Technical Note

Project:	Navan Cycle Scheme - R147 Poolboy Bridge to Kells Road Roundabout		
Subject:	Traffic and Transport Analysis		
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Date:	29/09/2022	Project No.:	5214376
Atkins No.:	5214376DG0044	Icepac No.:	
Distribution:	Meath Co. Co.	Representing:	Meath County Council

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 0	Working Draft	PD	NV	NV	NV	23/09/2022
Rev 1	Working Draft	PD	NV	NV	NV	29/09/2022
Rev 2	Final	PD	NV	NV	NV	05/10/2022

Client signoff

Client	Meath County Council
Project	Navan Cycle Scheme - R147 Poolboy Bridge to Kells Road Roundabout
Project No.	5214376
Client signature / date	

1. Introduction

1.1. Background

Meath County Council (the Client/MCC) as the Contracting Authority, appointed Atkins (the Consultant) to provide Engineering-led Multi-disciplinary Consultancy and Design services for the concept development & option selection, preliminary design and statutory processes of cycle provisions and associated works including public realm and urban enhancements on the R147 from Poolboy Bridge to Kells Road in Navan, Co. Meath, as part of the Navan Cycle Scheme.

1.2. Transport Assessment Methodology

This TTA has been undertaken in accordance with current best practice guidance and planning policies. The following documents have been referenced during the preparation of this report:

- NRA Traffic and Transport Assessment Guidelines (May 2014);
- TII Project Appraisal Guidelines (October 2016);
- Design Manual for Urban Roads and Streets (DMURS);
- TII Design Manual for Roads and Bridges (TII DMRB);
- NTA Transport Strategy for the Greater Dublin Area 2016-2035;
- National Cycle Manual;
- Meath County Development Plan 2021-2027;
- Greater Dublin Area Cycle Network Plan (December 2013); and
- NTA Alternate Future Scenario for Travel Demand, November 2020.

The primary objective of the Traffic and Transport Assessment (TTA) is to assess the possible impacts of the proposed Cycle scheme on relevant junctions

2. Receiving Environment

2.1. Site Location

The Project is located north of Navan Town centre, adjacent to the River Blackwater (which is part of the "River Boyne and River Blackwater" SAC). The western end of the scheme ties into the LDR4 Scheme while the eastern end ties into the R147/Flower Hill junction (Poolboy Bridge). Figure 2-1 illustrates the location and the extents of the route, which totals approximately 1.1km.

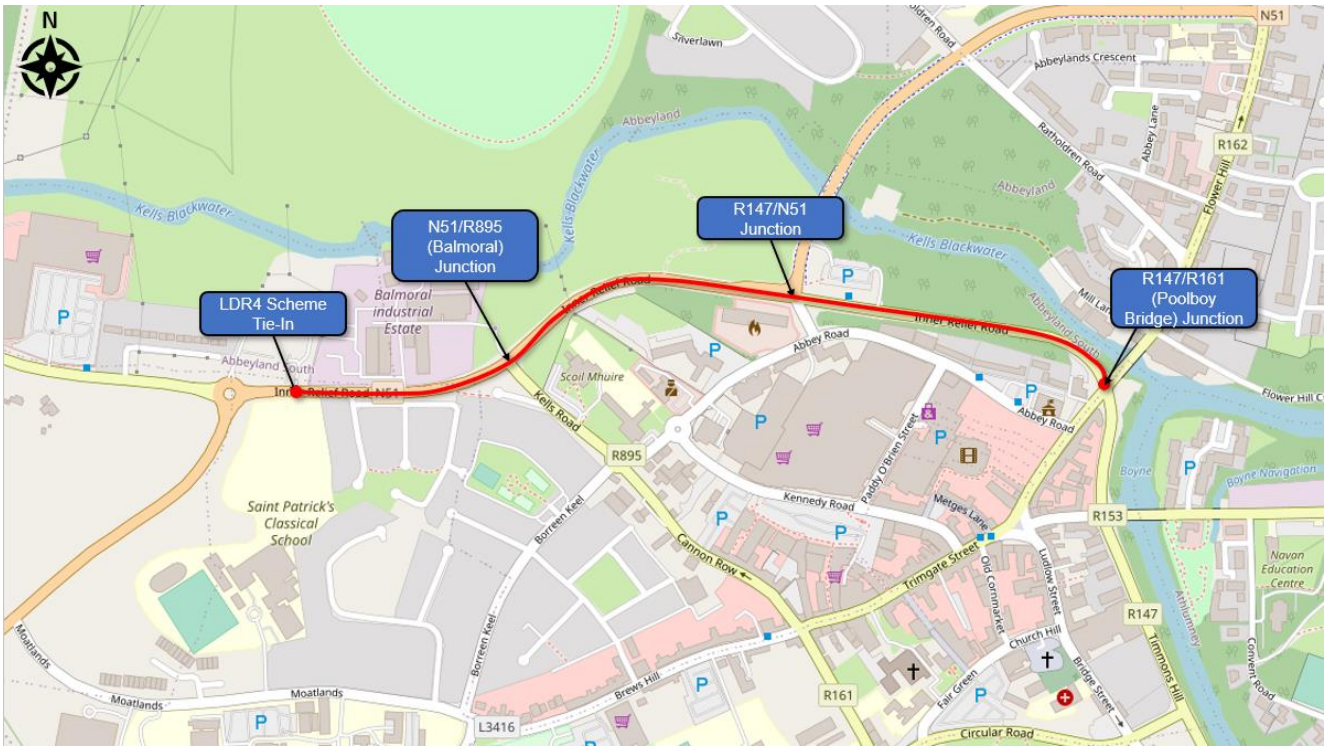


Figure 2-1 - Route Location and Extents

2.2. Policy Background

2.2.1. Greater Dublin Area Cycle Network

Several routes have been identified within the Greater Dublin Area Cycle Network Plan which are listed below. The route relevant to this project is the *"Na1: R147 Dublin/Kells Road between the N51 and Old Balreask Woods"* which is highlighted in the list below. This route is a Primary / Secondary route and is shown in Figure 2-2 below.

- M5: Boyne Valley Greenway from Drogheda to Navan to Trim to the Royal Canal Greenway at Longwood;
- **Na1: R147 Dublin/Kells Road between the N51 and Old Balreask Woods;**
- Na2: Metges Road/ East Orbital;
- Na3: Fairgreen to Johnstown with a new bridge over the River Boyne;
- Na4: Southern Ring from Johnstown to Athboy Road;
- Na5: Northern Cross from Athboy Road to Slane Road;
- Na6: Windtown Road to Commons Road; and
- Na7: Proudstown Road to Trim Road.

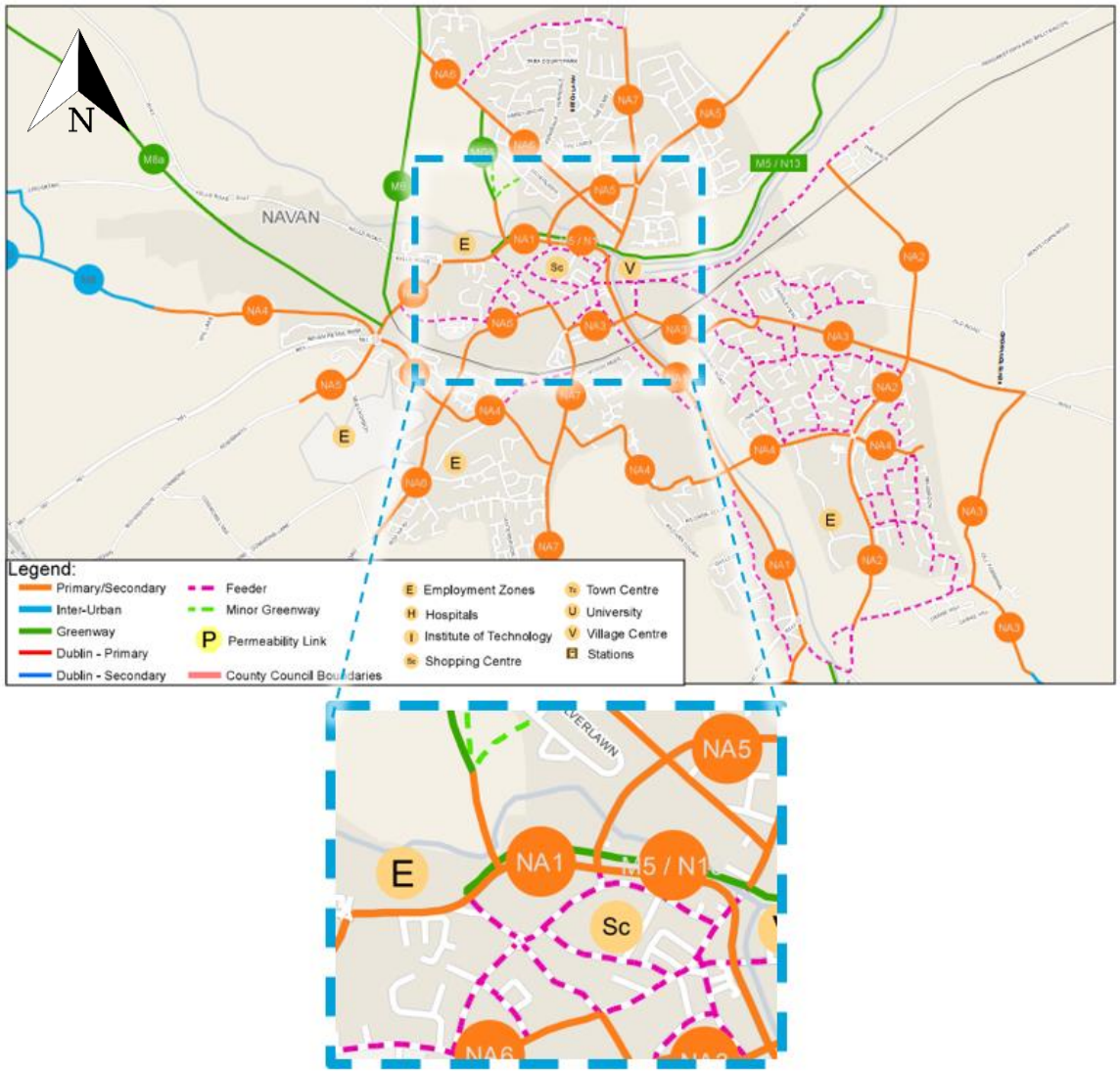


Figure 2-2 - Greater Dublin Area Cycle Network Plan (Navan)

2.3. Surrounding Road Network

2.3.1. Links

Regional Road R147 forms the main part of the proposed cycle scheme. It is a 2+2 single carriageway with a speed limit between 50-60 km/h along the proposed stretch of the cycle scheme. It is noted that the speed limit changes to 60kmph near Balmoral Junction.

Other key links include:

- **N51:** The tie in N51 northern arm is a 2+1 single carriageway with speed limit of 50 km/hr near the proposed cycle scheme. It joins and runs along the R147 at the middle of the cycle scheme where they form a signalised junction (R147/N51 Junction) and N51 forms the northern arm of the junction. The N51 running along the R147 Kells road forms a 2+2 single carriageway.
- **Watergate Street:** Watergate Street is a 1+1 single carriageway with speed limit of 50 km/hr near the proposed cycle scheme. It joins R147 at the eastern part of the proposed cycle scheme at the signalized junction (R147/R161 Poolboy bridge Junction) and forms the eastern arm of the junction.
- **R895 Cannon Row Rd:** The R895 Cannon Row Rd is a 2+1 single carriageway with speed limit of 50 km/hr near the proposed cycle scheme. It joins R147 at the western part of the proposed cycle scheme at the signalised junction (N51/R147 Balmoral Junction) and forms the southern arm of the junction.

2.3.2. Junctions

The key junctions which are proposed to be upgraded for the cycle scheme are as follows:

- R147/R161 Poolboy Bridge Junction,
- R147/N51 Junction, and
- N51/R895 Balmoral Junction.

These junctions are summarised in Figure 2-3 below.

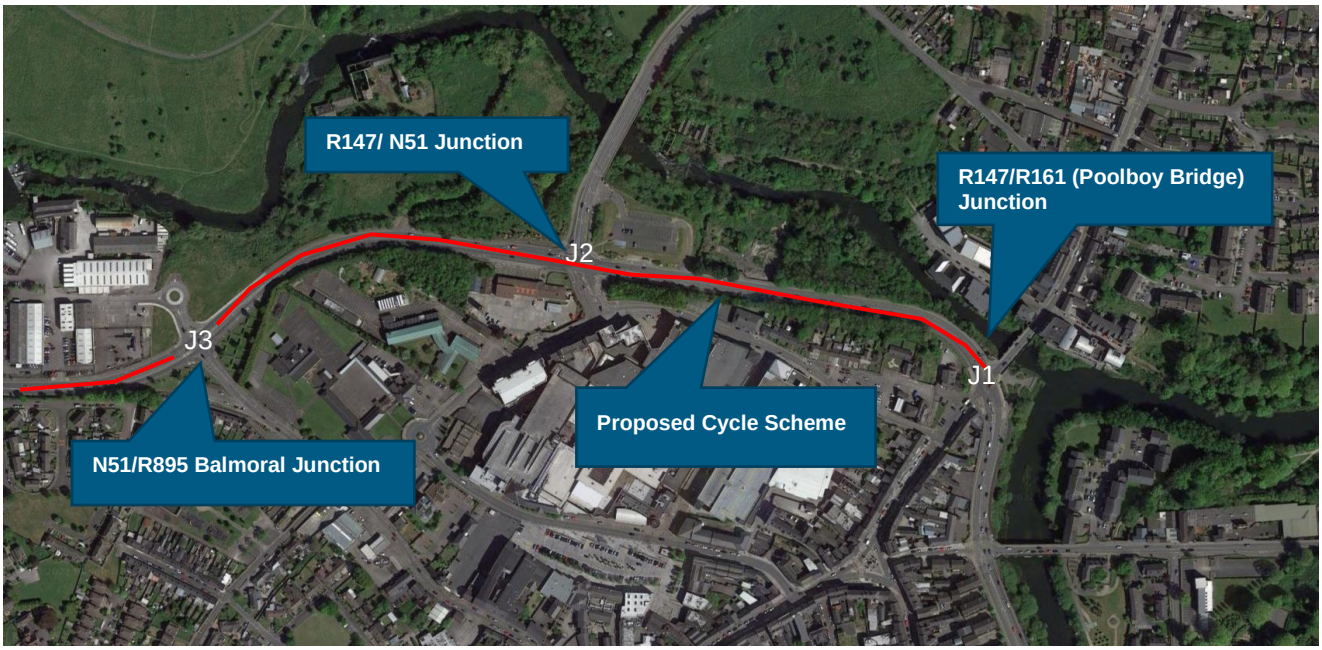


Figure 2-3 - Location of key junctions

2.3.3. Current Baseline Traffic Flows

Traffic surveys were commissioned and undertaken by IDASO on May 18, 2022 at the key junctions outlined in the previous section. The survey was undertaken between 07h00 am to 19h00 for 12 hours.

Based on the traffic survey data, the following morning and evening peak hours were determined:

- **AM Peak:** 08h00 to 09h00; and
- **PM Peak:** 17h00 to 18h00.

3. Future Assessment Scenarios

3.1. Background growth (NTA Growth)

The baseline traffic has then been grown in accordance with the growth in the number of trips per day as per the NTA National Demand Forecasting Model which is shown in Figure 3-1 below.

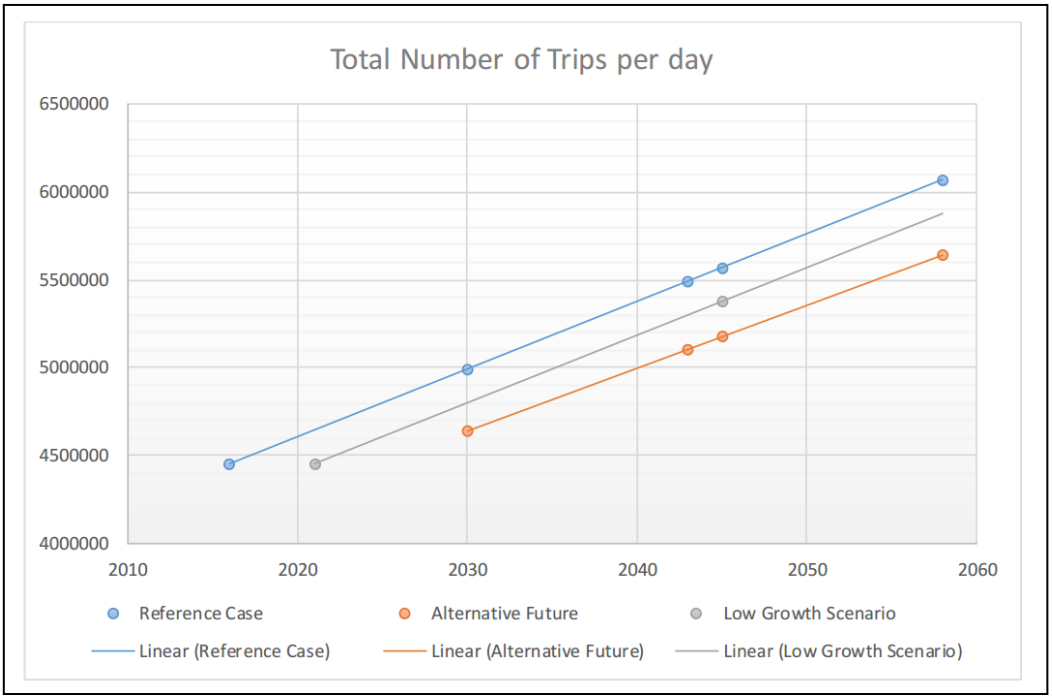


Figure 3-1 - Growth in number of trips per day (NTA National Forecasting Model)

Based on the above figure, the growth in number of trips per day for the Reference Case (Blue line) is summarised in Table 3-1 below.

Table 3-1 - Growth in number of trips per day (NTA National forecasting Model)

Year	Person Trip	Growth Rate over 10 years
2020	4,600,000	
2030	5,000,000	0.087
2040	5,400,000	0.080
2050	5,800,000	0.074
Average growth over each 10 year period		**0.080**
Average growth per year		**0.008**
Growth Factor		**1.008**

The number of trips per day is expected to increase by a factor of approximately 0.8% per year. The trips per day consist of all modes of transport including cars, public transport and active travel. Thus, the actual growth per mode may differ. In reality, considering modal shift targets and national policy, it is likely that the vehicle trip growth rate will be less than the overall trip growth rate. However, taking a conservative approach, it has been assumed that the overall growth factor applies to the baseline traffic.

3.2. Mode Share

The proposed cycle scheme will facilitate the shift in car-based modal share to active travel. However, this modal shift has not been considered as part of the scheme modelling for future year design scenarios as the exact impact of the improved modal shift is to be realised.

3.3. Modelled Scenarios

The model was run for the following scenarios during both AM and PM peaks:

- Opening Year (2024) – 'Do Nothing' Scenario;
- Opening Year (2024) – 'Do Something' Scenario;
- Opening Year + 5 (2029) – 'Do Nothing' Scenario;
- Opening Year + 5 (2029) – 'Do Something' Scenario;
- Opening Year + 15 (2039) – 'Do Nothing' Scenario; and
- Opening Year + 15 (2039) – 'Do Something' Scenario.

In the 'Do Nothing' Scenarios, the key junctions were assessed according to their existing configuration. In the 'Do Something' scenarios, the junctions were assessed based on the proposed layouts of the junctions as a part of the cycle scheme.

Traffic for the future design years was calculated based on growth factors discussed in the previous section.

3.4. Assessment Approach

The junctions were analysed individually using the following transport modelling software:

Table 3-2 - Junction Modelling Software Utilised

Modelling Software	Junction Type	Sites Modelled
JCT LinSig	Traffic Signals	• R147/R161 Poolboy Bridge Junction, • R147/N51 Junction, and • N51/R895 Balmoral junction.

All the junctions were analysed using the same modelling software for both 'Do Nothing' and 'Do Something' scenarios.

The terminology used throughout the analysis associated with the software is explained in the following section.

JCT LinSig

- **DOS:** This is the ratio of demand flow to capacity on a link. The saturation level is normally 90%. A degree of saturation below 90% represents a junction that is operating in an efficient and stable condition. If a link has a degree of saturation of between 90% and 100% it may still be operating to an adequate standard depending on the acceptability of queuing and delay. A degree of saturation of above 100% is considered to be over-capacity.
- **Mean Maximum Queue:** The sum of the maximum queue on a link (including uniform, random and oversaturation queues) averaged over all the cycles in the modelled time period.
- **Average Delay:** The average delay for each passenger car unit (pcu) on the lane averaged over the modelled time period.
- **Practical Reserve Capacity (PRC):** A measure of how much additional traffic could pass through the junction whilst maintaining a maximum degree of saturation of 90% on all lanes. Measured as a percentage.

3.5. Signalisation

In line with international best practice, the proposed layout for the upgraded signalised junctions is the “Protected junction”, which provides physical kerb build-outs to protect cyclists through the junction. The key design feature in relation to signalisation, is that the traffic signal arrangement removes any uncontrolled conflict between pedestrians and cyclists.

In general, for low volumes of left turning traffic, consideration can be given to allowing cyclists to proceed straight ahead on the same signal phase as straight-ahead and left-turning traffic, subject to an early start signal being provided for cyclists, plus a flashing amber left turn signal for traffic and additional warning signage for traffic. Where it is unsafe to allow straight ahead cyclist movement on the same signal phase as left-turning traffic, the design of the signal phasing will separate these movements into different signal phases. The threshold left-turn volumes for these two scenarios are shown in Figure 3-2 below.

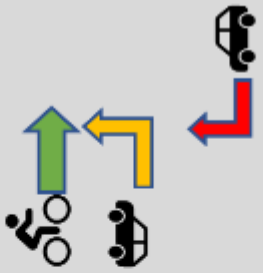
CYCLING THRESHOLD ASSESSMENT		
Turn Flow Thresholds (PCU/Hr)	Flashing Amber Cycle Priority Scenario	Separate Phase Scenario
0-100	100	100
101-150	150	150
>150	151	151

Figure 3-2 - Threshold for Controlling Cycle and Vehicle Conflict (Prelim Design Guidance Booklet, BusConnects)

Based on existing left-turning volumes, the following signalisation was considered for the three junctions proposed to be upgraded as shown in Table 3-3 below.

Table 3-3 – Proposed Signal Phasing

Junction	Proposed Signal Phasing
R147/R161 Poolboy Bridge Junction	Flashing Amber Cycle Priority Scenario
R147/N51 Junction	Separate Phase Scenario
N51/R895 Balmoral junction.	Separate Phase Scenario

4. Traffic Impact

As outlined in the previous section, the junctions were analysed individually using the LinSig software package. The LinSig direct output reports for each junction are included in Appendix A and the results are summarised below.

4.1. (J1) R147/R161 (Poolboy Bridge) Junction

The junction was analysed using LinSig software. The Junction Model Diagram has been illustrated in Figure 4-1 while the stage diagram for 'Do Something' scenarios is summarised in Figure 4-2 below.

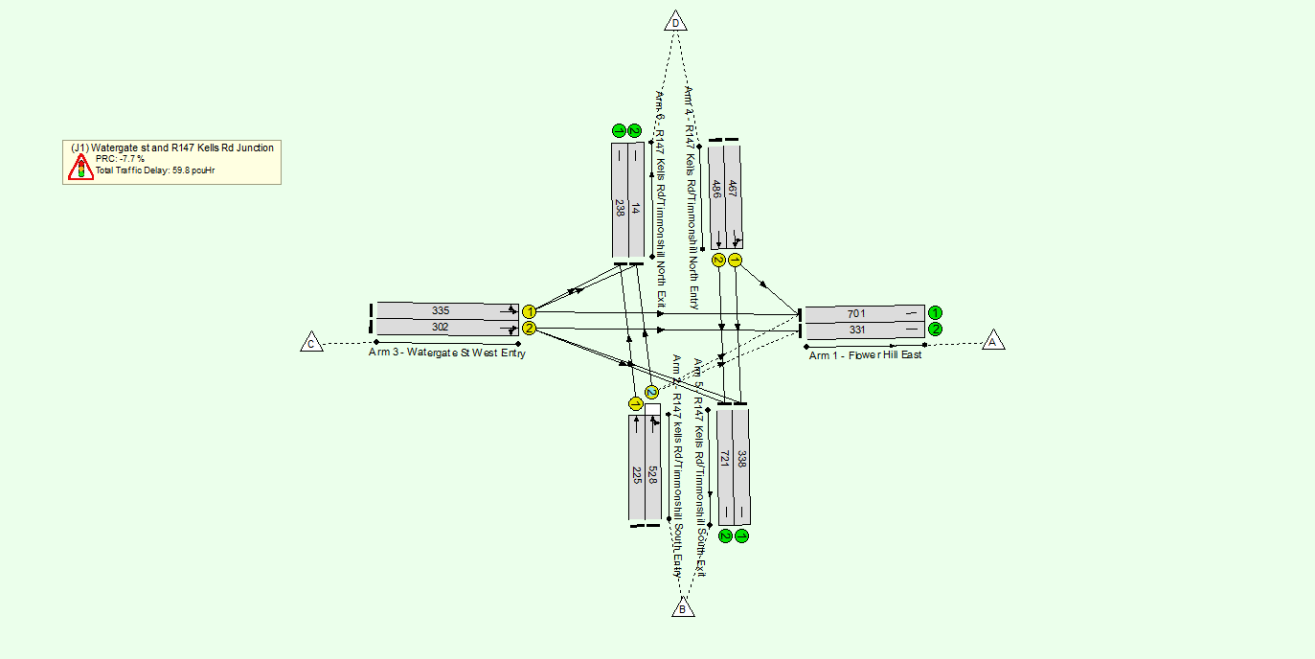


Figure 4-1 - (J1) Junction Model Diagram

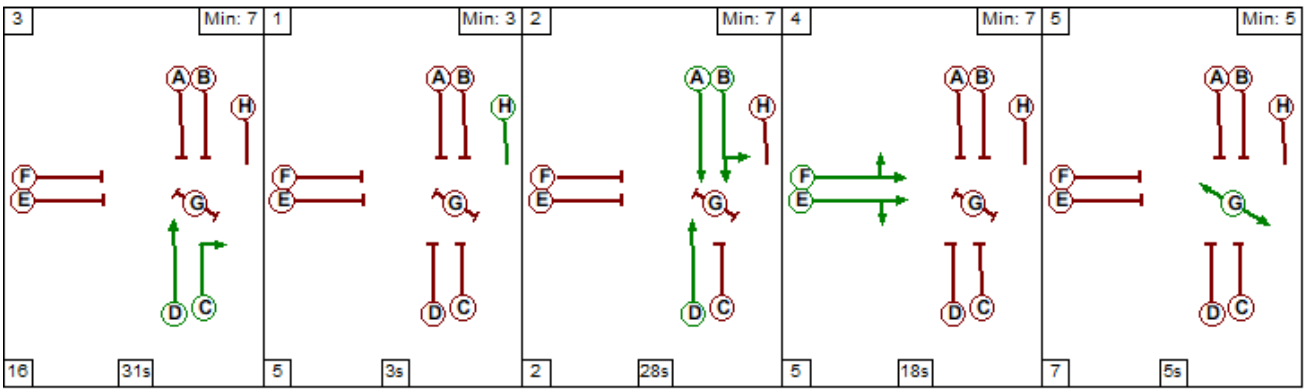


Figure 4-2 - Stage sequence diagram for (J1) R147/R161 (Poolboy Bridge) Junction

In the first stage, R147 Kells Rd south is provided general green. The second stage is followed by a dummy stage with minimum green of 3 seconds and the movement from R147 southern arm is stopped. The purpose of this phase is to ensure that cyclists have lead time before the general traffic phases starts in order to further reduce vehicular/cyclist conflict. In the third stage, R147 Kells Rd North is provided general green. In the fourth stage, both the lanes from the Watergate Street eastern arm gets green. In the fifth stage, the pedestrians are provided their own green stage. Simultaneously, Cyclists will also be able to cross this junction with the general green provided for the vehicles in the first 4 stages.

The following assumptions were made for the analysis:

- The second stage (Dummy stage) is called in every cycle for both AM and PM Peak scenarios. This stage is called to provide cyclists with a head start of 3 seconds.
- The scheme has provision of one way cycle lanes on both sides along the northern and southern arms which makes it possible to run cyclists with traffic;
- In the first four stages, cyclists are allowed to travel with the traffic;
- The green time for the pedestrian was based on a 5s green with an amber phase equal to the crossing width of the road divided by 1.2 m/s and a 2s red phase before traffic regains priority; and
- The junction was analysed with 120 seconds cycle time for both 'Do Nothing' and 'Do Something' scenario.

The results from the model is summarised below.

4.1.1. Opening Year (2024)

The results for the Opening year are shown in Table 4-1 and Table 4-2 below:

Table 4-1 - Junction Modelling Results for R147/R161 (Poolboy Bridge) Junction (Opening Year) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year (2024) – AM Peak							
R147 Kells Rd South (St)	**2/1 Ahead**	3.9	12.5	21.4%	3.7	12.3	23.7%
R147 Kells Rd South (Right)	**2/2 Right**	11.8	47.1	68.0%	13.5	61.5	80.5%
Watergate St West (Left)	**3/1 Ahead/Left**	6.3	69.4	65.9%	6.8	83.9	76.0%
Watergate St West (Right)	**3/2 Ahead/Right**	5.5	69.2	62.7%	6.3	83.4	74.0%
R147 Kells Rd North (Left)	**4/1 Left/Ahead**	13.5	41.1	66.8%	15.2	52.6	78.2%
R147 Kells Rd North (St)	**4/2 Ahead**	13.8	41.1	67.2%	15.8	52.7	78.9%
PRC (%)		**32.3%**			**11.8%**		

Table 4-2 - Junction Modelling Results for R147/R161 (Poolboy Bridge) Junction (Opening Year) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year (2024) – PM Peak							
R147 Kells Rd South (St)	**2/1 Ahead**	3.4	15.1	18.5%	3.2	14.3	20.3%
R147 Kells Rd South (Right)	**2/2 Right**	16.8	58.0	83.4%	22.1	95.4	95.7%
Watergate St West (Left)	**3/1 Ahead/Left**	11.8	74.6	82.9%	16.2	128.9	96.7%
Watergate St West (Right)	**3/2 Ahead/Right**	10.6	75.0	81.6%	14.8	127.8	95.9%
R147 Kells Rd North (Left)	**4/1 Left/Ahead**	15.3	61.9	83.2%	18.2	88.6	92.9%
R147 Kells Rd North (St)	**4/2 Ahead**	16.0	61.7	83.7%	19.7	88.9	93.6%
PRC (%)		**7.5%**			**-7.5%**		

The above table shows that PRC (Practical Reserve Capacity) for the junction is reduced by 21% and 15% respectively for 'Do Something' AM and PM Peak scenarios when compared to 'Do Nothing' Scenario. This reduction is attributed to the upgrade of the junction by changing the junction geometry and incorporating cycle lanes as per the DMURS standards. Pedestrian crossings were catered for by means of a separate stage which is called every cycle. This also resulted in the reduction of the overall capacity of the junction in both the scenarios.

Overall, the maximum DOS of all the arms were found to be in order of 60% for AM Peak and in order of 96% for PM Peak. The maximum average delay was observed to be around 2minute 8sec. This suggests that the junction was found to be operating over capacity for PM peak in the Do something scenario.

4.1.2. Opening Year + 5 (2029)

The results for the Opening year+5 is shown in Table 4-3 and Table 4-4 below.

Table 4-3 - Junction Modelling Results for R147/R161 (Poolboy Bridge) Junction (Opening Year+5) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 5 (2029) – AM Peak							
R147 Kells Rd South (St)	**2/1 Ahead**	3.9	11.7	21.7%	4.0	12.4	24.6%
R147 Kells Rd South (Right)	**2/2 Right**	13.4	54.9	77.4%	14.5	65.4	83.8%
Watergate St West (Left)	**3/1 Ahead/Left**	7.3	84.8	77.5%	7.3	87.7	78.8%
Watergate St West (Right)	**3/2 Ahead/Right**	6.5	84.8	75.4%	6.7	87.7	77.4%
R147 Kells Rd North (Left)	**4/1 Left/Ahead**	13.0	34.6	60.9%	16.4	55.5	81.6%
R147 Kells Rd North (St)	**4/2 Ahead**	13.3	34.5	61.1%	16.9	55.4	82.0%
PRC (%)		**16.1%**			**7.5%**		

Table 4-4 - Junction Modelling Results for R147/R161 (Poolboy Bridge) Junction (Opening Year+5) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 5 (2029) – PM Peak							
R147 Kells Rd South (St)	**2/1 Ahead**	3.5	15.2	19.2%	3.4	14.4	21.1%
R147 Kells Rd South (Right)	**2/2 Right**	18.8	65.0	87.9%	26.9	123.5	99.8%
Watergate St West (Left)	**3/1 Ahead/Left**	12.8	80.5	86.3%	19.2	157.0	100.3%
Watergate St West (Right)	**3/2 Ahead/Right**	11.6	80.4	85.0%	17.9	159.5	100.2%
R147 Kells Rd North (Left)	**4/1 Left/Ahead**	16.6	66.8	86.6%	21.5	109.2	97.1%
R147 Kells Rd North (St)	**4/2 Ahead**	17.4	66.9	87.2%	22.9	107.8	97.3%
PRC (%)		**2.4%**			**-11.5%**		

Similar to the Opening Year, the PRC for the 'Do Something' scenario is reduced when compared to the 'Do Nothing' scenario. The reduction is 9% and 14% respectively for AM and PM peak. This is again because of the reduction in capacity of the junction due to upgrade of the junction by changing the junction geometry and incorporating cycle lanes as per the DMURS standards.

Overall, the maximum DOS of all the arms were found to be in order of 100% for PM Peak. The maximum average delay was observed to be around 2minute 39sec. The junction is modelled with a cycle time of 2 minutes. That means, on an average, vehicles will have to wait more than one cycle to clear the signalized junction. This suggests that the junction is operating over capacity for the PM peak in the Do Something scenario.

4.1.3. Opening Year + 15 (2039)

The results for the Opening year+15 is shown in Table 4-5 and Table 4-6 below.

Table 4-5 - Junction Modelling Results for R147/R161 (Poolboy Bridge) Junction (Opening Year+15) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 15 (2039) – AM Peak							
R147 Kells Rd South (St)	**2/1 Ahead**	4.4	12.3	23.8%	4.3	12.6	26.7%
R147 Kells Rd South (Right)	**2/2 Right**	14.3	53.7	77.3%	17.5	79.2	90.7%
Watergate St West (Left)	**3/1 Ahead/Left**	7.8	82.9	78.1%	8.5	100.1	85.2%
Watergate St West (Right)	**3/2 Ahead/Right**	7.0	83.7	76.7%	8.0	100.4	84.2%
R147 Kells Rd North (Left)	**4/1 Left/Ahead**	16.6	47.1	77.1%	19.3	64.9	88.5%
R147 Kells Rd North (St)	**4/2 Ahead**	17.0	47.2	77.5%	19.9	64.7	88.7%
PRC (%)		**15.2%**			**-0.8%**		

Table 4-6 - Junction Modelling Results for R147/R161 (Poolboy Bridge) Junction (Opening Year+15) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 15 (2039) – PM Peak							
R147 Kells Rd South (St)	**2/1 Ahead**	3.8	15.3	20.8%	3.6	14.5	22.8%
R147 Kells Rd South (Right)	**2/2 Right**	24.3	90.6	95.9%	43.7	228.3	108.0%
Watergate St West (Left)	**3/1 Ahead/Left**	15.9	101.4	93.3%	30.1	259.0	108.9%
Watergate St West (Right)	**3/2 Ahead/Right**	14.3	100.8	92.3%	27.4	254.9	108.3%
R147 Kells Rd North (Left)	**4/1 Left/Ahead**	22.9	103.0	96.8%	33.6	190.4	105.0%
R147 Kells Rd North (St)	**4/2 Ahead**	24.0	103.6	97.2%	35.9	190.1	105.2%
PRC (%)		**-8.0%**			**-21.0%**		

The junction was found to be operating above capacity for both the peaks in the 'Do Nothing' and 'Do Something' scenarios. The DOS noted is around 90-108% and delay observed is around 4minutes and 19seconds for the PM peak period. The junction appears to be operating within capacity for the AM peak period in the Do Nothing scenario. Similar to other design years, PRC for 'Do Something' scenario is again reduced when compared to 'Do Nothing' scenario. The reduction was around 14% for AM peak and 13% for PM peak. This is again because of the reduction in capacity of the junction due to the upgrade of the junction by changing the junction geometry and incorporating cycle lanes as per the DMURS standards

In addition, the scheme is for facilitating active travel movements and discourage car based travel. Therefore, it is highly likely to have a shift in mode share from car based trip to active travel. Therefore, the level of background growth of car trips over 17 years is considered improbable.

4.2. (J2) R147/N51 Junction

The junction was analysed using LinSig software. The Junction Model Diagram has been illustrated in Figure 4-3 while the stage diagram for the 'Do Something' scenario is summarized in Figure 4-4 below.

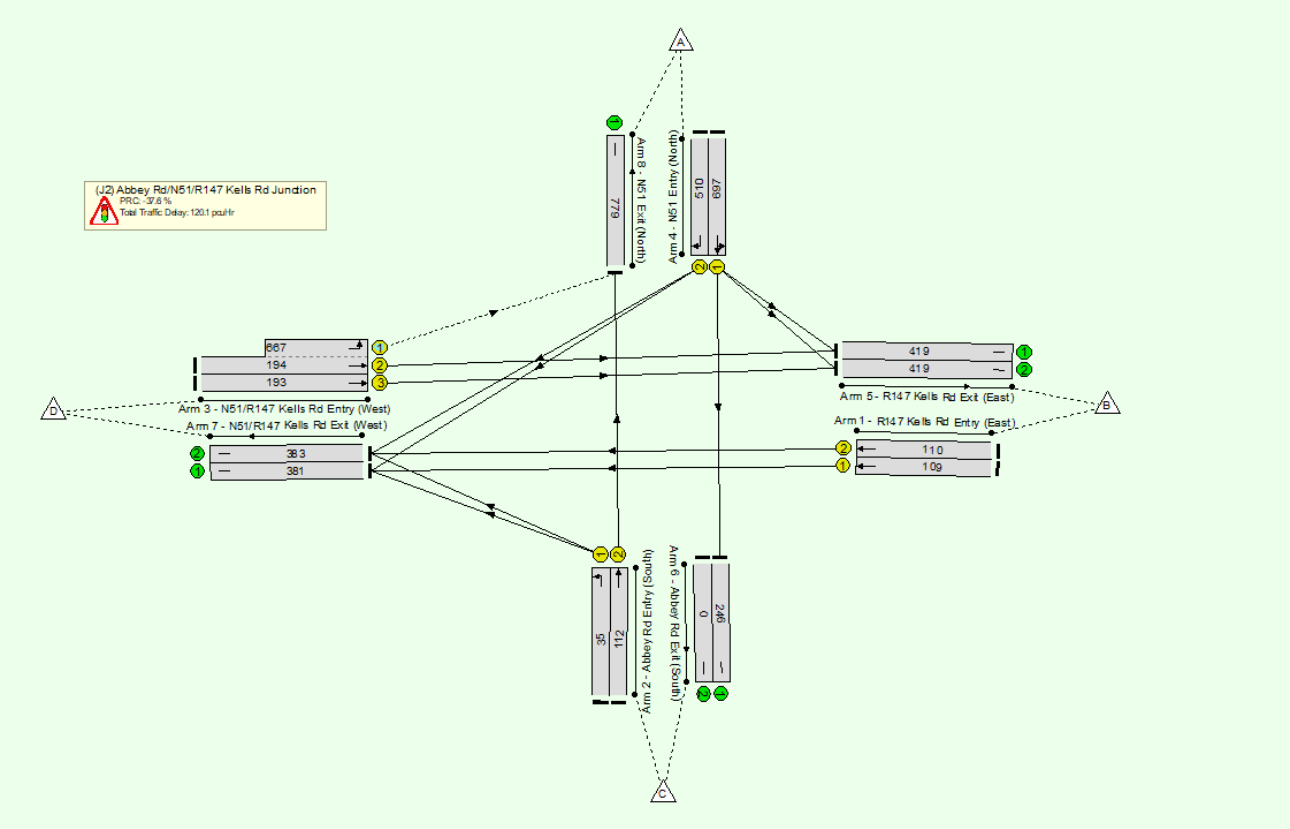


Figure 4-3 - (J2) Junction Model Diagram

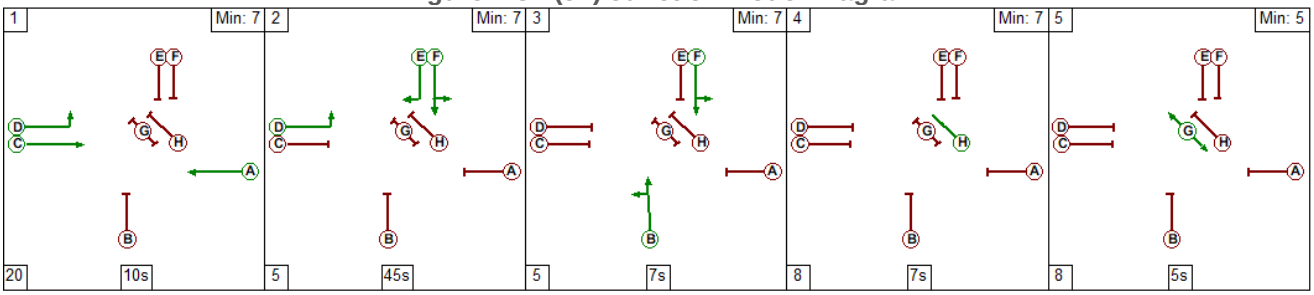


Figure 4-4 - Stage sequence diagram for R147/N51 Junction

In the first stage, both R147 Kells Rd east and west arms are provided general green. There are no Right turners along these arms. In the second stage, N51 north arm gets general green and the left turning movement from R147 Kells Rd west arm to the N51 north arm is also allowed. In the third stage, the Abbey Rd south arm is provided with the general green while the right turning movements from the N51 north arm is stopped. In the fourth stage, the cyclists get their own green stage. In the fifth stage, pedestrians are provided green, while cyclists get flashing amber. That means, cyclists can also move in this stage, but they need to yield for the pedestrians.

The following assumptions were made for the analysis:

- In the 'Do Something' Scenario the lane stacking capacity for the N51/R147 Kells Rd west (Left) has been significantly improved compared to the Do-Nothing Scenario. This measure has been implemented due to the high volume of turning movements in the lane during the PM peak period.
- The scheme has provision of one-way cycle lanes on both sides along all the arms which makes it possible to run cyclists with traffic. However, this will generate conflicts between cyclists and vehicles and will also

compromise the safety of the cyclists. Therefore, it's not feasible to run cyclists with traffic. A separate green stage from traffic has been provided to cyclists.

- From a safety point of view, cyclists and pedestrian also cannot have one single stage where both movements get green. Hence, a separate stage for cyclists from both traffic and pedestrians was provided.
- In both stage 4 and 5, cyclists are allowed to travel. Hence, cyclists can clear in stage 5 and intergreen provided after stage 5. Therefore, no intergreen was provided between both stages.
- The green time for the cycle stage was taken as 7 seconds along with an inter-green time of 8seconds between cyclists and pedestrians.
- The green time for the pedestrian was based on a 5s green with an amber phase equal to the crossing width of the road divided by 1.2 m/s and a 2 s red phase before traffic regains priority.
- The junction was analysed with 120 seconds cycle time for both 'Do Nothing' and 'Do Something' scenario.

The results from the model is summarised below.

4.2.1. Opening Year (2024)

The results for the Opening Year is summarised in Table 4-7 and Table 4-8 below.

Table 4-7 - Junction Modelling Results for R147/N51 Junction (Opening Year) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year (2024) – AM Peak							
R147 Kells Rd East (St)	**1/1 Ahead**	5.0	63.8	54.5%	6.4	100.5	80.3%
R147 Kells Rd East (St)	**1/2 Ahead**	5.0	63.8	54.5%	6.4	100.5	80.3%
Abbey Rd South (Left)	**2/1 Left**	0.4	70.7	9.1%	0.4	70.3	8.9%
Abbey Rd South (St)	**2/2 Ahead**	2.0	76.6	40.5%	2.0	77.1	41.0%
N51/R147 Kells Rd West (St/Left)	**3/2+3/1 Ahead/Left**	10.4	30.9	80.6/80.6%	10.5	33.8	95.7/54.3%
N51/R147 Kells Rd West (St)	**3/3 Ahead**	6.1	68.6	64.6%	10.2	154.9	95.1%
N51 North (St/Left)	**4/1 Ahead/Left**	19.8	21.8	72.5%	31.7	58.8	94.3%
N51 North (Right)	**4/2 Right**	19.9	30.8	75.4%	33.5	91.9	98.4%
PRC (%)		**11.7%**			**-9.3%**		

Table 4-8 - Junction Modelling Results for R147/N51 Junction (Opening Year) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year (2024) – PM Peak							
R147 Kells Rd East (St)	**1/1 Ahead**	3.5	52.7	34.3%	3.9	65.6	49.7%
R147 Kells Rd East (St)	**1/2 Ahead**	3.6	52.7	34.6%	4.0	65.8	50.1%
Abbey Rd South (Left)	**2/1 Left**	1.4	77.5	32.6%	1.3	72.3	28.5%
Abbey Rd South (St)	**2/2 Ahead**	6.3	136.8	87.0%	5.3	106.3	78.4%
N51/R147 Kells Rd West (St/Left)	**3/2+3/1 Ahead/Left**	128.8	437.9	125.9/125.9 %	21.0	41.4	88.2/82.9%
N51/R147 Kells Rd West (St)	**3/3 Ahead**	6.8	60.3	60.6%	9.4	106.2	87.7%
N51 North (St/Left)	**4/1 Ahead/Left**	17.1	22.3	67.2%	24.4	45.4	87.1%
N51 North (Right)	**4/2 Right**	13.3	27.8	60.0%	17.5	48.9	80.2%
PRC (%)		**-39.9%**			**2.1%**		

The junction was found to be operating above capacity for the AM and PM peak period in the 'Do Something' and 'Do Nothing' scenarios. The above table shows that PRC (Practical reserve Capacity) for the junction is reduced by 21% and increased by 42% for the 'Do Something' AM and PM Peak periods when compared to 'Do Nothing' Scenarios. The maximum DOS of all the arms were found to be in order of 98% and delay was noted to be 2minutes and 35seconds for AM Peak period.

Similarly, for the PM peak period in the 'Do Nothing' scenario the maximum DOS recorded was 125% with a delay of around 7 minutes and 18seconds. This behaviour was recorded for the arm N51/R147 Kells road west (Straight and left turning movements). However, for the 'Do Something' scenario the junction capacity was improved and a DOS of around 82-88% with a delay of 41seconds was recorded. This improvement in the 'Do Something' scenario was attributed due to the upgrade of the junction by increasing the lane stacking capacity of the left turning lane along the N51/R147 Kells Rd west arm when compared to the 'Do Nothing' scenario. This improvement was made to cater for the high volume of traffic making the left turning manoeuvre during the PM peak period which in-turn improves the overall capacity of the junction. The scheme is for facilitating active travel movements and discourage car based travel. Therefore, it is highly likely to have a shift in mode share from car based trip to active travel.

The reduction and improvements in the AM and PM peak periods is attributed to the upgrade of the junction by increasing the lane stacking capacity of the left turning lane along the R147 Kells Rd west arm and by incorporating cycle lanes as per the DMURS standards. Pedestrian crossings were catered for by means of a separate stage which is called every cycle. This resulted in the reduction of the overall capacity of the junction in

both the scenarios. In addition, a dedicated cyclist stage is included which further reduces available green time for vehicles at the junction.

4.2.2. Opening Year + 5 (2029)

The result for Opening Year + 5 is summarised in Table 4-9 and Table 4-10 below.

Table 4-9 - Junction Modelling Results for R147/N51 Junction (Opening Year + 5) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 5 (2029) – AM Peak							
R147 Kells Rd East (St)	**1/1 Ahead**	5.2	64.7	56.8%	7.0	108.2	83.7%
R147 Kells Rd East (St)	**1/2 Ahead**	5.2	64.7	56.8%	7.0	108.2	83.7%
Abbey Rd South (Left)	**2/1 Left**	0.4	70.8	10.0%	0.4	70.5	9.8%
Abbey Rd South (St)	**2/2 Ahead**	2.1	77.3	42.0%	2.1	77.8	42.5%
N51/R147 Kells Rd West (St/Left)	**3/2+3/1 Ahead/Left**	11.7	33.6	83.9/83.9%	11.1	34.4	99.7/56.5%
N51/R147 Kells Rd West (St)	**3/3 Ahead**	6.5	70.3	67.3%	12.0	183.2	99.1%
N51 North (St/Left)	**4/1 Ahead/Left**	21.5	23.1	75.5%	38.5	78.5	98.2%
N51 North (Right)	**4/2 Right**	21.3	32.5	78.6%	43.4	133.8	102.5%
PRC (%)		**7.3%**			**-13.9%**		

Table 4-10 - Junction Modelling Results for R147/N51 Junction (Opening Year + 5) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 5 (2029) – PM Peak							
R147 Kells Rd East (St)	**1/1 Ahead**	3.7	53.0	35.9%	4.1	66.4	51.9%
R147 Kells Rd East (St)	**1/2 Ahead**	3.7	53.0	35.9%	4.1	66.4	51.9%
Abbey Rd South (Left)	**2/1 Left**	1.4	77.9	33.5%	1.4	72.5	29.2%
Abbey Rd South (St)	**2/2 Ahead**	7.2	153.2	90.8%	5.9	113.9	81.8%
N51/R147 Kells Rd West (St/Left)	**3/2+3/1 Ahead/Left**	149.4	500.1	130.9/130.9 %	23.1	44.5	91.8/86.2%
N51/R147 Kells Rd West (St)	**3/3 Ahead**	7.1	61.4	63.1%	10.5	119.1	91.3%
N51 North (St/Left)	**4/1 Ahead/Left**	18.4	23.2	70.0%	27.1	51.3	90.6%
N51 North (Right)	**4/2 Right**	14.0	28.5	62.6%	18.9	52.1	83.6%
PRC (%)		**-45.5%**			**-2.0%**		

The junction was found to be operating above capacity for the 'Do Something' scenario for both the AM and PM peak periods. The above table shows that PRC (Practical reserve Capacity) for the junction is reduced by 21% and increased by 43% for the 'Do Something' AM and PM Peak periods when compared to 'Do Nothing' Scenarios. The maximum DOS of all the arms were found to be in order of 102% and delay was noted to be 3 minutes and 3 seconds for AM Peak period.

Similarly, for the PM peak period in the 'Do Nothing' scenario the maximum DOS recorded was 131% with a delay of around 8minutes and 20seconds. This behaviour was recorded for the arm N51/R147 Kells road west (Straight and left turning movements). However, for the 'Do Something' scenario the junction capacity was improved and a DOS of around 86-91% with a delay of 45seconds was recorded. This improvement in the 'Do Something' scenario was attributed due to the upgrade of the junction by increasing the lane stacking capacity of the left turning lane along the N51/R147 Kells Rd west arm when compared to the 'Do Nothing' scenario. This improvement was made to cater for the high volume of traffic making the left turning manoeuvre during the PM peak period which in-turn improves the overall capacity of the junction. The scheme is for facilitating active travel movements and discourage car based travel. Therefore, it is highly likely to have a shift in mode share from car based trip to active travel.

The reduction and improvements in the AM and PM peak periods is attributed to the upgrade of the junction by increasing the lane stacking capacity of the left turning lane along the R147 Kells Rd west arm and by incorporating cycle lanes as per the DMURS standards. Pedestrian crossings were catered for by means of a separate stage which is called every cycle. This resulted in the reduction of the overall capacity of the junction in both the scenarios. In addition, a dedicated cyclist stage is included which further reduces available green time for vehicles at the junction.

4.2.3. Opening Year + 15 (2039)

The result for Opening Year + 15 is summarised in Table 4-11 and Table 4-12 below.

Table 4-11 - Junction Modelling Results for R147/N51 Junction (Opening Year + 15) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 15 (2039) – AM Peak							
R147 Kells Rd East (St)	**1/1 Ahead**	5.8	66.9	61.5%	8.6	131.1	90.6%
R147 Kells Rd East (St)	**1/2 Ahead**	5.8	66.9	61.5%	8.6	131.1	90.6%
Abbey Rd South (Left)	**2/1 Left**	0.4	70.8	10.0%	0.4	70.5	9.8%
Abbey Rd South (St)	**2/2 Ahead**	2.3	79.0	45.8%	2.3	79.6	46.4%
N51/R147 Kells Rd West (St/Left)	**3/2+3/1 Ahead/Left**	16.7	44.6	91.2/91.2%	19.2	75.1	107.7/61.3%
N51/R147 Kells Rd West (St)	**3/3 Ahead**	7.3	74.8	73.1%	17.8	279.5	107.7%
N51 North (St/Left)	**4/1 Ahead/Left**	25.3	26.6	81.8%	66.0	177.0	106.4%
N51 North (Right)	**4/2 Right**	25.2	37.6	85.1%	72.2	253.9	111.0%
PRC (%)		**-1.3%**			**-23.3%**		

Table 4-12 - Junction Modelling Results for R147/N51 Junction (Opening Year + 15) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 15 (2039) – PM Peak							
R147 Kells Rd East (St)	**1/1 Ahead**	4.0	53.6	38.7%	4.6	68.2	55.9%
R147 Kells Rd East (St)	**1/2 Ahead**	4.0	53.7	39.0%	4.6	68.4	56.4%
Abbey Rd South (Left)	**2/1 Left**	1.5	79.0	36.3%	1.5	73.3	31.6%
Abbey Rd South (St)	**2/2 Ahead**	9.5	201.1	98.5%	7.1	135.8	88.7%
N51/R147 Kells Rd West (St/Left)	**3/2+3/1 Ahead/Left**	194.4	621.6	141.9/141.9 %	31.6	58.6	99.4/93.4%
N51/R147 Kells Rd West (St)	**3/3 Ahead**	7.9	64.3	68.4%	14.2	164.6	98.9%
N51 North (St/Left)	**4/1 Ahead/Left**	21.3	25.7	75.8%	37.2	81.8	98.3%
N51 North (Right)	**4/2 Right**	16.0	30.2	67.8%	22.8	63.1	90.6%
PRC (%)		**-57.6%**			**-10.4%**		

The junction was still found to be operating above capacity in the AM and PM peak periods for both the scenarios. As mentioned in the above two sections The reduction and improvements in the AM and PM peak periods is attributed to the upgrade of the junction by increasing the lane stacking capacity of the left turning lane along the N51/R147 Kells Rd west arm and by incorporating cycle lanes as per the DMURS standards.

The largest impact was mainly found to occur on N51/R147 Kells Rd west arm with DOS above 90% observed for both peaks. The maximum average delay was observed to be in the order of 10minutes and 22seconds in the PM peak for the 'Do Nothing' scenario which reduced to 59 seconds in the 'Do Something' scenario due to the upgrades implemented onto the junction.

In addition, as stated previously, the main aim of the scheme is to increase active travel mode share. Therefore, it is considered unrealistic that this level of background growth of car trips over 17 years is going to take place.

4.3. N51/R895 Balmoral Junction

The junction was analysed using LinSig software. The Junction Model Diagram has been illustrated in the Figure 4-5 and the stage diagram for 'Do Something' scenarios is summarised in the Figure 4-6 below.

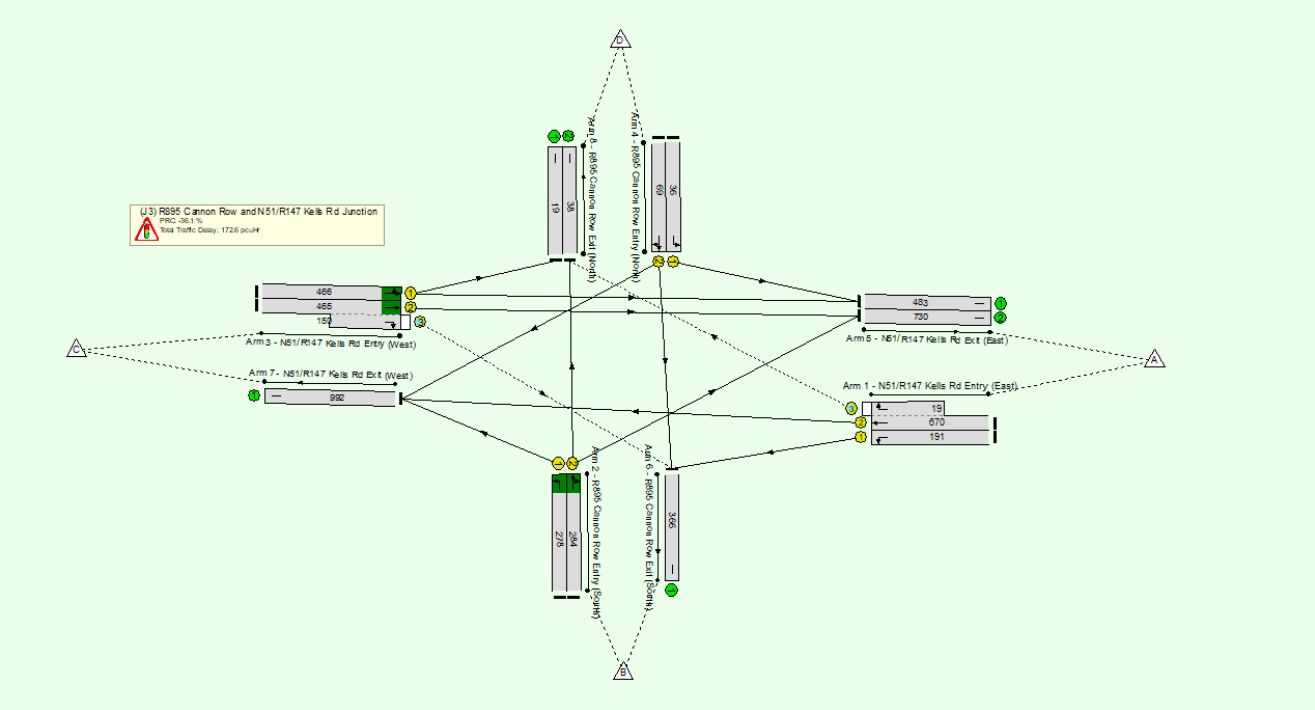


Figure 4-5 - (J3) Junction Model Diagram

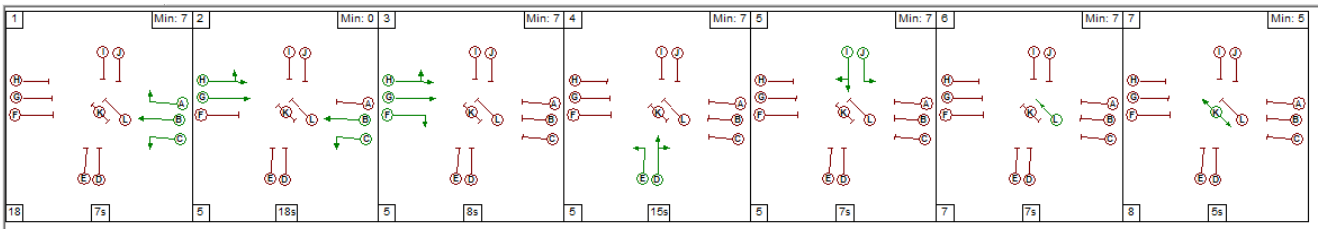


Figure 4-6 - Stage sequence diagram for N51/R895 Balmoral Junction

In the first stage, all the movements from R147 Kells Rd eastern arm are provided green. In the second stage, left and straight movements from both R147 Kells Rd western and eastern Arms are provided green. In the third stage, all the movements from R147 western Arm are provided green. In the fourth and fifth sage, R895 Cannon Row Rd south and north arms gets green respectively. Similar to the previous junction, in the penultimate stage, the cyclists get own green stage, and in the final stage pedestrians get green stage.

The following assumptions were made for the analysis.

- Stage 1 is to be called only on demand for the right turning movements from the R147 Kells Rd eastern arm. For both the peak periods, stage 1 is called only 50% times in one hour. Therefore, for both the peak periods, stage 1 was modelled to run one in every alternate cycle and bonus green was provided to the other arms.
- Similar to the previous junction, the scheme has provision of one-way cycle lanes on both sides along all the arms which makes it possible to run cyclists with traffic. However, this will generate conflicts between cyclists and vehicles and will also compromise the safety of the cyclists. Therefore, cyclists need separate stage from traffic for this junction.
- The green time for the cycle stage was provided as 7 seconds along with an inter-green time of 8seconds between cyclists and pedestrians.

- The green time for the pedestrian was based on a 5s green with an amber phase equal to the crossing width of the road divided by 1.2 m/s and a 2 s red phase before traffic regains priority.
- The junction was analysed with 120 seconds cycle time for both 'Do Nothing' and 'Do Something' scenarios.

The results from the model is summarised below.

4.3.1. Opening Year (2024)

The result for Opening Year is summarised in Table 4-13 and Table 4-14 below.

Table 4-13 - Junction Modelling Results for N51/R895 Balmoral junction (Opening Year) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year (2024) – AM Peak							
N51/R147 Kells Rd East (Left)	**1/1 Left**	6.8	27.6	38.2%	8.5	42.0	54.4%
N51/R147 Kells Rd East (St/Right)	**1/2+1/3 Ahead/Right**	22.7	43.7	83.8/83.8%	74.6	315.0	114.5/114.5 %
R895 Cannon Row South (Left)	**2/1 Left**	2.8	60.2	37.4%	3.6	79.2	58.4%
R895 Cannon Row South (St/Right)	**2/2 Ahead/Right**	8.2	88.5	81.5%	20.4	338.1	112.5%
N51/R147 Kells Rd West (St/Left)	**3/1 Ahead/Left**	5.9	18.7	30.6%	8.5	37.3	48.2%
N51/R147 Kells Rd West (St/Right)	**3/2+3/3 Ahead/Right**	9.6	49.3	85.0/85.0%	42.8	299.6	114.3/114.3 %
Balmoral Ind Estate (Left)	**4/1 Left**	0.0	6.6	0.9%	0.1	69.8	3.7%
Balmoral Ind Estate (St/Right)	**4/2 Ahead/Right**	0.4	68.4	8.7%	0.4	68.3	8.7%
PRC (%)			**5.8%**			**-27.2%**	

Table 4-14 - Junction Modelling Results for N51/R895 Balmoral junction (Opening Year) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year (2024) – PM Peak							
N51/R147 Kells Rd East (Left)	**1/1 Left**	4.0	29.6	25.6%	4.8	39.9	35.1%
N51/R147 Kells Rd East (St/Right)	**1/2+1/3 Ahead/Right**	20.6	48.5	83.5/83.5%	54.8	249.1	109.7/109.7 %
R895 Cannon Row South (Left)	**2/1 Left**	9.7	74.3	80.0%	24.5	289.4	110.0%
R895 Cannon Row South (St/Right)	**2/2 Ahead/Right**	9.6	70.1	77.4%	19.1	210.6	103.9%
N51/R147 Kells Rd West (St/Left)	**3/1 Ahead/Left**	9.6	24.8	45.7%	13.8	50.8	74.4%
N51/R147 Kells Rd West (St/Right)	**3/2+3/3 Ahead/Right**	12.4	34.4	65.0/65.0%	18.0	66.2	85.8/98.8%
Balmoral Ind Estate (Left)	**4/1 Left**	0.3	7.3	7.5%	1.2	76.5	29.3%
Balmoral Ind Estate (St/Right)	**4/2 Ahead/Right**	2.4	83.2	50.1%	2.4	82.9	49.8%
PRC (%)		**7.8%**			**-22.3%**		

The junction was found to be operating above capacity for both the peak periods in the 'Do Something' scenario. The above table shows that PRC (Practical reserve Capacity) for the junction is reduced by 33% and 30% respectively for 'Do Something' AM and PM Peak scenarios when compared to 'Do Nothing' Scenario. The maximum DOS of all the arms were found to be in order of 114% and the maximum delay was noted to be 5minutes and 38seconds in the AM Peak period along the N51/R147 Kells Rd East (St/Right) and R895 Cannon row south arm (St/Right). This reduction is attributed to the upgrade of the junction by changing the junction geometry and incorporating cycle lanes as per the DMURS standards. Pedestrian crossings were catered for by means of a separate stage which is called every cycle. This also resulted in the reduction of the overall capacity of the junction in both the scenarios. In addition, a dedicated cyclist stage is included which further reduces available green time for vehicles at the junction.

4.3.2. Opening Year + 5 (2029)

The result for Opening+5 year is summarised in Table 4-15 and Table 4-16 below.

Table 4-15 - Junction Modelling Results for N51/R895 Balmoral junction (Opening Year+5) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 5 (2029) – AM Peak							
N51/R147 Kells Rd East (Left)	**1/1 Left**	7.3	28.7	40.6%	9.0	42.6	56.7%
N51/R147 Kells Rd East (St/Right)	**1/2+1/3 Ahead/Right**	25.6	51.0	89.0/89.0%	90.2	380.3	119.2/119.2 %
R895 Cannon Row South (Left)	**2/1 Left**	3.0	60.7	39.2%	3.8	81.0	61.0%
R895 Cannon Row South (St/Right)	**2/2 Ahead/Right**	8.9	94.5	84.6%	23.8	390.0	116.7%
N51/R147 Kells Rd West (St/Left)	**3/1 Ahead/Left**	6.2	18.9	31.9%	9.0	37.7	50.3%
N51/R147 Kells Rd West (St/Right)	**3/2+3/3 Ahead/Right**	11.1	56.6	89.2/89.2%	53.1	361.4	119.1/119.1 %
Balmoral Ind Estate (Left)	**4/1 Left**	0.0	6.7	0.9%	0.1	69.8	3.7%
Balmoral Ind Estate (St/Right)	**4/2 Ahead/Right**	0.4	68.5	9.5%	0.4	68.5	9.5%
PRC (%)		**0.9%**			**-32.5%**		

Table 4-16 - Junction Modelling Results for N51/R895 Balmoral junction (Opening Year+5) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 5 (2029) – PM Peak							
N51/R147 Kells Rd East (Left)	**1/1 Left**	4.3	29.8	26.7%	5.0	40.2	36.5%
N51/R147 Kells Rd East (St/Right)	**1/2+1/3 Ahead/Right**	22.3	52.4	86.8/86.8%	67.6	312.5	114.1/114.1 %
R895 Cannon Row South (Left)	**2/1 Left**	10.5	79.1	83.2%	29.5	345.5	114.4%
R895 Cannon Row South (St/Right)	**2/2 Ahead/Right**	10.3	74.1	80.8%	23.8	266.3	108.4%
N51/R147 Kells Rd West (St/Left)	**3/1 Ahead/Left**	10.1	25.2	47.6%	14.7	52.9	77.4%
N51/R147 Kells Rd West (St/Right)	**3/2+3/3 Ahead/Right**	13.4	36.4	70.6/70.6%	22.6	90.3	89.4/103.2%
Balmoral Ind Estate (Left)	**4/1 Left**	0.3	7.4	7.8%	1.3	76.8	30.2%
Balmoral Ind Estate (St/Right)	**4/2 Ahead/Right**	2.5	84.2	51.7%	2.5	83.8	51.4%
PRC (%)		**3.7%**			**-27.2%**		

Similar to Opening Year scenario, the junction was found to be operating over the capacity for both 'Do Nothing' and 'Do Something' scenarios and a significant impact was made to the junction due to the upgrade. The PRC (Practical reserve Capacity) for the junction is reduced by 33% and 31% respectively for 'Do Something' AM and PM Peak scenarios when compared to 'Do Nothing' Scenario. The maximum DOS of all the arms were found to be in order of 119% and the maximum delay was noted to be 6minutes and 30seconds in the AM Peak period along the N51/R147 Kells Rd East (St/Right) and R895 Cannon Row South arm (St/Right). This reduction is attributed to the upgrade of the junction by changing the junction geometry and incorporating cycle lanes as per the DMURS standards. Pedestrian crossings were catered for by means of a separate stage which is called every cycle. This also resulted in the reduction of the overall capacity of the junction in both the scenarios. In addition, a dedicated cyclist stage is included which further reduces available green time for vehicles at the junction.

It is also noted that the proposed scheme is for facilitating active travel movements and discourage car-based travel. Therefore, it is highly likely to have a shift in mode share from car-based trip to active travel.

4.3.3. Opening Year + 15 (2039)

The result for Opening+5 year is summarised in Table 4-17 and Table 4-18 below.

Table 4-17 - Junction Modelling Results for N51/R895 Balmoral Junction (Opening Year+15) (AM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 15 (2039) – AM Peak							
N51/R147 Kells Rd East (Left)	**1/1 Left**	7.8	27.7	42.3%	9.0	42.6	56.7%
N51/R147 Kells Rd East (St/Right)	**1/2+1/3 Ahead/Right**	29.8	57.1	92.8/92.8%	90.2	380.3	119.2/119.2 %
R895 Cannon Row South (Left)	**2/1 Left**	3.4	67.2	48.3%	3.8	81.0	61.0%
R895 Cannon Row South (St/Right)	**2/2 Ahead/Right**	17.8	230.7	104.8%	23.8	390.0	116.7%
N51/R147 Kells Rd West (St/Left)	**3/1 Ahead/Left**	6.7	18.0	33.6%	9.0	37.7	50.3%
N51/R147 Kells Rd West (St/Right)	**3/2+3/3 Ahead/Right**	27.3	147.8	103.3/103.3 %	53.1	361.4	119.1/119.1 %
Balmoral Ind Estate (Left)	**4/1 Left**	0.0	6.7	1.1%	0.1	69.8	3.7%
Balmoral Ind Estate (St/Right)	**4/2 Ahead/Right**	0.4	68.5	9.5%	0.4	68.5	9.5%
PRC (%)		**- 16.5%**			**-32.5%**		

Table 4-18 - Junction Modelling Results for N51/R895 Balmoral Junction (Opening Year+15) (PM)

Arm	Arm Movement	'Do Nothing'			'Do Something'		
		Mean Max Queue (pcu)	Delay (s/pcu)	DOS	Mean Max Queue (pcu)	Delay (s/pcu)	DOS
Opening Year + 15 (2039) – PM Peak							
N51/R147 Kells Rd East (Left)	**1/1 Left**	4.7	30.1	28.8%	5.0	40.2	36.5%
N51/R147 Kells Rd East (St/Right)	**1/2+1/3 Ahead/Right**	27.9	68.4	94.0/94.0%	67.6	312.5	114.1/114.1 %
R895 Cannon Row South (Left)	**2/1 Left**	12.7	95.1	90.0%	29.5	345.5	114.4%
R895 Cannon Row South (St/Right)	**2/2 Ahead/Right**	12.2	86.4	87.6%	23.8	266.3	108.4%
N51/R147 Kells Rd West (St/Left)	**3/1 Ahead/Left**	11.3	26.0	51.6%	14.7	52.9	77.4%
N51/R147 Kells Rd West (St/Right)	**3/2+3/3 Ahead/Right**	16.4	45.3	84.4/84.4%	22.6	90.3	89.4/103.2%
Balmoral Ind Estate (Left)	**4/1 Left**	0.3	7.6	8.8%	1.3	76.8	30.2%
Balmoral Ind Estate (St/Right)	**4/2 Ahead/Right**	2.9	87.6	56.6%	2.5	83.8	51.4%
PRC (%)		**-4.5%**			**-27.2%**		

Similar to both design years, the junction was again found to be operating over the capacity for both scenarios with a significant impact of the upgrade being observed. The PRC (Practical reserve Capacity) for the junction is reduced by 16% and 23% respectively for 'Do Something' AM and PM Peak scenarios when compared to 'Do Nothing' Scenario. The maximum DOS of all the arms were found to be in order of 119% and the maximum delay was noted to be 6minutes and 30seconds in the AM Peak period along the N51/R147 Kells Rd East (St/Right) and R895 Cannon Row South arm (St/Right). Pedestrians and cyclists were catered for by means of a separate stage which is called every cycle. This also resulted in the reduction of the overall capacity of the junction in both the 'Do Something' and 'Do Nothing' scenarios. In addition, as stated previously, the main aim of the scheme is to increase active travel mode share. Therefore, it is considered unrealistic that this level of background growth of car trips over 17 years is going to take place.

5. Summary

The TTA assesses the impact of the prosed Navan Road (R147) cycle scheme on several key junctions. The junctions are as follows:

- (J1) R147/R161 Poolboy Bridge Junction,
- (J2) R147/N51 Junction, and
- (J3) N51/R895 Balmoral Junction.

All the junctions are proposed to be upgraded in accordance with DMURS to facilitate the movement of pedestrians and cyclists. The background traffic has been grown in accordance with the growth in the number of trips per day as per the NTA National Demand Forecasting Model. The proposed cycle scheme will facilitate the shift in car based modal share to active travel. The Signalised junctions were analysed individually using LinSig transport modelling software.

For all of the junctions, it is proposed to have one-way segregated cycle lanes on each side of the approaches which would allow cyclists to run with traffic. Both pedestrians and cyclists will be provided with separate signal stages to traverse the junctions. The active travel users are provided segregated facilities along the Navan Cycle Scheme which reduces all potential conflicts and improves general safety for the users.

It is not feasible to run cyclists with general traffic at all junctions and from a safety point of view, it is not possible to have a single stage for both cyclists and pedestrians. As a result, dedicated stages are provided separately for both cyclists and pedestrians. The junction results are summarised below:

(J1) Watergate St/R147 Kells Road junction

The 'Do Something' scenario, when compared to 'Do Nothing' scenario, results in a 9-21% reduction in the Practical Reserve Capacity for the junction across all the design years. The junction was found to be operating over capacity for all the design years in the 'Do Something' scenarios. However, for the AM Peak period, in the 'Opening Year' and 'Opening Year+5' design year, the junction is observed to operate within capacity. The reduction in capacity of junctions in 'Do Something' Scenarios is attributed to the upgrade by of the junction by changing the junction geometry and incorporating cycle lanes as per the DMURS standards along with the inclusion of pedestrian stage in every cycle.

(J2) Abbey Rd/N51/R147 Kells Road Junction

The 'Do Something' scenario, when compared to the 'Do Nothing' scenario, results in a 20-47% reduction in the Practical Reserve Capacity for the junction across all observed design years. The junction was found to be operating over the capacity for Opening, Opening+5 and Opening+15 design years scenarios. However, the junction was found to be operating within capacity for the 'Opening Year' design year in the PM peak period. The PRC in the PM peak period for the 'Do Something' scenario improved for all design years when compared with 'Do Nothing' Scenario. The reduction and improvements in the AM and PM peak periods is attributed to the upgrade of the junction by increasing the lane stacking capacity of the left turning lane along the R147 Kells Rd west arm and by incorporating cycle lanes as per the DMURS standards. Pedestrians and cyclists were catered for by means of a separate stage which is called every cycle.

(J3) R895 Cannon Row Rd/R147 Kells Road Junction,

The junction was found to be operating over the capacity for both 'Do Nothing' and 'Do Something' scenarios. A major impact of the upgrade was noted in 'Do Something' scenarios as compared to 'Do Nothing' scenarios. A 16-33% reduction in the Practical Reserve Capacity for the junction across all design year scenarios was observed. This reduction is attributed to the upgrade of the junction by changing the junction geometry like reducing lane widths etc. and by incorporating cycle lanes as per the DMURS standards. Pedestrians and cyclists were catered for by means of a separate stage which is called every cycle.

Overall, for most future year scenarios, the junction upgrade is anticipated to reduce capacity. However, the objective of the scheme is to facilitate the safe movement of cyclists and pedestrians at the expense of capacity for vehicles.

In addition, it should be noted that the increase in background traffic growth, particularly for Opening+15 design year scenarios, is unlikely to be realised given National and Regional travel policies and moves to more sustainable modes. It is therefore likely that the results for future years represent the minimum level of capacity that would be available at these junctions.