Technical Note

Project:	Gadbrook NPIF	**Project No:**	387230
Title:	Results of the junction modelling		
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INTRODUCTION

The existing four arm signal controlled junction of Gadbrook Road/A556 has been modelled using LINSIG 3.

Future improvements have then been tested based on designs prepared by Cheshire West and Chester (CWaC) Option 1 and Mott MacDonald (MM) Option 2. The improvements would increase the length of right turn lanes on the A556 and would provide a free flow left lane from the south.

The (MM) Option 2 Design provides a longer lead in lane for this left turn free flow than the (CWaC) Option 1 Design and also provides an additional short entry lane to the signals from the north.

TRAFFIC FLOWS

Traffic surveys were carried out on 12th October 2016 by NDC. The peak hour turning movements (AM 0800-0900 and PM 1700-1800) have been converted to equivalent passenger car units (PCU) and are shown in Figures 1 and 2 below:

Figure 1. Observed flows AM peak hour (0800-0900) 2016 in PCU

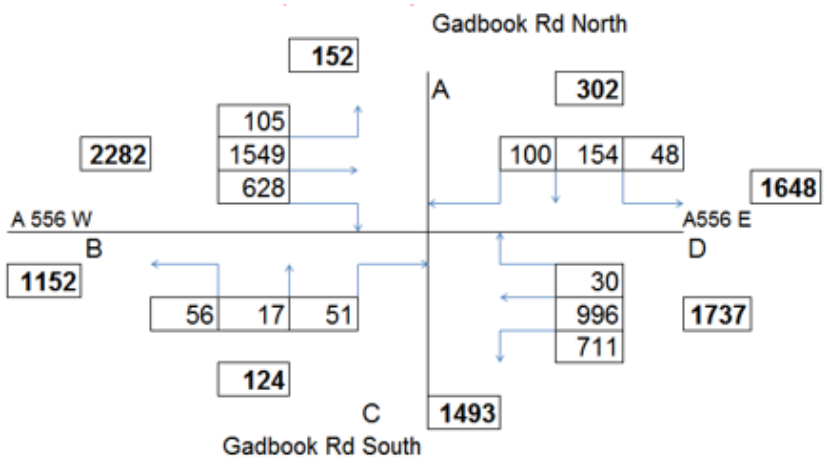
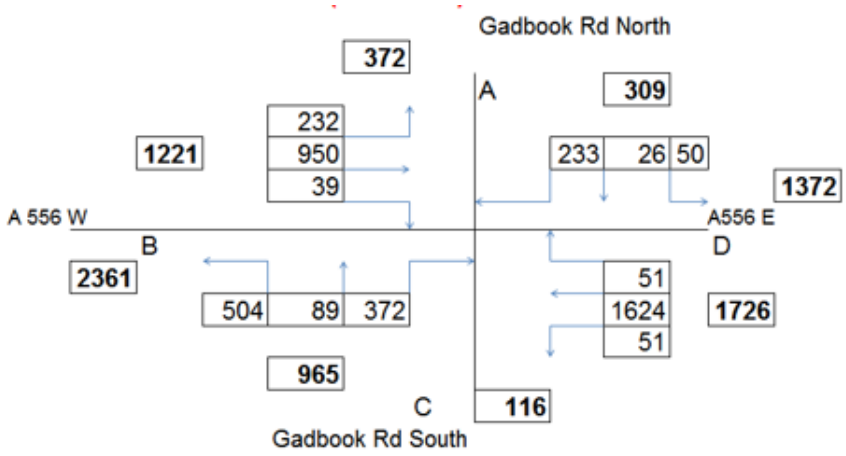


Figure 2. Observed flows PM peak hour (1700-1800) 2016 in PCU



Interpeak flows have also been considered to inform the SATURN modelling.

TRAFFIC GROWTH

In order to assess the future operation of the junction, the flows have been growthed to 2020 using the TEMPRO 7.2 growth factors in Table 1.

Table 1. TEMPro Growth Factors

Time	AM	Interpeak	PM
2016-2020 TEMPro Growth factor	1.0499	1.0562	1.0477

In order to avoid double counting the new employment trips on the network, the TEMPRO 7.2 growth factors have only been applied to those movements which would not be affected by the development traffic.

FUTURE TRIPS

EMPLOYMENT TRIP GENERATION

We understand that 1059 jobs are expected to be provided at Gadbrook Park, to the south of the junction by 2020. We have derived trip rates for Business Park (BP) uses from the TRICS database in order to determine the number of trips these additional employees would generate.

Although the jobs are expected to be mainly office related, the site is a business park and therefore the trip rates for business parks are likely to be more representative.

The business park rates were found to be approximately double the rates associated with office use therefore this assessment will represent a worst case assessment.

The trip rates per employee, from TRICS, are shown in the Table 2 with the actual number expected to be generated by the 1059 jobs shown in Table 3.

Table 2. Business Park Trip Rates Per Employee.

	Business Park (trip rate per employee)		
	Arrivals	Departures	Totals
AM	0.347	0.063	0.410
Interpeak	0.123	0.128	0.251
PM	0.044	0.277	0.321

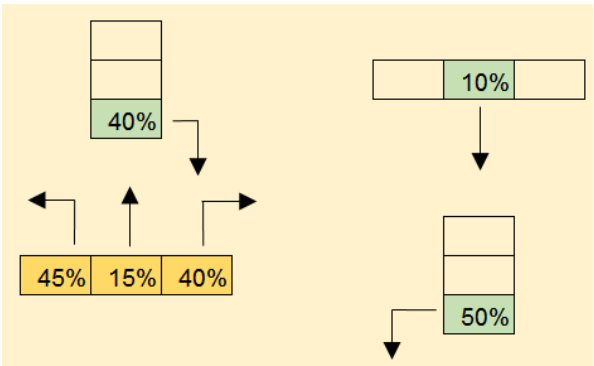
Table 3. Anticipated Total Number of Business Park Trips.

	Actual Business Park trips		
	Arrivals	Departures	Totals
AM	367	67	434
Interpeak	130	136	266
PM	47	293	340

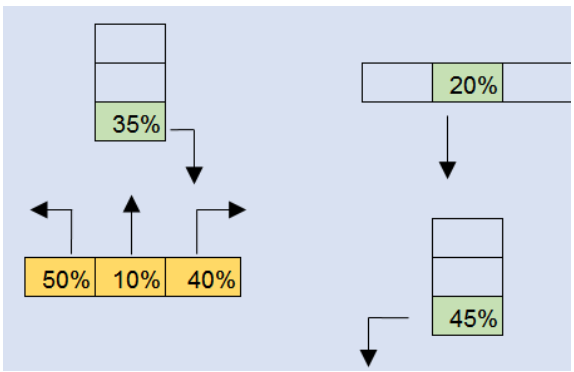
ASSIGNMENT OF FUTURE DEVELOPMENT TRIPS

The assignment of the additional trips onto the network has been based on the observed distribution of existing traffic at the junction and is shown in Figure 3, the actual number of trips are shown in Figure 4.

Figure 3. Assignment of trips around the junction.

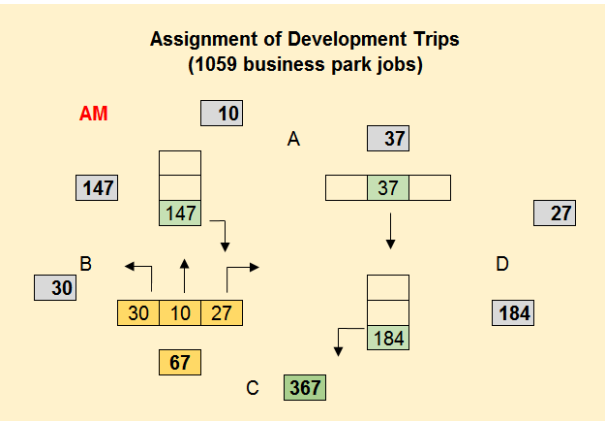


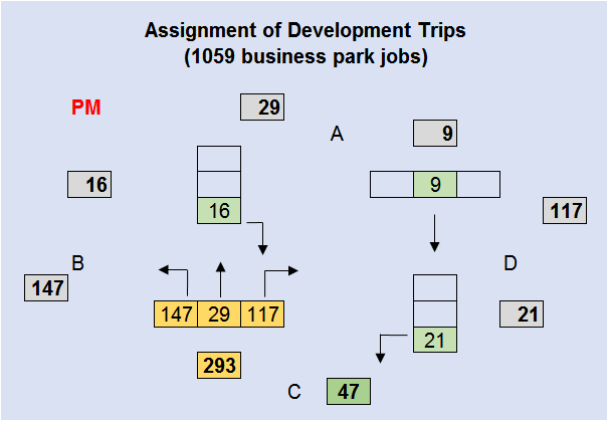
Distribution of development trips AM



Distribution of development trips PM

Figure 4. Peak Hour Development Trips.





EXISTING JUNCTION.

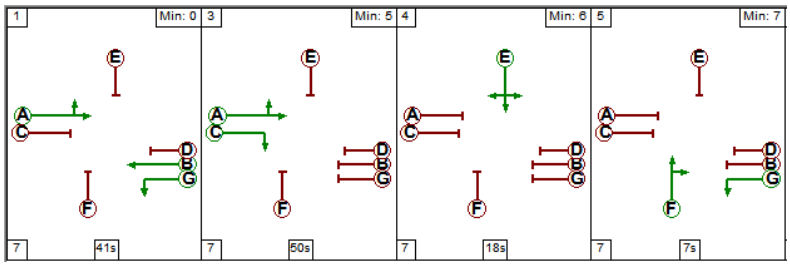
The existing signal timings have been provided by CWaC.

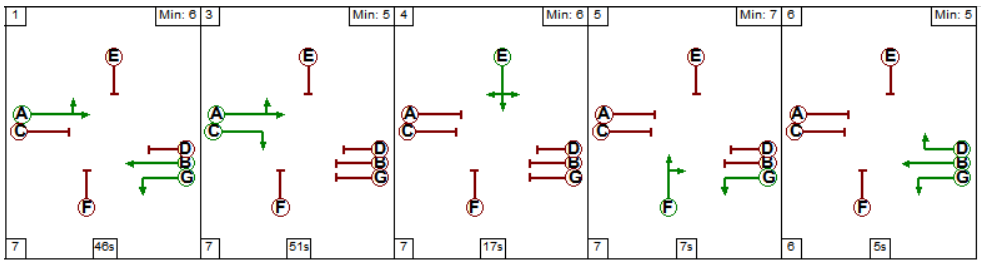
The current staging varies in each peak hour to reflect the change in demand and is shown in Figure 5; In the morning peak hour the westbound arm only runs in every other cycle, in the evening peak hour it is the eastbound arm which only runs in every other cycle. No information was available for the interpeak and therefore a 90s single cycle has been tested with each stage running once.

In the peak hours the junction operates with a cycle time of around 304s.

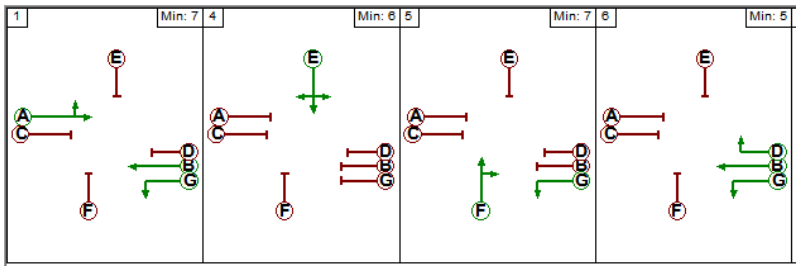
Figure 5. Existing Peak Hour Stage Sequences.

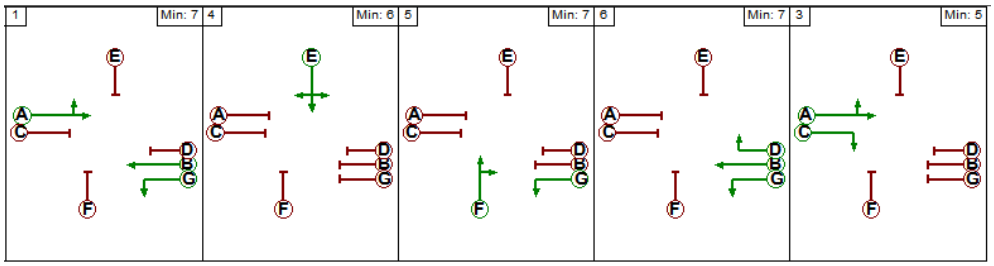
AM staging





PM staging





RESULTS OF THE LINSIG MODELLING OF THE EXISTING JUNCTION

The results of the assessment for 2020 with the 1059 business park jobs are shown in Table 4 overleaf.

AM PEAK HOUR

The LINSIG indicates that there would be significant congestion on all arms of the junction in the morning peak hour with degrees of saturation (deg satn) of around 115-130% and mean maximum queue lengths (MMQ) between 25-300pcu in length. (Ideally the deg. satn values should be no more than 90%.)

Delays to drivers on all arms would be between 7-12 minutes.

The practical reserve capacity (PRC) in the AM peak hour would be -48.7%. The PRC indicates the spare capacity in the junction and a value of 5% or more would be desirable, a negative value shows that the junction is over capacity.

PM PEAK HOUR

In the PM peak hour all arms of the junction would be over 105% deg.satn. and queues would be excessive. Drivers on all arms would experience delays of between 4-14 minutes.

Table 4 LINSIG results for Existing junction and Staging

Existing Junction and Staging	AM 2020 + 1059 BP jobs			PM 2020 + 1059 BP jobs		
	Deg Satn (%)	Delay* (s/pcu)	MMQ (pcu)	Deg Satn (%)	Delay* (s/pcu)	MMQ (pcu)
A556 Wbd AL	133.8	663	214	147.9	846	237
A556 Wbd AR	131.7	643	190	147.9	848	238
Gadbrook Rd S	117.4	467	27	147.4	230	322
A556 Ebd AL	126.4	528	301	108.5	274	65
A556 Ebd AR	132.8	636	187	108.0	312	62
Gadbrook Rd N	131.8	703	81	145.1	822	86
PRC (%)	-48.7			-64.4		
Total Delay (pcuHr)	838			893		

*Delays over 180s (3 minutes) are shown in red

LIMITATIONS OF THE LINSIG MODELLING

Mott MacDonald have taken advice from JCT with regard to how to model the proposed free flow left turn lane from the south due to the limitations of modelling short lanes in LINSIG.

LINSIG is not able to model the short lane which develops for the right turning traffic and the short lane which develops for the left turning traffic.

To overcome this the right turn short lane has been modelled accurately but the left turn free flow lane has been coded as an unconstrained long lane. The model therefore assumes that the left turn traffic is always able to access the lane. In reality there may be times when the lane is blocked (as it is not a full length lane) and therefore consideration has to be given to how often this happens.

Whilst the left lane is blocked by ahead/right turn traffic the left turning vehicles will be adding to the back of the queue in the ahead lane but this will not be reflected in the LINSIG modelling results.

PROPOSED JUNCTION LAYOUT: (CWaC) OPTION 1 DESIGN

The improvements proposed by Cheshire West and Chester (CWaC) Option 1 would increase the length of the right turn lanes on the A556 and would provide a free flow left lane from the south.

The results of the LINSIG modelling for this design are shown in Table 5.

Table 5 LINSIG results for Improved (CWaC) Option 1 junction

(CWaC) Option 1	AM 2020 + 1059 BP jobs			PM 2020 + 1059 BP jobs		
	Deg Satn (%)	Delay* (s/pcu)	MMQ (pcu)	Deg Satn (%)	Delay* (s/pcu)	MMQ (pcu)
A556 Wbd AL	132.9	642	217	105.4	190	81
A556 Wbd AR	130.0	618	176	105.5	199	76
Gadbrook Rd S AR	53.3	94	4	105.5	215	49**
A556 Ebd AL	126.5	534	307	87.6	61	24
A556 Ebd AR	132.0	613	197	104.1	78	26
Gadbrook Rd N	131.3	670	76	104.5	232	30
PRC (%)	-47.7			-17.2		
Total Delay (pcuHr)	798			180		

**Delays over 180s (3 minutes) are shown in red*

*** this queue would block access to the left turn lane and therefore left turning traffic would be forced to queue behind the ahead and right turning traffic. This is not reflected in LINSIG so in reality this queue would be longer (see comments below).*

In the AM peak hour the improvements would provide some benefits around the junction; there would be a reduction in delay on all arms to between 1½ - 11 minutes and queue lengths would also decrease.

The improvements would benefit the PM peak hour more significantly than the AM; the degrees of saturation would reduce to nearer 100% on all arms and all queues would be less than 100pcu. Delays on all arms would be between 1-3½ minutes.

However, as discussed above the limitations of LINSIG are not truly reflecting the operation of the junction in the evening peak hour when the queue on Gadbrook Road S is blocking entry to the left turn lane for some of the cycle.

Interrogation of the queue graphs in LINSIG indicates that the left lane would be blocked for around 75% of every 5 minute cycle. For this time any left turning traffic would add to the back of the 49 pcu queue of ahead and right turning vehicles.

PROPOSED JUNCTION LAYOUT: (MM) OPTION 2 DESIGN.

The (MM) Option 2 Design provides a longer lead in lane for the left turn free flow lane on Gadbrook Road South than the (CWaC) Option 1 Design and also provides an additional short entry lane to the signals from the north.

Table 6 LINSIG results for Improved (MM) Option 2 junction

(MM) Option 2	AM 2020 + 1059 BP jobs			PM 2020 + 1059 BP jobs		
	Deg Satn (%)	Delay* (s/pcu)	MMQ (pcu)	Deg Satn (%)	Delay* (s/pcu)	MMQ (pcu)
A556 Wbd AL	126.1	547	193	101.2	116	55
A556 Wbd AR	123.4	517	153	101.0	120	56
Gadbrook Rd S AR	55.0	93	4	100.6	136	37**
A556 Ebd AL	121.3	451	271	81.4	51	20
A556 Ebd AR	126.9	539	180	92.7	61	22
Gadbrook Rd N	126.4	591	66	100.8	177	23
PRC (%)	-41.0			-12.4		
Total Delay (pcuHr)	686			119		

**Delays over 180s (3 minutes) are shown in red*

*** this queue would block access to the left turn lane and therefore left turning traffic would be forced to queue behind the ahead and right turning traffic. This is not reflected in LINSIG so in reality this queue would be longer (see comments below).*

With the (MM) Option 2 design, there would still be congestion at the junction, particularly in the morning peak hour however the proposals would reduce the delays and queue lengths. The delays per pcu would reduce to between 1½ - 5 minutes in the AM peak hour and to less than 2.5 minutes in the PM peak hour.

However, in the evening peak hour the queue on Gadbrook Road S would block entry to the left turn lane for some of the cycle.

Interrogation of the queue graphs in LINSIG indicates that the left lane would be blocked for around 1½ minute (92s) of every 5 minute cycle. For this time any left turning traffic would add to the back of the 37pcu queue of ahead and right turning vehicles.

The queue graphs are appended for information.

CONCLUSION

The LINSIG modelling shows that the proposed improvements would benefit the operation of the signals although there would still be some level of queueing and delay in each peak hour.

The extended left turn free flow lane from the south, provided in the (MM) Option 2 design, would benefit this movement as access to the lane would be available for a greater proportion of each cycle than the shorter lane in the (CWaC) Option 1 design.

The total junction delay for each design is shown in Table 7.

Table 7 – Comparison of the Total Junction Delay for each geometric layout (pcuHr)

Total Junction Delay (pcuHr)	AM	PM
Existing	838	893
(CWaC) Option 1	798	180**
(MM) Option 2	686	119**

**These values will not accurately reflect the Total Junction Delay as they do not include the delay to the left turning traffic when it cannot access the free flow lane and has to queue behind the ahead and right turning vehicles.