ATKINS

Goodwill to All Junction

Proposed LinSig Model Report

London Borough of Harrow

06 June 2018

Notice

This document and its contents have been prepared and are intended solely for London Borough of Harrow's information and use in relation to the Goodwill to All junction improvement study.

Atkins Limited assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 20 pages including the cover.

Document history

Job number: 5153774			**Document ref:**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	Draft for LMAP 5 Audit	LE	GD	ND	CG	15/12/2017
Rev 2.0	Draft for LMAP 5 Audit	LE	GD	ND	CG	04/04/2018
Rev 3.0	Final	LE	GD	ND	CG	06/06/2018

Client signoff

Client	London Borough of Harrow
Project	Goodwill to All Junction
Document title	Goodwill to All Junction Study
Job no.	5153774
Copy no.	
Document reference	

Table of contents

Tables

1. Introduction

1.1. Background

Atkins has been appointed by the London Borough of Harrow (LBH) to provide transport consultancy services to improve the operations at the Harrow View / Headstone Drive / Headstone Gardens junction, also known as the Goodwill to All junction near Wealdstone in the LBH.

The LBH commissioned Atkins to develop a LinSig model, as part of the Transport for London (TfL) Model Auditing Process (MAP), to support the assessment and implementation of the design proposals at the junction.

LinSig Base models for the AM and PM peak hours were developed and approved through the TfL LinSig Model Auditing Process (LMAP Stage 2 and 3). This report provides details of the LinSig modelling assessment of the proposed design (TfL LMAP Stage 5) at the Harrow View / Headstone Drive junction.

1.2. Report Structure

The structure of this report is as follows:

- Section 2 outlines the proposals and modelling assessment for the LMAP 5 stage; and
- Section 3 provides a summary and conclusion.

2. LMAP Stage 5 Proposed Model

2.1. Purpose of Scheme

A Transport Assessment was conducted in June 2015 by CH2M Hill to review the impacts of the redevelopment of the former Kodak site known as Harrow View East, situated north-east of the junction. The mixed-use development comprising of residential units, health care facilities, primary school, retail, a care home and senior living accommodation along with community and leisure facilities is expected to be fully operational by 2026.

The Harrow View East Transport Assessment indicated that the Harrow View / Headstone Drive junction currently operates over capacity and this is expected to exacerbate due to the increase in traffic associated with the proposed development. The assessment did not consider geometric improvements but suggested revising signal timings to mitigate the performance of the junction. Further considerations of implementing MOVA or UTC control to improve the performance of the junction was also proposed.

Currently, the junction is a four-arm signalised junction, with uncontrolled pedestrian crossing points on all approaches. As the Harrow View East development is expected to generate higher pedestrian activity along with an increase in traffic flows, the study aims to investigate and identify suitable measures to improve junction capacity while providing signal controlled pedestrian crossings. The objectives of the study are to:

- Improve traffic flow through the Harrow View / Headstone Drive junction;
- Improve pedestrian and cycle safety;
- Reduce the risk of accidents within the area;
- Provide suitable parking / loading facilities in the vicinity of the junction; and
- Encourage walking and cycling within the area and promote sustainable transport.

A number of proposed designs were considered and assessed using the LMAP 3 validated base model. The options developed and tested are summarised in **Table 2-1** below, with the results of the assessment presented in **Appendix A**.

Table 2-1 Scheme Development Options

Option	Details
Option 1 (Staggered Crossings)	• Staggered signalised pedestrian crossings on all approaches; • Dedicated left turn lane on Headstone Drive; • Ahead movements also permitted on all right turn lanes; and • Headstone Gardens approach reduced from 3 lanes to 2.
Option 2A (Straight Across Crossings)	• Straight across signalised pedestrian crossings on all approaches; • Ahead and right permitted from Harrow View (N) with two-lane exit; • Harrow View (S) reduced to one lane for ahead and left movements, right turn remains restricted; and • Headstone Drive and Headstone Gardens approaches remain as existing.
Option 2B (Mix Stagger and Straight Across Crossings)	• As Option 2A with staggered crossings on the Headstone Drive and Headstone Gardens approaches.
Option 3 (Existing Layout with Straight Across Crossings)	• Existing junction layout with straight across signalised pedestrian crossings on all approaches; and • Tightened junction by bringing kerb lines in to reduce intergreens.
Option 4A (Right Turns Prohibited)	• Straight across signalised pedestrian crossings on all approaches; • Right turns restricted from all approaches; • Single lane approach on Harrow View (S); and • Two-lane exit on Harrow View (S).
Option 4B (Preferred Option)	• As Option 4A with right turns permitted from Headstone Drive.

Option	Details
(Headstone Dr. Right Turn Allowed)	
Option 5 (Straight Across Crossings with Two-Lane Exit)	• Straight across signalised pedestrian crossings on all approaches; and • Extended ahead and right turn flare on Harrow View (N) with a two-lane exit.
Option 6 (Unconstrained Junction Layout)	• Three lanes on Harrow View (N) approach; • Three lanes on Headstone Drive approach; • Two lanes on Harrow View (S) approach; • Four lanes on Headstone Gardens approach; and • Two lane exits on all approaches.

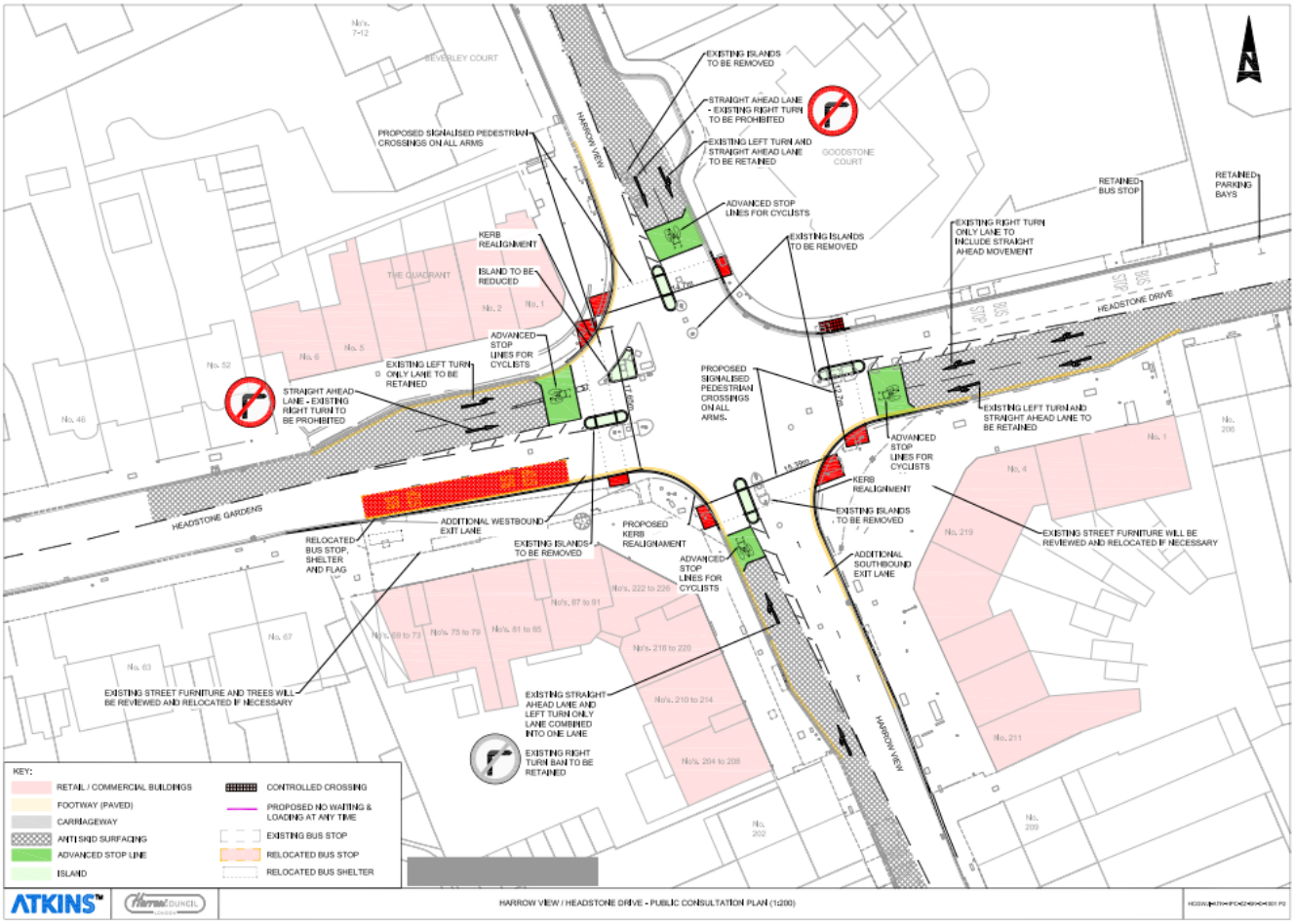
2.2. LinSig Model Development

LinSig base models were developed to assess the current performance of the Harrow View / Headstone Drive junction and were approved through the TfL MAP process. The approved LinSig base models were used as a basis for developing the LinSig proposed models for assessing the impact of the junction proposals.

2.3. Preferred Junction Design Proposal

The design of the Preferred Option is shown in **Figure 2-1**. The preliminary drawing of the Preferred Option set to 1:200 scale is shown in **Appendix B.**

Figure 2-1 Harrow View / Headstone Drive Proposed Design



2.4. L503 Changes to Model

The TfL approved LinSig base model was used as a basis for developing the LinSig Preferred Option model. Details of the changes made to the base model to incorporate the proposed design at the Harrow View / Headstone Drive junction are presented below. This included changes to lane configurations, lane lengths and intergreens, which were calculated using the proposed scheme drawing.

2.4.1. Physical Road Layout and Geometry

The following physical road layout and geometry changes are proposed, as shown in **Figure 2-1.**

- Existing right turns to be prohibited on Headstone Gardens and Harrow View (N) approaches and the current right turn restriction on Harrow View (S) to be retained;
- Provision of advanced stop lines for cyclists on all approaches;
- Removal of existing pedestrian crossing islands. Signalised pedestrian crossings to be installed on all arms;
- Additional exit lanes on Harrow View (S) and Headstone Gardens;
- Existing right turn lane converted into straight ahead on Harrow View (N), with ahead and left lane retained;
- Existing right turn lane on Headstone Drive converted to ahead and right;
- Two lanes on Harrow View (S) consolidated into one lane; and
- Three lanes reduced to two on Headstone Gardens, removing the right turn and retaining the existing ahead and left.

The changes highlighted above and in Figure 2-1 have been reflected in the proposed LinSig model.

2.4.2. Lane Markings and Usage

The existing junction layout permits right turn manoeuvres from all approaches except Harrow View (S) approach. The lane markings in the proposed designs will reflect the revised lane definitions. Right turns will only be permitted from Headstone Drive to Harrow View (N) in the future junction layout.

2.4.3. Saturation Flows

In the Preferred Option design, where the lane widths have changed, saturation flow values has been updated based on the following criteria:

- Use of RR67 to calculate saturation flow values where observed saturation flow calculations was not conducted in the existing layout;
- Proportional increase of saturation flow values based on the observed saturation flow data and changes to lane width; and
- Use of existing saturation flow values where lane widths in the Preferred Option remain similar to the existing layout.

Table 2-2 provides the saturation values used to model the Preferred Option.

Table 2-2 Existing and Preferred Option Saturation Flow Values

Approach	Existing Layout			Preferred Option	
	Base width (m)	Model Sat Flows	Base Model Sat Flow Values	Proposed Width (m)	Proposed Sat Flow Values
Harrow View (N) L1	2.6	Observed	1772	3	2045
Harrow View (N) L2	2.5	RR67	1735	3	1915
Headstone Drive L1	3	Observed	1800	3	1800
Headstone Drive L2	2.5	RR67	1759	3	1807
Harrow View (S) L1	2.4	RR67	1712		
Harrow View (S) L2	3	Observed	1930	4	2015

Headstone Gardens L1	2.5	RR67	1759	3	1807
Headstone Gardens L2	2.7	Observed	1687	3	1873
Headstone Gardens L3	2.6	RR67	1705		

2.4.4. Signal Timings

Due to the layout changes at the junction which included changes in lane configuration and kerb lines and the addition of an all-red pedestrian phase, new signal timings have been proposed for the junction. **Table 2-3** presents the existing Phase Intergreen data applied in the Base LinSig models.

Table 2-4 shows the proposed Phase Intergreen data (for the non-dummy phases) applied in the proposed LinSig models. It must be noted that the dummy phases have been excluded from the proposed phase intergreen data in **Table 2-3.**

The existing and proposed phases are shown in **Figures 2-2** and **2-3**, respectively.

Figure 2-2 Harrow View / Headstone Drive Existing Stage Sequence

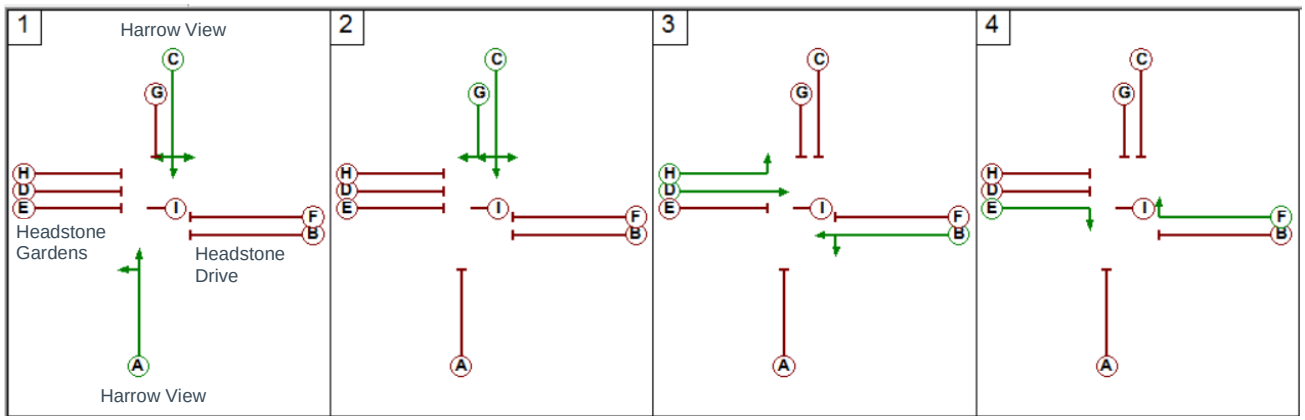


Figure 2-3 Harrow View / Headstone Drive Proposed Stage Sequence

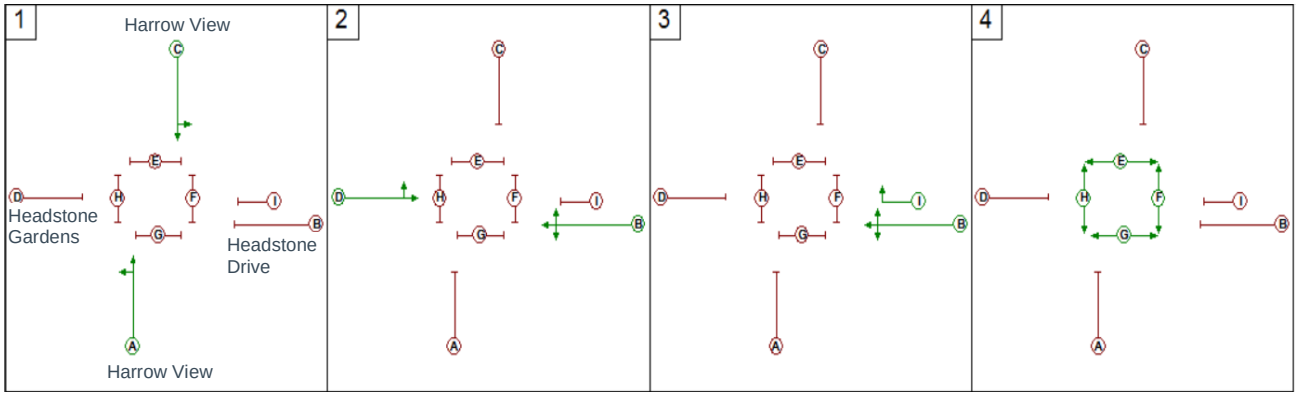


Table 2-3 Existing Phase Intergreen Data for Junction 29/04

	A	B	C	D	E	F	G	H	I
A	-	5	-	6	5	5	5	7	3
B	6	-	5	-	5	-	5	-	3
C	-	5	-	5	5	5	-	-	3
D	5	-	6	-	-	5	6	-	3
E	5	6	5	-	-	-	5	-	3
F	6	-	6	8	-	-	6	8	3
G	5	5	-	5	5	5	-	-	3
H	5	-	-	-	-	5	-	-	3
I	2	2	2	2	2	2	2	2	-

Table 2-4 Proposed Phase Intergreen Data for Junction 29/04

	A	B	C	D	E	F	G	H	I
A	-	5	-	8	8	-	5	8	5
B	7	-	5	-	11	5	8	9	-
C	-	7	-	5	5	9	8	-	6
D	5	-	6	-	7	9	-	5	5
E	17	17	17	17	-	-	-	-	17
F	-	17	17	17	-	-	-	-	17
G	17	17	17	-	-	-	-	-	-
H	17	17	-	17	-	-	-	-	-
I	7	-	6	8	10	5	-	-	-

2.4.5. Cycle Time Selection

The cycle times assessed in the proposed LinSig model are presented in **Table 2-5**. During both peak hours, an increase in cycle time has been proposed from the existing scenario, to accommodate for both the growth in traffic and the addition of an all-red pedestrian phase.

An initial assessment, per TfL recommendation, was conducted using cycle lengths 72s, 80s, 88s, 96s, 104s, 112s and 120s for AM and PM Peak Hours to assess the impact of the cycle time on DoS and queue length. Results of the assessment is presented in **Appendix C**. Based on the assessment, a 120 second cycle time has been proposed as it provides the most benefit in mitigating the impact of increased vehicular traffic and demand for the pedestrian phase in the Future Year 2026.

Table 2-5 Proposed Cycle Times

Peak Hour	Existing Cycle Time (s)*	Proposed Cycle Time (s)	
		2016	2026
AM Peak	82	120	120
PM Peak	81	120	120

**Existing cycle times taken from observed average cycle times (see LMAP 3 report)*

2.5. L504 Model Scenario

- Proposed – AM and PM peak 2016 with 120 second cycle time; and
- Proposed – AM and PM peak 2026 with 120 second cycle time.

2.6. L505 Flow Consistency Check

Traffic flows for the LinSig assessment were derived from the observed traffic counts undertaken in November 2016, as outlined at the LMAP 2 stage. For the 2016 scenario, the base flows have been retained apart from the restricted right turn movements. The right turn flows have been removed as it has been assumed that the right turning traffic will take alternative routes to reach their destination, away from the Harrow View / Headstone Drive junction.

To assess the future year, base traffic flows have been uplifted to 2026 flows. To uplift the flows TEMPRO growth factor (AM - 1.0868 and PM - 1.0897) from 2016 to 2026 has been applied to the background traffic. Flows for the committed developments (taken from the 2015 Harrow View Transport Assessment) and development trips generated from the Harrow View (Kodak site) Development were applied.

2.7. L506 Demand Dependent Stage Frequencies

When adding in the pedestrian phase, we have assumed that it is called in every cycle to model a worst-case scenario.

2.8. L507 Model Optimisation Strategy

As the proposed model includes changes to geometry and lane designations, under-utilised green times (UGT) have been removed from the base model based on the following:

- UGT was previously calculated on Harrow View (N) as right turning traffic was giving way in a short flare lane, therefore blocking the ahead movement. As the proposed design removes right turns from this approach, the UGT data has been also been removed.
- Bonus green times were added in the base model, to match observed cycle times with average green times for each phase. The proposed model has an increased cycle time and therefore have been removed from the proposed model.

2.9. L508 Degree of Saturation (DoS) Comparison

The proposed LinSig model has been optimised for Practical Reserve Capacity (PRC) and the results are resented in **Table 2-6,** showing a comparison of Degree of Saturation (DoS) for the LinSig base and proposed models. The results indicate that the junction will operate at over 100% DoS in 2026 future scenario in both the AM and PM peak hours on the majority of approaches. However, providing an all-red phase and signalised crossings will greatly improve safety for pedestrians at the junction.

The results of the 2016 preferred option flow show a reduction in DoS from the base scenario on the Harrow View (N), Headstone Drive and Headstone Gardens approaches during both the AM and PM peaks. The model predicts a maximum increase in DoS of 120.8% in FY 2026.

Table 2-6 Comparison of Base and Proposed Model Degree of Saturation

Approach	AM Peak				PM Peak			
	Existing Layout		Preferred Option		Existing Layout		Preferred Option	
	Base 2016 (CT-82s)	FY 2026 (CT-120s)	Base 2016 (CT-120s)	FY 2026 (CT-120s)	Base 2016 (CT-81s)	FY 2026 (CT-120s)	Base 2016 (CT-120s)	FY 2026 (CT-120s)
Harrow View (N) Left and Ahead	99.0%	108.1%	84.5%	113.8%	97.5%	117.4%	73.5%	89.2%
Harrow View (N) Right								
Headstone Drive Left and Ahead	94.3%	110.2%	83.6%	103.6%	95.9%	122.5%	87.7%	104.0%
Headstone Drive Right		110.0%						117.8%
Harrow View (S) Left	66.4%	88.4%	96.8%	116.8%	91.8%	92.0%	99.3%	121.5%
Harrow View (S) Ahead								
Headstone Gardens Left	94.5%	108.8%	100.5%	117.9%	91.8%	121.2%	98.2%	123.5%
Headstone Gardens Ahead								
Headstone Gardens Right	40.1%	48.1%			28.1%	35.7%		

2.10. L509 Queue Length Comparison

Table 2-7 shows the comparison of queue lengths for the LinSig base and proposed models. The results indicate that with the proposed improvements, in the 2016 scenario, queue lengths are predicted to decrease on Harrow View (N) but show a marginal increase on other approaches. The 2026 scenario predicts increased queueing on Harrow View (S), in both peak hours. Harrow View (N) and Headstone Drive showed a decrease in both peak hours and Headstone Gardens showed a marginal decrease in the PM peak hour. In general, the Preferred Option provides lower queues when compared to existing layout in FY 2026 while incorporating signalised crossings for pedestrians.

Table 2-7 Comparison of Base and Proposed Model Queue Lengths (PCUs)

Approach	AM Peak				PM Peak			
	Existing Layout		Preferred Option		Existing Layout		Preferred Option	
	Base 2016 (CT-82s)	FY 2026 (CT-120s)	Base 2016 (CT-120s)	FY 2026 (CT-120s)	Base 2016 (CT-81s)	FY 2026 (CT-120s)	Base 2016 (CT-120s)	FY 2026 (CT-120s)
Harrow View (N) Left and Ahead	22.3	57.1	13.7	60.2	21.4	80.4	11.4	17.2
Harrow View (N) Right								
Headstone Drive Left and Ahead	20.8	78.3	22.0	55.4	21.6	115.9	23.0	61.4
Headstone Drive Right								
Harrow View (S) Left	8.6	18.8	21.9	59.4	15.4	24.0	27.6	80.8
Harrow View (S) Ahead								
Headstone Gardens Left	21.3	70.5	37.5	100.4	17.2	108.7	30.1	114.5
Headstone Gardens Ahead								
Headstone Gardens Right	1.9	3.0			1.5	2.4		

3. Summary and Conclusion

Calibrated LinSig base models (for the LMAP 2 stage) and validated base models (for the LMAP 3 stage) were developed for the Harrow View / Headstone Drive junction for the AM (08:00 – 09:00) and PM (17:15 – 18:15) peak hours. The models were audited and subsequently approved by TfL.

Various options were assessed and Option 4B was selected as the preferred option based on the following:

- Improve safety for pedestrians by providing signalised pedestrian crossings on all arms, whilst mitigating predicted increases in future traffic flow due to proposed developments;
- Alternate routes available for the right turn prohibited movements from on Headstone Garden and Harrow View North; and
- Feedback from LBH Portfolio Manager.

consulation with the Portfolio Manager at LBH. The TfL approved LinSig base models were modified to reflect proposed design and signal staging changes at the junction. The proposal includes the following changes:

- Existing right turns to be prohibited on Headstone Gardens and Harrow View (N) approaches;
- Provision of advanced stop lines for cyclists on all approaches;
- Removal of existing pedestrian crossing islands. Signalised pedestrian crossings to be installed on all arms;
- Additional exit lanes on Harrow View (S) and Headstone Gardens;
- Existing right turn lane converted into straight ahead on Harrow View (N), with ahead and left lane retained;
- Existing right turn lane on Headstone Drive converted to ahead and right;
- Two lanes on Harrow View (S) consolidated into one lane; and
- Three lanes reduced to two on Headstone Gardens, removing the right turn and retaining the existing ahead and left.

The results of the assessment indicate that, during both peak hours, the cycle time would have to be increased to 120 seconds to provide sufficient green times on each approach and provide an all-red phase for pedestrians. The junction was also optimised for PRC in all scenarios to optimise the junction's performance.

A comparison of the base and proposed modelling results for FY 2026 indicate that the proposed changes to the junction are predicted to improve performance on Harrow View (N), Headstone Drive and Headstone Garden approaches. A marginal increase in DoS and queue is reported at Harrow View (S) approach. The results show the proposed option operates at 20% over theoretical capacity in the FY 2026, but allows right turn movement for the critical east approach while prohibiting right turns from the north and west approaches. However, the Preferred Option design caters for increased vehicular demand and provide signalised crossings for pedestrians. Therefore, it is recommended that the proposed design is progressed.

Appendices

Appendix A. Scheme Options

An optioneering process has been undertaken to develop several schemes that could be considered to improve the Goodwill to All junction for pedestrians and address the scheme objectives. Our approach has been to develop several options for the scheme proposal, which have subsequently been assessed in terms of their relative advantages and disadvantages, considering traffic modelling results and additional criteria outlined by the objectives of the study. The concept options developed for the study are summarised below.

Table 3-1 Goodwill to All Junction Improvement Options

Option	Details
Option 1 (Staggered Crossings)	• Staggered signalised pedestrian crossings on all approaches; • Dedicated left turn lane on Headstone Drive; • Ahead movements also permitted on all right turn lanes; and • Headstone Gardens approach reduced from 3 lanes to 2.
Option 2A (Straight Across Crossings)	• Straight across signalised pedestrian crossings on all approaches; • Ahead and right permitted from Harrow View (N) with a two-lane exit; • Harrow View (S) reduced to one lane for ahead and left movements, right turn remains restricted; and • Headstone Drive and Headstone Gardens approaches remain as existing.
Option 2B (Mix Stagger and Straight Across Crossings)	• As Option 2A with staggered crossings on the Headstone Drive and Headstone Gardens approaches.
Option 3 (Existing Layout with Straight Across Crossings)	• Existing junction layout with straight across signalised pedestrian crossings on all approaches; and • Tightened junction by brining kerb lines in to reduce intergreens.
Option 4A (Right Turns Prohibited)	• Straight across signalised pedestrian crossings on all approaches; • Right turns restricted from all approaches; • Single lane approach on Harrow View (S); and • Two-lane exit on Harrow View (S).
Option 4B (Preferred Option) (Headstone Dr. Right Turn Allowed)	• As Option 4A with right turns permitted from Headstone Drive.
Option 5 (Straight Across Crossings with Two-Lane Exit)	• Straight across signalised pedestrian crossings on all approaches; and • Extended ahead and right turn flare on Harrow View (N) with a two-lane exit.
Option 6 (Unconstrained Junction Layout)	• Three lane approach on Harrow View (N); • Three lane approach on Headstone Drive; • Two lane approach on Harrow View (S); • Four lane approach on Headstone Gardens; and • Two lane exits on all approaches.

3.1.2. 2016 Traffic Modelling Results

A total of 6 options and a further 2 sub options were tested using the validated base model. The results of the 2016 proposed models for the AM and PM peak hours are shown in Table 3-2 and Table 3-3 below.

Table 3-2 AM Peak 2016 Degree of Saturation Results

Approach	Degree of Saturation (%)								
	Base (82s CL)	Op 1	Op 2A	Op 2B	Op 3	Op 4A	Op 4B	Op 5	Op 6
Harrow View (N) Ahead and Left	99.0	136.7	105.6	97.9	113.6	80.2	84.5	111.9	65.8
Harrow View (N) Right									70.0
Headstone Drive Ahead and Left	94.3	138.3	111.1	116.7	106.6	63.8	82.1	105.9	69.2
Headstone Drive Right									66.4
Harrow View (S) Left	66.4	113.9	118.7	113.7	112.9	84.3	96.8	105.7	72.1
Harrow View (S) Ahead									
Headstone Gardens Left	94.5	141.8	120.9	118.1	113.3	86.4	96.3	115.4	71.9
Headstone Gardens Ahead									71.9
Headstone Gardens Right	40.1		66.0	15.1	66.0			66.0	61.0

Table 3-3 PM Peak 2016 Degree of Saturation Results

Approach	Degree of Saturation (%)								
	Base (81s CL)	Op 1	Op 2A	Op 2B	Op 3	Op 4A	Op 4B	Op 5	Op 6
Harrow View (N) Ahead and Left	97.5	134.5	111.7	111.5	119.6	68.3	71.6	105.3	63.6
Harrow View (N) Right				111.7				117.6	76.6
Headstone Drive Ahead and Left	95.9	133.4	122.0	115.9	117.0	64.5	87.7	117.7	80.1
Headstone Drive Right			121.1		107.7			107.6	80.7
Harrow View (S) Left	91.8	123.9	119.1	114.8	116.5	85.5	96.2	118.6	80.8
Harrow View (S) Ahead									
Headstone Gardens Left	91.8	134.9	119.9	114.0	112.5	85.6	95.9	114.0	73.8
Headstone Gardens Ahead									73.8
Headstone Gardens Right	28.1		57.2	14.8	50.8			50.8	59.8

The results of the traffic modelling show that all options, excluding Options 4A, 4B and Option 6, show the junction operating over 100% DoS on a number of arms with the proposed designs, based on 2016 traffic flows. Although Option 6 shows the junction operating within capacity, this option would involve re-configuring the junction to include multiple extra lanes, at a junction that has limited space and a number of identified services.

3.1.3. 2026 Traffic Modelling Results

Each proposed design option was tested using proposed 2026 traffic flows, based on the uplift generated using TEMPRO, committed developments and the Kodak site trip generation. The results of the 2026 modelling are shown in Table 3-4 and Table 3-5.

Table 3-4 AM Peak 2026 Degree of Saturation Results

Approach	Degree of Saturation (%)								
	Base (82s CL)	Op 1	Op 2A	Op 2B	Op 3	Op 4A	Op 4B	Op 5	Op 6
Harrow View (N) Ahead and Left	124.2	172.1	141.6	136.3	139.5	105.2	110.4	144.5	78.1
Harrow View (N) Right									87.3
Headstone Drive Ahead and Left	122.5	175.6	140.0	143.4	140.9	79.3	103.6	140.0	86.8
Headstone Drive Right			128.1		135.1			128.1	85.3
Harrow View (S) Left	74.7	127.0	137.9	137.9	121.7	98.0	112.5	131.6	88.0
Harrow View (S) Ahead									
Headstone Gardens Left	116.5	173.0	145.0	141.6	142.3	103.5	115.4	145.0	86,3
Headstone Gardens Ahead									86.3
Headstone Gardens Right	43.8		71.3	16.3	71.3			71.3	72.8

Table 3-5 PM Peak 2026 Degree of Saturation Results

Approach	Degree of Saturation (%)								
	Base (81s CL)	Op 1	Op 2A	Op 2B	Op 3	Op 4A	Op 4B	Op 5	Op 6
Harrow View (N) Ahead and Left	181.1	162.8	124.1	115.6	135.1	84.9	86.8	128.2	79.7
Harrow View (N) Right				121.7					92.8
Headstone Drive Ahead and Left	115.9	166.5	140.1	140.4	138.0	74.8	104.0	140.1	96.4
Headstone Drive Right	113.0		150.9		134.2		117.8	134.2	92.9
Harrow View (S) Left	109.0	152.3	146.4	140.9	143.4	107.2	117.6	148.4	95.0
Harrow View (S) Ahead									
Headstone Gardens Left	118.6	162.7	147.3	140.2	141.7	105.8	120.8	147.3	96.2
Headstone Gardens Ahead									96.2
Headstone Gardens Right	30.7		62.5	15.1	55.5			55.5	77.6

The results for the 2026 traffic modelling show similar patterns the 2016 models, however with higher DoS results predicted on the approaches due to heavier traffic flows. All approaches, excluding Headstone Gardens right turn, exceed 90% DoS on almost all approaches during the peak hours.

As the junction was already operating at practical capacity on a number of approaches, adding pedestrian crossings into the junction increased the DoS for all scheme proposals. Several mitigation measures have been proposed to minimise the impact of introducing pedestrian crossings on the junction. Option 4A provided the best results from the modelling, as this option restricts right turn movements from all directions.

3.2. Preferred Option

It is recommended that the Option 4B with design layout changes, addition of pedestrian crossings and traffic management proposals to ban right turns should be taken forward. Although the 2026 future modelling scenario predicts that the model will operate over capacity, the benefits associated with providing signalised pedestrian crossings will increase safety at the junction.

Appendix B. Preliminary Design (Consulation Plan - Preferred Option)

Appendix C. Cycle Time Variation

To select an appropriate cycle time for the preferred option (4b), tests were run using the validated LinSig model to assess the impact of changing the cycle time in the 2026 future scenario. The results of Degree of Saturation (DoS) and Mean Max Queue are shown in Table C-1 and Table C-3. The preferred option has been tested with the base cycle time (82s), plus four variations.

As shown by the results below, the longer cycle time reduces both DoS and queue length results at the junction. Therefore, a cycle time of 120 seconds has been selected for the preferred option, as the modelling shows it will have the least impact on the operation of the junction in the 2026 future scenario.

Table C-1 Option 4b 2026 Degree of Saturation (DoS) Results AM Peak

Approach	AM Peak 2026 (Cycle Time) – DOS %						
	72s	80s	88s	96s	104s	112s	120s
Harrow View (N) Ahead and Left	135.5	134.1	126.7	121.1	116.8	113.3	110.4
Harrow View (N) Right							
Headstone Drive Ahead and Left	136.2	123.0	117.0	112.5	108.9	106.0	103.6
Headstone Drive Right							112.5
Harrow View (S) Ahead and Left	182.2	168.7	148.5	135.0	125.3	118.1	
Headstone Gardens Left	199.2	162.3	146.1	134.9	126.7	120.4	115.4
Headstone Gardens Ahead							
Headstone Gardens Right							

Table C-2 Option 4b 2026 Degree of Saturation (DoS) Results PM Peak

Approach	PM Peak 2026 (Cycle Time) - DOS %						
	72s	80s	88s	96s	104s	112s	120s
Harrow View (N) Ahead and Left	113.1	106.9	98.0	95.1	92.7	90.8	86.8
Harrow View (N) Right							
Headstone Drive Ahead and Left	130.5	121.3	118.1	112.6	108.3	104.9	104.0
Headstone Drive Right						110.0	117.8
Harrow View (S) Ahead and Left	198.8	173.6	148.5	138.8	131.6	126.0	117.6
Headstone Gardens Left	194.7	166.3	154.3	140.8	131.1	123.8	120.8
Headstone Gardens Ahead							
Headstone Gardens Right							

Table C-3 Option 4b 2026 Queue Length Results AM Peak

Approach	AM Peak 2026 (Cycle Time)						
	72s	80s	88s	96s	104s	112s	120s
Harrow View (N) Ahead and Left	106.8	90.5	89.4	77.8	68.3	60.3	54.0
Harrow View (N) Right							
Headstone Drive Ahead and Left	117.9	98.9	73.9	63.3	55.3	49.6	45.1
Headstone Drive Right							
Harrow View (S) Ahead and Left	128.9	94.9	83.0	59.8	41.4	28.9	23.4
Headstone Gardens Left	211.1	176.9	138.0	116.8	99.2	84.6	72.6
Headstone Gardens Ahead							
Headstone Gardens Right							

Table C-4 Option 4b 2026 Queue Length Results PM Peak

Approach	PM Peak 2026 (Cycle Time)						
	72s	80s	88s	96s	104s	112s	120s
Harrow View (N) Ahead and Left	40.6	29.0	29.8	23.0	19.8	18.7	20.2
Harrow View (N) Right							
Headstone Drive Ahead and Left	108.8	88.1	62.1	51.1	43.7	44.9	43.2
Headstone Drive Right							
Harrow View (S) Ahead and Left	146.5	116.9	108.2	87.4	70.3	56.3	54.9
Headstone Gardens Left	213.7	177.8	137.3	114.9	96.3	81.0	68.4
Headstone Gardens Ahead							
Headstone Gardens Right							

Gayathri Dharmavaram
Atkins Limited
Woodcote Grove
Ashley Road
Epsom
Surrey
KT18 5BW
Email Gayathri.Dharmavaram@atkinsglobal.com