



## **Harrogate – Phase 2**

Harrogate Borough Council

### **Option 3 Modelling Update**

Revision 2

25/01/2018



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### Document history and status

Revision	Date	Description	By	Review	Approved
1	22/11/2017	Draft for client review	VM / AJ	RM / SF	TB
2	25/01/2018	Final report for submission incorporating client comments	VM / AJ	RM / SF	TB

## 1. Background Information

Jacobs was commissioned by Harrogate Borough Council (HBC) in autumn 2016 to support the development of their local plan. The following four growth scenarios were assessed by Jacobs during the initial Phase 2 work to identify a preferred option:

- Do Minimum – Committed developments and background growth only;
- Option 1 – Urban Growth option;
- Option 2 – Flaxby new settlement option; and
- Option 3 – Green Hammerton new settlement option.

Transport modelling using the Harrogate District Transport VISUM Model has been completed for all of these options and a final report summarising results and methodology is available online at [www.harrogate.gov.uk](http://www.harrogate.gov.uk) through the planning and development section.

The findings outlined in this modelling report were then used for junction mitigation work undertaken by Jacobs aiming to alleviate congestion at key junctions performing close to or above their capacity limits once the proposed developments have been implemented.

## 2. Modelling Update

Harrogate Borough Council has proposed additional sites to fulfil the housing and employment requirements of the district. In order to assess the impacts of these developments on the road network around Harrogate, Knaresborough and Ripon, Jacobs has been asked to repeat the Phase 2 work including these additional sites. As the proposed developments will induce additional growth, it is required to update the forecasting process and rerun the model to accurately gauge any cumulative effects. It has been agreed to use the previous 2035 “Option 3 – Green Hammerton new settlement option” scenario as a starting point for this task and add the additional growth on top. This updated version of Option 3 shall therefore be referred to as “Option 3a” throughout this report.

It should be noted that some of the previously modelled developments have been updated as planning has progressed since October 2016 and Option 3a therefore includes both, updated and additional demand. As shown in **Table 6**, an additional site has been added to the list of committed developments and therefore been included in all newly modelled scenarios.

Any changes made to either demand or the network in a transport model have potential to affect routing decisions, link flows and junction performance. With Do Minimum versus Do Something comparisons being one of the key tasks of the Phase 2 modelling, HBC and Jacobs have agreed to also rerun the Do Minimum 2035 scenario incorporating any changes made to the network. Whilst comparisons between Option 3a and the updated Do Minimum are straightforward, any differences between Option 3a and the previous Option 3 outlined within this report are only for referencing purposes since the latter scenario has not been updated. Option 3a should therefore be treated as a separate standalone option rather than an advancement of Option 3.

This technical note represents an addendum to the existing Harrogate Phase 2 modelling report and should be considered alongside the latter. Whilst the original report summarises the methodology applied and results derived as of October 2016, this technical note focusses solely on the “Option 3a” work and any associated tasks completed during and after July 2017.

### 3. Local Plan Options

Jacobs has been supplied with a list of the additional developments including their anticipated purpose and proposed sizes by Harrogate Borough Council. These sites have either been added into the model on top of the existing Option 3 sites, or amended accordingly.

In addition, the council has undertaken an update of development scale for some of the sites considered in the initial three options, as planning has progressed since they were first modelled. In addition, four developments that were originally only considered in Options 1 and 2 have now also been included in Option 3a. For these sites, which are GH2, GH4, GH9 and KH11, the number of houses increases from 134 to 157. **Table 1** shows the developments that have been updated by HBC.

**Table 1 – 2017 Model Update Changes in Housing Development Sizes**

Site ID	Number of Dwellings (2017 Model Update)	Number of Dwellings (2016 Model)
BM2	48	40
BM3	32	20
BM4	46	16
BW1	32	27
BW9	22	18
DB1	72	42
DF2	98	62
DF4	51	43
DR1	11	9
DR8	106	88
GB2	13	11
HM7	36	30
KB1	34	36
KL2	23	19
KL2_	22	19
KL6	86	72
KM4	38	31
MG6	12	10
NS1	65	54
NS3	160	134
RN2	16	14
RN3	18	15
SB1	56	45
SB5	29	24
SH1	62	52
SP4	26	22
SP5	97	80
SV1	107	57
GH11	2,774	2,130
PN13	0	254
GH2	55	46
GH9	54	45
KH11	30	25

Besides the housing developments outlined in **Table 1**, changes have also been made to employment sites. HBC have requested that site TW2 be removed, which had previously been modelled as part of Option 3. **Table 2** provides a high level summary of the quantum of Local Plan development that has been tested in each of the four scenarios modelled.

**Table 2 – Summary of housing development for each option (2035 only)**

	Option 1- Urban Growth	Option 2 – Flaxby	Option 3 – Green Hammerton	Option 3a – Green Hammerton and new sites	Notes
Quantum of identified housing sites consistent across all options	6,698 homes			6,769 homes	Option 3a figures contain development updates made by HBC in June 2017 ( <b>Table 1</b> )
Quantum of identified employment consistent across all options	96,000 sqm of B1a; 34,700 sqm of B1c; 31,700 sqm of B2; 33,400 sqm of B8			96,000 sqm of B1a; 24,300 sqm of B1c; 21,300 sqm of B2; 28,200 sqm of B8	Site TW2 has been removed as described above
Additional identified housing in each option	134 homes	2,884 homes	2,130 homes	4,671 homes	Option 3a includes the 2,130 homes of Option 3, 157 homes included from Options 1 & 2, plus an additional 2,384 homes proposed
Additional identified employment in each option	0			71,019 sqm of B1a, 142,419 sqm of B2, 124,368 sqm of B8	An additional fixed number of trips has been included for 16/05254/OUTMAJ and 16/05473/FULMAJ as provided by HBC (see <b>Table 5</b> )
Windfall housing in each option	1,650 homes				Houses split equally across all zones in Harrogate Borough
Total housing in each option	8,482 homes	11,232 homes	10,478 homes	13,090 homes	
Total employment each option	96,000 sqm of B1a; 34,700 sqm of B1c, 31,700 sqm of B2; 33,400 sqm of B8		170,496 sqm B1a, 34,700 sqm B1c, 179,682 sqm of B2, 157,768 sqm of B8		

**Table 2** demonstrates a high degree of similarity between each of the four Local Plan options, with most of the employment and housing sites being identical across each option. To assist in understanding the difference between the options, **Table 3** provides a summary of the housing sites which are **not** consistent across all options.

**Table 3 – Development sites not included within each option (2035 only)**

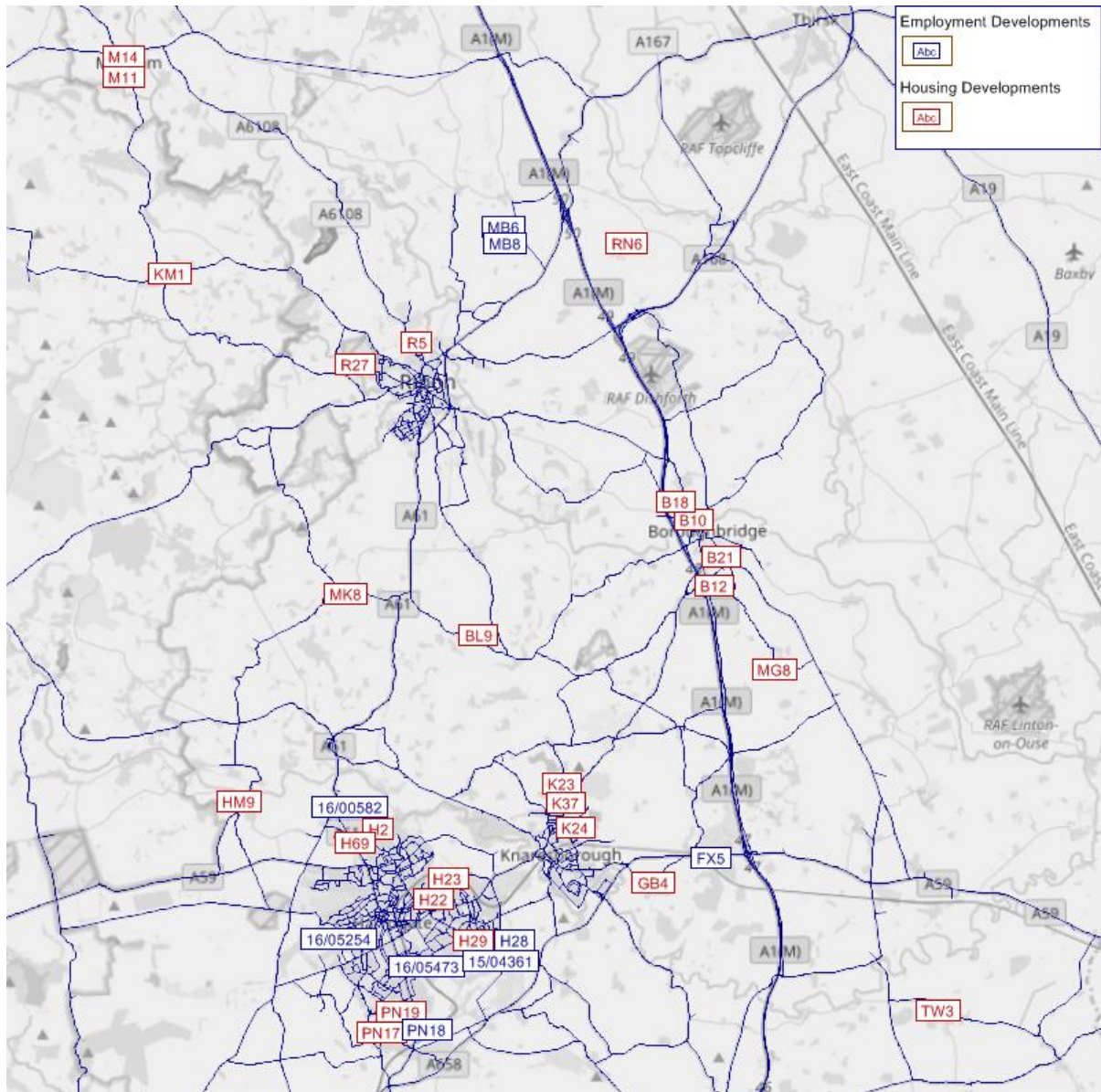
Option1 – Urban Growth		Option 2 – Flaxby		Option 3 – Green Hammerton		Option 3a – Green Hammerton and new sites	
Site ref no.	No. of homes	Site ref no.	No. of homes	Site ref no.	No. of homes	Site ref no.	No. of homes
KH11	25	KH11	25			KH11	30
GH2	46	GH2	46			GH2	55
GH4	18	GH4	18			GH4	18
GH9	45	GH9	45			GH9	54
		FX3	2,750				
				GH11	2,130	GH11	2,774
						Additional Developments (see Table 4)	

**Table 4** provides information about the 2,384 additional houses proposed as part of Option 3a and their distribution across different sites. The locations of these sites within the model area are shown in red in **Figure 1**.

**Table 4 – Additional housing included in Option 3a**

Site ID	Number of Houses
B10	67
B12	397
B18	28
B21	216
BL9	41
GB4	43
H2	70
H22	90
H23	140
H69	73
HM9	101
K23	18
K24	148
K37	146
KM1	33
M11	59
M14	27
MG8	32
MK8	46
PN19	285
PN17	72
R27	63
R5	53
RN6	8
TW3	53
16/00582/OUTMAJ	75

**Figure 1 – Proposed Development Locations**



In addition to the housing sites described in **Table 4**, HBC has also requested additional employment sites to be included either within Do Minimum and Option 3a, or Option 3a only. For these employment sites, information has either been provided in area size and type or as a fixed amount of trips. **Table 5** describes these employment sites in more detail, while their location is displayed in blue in **Figure 1**.



**Table 5 – Additional employment sites included in Option 3a**

Site ID	Scenario Included	Type	Floor Area (sqm)	Comment
FX5	DS3a	B1a	10,935	
		B8	98,415	
PN18	DS3a	B1a	34,404	
		B2	80,276	
MB6	DS3a	B2	14,454	
		B8	7,743	
MB8	DS3a	B2	33,993	
		B8	18,210	
H28	DS3a	B1a	10,935	
		B1b	98,415	
		B1c	34,404	
		B2	80,276	
17/00702/FUL	DS3a			Negligible amount of trips – not added into model
16/05254/OUTMAJ	DS3a			Trips provided by HBC AM IB 9, OB 0 PM IB 0, OB 11
16/05473/FULMAJ	DS3a			Net reduction of trips AM IB -68, OB -16 PM IB -13, OB -15
16/04654/FUL	DS3a			Negligible amount of trips – not added into model
15/04361/FULMAJ	DM / DS3a			Trips provided by HBC AM IB 11, OB 19 PM IB 14, OB 9

This section explains the setup of Option 3a and puts the scenario to be modelled in context with the other options previously assessed. HBC has moved to a preferred area of search for the proposed new settlement. The final site boundary may not therefore be in the exact same area as when the modelling scenarios were developed. The overall anticipated quantum of development remains unchanged and the broad area proposed for the settlement covers the same part of the district. The modelling work is therefore considered relevant for this strategic assessment regardless of the final boundary chosen.

## 4. Methodology

### 4.1 Forecasting Updates

The development changes and additions outlined in **Section 3** have been added into the existing forecasting process and are therefore fully represented within the final 2035 growth figures and not constrained to TEMPRO as per previous work. A detailed description of the forecasting methodology was provided within the main report.

For both housing and employment sites, the same trip rates as for the original Phase 2 work have been used with the exception of site PN18. As this site is expected to be well-served by public transport, car mode share has been assumed to be 55% for B1 and trip rates have therefore been adjusted to the following (previous trip rates given in brackets for comparison):



**Table 6 – PN 18 Updated B1 Trip Rates**

Time Period	Arrival	Departure
AM	1.408 (1.819)	0.2145 (0.242)
PM	0.10725 (0.195)	0.80465 (1.463)

Sites where a fixed number of trips have been supplied could be added directly into the forecasting process without any further calculations being necessary.

HBC has provided Jacobs with zone locations for most developments. In case this information was not available, Jacobs has determined the correct location using GIS layers of the zoning system and the proposed sites. **Table 7** shows the model zone numbers that have been used for each of the new sites.

**Table 7 – Option 3a new development zones**

Site ID	Zone Number	Site ID	Zone Number
B10	4003	MG8	4010
B12	4024	MK8	4202
B18	4003	PN19	1606
B21	4022	PN17	1606
BL9	4306	P12	4210
GB4	4408	R27	3005
H2	1403	R5	3001
H22	1424	RN6	4006
H23	1422	TW3	4017
H87	1407	16/00582/OUTMAJ	1428
H69	1407	FX5	4425
HM9	4206	PN18	1606
K23	2006	H27	1307
K24	2004	MB6	4311
K37	2001	MB8	4311
KM1	4215	16/05254/OUTMAJ	1028
M11	4214	16/05473/FULMAJ	1605
M14	4214	H28	1608
15/04361/FULMAJ	1608		

Development traffic was then added to the respective zones using the default trip distribution proportions for each individual zone. It has been agreed with HBC to use the existing Flaxby employment distribution (**Table 8**) for the new FX5 employment site given that extensive work has been undertaken as part of the Phase 2 work to distribute business trips associated with that development. FX5 now has permission and the agreed trip distribution implies a reduced level of trips heading west towards / from Harrogate and Knaresborough. Junction 47 of the A1(M) is being addressed through a separate piece of work so the solution for this junction will remain valid.

**Table 8 – Trip Distribution Proportions for FX5 Flaxby Employment Site**

Site ref no.	No. of homes	
A1(M) North	15.2%	All trips assigned onto A1(M) to north and continue on A1(M) out of the model
A59 E to York	9.5%	All trips will be sent to York to east and out of the model
A1(M) South	7.2%	All trips assigned onto A1(M) to south and continue on A1(M) out of the model
A59 W towards Harrogate	68.0%	Trips distributed as per the flows bundle proportions on the A59
Internal trips	0.0%	-

No additional HGV or LGV trips have been added into the model as this has been done as part of the original forecasting and the impacts of the additional developments, which are mainly residential, are considered negligible.

Any further considerations applied to the forecasting process as part of the previous work have been transferred to both Do Minimum and Option 3a as well. The new scenarios therefore include the proposed railway line improvements between Harrogate and Leeds.

Using the above methodology for updating the Do Minimum and creating Option 3a leads to the trip matrix totals shown in **Table 9** for internal zones within Harrogate district. Strategic long range journeys passing through the detailed model area (external to external trips) have not been included within these figures. Previous Do Minimum and Option 3 matrix totals are referenced for comparison purposes.

**Table 9 – Future Year Trip Matrix Totals**

Scenario	2035	
	AM Matrix Totals	PM Matrix Totals
Do Minimum Old	185,126	275,528
Do Minimum New	185,138	275,538
Option 3	188,437	279,316
Option 3a	190,219	281,185

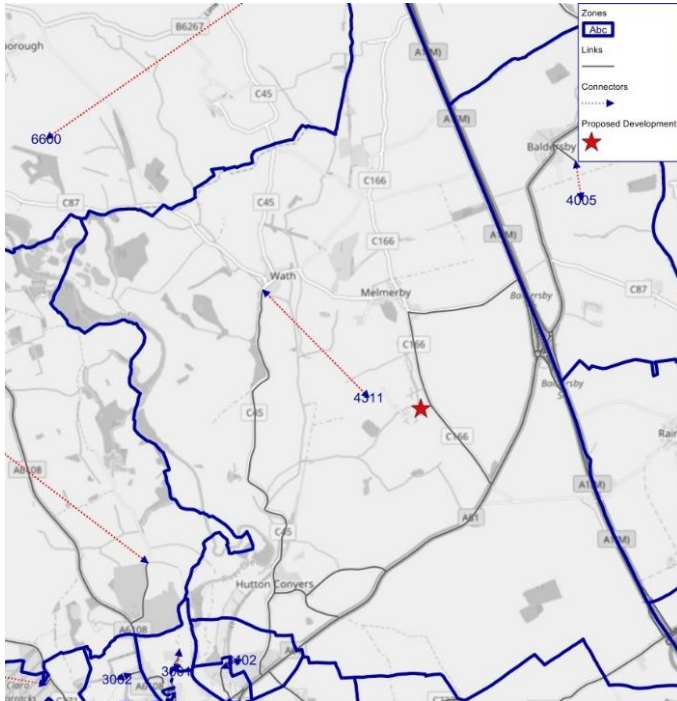
**Table 9** shows a further increase of trips in the new scenarios compared to previous runs, which is logical given the additional sites considered.

## 4.2 Model Updates

The updated demand matrices described within the previous chapter have been applied to both, Do Minimum and Option 3 2035 AM and PM VISUM models. Whilst it was originally anticipated to not make any changes to the model network, initial model runs have shown a necessity to amend certain zones, junctions and links.

Due to the proposed new employment area south of Melmerby and the additional trips associated with this, the zone connector for zone 4311 has been moved to enable traffic to enter the network at the more suitable location at Melmerby Green Lane. **Figure 2** shows the development location and the original connector setup used for all previous models.

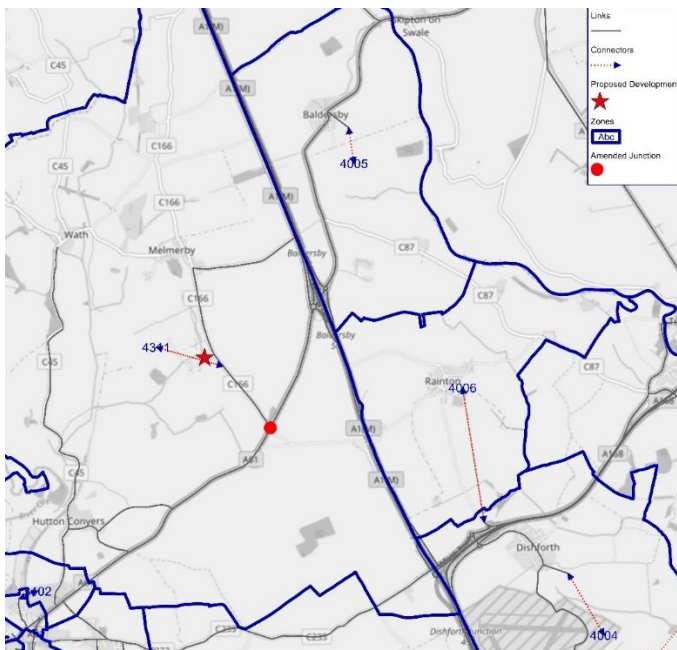
**Figure 2 – Original Connector Setup Zone 4311**



**Figure 2** shows that zone 4311 is located outside of the detailed model area and connected to Hutton Lane South of Wath. Using the existing zoning system for the Option 3a modelling would therefore add the additional demand from sites MB6 and MB8 onto Hutton Lane rather than Melmerby Green Lane which it should be using according to the corresponding planning application. As both developments have a combined GFA of almost 75,000 sqm and therefore account for a significant increase in demand, it is important that trips enter the network at the correct location.

In order to model the traffic situation around Melmerby accurately and allow development traffic to access the network via the most sensible route (Melmerby Green Lane), it has been agreed with HBC to move the zone connector. Rather than feeding into Hutton Lane, demand now accesses the network in Melmerby. **Figure 3** details the new access arrangement.

**Figure 3 – New Connector Setup Zone 4311**



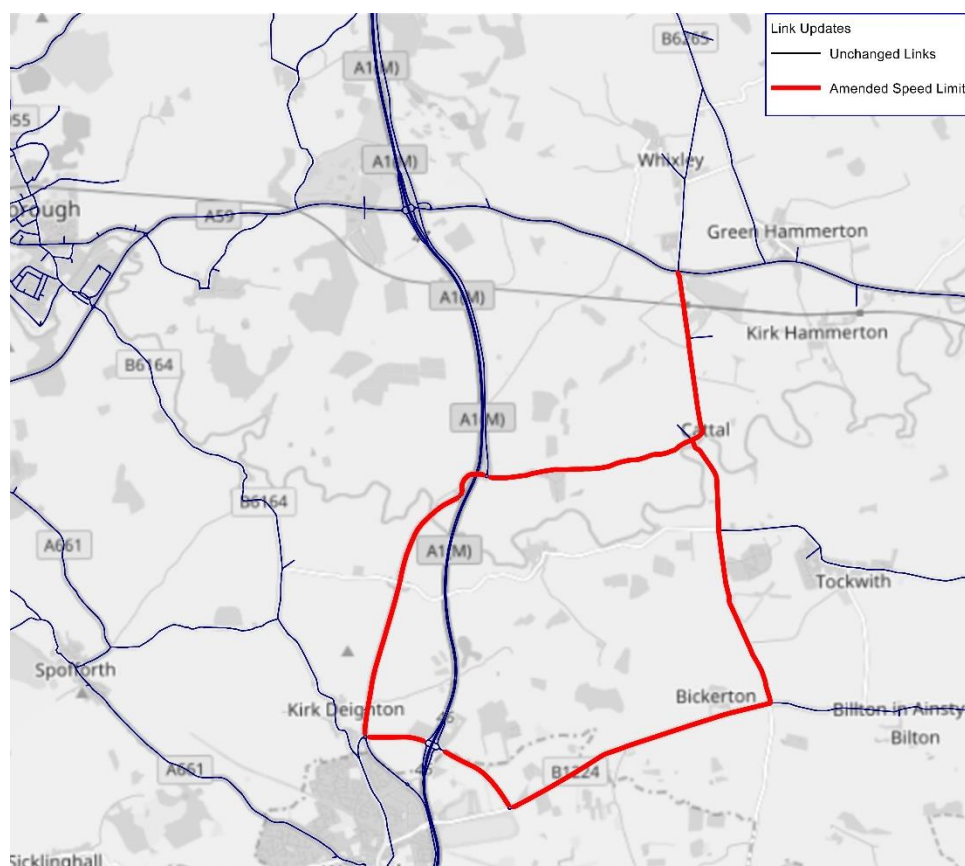
It should be noted that these network amendments will impact on traffic volumes on the A61 between Ripon and the A1(M). Vehicles previously accessing zone 4311 will now not travel along the A61 until Hutton Lane as they will leave the A61 at Melmerby Green Lane.

By contrast, journeys accessing the zone via Ripon will now travel further along this road. Direct comparisons of junction performance between Option 3 and Option 3a should therefore not be undertaken for sites in the vicinity of zone 4311 and along the A61. The shift of traffic from Hutton Lane towards Melmerby Green Lane and the exclusion of delays at the corresponding junction might also impact on junction performance and journey times in the area and therefore cause rerouting of trips.

During previous model runs, southbound traffic originating from the new Hammerton development was travelling via Cattal and Wetherby instead of using the A1(M) due to delays occurring along the A59 and on Junction 47. Jacobs has therefore agreed with HBC to reduce speeds on selected links to achieve the likely route choice and eliminate ratrunning within the area by moving traffic back on the A1(M).

**Figure 4** shows all roads where maximum travel speeds have been changed from 35mph to 30mph as part of the model update to ensure a more realistic representation of the current travel conditions within the model.

**Figure 4 –Link Speed Limit Adjustments**



During the forecasting process, all required demand has been fed into the model as part of the updated matrices. However, in some instances, the existing model network is not able to handle these additional trips due to significant flow increases in areas where there was only a small amount of traffic beforehand.

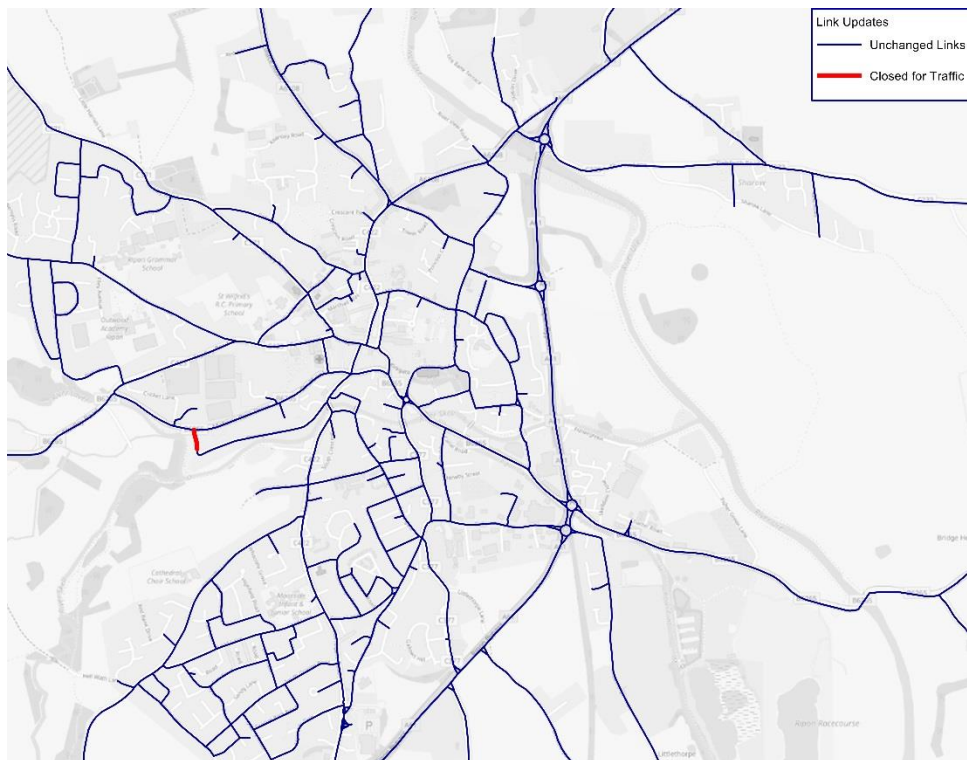
An example for this are zones where significant new developments are located (Pannal and Melmerby). Both zones are connected to the transport network through small one lane priority

junctions at Fulwith Road and Melmerby Green Lane. Once the additional demand is added in, this causes delays for all turns onto the main roads. As a result, not all development trips can enter the network as planned and further network updates are required to model these developments accurately. Jacobs and HBC have therefore agreed to change the node type from priority to uncontrolled as this eliminates all delay, maximises junction throughput and ensures a correct test of the scenario.

Further changes to the model network have been made in Ripon, where the Eastern part of Borrage Lane has been closed for all traffic as requested by HBC and shown in **Figure 5**. In addition, signal times within the city centre have been adjusted for all scenarios and time periods to increase road capacity and therefore ensure that all traffic is within the model for a robust assessment.

Whilst signals within the base model have been coded according to the controller specifications provided by HBC, turning proportions at the city's main junctions change as a result of the proposed developments requiring an update of certain signal stages. Jacobs has tried to minimise these amendments and ensured that all traffic can pass through Ripon.

**Figure 5 –Link Closure**



## 5. Forecast Option Results

### 5.1 Introduction

This section sets out the modelling results for the updated Do Minimum and the new Option 3a scenario modelling using the methodology described within the previous chapters. Do Something modelling work has been based on the previous Option 3 (Green Hammerton) 2035 AM and PM versions of the calibrated and validated fully WebTAG compliant 2015 VISUM model covering the area around Harrogate, Knaresborough and Ripon.



The following results will be presented:

- Traffic Impacts and Flows Differences – shows the change in traffic flows as a result of the options considered; and
- Forecast Volume to Capacity Ratios – shows the Volume to Capacity ratios for junctions within the detailed model area and highlighting junctions that are brought over capacity as a result of the Local Plan.

## **5.2 Traffic Impacts and Flow Differences**

Once demand had been assigned to the model, results can be sense checked by comparing the model results for both AM and PM peak to the respective Do Minimum outcomes. Whilst both of these scenarios are not comparable like for like, undertaking this test provides an indication about the impacts of the proposed developments on the road network.

For each time period the Do Something options were compared to the Do Minimum scenario using the version comparison tool in VISUM which allows for a direct analysis of network performance across two separate models. The results of these were graphically displayed for both Harrogate / Knaresborough and Ripon and are presented in **Figure 6** to **Figure 9**.

Figure 6 – Harrogate and Knaresborough Option 3a – DM(AM)





Figure 7 – Ripon Option 3a – DM(AM)



**Figure 8 – Harrogate and Knaresborough Option 3a – DM(PM)**

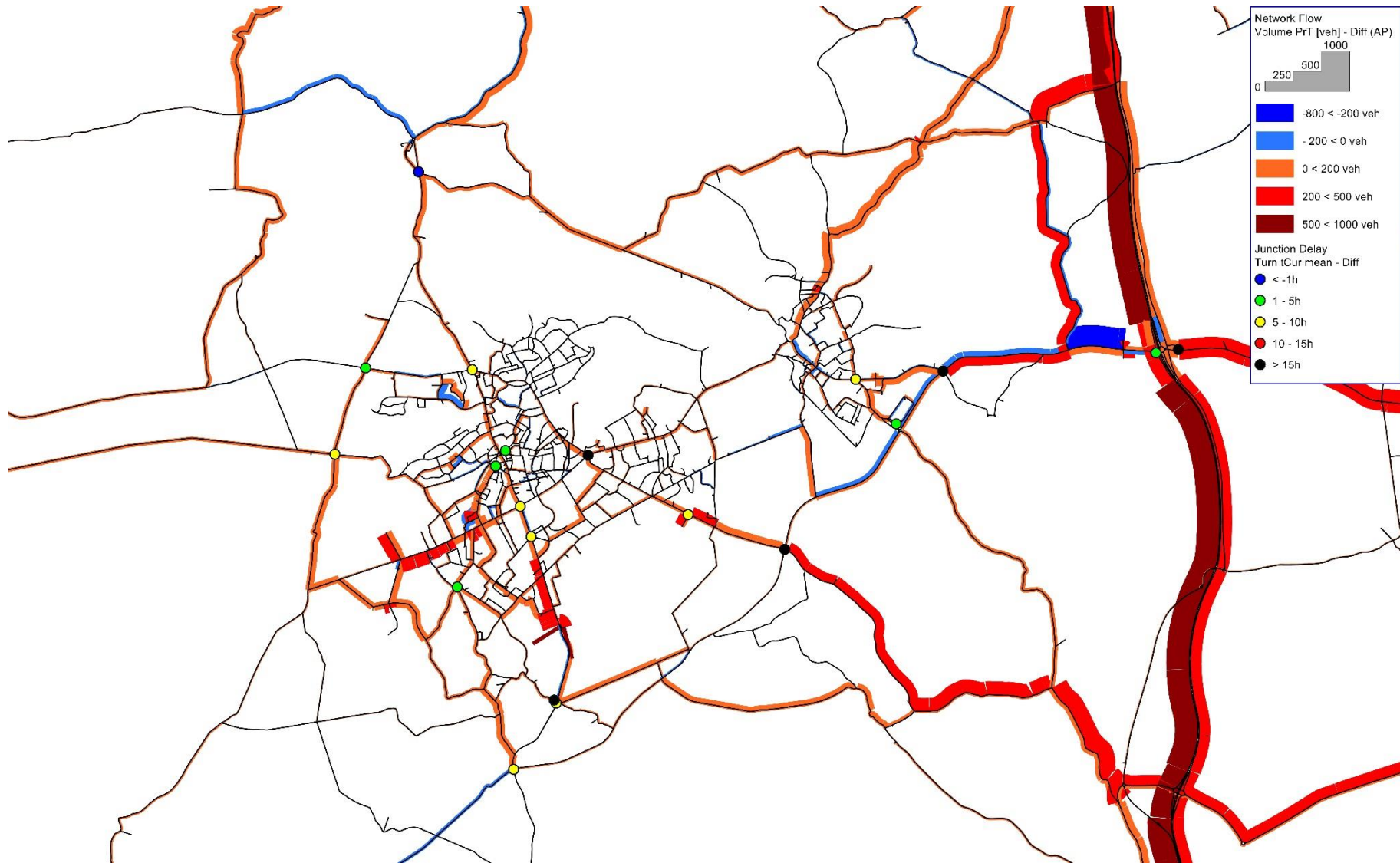


Figure 9 – Ripon Option 3a – DM(PM)



Looking at the AM 2035 model in Harrogate and Knaresborough (**Figure 6**), significant traffic increases can be observed on the A61 North of Pannal, the A661 Wetherby Road and on the A59 near Flaxby and Hammerton. For all of these areas, large employment sites have been modelled as part of Option 3a requiring vehicles to access these sites during the morning peak. The additional demand generated by the proposed employment site in Flaxby also causes rerouting of strategic eastbound traffic using the A59 in the Do Minimum scenario due to capacity issues on this route, which explains the reduction between Flaxby and the A1(M). In general, it can be seen that all routes accessing Harrogate from the East, including the A1(M) show a significant increase of traffic compared to the Do Minimum.

The same patterns can be observed for the PM peak (**Figure 8**) just in reverse order and to a lesser extent. Referring to this, it should be noted that matrix totals in the model have always been significantly higher for the PM peak compared to the AM due to observed demand results. With the road network in the area therefore being more congested, high capacity routes like the A1(M) are used by both strategic and local traffic wherever possible.

The new residential developments proposed in the North-West of Ripon account for an increase of traffic within the city as shown in **Figure 7** and **Figure 9**. In addition, the new employment sites close to Melmerby attract additional traffic onto the A61 between Ripon and the A1(M) in both directions and time periods. The new employment site in Melmerby also attracts strategic traffic from the North and South accessing the village via the A1(M).

### 5.3 Forecast Volume to Capacity Ratios

Analysis on the performance of junctions on the network has also been undertaken for Option 3a using a volume capacity ratio (VCR) on the turns in the model and total junction delay.

VCR is a ratio representing the degree of saturation of a particular stretch of road, with values closer to 0 representing free flow conditions and values approaching or greater than 100 indicating high levels of congestion. Observations on many roads has shown that delay rises considerably at v/c ratios of above 85, and that significant delays occurs at VCR ratios of above 100.

Mitigation measures to address Local Plan development proposals are based on the VCR value at key junctions. A list of the worst junctions regarding VCR for both, Do Minimum and Do Something has been presented within the original report. HBC has requested Jacobs update this list to include the latest Option 3a modelling and therefore highlight additional issues that might occur at specific junctions once the developments have been introduced. The results of this analysis are shown in **Table 10** (AM) and **Table 11** (PM) with values of under 85 shown in light blue, values of between 85 and 100 shown in blue and over 100 shown in dark blue.

**Table 10 – AM 2035 VCR Tables**

Model Node no.	Junction	Maximum VCR at junction for:	
		DM	Opt 3a
19	A6108 North Road / A6108 Palace Road	95.9	89.0
28	A661 / A658	74.9	97.7
35	A658 / B6164 Grimbald Crag Way Roundabout	84.3	100.7
41	A59 York Road / A658 Roundabout	78.0	100.3
49	Hookstone Road / Hornbeam Park Ave	60.5	95.6
50	A59 York Road / B6164	78.5	100.0
55	A61 / Pannal Bank / Follifoot Road	79.1	100.0
57	A1(M) NB J47 offslip to A59	65.8	89.6
60	A59 New Rd offslip to A1(M) J47	70.5	87.7
62	B6162 Otley Road / Crag Lane	90.8	100.0
98	A61 Ripon Road / Otley Road	100.0	100.0
1098	A61 Leeds Road / Vernon Road	51.7	100.9
1116	A61 Leeds Road / Leadhall Lane	77.3	103.5
1445	Somerset Row / Low Skellgate	99.9	100.0
1472	A59 Skipton Road / Claro Road	85.0	86.5
1487	North Street / Coltsgate Hill	92.8	100.0
1676	Hookstone Road / Hookstone Drive / Oatlands Drive	75.5	91.6
1937	A661 Wetherby Road / Hookstone Chase	86.6	100.0
2475	B 6164 Wetherby Road / footpath parallel to River Nidd	71.0	89.6
1000917	Howhill Quarry Road opposite Le Campsite Harrogate	79.5	89.9

**Table 10** shows that junctions number 28, 35, 41 and 55 are reaching their capacity limits once the new developments have been introduced. The increase in traffic at both locations is caused by the additional vehicles travelling towards Pannal and Flaxby, as well as along Wetherby Road.

Junction 57 and 60 show an increase of VCR which is related to additional traffic on the gyratory going to the new developments at Hammerton, Flaxby and Pannal.

The additional traffic to and from Pannal impacts on junctions 1098 and 1116 as development traffic turning onto this route causes delays and therefore leads to a higher VCR.

Traffic originating from the new sites in Ripon (R5 and R27) travels through the city centre on Coltsgate Hill before turning onto North Street. These additional journeys worsen the situation at junction 1487, which is now operating at 100% capacity.

Junction 1937 (Woodlands) has been subject to congestion in the model and was previously considered for mitigation measures. It is reaching its capacity limit once the new developments on Wetherby Road have been completed.

The traffic situation on clocktower junction (19) improves as part of the Do Something due to the signal improvements Jacobs has undertaken in Ripon to maximise throughput.



**Table 11 – PM 2035 VCR Tables**

Model Node no.	Junction	Maximum VCR at junction for:	
		DM	Opt 3a
8	A61 Leeds Road / A61 W Park Roundabout	82.0	95.9
10	A61 Ripon Road / A59 Skipton Road Roundabout	92.0	96.8
19	A6108 North Road / A6108 Palace Road	65.4	92.0
30	A61 Ripon Road / B6165 Roundabout	78.4	86.2
35	A658 / B6164 Grimbald Crag Way Roundabout	80.8	93.0
50	A59 York Road / B6164	83.5	92.4
55	A61 The Carr Leeds Road / Follifoot Road	87.8	85.3
58	A59 offslip to A1(M) J47 onslip (west arm)	62.7	100.0
59	A1(M) Junction 47 offslip to A59 New Road onslip (east)	80.0	98.4
61	A59 New Road / A168 offslip to A59	82.9	99.9
62	B6162 Otley Road / Crag Lane	100.5	97.8
98	A61 Ripon Road / Otley Road	100.0	100.0
157	A61 Ripon Road / Grainbeck Lane	76.9	84.1
357	Cold Bath Road / W Cliffe Grove	92.5	106.5
1031	A59 Skipton Road / Woodfield Road	84.4	88.2
1098	A61 Leeds Road / Vernon Road	70.9	92.7
1275	A59 Skipton Road / Regent Ave	89.8	101.1
1378	Westgate / Blossomgate	48.3	91.2
1445	Somerset Row / Low Skellgate	100.0	100.0
1487	North Street / Coltsgate Hill	74.1	100.0
2334	A6055 Boroughbridge Road / Greengate Lane	78.5	91.2
3419	A61 Ripon Road / Road leading to the HACs Group	81.1	89.1
4337	A59 Roundabout (Harrogate Paintball Centre)	49.8	88.3

**Table 11** shows that the new employment site South of Flaxby will add a significant number of trips to the network during the evening peak. This leads to the new roundabout on the A59 (4337) reaching its capacity limit, but for the purposes of strategic modelling it does not exceed the 85 benchmark by a sufficient amount to merit detailed consideration.

Additional traffic from the new site in Pannal travelling North along Wetherby Road impacts on the performance of Leeds Road / West (8), as the junction's VCR increases from 82 to 96 per cent.

In contrast to the morning peak, VCR values for clocktower junction (19) increase from 65 to 92 after amending the signal times. As this is the only way to ensure that all traffic enters the model, Jacobs recommended to develop an individual junction model in LinSIG to model flows for both peaks. This work has been undertaken and the results are discussed in the mitigation section.

As mentioned previously, traffic volumes within Ripon town centre increase as a result of new developments within that area. Besides the signalised junctions, which have been improved by Jacobs, priority junctions are also facing longer queues and turning times. Junction 1378 can be stated as an example for that as the DS VCR ratio for right turns is greater than 90 due to the fact that it's harder to find a suitable gap to make a turn once there are more vehicles on the road.

Junctions 35, 1098, 1487, as well as the A1(M) Junction 47 gyratory (58, 59 and 61) feature the same flow characteristics as the morning peak, which leads to a higher Do Something VCR.

As traffic volumes on the A61 Ripon Road increase in both directions during the PM peak, vehicles turning onto the main road from Grainbeck Lane experience delays. This accounts for the higher VCR ratio for junction 157. A similar pattern can also be observed at the West Cliffe Grove / Cold Bath Road junction (357) and the Skipton Road / Regent Avenue junction (1275), where a flow increase on the major arms delays turning movements on the minor ones. These junctions are considered further in the mitigation section.

Finally, the additional traffic resulting from the new developments North of Knaresborough (K23, K24 and K37) accounts for the higher DS VCR on junction 2334 (A6055 Boroughbridge Road / Greengate Lane). This is likely to be due to all three developments accessing the highway network from the same point in the model which will not be the situation in reality.

## 6. Conclusion

HBC commissioned Jacobs to assess the impacts of adding an additional 2,384 homes and various employment sites to the existing Option 3 “Green Hammerton” VISUM model to determine additional capacity problems in the region’s transport network. This addendum report has outlined the methodology applied to update the model and summarised the final results, whilst **Table 12** summarises all the modelling work undertaken as part of the Harrogate Development testing up to date.

**Table 12 – Harrogate Phase 2 Modelling Summary**

Date	Model Reference	Model Description	Model Scenarios	Related Documents
August 2016	Original Run	Original forecast runs incorporating committed developments and growth scenarios	2025 & 2035 DM, DS1, DS2 & DS3	Harrogate Phase 2 – Final Draft
August 2017	Updated DS3 Run	Updated August 2016 Option 3a models incorporating additional sites, updated development sizes and network changes	2035 DM & DS3a	Option 3 Technical Note
September 2017	Updated DS3a Run	As above with Ripon queueing removed through signal changes	2035 DM & DS3a	Option 3 Technical Note – Rev1

It can be concluded that the new developments will add additional trips for both AM and PM peak period in 2035. However, whilst general traffic volumes increase compared to the previous Option 3 model, the network is still able to absorb this increase in demand. Mainly junctions along the major access routes into Harrogate, Knaresborough and Ripon are reaching their capacity limits once the new developments are introduced. Capacity issues are also present in the area of A1(M) junction 47.

Potential mitigation measures will be identified to address the issues highlighted by the modelling work. These mitigations are discussed in the accompanying mitigation note.



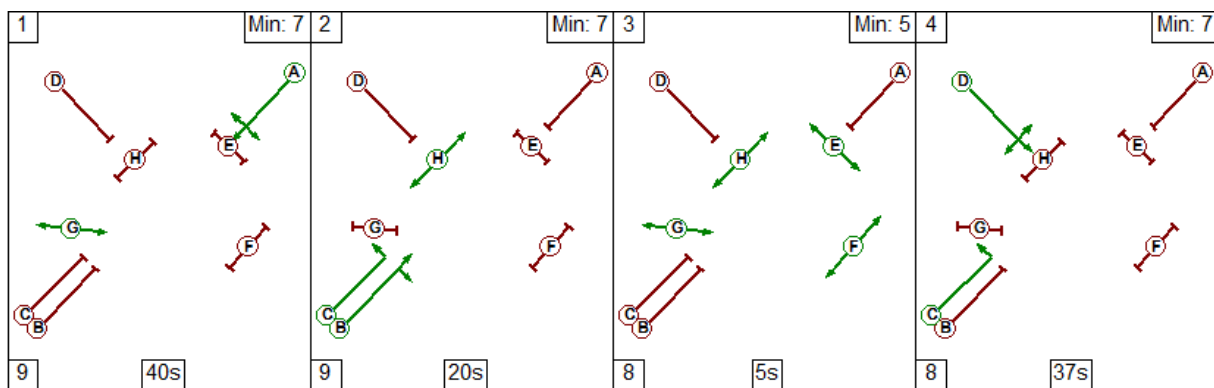
The mitigation work in this document details the work that Jacobs has undertaken on behalf of Harrogate Borough Council to look at some of the junctions highlighted as being impacted on by proposed Local Plan development. At this stage the mitigation has not been agreed with North Yorkshire County Council (NYCC). Therefore, there is no formal confirmation as to the suitability of the proposed junction designs to the highway authority though both councils will continue to work together to develop appropriate solutions.

The Do Minimum scenario in the following tables refers to existing traffic levels plus trips from development that already has planning permission (outside the sites included in the local plan) and inclusive of background growth. The Do Something column then reflects the Do Minimum plus the proposed local plan development trips. RFC refers to ratio of flow capacity associated with the junction. Broadly speaking any value in this column over 0.85/0.90 reflects congestion. MMQ represents maximum mean queue length. PRC is the practical reserve capacity of the junction and the total delay is measured in passenger car units which is a transportation measure where 1 pcu = 1 car whereas a lorry can be represented as 3.5 pcu. Total delay reflects all vehicle types within the model.

## Junction 1 – Clock Tower Junction, Ripon, Node Number 19

The unmitigated scenario has been modelled using the existing road layout and signal timings.

*Current Staging Plan:*



*Unmitigated Layout:*

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	MMQ	RFC	MMQ	RFC	MMQ	RFC	MMQ
1/1	Princess Road	0.09	0.0	0.09	0.0	0.11	0.1	0.14	0.1
2/2+2/1	North Street Ahead Left	1.13	44.3	0.71	8.4	1.64	190.1	1.67	154.1
2/3	North Street Right	0.07	0.7	0.09	0.8	0.10	1.2	0.16	1.3
3/1	Palace Road Ahead Left Right	0.89	19.7	1.06	34.9	0.99	33.0	1.22	76.5
4/1	North Road Exit	0.20	0.1	0.18	0.1	0.27	0.7	0.19	0.1
5/1	North Street Exit	0.09	0.0	0.17	0.1	0.18	0.1	0.20	0.1
6/1	Palace Road Exit	0.22	0.1	0.25	0.2	0.20	0.1	0.25	0.2
7/1+7/2	North Road Ahead Left Right	0.58	10.4	0.95	20.8	0.93	17.3	1.27	122.9
PRC (%)		-25.3		-17.9		-82.5		-85.2	
Total Delay (pcuHr)		50.26		43.09		209.84		326.39	

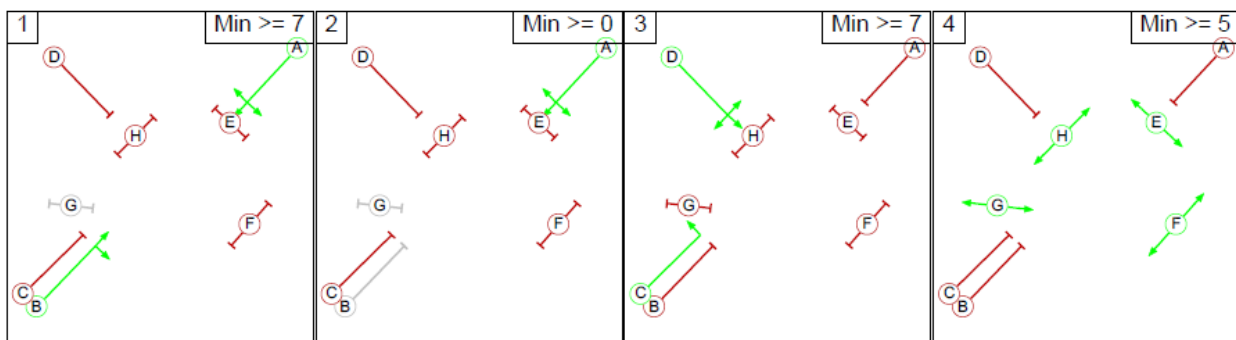
Mitigation required for both Do Something Scenarios.

## Mitigated Layout:

The mitigation options at the junction are limited with the Clocktower and close proximity of private land surrounding all sides of the junction posing significant constraints. Whilst efficiencies were found in extending the overall signal cycle time and optimising the timings, the gains were not found to be sufficient to mitigate the impacts of the Local Plan.

The flared lane on the North Road Eastern arm has been extended to 63m to allow for two lanes and an increased amount of right turners. Similarly, the left turn flare lane on the North Street Western arm has been increased to 57m. In addition, the staging of the junction has been adjusted as part of the proposed mitigation to allow the northbound and southbound movements to run in parallel with two right turn pockets provided in the centre of the junction. The current and proposed stage plans are shown below.

## Updated Staging Plan:



To accommodate this signal plan and the northbound left turn from North Street into Palace Road during a different stage, the roadscape on the southern arm would also require redesignating.

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	MMQ	RFC	MMQ	RFC	MMQ	RFC	MMQ
1/1	Princess Road	0.09	0.0	0.10	0.1	0.11	0.1	0.17	0.1
2/1	North Street Ahead Left	0.22	3.7	0.25	3.9	0.36	4.2	0.41	6.7
2/2	North Street Right	0.72	10.1	0.25	4.6	0.91	13.5	0.80	15.4
3/1	Palace Road Ahead Left Right	0.66	13.2	0.83	16.5	0.96	24.6	1.05	39.2
4/1	North Road Exit	0.21	8.4	0.18	4.0	0.38	15.9	0.28	15.0
5/1	North Street Exit	0.09	0.0	0.17	0.1	0.18	0.1	0.24	0.2
6/1	Palace Road Exit	0.23	7.9	0.25	5.3	0.25	10.1	0.34	17.0
7/1+7/2	North Road Ahead Left Right	0.68	9.8	0.69	10.5	0.95	13.6	1.05	45.8
PRC (%)		25.1		8.3		-6.1		-16.5	
Total Delay (pcuHr)		16.12		15.99		39.23		76.15	

## **Junction 2 – High Skellgate / Low Skellgate / Somerset Row, Ripon, Node Number 1445**

This junction requires a substantial intervention to enable delivery of the proposed Local Plan development allocations. Work is underway to finalise potential solutions and will be published in due course. HBC and NYCC are working together to develop appropriate solutions to mitigate the impact of traffic generated by the local plan allocations.

## Junction 3 – A59 / A658, Knaresborough, Node Number 41

*Unmitigated Layout:*

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	Q	RFC	Q	RFC	Q	RFC	Q
Arm 1	A59 York Road (NE)	0.52	1.1	0.61	1.5	0.62	1.6	0.73	2.6
Arm 2	Goldsborough Road (SE)	0.12	0.1	0.21	0.3	0.21	0.3	0.27	0.4
Arm 3	A658 Bypass (SW)	0.39	0.7	0.51	1.0	0.56	1.3	0.47	0.9
Arm 4	A59 York Road (NW)	0.47	0.9	0.43	0.8	0.59	1.4	0.39	0.6

No mitigation required as junction performance meeting guidance for all scenarios and time periods.

## Junction 4 – Woodlands, Harrogate, Node Number 1937

This junction requires a substantial intervention to enable delivery of the proposed Local Plan development allocations. Work is underway to finalise potential solutions and will be published in due course. HBC and NYCC are working together to develop appropriate solutions to mitigate the impact of traffic generated by the local plan allocations.

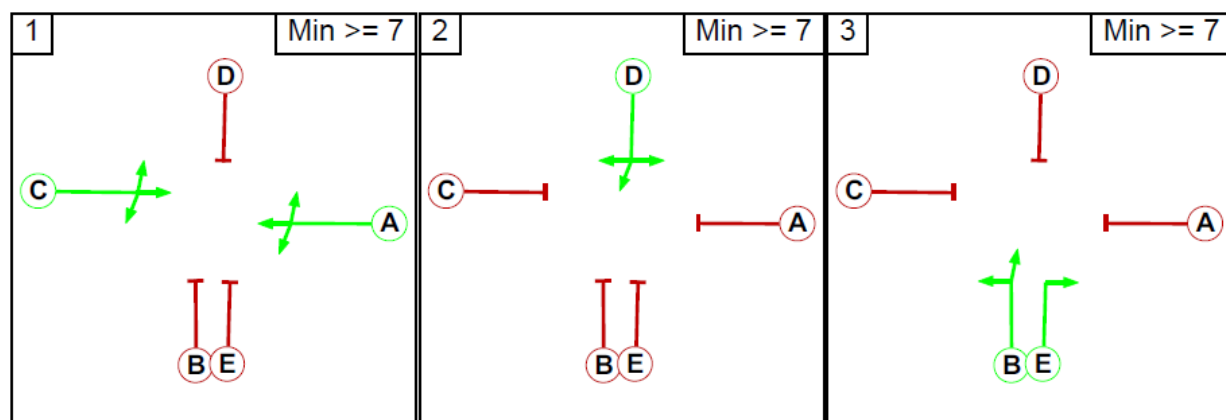
## Junction 5 – Leeds Road M&S, Harrogate, Node Number 1116

This junction requires a substantial intervention to enable delivery of the proposed Local Plan development allocations. Work is underway to finalise potential solutions and will be published in due course. HBC and NYCC are working together to develop appropriate solutions to mitigate the impact of traffic generated by the local plan allocations.

## Junction 6 – Otley Road / Crag Lane, Harrogate, Node Number 62

The junction has a committed scheme in place to signalise all arms to form a signalised crossroads. At the time of the modelling, a plan of the proposed signalised junction layout was not available and the layout has thus been assumed to be accommodated within the existing carriageway. It should also be noted that the VISUM strategic modelling added development traffic from the H49 development to the zone connector off the northern arm of the junction whereas the actual access is anticipated to be from an access of the western arm. The traffic flows used in the LinSig modelling were thus amended to take this into account. As an existing signal plan was not available, the results below are for the optimised signal timings.

*Current Staging Plan:*



*Unmitigated Layout:*

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	MMQ	RFC	MMQ	RFC	MMQ	RFC	MMQ
1/2+1/1	Beckwith Head Road Left Ahead Right	0.62	4.7	0.55	5.0	0.39	1.8	0.71	4.1
2/1	Otley Road WB Exit	0.03	0	0.11	0.1	0.07	0	0.23	0.1
3/1	Crag Lane (Exit)	0.05	0	0.07	0	0.03	0	0.04	0
4/1	Otley Road EB (Exit)	0.19	0.1	0.21	0.1	0.22	0.1	0.23	0.1
5/1	Beckwith Head Road (Exit)	0.28	0.2	0.12	0.1	0.42	0.4	0.21	0.1
6/1	Otley Road EB Left Ahead Right	0.13	1.6	0.15	2.0	1.35	93.4	0.30	3.7
7/1	Crag Lane Right Left Ahead	0.63	3.4	0.56	4.0	0.82	5.1	0.69	4.2
8/1	Otley Road WB Ahead Right Left	0.63	11.2	0.58	9.4	0.71	14.2	0.70	14.3
PRC (%)		42.2		54.5		-50.1		27.3	
Total Delay (pcuHr)		8.24		8.42		93.64		10.18	

Mitigation required for the AM Do Something Scenario.

*Mitigated Layout:*

The LinSig modelling showed that the junction could not be brought within capacity within the available roadspace. Given the turning movements and available land, an additional lane of five vehicles length for right turning vehicles has been added to the western Otley Road arm, with the junction subsequently modelled to operate within capacity.

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	MMQ	RFC	MMQ	RFC	MMQ	RFC	MMQ
1/2+1/1	Beckwith Head Road Left Ahead Right	0.62	4.7	0.55	5.0	0.39	1.8	0.64	3.8
2/1	Otley Road WB Exit	0.03	0	0.11	0.1	0.07	0	0.22	0.1
3/1	Crag Lane (Exit)	0.05	0	0.07	0	0.03	0	0.04	0
4/1	Otley Road EB (Exit)	0.19	0.1	0.21	0.1	0.26	0.2	0.23	0.1
5/1	Beckwith Head Road (Exit)	0.28	0.2	0.12	0.1	0.45	0.4	0.21	0.1
6/1	Otley Road EB Left Ahead Right	0.13	1.6	0.15	2.0	0.63	4.8	0.25	3.0
7/1	Crag Lane Right Left Ahead	0.57	3.2	0.56	4.0	0.72	4.1	0.69	4.1
8/1	Otley Road WB Ahead Right Left	0.62	11.4	0.55	9.1	0.70	14.4	0.70	14.2
PRC (%)		44.7		60.5		25.8		29.5	
Total Delay (pcuHr)		8.11		8.30		10.75		9.80	

**Junction 8 – A658 / B6164 / Wetherby Road, Harrogate, Node Number 35**

As the traffic flows around the junction are relatively uneven, the unmitigated junction has been modelled in 'lane simulation mode', which tests the capacities of individual lanes. Lane simulation mode provides Level of Service (LOS) figures for each arm instead of RFC values.

*Unmitigated Layout:*

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		LOS	Q	LOS	Q	LOS	Q	LOS	Q
Arm 1	A658 North	F	22.1	F	14.1	F	57.5	F	50.9
Arm 2	Wetherby Road	A	0.6	C	2.4	B	1.3	D	3.4
Arm 3	A658 South	A	1.7	A	2.3	B	4.9	A	1.6
Arm 4	B6164 West	D	8.5	F	28.1	F	56.8	F	16.8

A level of Service of E or F indicates that the junction is performing poorly in certain areas (A658 and B6164) and should therefore be assessed in more detail.

*Mitigated Layout:*

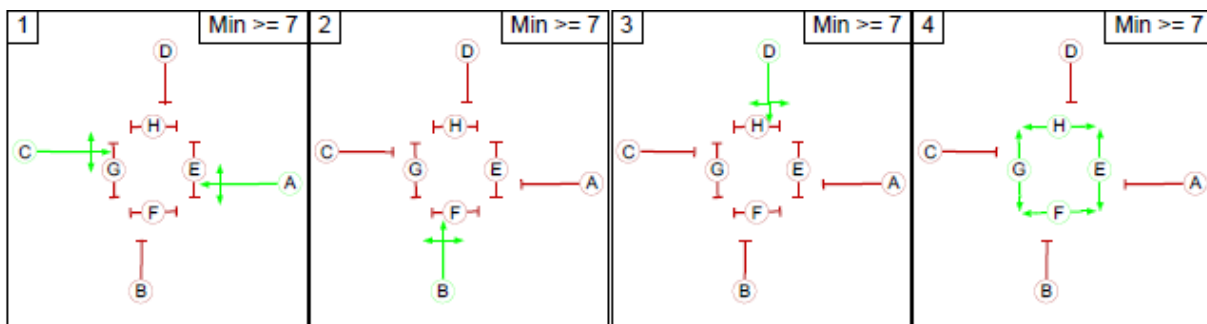
In the immediate vicinity around the junction there is land within the designated highway boundary. The initial modelling showed that lane usage on the northern A698 and eastern Wetherby Road arms was relatively uneven and therefore the Local Plan impacts can be mitigated by permitting ahead movements to use both lanes. This requires some widening of the exits of the respective arms. The issues on the B6164 western arm can be mitigated by increasing the flare length for both lanes on the approach to the junction. It can be assumed that lanes would be evenly used as part of the changed layout and 'lane simulation mode' is therefore not required.

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	Q	RFC	Q	RFC	Q	RFC	Q
Arm 1	A658 North	0.58	1.4	0.56	1.3	0.70	2.3	0.65	1.9
Arm 2	Wetherby Road	0.20	0.3	0.39	0.6	0.35	0.6	0.45	0.8
Arm 3	A658 South	0.45	0.9	0.46	0.9	0.55	1.3	0.41	0.7
Arm 4	B6164 West	0.58	1.4	0.61	1.6	0.77	3.4	0.63	1.7

**Junction 10 – A59 / B6164 / Chain Lane, Harrogate, Node Number 50**

Modelling for this junction has been undertaken using the committed cross-roads layout.

*Current Staging Plan:*



## Unmitigated Layout:

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	MMQ	RFC	MMQ	RFC	MMQ	RFC	MMQ
1/1+1/2	A59 York Road (E) Left Ahead Right	0.85	16.9	1.03	41.3	1.09	56.9	1.09	60.8
2/2+2/1	B6164 Wetherby Road Right Left Ahead	0.86	8.2	1.01	18.5	1.05	19.1	1.08	29.6
3/1+3/2	A59 York Road (W) Ahead Right Left	0.74	13.6	0.68	12.3	0.86	18.2	0.69	12.9
4/2+4/1	Chain Lane Left Ahead Right	0.88	10.1	1.04	21.6	1.07	36.4	1.05	21.7
PRC (%)		2.5		-15.9		-21.6		-20.9	
Total Delay (pcuHr)		26.85		65.57		98.86		95.17	

Mitigation required for PM Do Minimum and both Do Something Scenarios.

## Mitigated Layout:

The mitigated layout consists of extended right turn pockets for both arms on the A59. The overall junction layout (cross-roads) and the signal stages have not been changed.

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	MMQ	RFC	MMQ	RFC	MMQ	RFC	MMQ
1/1	A59 York Road (E) Left Ahead	0.77	13.7	0.88	23.9	0.92	25.6	0.92	27.6
1/2	A59 York Road (E) Right	0.20	0.8	0.17	0.9	0.36	1.4	0.22	1.2
2/2+2/1	B6164 Wetherby Road Right Left Ahead	0.78	6.8	0.88	13.2	0.92	11.8	0.92	15.6
3/1	A59 York Road (W) Ahead Left	0.67	11.7	0.60	13.0	0.76	17.9	0.61	13.4
3/2	A59 York Road (W) Right	0.23	0.9	0.29	0.9	0.47	1.5	0.35	1.0
4/2+4/1	Chain Lane Left Ahead Right	0.77	7.4	0.88	12.0	0.92	19.7	0.91	12.8
PRC (%)		15.4		1.8		-2.6		-2.4	
Total Delay (pcuHr)		20.52		30.0		38.76		35.14	

## **Junction 14 – A61 / Pannal Bank / Follifoot Road, Harrogate, Node Number 55**

This junction requires a substantial intervention to enable delivery of the proposed Local Plan development allocations. Work is underway to finalise potential solutions and will be published in due course. HBC and NYCC are working together to develop appropriate solutions to mitigate the impact of traffic generated by the local plan allocations.

## **Junction 15 – Hookstone Road / Oatlands Drive, Harrogate, Node Number 1676**

A sensitivity test has been run in VISUM using AM DS3a flows. Additional green time has been allocated to Hookstone Road and Hookstone Drive, whilst cycle time for the South Eastern arm linking Hookstone Drive to St John Fisher School has been shortened assuming that this stage would not be activated during every signal cycle. As a result, junction VCR decreases from 91% to 81% causing the junction to operate within capacity. No further mitigation work has therefore been undertaken.

## **Junction 20 – Leeds Road / West Park, Harrogate, Node Number 8**

A junction model has been developed for this junction using Junctions 9 software and flows obtained from the VISUM model. Whilst VISUM declares this junction as operating over capacity, ARCADY declares it as fit for purpose.

*Unmitigated Layout:*

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	Q	RFC	Q	RFC	Q	RFC	Q
Arm 1	A61 York Place	0.30	0.4	0.39	0.6	0.35	0.5	0.38	0.6
Arm 2	Leeds Road	0.46	0.9	0.59	1.5	0.44	0.8	0.67	2.0
Arm 3	B6161 Otley Road	0.45	0.8	0.34	0.5	0.49	1.0	0.36	0.6
Arm 4	West Park	Oneway Road							

No mitigation required as junction performance meeting guidance for all scenarios and time periods.

**Junction 21 – Kestrel Roundabout, Harrogate, Node Number 28**

A junction model has been developed for this junction using Junctions 9 software and flows obtained from the VISUM model.

*Unmitigated Layout:*

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	Q	RFC	Q	RFC	Q	RFC	Q
Arm 1	A658 North	0.60	1.5	0.55	1.2	0.73	2.8	0.63	1.7
Arm 2	A661 East	0.63	1.8	0.55	1.2	0.82	4.4	0.58	1.4
Arm 3	A658 South	0.51	1.0	0.64	1.8	0.65	1.9	0.67	2.0
Arm 4	A661 Wetherby Road West	0.70	2.3	0.83	4.9	0.80	4.1	0.97	18.8

Mitigation required for the PM Do Something Scenario.

*Mitigated Layout:*

A third lane has been added for the A661 Wetherby Road allowing for one left turn lane, one straight ahead lane and the final lane being straight ahead and right. As two straight ahead lanes require two exit lanes for the A661 East arm, an additional pocket has been added, which merges into one lane shortly after the roundabout.

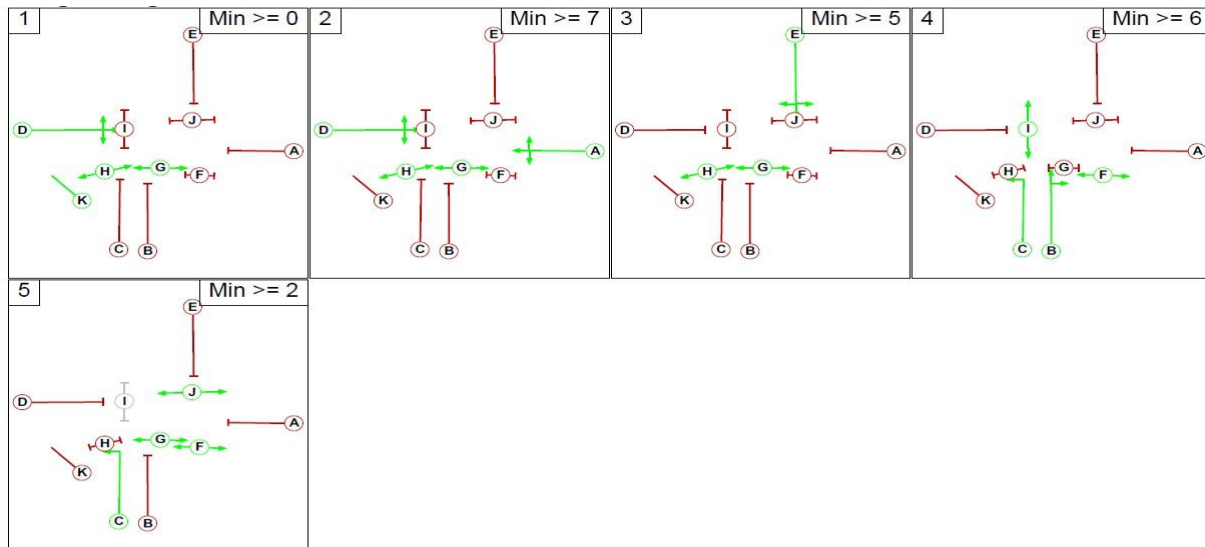
Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	Q	RFC	Q	RFC	Q	RFC	Q
Arm 1	A658 North	0.60	1.5	0.55	1.2	0.73	2.8	0.63	1.7
Arm 2	A661 East	0.63	1.8	0.55	1.2	0.82	4.4	0.58	1.4
Arm 3	A658 South	0.51	1.0	0.64	1.8	0.65	1.9	0.67	2.0
Arm 4	A661 Wetherby Road West	0.60	1.5	0.71	2.5	0.69	2.3	0.83	4.8

**Junction 22 – Hookstone Road / Hornbeam Park Avenue, Harrogate, Node Number 49**

A junction model has been developed for this junction using LinSig software. Flows were obtained from the VISUM model. As Rayleigh Road is not included in the model, Hornbeam Crescent flows have been used to infill the missing values. Turning proportions for Rayleigh Road and signal timings have been obtained from the “Land at Harrogate Collage TA” provided to Jacobs by HBC in September 2017. Whilst VISUM declares this junction as operating over capacity, LinSIG declares it as fit for purpose.



## Current Staging Plan:



## Unmitigated Layout:

Arm		Do Minimum AM Peak		Do Minimum PM Peak		Do Something AM Peak		Do Something PM Peak	
		RFC	MMQ	RFC	MMQ	RFC	MMQ	RFC	MMQ
1/1	Rayleigh Road Left Right Ahead	0.68	6.5	0.71	3.9	0.81	8.1	0.68	3.3
2/1	Hookstone Road Right Ahead Left	0.68	14.7	0.79	12.4	0.80	20.2	0.78	12.5
3/1	Hornbeam Park Avenue Left	0.09	1.1	0.14	2.2	0.16	1.8	0.14	2.3
3/2	Hornbeam Park Avenue Ahead Right	0.68	7.2	0.77	17.3	0.78	7.7	0.78	17.5
6/2 +6/1	Hookstone Road West Left Ahead Right	0.42	4.3	0.51	7.3	0.53	7.9	0.57	8.7
PRC (%)		31.8		14.4		10.7		15.8	
Total Delay (pcuHr)		15.43		18.54		20.44		18.87	

No mitigation required as junction performance meeting guidance for all scenarios and time periods.

### **Junction 23 – Leeds Road / Vernon Road, Harrogate, Node Number 1098**

An additional zone connector has been added at Leeds / Road Norfolk Road in order to distribute traffic across several links. No pre-set connector splits have been assigned and traffic therefore uses the most suitable alternative to enter the model. AM VCR can be reduced to 48.28%, whilst the updated PM value is 38.25%. It is therefore assumed that the junction operates within capacity and that a detailed junction model will not be required.

### **Junction 24 – Cold Bath Road / West Cliffe Grove, Harrogate, Node Number 357**

An additional zone connector has been added at Harlow Oval in order to distribute traffic across several links. No pre-set connector splits have been assigned and traffic therefore uses the most suitable alternative to enter the model. AM VCR can be reduced to 78.55%, whilst the updated PM value is 71.29%. It is therefore assumed that the junction operates within capacity and that a detailed junction model will not be required.