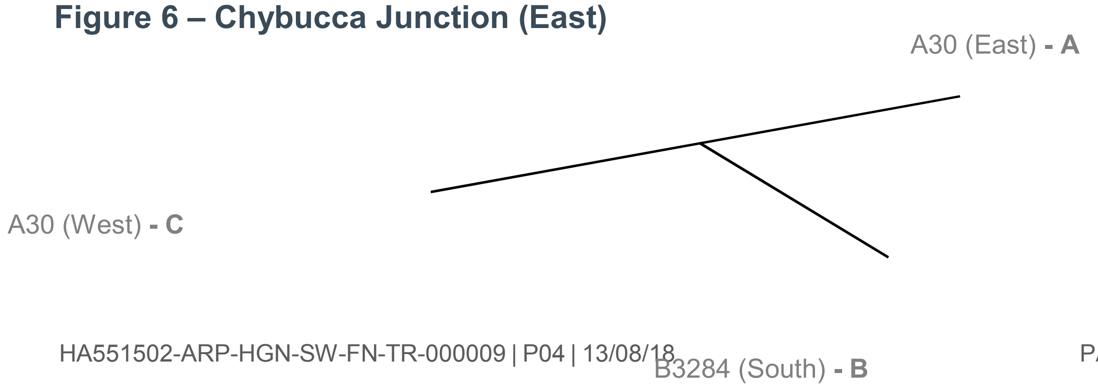


Figure 6 – Chybucca Junction (East)

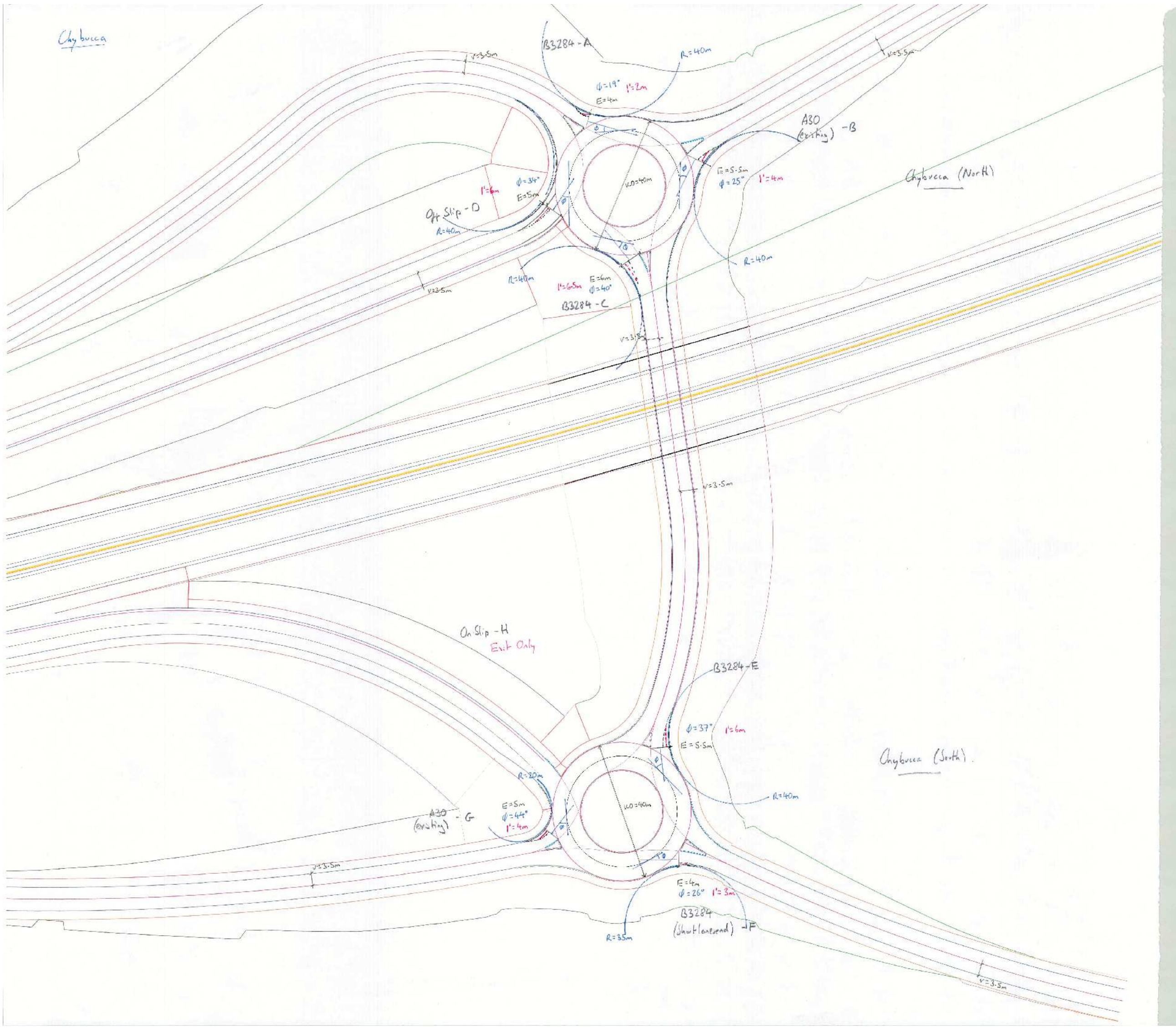


3.2 Geometries

3.2.1 Again, the geometries were extracted from the available mapping, which excluded road markings and therefore the modelling geometries had to be extrapolated from the mapping and aerial photographs.

3.2.2 The proposed layout replaces the existing priority junctions with a grade-separated dumb-bell roundabout layout. This can be seen in Figure 7.

Figure 7 – Chybucca Junction Proposed Layout



3.3 Results

Table 4 – Chybucca (West) Existing Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	Base 2015					
B3284 (N) – left turn	1	15.69	0.42	1	13.4	0.32
B3284 (N) – right turn	0	0	0	0	0	0
A30 (E) – right turn	1	14.77	0.33	2	37.61	0.55
	DM 2023					
B3284 (N) – left turn	1	16.02	0.35	1	15.48	0.33
B3284 (N) – right turn	0	0	0	0	0	0
A30 (E) – right turn	1	15.53	0.37	1	30.28	0.41
	DM 2038					
B3284 (N) – left turn	1	26.09	0.44	0	24.65	0.1
B3284 (N) – right turn	0	0	0	0	0	0
A30 (E) – right turn	1	19.59	0.42	1	20.99	0.3
	DM 2023 Summer					
B3284 (N) – left turn	2	37.95	0.64	185	1831.29	2.18
B3284 (N) – right turn	0	0	0	0	0	0
A30 (E) – right turn	383	3060.96	2.44	16	175.95	1.03
	DM 2038 Summer					
B3284 (N) – left turn	2	61.36	0.71	1	26.91	0.33
B3284 (N) – right turn	0	0	0	0	0	0
A30 (E) – right turn	447	4029.47	3.13	2	50.43	0.71

Table 5 – Chybucca (East) Existing Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	Base 2015					
B3284 (S) – left turn	1	12.85	0.42	5	42.16	0.83
B3284 (S) – right turn	0	0	0	0	0	0
A30 (W) – right turn	20	163.6	1.04	12	106.7	0.98
	DM 2023					
B3284 (S) – left turn	1	18.21	0.57	9	88.25	0.96
B3284 (S) – right turn	0	0	0	1	434.53	0.78
A30 (W) – right turn	15	136.7	1	4	43.58	0.81
	DM 2038					
B3284 (S) – left turn	5	73.5	0.87	136	1678.1	n/a
B3284 (S) – right turn	0	0	0	7	1190.46	n/a
A30 (W) – right turn	11	119.4	0.96	3	43.05	0.77
	DM 2023 Summer					
B3284 (S) – left turn	371	2837.6	2.58	521	59999940	n/a
B3284 (S) – right turn	0	0	0	11	59999940	n/a
A30 (W) – right turn	5	60.57	0.86	289	2157.31	2
	DM 2038 Summer					
B3284 (S) – left turn	403	2731.22	2.82	178	1977.64	n/a
B3284 (S) – right turn	0	0	0	9	2198.78	n/a
A30 (W) – right turn	4	57.51	0.83	4	62.41	0.82

Table 6 – Chybucca (North) Proposed Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	DS 2023					
B3284 (N)	0	6.32	0.27	0	4.89	0.15
New Minor Arm	0	4.82	0.04	0	4.49	0.1
B3284 (S)	0	3.07	0.09	0	3.32	0.18
A30 off-slip	1	3.6	0.43	1	3.18	0.36
	DS 2038					
B3284 (N)	0	6.84	0.3	0	4.74	0.09
New Minor Arm	0	5.47	0.14	0	4.68	0.16
B3284 (S)	0	3.12	0.09	0	3.17	0.19
A30 off-slip	1	3.75	0.45	1	3.29	0.38
	DS 2023 Summer					
B3284 (N)	0	4.44	0.16	0	4.99	0.22
New Minor Arm	0	4.18	0.03	0	3.89	0.1
B3284 (S)	1	5.72	0.47	1	4.96	0.48
A30 off-slip	1	3.69	0.34	1	3.9	0.38
	DS 2038 Summer					
B3284 (N)	0	4.57	0.18	0	4.44	0.12
New Minor Arm	0	4.37	0.11	0	4.04	0.17
B3284 (S)	1	5.91	0.48	1	5.11	0.5
A30 off-slip	1	3.77	0.35	1	3.91	0.37

Table 7 – Chybucca (South) Proposed Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	DS 2023					
B3284 (N)	3	10.33	0.73	1	4.82	0.44
New Minor Arm (S)	1	3.99	0.31	2	7.01	0.61
New Minor Arm (W)	0	3.46	0.01	0	4.41	0.02
	DS 2038					
B3284 (N)	5	15.56	0.82	1	5.58	0.51
New Minor Arm (S)	1	4.37	0.35	2	7.59	0.63
New Minor Arm (W)	0	3.45	0.01	0	4.42	0.03
	DS 2023 Summer					
B3284 (N)	1	5.43	0.51	0	2.87	0.05
New Minor Arm (S)	0	3.68	0.25	1	4.98	0.46
New Minor Arm (W)	0	0	0	0	3.85	0.01
	DS 2038 Summer					
B3284 (N)	2	6.56	0.59	0	3.01	0.1
New Minor Arm (S)	0	3.96	0.28	1	5.29	0.47
New Minor Arm (W)	0	0	0	0	3.88	0.02

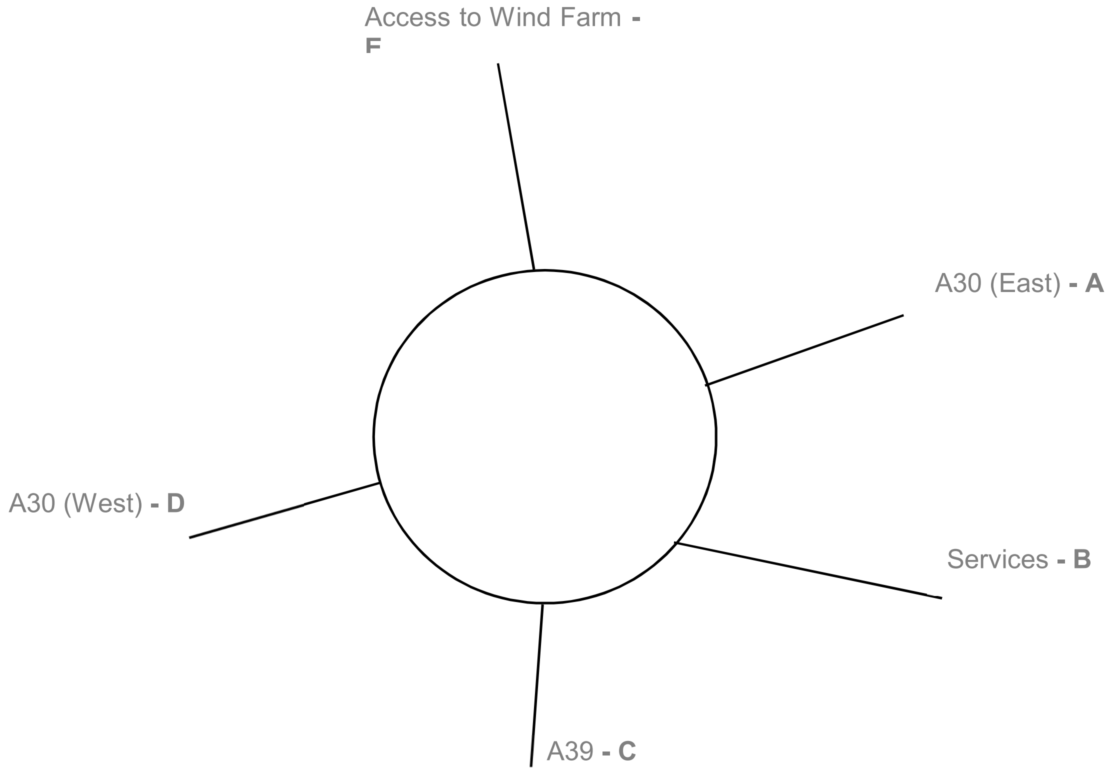
3.3.1 As illustrated within the summary results within Table 6 and Table 7, the proposed layout operates below practical capacity in both the 2023 and 2038 design years both in neutral and summer months.

4 Carland Cross Roundabout – A30/A39

4.1 Overview

4.1.1 The rough layout of the Carland Cross Roundabout is shown in Figure 8.

Figure 8 – Carland Cross Roundabout



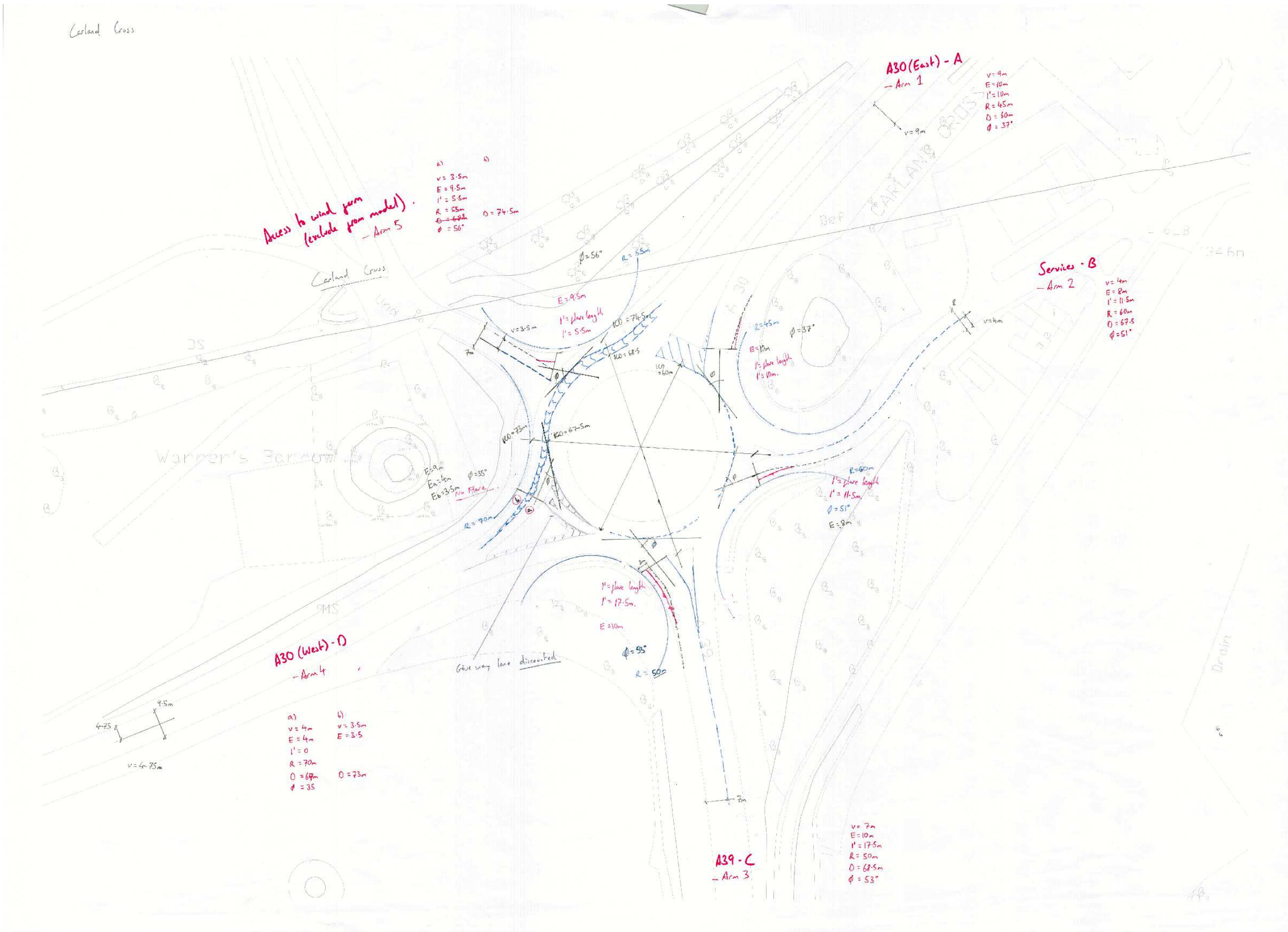
4.2 Geometries

4.2.1 Due to the segregated lane marking on approach Arm D – A30 (West), two models were created to assess the capacity of this arm. Model (a) was used to assess the right-hand lane based on the lane geometries and only assigning the traffic which would utilise this lane. Traffic in this lane can go straight to the A30 (East) and right to Services or the A39.

4.2.2 Model b) was used to assess the left-hand lane (the arm only had two lanes) using the same method as a). Traffic in this lane can go only straight on to the A30 (East). Even though most of the traffic travelling straight would use the priority lane (b), there is no distinction in the traffic flow data received so straight-ahead traffic was split 50/50 between (a) and (b). It should be noted that traffic accessing the wind farm was excluded from the model as it was deemed to be negligible.

4.2.3 The proposed grade separated layout at Carland Cross is a pair of new dumbbell roundabouts which are assessed individually under the Do-Something Proposed scenarios. This can be seen in Figure 9.

Figure 9 – Carland Cross Junction Proposed Layout



4.3 Results

Table 8 – Carland Cross (a) Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	Base 2015					
A30 (E)	5	7.7	0.82	3	5.43	0.73
Services	0	8.58	0.17	0	6.77	0.15
A39	1	4.17	0.41	1	5.8	0.58
A30 (W)	3	15.83	0.73	8	42.4	0.9
Wind Farm Access	0	0	0	0	0	0
	DM 2023					
A30 (E)	10	13.93	0.9	5	7.76	0.82
Services	0	12.97	0.28	0	8.82	0.2
A39	1	4.95	0.48	1	5.62	0.53
A30 (W)	5	26.63	0.84	21	88.78	1
Wind Farm Access	0	0	0	0	0	0
	DM 2038					
A30 (E)	32	40.5	0.99	16	21.64	0.94
Services	1	21.69	0.4	1	15.91	0.32
A39	1	5.35	0.49	1	5.59	0.46
A30 (W)	19	77.5	0.98	27	99.42	1.02
Wind Farm Access	0	0	0	0	0	0
	DM 2023 Summer					
A30 (E)	17	23.63	0.95	12	17.36	0.93
Services	1	15.53	0.32	0	13.53	0.24
A39	1	6.27	0.55	1	6.18	0.53
A30 (W)	63	212.88	1.12	107	370.91	1.21
Wind Farm Access	0	0	0	0	0	0
	DM 2038 Summer					
A30 (E)	70	77.88	1.03	121	121.58	1.07
Services	1	24.27	0.43	1	23.36	0.37
A39	1	6.38	0.56	1	5.63	0.44
A30 (W)	157	591.78	1.31	147	514.06	1.27
Wind Farm Access	0	0	0	0	0	0

Table 9 – Carland Cross (b) Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	Base 2015					
A30 (E)	5	6.93	0.8	3	4.91	0.71
Services	0	8.25	0.16	0	6.4	0.14
A39	1	4.17	0.41	1	5.8	0.58
A30 (W)	2	12.45	0.65	4	21.24	0.77
Wind Farm Access	0	0	0	0	0	0
	DM 2023					
A30 (E)	8	11.67	0.88	4	6.85	0.8
Services	0	12.32	0.27	0	8.32	0.19
A39	1	4.95	0.48	1	5.62	0.53
A30 (W)	3	18.25	0.76	8	37.94	0.89
Wind Farm Access	0	0	0	0	0	0
	DM 2038					
A30 (E)	24	31.08	0.97	14	18.92	0.93
Services	1	21.25	0.39	1	15.99	0.32
A39	1	5.4	0.5	1	5.6	0.46
A30 (W)	9	42.75	0.91	17	67.08	0.97
Wind Farm Access	0	0	0	0	0	0
	DM 2023 Summer					
A30 (E)	13	17.78	0.92	10	13.7	0.91
Services	0	14.87	0.31	0	12.64	0.23
A39	1	6.23	0.55	1	6.19	0.53
A30 (W)	24	96.02	1.01	56	185.18	1.1
Wind Farm Access	0	0	0	0	0	0
	DM 2038 Summer					
A30 (E)	51	59.73	1.01	107	107.35	1.06
Services	1	26.46	0.46	1	25.96	0.4
A39	1	6.58	0.57	1	5.75	0.45
A30 (W)	103	364.72	1.21	117	392.24	1.21
Wind Farm Access	0	0	0	0	0	0

Table 10 – Carland Cross (North) Proposed Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	DS 2023					
A30 (W) off-slip	0	2.38	0.05	0	2.38	0.05
New Overbridge	1	4.09	0.43	3	7.76	0.7
New Minor Arm (W)	0	4.45	0.27	1	5.79	0.3
	DS 2038					
A30 (W) off-slip	0	2.7	0.12	0	2.46	0.07
New Overbridge	1	4.51	0.49	4	11.39	0.8
New Minor Arm (W)	1	5.84	0.44	1	7.18	0.4
	DS 2023 Summer					
A30 (W) off-slip	0	2.4	0.05	0	2.4	0.05
New Overbridge	1	4.01	0.43	2	5.84	0.61
New Minor Arm (W)	1	5.11	0.34	1	5.82	0.35
	DS 2038 Summer					
A30 (W) off-slip	0	2.75	0.12	0	2.48	0.08
New Overbridge	1	4.47	0.49	2	7.51	0.69
New Minor Arm (W)	1	7.62	0.56	1	7.45	0.47

Table 11 – Carland Cross (South) Proposed Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	DS 2023					
New Overbridge	0	2.94	0.11	0	2.94	0.11
A30 (E) off-slip	1	3.38	0.41	1	3.25	0.39
Service Access	0	3.1	0.09	0	3.01	0.08
A39	0	1.96	0.18	1	2.56	0.38
	DS 2038					
New Overbridge	0	3.67	0.29	0	3.08	0.15
A30 (E) off-slip	1	4.32	0.5	1	3.6	0.44
Service Access	0	3.63	0.11	0	3.21	0.09
A39	0	2.08	0.22	1	3.14	0.47
	DS 2023 Summer					
New Overbridge	0	3.04	0.14	0	2.95	0.12
A30 (E) off-slip	1	3.63	0.43	1	3.35	0.43
Service Access	0	3.08	0.08	0	3.06	0.07
A39	0	1.92	0.21	1	2.36	0.33
	DS 2038 Summer					
New Overbridge	0	3.74	0.3	0	3.09	0.16
A30 (E) off-slip	1	4.57	0.51	1	3.76	0.49
Service Access	0	3.57	0.1	0	3.28	0.08
A39	0	2.06	0.25	1	2.76	0.41

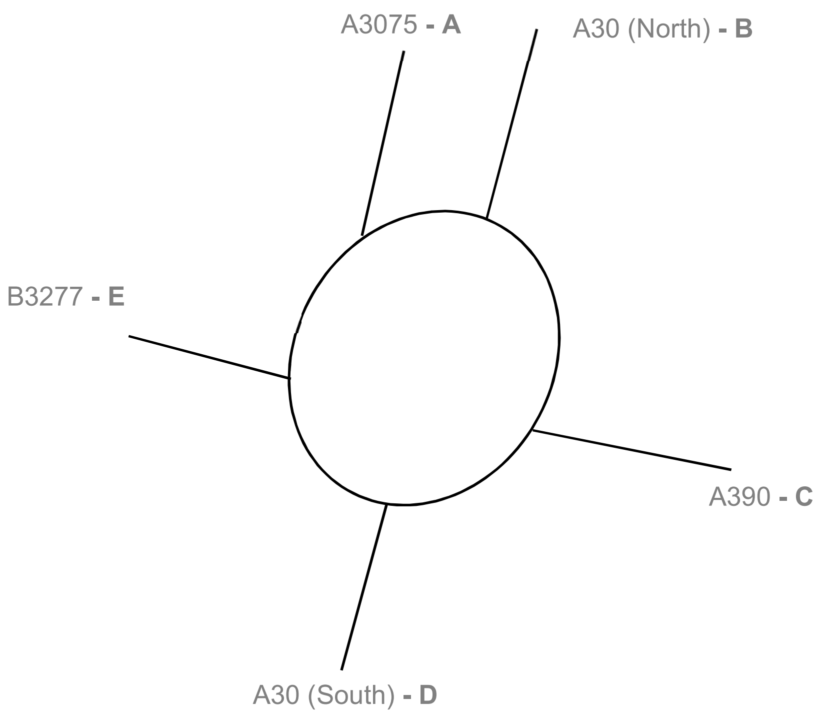
4.3.1 The proposed layout is shown to faciliate future year demands, with all approach arms operating below practical capacity and minimal queuing evident in both summer and neutral months.

5 Chiverton Roundabout – A30/A390/B3277

5.1 Overview

5.1.1 The rough layout of the Chiverton Roundabout is shown in Figure 10.

Figure 10 – Chiverton Roundabout



5.2 Geometries

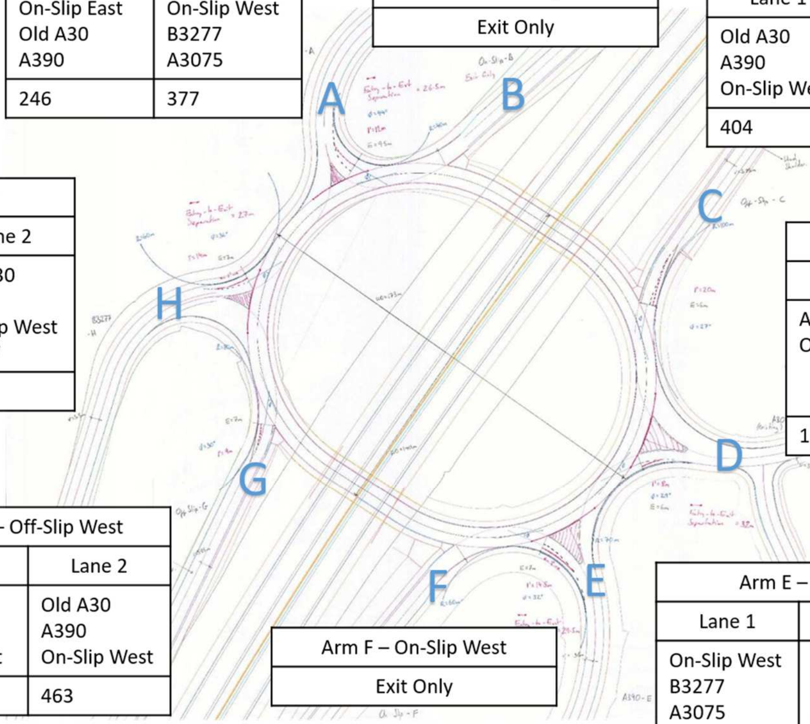
5.2.1 The geometries were extracted from the available mapping, which excluded road markings and therefore the modelling geometries had to be extrapolated from the mapping and aerial photographs.

5.2.2 Similar to Carland Cross, a number of the approach arms to Chiverton include segregated movements, with hatching between lanes. To assess this type of layout within Junctions 9, a lane simulation module within Junctions 9 was used, using geometries and demands attributable to each lane. Because this module was used, Junctions 9 cannot calculate the RFC for each arm and as such, the RFC columns are left blank for all scenarios using the module.

5.2.3 The proposed layout replaces the existing at-grade roundabout with a grade-separated all movement roundabout. It is shown in Figure 11.

5.2.4 This junction was modelled assuming a neutral month and assuming a summer month.

Figure 11 – Proposed Chiverton Roundabout Layout



Arm A – A3075	
Lane 1	Lane 2
On-Slip East Old A30 A390	On-Slip West B3277 A3075
246	377

Arm B – On-Slip East
Exit Only

Arm C – Off-Slip East	
Lane 1	Lane 2
Old A30 A390 On-Slip West	B3277 A3075 On-Slip East
404	166

Arm H – B3277	
Lane 1	Lane 2
A3075 On-Slip East	Old A30 A390 On-Slip West B3277
379	166

Arm D – Old A30	
Lane 1	Lane 2
A390 On-Slip West	B3277 A3075 On-Slip East Old A30
15	6

Arm G – Off-Slip West	
Lane 1	Lane 2
B3277 A3075 On-Slip East	Old A30 A390 On-Slip West
144	463

Arm F – On-Slip West
Exit Only

Arm E – A390	
Lane 1	Lane 2
On-Slip West B3277 A3075	On-Slip East Old A30 A390
357	288

5.3 Results

Table 12 – Chiverton Cross Existing Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	Base 2015					
1 - A3075	5	21.81		3	14.32	
2 - A30 (North)	6	15.11		6	12.59	
3 - A390	2	10.83		33	114.83	
4 - A30 (South)	7	10.96		13	22.09	
5 - B3277	3	15.3		3	17.48	
	DM 2023 Neutral					
1 - A3075	18	78.84		5	29.26	
2 - A30 (North)	46	94.14		11	23.87	
3 - A390	2	12.86		65	212.49	
4 - A30 (South)	19	27.03		64	91.61	
5 - B3277	6	29.02		4	22.5	
	DM 2038 Neutral					
1 - A3075	91	454.2		36	131.14	
2 - A30 (North)	98	210.33		55	85.43	
3 - A390	7	27.9		110	459.51	
4 - A30 (South)	112	128.5		154	234.55	
5 - B3277	22	95.98		15	59.13	
	DM 2023 Summer					
1 - A3075	108	581.86		365	1355	
2 - A30 (North)	62	124.37		59	109.79	
3 - A390	4	20.67		63	281.04	
4 - A30 (South)	184	231.43		143	196.41	
5 - B3277	10	43.47		13	58.85	
	DM 2038 Summer					
1 - A3075	133	645.06		794	2057.88	
2 - A30 (North)	126	291.36		139	262.48	
3 - A390	38	134.94		888	2366.28	
4 - A30 (South)	441	629.35		158	213.7	
5 - B3277	27	111.44		63	271.73	

Table 13 – Chiverton Cross Proposed Junction Performance

	AM			PM		
	Queue (PCU)	Delay (s)	RFC	Queue (PCU)	Delay (s)	RFC
	DS 2023					
A - A3075	4	19.73		3	18.27	
C- Off-Slip East	2	11.43		1	5.51	
D - Old A30	0	10.17		2	16.77	
E - A390	1	6.14		7	20.15	
G - Off-Slip West	2	7.25		1	6.92	
H - B3277	2	10.09		2	10.27	
	DS 2038					
A - A3075	28	111.33		30	123.91	
C- Off-Slip East	7	29.89		1	6.58	
D - Old A30	0	15.27		3	23.1	
E - A390	2	8.25		6	18.78	
G - Off-Slip West	2	9.32		3	10.54	
H - B3277	5	19.26		8	33.06	
	DS 2023 Summer					
A - A3075	5	21.96		206	789.46	
C- Off-Slip East	2	13.69		1	8.39	
D - Old A30	0	8.86		0	8.31	
E - A390	1	5.61		8	22.79	
G - Off-Slip West	2	7.15		2	8.66	
H - B3277	2	11.9		2	11.53	
	DS 2038 Summer					
A - A3075	57	209.69		607	1683.8	
C- Off-Slip East	8	31.46		2	10.5	
D - Old A30	0	24.11		0	10.4	
E - A390	3	9.16		9	20.75	
G - Off-Slip West	6	23.48		6	20.7	
H - B3277	10	39.85		17	70.1	

5.3.1 The existing roundabout is shown to exceed capacity during future Do-Min scenarios, with excessive queues and high delay. Table 13 presents the future year Do Something results with the proposed new grade-separated roundabout.

5.3.2 Overall the Chiverton proposals are shown to provide adequate capacity for both 2023 and 2038 demands, although in the summer Do Something scenario's arms A (A3075) and H (B3277) have excessive delays.

5.3.3 A signal controlled option of the same layout has been shown to reduce queuing and delays during the summer months, and balance these more evenly across all arms of the junction, although is still significant on some arms.

5.3.4 It is recommended that future provision for part-time traffic signals to be included in the design, such as ducts and chambers for the signal equipment, so that traffic signals can be installed in the future with minimum disruption if found to be required in the summer months. The junction modelling will need to be updated once the more detailed layout has been developed.

5.3.5 Further widening of the roundabout to fully cater for the peaks in summer traffic is not recommended, as this would lead to layout which over-caters for demand for the rest of the year, which is likely to increase vehicle speeds, lead to driver confusion, and increase the likelihood of collisions.

Arup Approvals

Version	Role	Name	Signature	Date
P04	Author	Hayden Manuell	<SIGNATURE>	13/08/2018
	Checker	James Eastham	<SIGNATURE>	13/08/2018
	Approver	Tom Metcalfe	<SIGNATURE>	13/08/2018
	Authoriser	Simon Westwood	<SIGNATURE>	13/08/2018

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Memorandum

A30 Chiverton to Carland Cross

Subject:	**Response to CC comments on operational modelling of Carland Cross**
To:	
Document Reference:	**HA551502-ARP-HGN-SW-FN-TR-000011**
Revision:	**P02**
Suitability (status):	**S3**
Date:	28 November 2018
Copies:	
From:	

1 Introduction

1.1.1 As part of the collaborative approach to the A30 Chiverton to Carland Cross, there have been ongoing discussions with Cornwall Council (CC) in relation to the impact that the scheme will have on the local roads. As part of this the Combined Modelling and Appraisal (ComMA) report and a technical note outlining the Operational Assessment of key junctions on the scheme were issued to CC for their information.

1.1.2 Following a review of these documents by CC have raised a query regarding the queue reported in the Operational Assessment technical note for the A39 approach at Carland Cross as this is low in comparison to the queue acknowledged to occur at this junction.

1.1.3 This technical note sets out our response to this query. In addressing this query we have considered the calibration/validation of the SATURN strategic model specifically at the Carland Cross junction and the Junctions 9 modelling.

2 Junction Model Within SATURN

2.1 Carland Cross Junction Turning Counts

2.1.1 As part of the A30 2015 base year model calibration and validation the modelled turning counts at Carland Cross have been compared to the observed turning counts. As with link counts, the fit between the observed and modelled flows are assessed via either GEH or the modelled flows being within five percent of the modelled flows as per WebTAG guidance.

2.1.2 Table 1, Table 2 and Table 3 show whether the individual turning movements at Carland Cross pass both the GEH and percentage difference criteria for all three time periods, even though it is only necessary to pass one or the other.

Table 1: AM Peak validation results (flow difference and GEH combined pass)

All Vehicles		To Arm				
		A	B	C	D	Total
From Arm	A	PASS	PASS	PASS	PASS	100%
	B	PASS	PASS	PASS	PASS	100%
	C	PASS	PASS	PASS	PASS	100%
	D	PASS	PASS	PASS	PASS	100%
	Total	100%	100%	100%	100%	100%

Table 2: Inter peak validation results (flow difference and GEH combined pass)

All Vehicles		To Arm				
		A	B	C	D	Total
From Arm	A	PASS	FAIL	PASS	FAIL	50%
	B	FAIL	PASS	PASS	PASS	75%
	C	PASS	PASS	PASS	PASS	100%
	D	PASS	FAIL	PASS	PASS	75%
	Total	75%	50%	100%	75%	75%

Table 3: PM peak validation results (flow difference and GEH combined pass)

All Vehicles		To Arm				
		A	B	C	D	Total
From Arm	A	PASS	PASS	PASS	FAIL	75%
	B	PASS	PASS	PASS	PASS	100%
	C	FAIL	PASS	PASS	FAIL	50%
	D	PASS	PASS	PASS	PASS	100%
	Total	75%	100%	100%	50%	81%

2.1.3 As can be seen from the tables above, the AM peak passes for GEH and percentage change in comparison to the observed traffic flows. For the inter and PM peak period the results show that not all of the movements pass both GEH and percentage difference. But, in order to meet the criteria they must pass one or the other of the requirements and when this is considered the junction passes in all three time periods.

2.1.4 The WSP model developed for PCF Stage 2 shows similar traffic flows as per the Arup updated PCF Stage 3 model.

2.2 A39 Journey Time Data

2.2.1 Journey Time data for the A39 collected in 2015 was provided by Cornwall Council between Carland Cross and the junction between the A39 and A390 at Union Hill.

The results from the modelling show that the northbound journey times meet the WebTAG validation criteria, in particular the section between Trispen and Carland Cross, these can be seen in Table 4.

Table 4: Journey times for A39 Northbound

Journey Time Section	AM Peak	Inter Peak	PM Peak
A39 Northbound (Between Until Hill Junction and Bodmin Road Rdbt)	Yes	Yes	Yes
A39 Northbound (Between Bodmin Road Rdbt and St Erme)	Yes	Yes	Yes
A39 Northbound Between St Erme and Trispen)	Yes	Yes	Yes
A39 Northbound (Between Trispen and Carland Cross Rdbt)	Yes	Yes	Yes

2.2.2 A comparison between the PCF Stage 2 and Stage 3 journey times shows that for the AM peak the Stage 3 journey time is slightly longer than Stage 2, the Inter peak journey time is longer in the Stage 3 model and that the PM peak Stage 3 journey time is significantly longer than Stage 2. Overall, the Stage 3 journey times are longer than the Stage 2 journey times.

2.2.3 A comparison of the observed journey times with journey times from Google show that the observed times are overall in correlation with the Google times.

2.2.4 The PCF Stage 3 SATURN model meets the required calibration and validation criteria for junction counts and journey times. The comparison of the observed data and modelled data shows the SATURN model is a true reflection of the base year network performance.

2.3 SATURN Model Junction Results

2.3.1 Table 5 shows the average queue length (in PCUs) from the PCF Stage 2 and PCF Stage 3 SATURN model for Carland Cross for comparison, these are for the 2015 Base year.

Table 5: SATURN model results for Carland Cross (average queue)

Arm	AM		PM	
	WSP Stage 2	Arup Stage 3	WSP Stage 2	Arup Stage 3
2015				
A30 (east)	0	0	0	0
Services	15	19	0	2
A39	0	1	1	19
A30 (West)	0	0	0	0
2022/2023				
A30 (east)	0	1		0
Services	25	5		1
A39	1	6		34
A30 (West)	0	0		0
2037/2038				
A30 (east)	1	52	0	1
Services	38	13	13	11
A39	6	29	4	68
A30 (West)	0	0	0	0

2.3.2 As can be seen from Table 5, the changes to the Stage 3 model have resulted in differences in queues on the arms of Carland Cross. The PCF Stage 3 model is showing significant queuing on the A39 arm, especially in the PM peak.

3 Do Minimum Operational Assessment

3.1 Traffic Flows

3.1.1 Figure 1 shows the arm labels for Carland Cross and Table 6 and Table 7 show the forecast traffic flows at Carland Cross for 2023 and 2038 do minimum scenarios.

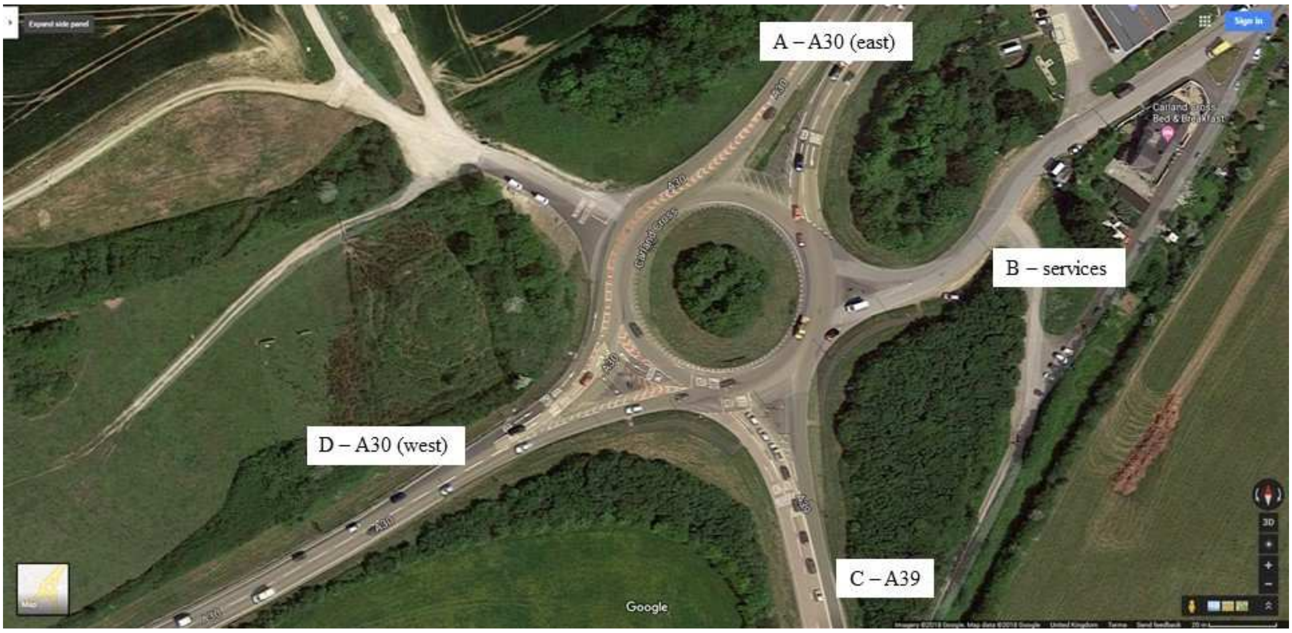

Figure 1: Carland Cross junction

Table 6: Do minimum 2023 traffic flows for Carland Cross

	AM Peak				
	A	B	C	D	Total
A	0	27	821	1,542	2,390
B	32	0	38	27	97
C	596	14	0	23	633
D	1,261	42	27	0	1,330
Total	1,889	83	886	1,592	4,450
	PM Peak				
	A	B	C	D	Total
A	0	35	612	1,493	2,140
B	27	0	8	56	91
C	693	14	0	0	707
D	1,413	40	45	0	1,498
Total	2,133	89	665	1,549	4,436

Table 7: Do minimum 2038 traffic flows for Carland Cross

	AM Peak				
	A	B	C	D	Total
A	0	28	871	1,704	2,603
B	35	0	35	30	99
C	588	12	0	0	600
D	1,526	42	19	0	1,587
Total					
	PM Peak				
	A	B	C	D	Total
A	0	38	728	1,740	2,506
B	38	0	7	52	97
C	531	7	0	0	538
D	1,677	39	0	0	1,716
Total	2,246	84	735	1,792	4,857

3.2 Lane Markings

3.2.1 On the A30 east arm the nearside lane is for the services and the A39 and the offside lane is the A30 (west) i.e. for the 2023 AM peak there will be 848 vehicles in the nearside lane and 1,542 in the offside lane.

3.2.2 On the A39 arm the nearside is for the A30 (west) and the offside lane is for the A30 (east) and the services i.e. in 2023 AM peak there will be 23 vehicles in the nearside lane and 610 in the offside lane.

3.3 Operational Modelling Results – PCF Stage 2 and Stage 3

3.3.1 A comparison of the PCF Stage 2 and PCF Stage 3 queues from the operational assessment for Carland Cross is shown in Table 8, for the 2023 and 2038 forecast years.

Table 8: Carland Cross operational modelling queue lengths for PCF Stage 2 and 3

Arm	AM		PM	
	Stage 2	Stage 3	Stage 2	Stage 3
2022/2023				
A30 (east)	280.08	9.7	169.58	5.0
Services	0.14	0.4	0.10	0.2
A39	4.80	1.0	46.32	1.2
A30 (West)	0.18	5.4	0.16	21.3
2037/2038				
A30 (east)	609.47	31.5	420.15	15.6
Services	0.14	0.6	0.10	0.5
A39	22.06	1.0	93.86	0.9
A30 (West)	0.28	19.0	0.18	27.2

3.3.2 The Table above sets out the queue length results from the operational assessment for PCF Stage 2 and Stage 3 for Carland Cross in the do minimum scenario (without the A30 Chiverton to Carland Cross scheme).

3.3.3 The data shows there are significant differences between the queues on the A39 between the PCF Stage 2 and Stage 3 models. The differences between the PCF Stage 2 and 3 assessments are due in part to the approach taken to model Carland Cross. Different approaches have been taken due to the unbalanced lane flows that occur on key arms of Carland Cross.

3.3.4 Carland Cross requires an alternative approach in order to account for the unbalanced lane usage that occurs on certain arms. This unbalanced lane usage occurs as a result of the traffic flows and lane markings.

3.3.5 The Stage 2 WSP approach was to model all arms as single lanes only with an adjustment to the capacity to compensate for the use of the removed lane. This is an effective way of accounting for the unbalance lane usage, but it will overestimate the queues and delays on each arm as it does not completely account for the capacity of the removed lane.

3.3.6 The PCF Stage 3 Arup approach was to model the junction in accordance with established practice of using Junctions 9 to model the junction as it is on the ground. The issue with this approach is that Junctions 9 assumes traffic flows are balanced across all the lanes, which on some arms at Carland Cross is not the case. This is the traditional approach for modelling roundabouts but does not accurately model situations where traffic flows are not balanced across multiple approach lanes. In these situations, Junctions 9 underestimates the queues and delays on each arm as the capacity in the model is greater than in reality.

3.3.7 The difference in approach can be seen in Table 8 where queues from the PCF Stage 3 models are significantly lower than those from PCF Stage 2. This is an issue with regards to the A39 arm as it is known that there are significant queues on this arm as a result of heavy traffic on the A30 travelling westbound creating capacity issues at the junction.

3.3.8 To address this issue an alternative methodology for modelling this junction has been applied in order to provide more robust and accurate results for this junction. Within the latest version of Junctions 9.5.0.6896 there is the opportunity to use a simulation mode that allows the user to model movements from individual lanes and thus deal with the issue of unequal lane usage.

3.4 Alternative Methodology Results

3.4.1 The Carland Cross model was updated to use the lane simulation mode to assess the junction. The results for this can be seen in Table 9

Table 9:Carland Cross alternative methodology results

Arm	AM		PM	
	Queue (PCUs)	Delay (secs)	Queue (PCUs)	Delay (secs)
2015				
A30 (east)	67.8	89.03	55.6	87.70
Services	0.2	8.15	0.2	6.29
A39	3.5	19.55	52.9	193.73
A30 (West)	3.2	16.59	7.4	34.03
2023				
A30 (east)	132.4	197.35	118.6	185.28
Services	0.3	9.11	0.2	7.20
A39	5.7	28.02	17.5	78.04
A30 (West)	5.64	28.57	22.7	90.27
2038				
A30 (east)	265.5	409.68	297.3	480.65
Services	0.4	10.82	0.4	8.68
A39	5.4	29.51	3.5	21.54
A30 (West)	23.6	82.71	30.9	104.00

3.4.2 Table 9 shows that utilising the lane simulation model results in queues on the A39 in 2015 that are closer to those observed and with delays that are close to those recorded from the journey time surveys and from Google directions.

4 Do Something Operational Assessment

4.1.1 Within the operational assessment note, the do something designs were assessed using the original traditional approach with traffic flows balanced across lanes. This showed that the junctions worked in the Do Something scenario and the results can be seen in the Operational Assessment Technical Note (HA551502-ARP-HGN-SW-FN-TR-000009). But, with having utilised the lane simulation methodology for the do minimum scenarios a sensitivity test was undertaken using this approach to ensure the new junctions worked in the do something scenario. These results can be seen in Table 10 and Table 11.

Table 10: Carland Cross 2023 do something operational results (lane simulation)

Arm	AM		PM	
	Queue (PCUs)	Delay (secs)	Queue (PCUs)	Delay (secs)
North Roundabout				
A30 on/off slip	0.1	2.47	0.0	2.46
Link Road	2.0	8.51	5.0	14.10
A30 (existing)	1.3	10.82	1.4	15.21
South Roundabout				
Link Road	0.3	6.20	0.2	6.10
A30 off slip	2.0	8.92	2.1	7.98
Services	0.2	6.47	0.1	6.37
A39	0.7	5.14	3.5	13.4

Table 11: Carland Cross 2038 do something operational results (lane simulation)

Arm	AM		PM	
	Queue (PCUs)	Delay (secs)	Queue (PCUs)	Delay (secs)
North Roundabout				
A30 on/off slip	0.2	2.68	0.1	2.46
Link Road	2.2	9.7	12.5	29.63
A30 (existing)	2.2	14.13	2.3	21.47
South Roundabout				
Link Road	1.3	10.55	0.4	6.52
A30 off slip	4.1	13.4	2.8	9.24
Services	0.3	7.36	0.3	6.48
A39	1.0	5.44	8.0	24.03

4.1.2 Table 10 and Table 11 show that for the do something scenarios the north and south roundabouts work when assessed using the lane simulation approach.

5 Summary

5.1.1 This Technical Note sets out our response to a query from Cornwall Council in relation to queuing on the A39 arm of Carland Cross in the operational assessment.

5.1.2 A review of the calibration and validation of the SATURN model at Carland Cross was undertaken. This review showed that overall the SATURN model calibrated and validated at this junction.

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Memorandum

A30 Chiverton to Carland Cross

Subject:	**A39 at Carland Cross junction**
To:	
Document Reference:	**HA551502-ARP-HGN-SW-FN-TR-000012**
Revision:	**P02**
Suitability (status):	**S3**
Date:	Click here to enter a date.
Copies:	
From:	

1 Introduction

1.1.1 As part of the work undertaken for the A30 assessment the key junctions on the route have been assessed using Junctions 9 as this provides a robust and accurate assessment as to how these junctions will operate based on the forecast traffic flows from the A30 SATURN model.

1.1.2 A presentation was prepared to show the key findings of the assessment with Cornwall Council and Cormac. During this meeting on 15th November 2018 in Bodmin, queues on the A39 arm at Carland Cross were discussed as the operational modelling shows the queues on this arm decreasing in forecast years compared to the 2015 base year scenario. This was raised during the meeting and this technical note outlines our findings and reasoning for the results presented.

2 Carland Cross Operational Assessment

2.1 Results

2.1.1 For details on the methodology applied to undertake operational assessment of Carland Cross please see the file note HA551502-ARP-HGN-SW-FN-TR-000009 Operational Assessment.

2.1.2 The results of the operational modelling of Carland Cross for the base and forecast year scenarios are shown in Table 1 below.

Table 1: Operational assessment results for 2015 base and 2023 and 2038 do minimum scenarios

Arm	AM		PM	
	Queue (PCU)	Delay (secs)	Queue (PCU)	Delay (secs)
	2015			
A30 (east)	67.8	89.03	55.6	84.70
Services	0.2	8.15	0.2	6.29
A39	3.5	19.55	52.9	193.73
A30 (west)	3.2	16.59	7.4	34.03
	2023			
A30 (east)	132.4	197.35	118.6	185.28
Services	0.3	9.11	0.2	7.20
A39	5.7	28.02	17.5	78.04
A30 (west)	6.4	28.57	22.7	90.27
	2038			
A30 (east)	265.5	409.68	297.3	480.65
Services	0.4	10.82	0.4	8.68
A39	5.4	29.51	3.5	21.54
A30 (west)	23.6	82.71	30.9	104.00

2.1.3 Table 1 shows that in the PM peak the queue on the A39 decreases in forecast years compared to the base year, whereas, queues on the A30 arms increase. In the AM peak queues increase on all arms.

2.1.4 Examination of the traffic flows extracted from the SATURN model and used for the operational assessment show a decrease in traffic on the A39 in the forecast years for the PM peak period compared to the base year scenario.

3 SATURN Modelling

3.1 Results of Select Link Analysis

3.1.1 The traffic flows entered in the Junctions 9 Operational Assessment model have come directly from the A30 SATURN model. Figures 1 and 2 below show the forecast change in flows between the base year scenario and the forecast year do minimum scenarios (2023 and 2038 PM peak). Green represents an increase in traffic flow, blue a decrease.

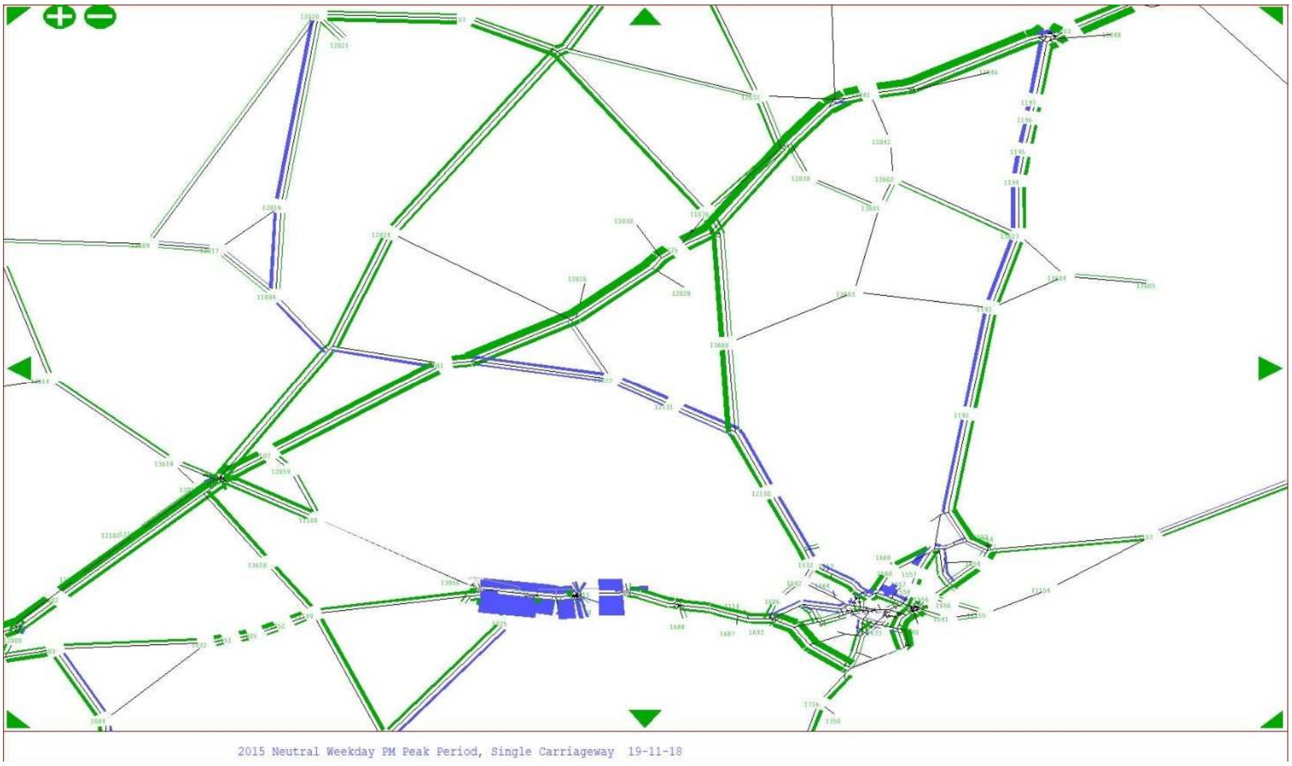

Figure 1: Flow difference between the 2015 base and 2023 do minimum PM peak

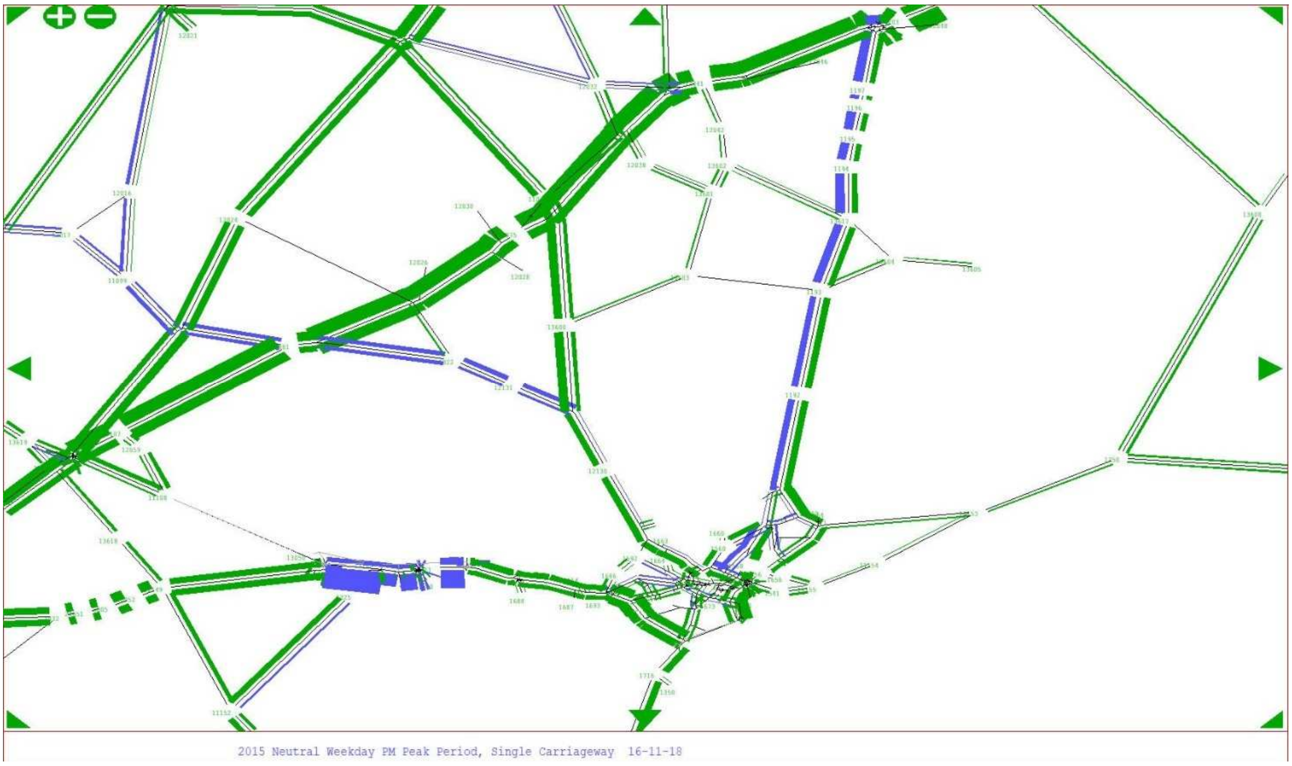

Figure 2: Flow Difference between the 2015 base and 2038 do minimum PM peak

3.1.2 Figure 1 and Figure 2 show there is a decrease in traffic on the northbound A39 between Truro and the Carland Cross junction. In 2023 there are approximately

90 less vehicles on the A39 than in 2015 and in 2038 there are approximately 200 vehicles less on the A39 than in 2015.

3.1.3 This decrease in traffic would suggest reassignment of trips previously using the A39 in the base year is occurring. The likely reason for this is due to increases in traffic flows on the A30 increasing delay at the Carland Cross junction for those approaching the junction on the A39.

3.1.4 Utilising the Select Link Analysis (SLA) tool within SATURN and selecting the northbound A39 approaching Carland Cross junction it was possible to compare the trip assignment for trips on the A39 between the Base and 2023 and 2038 scenarios.

3.1.5 By comparing the SLA between the three scenarios, see Figure 3, Figure 4 and Figure 5, it was possible to determine that there were significant changes in traffic flows from two areas in particular, these being south west of Truro and A390 to the west of Treliske. This reduction in the flow on the A39 from these two areas is particularly visible in 2038.

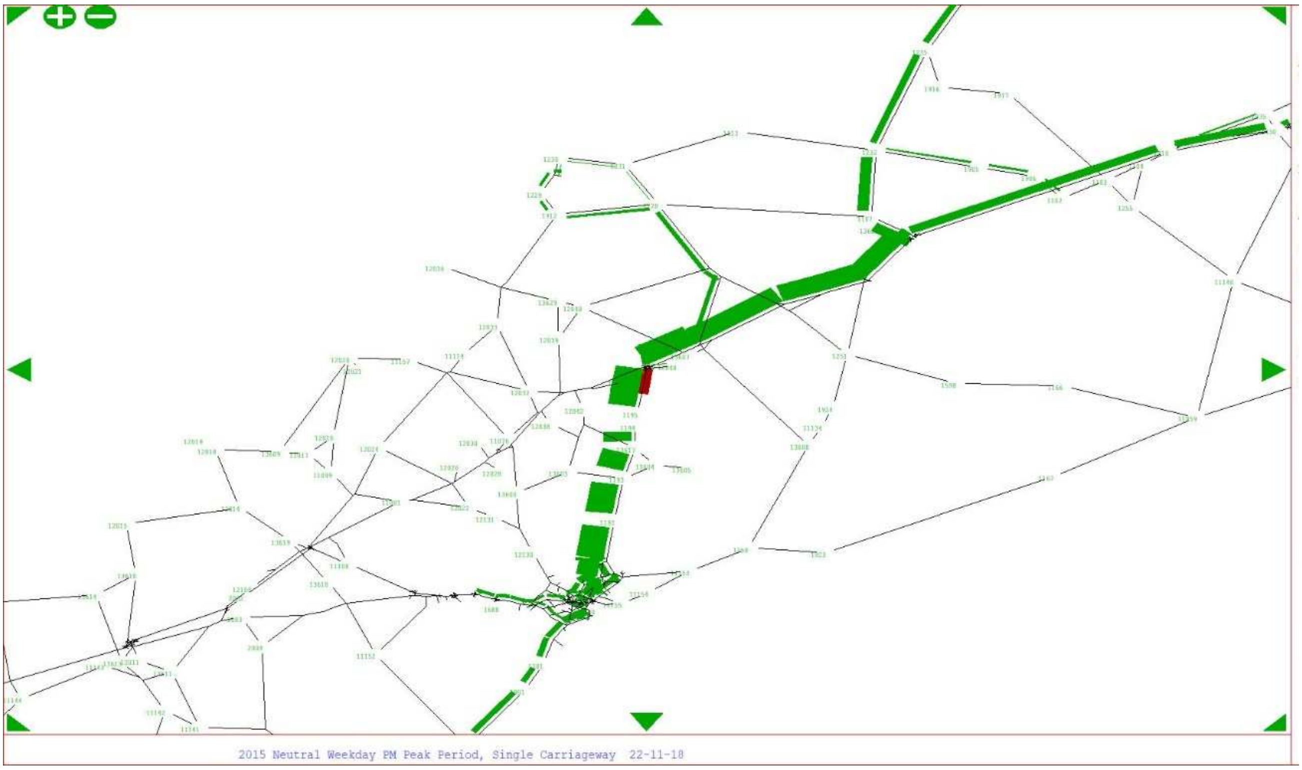

Figure 3: 2015 Base PM peak A39 flows

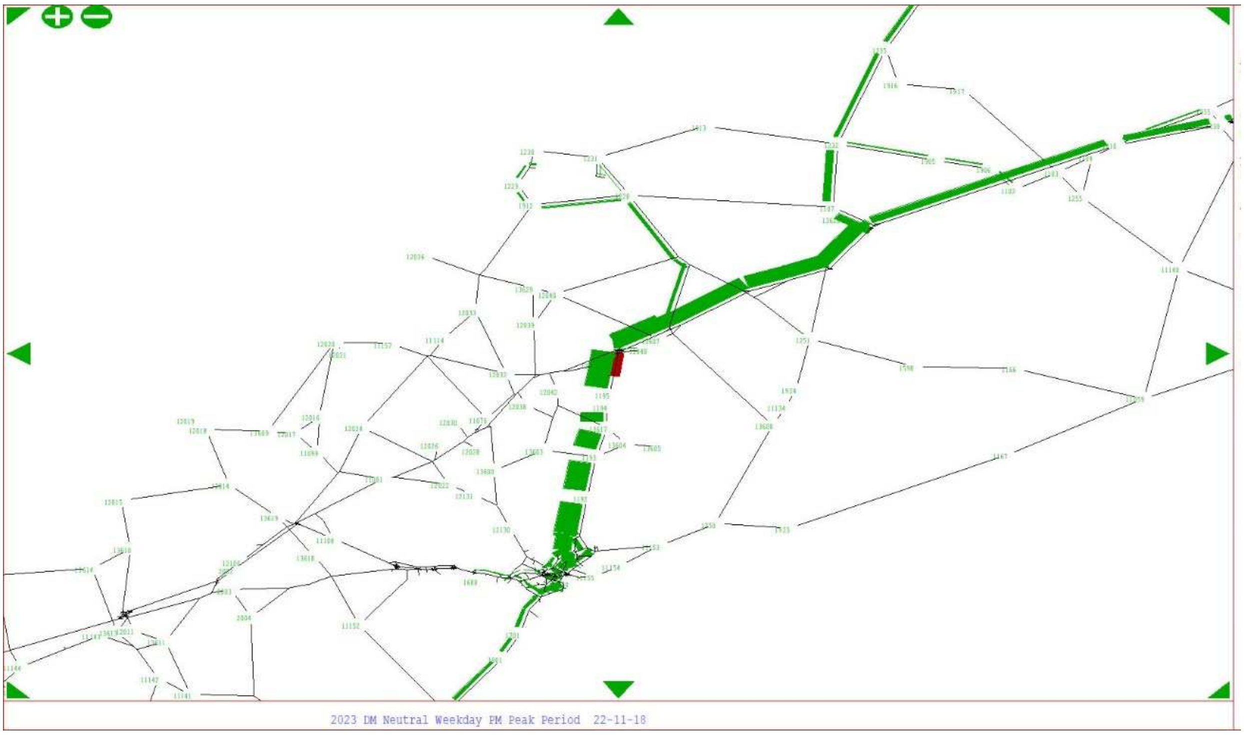

Figure 4: 2023 PM do minimum A39 flows

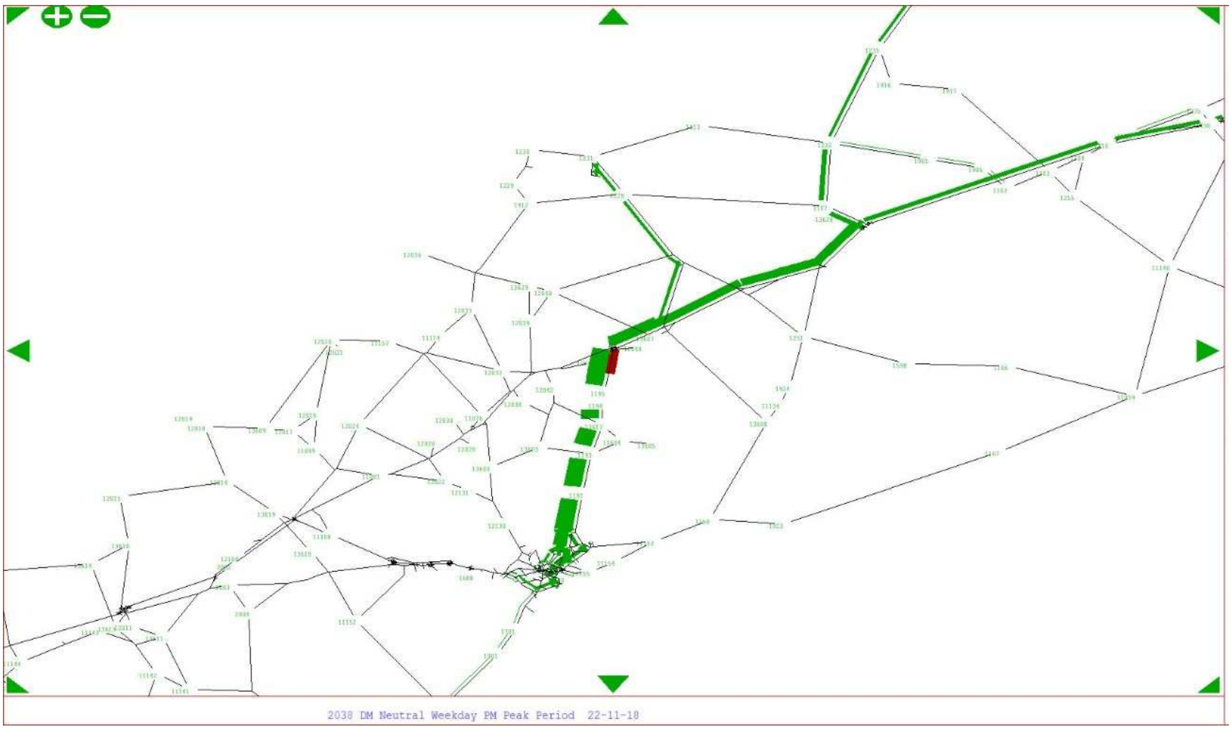

Figure 5: 2038 PM do minimum A39 flows

3.1.6 Figure 6, Figure 7 and Figure 8 show an eastbound SLA from the A30 east of the Carland Cross junction from the Base, 2023 and 2038 Do Minimum scenarios.

These figures show the decrease in traffic using the A39 from origins in south-west Truro (A390) and the A39 south of Truro.

3.1.7 The figures also show a greater number of trips routeing to this link from the A393 and then the A30 through Chiverton and Carland Cross in the forecast year scenarios (particularly 2038) compared to the base year scenario. A similar trend for those trips originating on the A390 west of Truro shows that the reassignment switches to the route via Chiverton Cross and the A30 in the forecast years compared to the base year. The changes in traffic assignment are more visible in the 2038 scenario than the 2023 scenario.

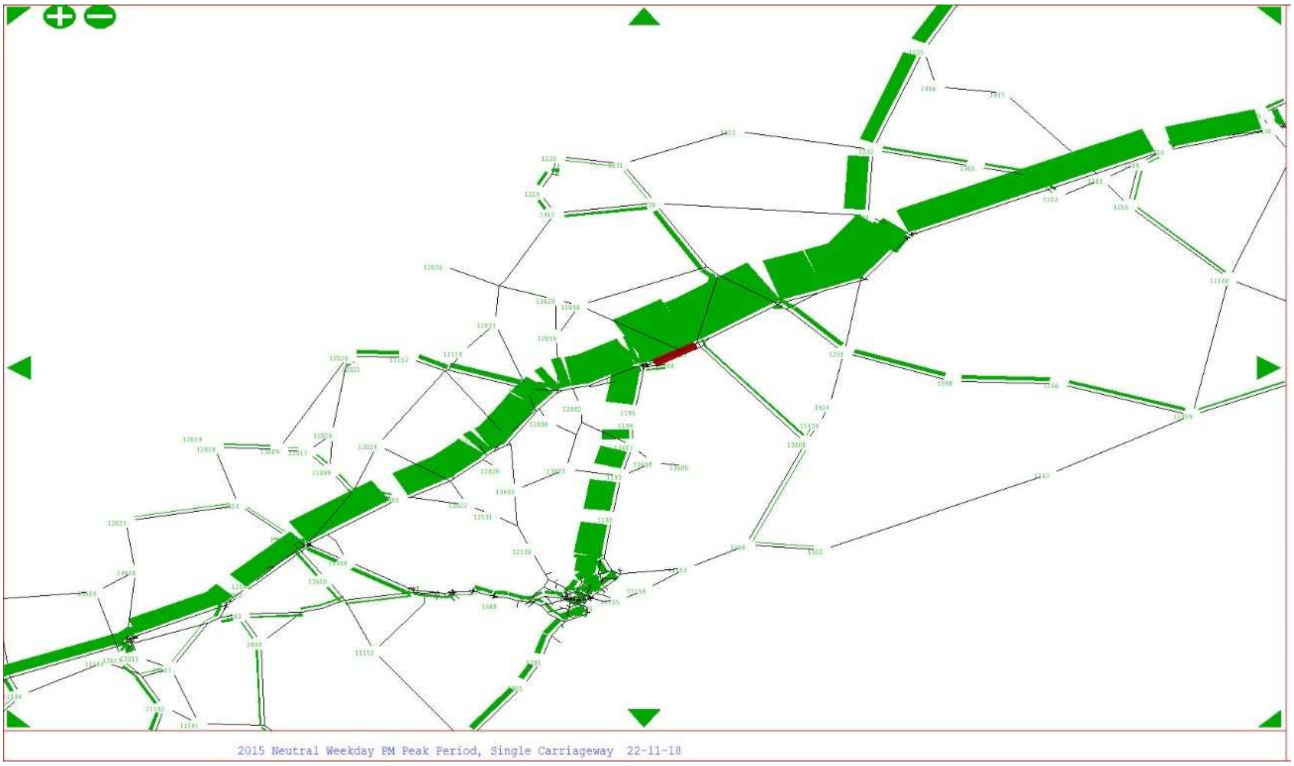

Figure 6: 2015 base PM traffic flows from A30 east of Carland Cross

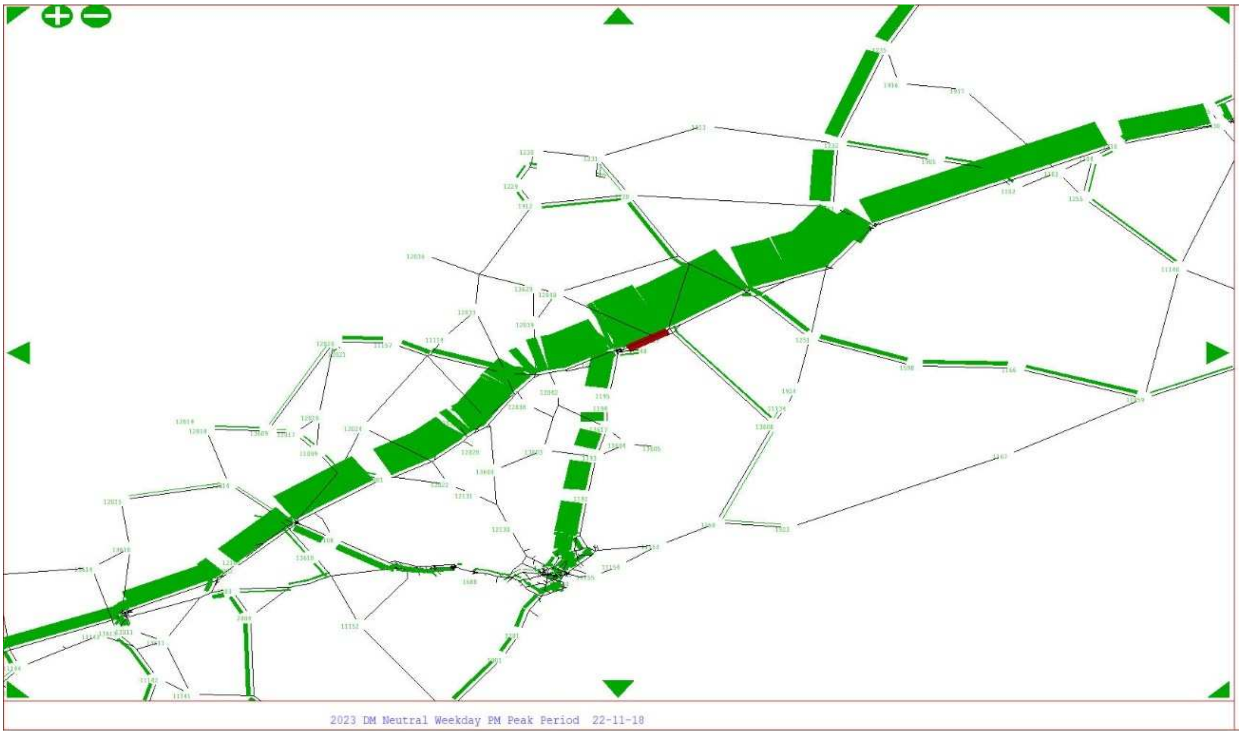

Figure 7: Do minimum 2023 PM traffic flows from A30 east of Carland Cross

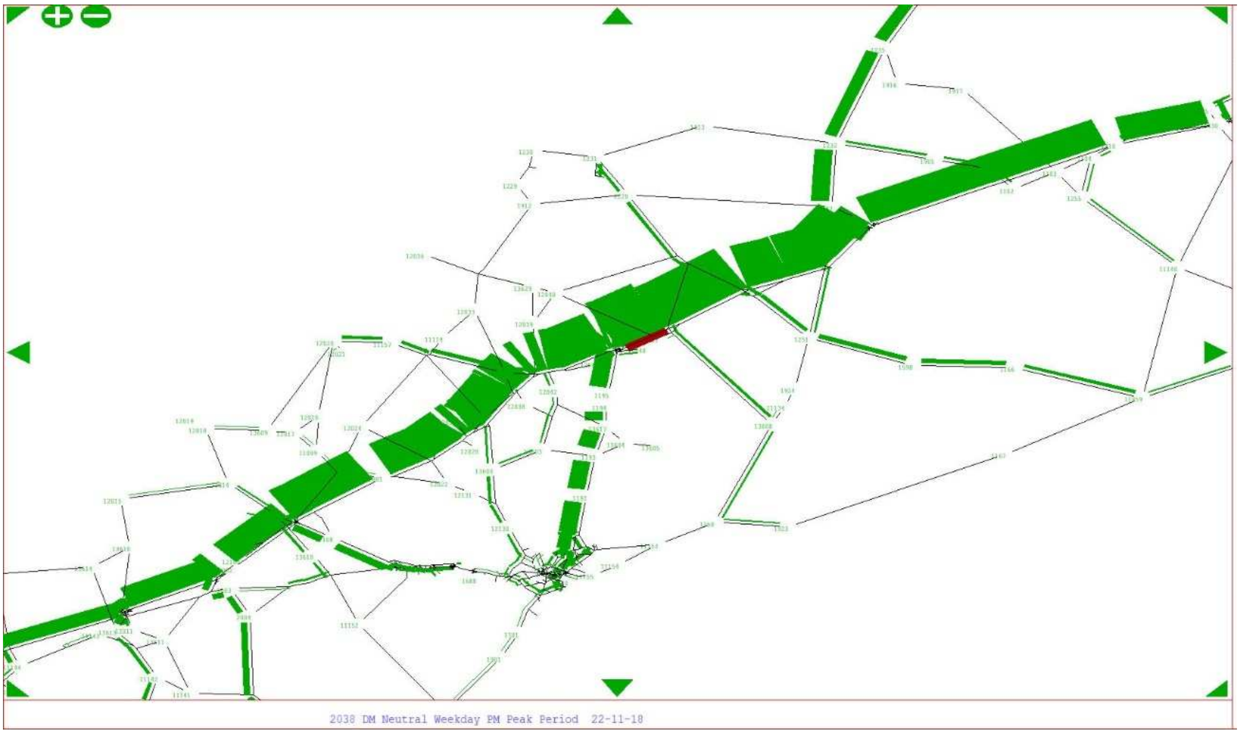

Figure 8: Do minimum 2038 PM traffic flows from A30 east of Carland Cross

3.2 Reasoning

3.2.1 Examination of the A30 SATURN model shows that the traffic reassignment is occurring due to congestion on the A39 northbound approach arm at Carland Cross junction. The cause of this congestion is the increase in east-west A30 traffic reducing capacity for northbound A39 traffic to enter the Carland Cross junction. This results in delay on the A39 increasingly significantly and thus resulting in vehicles from the origins identified through the SLA analysis vehicles reassigning to the A393/A390 and then routeing via the A30 to Carland Cross.

4 Summary

4.1 Summary

4.1.1 This Technical Note sets out the details on the operational modelling of the A39 northbound approach to the Carland Cross roundabout in the forecast year scenario.

4.1.2 Examination of the 2023 and 2038 A30 SATURN model has shown there is a forecast decrease in traffic on the northbound A39 as a result of traffic being reassigned to alternative routes from areas south of Truro. This reassignment is due to reduced capacity on the northbound A39 arm at the Carland Cross junction due to increases in east-west A30 traffic in the forecast year scenarios.

Arup Approvals

Version	Role	Name	Signature	Date
P02	Author	James Eastham	<SIGNATURE>	23/11/18
	Checker	James Eastham	<SIGNATURE>	23/11/18
	Approver	Tom Metcalfe	<SIGNATURE>	23/11/18
	Authoriser	Simon Westwood	<SIGNATURE>	23/11/18

5.1.3 A review of the operational models showed that the junction had been modelled in accordance with established practice, but that this approach does not accurately model situations where traffic flows are not balanced across the approach lanes.

5.1.4 Within the latest version of Junctions 9 there is a simulation approach that allows individual modelling of lanes and the ability to specify movements from each lane. This approach was used for Carland Cross and the resulting queues on the A39 were closer to those shown in observed data.

5.1.5 The do something operational models used the traditional approach and the results showed the junctions that form Carland Cross operate within capacity. But, a test was undertaken utilising the simulation approach to ensure the junctions operate within capacity. The results from this show they are forecast to operate within capacity.

Arup Approvals

Version	Role	Name	Signature	Date
P02	Author	James Eastham	<SIGNATURE>	28/11/18
	Checker	James Eastham	<SIGNATURE>	28/11/18
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