SKANSKA

New A47 East Junction

Wisbech Access Study

August 2017

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Cambridgeshire County Council / Fenland District Council

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Glossary

Term	Description
Junction Turning Flows	The number of vehicles making an individual movement at a junction, as recorded within traffic surveys
Free Flow	Unobstructed traffic flow, recorded between the hours of 00:00 and 05:00
Data Segments	The breakdown of a road into small sections, within a data set. In this instance segments are derived from satellite navigation data
Forecast Traffic Flows	Traffic flows predicted for the years of 2021, 2026 and 2031, on the basis of proposed development sites across Wisbech
SATURN Zones	A geographical area within the SATURN model, enabling an assignment of trips and the creation of an origin and destination matrix
Select Link Analysis	A tool within the Saturn model software, enabling the user to select a link (either a single link or a series of multiple links) and extract flow / origin and destination data for a specific route
Inscribed Circle Diameter (ICD)	A geometric measure used within ARCADY modelling, which describes the size (in metres) of the largest circle that can be fitted into the junction outline (including the roundabout infrastructure and lane allocations on the circulatory)
PICADY	Modelling software used when modelling priority junctions, including staggered junctions, crossroads and signalised junctions
ARCADY	Modelling software used when modelling roundabouts
Do Minimum Scenario	'Do-Minimum', refers to the baseline of a study and represents the conditions which would exist if the scheme did not go ahead
Ratio Flow to Capacity (RFC)	An indication of the likely performance of a junction in relation to capacity, with a value of 0.85 showing a practical capacity threshold, and a value greater than 1.00 showing the stage whereby demand flow is equal or has exceeded capacity

Level of Service (LOS)	Qualitative measure used to indicate the level of traffic, and quantify the junction/ carriageway performance with measure such as capacity, delay etc.
Approach Half Width	Geometric measure used within ARCADY modelling, which indicates the shortest road width between the median line and the nearside edge of the road (before any flared lanes)
Entry Width	Geometric measure used within ARCADY modelling, which indicates is the width of the carriageway at the point of entry.
Effective Flare Length	Geometric measure used within ARCADY modelling, which indicates the average length over which the entry to the roundabout widens
Entry Radius	Geometric measure used within ARCADY modelling, which indicates the minimum radius of curvature of the nearside kerb line over the distance from 25m ahead of the give way line to 10m downstream of it
Entry Angle	Geometric proxy used within ARCADY modelling, which indicates the conflict angle between entering and circulating traffic streams
Sensitivity Test	Tests undertaken to allow changes in modelling (i.e. geometry) and forecasting assumptions (i.e. number of houses)
Unequal Lane Usage	Where one lane approach on an approach arm is used more than the remaining lane, therefore resulting in traffic in the dominant lane blocking access to the minor lane traffic flow.

1. Introduction

Wisbech Access Study

This assessment forms part of the first phase of the Wisbech Access Study. The Wisbech Access Study consists of two distinct phases. The first phase is a series of individual scheme assessments, and the second phase of the study consists of a packaging assessment, as shown in Figure 1.1 beneath. Note that this assessment is highlighted in green to demonstrate its relationship to the wider study.

Figure 1.1: Wisbech Access Study Components

New A47 Junction: East

The A47 East Junction refers to the junction of Broadend Road and the A47 trunk road to the east of Wisbech. The need to upgrade this junction was identified as part of the Wisbech Area Transport Study (WATS) and is required to facilitate the East Wisbech urban extension identified within the Local Plan (Policy LP8) as the Wisbech East Site.

The purpose of this assessment is to determine what form of junction is required to facilitate the development, providing adequate access between the development site and strategic road network, whilst mitigating the impact of delay on the A47.

Scheme Location

Broadend Road Junction is located within the county of Norfolk and lies immediately east of the Cambridgeshire and Norfolk border. The junction itself is positioned along the A47 and east of Wisbech. As part of the A47 strategic transport link, this junction provides a point of access for Wisbech to the wider transport network including Peterborough, March, King's Lynn, Norwich and Great Yarmouth.

The junction is currently a staggered priority junction on a single carriage way road, as indicated by Figure 1.2. It is located approximately halfway along the A47 between the roundabouts of the A47 / A1101 Elm High Road to the southwest and the A47 Walton Highway / Lynn Road roundabout to the northeast, as shown in Figure 1.3.

Figure 1.2: Current Layout of Broadend Road Junction

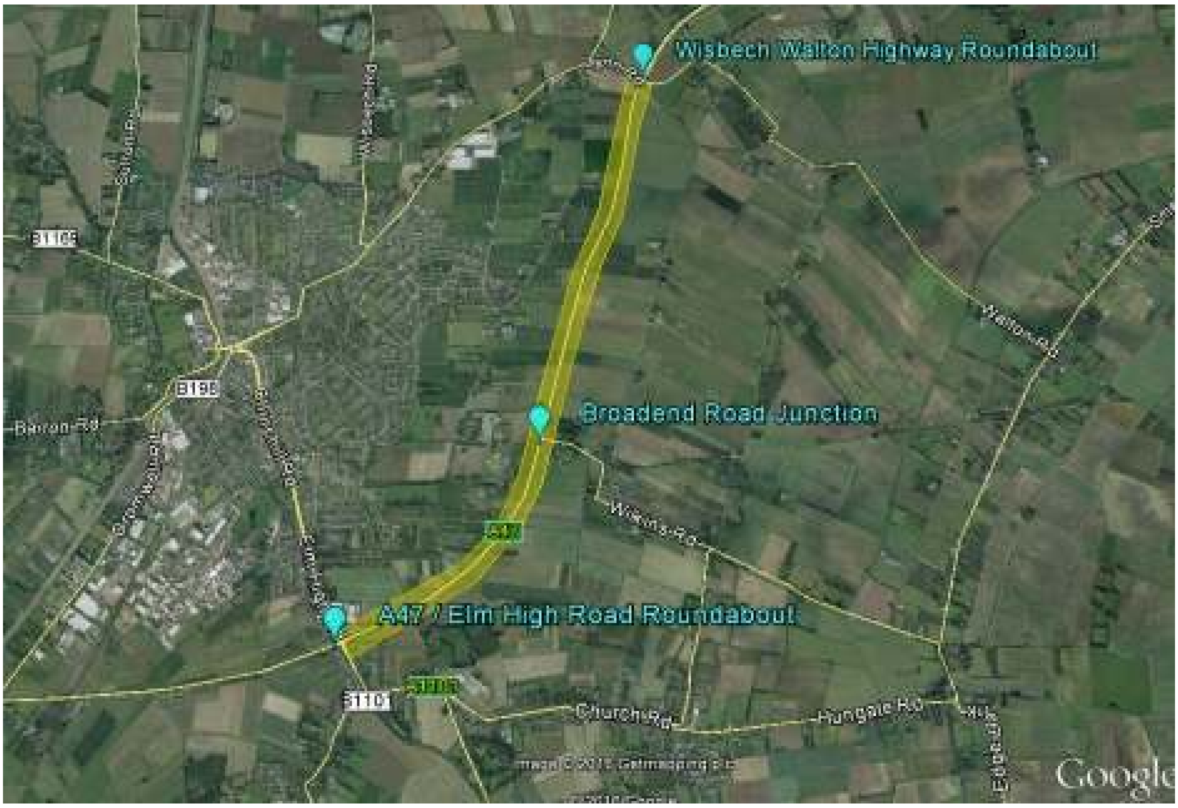


Figure 1.3: Location of Broadend Road Junction

The land use surrounding Broadend Road Junction is primarily agricultural, with small clusters of residential properties located on both sides of the junction. Several industrial units are positioned to the west of the junction along Broadend Road West.

2. Existing Conditions

This chapter considers the existing conditions in the vicinity of the Broadend Road Junction, including:

- Junction Turning Flows;
- Journey Times and Delay;
- Accident Data;
- Land Ownership;
- Flood Risk; and,
- Environmental Considerations.

Junction Turning Flows

Turning counts were undertaken at the junction on Tuesday 19th January 2016. The survey recorded vehicle turning movements at the junction over a 12 - hour period between 07:00-19:00. The day of survey was considered typical, with no incidents reported that might affect the observed turning movements.

The results from the surveys are shown in Figures 2.1 to 2.3 below, for the time periods of 12-hour (7am-7pm), AM peak hour (08:00 – 09:00) and the PM peak hour (17:00 – 18:00).

The results for the 12-hour period are shown in Figure 2.1 beneath.

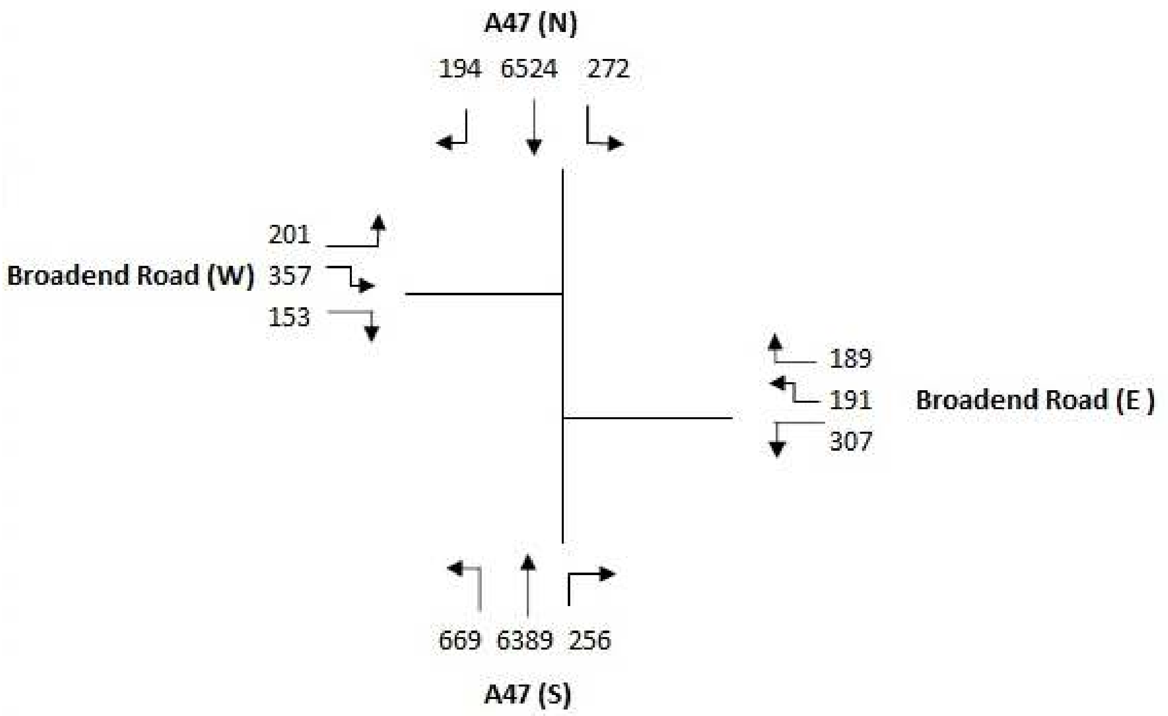


Figure 2.1: Broadend Road Junction 12 Hour Traffic Count (07:00 - 19:00)

Figure 2.1 shows that the primary traffic flow through Broadend Road Junction is along the A47, which is well balanced with approximately 7,000 vehicles recorded in each direction. The largest turning flow from the A47 was from the A47 South (S) to Broadend Road West (W).

There were 711 vehicles recorded using the Broadend Road West approach during the survey, with the majority of vehicles travelling straight over to Broadened Road East.

There were 687 vehicles recorded using the Broadend Road East approach and the most dominant movement was the left turn towards the A47 South.

It is interesting to note the imbalance in turning movements entering from the Broadend Road East and West aproaches; that the dominant movement from Broadend Road West is straight across whilst from Broadend Road east is left-turning onto the A47.

The survey results for the AM peak hour are shown in Figure 2.2 beneath.

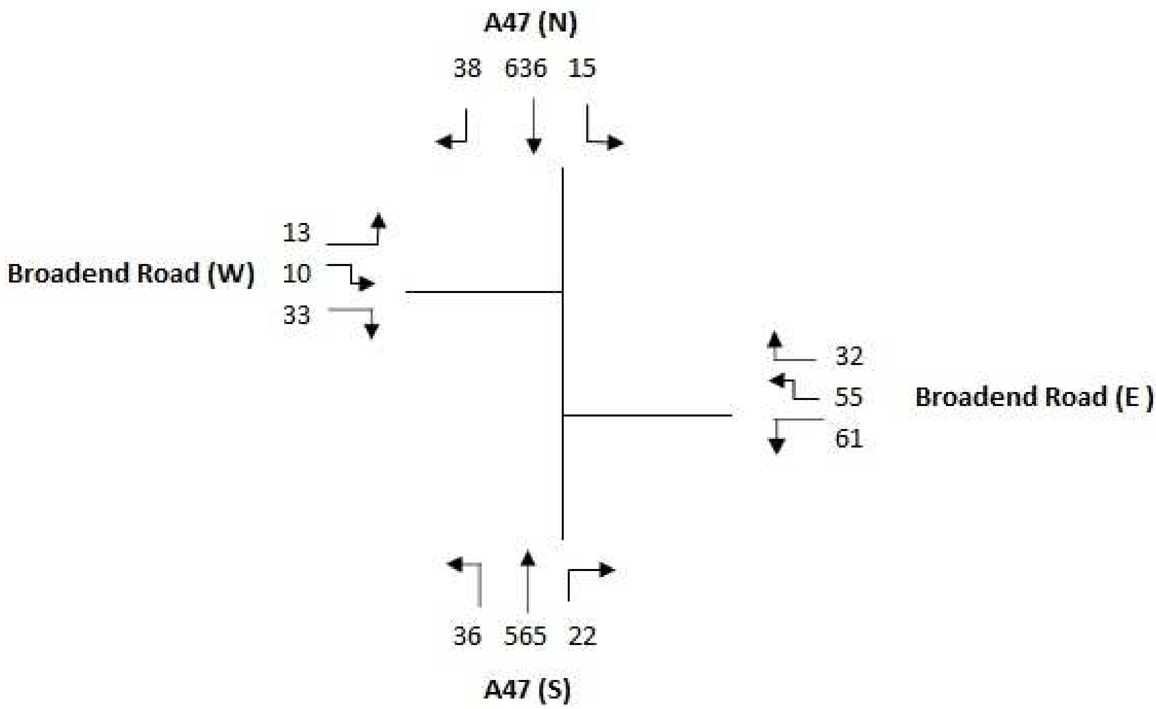


Figure 2.2: Broadend Road Junction AM Peak Hour Traffic Count (08:00 - 09:00)

The primary traffic flow through the junction during the AM peak hour is along the A47, which is again very evenly balanced in both directions, indicating a lack of tidality (it is normal to observed a dominant peak movement which usually reversed during the other peak period – absence can indicated balanced commuting movements or long distance strategic routes such as with the A47). The largest turning movements from the A47 during the AM peak hour are from the A47 North and A47 South into Broadend Road West (towards Wisbech).

The Broadend Road West approach is the least heavily used approach during this period, with 56 vehicles counted during the hour. The majority of these (33) were recorded making a right turn towards the A47 South.

There were 148 vehicles recorded using the Broadend Road East approach. The turning movements were fairly balanced on this approach during this period, although the highest proportion turned left onto the A47 South, followed closely by the ahead movement to Broadend Road West.

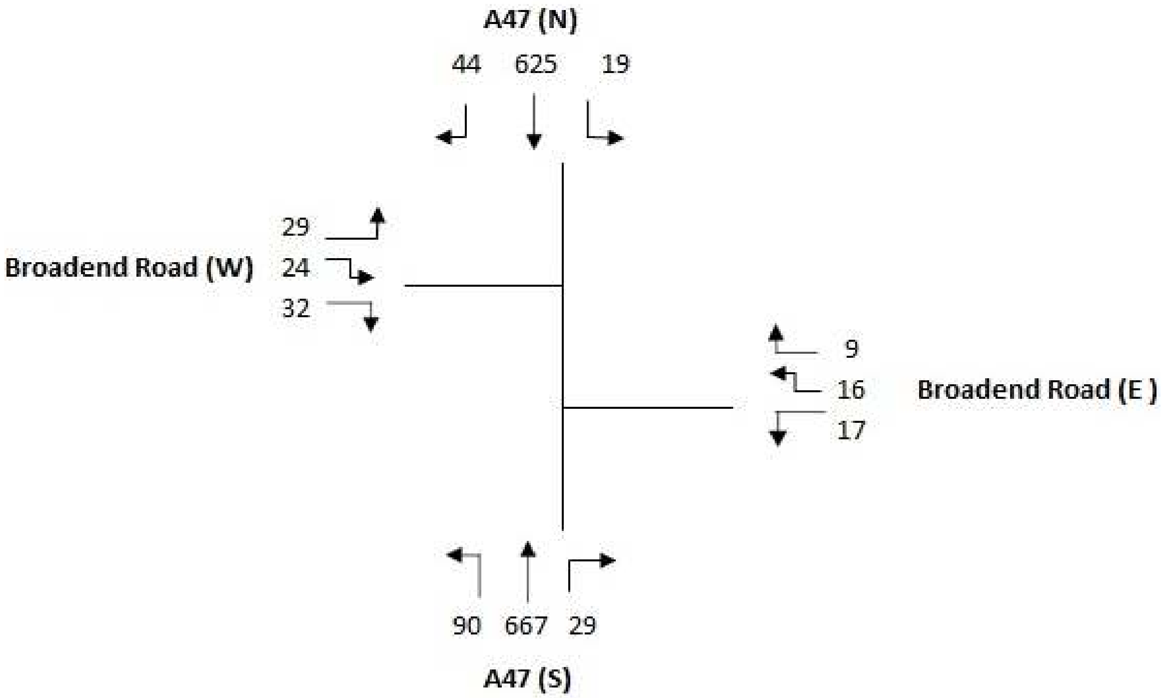


Figure 2.3: Broadend Road Junction PM Peak Hour Traffic Count (17:00 - 18:00)

During the PM peak hour the A47 trunk toad flow remains the dominant movement, and is relatively well balanced as in the other time periods with lack of tidality. The largest turning movement from the A47 is the left turn from the A47 South to Broadend Road West.

The traffic flows on both Broadend Road approaches are very light. Broadend Road West is the busier of the two side arms and the turning movements are well balanced in all directions.

There were only 42 vehicles recorded on the Broadend Road East approach during the PM peak hour, the majority of which either turned left onto the A7 South or ahead to Broadend Road West.

Journey Time and Delay – A47 Trunk Road

Satellite Navigation data has been used to assess journey times and delay along the A47, between the A47 / Elm High Road roundabout to the southwest and the Wisbech Walton Highway / Lynn Road roundabout to the northeast. Figure 2.4 highlights the area for which data has been analysed.

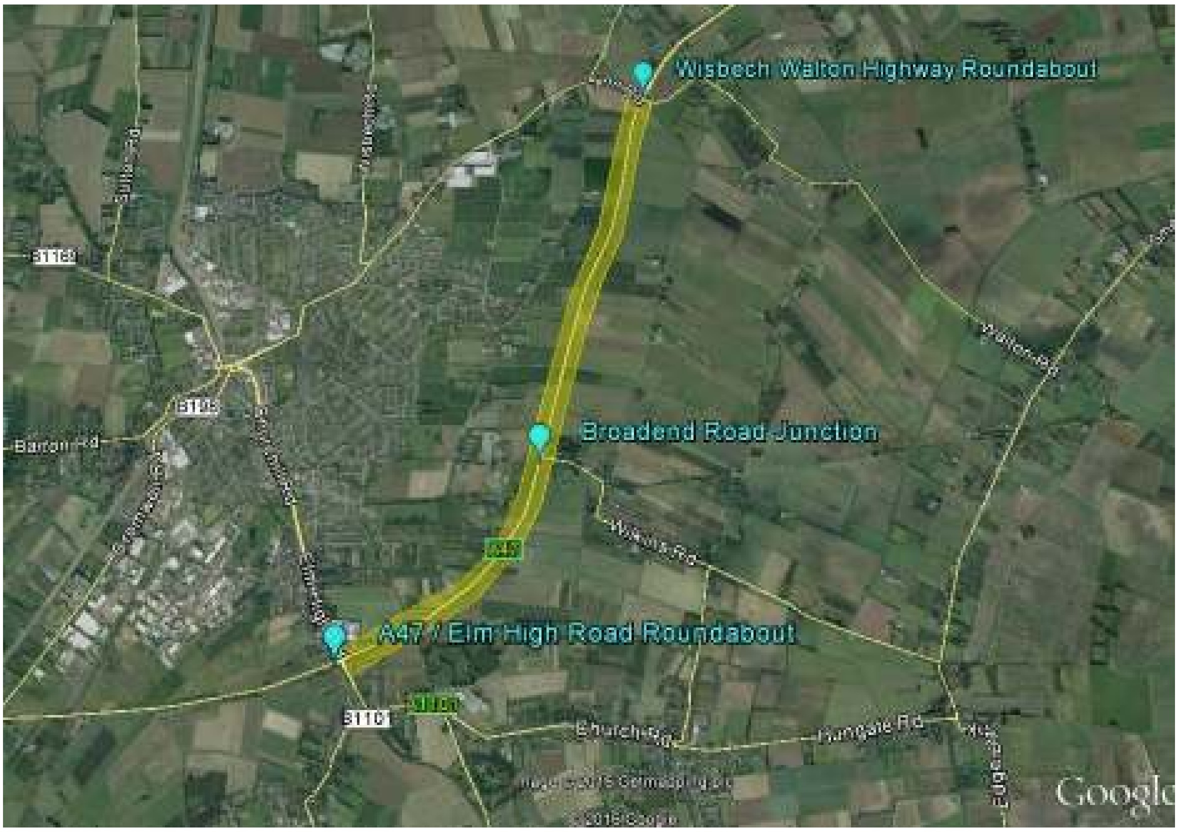


Figure 2.4: A47 Route Assessed for Journey Times and Delay

The TomTom dataset is based on information collected between 2nd November 2015 and 22nd January 2016, excluding weekends, bank holidays and the Christmas period. Time periods selected to assess journey times and delay include:

- Free Flow – between the hours of 0:00 and 05:00;
- AM Peak – between the hours of 08:00 and 09:00; and,
- PM Peak – between the hours of 17:00 and 18:00.

Within the TomTom dataset the carriageway is divided into multiple sections called Segments. In order to compare journey times and calculate delay, road segments have been totalled providing an average travel time for the length of road detailed in Figure 2.4 above.

To calculate delay, the average travel time for the Free Flow period has been used as the base measurement as it most likely represents conditions of unobstructed travel. The additional travel time (beyond that recorded in the Free Flow period) for each of the peak hours is then taken as the delay, as shown in the equation below:

AM (or PM) Average Travel Time (s) – Free Flow Average Travel Time (s) = Delay (s)

The following tables highlight the journey time and delay for the A47 Trunk Road, with data separated for northbound and southbound movements. Segments used within this assessment total 3.1 miles.

Table 2.1: Journey Times and Delay for the A47 Northbound

A47 Northbound		Average Travel Time (Seconds)	Average Delay (Seconds)
Free Flow	(00:00 – 06:00)	213	N/A
AM Peak	(08:00 – 09:00)	238	24
PM Peak	(17:00 – 18:00)	244	31

Table 2.1 shows the Free Flow time for the A47 northbound carriageway is 213 seconds (3 minutes and 55 seconds), over the distance of 3 miles.

The A47 northbound carriageway experiences delay across both peak hours, however PM peak hour delay is shown to be higher with 31 seconds added to journey times. A higher PM delay reflects traffic flows identified within Figures 2.2 and 2.3.

AM peak delay is shown to be lower with 24 seconds added to journey times.

Table 2.2: Journey Times and Delay for the A47 Southbound

A47 Southbound		Average Travel Time (Seconds)	Average Delay (Seconds)
Free Flow	(00:00 – 06:00)	215	N/A
AM Peak	(08:00 – 09:00)	248	34
PM Peak	(17:00 – 18:00)	301	86

Table 2.2 shows the Free Flow time for the A47 southbound carriageway is 215 seconds (3 minutes and 57 seconds), over the distance of 3 miles.

The A47 southbound carriageway experiences delay across both peak hours, with the PM peak being higher with 86 seconds (1 minute 26 seconds) added to journey times.

AM peak delay is less serve than the Pm peak hour for the southbound movement, however is still high with 34 seconds added to journey times.

In comparing the northbound and southbound carriageways, delay is higher across both peak hours when travelling southbound towards Wisbech.

Journey Time and Delay - Broadend Road Approaches

Journey times and delay have been calculated for the Broadend Road approaches to the junction, using the same TomTom dataset described above. Road segments used in this instance are shown in Figure 2.5 below, which total 173 metres on the Broadend Road East approach and 165 metres on the Broadend Road West approach.

Figure 2.5: TomTom Segments Assessed at Broadend Road Junction

The following tables show the journey times and delay for both of the Broadend Road approaches.

Table 2.3: Journey Times and Delay for Broadend Road East Approach

Broadend Road East		Average Travel Time (Seconds)	Average Delay (Seconds)
Free Flow	(00:00 – 06:00)	21	N/A
AM Peak	(08:00 – 09:00)	21	0
PM Peak	(17:00 – 18:00)	33	12

Table 2.3 shows the Free Flow time for the Broadend Road approach is 21 seconds, calculated over a distance of 173 metres.

No delay is shown for the AM peak hour, however delay increases to 12 seconds during the PM peak hour.

Table 2.4: Journey Times and Delay for Broadend Road West Approach

Broadend Road West		Average Travel Time (Seconds)	Average Delay (Seconds)
Free Flow	(00:00 – 06:00)	21	N/A
AM Peak	(08:00 – 09:00)	32	11
PM Peak	(17:00 – 18:00)	30	9

Table 2.4 shows the Free Flow time along the Broadend Road West approach is 21 seconds, over 165 metres.

Delay is shown to occur across both peak hours, however the AM peak hour is marginally higher with 11 seconds added to journey times. Delay shown on this approach is not considered to be significant.

Delay by Turning Movement – Broadend Road Approaches

The traffic survey footage recorded on the 19th January 2016 has been used to calculate the delay by turning movement on each of the Broadend Road approaches to the junction.

Delay has been calculated by recording how long vehicles are stationary before clearing the junction, for both the AM and PM peak hours. Figure 2.6 beneath highlights the turning movements that have been assessed.

Figure 2.6: Turning Movements used to Calculate Average Delay at Broadend Road Junction

The average delay experienced at Broadend Road Junction when making the above turning movements is shown beneath in Tables 2.5 and 2.6.

Table 2.5: Average Peak Hour Delay for Broadend Road East

Broadend Road East	AM Peak Average Delay (Seconds)	PM Peak Average Delay (Seconds)
Left Turn	10	10
Right Turn	18	27

Table 2.5 shows that both right and left turning vehicles (originating from Broadend Road east) experience delay across both peak hours.

Delay for right turning vehicles (movement Broadend Road east to A47 North) is shown to be higher across peak hours, when compared to the left turn movement. Delay for this movement is higher during the PM peak hour, whereby 27 seconds is added to journey times.

It is worth noting that the traffic surveys were undertaken in January when the PM peak hour would be in darkness. This may be a partial factor in the increased delay observed during the PM peak hour as driver hesitancy increases during darkness.

Table 2.6: Average Peak Hour Delay for Broadend Road West

Broadend Road West	AM Peak Average Delay (Seconds)	PM Peak Average Delay (Seconds)
Left Turn	9	12
Right Turn	20	24

Table 2.6 shows that both left and right turning vehicles (originating from Broadend Road west) experience delay across both peak hours.

Similarly to the Broadend Road east, delay for right turning vehicles is shown to be higher across peak hours, when compared to the left turn movement. Delay is shown to be higher during the PM peak, whereby 24 seconds of delay is added to journey times.

Delay experienced for left turning vehicles is less than half in both peak hours, reflecting a similar pattern to Broadend Road East.

Maximum Peak Period Junction Delay (delay per vehicle)

The tables above indicate the average delay that was recorded during the survey footage. Whilst there is benefit attached to highlighting the average delay for the approaches of Broadend Road, it doesn't show the maximum delay experienced on an individual vehicle basis.

With this in mind, the maximum delay recorded (for a vehicle) during this assessment is shown in Tables 2.7 and 2.8 on the following page, for both Broadend Road east and west approaches.

Table 2.7: Maximum Delay Experienced per Vehicle at Broadend Road East Approach

Broadend Road East	AM Peak Maximum Delay (Seconds)	PM Peak Maximum Delay (Seconds)
Left Turn	68	41
Right Turn	114	86

Table 2.7 shows the maximum delay for this approach is higher for the right turning vehicles, reflecting data displayed in Figure 2.5. The maximum delay for this movement is shown to be greater during the AM peak hour, with 114 seconds (1 minute 54 seconds) added to journey times.

Maximum delay in the PM peak (for the right turn) is still high with 86 seconds (1 minute 24 seconds) recorded.

Table 2.8: Maximum Delay Experienced per Vehicle at Broadend Road West Approach

Broadend Road East	AM Peak Maximum Delay (Seconds)	PM Peak Maximum Delay (Seconds)
Left Turn	39	56
Right Turn	128	128

Similarly to the data shown in Table 2.7, the maximum delay on this approach is higher for right turning vehicles, with a maximum of 128 seconds (2 minutes 8 seconds) of delay recorded across both peak hours. This highlights the difficulty of crossing two lanes of traffic on the trunk road, and the longer time periods spent waiting for an appropriate gap in the traffic to become available.

Both Tables 2.7 and 2.8 show maximum vehicle delay to be four times greater than the average delay recorded for Broadend Road Junction. This indicates the junction is effectively operating at or approaching capacity during the morning and evening peak periods. Such delays could encourage more motorists to start to take unnecessary risk and utilising smaller gaps in the traffic to complete their turning manoeuvre.

Accident Data

Accident data for Broadend Road Junction and the surrounding area has been obtained from Norfolk County Council, for the period of 2010 to 2015. Over this period a total of nine accidents were reported in the vicinity of Broadend Road Junction.

Table 2.9 on the following page provides a summary of the accidents that have occurred within this time period, indicating the year and severity.

Table 2.9: Broadend Road Junction Accident Data Summary

Year	Severity	Summary
2011	Slight	V1 overtaking impacts V2
2011	Slight	U-turning V1 impacts front of V2
2011	Fatal	V1 overtaking impacts front of V2
2011	Slight	V1 swerves into other lane impacts V2
2012	Fatal	V1 losses control and overturns
2012	Slight	V1 hits pedestrian whilst overtaking
2012	Slight	V1 overtaking, slight impact with V2
2015	Slight	V1 hits horse whilst overtaking

The location of these accidents are displayed in Figure 2.7 beneath.

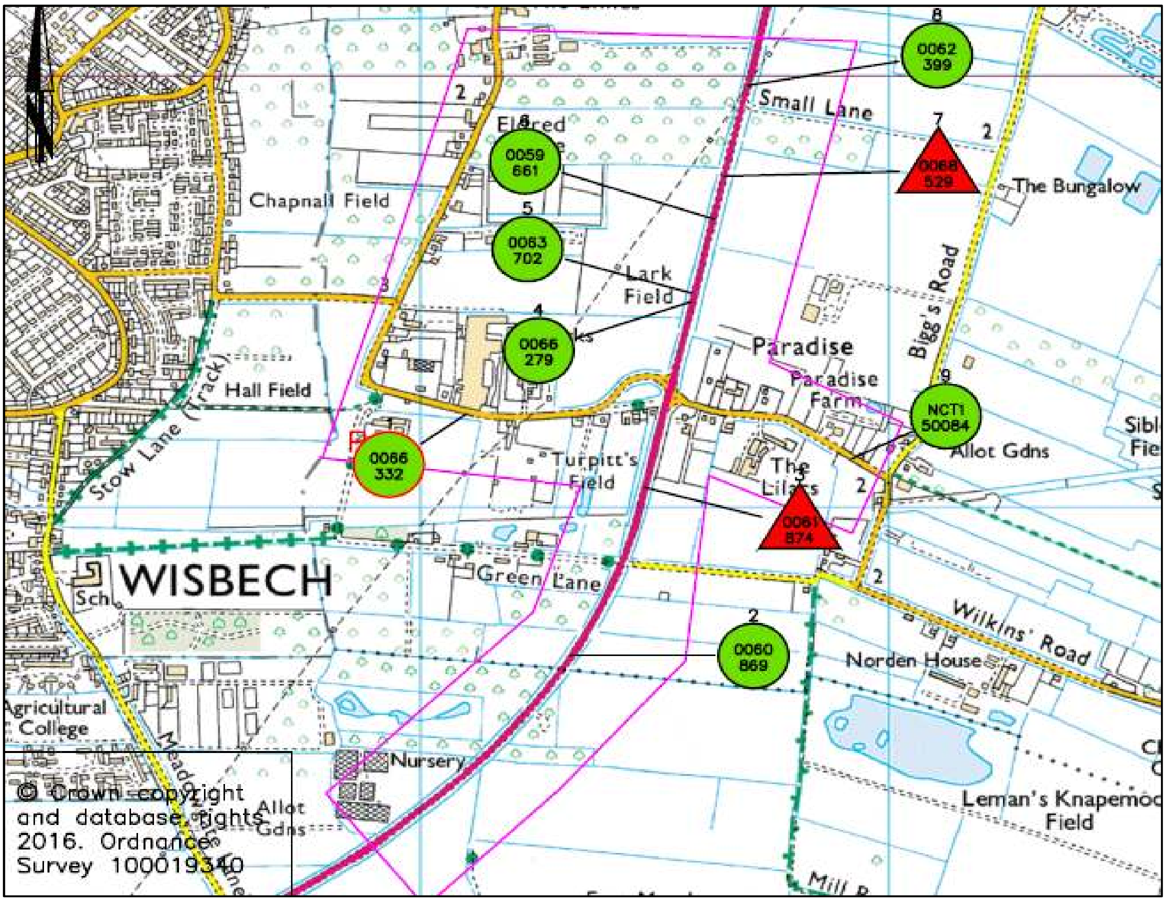


Figure 2.7: A47 Broadend Road Junction Accident Plot, 2010 – 2015

The data shows that seven of the accidents have been classified as slight in severity, with the remaining two being fatal. It should be noted that none of the reported accidents occurred at the Broadend Road Junction itself, but further along the A47 or either of the approach roads.

Land Ownership

The A47 trunk road is the responsibility of Highways England. The Highways England boundary plan for the A47 and Broadend Road Junction is shown beneath. The areas contained within the red land parcels are within the highway boundary for which Highways England is responsible.

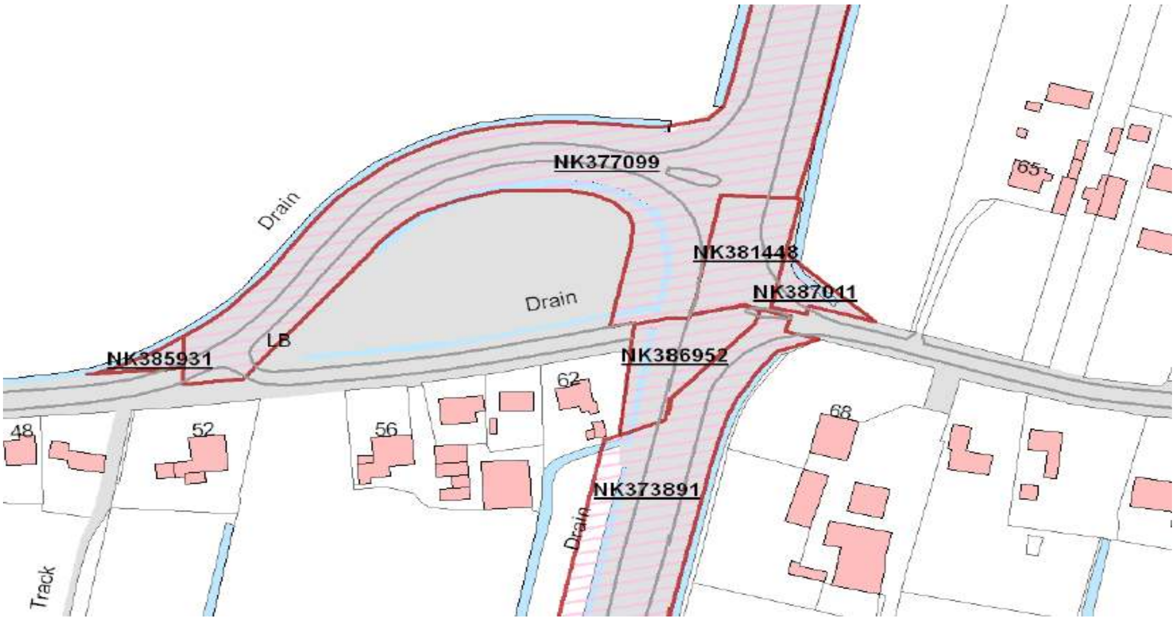


Figure 2.8: Highways England Boundary for Broadend Road Junction

An additional land registry search was undertaken for some of the privately owned / unoccupied land to the northwest of the junction. Figure 2.9 highlights the boundary plan and individual parcels of land.

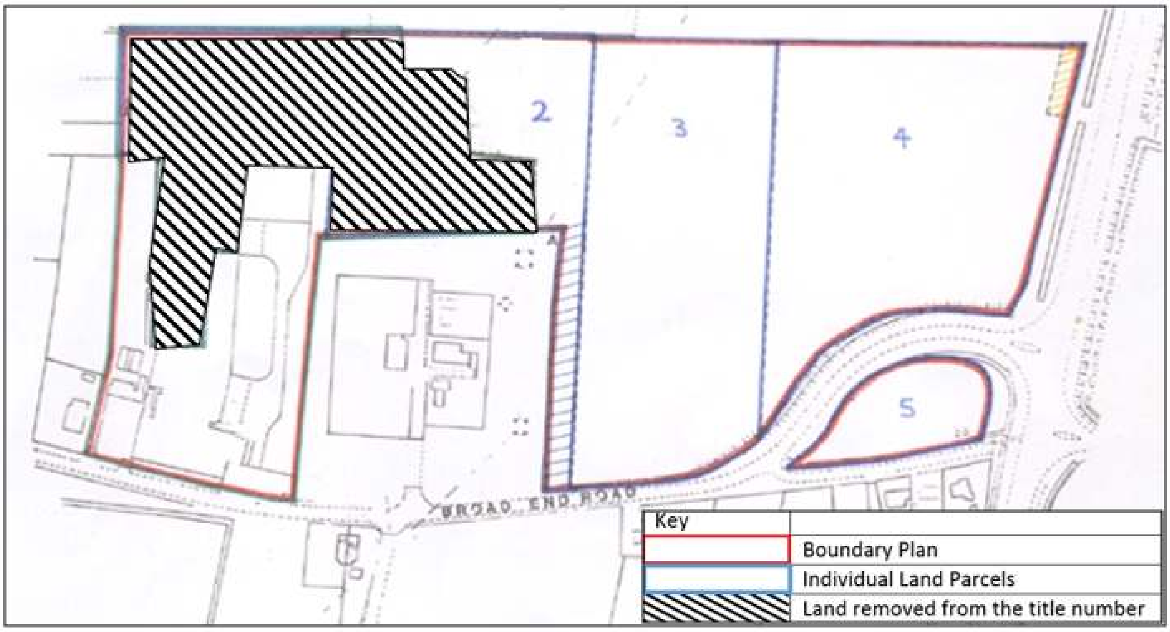


Figure 2.9: Land Registry Search for Privately Owned Land North and West of Broadend Road Junction

Flood Risk

Using data provided by the Environment Agency, Figure 2.10 shows the A47 / Broadend Road Junction lies within Flood Zone 2 (medium risk).

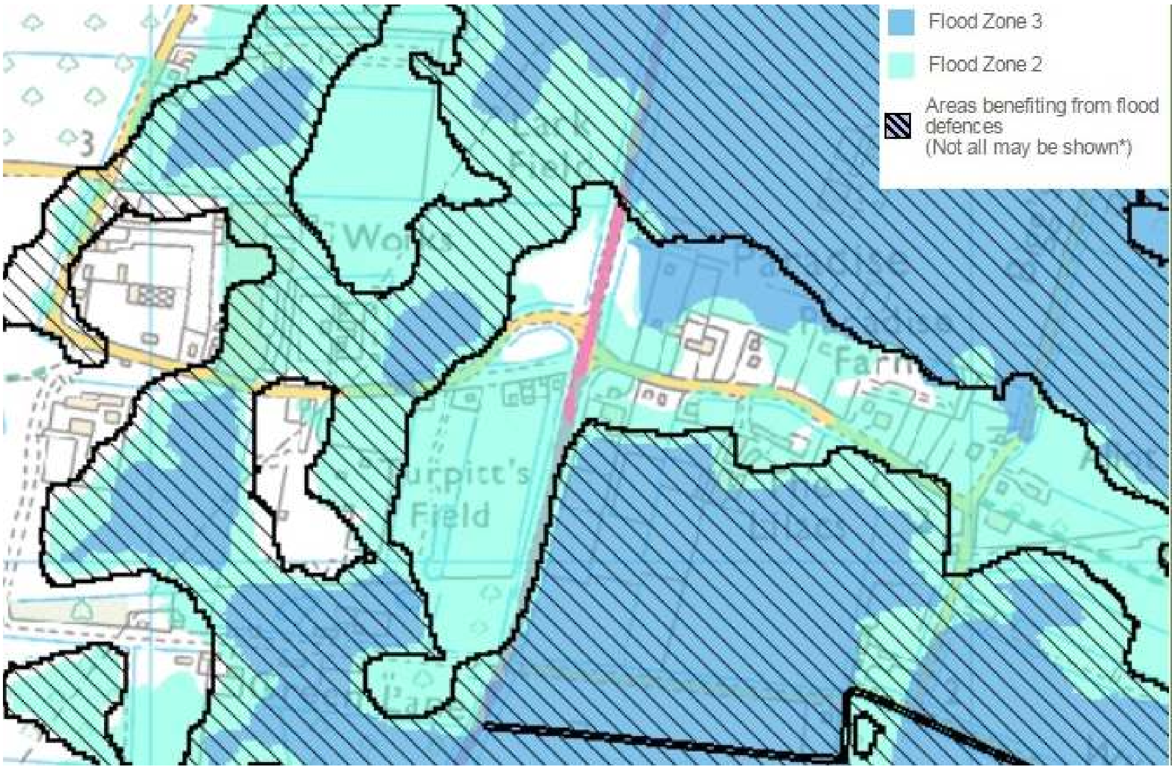


Figure 2.10: Flood Risk for Broadend Road Junction

Environmental Considerations

An environmental assessment of the study area has been completed using the government mapping tool MAGIC. The assessment identified the following environmental considerations:

- The presence of traditional Orchards to the east and southwest of the Broadend Road Junction, as shown in Figure 2.11; and,
- The presence of the breeding species which are found across the town.

These observations should be considered within any scheme design, but are not considered to be sensitive enough to significantly impact on the deliverability of a scheme at this location.

Figure 2.11: Presence of Traditional Orchards within the Vicinity of Broadend Road Junction

3. Development Proposals

Introduction

This chapter provides an overview of the East Wisbech urban extension, outlining the development proposal, construction phasing and predicted development traffic flows. The assessment of junction improvements at the A47 / Broadend Road Junction are directly associated with facilitating this development.

East Wisbech Development Proposal

The East Wisbech development site covers an area of 73 ha (180 acres), and spans across the administrative boundary of Fenland District Council (Cambridgeshire) and Kings Lynn and West Norfolk District Council (Norfolk). The majority of the site forms the east strategic allocation of growth for Wisbech, as specified within the Fenland Local Plan (2014). The remainder of the site is identified within the Core Strategy of Kings Lynn and West Norfolk (KL&WN) (2011), which acknowledges that additional land to the east of the border is needed to aid the level of growth required for Wisbech.

The broad concept plan for the site will be jointly agreed by both councils. Figure 3.1 highlights the division in land allocations across both councils.

It should be noted that the external company ATLAS, Homes and Communities Agency (HCA) team responsible for developing large scale planning applications, are assisting with this project on behalf of the two councils named above.

Figure 3.1: Location and Council Land Allocations of the East Wisbech Development Site

The proposed development will be predominantly residential and is planned to consist of:

- 900 / 1,000 dwellings allocated by FDC;
- 550 dwellings allocated by KL&WN;
- Improved A47 access;
- A primary school;
- A local centre;
- Pedestrian and cycle routes; and,
- Open space.

Access to and from the site onto the existing network is currently proposed to be via several points located around the development boundary, allowing traffic to distribute across Wisbech. The primary access linking the development to the strategic network (A47) will be via Sandy Lane and the Broadend Road junction. The Broadend Road Junction with the A47 will require improvement to accommodate the forecasted increase in traffic resulting from the development.

Spatial Planning Workshop

A workshop was held on the 6th November 2015 and attended by members of the East Wisbech Steering Group. The purpose of the workshop was to establish development objectives and spatial concept plans for the site. The outcome of the workshop was intended to inform further site-wide options and master planning work, including the broad concept plan.

As a result of the workshop a spatial plan was produced based on the concept designs presented by three workshop groups. The spatial plan, as indicated in Figure 3.2, highlights common themes of housing, drainage, green routes and proposed local infrastructure. Please note the figure shown below is not the Broad Concept Plan for the East Wisbech development.

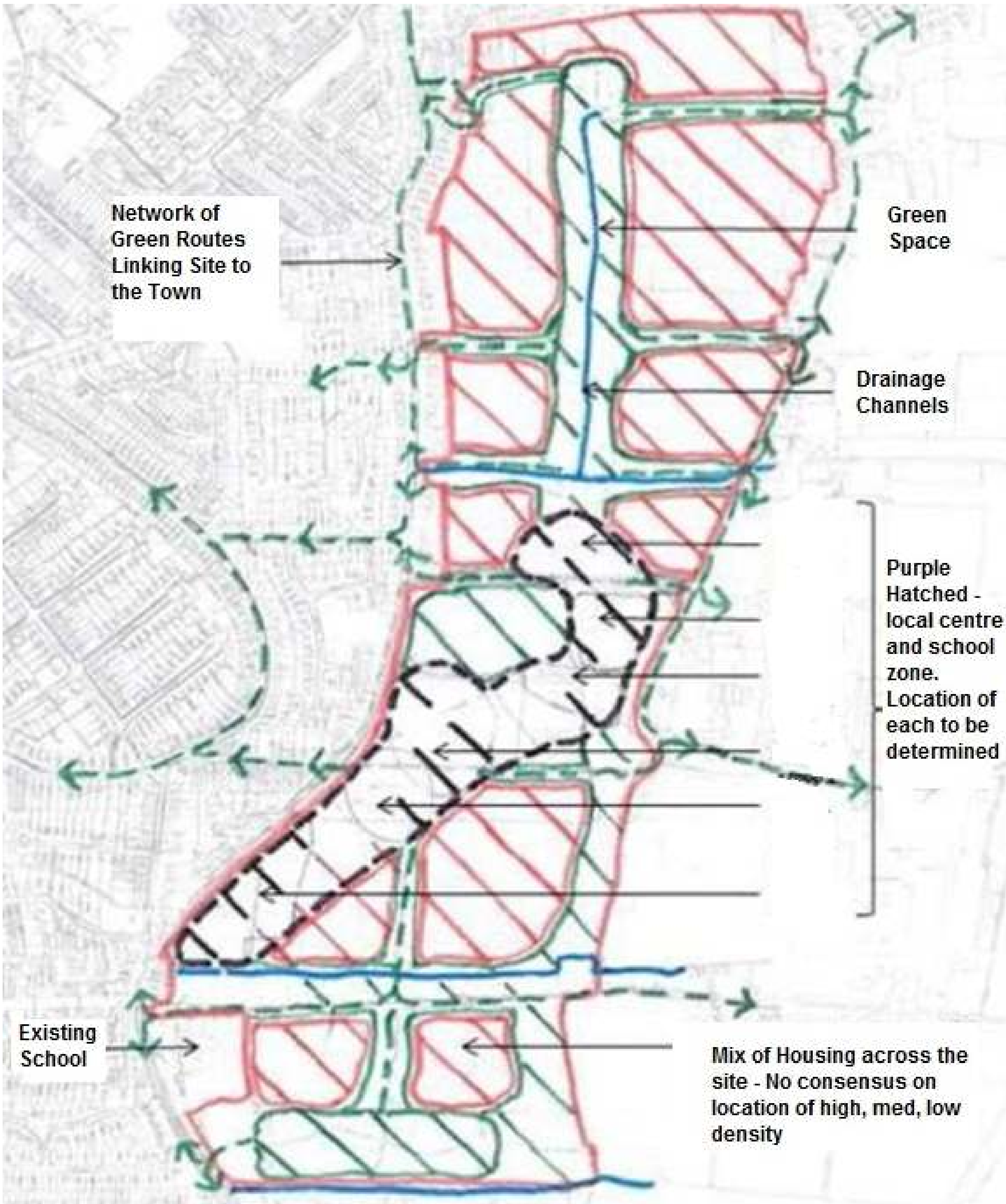


Figure 3.2: Workshop Spatial Plan for the East Wisbech Development Site

Proposed Development Phasing

The proposed phasing for the Wisbech East development is shown beneath, and highlights the proposed housing allocations for both councils of Fenland District Council and Kings Lynn and West Norfolk District Council.

Table 3.1: Proposed Phasing for East Wisbech Development

Phasing Period	Fenland Allocation	Kings Lynn and West Norfolk Allocation
2016 - 2021	170	100
2022 - 2026	365	300
2027 – 2031	365	150

Development Traffic

The Wisbech Access Transport Study (WATS) model (2015 base) has been used to gather the following information for use in the junction assessment of Broadend Road:

- Extraction of forecasted traffic flows for future years of 2021, 2026 and 2031,and;
- Extraction of origin and destination data for the number of vehicles travelling between Broadend Road Junction and the East Wisbech Development site.

The East Wisbech development site is represented within the WATS model using a series of SATURN zones dedicated to development traffic. The zones assigned trips for the site include 50250, 30212 and 30255 as shown in in Figure 3.3 below.

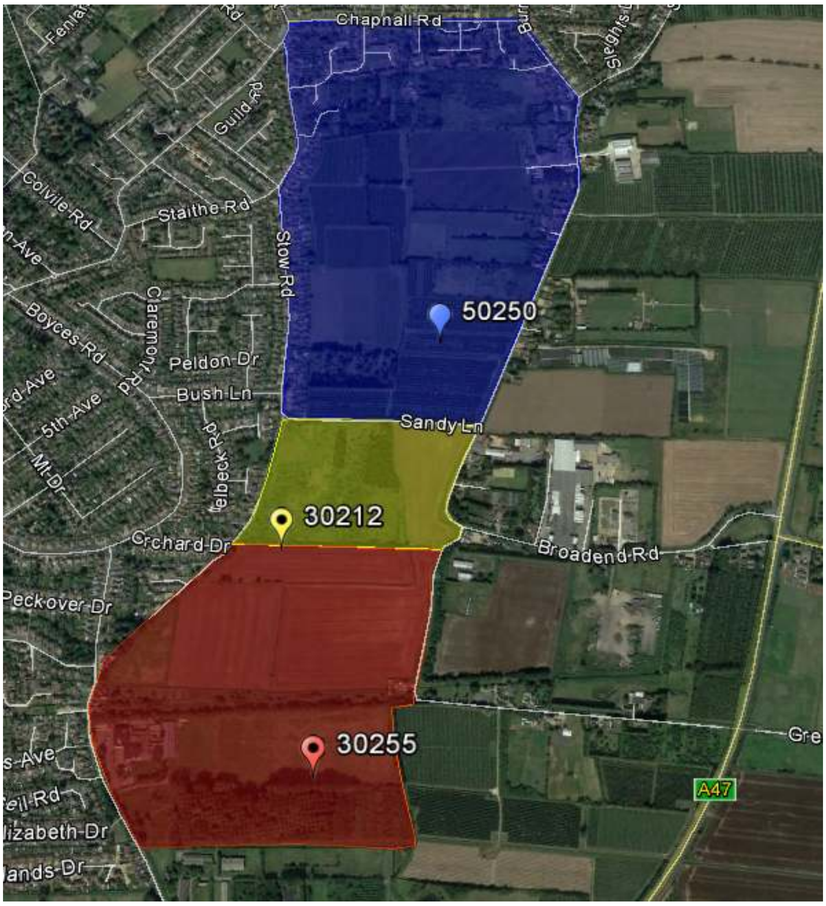


Figure 3.3: Representation of the East Wisbech SATURN Zones

The forecast traffic flows for the Broadend Road Junction are shown in Table 3.2, which are shown for both the AM (08:00 – 09:00) and PM peaks (17:00 – 18:00) periods.

Table 3.2: Future Year Traffic Flows for Broadend Road Junction

From	To	AM Peak			PM Peak		
		2021	2026	2031	2021	2026	2031
A47 (N)	Broadend Road (E)	17	19	21	17	19	20
A47 (N)	A47 (S)	814	864	969	802	823	915
A47 (N)	Broadend Road (W)	12	15	19	10	17	35
Broadend Road (E)	A47 (S)	61	61	61	17	17	17
Broadend Road (E)	Broadend Road (W)	24	51	48	56	47	43
Broadend Road (E)	A47 (N)	47	51	55	29	32	35
A47 (S)	Broadend Road (W)	133	155	173	151	178	225
A47 (S)	A47 (N)	712	786	835	837	902	989
A47 (S)	Broadend Road (E)	22	22	22	29	29	29
Broadend Road (W)	A47 (N)	13	17	20	9	12	15
Broadend Road (W)	Broadend Road (E)	4	5	22	7	11	13
Broadend Road (W)	A47 (S)	78	101	133	151	101	127

Select Link analysis has been used to determine the number of vehicles forecast to travel between the East Wisbech Development site and Broadend Road Junction by 2031. These are shown beneath for each of the peak hours in Tables 3.3 and 3.4.

Table 3.3: 2031 AM Peak - Forecast Trips between the Development and the A47

2031 AM Development Traffic	Zone 50250	Zone 30212	Zone 30255
From Development to Broadend Road Junction	25	198	35
Broadend Road Junction to Development	23	203	24

The table shows that there the development generates a higher number of trips towards the junction than it attracts during the AM Peak. A total of 258 trips passing through Broadend Road Junction originate from the East Development site during the AM peak hour.

Table 3.4: 2031 PM Peak - Forecast Trips between the Development and the A47

2031 PM Development Traffic	Zone 50250	Zone 30212	Zone 30255
From Development to Broadend Road Junction	18	244	29
Broadend Road Junction to Development	13	250	63

The table shows that number of trips generated and attracted by the development are very fairly balanced during the PM Peak, and that a total of 282 trips using the junction by 2031 are expected to be associated with this development.

4. Option Selection

Option Identification Workshop

A workshop was held on the 28th January 2016 at Shire Hall, Cambridge, to determine the potential junction types to be assessed for the A47 East Junction at Broadend Road.

The workshop was attended by professionals from various disciplines, and included representatives from Fenland District Council, Cambridgeshire County Council, the Borough of Kings Lynn and West Norfolk and Highways England.

The workshop considered a list of potential junction layouts against a set of criteria to determine which forms should be included in the assessment. The potential junction layouts considered were drawn from standard junction forms that are commonly used across the highway network. The comments and conclusions from this workshop are provided below, with further detail available in Appendix B.

Scoring Criteria

The criteria used to assess the potential junction layouts are listed beneath. These criteria are a combination of those included within the DfT's East assessment framework and a series of local objectives.

- Impact on congestion and emissions;
- Impact on A47 journey time reliability;
- Access to / from A47;
- Impact on road safety;
- Making use of existing infrastructure;
- Impact on local environment;
- Potential for sustainable transport provision; and,
- Could it be considered controversial? (Potentially compromising deliverability).

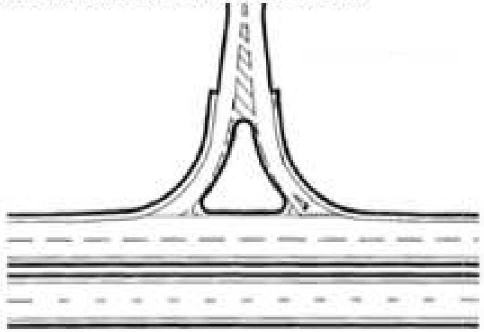
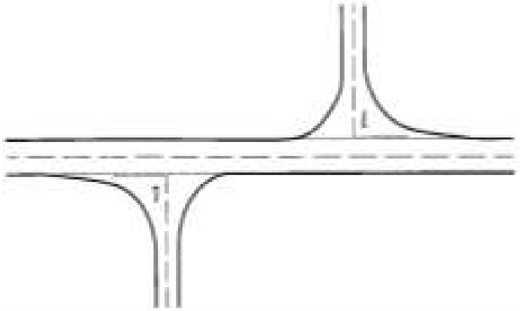
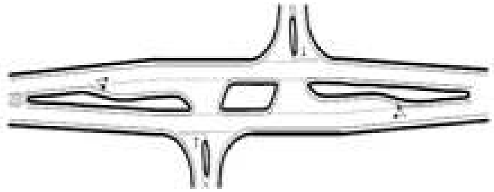
Junction Layouts

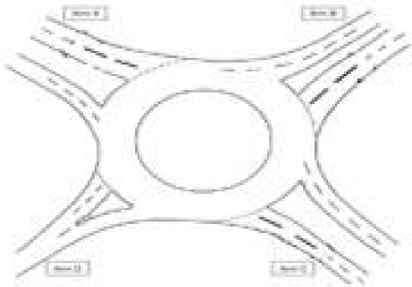
The potential forms of junction discussed within the workshop included:

- Left in / Left out;
- Priority Junction;
- Priority Junction with Single Lane Dualling;
- Signalised Junction;
- Simple Roundabout;
- Enhanced Roundabout; and,
- Overbridge with Slip Roads.

Each of the junction layouts have associated advantages and disadvantages, which are outlined in the table beneath.

Table 4.1: Junction Layout Summary

Junction Type	Left in / Left out (LILO)	Priority Junction (Existing)	Priority with single lane dualling
Diagram	LILO refers to the restricted turning movement that can be made at the junction. 	Priority junctions occur when a minor road meets a major road. 	Single lane dualling is formed by widening the major road in order to provide a central reservation as well as waiting space for right turning vehicles. 
Advantages	• Preserves access to a minor road; • Allows the main road to remain free-flowing; • Low cost option that requires minimal land take and; • Increases safety as removes the cross-traffic right turn movement.	• Allows for turning movements in both directions; and, • Minimal or no delay is added to the major road.	• Allows for turning movements in both directions, • Prevents overtaking, reduced accident rates; • Reduces speeds through the junction; and, • Minimal or no delay is added to the major road
Disadvantages	• Only provides turning movements in one direction, creating detours for those wanting to turn right; • Movements from minor roads are dependent on available gaps in the traffic flow; and, • Access onto minor road may create rat runs, if major road experiences delays.	• Movements from minor roads are dependent on available gaps in the traffic flow; • Increased accident rates, as the length of acceptable space required for pulling out onto the main road gets shorter, the longer the individual is stationary at the junction; and, • Increased conflict points as a result of more junction arms as well as the cross-traffic movements.	• Movements from minor roads are dependent on available gaps in the traffic flow; • Significantly increased accident rates, as the length of acceptable space required for pulling out onto the main road gets shorter, the longer the individual is stationary at the junction; and, • Increased conflict points as a result of cross-traffic movements.

	Signalised Junction	Simple Roundabout (& Enhanced Roundabout)	Overbridge and Slip Roads
Diagram	Introduction of traffic signals allows traffic movement and right of way to be dictated. 	Circular junction in which the traffic travels almost continuously in one direction around the central island. Priority is given to those already on the circulatory. 	Slip roads allow drivers to join/ leave a carriageway, whilst overbridges allow a change in direction without lengthy detours 
Advantages	• Allows for pedestrian crossings to be integrated into the junction, increasing pedestrian and cyclist safety; • Allows for controlled right turn movements, reduction in collisions/ accident rates; and, • Signals can be programmed to reduce delay on approaching arms.	• Maintains free-flowing traffic/ minimal delay added; • Eliminates cross-traffic movements; • Traffic calming effect reducing traffic speeds and accidents; and, • Can be **enhanced** following elements of increased island diameter, signals, number of approaches and left-hand flares.	• Maintains free-flowing traffic, with minimal delay added to journey times; • Can accommodate footpaths and cycle ways on the overbridge; and, • Allows traffic to join/ leave the carriageway in both directions, no detour needed.
Disadvantage	• Creates a disjointed traffic flow/ increased waiting times; • Delay significantly higher during off-peak hours; • Potential increase in rear end shunts; and, • Maintenance costs are high, with signal failures being a common problem.	• Requires a larger land take; • Length of acceptable space required for pulling out onto the main road gets shorter, the longer the individual is stationary at the junction; and, • Delay can be added during peak hours.	• Requires a larger land take and visual impact; • Merging is required for vehicles joining the carriageway, likely to have a high accident rate; and, • Increased maintenance required.

Workshop Outcome

Tables 4.2 to 4.8 below show the workshop consensus of opinion on the possible form of junction against the criteria described above, and summarises whether the option should be retained for further assessment or be dismissed.

Comments shown in green were considered to be of significant benefit, whilst comments in red were considered to be significant weaknesses. It is these highlighted cells that were chosen as the key drivers for an option being retained or dismissed. On this basis cells remaining in white represent either existing conditions or comments considered less significant than those highlighted in either red or green.

Left In / Left Out (LILO)

Table 4.2: Workshop Comments for Left in / Left Out (LILO) Junction

Criteria	Comment
Impact on congestion and emissions	Greater emissions associated with detours required for vehicles wanting to turn right. Detours on site for vehicles wanting to travel northbound will be via Elm High Road Roundabout, which will add more vehicles onto an junction which is already operating over capacity
Impact on A47 journey time reliability	Priority will remain on the A47, with minimal / no delay added for this stretch of road when approaching Broadend Road Junction LILO will have no impact on the A47, past the stretch in question
Access to / from A47	Access onto the A47 from side roads will be compromised, with vehicles restricted to left turning movement Access off the A47 onto side roads will remain the same as present.
Impact on safety	Safety risks associated with this junction type may increase with potential U-turners, illegal right turns etc. Merging with the A47 from the side roads may be difficult. Increased risk taking associated with gap availability and prolonged time spent stationary at the junction.
Will it be considered controversial?	Not believed it would be seen as acceptable safety improvement by local safety group. No provision for pedestrian or cycle facility could be added to the junction with this layout.
Making use of existing infrastructure	Regression of the existing junction infrastructure. Traffic flows on junction side roads will be impacted with added delay whilst joining the A47
Impact on local environment	Diverted traffic which would usual turn right will add congestion at Elm High Roundabout, impacting not only the operation of the roundabout but wider network of Elm High Road, Weasenham Lane etc.

Status: **Dismissed**

Priority Junction

Table 4.3: Workshop Comments for a Priority Junction

Criteria	Comment
Impact on congestion and emissions	Would reflect current situation at the junction. The existing junction is effectively operating at capacity, as evidence by the maximum turning delays observed. The Existing layout would therefore not be capable of accommodating any further turning traffic movements during peak periods, limiting the potential for land use growth off Broadend Road
Impact on A47 journey time reliability	Priority will remain on the A47, with minimal / no delay added for this stretch of road when approaching Broadend Road Junction
Access to / from A47	Access onto the A47 is dependent on gaps in traffic flow. Some delay is currently experienced whilst waiting to join the A47 from side roads, particularly for right turners.
Impact on safety	Keeping same junction layout does not address safety concerns expressed by locals and councillors. Safety concerns raised over; location along a flat/ straight stretch of road, limited pre-warning of the junction, side roads dependent on gap availability in A47 traffic flow; cross movements at the junction etc.
Will it be considered controversial?	This junction option will be viewed as not addressing safety issues raised. Future growth corresponding to proposed development will exacerbate these issues.
Making use of existing infrastructure	Existing infrastructure will remain. Minimal land take would be needed. Traffic flows on junction side roads will see no improvement when joining the A47.
Impact on local environment	Minimal land take required for this junction infrastructure.

Status: **Dismissed**

Priority Junction with Single Lane Dualling

Table 4.4: Additional Workshop Comments for a Priority Junction with Single Lane Dualling

Criteria	Comment
Impact on congestion and emissions	Would reflect current situation at the junction.
Impact on A47 journey time reliability	Priority will remain on the A47, with minimal / no delay added for this stretch of road when approaching Broadend Road Junction
Access to / from A47	Access onto the A47 is dependent on gaps in traffic flow. Some delay is currently experienced whilst waiting to join the A47 from side roads, particularly for right turners.
Impact on safety	Provision of a right turn lane would make junction safer and more visible for A47 mainline traffic. (Subsequent Note: Further investigation into this comment has since shown that there is often an inherent safety risk associated with these junctions).
Will it be considered controversial?	This junction option will be viewed as not addressing safety issues raised.
Making use of existing infrastructure	Would largely use the existing junction infrastructure, however land take would be needed to cater for central right turn lanes. .
Impact on local environment	Minimal land take required for this junction infrastructure.

Status: **Dismissed**

Signalised Junction

Table 4.5: Workshop Comments for a Signalised Junction

Criteria	Comment
Impact on congestion and emissions	Greater emissions associated with stationary traffic Signals create a build-up of traffic, whilst on red, however gating from signals would potentially allow A47 traffic at the adjoining roundabouts each side of Broadend Road Junction to clear.
Impact on A47 journey time reliability	Signals will create a disjointed traffic flow for the A47 and introduce significant delay for motorists. Highway England disapproval.
Access to / from A47	Signalled junction would improve access onto/ off A47 from side roads Current safety risks and delay experienced for right turners will be addressed. Opportunity to introduce pedestrian and cycle facilities at the junction
Impact on safety	Signals will provide side road traffic with an equal chance to exit the junction, reducing risks associated with gap availability and risk taking behaviour. Due to the positioning of the current on the local landscape, advanced warnings of signals will be required. On the surrounding network, signals do not feature making them unexpected to road users.
Will it be considered controversial?	This option would greatly disbenefit HGV drivers and through traffic.
Making use of existing infrastructure	Additional land take would be required.
Impact on local environment	Visibility of signals on the local network may be an issue.

Status: **Dismissed**

Simple Roundabout

Table 4.6: Workshop Comments for a Simple Roundabout

Criteria	Comment
Impact on congestion and emissions	Greater emissions associated with stationary or slowing vehicles on the approach to the roundabout Congestion / queues may build whilst vehicles are waiting to join the circulatory
Impact on A47 journey time reliability	Journey times for A47 traffic will increase, traffic flow becomes disjointed. Slowing of vehicles on the approach to the approach to the roundabout is seen as potential safety improvement.
Access to / from A47	Roundabout would improve the access of all approaches
Impact on safety	Roundabout would slow vehicles down, and remove the opportunity for overtaking in this location Roundabout adds an obstacle on the network, advanced warning for motorists will be required.
Making use of existing infrastructure	Additional land take would be required
Impact on local environment	Confined space at current junction location, visual impact for nearby houses would be an issue

Status: **Shortlisted**

Enhanced Roundabout

In addition to comments listed for the above ‘standard roundabout’, Table 4.7 highlights extra comments considered for an enhanced roundabout. Enhanced features would include two lane approaches and two lane exits, and a larger Inscribed Circle Diameter (ICD).

Table 4.7: Additional Workshop Comments for an Enhanced Roundabout

Criteria	Comment
Making use of existing infrastructure	Additional land take would be required, to cater for more complex design.
Impact on local environment	Greater impact for residents created – emissions, noise etc.

Status: **Shortlisted**

Overbridge with Slip Roads

Table 4.8: Workshop Comments for a Slip Road and Over Bridge

Criteria	Comment
Impact on congestion and emissions	Little congestion would be added onto the network
Impact on A47 journey time reliability	The A47 would remain free flowing
Access to / from A47	Access onto the A47 would improve, however safety concerns associated with the merging process of the slip road Over bridge could accommodate pedestrian and cycle facilities
Impact on safety	Merging onto the A47 would become a safety risk, still dependent on gaps in the traffic.
Making use of existing infrastructure	None of the existing infrastructure would be used, significant land take would be required. Cost would be very significant.
Impact on local environment	Visual impact in the local area is high, intrusive for local residents.

Status: **Dismissed**

Shortlisted Options

The following options were shortlisted during the workshop to be taken forward for further assessment:

- Simple roundabout (single lane approaches with flares); and,
- Enhanced roundabout (two lane approaches with two lane exits).

5. Option Assessment

Introduction

This chapter outlines the assessment process and results for the options progressed from the option selection workshop. The assessment has been completed to determine the operational viability of the proposed options with forecast traffic flows applied, as well as to understand the impact of delay on the strategic road network.

The following modelling packages have been used to assess the options:

- PICADY modelling software in TRL'S Junction 9 for priority junctions; and,
- ARCADY modelling software in TRL'S Junction 9 for roundabouts.

The options have been assessed and compared to the Do Minimum (DM) scenario, in which future year traffic flows (including from the Wisbech East development), are applied to the existing highway network. The purpose of the Do Minimum scenario is to demonstrate what would happen if development and growth continue without the proposed highway improvements, providing a base case against which each of the options can be compared.

Scenarios Assessed

The following scenarios have been assessed for each of the junction types:

- AM Peak Hour (08:00 – 09:00) and PM Peak Hour (17:00 – 18:00); and,
- 2021, 2026 and 2031 Future Year Scenarios.

Future Year Traffic Flows

Future year traffic turning movements have been extracted from the existing WATS model (updated May 2017) for each of the peak hour time periods during the forecast years.

The junction has been modelled as both a priority junction and a roundabout within the WATS model, and the demand turning movement extracted for each option. The forecast traffic flows within the WATS model vary depending on whether the A47 / Broadend Road junction is a priority junction or a roundabout as the model assigns traffic throughout the network based on considerations such as delay, which varies dependent on the form of the junction.

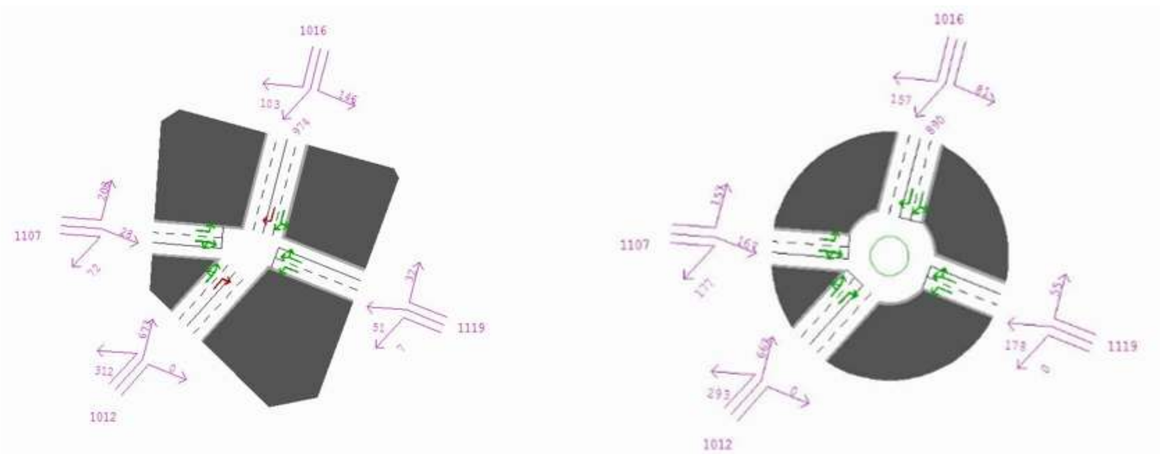


Figure 5.1: 2031 PM Peak Hour Demand Flows from WATS Model: As a priority or roundabout solution

Options Assessed

The options assessed for the A47 / Broadend Road Junction are listed beneath. These options were derived from the option selection workshop described in Chapter 4.

- **DM Scenario** – Existing junction infrastructure, assessed against forecasted traffic flows to provide a base scenario against which the options could be measured;
- **Option 1** – Simple roundabout with a 40 m ICD and single lane approaches, using a standard set of geometry;
- **Option 2** – Simple roundabout with a 40 m ICD and single lane approaches with 30 m flares, using a standard set of geometry; and,
- **Option 3** – Enhanced roundabout with a 50 m ICD and two lane entries along the A47 approaches.

Further detail on each of the options assessed is outlined beneath, including the geometry used within the assessment and model results.

Model Outputs

The following measures have been used to understand the impact of the proposed layout changes to Broadened Road Junction, and the likely impact this will have on the A47:

Ratio Flow to Capacity (RFC) indicates the likely performance of a junction, with a value of 0.85 being a practical capacity threshold (orange). Any value greater than 1.00 implies the demand flow is equal or has exceeded capacity (red).

Queue Lengths (PCU) indicates the likely impact of queuing on the approach to the junction and on the surrounding network.

Delay (seconds) indicates the likely impact of vehicle delay on journey times as a consequence of the junction.

LOS (Levels of Service) indicates the expected level of service that vehicles will experience using the junction, where 'A' represents free flow conditions, and 'F' represents break down as a result of exceeding capacity.

ARCADY and PICADY model reports are available upon request for all options discussed within the remainder of this chapter.

Do Minimum

This option reflects the current infrastructure of Broadend Road Junction as a staggered priority junction, with dedicated right turn lanes and ghost islands incorporated into junction design.

Option Geometry

The geometry assumed for this option is shown below, together with a table below providing the necessary geometric definitions.

Table 5.1: Geometry Input for Broadend Road East and West for Existing Infrastructure

	W (m)	Wcr (m)	W b-a/d-c (m)	Wb-c/d-a (m)	W c-b/a-d (m)	Vl (m)	Vl (m)
Junction Minor Arms	10	0	3.7	3.7	3.7	100	100

Table 5.2: Geometry Input Description

Input	Description
W	The width of the major road at the junction
W CR	The width of the central reservation (if no reservation or ghost island 0)
W b-a / d-c	Average lane with for vehicles turn right-out
W b-c / d-a	Average lane width for vehicles turn left-out
W c-b / a-d	Average lane width for right turn-in vehicles. If no explicit provision for right turns use 2.2m
Vl	Visibility to the left, to be no greater than 250m
Vr	Visibility to the right, to be no greater than 250m

The following diagram highlights the streams of traffic that have been reported within the model results.

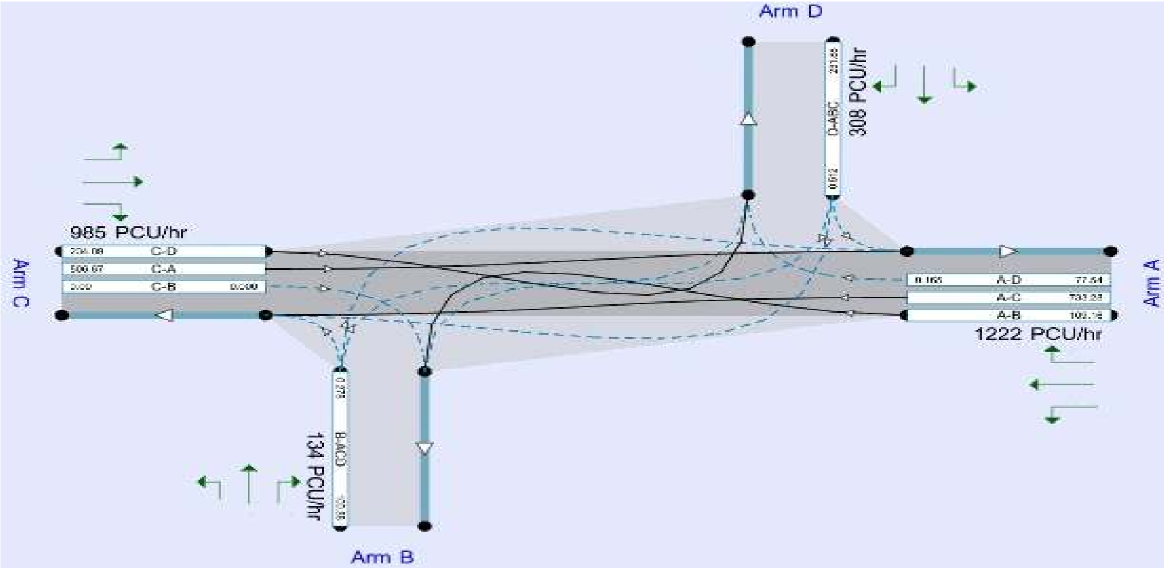


Figure 5.2: Do Minimum Modelling

Note that Arm A represents the A47 North, Arm B represents Broadend Road East, Arm C represents the A47 South and Arm D represents Broadend Road West.

Validation of the Do Minimum Model

The 'Do Minimum' assessment results have been validated against the survey data undertaken in January 2016 and described in Chapter 2.

The model has been validated against delay for each of the Broadend Road approaches (Stream B-ACD and Stream D-ABC). The A47 trunk road is currently free flowing through the junction, and therefore there is no delay to validate against.

The survey results highlighted below were extracted from Tables 2.5 and 2.6 (Chapter 2). In order to replicate the traffic stream information reported from PICADY model outputs (combined delay for all minor arm turning movements), survey data per individual turn movement have been added together and an average taken.

Table 5.3: Priority Junction 2016 Validation Results

	Survey Data	PICADY model output
	AM Peak	
Stream B-ACD (Broadend Road East)	14.0	12.0
Stream D-ABC (Broadend Road West)	14.7	14.7
	PM Peak	
Stream B-ACD (Broadend Road East)	18.5	11.2
Stream D-ABC (Broadend Road West)	18.4	13.4

The results show that the model validates well during the AM Peak, and closely replicates conditions observed on site during the traffic surveys undertaken in January 2016.

During the PM Peak the model appears to be under representing delay on the side arms. This means that the difference in delay shown in the comparison of the options against the Do Minimum scenario may actually be greater than that reported by the modelling.

Although Table 5.3 above shows that the Do Minimum PICADY model closely replicates observed delay, it is acknowledged that the survey sample against which the model is validated is relatively low compared to the total flow through the junction. Therefore the Do Minimum Model described above has only been used to understand the relative impact of each of the options, and an operational assessment of the preferred option will be undertaken using a purpose built VISSIM model which will be validated against observed journey times derived from TomTom data for all approaches (including the A47). This will allow a much more robust validation, providing much greater credibility to the assessment of the preferred option.

Option Assessment Results

Results for the priority junction modelling are provided in the tables below, which are separated by forecast year.

Table 5.4: 2021 Do Minimum Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
Stream B-ACD	0.4	0.7	18.4	C
Stream A-D	0.1	0.1	9.0	A
Stream D-ABC	0.3	0.4	17.3	C
Stream C-B	0.1	0.1	8.7	A
	PM			
Stream B-ACD	0.3	0.3	17.2	C
Stream A-D	0.1	0.1	9.2	B
Stream D-ABC	0.4	0.6	20.2	D
Stream C-B	0.1	0.1	8.9	A

Table 5.4 shows that the existing priority junction is expected to operate within capacity in 2021. Despite the junction operating within capacity, the minor arms of Broadend Road East (Stream B-ACD) and West (Stream D-ABC) are expected to experience delay when joining the A47.

Delay on Stream B – ACD and D – ABC is shown to be between 17 and 20 seconds by 2021, with Broadend Road West in particular approaching an unstable flow in the PM peak hour, as indicated by the LOS category 'D'.

Delay for vehicles wanting to turn right from either A47 approaches (Stream A-D and Stream C-B) appears balanced over peak hours, with both movements experiencing an increase in journey times by around 9 seconds.

Table 5.5: 2026 Do Minimum Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
Stream B-ACD	0.5	0.9	24.0	C
Stream A-D	0.1	0.1	9.5	A
Stream D-ABC	0.4	0.6	22.6	C
Stream C-B	0.1	0.1	9.1	A
	PM			
Stream B-ACD	0.3	0.4	22.3	C
Stream A-D	0.1	0.1	10.1	B
Stream D-ABC	0.5	1.1	31.3	D
Stream C-B	0.1	0.1	9.3	A

Like 2021 the junction is expected to operate within capacity by 2026, however the same issue of unstable flow (LOS D) is shown for movements originating from Broadend Road West, which is to facilitate development traffic.

Delay in 2026 is shown to have increased for both minor arms, with a maximum delay of 31 seconds added to journey times for Broadend Road West in the PM peak hour.

Table 5.6: 2031 Do Minimum Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
Stream B-ACD	0.7	1.5	35.9	E
Stream A-D	0.1	0.1	10.0	B
Stream D-ABC	0.5	1.0	32.3	D
Stream C-B	0.1	0.1	9.6	A
	PM			
Stream B-ACD	0.5	0.6	26.8	D
Stream A-D	0.1	0.1	10.7	B
Stream D-ABC	0.8	1.4	38.2	E
Stream C-B	0.1	0.1	9.5	A

Table 5.6 shows that the junction is expected to operate within capacity by 2031. Despite this, it should be noted RFC values for both minor arms have increased within this scenario reaching 0.7 (Broadend Road East) and 0.8 (Broadend Road West).

Similarly to 2026, the junction in 2031 is shown to have increased delay on the minor approaches, reaching a high of 38 seconds on Broadend Road West during the PM peak hour. A LOS ‘E’ for this approach indicates an unstable flow, with the approach approaching capacity.

Based on the information presented in Tables 5.4 – 5.6, the existing priority junction at Broadend Road is not expected to operate adequately for facilitating growth of the East Wisbech site.

Across forecast years assessed, delay on both minor arms, more specifically Broadend Road West, are shown to increase to a maximum of 38 seconds, resulting in the approach performing with an unstable flow of LOS 'D' or 'E'.

The conclusion of this assessment is that the existing junction would provide insufficient access onto the strategic network for vehicles originating from the East Wisbech Development site, which could result in alternative routes through Wisbech being used. This therefore suggests improvement to this junction is required in order to facilitate the level of growth stated within the Local Plan (2014) for the East Wisbech site.

Option 1

The first option assessed was a 40 metre ICD roundabout, using a standard set of highway geometric parameters. The option assumes a single lane entry / exit for all four approach arms.

Option Geometry

The geometry used for this option is detailed in the table beneath. Note that the geometric parameter descriptions outline in Table 5.8 are consistent for all of the options considered within this chapter.

Table 5.7: Option 1 Geometric Input

	V (m)	E (m)	L' (m)	R (m)	D (m)	PHI (deg)
All Approaches	3.65	7.3	30	30	45	50

Table 5.8: Geometry Input Description for proposed Roundabout Options

Geometric Parameter	Description
V (m)	Road half width
E (m)	Entry width
L' (m)	Effective flare length
R (m)	Entry radius
D (m)	Inscribed circle diameter
PHI (deg)	Entry angle

Option Results

The results for the assessment of Option 1 are shown beneath, separated by forecast year.

Table 5.9: Option 1 2021 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	0.9	6.2	25.5	D
Broadend Road (E)	0.2	0.3	8.0	A
A47 (S)	0.9	7.0	28.0	D
Broadend Road (W)	0.2	0.2	6.4	A
	PM			
A47 (N)	0.9	7.6	32.1	D
Broadend Road (E)	0.2	0.2	8.01	A
A47 (S)	1.1	40.2	121.6	F
Broadend Road (W)	0.3	0.4	8.11	A

Table 5.9 shows that with the geometric parameters of Option 1, the A47 approaches during the AM peak hour are approaching an unstable flow (LOS D), with RFC values greater than the capacity threshold of 0.85.

In contrast, during the PM peak hour of 2021, the A47 South approach is predicted to operate over capacity, as shown by an RFC value of 1.1. LOS category 'F' reiterates the point of a break down in traffic flow along this approach, which results in a delay of 121 seconds (2 minutes 1 second).

Under the scenario of 2021, a roundabout is shown to improve the operation of the Broadend Road approaches. Delay on these approaches (across both peak hours) does not reach greater than 8 seconds.

Table 5.10: Option 1 2026 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	0.9	11.6	45.1	E
Broadend Road (E)	0.3	0.5	9.6	A
A47 (S)	1.0	24.1	81.8	F
Broadend Road (W)	0.2	0.3	7.2	A
	PM			
A47 (N)	0.9	8.2	33.2	D
Broadend Road (E)	0.2	0.2	7.7	A
A47 (S)	1.1	87.9	268.5	F
Broadend Road (W)	0.2	0.3	7.3	A

In 2026 across both peak hours, the A47 North approach is expected to be approaching capacity (RFC 0.9), whilst the A47 South approach is predicted to operate over capacity (1.0 or greater).

Congestion and delay in 2026 is shown to be greater in the PM peak, whereby a high of 268 (4 minutes 28 seconds) is added to journey times, for vehicles travelling northbound from the Elm High Road Roundabout.

Similarly to 2021 results, both the Broadend Road approaches operate well within capacity, as indicated by the LOS category 'A' which highlights free flowing speed.

Table 5.11: Option 1 2031 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	1.1	52.0	155.5	F
Broadend Road (E)	0.4	0.5	10.9	B
A47 (S)	1.1	52.4	153.5	F
Broadend Road (W)	0.3	0.4	8.0	A
	PM			
A47 (N)	1.1	35.1	112.7	F
Broadend Road (E)	0.2	0.2	8.7	A
A47 (S)	1.3	192.4	630.7	F
Broadend Road (W)	0.2	0.4	7.63	A

Table 5.11 highlights that by 2031, the roundabout is over capacity during the AM and PM peaks, particularly along the A47 approaches. With an RFC value of greater than 1.0 and LOS 'F', queues will be commonplace at the roundabout, as reflected by the highest queue of 192.4 vehicles during the PM peak.

Delay during for the A47 approaches appears balanced in the AM peak hour with around 155 seconds (2 minutes 35 seconds) added to journey times. However, during the PM peak hour the delay is predicted to increase significantly for the A47 South approach to 630 seconds (10 minutes 30 seconds).

Such high delays on this approach (travelling northbound) during the PM peak highlights the tidaility of travel along this section of the A47, with a greater number of vehicles travelling southbound destined for Wisbech during the AM peak, and vehicles travelling northbound originating from Wisbech during the PM peak hour.

Option Summary

Using the geometric parameters within Option 1, this roundabout would operate close to or at capacity by 2021, particularly for the A47 approaches. Significant queue lengths and delay would be commonplace from 2021 onwards, however is predicted to reach a high of 10 minutes travelling northbound on the A47 in the PM of 2031.

With significant congestion and delay when travelling northbound on the A47, queue backs associated with the Broadend Road junction may have knock on impact on the already congested A47 / Elm High Road roundabout.

Option 2

The second option assessed for this scheme was a 40 ICD roundabout with each approach having the geometric parameters of a single lane entry accompanied with a 30 metre flare. As with Option 1 a standard set of geometric parameters was used within this assessment.

Option Geometry

The geometry used for this option is detailed in the table beneath. Note that this geometry applies to each of the roundabout approaches.

Table 5.12: Option 2 Geometric Input

	V (m)	E (m)	L (m)	R (m)	D (m)	PHI (deg)
All arm approaches	3.65	7.3	30	30	50	50

Option Results

The results for the assessment of Option 2 are shown beneath, separated by forecast year.

Table 5.13: Option 2 2021 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	0.5	1.2	4.5	A
Broadend Road (E)	0.1	0.1	3.6	A
A47 (S)	0.6	1.2	4.6	A
Broadend Road (W)	0.1	0.1	3.2	A
	PM			
A47 (N)	0.6	1.2	4.8	A
Broadend Road (E)	0.1	0.1	3.6	A
A47 (S)	0.7	2.4	5.9	A
Broadend Road (W)	0.2	0.1	3.7	A

Table 5.13 highlights the roundabout is expected to operate within capacity across both peak hours, with the highest RFC of 0.7 present for the A47 South approach during the PM peak hour.

Delay generated from the roundabout design appears minimal reaching a high of 6 seconds, which reflects the fact all approaches operate with a LOS category ‘A’, which indicates free flowing traffic.

Table 5.14: Option 2 2026 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	0.6	1.4	5.0	A
Broadend Road (E)	0.2	0.2	4.0	A
A47 (S)	0.6	1.6	5.5	A
Broadend Road (W)	0.1	0.1	3.4	A
	PM			
A47 (N)	0.6	0.1	4.8	A
Broadend Road (E)	0.1	2.4	3.5	A
A47 (S)	0.7	0.1	7.0	A
Broadend Road (W)	0.1	1.2	3.7	A

As with 2021, the roundabout is expected to operate within capacity during both peak hours in 2026, with all approaches operating with a LOS of category ‘A’. Minimal delay of 7 seconds reflects the predicted free-flowing nature of the A47 and minor roads. Minor roads experience a reduction in delay from currently experienced, with a maximum shown of 4 seconds.

Table 5.15: Option 2 2031 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	0.7	1.9	6.3	B
Broadend Road (E)	0.2	0.2	4.4	A
A47 (S)	0.7	1.9	6.2	A
Broadend Road (W)	0.2	0.2	3.7	A
	PM			
A47 (N)	0.7	1.7	5.9	A
Broadend Road (E)	0.1	0.1	3.9	A
A47 (S)	0.9	3.8	10.2	B
Broadend Road (W)	0.2	0.2	4.1	A

Table 5.15 highlights that by 2031, the roundabout is approaching capacity, particularly along the A47 south approach. In comparison to forecasted years of 2021 and 2026, queue lengths on this approach are doubled in 2031 reaching 3.8 PCU.

Despite the A47 North approach remaining within the 0.85 threshold, an increase to an RFC of 0.7 is shown within this scenario.

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Option 2 Sensitivity Test – Unequal Lane Usage

A test of unequal lane usage was completed for the geometric parameters used within this option. The purpose of this sensitivity test was to highlight any changes in ARCADY outputs, as a result of the software being 'blind' to unused or unequally used lanes.

The procedure used to test non-use or unequal lane usage was to re-run the model for each of the A47 approaches, whilst assuming a single lane entry approach accommodating the flows of the A47 (highest flows) and that shown for the left or right turn lanes for vehicles destined for Broadend Road West and the East Wisbech Development site. Under this test the lane allocations would represent:

- A47 North Approach – ahead and left lane for the A47 and Broadend Road East and a dedicated right turn lane into Broadend Road West and the East Wisbech Development site; and;
- A47 South Approach – dedicated left lane into Broadend Road West the East Wisbech Development Site as well as an ahead and right lane for the A47 and Broadend Road East.

Table 5.16: Option 2 2031 Sensitivity Test for Unequal Lane Usage Results

	RFC	Delay (S)
	AM	
A47 (N)	1.2	284.3
A47 (S)	1.2	287.2
	PM	
A47 (N)	1.1	195.4
A47 (S)	1.4	305.4

The results of the sensitivity test show the RFC's along the A47 approaches to the roundabout exceed capacity across both peak hours. When assuming unequal lane usage within this option (with A47 traffic and development traffic sharing lanes), the dominant ahead movement on the A47 is predicted to block access to the flared lane, resulting in greater queue lengths and delay than highlighted within the Tables 5.14 – 5.16 above.

Delay is shown to be higher on the A47 South approach across both peak hours, with delay shown to reach a maximum of 305 seconds (5 minutes 5 seconds).

The unequal lane usage assessment for both options confirms that a single lane entry with a 30 m flare along the A47 is inadequate. The straight-ahead traffic for both A47 directions needs to be split across two lanes, requiring a two lane exit which then merges down to a single lane after an appropriate distance.

Option 2 Summary

Using the geometric parameters within Option 2, this roundabout is initially shown to operate within capacity across forecast years of 2021, 2026 and 2031. However when testing unequal lane usage, results show that the A47 traffic is likely to queue back from the circulatory ultimately blocking the flared approach included to facilitate development traffic. Therefore, it should be expected that by 2031, the A47 approaches will operate over capacity.

Option 3

This option assesses an enhanced roundabout with an enlarged ICD of 50 metres. Geometric parameters used within this option assume two lane entries and exits along the A47 mainline, with a single lane approach with a 30 m flare on the approaches of Broadend Road East and West.

Note, geometry used for the A47 approaches assumes that the second lane is a flare in excess of 100 metres.

Option Geometry

The geometry used for this option is detailed in the table beneath.

Table 5.17: Option 3 Geometric Input

	V (m)	E (m)	L (m)	R (m)	D (m)	PHI (deg)
A47 Approaches	7.3	7.3	100	30	50	50
Broadend Road Approaches	3.65	7.3	30	30	50	50

Option Results

The results for the assessment of Option 3 are shown beneath, separated by forecast year.

Please note a sensitivity test for unequal lane usage for Option 3 has not been completed, following the design of this option incorporating two lane entries and exits for the A47. This also means that vehicles destined for the development site, utilising either the left or right lane movements from the A47 approaches, are more likely to be about to enter the flare alongside the A47 traffic, rather than the A47 traffic blocking the flare as shown in Option 2 with the 30 m.

Table 5.18: Option 3 2021 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	0.5	0.8	3.3	A
Broadend Road (E)	0.1	0.1	3.4	A
A47 (S)	0.5	0.9	3.4	A
Broadend Road (W)	0.1	0.1	3.1	A
	PM			
A47 (N)	0.5	0.9	3.5	A
Broadend Road (E)	0.1	0.1	3.5	A
A47 (S)	0.6	1.2	4.0	A
Broadend Road (W)	0.2	0.2	3.6	A

Table 5.18 shows that the roundabout is expected to operate within capacity across both peak hours, with all approaches operating under a LOS category ‘A’ (free flowing traffic). The highest RFC shown 0.6 for the A47 South approach during the PM peak hour. RFC values for both minor arms is minimal, reaching a high of 0.2

The inclusion of two lane entries along the A47 has resulted in delay being halved in comparison to Options 1 and 2. The greatest delay within this option for the A47 approaches is shown to reach a maximum of 4 seconds.

Table 5.19: Option 3 2026 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	0.5	1.0	3.6	A
Broadend Road (E)	0.2	0.2	3.7	A
A47 (S)	0.5	1.1	3.8	A
Broadend Road (W)	0.1	0.1	3.3	A
	PM			
A47 (N)	0.5	0.9	3.4	A
Broadend Road (E)	0.1	0.1	3.3	A
A47 (S)	0.6	1.5	4.5	A
Broadend Road (W)	0.1	0.1	3.5	A

As with 2021 the roundabout in 2026 is expected to operate within capacity across both peak hours, with all approaches operating with a LOS of category ‘A’. Minimal delay of less than 5 seconds reflects the predicted free flowing nature of the A47 and minor roads.

Table 5.20: Option 3 2031 Results

	RFC	Queue (PCU)	Delay (S)	LOS
	AM			
A47 (N)	0.6	1.3	4.2	A
Broadend Road (E)	0.2	0.2	4.2	A
A47 (S)	0.6	1.3	4.1	A
Broadend Road (W)	0.2	0.2	3.6	A
	PM			
A47 (N)	0.5	1.2	4.0	A
Broadend Road (E)	0.1	0.1	3.7	A
A47 (S)	0.7	2.1	5.6	A
Broadend Road (W)	0.2	0.2	3.9	A

Table 5.20 shows that the roundabout is expected to operate within capacity by 2031, with the highest RFC value being 0.7 for the A47 South approach during the PM peak hour.

Despite, the increase in traffic passing through this junction due to the development site, the maximum delay to the A47 is shown to be 5.6 seconds, which is halved in comparison to Options 1 and 2.

Option 3 Summary

Using the geometric parameters within Option 3, this roundabout is predicted to operate within capacity through all future years assessed. With the addition of two lane entry and exits along the A47 approaches, delay and queue lengths recorded for this option are halved in comparison to Options 1 and 2.

6. Option Comparison

The table on the following page shows the option comparison for each of the roundabout options discussed in the Option Assessment chapter. Results of the Do Minimum scenario (existing junction) have not been included within this table, as the junction assessment has demonstrated the junction fails to satisfactory operate by 2021 and therefore not an acceptable solution.

Cells highlighted in blue indicate the best performing option, in relation to RFC and delay. In this instance the optimum value for all approaches across the options assessed have been highlighted.

The Option Assessment and Option Comparison Table demonstrate that Option 3 is the optimum performer in relation to both RFC and delay.

The option is expected to operate within capacity during both peak hours by 2031 and is able to accommodate the development traffic anticipated from the Wisbech East Development. The results show that Option 3 is expected to reduce delay along the A47 by almost half when compared to Options 1 and 2.

Option 3 is an enhanced roundabout with an ICD of 50 metres, two 100m lane entries and exits on both A47 approaches, and single lane approaches for Broadend Road East and West with an effective flare of 30 metres.

This option is explained in more detail, including an outline cost estimate in the following chapter.

Table 6.1: Roundabout Option Comparison Summary

	AM						PM					
	2021						2021					
	RFC			Delay (seconds)			RFC			Delay (seconds)		
	Opt. 1	Opt. 2	Opt. 3	Opt. 1	Opt. 2	Opt.3	Opt.1	Opt. 2	Opt.3	Opt.1	Opt. 2	Opt. 3
A47 (N)	0.9	0.5	0.5	25.5	4.5	3.3	0.9	0.6	0.5	32.1	0.6	3.5
Broadend Road (E)	0.2	0.1	0.1	8.0	3.6	3.4	0.2	0.1	0.1	8.0	3.6	3.5
A47 (S)	0.9	0.6	0.5	28.0	4.6	3.4	1.1	0.7	0.6	121.6	4.6	4.0
Broadend Road (W)	0.2	0.1	0.1	6.4	3.2	3.1	0.3	0.2	0.2	8.11	3.2	3.6
	2026						2026					
	Opt. 1	Opt. 2	Opt. 3	Opt.1	Opt. 2	Opt. 3	Opt. 1	Opt. 2	Opt. 3	Opt.1	Opt. 2	Opt. 3
A47 (N)	0.9	0.6	0.5	45.1	5.0	3.6	0.9	0.6	0.5	33.2	4.8	3.4
Broadend Road (E)	0.3	0.2	0.1	9.6	4.0	3.7	0.2	0.1	0.1	7.7	3.5	3.3
A47 (S)	1.0	0.6	0.6	81.8	5.5	3.8	1.1	0.7	0.6	268.5	7.0	4.5
Broadend Road (W)	0.2	0.1	0.1	7.2	3.4	3.3	0.2	0.1	0.1	7.3	3.7	3.5
	2031						2031					
	Opt. 1	Opt. 2	Opt. 3	Opt.1	Opt. 2	Opt. 3	Opt. 1	Opt. 2	Opt. 3	Opt.1	Opt. 2	Opt. 3
A47 (N)	1.1	1.2	0.6	155.5	284.3	4.2	1.1	1.1	0.5	112.7	195.4	4.0
Broadend Road (E)	0.4	0.2	0.2	8.0	4.4	4.2	0.2	0.1	0.1	8.7	3.9	3.7
A47 (S)	1.1	1.2	0.6	153.5	287.2	4.1	1.3	1.4	0.7	630.7	305.4	5.6
Broadend Road (W)	0.3	0.2	0.2	8.0	3.7	3.6	0.2	0.2	0.2	7.6	4.1	3.9

Option 1 40m ICD, single lane entry **Option 2** 40m ICD, 30 m flares **Option 3** 50m ICD / 2 lane entry and exits on A47

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7. VISSIM Assessment

This chapter documents the operational assessment of the shortlisted option using VISSIM micro-simulation modelling software.

Broadend Road VISSIM Model

A purpose built model of the A47 / Broadend Road junction has been constructed in VISSIM. This is to provide a model that can be robustly validated, and that can be used to understand the performance and impact of the shortlisted option in greater detail.

The model has been validated against the same TomTom dataset used throughout the Wisbech Access Study and described in the overarching *Phase 1 Report*.

Full details on the construction of the model and its validation, as well as its use, can be found within the 'Broadend Road VISSIM Assessment Report, in Appendix A.

Shortlisted Option Summary

Option 3 was the shortlisted option progressed from the previous chapter. Option 3 consists of: 'An enhanced roundabout with an ICD of 50 metres, two 100m lane entries and exits on both A47 approaches, and single lane approaches for Broadend Road East and West with an effective flare of 30 metres'

Figure 7.1 outlines the roundabout layout assessed within VISSIM for Option 3a.

Figure 7.1: Option 3a VISSIM Design

A variation of Option 3 was created by Highway Engineers whilst developing the design for the original Option 3.The original Option 3 is now referred to as Option 3a for the remainder of this report. The design for the alternative option, which will be recorded as Option 3b, is described below:

'An unconventional oval shaped roundabout with a 50 metre ICD, which retains the two lane entry and exits on the A47 approaches, as well as the flared approach on the minor arms of Broadend Road West and East'.

Figure 7.2 below shows the layout used within VISSIM for Option 3b.

Figure 7.2: Option 3b VISSIM Design

The decision to assess this second option within the VISSIM assessment, was based on the benefits that are associated with the unconventional roundabout design. Design benefits for this option include:

- Reduced delay to the A47 trunk Road;
- Easier entry angles for HGV's; and,
- Increased use of the existing junction infrastructure.

Modelling Assessment

In order to evaluate proposed schemes and quantify potential benefits, both the existing conditions and new design proposals have been assessed using traffic modelling software.

Modelling assessments for these schemes have been conducted using the VISSIM micro-simulation software (version 5.40-09), which is part of the PTV Vision Transport modelling. The five basic components that VISSIM is built upon include:

- Highway network (Link / connectors);
- Traffic control systems (signals, stop-give way controls);
- Traffic inputs;
- Vehicle type and compositions; and,
- Vehicle routes.

VISSIM has been used to analyse the movement of motorised and non-motorised traffic, including car, bus, pedestrian and cycle operations, under constraints such as lane configuration, traffic composition and junction form.

More information regarding VISSIM and the Wisbech VISSIM Model validation can be found within the 'Wisbech VISSIM Model LMVR report'.

Modelled Scenarios

The following scenarios have been assessed for both Options for both the AM and PM peak hours for the forecast years of 2021, 2026 and 2031:

- Do Minimum scenario; and,
- Do Something (with scheme).

Please note, this assessment of Option 3 was undertaken on traffic flows that did not include the WLR (w/out WLR) to ensure that they could operate without the diversionary benefits that the WLR was expected to deliver.

Modelling Summary

The following series of tables provide a comparison of Options 3a and 3b for the scenarios assessed. Results The Do Minimum Model has been used as a baseline, enabling the benefits of the proposed schemes to be quantified and evaluated.

Cells highlighted in blue represent the optimum performer per approach.

Note, data presented within the following tables have been extracted from the 'Broadend Road Junction VISSIM Assessment Report' (see Appendix A).

Table 7.1: Option Comparison – 2021

	AM Peak Hour								
	Avg. Queue (m)			Avg. Delay (s)			LOS		
	DM	3a	3b	DM	3a	3b	DM	3a	3b
A47 (N)	0.0	0.1	0.2	5.0	5.0	5.3	A	A	A
BER (E)	0.3	0.2	0.2	15.6	5.8	5.8	C	A	A
A47 (S)	0.0	0.2	0.4	3.8	4.5	5.1	A	A	A
BER (W)	0.1	0.1	0.1	12.7	3.1	4.0	B	A	A
	PM Peak Hour								
	DM	3a	3b	DM	3a	3b	DM	3a	3b
A47 (N)	0.0	0.2	0.3	3.5	5.0	5.3	A	A	A
BER (E)	0.0	0.0	0.0	6.8	2.8	2.6	A	A	A
A47 (S)	0.0	0.1	0.3	3.1	4.4	4.9	A	A	A
BER (W)	0.0	0.1	0.1	18.4	3.6	4.3	C	A	A

Table 7.1 above highlights both options are predicted to perform within capacity for the peak hours of 2021.

Broadend Road approaches are shown to operate better than the Do Minimum scenario, which reflects the improved accessibility to the trunk road over the existing junction design. The delay on the A47 is shown to be marginally worse, as vehicles on the A47 no longer have priority.

Table 7.2: Option Comparison – 2026

	AM Peak Hour								
	Avg. Queue (m)			Avg. Delay (s)			LOS		
	DM	3a	3b	DM	3a	3b	DM	3a	3b
A47 (N)	0.0	0.2	0.4	5.5	5.5	5.9	A	A	A
BER (E)	1.0	0.3	0.3	22.7	6.3	6.3	C	A	A
A47 (S)	0.0	0.4	0.6	4.2	4.9	5.6	A	A	A
BER (W)	0.7	0.2	0.1	17.2	3.5	4.7	C	A	A
	PM Peak Hour								
	DM	3a	3b	DM	3a	3b	DM	3a	3b
A47 (N)	0.0	0.3	0.6	3.7	5.4	6.0	A	A	A
BER (E)	0.0	0.0	0.0	7.6	3.0	2.8	A	A	A
A47 (S)	0.0	0.1	0.4	3.4	5.0	5.6	A	A	A
BER (W)	0.0	0.2	0.2	30.1	4.0	4.9	D	A	A

Table 7.2 above highlights both options are predicted to perform within capacity for the peak hours of 2026.

Under 2026 the greatest benefit is shown for the Broadend West approach, which follows the increased traffic demand from the East Wisbech Development Site.

Table 7.3: Option Comparison – 2031

	AM Peak Hour								
	Avg. Queue (m)			Avg. Delay (s)			LOS		
	DM	3a	3b	DM	3a	3b	DM	3a	3b
A47 (N)	0.0	0.4	0.7	6.0	6.2	6.8	A	A	A
BER (E)	3.0	0.5	0.5	35.5	7.2	7.1	E	A	A
A47 (S)	0.0	0.7	1.2	4.7	5.7	6.5	A	A	A
BER (W)	4.1	0.3	0.2	34.0	4.3	5.4	D	A	A
	PM Peak Hour								
	DM	3a	3b	DM	3a	3b	DM	3a	3b
A47 (N)	0.0	0.4	0.6	3.9	5.7	6.2	A	A	A
BER (E)	0.0	0.0	0.0	10.7	3.5	3.4	B	A	A
A47 (S)	0.0	0.2	0.5	3.5	5.2	5.9	A	A	A
BER (W)	10.8	0.3	0.2	57.3	4.9	4.9	F	A	A

Table 7.3 above highlights both options are predicted to perform within capacity for the peak hours of 2031.

Within 2031 the existing junction (DM) is predicted to be operating at or over capacity, especially in relation to the Broadend Road approaches, as shown by delay and LOS values (E / F). Roundabout schemes 3a and 3b are shown to significantly improve queue lengths, delay as well as LOS during this time period in comparison to the existing junction layout.

Option Summary

Both Options 3a and 3b are predicted to operate within capacity across all scenarios assessed, with both options significantly improving the performance of the junction (especially in 2031) when compared to the Do Minimum scenario.

Despite marginal differences shown within the results of Option 3a and 3b, Option 3b is the option that has been progressed to the Concept Highway Design stage of this study. The decision to progress Option 3b over Option 3a was based on the additional benefits associated with the unconventional oval shaped design, which are consist of reduced delay to the A47 trunk Road and easier entry angles for HGV’s.

8. Concept Highway Design

Introduction

This chapter outlines the Concept Highway Design and cost- estimate for the preferred options identified within this report. The chapter includes:

- Design Assumptions and Input decisions;
- Concept Design Drawings;
- STATS Review; and,
- Road Safety Review.

Preferred Option

The schemes within the Wisbech Access Study have been designed to concept design level. Designs are based on national and local highway standards, and make clear reference where departures from standards are proposed. Concept designs are adequate to undertake transport assessments, and to inform Outline Business Cases. Any further level of design would require highway surveys, including topographical surveys.

Scheme designs have been informed by an initial STATs search, to identify if any public utilities would be affected by the scheme, and a cost provision added to the scheme cost if anything was found.

As identified within the previous chapters, Option 3b was the preferred option progressed to the concept design stage of the Wisbech Access Study. The description below provides a summary of options 3b:

Option 3b:

- 'An unconventional oval shaped roundabout with a 50 metre ICD, which retains the two lane entry and exits on the A47 approaches, as well as the flared approach on the minor arms of Broadend Road West and East'.

Design Assumptions and Input Decisions

All designs are concept designs based on Ordinance Survey mapping. Level information is unknown and therefore embankments/cuttings and footprints should be treated as indicative.

This A47 scheme has been designed using the Design Manual for Roads and Bridges (DMRB). Where DMRB does not apply or is irrelevant, the scheme is designed using the Manual for Streets 1 & 2 alongside the Cambridgeshire Estate Road specification.

Scheme assumptions concerning geometric parameters of lane length and flare length alongside capacity decisions have been informed by the assessment work described earlier within this report.

The design assumes land take to the north, east and west of the junction to accommodate for the re-location of drainage.

Figures 8.1 on the following page shows the Concept Highway Design for the option described above.

Figure 8.1: Option 3B Concept Highway Design

STATS Review

As part of the concept design process, searches have been undertaken to determine whether any STATS exist within the vicinity of the proposed schemes. STATS refers to utilities or services which run beneath the surface of the road, for example:

- Electricity Cables;
- Gas Mains;
- Water Mains and sewers; and,
- Telecommunications Wires.

This information will be necessary for further design stages, including more detailed scheme cost estimates. The presence of STATS may also dictate amendments to a scheme design at a later point.

Table 8.1 and Figure 8.2 below highlights the STATS present within the vicinity of the scheme location.

The cells highlighted in blue within Table 8.1 indicate the STATS present for within this scheme location.

Table 8.1: STATs Present in Scheme Area

Anglian Water surface sewer (SWS)	Anglian Water portable water (AW)	Anglian Water foul sewer (Foul)	National Grid LP Gas Main (Gas LP)	National Grid MP Gas Main (Gas MP)
UKPN overhead electric (Elec OH)	UKPN underground electric (Elec UG)	Gas Main (Fulcrum MPG)	BT open reach underground Comms (BT)	Virgin Media underground Comms (VM)

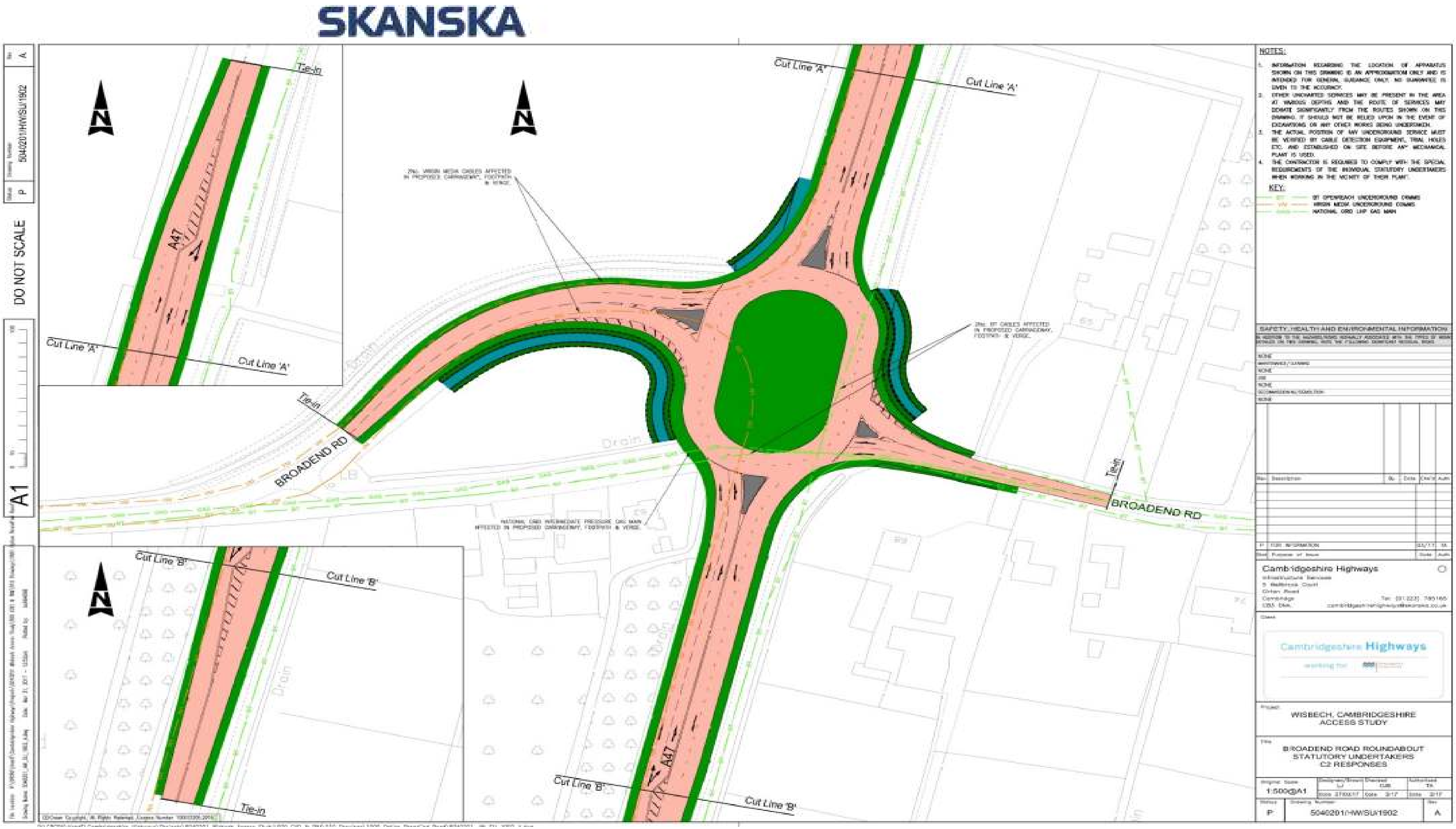

Figure 8.2: Statutory Plan Option 3B

Road Safety Review

The Concept Designs have been subject to an initial Road Safety Review by Cambridgeshire County Council. The purpose of the Road Safety Review is to identify potential safety issues associated with the schemes prior to any further design phase, and in particular any that could compromise scheme deliverability.

Note that this does not constitute a formal Road Safety Audit, and is instead initial feedback based on the Concept Designs. It should also be noted that does it does not necessarily reflect the opinions of Norfolk County Council or Highways England. Schemes that fall within the jurisdiction of Norfolk County Council or Highways England will also need to satisfy their Road Safety Requirements as part of the design process.

Comments from the Road Safety Review are documented in Table 8.2 below.

Table 8.2: Road Safety Review for Broadend Road Junction

Road Safety Feedback	Comment
This option will make it easier to pull onto the A47 from side roads.	Agreed.
The short cul-de-sac on the southern side, west of the roundabout will have very limited visibility to potentially fast moving vehicles approaching from the east.	This is an existing issue, although safety enhancements can be considered more carefully during the detailed design phase.

Scheme Cost Estimate

Cost estimates have been produced for Option 3b, which has been completed using 2017 prices. It should be noted that the inflation within the construction industry is approximately 4 -5 % per annum.

Although these costs are considered to be robust, these cost estimates are based on concept level designs, and may alter in the future subject to further information becoming available during later design stages.

The cost estimates include the following items:

- Drainage;
- Carriageway;
- Junctions;
- Footpaths;
- Street Lighting;
- Signing and Lining;
- Preliminaries, including design (10% const. cost) and supervision (20% const. cost);
- Traffic Management;
- Land purchase and compulsory purchase estimates;
- Demolition;
- Land Acquisition, and,
- Optimism Bias @ 45%.

The cost estimates excludes the following items:

- Services Diversions;
- Contaminated Land Treatment; and,
- Local Planning Fees.

Land Acquisition and Demolition Costs

The following costs have been applied where land acquisition or demolition is required by a scheme. These costs are considered relevant to the location of the schemes and are derived from experience of other similar schemes within the region.

- Land Acquisition – Agricultural £37, 500 per hectare;
- Land Acquisition – Urban / Built £125,000 per hectare;
- Compulsory Purchase Order – Dwelling £277,500 per dwelling; and,
- Demolition – £70m2 or £7,500 per dwelling.

Optimism Bias

The scheme costs also include 45% optimism bias. This is an uplift that is applied to the final scheme cost in line with DfT guidance on preparing scheme cost estimates. The DfT describes optimism bias in their Web Tag Note 'A1.2 Scheme Costs' (November 2014) as:

'*Optimism bias is the demonstrated systematic tendency for appraisers to be overly optimistic about key parameters. Theorists on cost overrun suggest that optimism bias could be caused by the organisation of the decision-making process and strategic behaviour of stakeholders involved in the planning and decision-making processes.*

Different levels of optimism bias should be applied to scheme costs depending on the nature of the scheme (road, rail, ITS etc.) and how developed proposals or designs are. The schemes costed as part of the study are road schemes and are all at the first stage of scheme development. As a result of this an optimism bias of 45% is applied to the scheme costs.

Cost estimates for the scheme, including optimism bias are summarised in the table beneath. More detailed breakdowns of the costs are provided in Appendix C.

Note that these costs assume schemes are delivered in isolation, and do not reflect the potential cost savings that may be associated with delivering adjacent or overlapping schemes at the same time.

Table 8.3: Option 3B Scheme Cost Estimate

Cost Description	Cost
Land Acquisition	£6,600.00
Demolition	£0.00
Construction	£1,596,802.00
Design (10% of const. cost)	£159,680.20
Supervision, site facilities and site fences (20% of const. cost)	£319,680.40
Traffic management	3272,000.00
Sub Total	**£2,354,442.60**
Optimism bias (@45%)	£1,062,469.17
Total	**£3,416,911.77**

9. Summary

Skanska have been commissioned by Cambridgeshire County Council to undertake an assessment of options to improve the Broadend Road junction with the A47. This assessment forms part of the first phase of the Wisbech Access Study.

The purpose of this assessment is to determine what form of junction is required to facilitate the proposed Wisbech East development, providing adequate access between the development site and strategic road network, whilst mitigating the impact of delay on the A47 itself. Improved safety at the site has also been an important consideration throughout this assessment.

This report has considered the existing conditions within the vicinity, including traffic flow and congestion, land use and ownership, flood risk and other ecological considerations.

The report has also considered the development proposals for the Wisbech East development site, including the planned composition and phasing of the site as well as the anticipated increase in traffic using the A47 / Broadend Road Junction resulting from it.

A summary of the Option Identification workshop held in January 2016 is provided. This sets the context and includes the justification for the selection of options assessed for upgrading the junction.

As well as assessing three potential improvement options, a Do Minimum Scenario was assessed for comparison, in which the forecast future year traffic was loaded onto the existing network to determine how it would perform. This assessment was undertaken using PICADY, and showed that an upgrade would be required by 2021 based on the current build profile, and that a priority junction is insufficient.

The initial option assessment was undertaken in ARCADY, and the following options that were identified in the January 2016 workshop described above:

- **Option 1** – Simple roundabout with a 45 m ICD, using a standard set of geometry;
- **Option 2** – Enhanced roundabout with a 50 m ICD, using a standard set of geometry;
- **Option 3** – Enhanced roundabout with a 50 m ICD and two lane entries along the A47 approaches.

All options were assessed against the AM peak hour (08:00 – 09:00) and PM peak hour (17:00 – 18:00) for the forecast years 2021, 2026 and 2031, using future year traffic flows extracted from the WATS model.

The assessment initially suggested that all options would work within capacity by the horizon year of 2031. However, ARCADY has a known deficiency when modelling unequal lane usage, and so a sensitivity test was undertaken to determine how each of the options would perform on the expectation that all A47 ahead traffic would share a single lane.

The results from the unequal lane usage sensitivity test confirm that the A47 would be over capacity in both peaks by 2021 for Option 1 and Option 2. However, Option 3 is expected to operate well within capacity in all forecast years, and so this option was progressed to Concept Design. A variation of this option was also introduced at the concept design stage, this is referred to as Option 3B.

Both Option 3 and Option 3B have undergone a detailed operational assessment using a purpose built VISSIM model. This assessment has confirmed that both options performed well within capacity across forecast years.

Despite marginal differences shown within the results of Option 3a and 3b, Option 3b was the option progressed to the Concept Highway Design stage of this study. The decision to progress Option 3b over Option 3a was based on the additional benefits associated with the unconventional oval shaped design, which are consist of reduced delay to the A47 trunk Road and easier entry angles for HGV’s.

Chapter 8 of this report outlines the Concept Highway Design of Option 3b, alongside STAT review, road safety reviews, design input and assumptions and a cost estimate.

SKANSKA

Appendix A – VISSIM Assessment Report

Broadend Road Junction VISSIM Assessment Report

Cambridgeshire County Council and Fenland District Council

21 July 2017

Notice

This document and its contents have been prepared and are intended solely for Skanska, Cambridgeshire County Council and Fenland District Council's information and use in relation to the Broadend Road Junction Improvement Scheme Project

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This document has 39 pages including the cover.

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Client	Skanska
Project	Broadend Road Junction VISSIM Assessment Report
Document title	Broadend Road Junction
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Document reference	

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Figures

1. Introduction

Background

1.1. Atkins has been commissioned by Skanska, on behalf of Fenland District Council (FDC) and Cambridgeshire County Council (CCC), to evaluate two proposed highway improvement schemes at the Broadend Road / A47 junction to the east of Wisbech.

1.2. The Broadend Road junction assessment forms part of the wider Wisbech Access Study and runs parallel to the Wisbech proposed option VISSIM assessments that have also been undertaken by Atkins.

1.3. In order to evaluate the proposed schemes, both the existing conditions and the proposals need to be assessed in traffic modelling software to quantify their benefits. This report documents the construction, calibration and validation of base AM and PM peak traffic models, along with the results of the future year proposed schemes.

Traffic Modelling

1.4. The Broadend traffic model has been developed using VISSIM micro-simulation software version 5.40-09, which is part of the PTV Vision Transport modelling suite and is a microscopic traffic flow simulation model based on car following and lane change logic. VISSIM can analyse motorised and non-motorised traffic including bus / tram, pedestrian and bicycle operations under constraints such as lane configuration, traffic composition, traffic signals, and bus / tram stops. VISSIM does not follow the conventional link / node modelling system of macro traffic models, but instead utilises a link / connector system that enables complex highway geometry to be modelled. The link / connector system also permits different methods of traffic control, such as signal, give way or stop, to be utilised anywhere in the model. VISSIM is also capable of modelling vehicle actuated traffic control utilising the Vehicle Actuated Programming (VAP) module, as well as simulating MOVA signal control using the PCMOVA module from TRL. Therefore, it is an appropriate tool for the evaluation of the combination of complex geometry and traffic controls (give way and traffic signal) operations that will be assessed within the study area.

1.5. The Broadend Road Junction is located on the A47 to the east of Wisbech. The study area covers all approaches to the junction and is shown in Figure 1.1 bounded by the black line, with the VISSIM network extents provided in Figure 1.2.

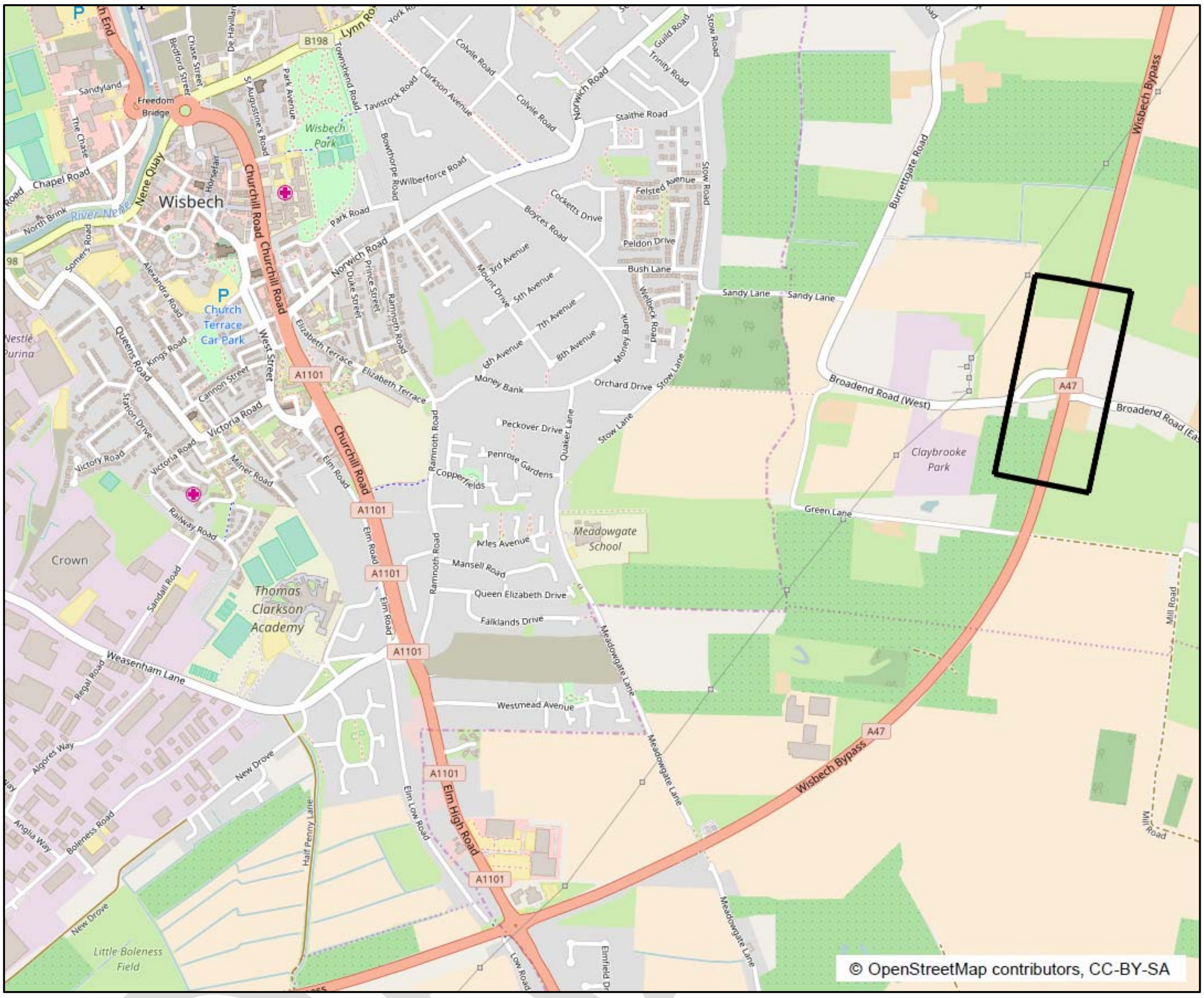


Figure 1.1 Study area

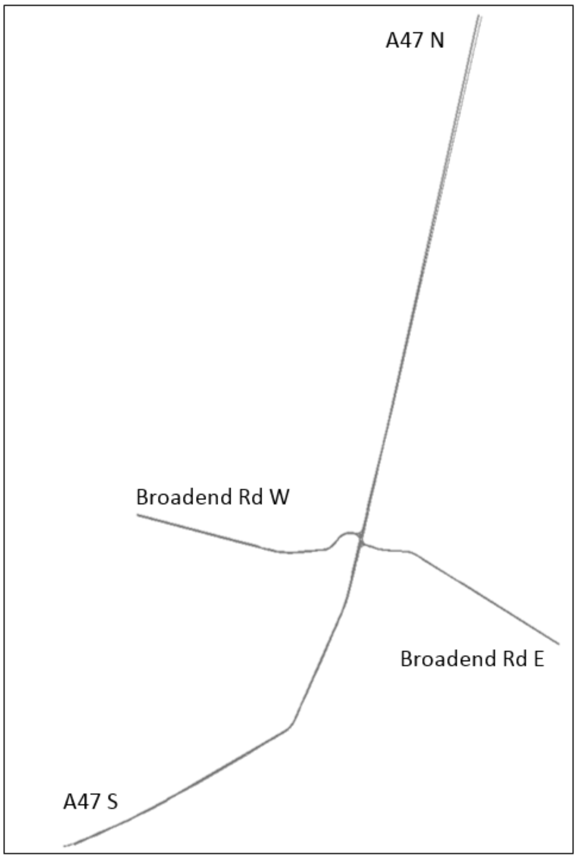


Figure 1.2 VISSIM network extent

1.6. The VISSIM traffic model has been constructed to represent the morning AM peak period from 0800 to 0900 and an evening PM peak period from 1700 to 1800, to maintain consistency with the Wisbech SATURN model built as part of the Wisbech Area Transport Study (WATS) and the VISSIM work undertaken on Wisbech town centre. A 30 minute 'warm up' period has been added prior to each model peak to populate the model network with vehicles and create representative peak period traffic conditions for undertaking model output data analysis.

1.7. Figure 1.3 outlines the key modelling processes that have been undertaken during the development of the Broadend Road Junction model.

1.8. The report is set out as follows:

- Section 2 – Data Collection;
- Section 3 – Model Development;
- Section 4 – Model Calibration and Validation;
- Section 5 – 2016 Existing Validation Results;
- Section 6 – Future Year Modelling;
- Section 0 – 2021 Comparison Results;
- Section 8 – 2026 Comparison Results;
- Section 9 – 2031 Comparison Results; and,
- Section 10 – Summary and Conclusion.

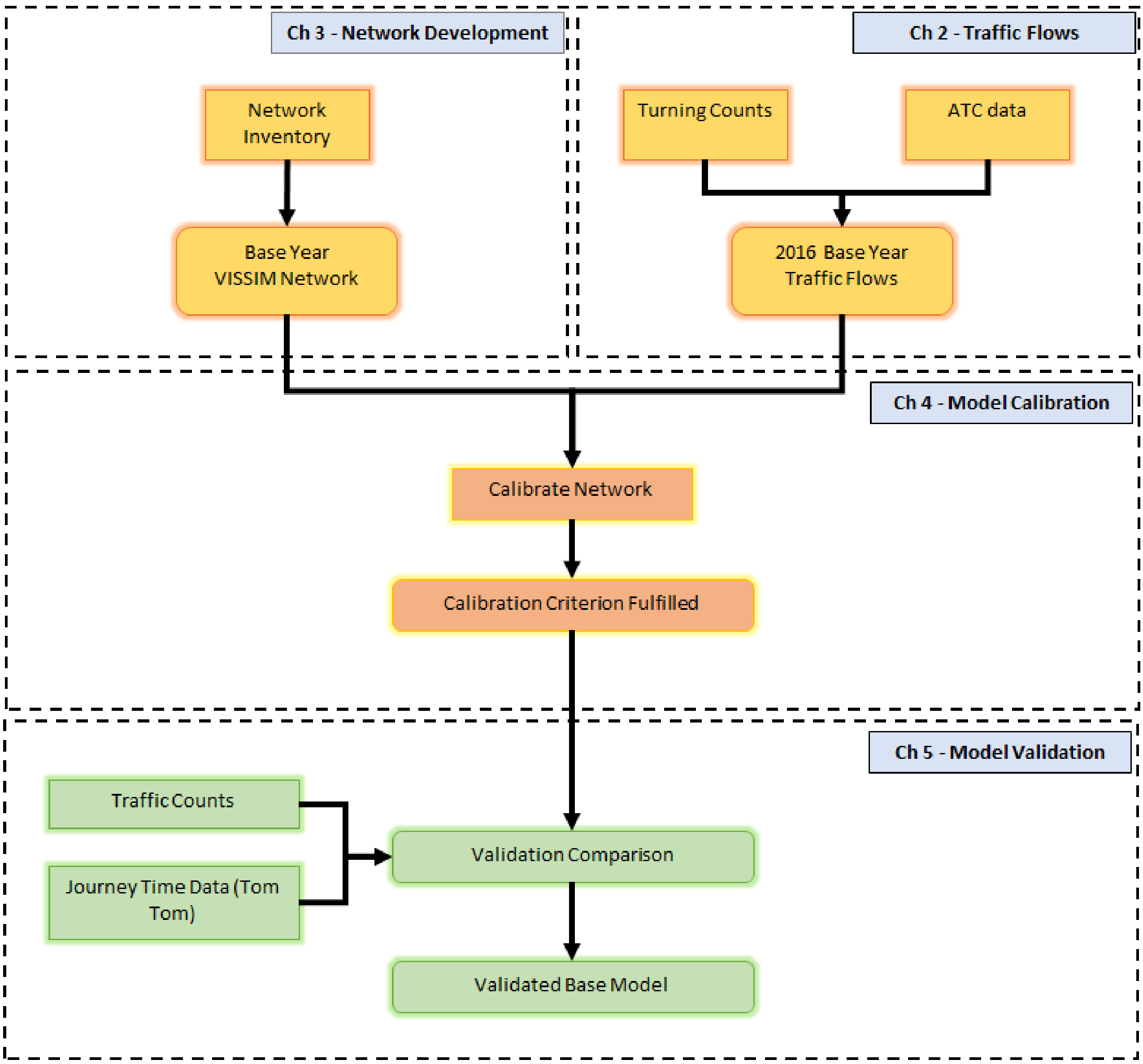


Figure 1.3 Modelling process

2. Data Collection

2.1. A data collection exercise was undertaken to summarise existing traffic survey data to be utilised for the VISSIM modelling; this is described in this chapter by category of data. All surveys listed below were commissioned by Skanska and provided to Atkins for use in this study.

Vehicle Turning Counts

2.2. A Manual classified count (MCC) was conducted using Car & Light Goods Vehicles (LGV), Other Goods Vehicles (OGV1, OGV2), Motorbike, and Bus classifications and covering a 12-hour period between 07:00 and 19:00 on Tuesday 19th January 2016 at the Broadend Road Junction.

Turning Movements

2.3. The turning count was utilised for junction flows within the network in 15 minute intervals. The resulting turning movements through the junction for both the AM and PM peak are shown in Appendix A.

Travel Times

2.4. Observed vehicle travel time data for the entire Wisbech area has been sourced from Satellite-Navigation (Sat-Nav) devices. Motorists who use satellite navigation devices have the option to voluntarily allow anonymous data about their journeys to be collected and used to provide a range of services, including the analysis of historic journey times along specific routes. Use of such data provides a greater sample of journey times than could normally be collected by the "floating observer" method of journey time surveys.

2.5. Travel times, excluding weekends and the Christmas holiday period, have been obtained from 2nd November 2015 to 22nd January 2016 for every link within the study area.

2.6. The travel time data was collected for the AM peak (08:00-09:00) and the PM peak (17:00-18:00) as hourly periods.

2.7. Each approach to the junction were selected from the main data and were chosen as the most appropriate method of validation. The routes are shown in Figure 2.1.

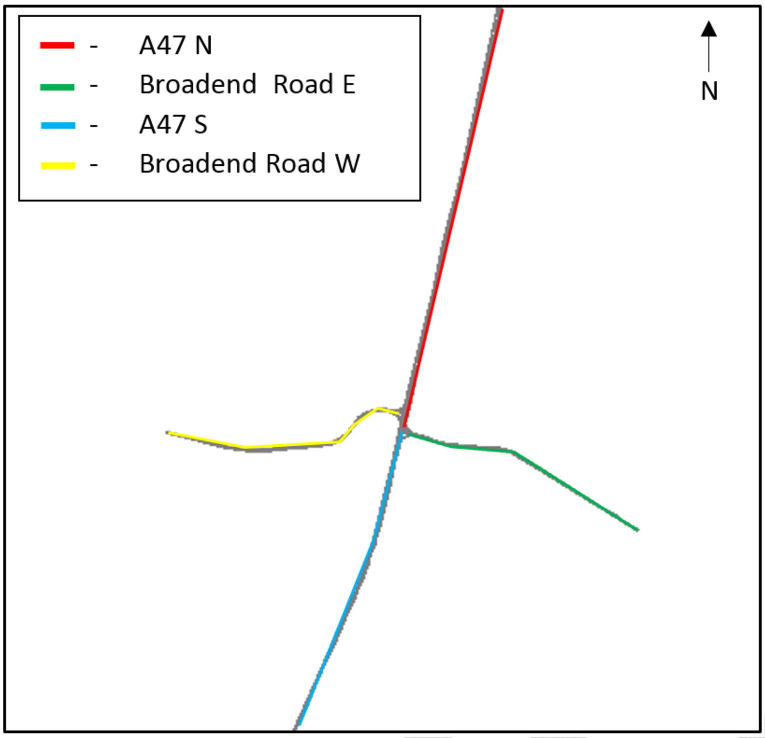


Figure 2.1 Travel Time Routes

Bus Services

2.8. The network includes several bus routes, although there are no associated bus stops within the network extents. Therefore, buses were not coded into the model separately and were included in the flows extracted from the surveyed turning counts.

3. Model Development

Model Software

3.1. The VISSIM Software is comprised of five basic components:

- Highway networks (links and connectors);
- Traffic control systems (signal, stop and give-way control);
- Traffic inputs;
- Vehicle type and compositions; and,
- Vehicle routes.

3.2. VISSIM version 5.40-09 has been used to construct and run the model.

Highway Network

3.3. The base road network for the existing conditions VISSIM models was constructed for both peaks based upon an Ordnance Survey CAD background.

3.4. In order to facilitate realistic queuing and vehicle behaviour, the link type Urban (left side rule) was used on the network. The driver behaviour parameters were set at a default and utilised driving parameter Wiedemann 74.

Flows

3.5. The peak hours selected for the modelling were 0800-0900 for the AM peak and 1700-1800 in the PM peak, which is consistent with the Wisbech Area Transport Study SATURN Model refresh, currently being undertaken and which forms a separate part of the project, but will be utilised in conjunction with future VISSIM modelling.

3.6. Traffic flow profiles were undertaken on the MCC survey data and showed a good fit in the AM peak, although the PM peak appears to start marginally earlier. Since a 30-minute warm-up period is included in the modelling the peak flows would still be modelled. To remain consistent with the WATS model the PM Peak remained between 1700-1800. Figure 3.1 and

3.7. Figure 3.2 show the flow profiles for the AM and PM peaks respectively, with the cumulative line representing the hourly total.

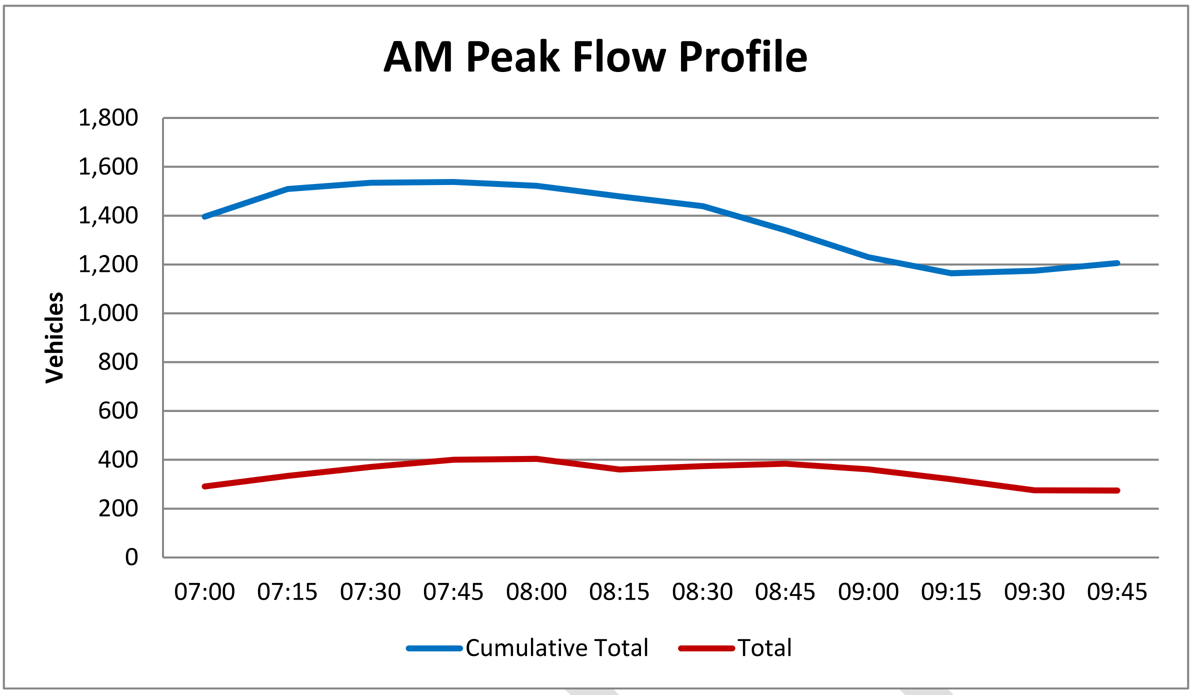


Figure 3.1 AM Peak Flow Profile

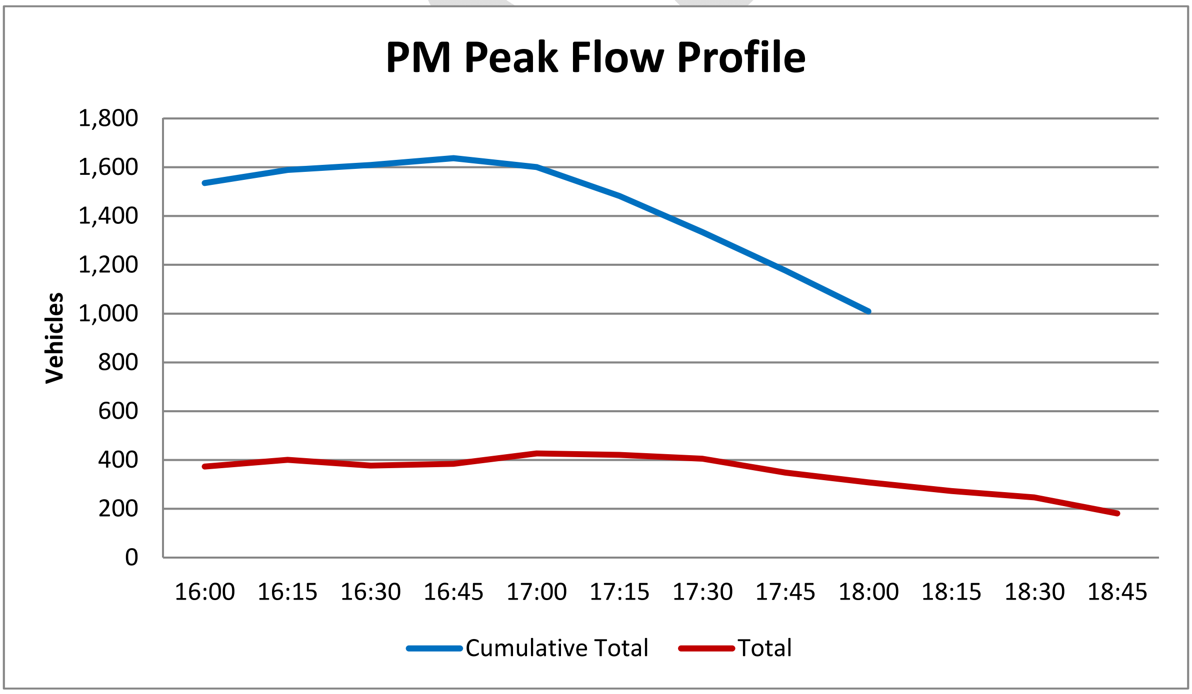


Figure 3.2 PM Peak Flow Profile

Vehicle Types and Classes

3.8. VISSIM uses individual vehicle models that are grouped into vehicle types, which are then subsequently grouped into vehicle classes. Vehicle classes for Car, LGV, HGV, Bus and Motorcycle were used within the model. The Car vehicle class was further split into small and large cars, using a previously defined distribution of 75% small cars and 25% large cars such as MPVs, and the HGV vehicle class was further split into OGV1 and OGV2 using traffic count data. All other vehicle classes contained a single vehicle type.

Vehicle Inputs and Compositions

3.9. The traffic flow networks for the AM and PM peak periods were used to determine the total vehicle inputs at all entries into the network in 15 minute intervals.

3.10. The survey data was used to calculate the vehicle type compositions at the entry points to the network in 15 minute intervals.

Vehicle Routes

3.11. The model utilised static routing of vehicles through the network, with the appropriate data was obtained from the classified turning counts.

3.12. The traffic flows for the AM and PM peaks were used to determine the total vehicle routes throughout the network in 15 minute intervals.

Traffic Control System

3.13. Priority rules were placed at all give-way locations, with separate rules for lights and heavy vehicles to account for differing gap acceptance values required by larger slower HGV's.

Outputs

3.14. Measures of effectiveness have been coded and output from VISSIM including the following:

- General network performance statistics;
- Junction analysis (including demand and supply volumes, average and maximum queue lengths); and,
- Travel times.

3.15. The process of calibration and validating the existing conditions models is described in the following sections of this report.

4. Model Calibration and Validation

Introduction

4.1. In order to confirm that the model is fit for purpose of the evaluation of proposed improvement measures, and to provide credibility to results, it is necessary to calibrate and validate the model. The calibration process involves changing the network set up and behavioural characteristics to achieve a match between observed and modelled data.

4.2. Model validation assesses the accuracy of the model by comparing traffic data from the model with independent traffic data not used in the model building process. Validation is directly linked to the calibration process as adjustments in calibration are needed to improve the model's ability to replicate observed traffic conditions.

Calibration Process

4.3. During the calibration process, the network has been comprehensively scrutinised and checked. Adjustments have been made to improve the overall performance of the model based on comparisons with observed data.

4.4. The following adjustments were carried out during the calibration process.

Vehicle Following Behaviour and Link Type

4.5. The Urban Left-Side Rule (motorised) link type has been used on the entire network, although Broadend Road east and west are particularly narrow. For these side roads, an amended version of this link type, Urban Left-Side Rule (low sat) was used, which varies car following behaviours in order to replicate the decrease in capacity.

4.6. All link types utilised within the model had the 'smooth close up behaviour' parameter activated which allows vehicles to slow down more evenly when approaching a standing obstacle.

Average Standstill Distance

4.7. The average standstill distance (between stationary vehicles) for all link types utilised has been kept at the default value of 2.0 metres.

Speed Distributions

4.8. Speed distributions define the free-flow speeds at which vehicles will wish to travel in the model if not hindered by other vehicles on the network. The distribution will range from the lowest likely speed to the maximum likely speed chosen by drivers for any particular speed limit.

4.9. The speed limit along the A47 is 60 mph for lights and 50mph for heavies. A speed distribution of 60mph (55mph – 65mph) for lights and 50mph (45mph – 55mph) for heavies was utilised initially, although this produced modelled travel times that were much quicker than the observed along the A47.

4.10. The speed limit for Broadend Road West is marked as 40mph, although it was unclear what the speed limit of Broadend Road East is on site, it was assumed that this would also be 40mph. A speed distribution of 35-45mph was utilised on these links, but again this returned much faster modelled travel times than observed.

4.11. Therefore, the observed speeds from the satellite data for each route in the model were reviewed to understand what speeds vehicles were travelling at on site. Tables 4.1 to 4.4 show the free flow speeds (0000-0600), the AM peak speed and PM peak speed for each link segment in the observed data that make up the same route within the model for each of the four routes as shown in Figure 2.1.

Table 4.1 A47 SB Speeds

	A47 SB Average Speed (mph)		
Segment	FreeFlow (00:00 - 06:00)	AM (08:00 - 09:00)	PM (17:00 - 18:00)
1	57.28	52.10	49.74
2	52.79	45.79	43.56
3	53.68	46.51	45.02
Avg	**54.58**	**48.13**	**46.11**

Table 4.2 Broadend Road WB Speeds

	Broadend Road WB Average Speed (mph)		
Segment	FreeFlow (00:00 - 06:00)	AM (08:00 - 09:00)	PM (17:00 - 18:00)
1	18.81	30.18	25.53
2	22.48	32.72	27.48
3	23.27	33.29	28.94
4	21.35	25.73	20.06
5	16.89	13.89	8.03
Avg	**20.56**	**27.16**	**22.01**

Table 4.3 A47 NB Speeds

	A47 NB Average Speed (mph)		
Segment	FreeFlow (00:00 - 06:00)	AM (08:00 - 09:00)	PM (17:00 - 18:00)
1	55.87	51.24	49.93
2	57.91	53.27	51.71
3	56.45	50.98	48.57
4	53.61	47.40	43.93
5	53.31	47.52	44.17
Avg	**55.43**	**50.08**	**47.66**

Table 4.4 Broadend Road EB Speeds

	Broadend Road EB Average Speed (mph)		
Segment	FreeFlow (00:00 - 06:00)	AM (08:00 - 09:00)	PM (17:00 - 18:00)
1	28.79	34.60	32.99
2	19.18	24.40	24.23
3	16.96	11.93	11.45
4	23.97	5.96	6.68
Avg	**22.22**	**19.22**	**18.84**

4.12. The observed data in Tables 4.1 and 4.3 show that on the edge of the network along the A47 (at least 1km from the junction) vehicles speeds are not reaching 60mph, even in free flow conditions. It should also be noted that speeds drop as vehicles approach the junction.

4.13. The A47 is relatively narrow along the study area, with limited room for overtaking. The Broadend junction is a staggered crossroads, with limited visibility and no street lighting, thereby making it a more hazardous junction. Therefore, it is deemed that drivers are naturally more cautious along this section of the A47 and through the junction. To aid with calibration of the model, the speed limit was reduced to match the observed average travel time for the A47. A speed distribution of 50mph (45mph-55mph) has been utilised for the A47 in both direction.

4.14. Tables 4.2 and 4.4 show that vehicles are driving much slower than the onsite speed limits along the two Broadend Road approaches to the junction, especially at the stop lines. Therefore, the speeds have been reduced to a distribution of 20mph-30mph for these two roads.

4.15. Reduced speed areas were utilised to slow vehicles in the network at junction turns.

4.16. Reduced speeds were placed along Broadend Road east to slow vehicles due to the exceptionally narrow lanes and poor visibility, where vehicles would have to wait or pull to the side to allow others to pass.

4.17. Reduced speeds were placed along Broadend Road west to slow vehicles on the narrow, tight bends on the approach to the junction.

4.18. Reduced speeds were placed along the A47 on the approach to the junction turns, to model the slowing of vehicles in advance of the turns onto Broadend Road.

Priority Rules

4.19. Priority rules are used to model give way parameters for roundabouts and priority junctions.

4.20. Gap timings were increased from the default 3.6 seconds for all vehicles at each approach to the junction due to the relatively dangerous nature of the unlit junction and the more cautious driving behaviour as vehicles are giving way to relatively high speed traffic. In all instances the gap times were increased to 4 seconds.

Random Seed Criteria

4.21. The stochastic nature of micro-simulation models means that by simply changing the random seed number, the sampling of values from specified distributions is changed and this will create different model results. VISSIM uses random seeds to vary traffic conditions, including the pattern in which vehicles are released into the network. This is designed to represent daily variations between traffic conditions. Without this variation, the model would not reflect the variability that exists in actual traffic conditions. For this model 16 random seeds were used.

Validation

GEH Statistics

4.22. The Geoffrey E. Havers (GEH) statistic is a standard way of comparing observed and modelled flows as defined in the Design Manual for Roads and Bridges (DMRB) Volume 12, Chapter 4. It is used to remove the bias that exists when comparing flows of different magnitudes using percentages.

4.23. The GEH statistic is calculated as follows:

$$GEH = \sqrt{\frac{(M-C)^2}{(M+C)/2}}$$

4.24. Where:

GEH………………..is the GEH statistic;

M………………….. is the modelled flow; and

C………………….. is the observed flow

4.25. The accuracy of the modelled flows can also be assessed by comparing observed and modelled flows on an x-y plot and performing a linear regression analysis to calculate R^2, and the slope of the regression line through the origin. Typically, a value of $R^2 \geq 0.95$, and slope within the range 0.90 and 1.10 would imply that the modelled flows are a good fit within the observed flows. A slope exceeding unity implies that the model is over predicting flows, while a slope less that unity suggests that the model is under-predicting observed flows.

4.26. In summary, the following set of acceptable ranges and limits have been used to assess model calibration based upon all turning movements within the study area:

- GEH value: ≤5.0 in at least 85% of cases;
- R^2 value: greater than or equal to 0.95; and,
- Slope of linear regression: within the range 0.90 to 1.10.

Travel Times

4.27. The observed travel times have been compared to the modelled travel times as stated in TAG Unit M3.1 and DMRB Volume 12. All travel times have been weighted by the number of vehicles making the journey. The acceptance criteria of modelled journey times are within +/- 15 percent of surveyed journey times for 85% of routes.

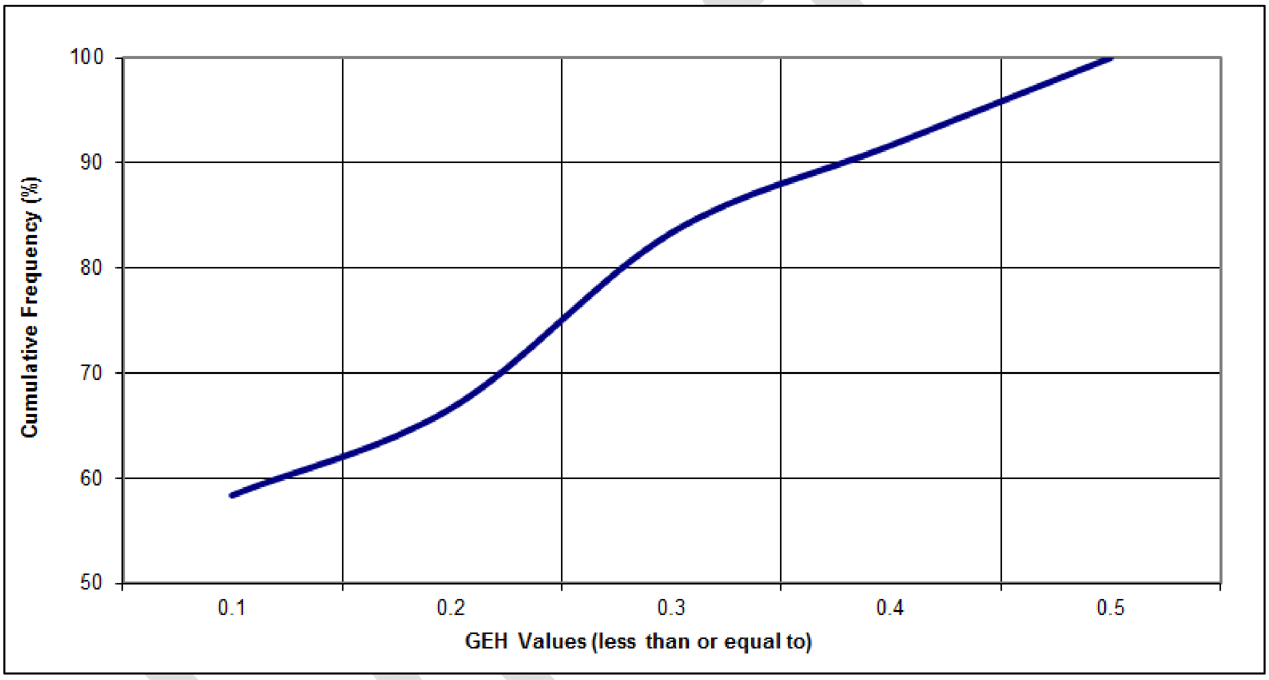
5. 2016 Existing Conditions Validation Results

AM Peak

GEH Statistics

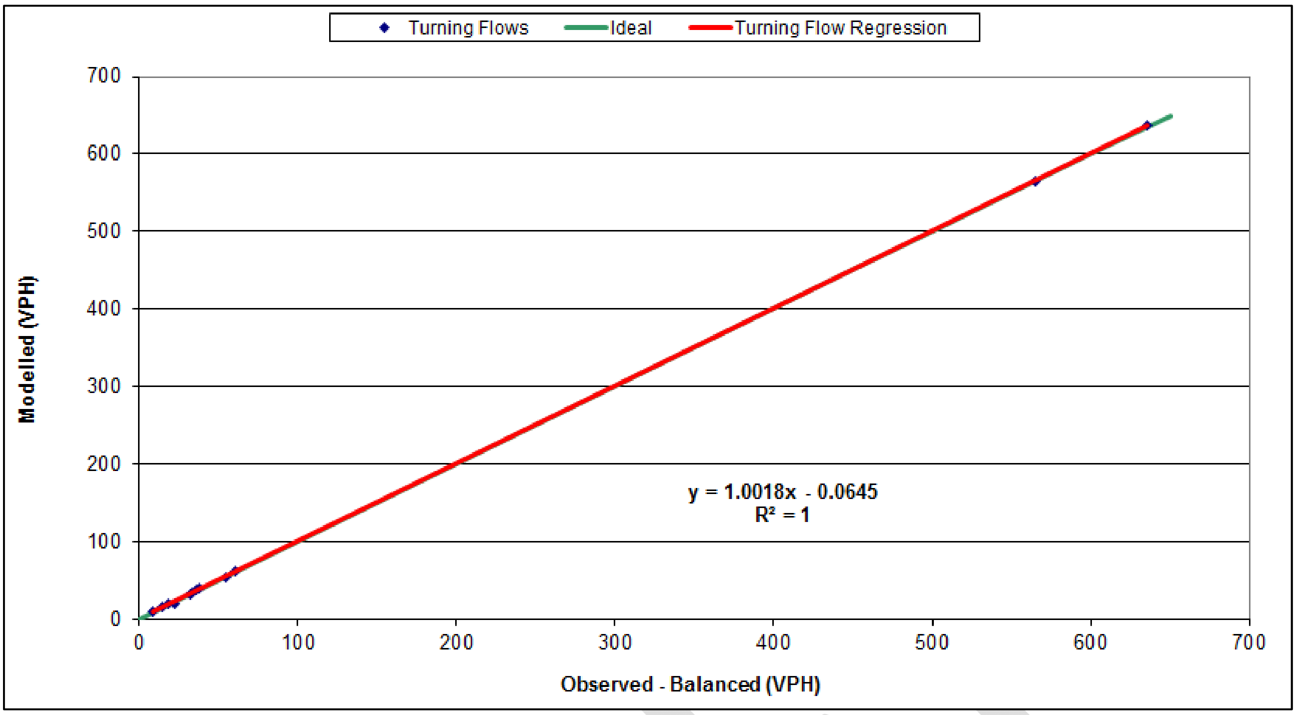
5.1. The GEH statistic assessments have been conducted on all turning movements at all junctions in the modelled network. A cumulative frequency plot of the AM Peak GEH values is shown in Figure 5.1 below. The plot indicates that the model meets the first criteria, in that 100% of cases are less than or equal to a GEH of 0.5.

Figure 5.1 AM Peak Cumulative Frequency of GEH Values



5.2. The linear regression of the modelled total flows and observed total flows was also analysed. A high correlation coefficient (R^2) was achieved with the results shown in Figure **5.2**. The R^2 statistic is judged on a scale of 0 to 1, with 1 indicating a perfect correlation between the two datasets.

Figure 5.2 AM Peak Linear Regression of Traffic Flows



5.3. Regression of the AM peak observed versus modelled flows showed an R^2 value of 1 and a slope of 1.0018 demonstrating that the model shows an excellent fit and meets the second and third validation criteria.

5.4. In summary, the AM Peak has met all of the GEH validation criteria and is considered to be calibrated extremely well to the surveyed traffic flows.

Junction Performance

5.5. A summary of the overall junction analysis results for the 2016 existing AM peak period model is shown in Table 5.1 below. The table shows the summary performance for each movement within the peak hour assessed.

5.6. Table 5.1 provides information on modelled and observed flow differences, average and maximum queue lengths and average delays. The Level of Service (LOS) indicator has also been included in order to provide a quick reference to junction performance.

5.7. The LOS is an American concept derived from their Highway Capacity Manual (2000). It rates performance based upon delay thresholds on an A to F grading as follows:

- LOS A – 0 to 10 seconds;
- LOS B – 10 to 20 seconds (10 to 15 seconds for unsignalised junctions);
- LOS C – 20 to 35 seconds (15 to 25 seconds for unsignalised junctions);
- LOS D – 35 to 55 seconds (25 to 35 seconds for unsignalised junctions);
- LOS E – 55 to 80 seconds (35 to 50 seconds for unsignalised junctions); and,
- LOS F – Over 80 seconds (over 50 seconds for unsignalised junctions).

5.8. Any junctions operating at LOS E or F are highlighted in light blue. A LOS E is considered to be at capacity whilst a LOS F is considered to be over capacity.

Table 5.1 2016 AM Peak Summary of Junction Performance

		Volume				Queue Length (m)		Delay (s)	LOS
Movement	Direction	Model	Count	GEH	Accept	Max	Avg	Avg	
A47 N to Broadend E	N-E	15	15	0.0	✓	0.0	0.0	3.3	A
A47 N to A47 S	N-S	638	636	0.1	✓	0.0	0.0	4.1	A
A47 N to Broadend W	N-W	39	38	0.2	✓	0.0	0.0	6.8	A
Broadend E to A47 S	E-S	61	61	0.0	✓	26.3	0.1	6.3	A
Broadend E to Broadend W	E-W	53	55	0.3	✓	26.2	0.1	13.9	B
Broadend E to A47 N	E-N	32	32	0.0	✓	26.2	0.1	13.2	B
A47 S to Broadend W	S-W	38	36	0.3	✓	0.0	0.0	1.5	A
A47 S to A47 N	S-N	565	565	0.0	✓	0.0	0.0	3.2	A
A47 S to Broadend E	S-E	20	22	0.4	✓	0.0	0.0	7.0	A
Broadend W to A47 N	W-N	19	18	0.2	✓	13.2	0.0	4.1	A
Broadend W to Broadend E	W-E	9	9	0.0	✓	13.2	0.0	10.3	B
Broadend W to A47 S	W-S	33	33	0.0	✓	13.2	0.0	13.0	B
Total	**All**	**1523**	**1520**	-	**100%**	**26.3**	**0.0**	**4.7**	**A**

5.9. Table 5.1 shows that overall the network is operating well within capacity with a LOS A in the AM peak.

5.10. The two Broadend approaches are operating slightly worse than the A47 with LOS of B and longer delays, although no major issues are being experienced at the junction.

Travel Times

5.11. Table 5.2 shows the comparison of the modelled average journey times to the observed travel times for the four junction approaches within the network as shown in Figure 2.3, for the AM peak period.

Table 5.2 2016 AM Peak Summary of Travel Times (s)

			Average Journey Times (secs) All Vehicles				
					Average Limits 15%		
Loc	From	To	Weighted Model Average	Observed Average	Lower	Upper	Model
1011	A47 N	Junction	118	112	95	129	✓
1012	Broadend Rd E	Junction	54	47	40	54	✓
1013	A47 S	Junction	77	73	62	84	✓
1014	Broadend Rd W	Junction	53	55	47	63	✓
Overall A47/Broadend Junction							**100%**

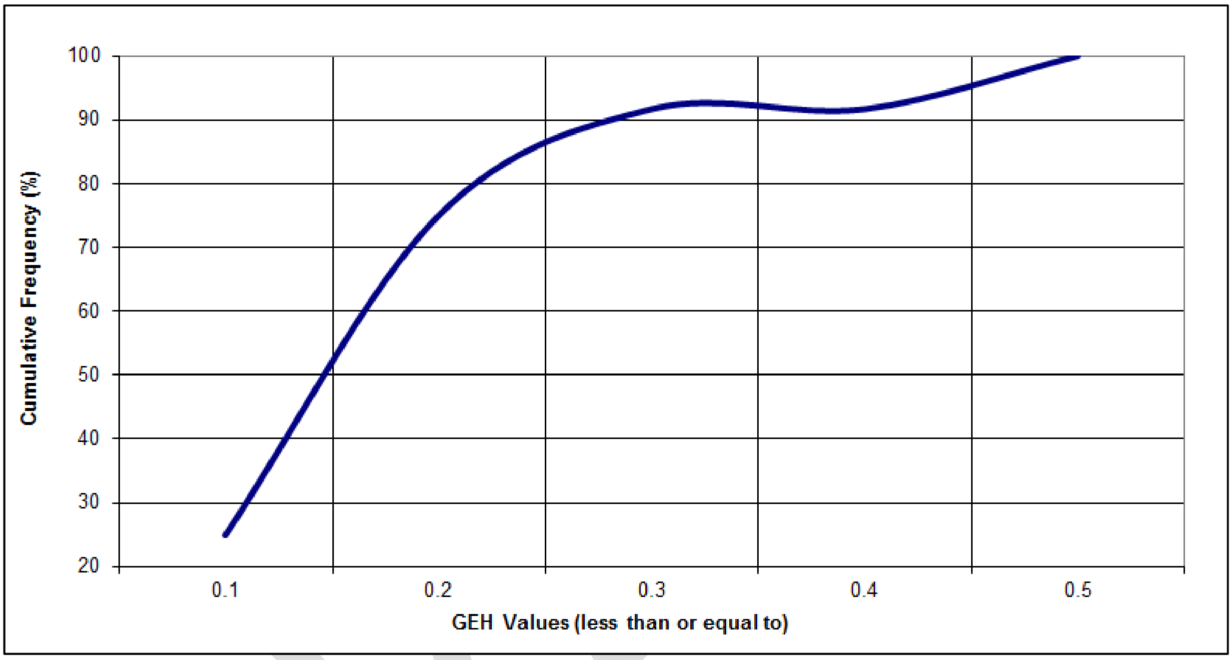
5.12. Table 5.2 shows overall 100% of average modelled journey times are within +/- 15 % of the observed average full route journey times.

PM Peak

GEH Statistics

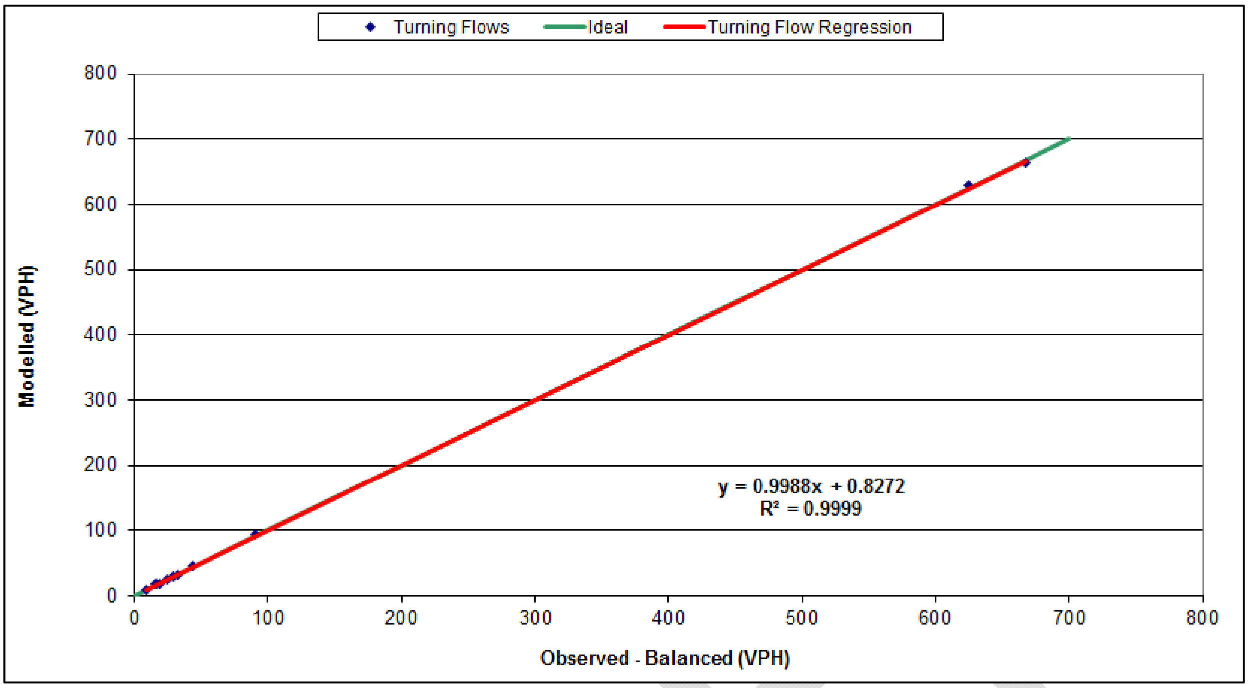
5.13. The GEH statistic assessments have been conducted on all turning movements at all junctions in the modelled network. A cumulative frequency plot of the PM Peak GEH values is shown in Figure 5.3 below. The plot indicates that the model meets the first criteria, in that 100% of cases are less than or equal to a GEH of 0.5.

Figure 5.3 PM Peak Cumulative Frequency of GEH Values



5.14. The linear regression of the modelled total flows and observed total flows was also analysed. A high co-efficient correlation (R^2) was achieved with the results shown in Figure 5.4. A value of R2 = 1 implies a perfect correlation between the two datasets.

Figure 5.4 PM Peak Linear Regression of Traffic Flows



5.15. Regression of the PM Peak observed versus modelled flows showed an R^2 value of 0.9988 and a slope of 0.999 demonstrating that the model shows an excellent fit and meets the second and third validation criteria.

5.16. In summary, the PM Peak has met all the GEH validation criteria and is considered to be calibrated extremely well to the surveyed traffic flows.

Junction Performance

5.17. A summary of the overall junction analysis results for the 2016 existing AM peak period model is shown in Table 5.3 below. The table shows the summary performance for each movement within the peak hour assessed.

Table 5.3 2016 AM Peak Summary of Junction Performance

		Volume				Queue Length (m)		Delay (s)	LOS
Movement	Direction	Model	Count	GEH	Accept	Max	Avg	Avg	
A47 N to Broadend E	N-E	45	44	0.1	✓	0.0	0.0	3.8	A
A47 N to A47 S	N-S	629	625	0.2	✓	0.0	0.0	4.2	A
A47 N to Broadend W	N-W	19	19	0.0	✓	0.0	0.0	6.9	A
Broadend E to A47 S	E-S	17	17	0.0	✓	5.0	0.0	3.9	A
Broadend E to Broadend W	E-W	17	16	0.2	✓	5.0	0.0	11.3	B
Broadend E to A47 N	E-N	9	9	0.0	✓	5.0	0.0	11.5	B
A47 S to Broadend W	S-W	94	90	0.4	✓	0.0	0.0	1.9	A
A47 S to A47 N	S-N	663	667	0.2	✓	0.0	0.0	3.6	A
A47 S to Broadend E	S-E	30	29	0.2	✓	0.0	0.0	6.1	A
Broadend W to A47 N	W-N	30	29	0.2	✓	6.6	0.0	5.1	A
Broadend W to Broadend E	W-E	25	24	0.2	✓	6.6	0.0	13.4	B
Broadend W to A47 S	W-S	31	32	0.2	✓	6.6	0.0	13.1	B
Total	**All**	**1609**	**1601**	**-**	**100%**	**6.6**	**0.0**	**4.3**	**A**

5.18. Table 5.3 shows that overall the network is operating well within capacity with LOS A in the PM Peak.

Travel Times

5.19. 4 shows the comparison of the modelled average journey times to the observed travel times for all vehicles for the PM Peak period.

Table 5.4 2016 PM Peak Summary of Travel Times (s)

			Average Journey Times (s)				
			Weighted Model Average	Observed Average	Average Limits 15%		
Loc	From	To			Lower	Upper	Model
1011	A47 N	Junction	118	120	102	138	✓
1012	Broadend Rd E	Junction	52	61	52	70	✓
1013	A47 S	Junction	78	76	65	87	✓
1014	Broadend Rd W	Junction	54	54	46	62	✓
Overall A47/Broadend Junction							**100%**

5.20. 4 shows overall 100% of average modelled journey times are within +/- 15 % of the observed average journey times. Therefore, the model is considered to be validated well to observed travel times.

Validation Summary

5.21. In summary, both peaks are considered representative of the existing traffic conditions, providing a robust representation of the base year (2016) traffic conditions within the modelled network. The model can therefore be used to forecast the likely operation performance arising from the proposed highway improvement schemes.

6. Future Year Modelling

6.1. A proposed development (East Wisbech urban extension) is planned for the area immediately off Broadend Road West, with access from Sandy Lane, and will be phased over a 10-year period.

6.2. To accommodate the forecasted increase in traffic from the development and provide adequate access to/from the A47, the junction is required to be upgraded. An assessment on the most appropriate form the new junction will take and further details on the type and size of the development, was undertaken by Skanska and is documented in their report titled 'New A47 Junction: East'.

6.3. The proposed schemes will be assessed for the future years of 2021, 2026 and 2031, in line with the phased development. Two options will be assessed and both are variations on roundabout designs that have been undertaken by Skanska. Atkins have not reviewed the designs to check they conform to highway standards.

Flow Methodology

6.4. The Broadend Road junction assessment forms part of the wider Wisbech Access Study and runs parallel to the Wisbech proposed option VISSIM assessments that have also been undertaken by Atkins. The Wisbech town centre model was audited by AECOM on behalf of Highways England (HE) and they raised a concern regarding the data used within the modelling as January is not considered a neutral month. January data was used due to initial project deadlines at the time of commissioning the modelling work which drove the decision to undertake the surveys in January rather than be delayed until the spring.

6.5. A comparison of the January 2016 traffic data utilised in the modelling and ATC data for a neutral month of November 2015 was undertaken for the A47 flows. November 2015 was chosen as this is the month the surveys were conducted for the WATS SATURN model, for which the future year flows for this assessment and the Wisbech town centre modelling would be taken from.

6.6. The comparison of flows showed that the January 2016 A47 flows were slightly lower than those in November 2015 and so the base year VISSIM flows for the through movements eastbound and westbound at the Broadend Road junction were increased by the percentages shown in Table 6.1.

Table 6.1 A47 Growth Factors

	Eastbound		Westbound	
	AM	PM	AM	PM
Broadend Jan flows	615	705	689	688
Diff Jan Broadend Model - Nov Avg	-12	5	-41	8
% Diff Jan Model - Nov Avg	-2%	0.6%	-6%	1%
GEH	0.5	0.2	1.5	0.3

6.7. The future year flows utilised in VISSIM for this assessment have been taken from the WATS SATURN model and were created using the following process:

- Turning counts for the VISSIM network were extracted from the 2016, 2021, 2026 and 2031 SATURN model;
- The absolute and percentage difference between SATURN modelled 2016 and each future year were calculated;
- The percentage difference for each future year was then applied to the updated VISSIM 2016 flows. Large percentage differences (below 50% or above 150%) were sense checked and absolute values were applied if necessary (a large percentage difference may not be a large absolute difference);

Future Year VISSIM Modelling

6.8. To evaluate and quantify the benefits of the proposed options in the future years, a Do Minimum (DM) scenario is required for each future year.

6.9. The base year VISSIM model was updated with the 2021, 2026 and 2031 flows to create a DM scenario.

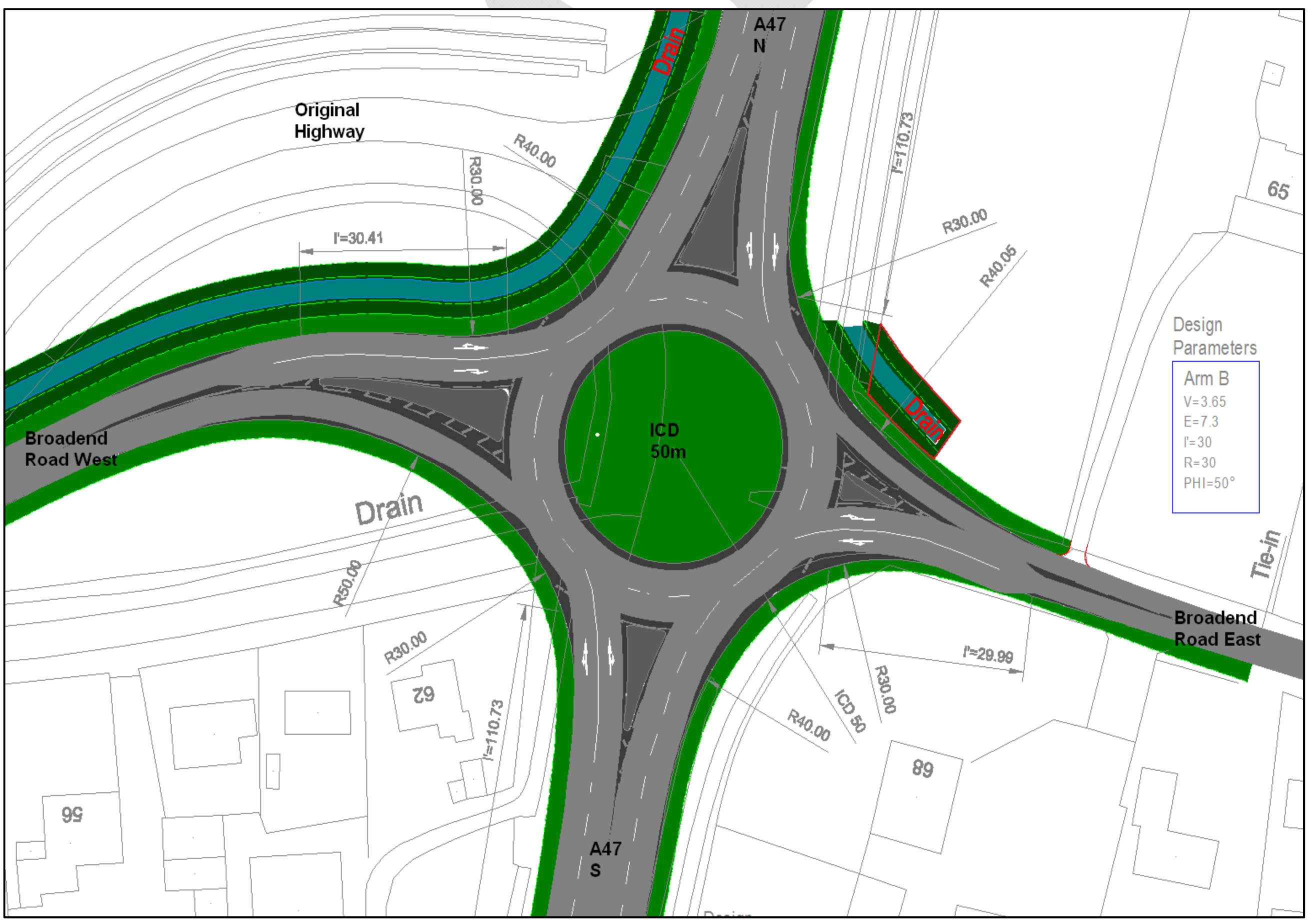
6.10. Two options have been assessed and for the purposes of this report have been named Do Something Option 1 (DS1) and Do Something Option 2 (DS2) which are described in more detail below. The DM VISSIM model was utilised and amended accordingly.

Do Something Option 1

6.11. The first design to be assessed is the implementation of a new roundabout with an inscribed circle diameter (ICD) of 50m at the Broadend Road Junction. The main changes are as follows and are shown in Figure 6.1:

- Broadend Road west is moved south from its current location to join the new roundabout with the geometry of the approach straightened;
- All approaches flare to two lanes; and,
- The A47 exits incorporate two lanes for 140m before returning to single carriageway.

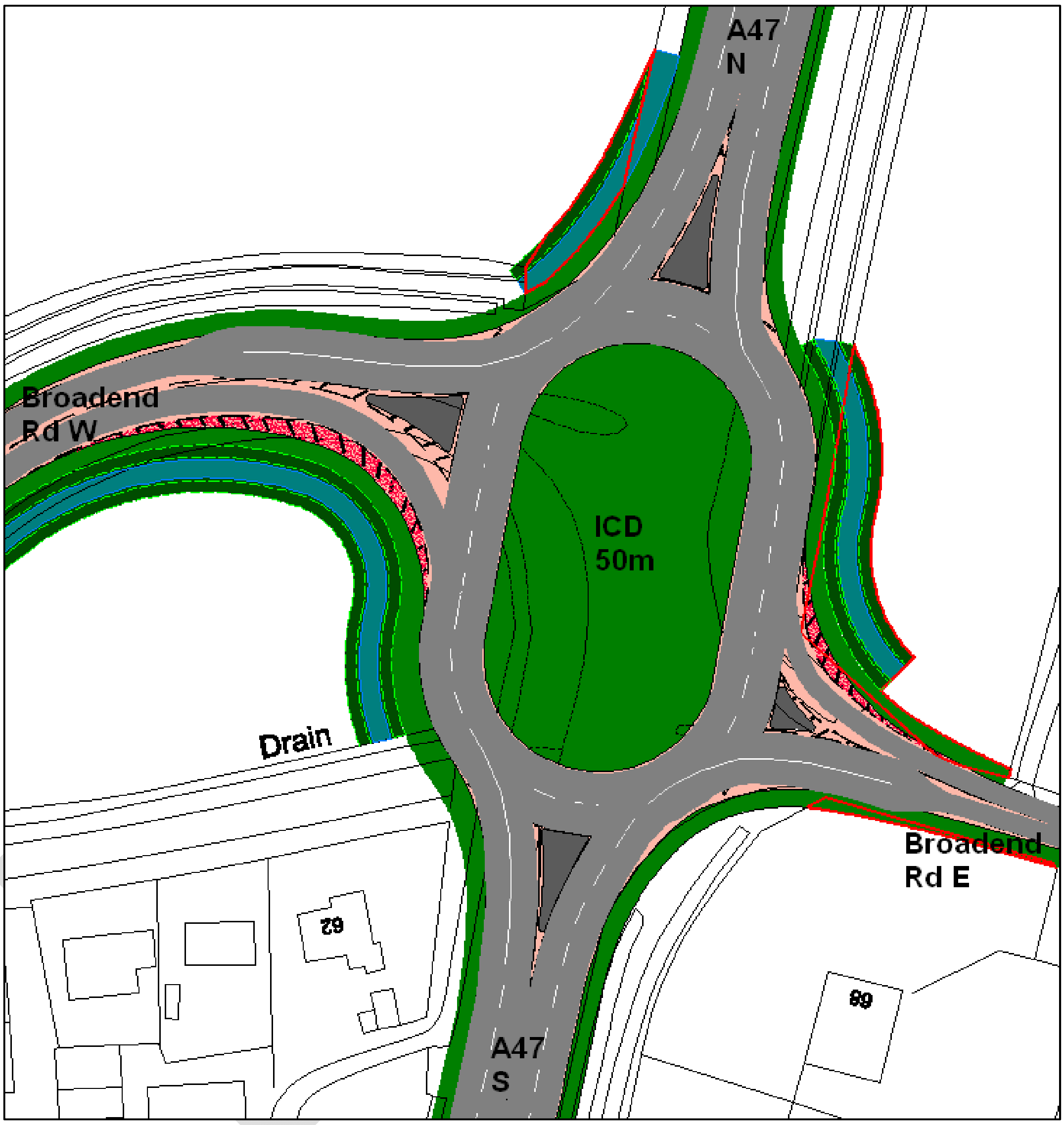
Figure 6.1 Do Something Option 1 Layout



Do Something Option 2

6.12. The second design to be assessed is an oval roundabout at the Broadend Road Junction, which utilises the road alignment of the existing staggered junction and prevents the need to move the Broadend Road West approach as per Option 1. Option 2 incorporates an ICD of 50m with two lane flares at each approach and A47 exits. The proposed layout for Option 2 is shown in Figure 6.2.

Figure 6.2 Do Something Option 2 Layout



7. 2021 Comparison Results

7.1. A summary each approach to the Broadend Road junction for DS1 and DS2 have been compared back to the 2021 DM. The results in terms average queues (m), average delay (s) and LOS and are shown in Tables 7.1 and 7.2 for the AM and PM peaks respectively. The light blue shaded cells represent the optimum performer. Full turning movement comparison results, including the maximum queue lengths (m), are provided in Appendix B.

Table 7.1 2021 AM Peak Approach Comparison

Approach	AM Peak								
	Avg QL (m)			Delay (secs)			LOS		
	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
A47 N	***0.0***	0.1	0.2	5.0	***5.0***	5.3	A	***A***	A
Broadend E	0.3	***0.2***	***0.2***	15.6	***5.8***	5.8	C	***A***	A
A47 S	***0.0***	0.2	0.4	***3.8***	4.5	5.1	***A***	A	A
Broadend W	***0.1***	***0.1***	***0.1***	12.7	***3.1***	4.0	B	***A***	A
Total	***0.1***	0.2	0.2	5.9	***4.8***	5.2	A	***A***	A

Table 7.2 2021 PM Peak Approach Comparison

Approach	PM Peak								
	Avg QL (m)			Delay (secs)			LOS		
	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
A47 N	***0.0***	0.2	0.3	***3.5***	5.0	5.3	***A***	A	A
Broadend E	***0.0***	***0.0***	***0.0***	6.8	2.8	***2.6***	A	A	***A***
A47 S	***0.0***	0.1	0.3	***3.1***	4.4	4.9	***A***	A	A
Broadend W	0.5	***0.1***	***0.1***	18.4	***3.6***	4.3	C	***A***	A
Total	***0.1***	***0.1***	0.2	***4.5***	4.6	5.0	***A***	A	A

7.2. The 2021 results show that in both peaks, both options are forecast to operate well within capacity with all approaches operating with an LOS A.

7.3. Both Broadend Road approaches are showing benefits over the DM network as vehicles can access the roundabout more easily and more safely compared with the existing junction design.

7.4. Both A47 approaches experience marginally higher delays as vehicle no longer have priority with the roundabout designs.

8. 2026 Comparison Results

8.1. A summary of each approach to the Broadend Road junction for DS1 and DS2 scenario have been compared back to the 2026 DM. The results in terms average queues (m), average delay (s) and LOS and are shown in Tables 8.1 and 8.2 for the AM and PM peaks respectively. The light blue shaded cells represent the optimum performer. Full turning movement comparison results, including the maximum queue lengths (m), are provided in Appendix C.

Table 8.1 2026 AM Peak Approach Comparison

Approach	AM Peak								
	Avg QL (m)			Delay (secs)			LOS		
	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
A47 N	***0.0***	0.2	0.4	5.5	***5.5***	5.9	A	***A***	A
Broadend E	1.0	***0.3***	***0.3***	22.7	6.3	***6.3***	C	A	***A***
A47 S	***0.0***	0.4	0.6	***4.2***	4.9	5.6	***A***	A	A
Broadend W	0.7	0.2	***0.1***	17.2	***3.5***	4.7	C	***A***	A
Total	0.4	***0.3***	0.4	7.2	***5.2***	5.7	A	***A***	A

Table 8.2 2026 PM Peak Approach Comparison

Approach	PM Peak								
	Avg QL (m)			Delay (secs)			LOS		
	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
A47 N	***0.0***	0.3	0.6	***3.7***	5.4	6.0	***A***	A	A
Broadend E	***0.0***	***0.0***	***0.0***	7.6	3.0	***2.8***	A	A	***A***
A47 S	***0.0***	0.1	0.4	***3.4***	5.0	5.6	***A***	A	A
Broadend W	2.3	***0.2***	***0.2***	30.1	***4.0***	4.9	D	***A***	A
Total	0.6	***0.1***	0.3	5.7	***5.1***	5.6	A	***A***	A

8.2. The 2026 results show that in both peaks, both options are forecast to operate well within capacity with all approaches operating with an LOS A.

8.3. The Broadend West approach has the most benefits with this scheme as a result of the development traffic putting more demand on the approach.

9. 2031 Comparison Results

9.1. A summary covering each approach to the Broadend Road junction for DS1 and DS2 scenarios have been compared back to the 2031 DM. The results in terms average queues (m), average delay (s) and LOS and are shown in Tables 9.1 and 9.2 for the AM and PM peaks respectively. The light blue shaded cells represent the optimum performer. Full turning movement comparison results, including the maximum queue lengths (m), are provided in Appendix D.

Table 9.1 2031 AM Peak Approach Comparison

	AM Peak								
Approach	Avg QL (m)			Delay (secs)			LOS		
	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
A47 N	***0.0***	0.4	0.7	***6.0***	6.2	6.8	***A***	A	A
Broadend E	3.0	***0.5***	***0.5***	35.5	7.2	***7.1***	E	A	***A***
A47 S	***0.0***	0.7	1.2	***4.7***	5.7	6.5	***A***	A	A
Broadend W	4.1	0.3	***0.2***	34.0	***4.3***	5.4	D	***A***	A
Total	1.8	***0.5***	0.6	10.1	***5.9***	6.6	B	***A***	A

Table 9.2 2031 PM Peak Approach Comparison

	PM Peak								
Approach	Avg QL (m)			Delay (secs)			LOS		
	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
A47 N	***0.0***	0.4	0.6	***3.9***	5.7	6.2	***A***	A	A
Broadend E	***0.0***	***0.0***	***0.0***	10.7	3.5	***3.4***	B	A	***A***
A47 S	***0.0***	0.2	0.5	***3.5***	5.2	5.9	***A***	A	A
Broadend W	10.8	0.3	***0.2***	57.3	***4.9***	5.5	F	***A***	A
Total	2.7	***0.2***	0.4	8.8	***5.3***	5.9	A	***A***	A

9.2. The 2031 results are consistent with the 2021 and 2026 and forecast that in both peaks, both options are forecast to operate well within capacity with all approaches operating with an LOS A.

9.3. In 2031, the Broadend Road approaches are operating at and over capacity in the DM, but the roundabout schemes significantly improve the delays for these approaches, which are operating well within capacity.

10. Summary and Conclusion

10.1. Atkins has been commissioned by Skanska, on behalf of Fenland District Council (FDC) and Cambridgeshire County Council (CCC), to evaluate a number of proposed highway improvement schemes for the Broadend Road / A47 junction in Wisbech.

10.2. In order to evaluate the proposed schemes, both the existing conditions and the proposals need to be assessed in traffic modelling software to quantify their benefits.

10.3. The purpose of the base year VISSIM model is to replicate accurately the existing conditions so that the model can then be used for proposed option testing and future year assessments.

10.4. The VISSIM traffic model has been constructed to represent the morning AM peak period from 0800 to 0900 and an evening PM peak period from 1700 to 1800 and also to keep the times consistent with the SATURN model of the same area.

10.5. The models have been coded in VISSIM, using links and connectors, aerial mapping, Google Street View, priority rules, desired speed decisions and reduced speed areas.

10.6. The traffic flows utilised in the model were taken from turning count surveys undertaken on Tuesday 19th January 2016 and therefore, the model seeks to replicate this survey day. On taking the models forward for option testing a comparison of flows showed that the January 2016 A47 flows were slightly lower than those in a neutral month of November 2015 and so the base year VISSIM flows for the through movements eastbound and westbound at the Broadend Road junction were increased for the option testing only.

10.7. To confirm that the model is fit for purpose of the evaluation of proposed improvement measures, and to provide credibility to results, it is necessary to calibrate and validate the model. The calibration process involves changing the network set up and behavioural characteristics to achieve a match between observed and modelled data.

10.8. The VISSIM model was largely developed using default parameters, however, during the model calibration process, these parameters were reviewed and some adjustments were required to better fit the observed driver behaviour and operating conditions.

10.9. Model validation assesses the accuracy of the model by comparing traffic data from the model with independent traffic data not used in the model building process. Validation is directly linked to the calibration process as adjustments in calibration are needed to improve the model's ability to replicate observed traffic conditions.

10.10. Model validation was based on best practice advice and guidance. Modelled and observed traffic flows and journey times were compared for all turning movements and routes in the model respectively. Both have been shown to meet the DMRB criteria for acceptability for both time periods as shown in Table 10.1.

Table 10.1 Validation Summary

Validation Element	AM Peak		PM Peak	
Flow	100%	13/13*	100%	13/13*
Journey Time	100%	4/4**	100%	4/4**

*Number of turning movements with GEH <5 out of total number of turning movements

**Number of journey time routes within +/- 15% or 1 minute out of the total number of journey time routes

10.11. In both the AM and PM peak, all approaches to the Broadend Rd and A47 junction validated to the observed journey time. The travel times were an average of a 3 month period (November 2015 to January 2016).

10.12. The models are considered fit for purpose, providing a robust representation of the 2016 base year traffic conditions within the study area. The model can therefore, be used with confidence to assess the various improvement options and future year schemes.

10.13. To accommodate the forecasted increase in traffic from the East Wisbech urban extension development and provide adequate access to/from the A47, the junction is required to be upgraded.

10.14. Two options have been assessed and both are variations on roundabout designs that have been undertaken by Skanska. The proposed schemes will be assessed for the future years of 2021, 2026 and 2031, in line with the phased development which will be along Sandy Lane off Broadend Road west.

10.15. The first design to be assessed is the implementation of a new roundabout with an inscribed circle diameter (ICD) of 50m at the Broadend Road Junction. The Broadend Road west approach is re-aligned to the south to join the roundabout. All approaches have two lane flares and the A47 exits have 2 lane merges which drop back to single lane after approximately 140m.

10.16. The second design to be assessed is an oval roundabout with an ICD of 50m at the Broadend Road Junction, which utilises the road alignment of the existing staggered junction and prevents the need to move the Broadend Road West approach as per Option 1. All approaches have two lane flares and the A47 exits have 2 lanes merges for approximately 140m.

10.17. Therefore, both designs are similar, except Option 2 utilises the existing road layout for each approach.

10.18. The results for all forecast years have shown that both roundabouts are predicted to operate well within capacity and provide significant improvements in performance for the Broadend Road approaches by 2031. Tables 10.2 and 10.3 provide a quick glance summary of findings for each option, for each peak by year.

Table 10.2 Option 1 Summary

	Broadend Road Option 1		
	2021	2026	2031
AM Peak	All approaches to new Rbt operating well within capacity. Overall LOS A.	All approaches to new Rbt operating well within capacity. Overall LOS A.	All approaches to new Rbt operating well within capacity. Overall LOS A.
PM Peak	All approaches to new Rbt operating well within capacity. Overall LOS A.	All approaches to new Rbt operating well within capacity. Overall LOS A.	All approaches to new Rbt operating well within capacity. Overall LOS A.

Table 10.3 Option 2 Summary

	Broadend Road Option 2		
	2021	2026	2031
AM Peak	All approaches to new Rbt operating well within capacity. Overall LOS A.	All approaches to new Rbt operating well within capacity. Overall LOS A.	All approaches to new Rbt operating well within capacity. Overall LOS A.
PM Peak	All approaches to new Rbt operating well within capacity. Overall LOS A.	All approaches to new Rbt operating well within capacity. Overall LOS A.	All approaches to new Rbt operating well within capacity. Overall LOS A.

Appendices

Appendix A. 2016 Traffic Flows

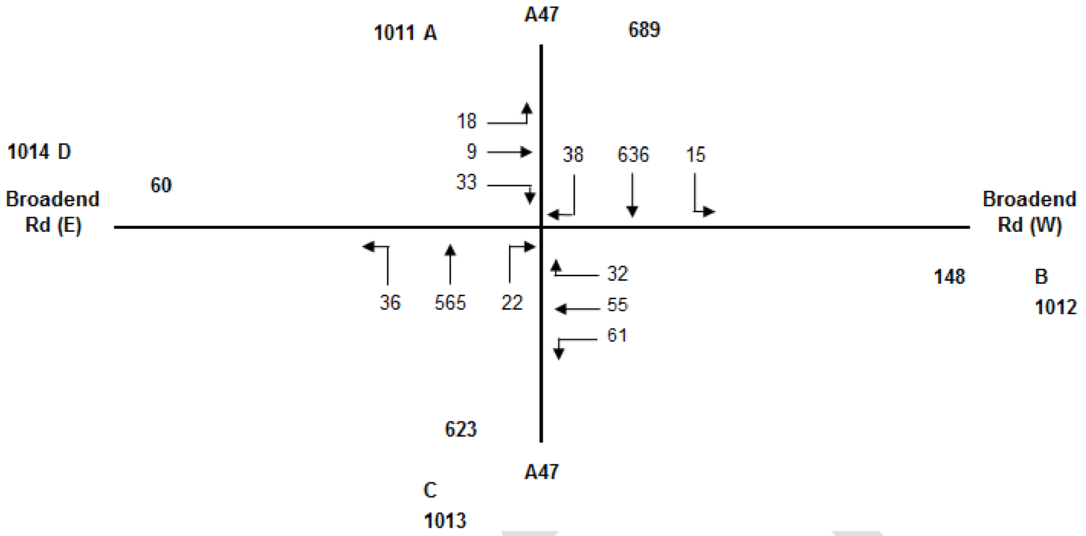


Figure A.1 2016 AM Peak Total Vehicle Turning Movements (0800-0900)

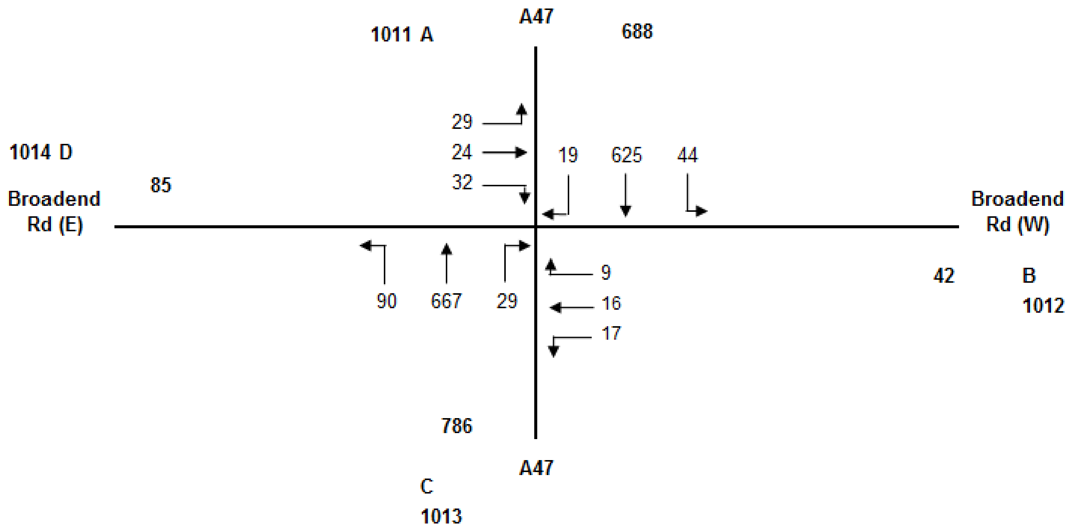


Figure A.2 2016 PM Peak Total Vehicle Turning Movements (1700-1800)

Appendix B. 2021 Proposed Comparison Results

Broadend Junction 2021 Comparison Results

AM Peak

Junction	Movement	Direction	Volume			Max Queue			Avg Queue (m)			Delay (s)			LOS		
			DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
Broadend	Broadend W to A47 S	W-S	33	33	33	13.2	20.2	21.00	0.0	0.1	0.1	13.0	3.1	4.5	B	A	A
	Broadend W to A47 N	W-N	19	19	19	13.2	20.2	21.00	0.0	0.1	0.1	4.1	2.6	4.4	A	A	A
	Broadend W to Broadend E	W-E	9	9	9	13.2	20.2	21.00	0.0	0.1	0.1	10.3	2.7	4.9	B	A	A
	A47 N to A47 S	N-S	638	638	638	0.00	38.8	41.6	0.0	0.1	0.2	4.1	4.5	4.8	A	A	A
	A47 N to Broadend E	N-E	15	15	15	0.00	38.8	41.6	0.0	0.1	0.2	3.3	4.3	5.0	A	A	A
	A47 N to Broadend W	N-W	39	39	39	0.00	38.8	41.6	0.0	0.1	0.2	6.8	5.2	6.0	A	A	A
	A47 S to A47 N	S-N	565	565	565	0.00	37.8	40.8	0.0	0.2	0.4	3.2	4.4	4.8	A	A	A
	A47 S to Broadend E	S-E	20	20	20	0.00	37.8	40.8	0.0	0.2	0.4	7.0	4.8	6.0	A	A	A
	A47 S to Broadend W	S-W	38	38	38	0.00	37.8	40.8	0.0	0.2	0.4	1.5	4.3	5.3	A	A	A
	Broadend E to A47 S	E-S	61	61	61	26.3	28.1	31.5	0.1	0.1	0.2	6.3	5.1	5.6	A	A	A
	Broadend E to A47 N	E-N	32	32	32	26.2	28.1	31.5	0.1	0.1	0.2	13.2	4.6	5.3	B	A	A
	Broadend E to Broadend W	E-W	53	54	54	26.2	28.1	31.5	0.1	0.1	0.2	13.9	5.0	5.8	B	A	A
	Total		1523	1524	1523	26.3	38.8	41.6	0.0	0.1	0.2	4.7	4.4	4.9	A	A	A

PM Peak

Junction	Movement	Direction	Volume			Max Queue			Avg Queue (m)			Delay (s)			LOS		
			DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
Broadend	Broadend W to A47 S	W-S	41	41	41	48.5	26.1	18.1	0.5	0.1	0.1	24.2	3.4	4.3	C	A	A
	Broadend W to A47 N	W-N	49	49	49	48.5	26.1	18.1	0.5	0.1	0.1	9.4	3.4	4.0	A	A	A
	Broadend W to Broadend E	W-E	51	51	51	48.5	26.1	18.1	0.5	0.1	0.1	22.3	3.9	4.7	C	A	A
	A47 N to A47 S	N-S	767	767	767	0.00	40.4	41.3	0.0	0.2	0.3	3.5	5.0	5.3	A	A	A
	A47 N to Broadend E	N-E	40	40	40	0.00	40.4	41.3	0.0	0.2	0.3	3.4	5.6	5.9	A	A	A
	A47 N to Broadend W	N-W	12	12	12	0.00	40.4	41.3	0.0	0.2	0.3	6.7	4.9	5.7	A	A	A
	A47 S to A47 N	S-N	817	817	817	0.00	32.1	49.4	0.0	0.1	0.3	3.1	4.4	4.9	A	A	A
	A47 S to Broadend E	S-E	30	30	30	0.00	32.1	49.4	0.0	0.1	0.3	6.5	5.5	5.7	A	A	A
	A47 S to Broadend W	S-W	95	95	95	0.00	32.1	49.4	0.0	0.1	0.3	2.3	4.4	5.1	A	A	A
	Broadend E to A47 S	E-S	17	17	17	0.00	10.9	10.1	0.0	0.0	0.0	3.7	2.4	2.3	A	A	A
	Broadend E to A47 N	E-N	4	4	4	0.00	10.9	10.1	0.0	0.0	0.0	13.6	3.5	3.3	B	A	A
	Broadend E to Broadend W	E-W	4	4	4	0.00	10.9	10.1	0.0	0.0	0.0	13.4	3.5	3.2	B	A	A
	Total		1926	1925	1925	48.5	40.4	49.4	0.1	0.1	0.2	4.5	4.6	5.0	A	A	A

Appendix C. 2026 Proposed Comparison Results

Broadend Junction 2026 Comparison Results

			AM Peak														
			Volume			Max Queue			Avg Queue (m)			Delay (s)			LOS		
Junction	Movement	Direction	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
Broadend	Broadend W to A47 S	W-S	57	57	57	88.8	26.5	27.4	0.7	0.2	0.1	22.2	3.5	4.5	C	A	A
	Broadend W to A47 N	W-N	55	56	56	88.7	26.5	27.4	0.7	0.2	0.1	10.2	3.5	4.7	B	A	A
	Broadend W to Broadend E	W-E	24	24	24	88.8	26.5	27.4	0.7	0.2	0.1	21.3	3.6	5.0	C	A	A
	A47 N to A47 S	N-S	925	923	925	0.0	39.7	54.2	0.0	0.2	0.4	5.5	5.5	5.9	A	A	A
	A47 N to Broadend E	N-E	21	21	21	0.0	39.7	54.2	0.0	0.2	0.4	4.5	5.8	5.5	A	A	A
	A47 N to Broadend W	N-W	20	19	20	0.0	39.7	54.2	0.0	0.2	0.4	8.4	6.6	6.9	A	A	A
	A47 S to A47 N	S-N	745	746	745	0.0	49.0	57.0	0.0	0.4	0.6	4.2	4.9	5.6	A	A	A
	A47 S to Broadend E	S-E	8	8	8	0.0	49.0	57.0	0.0	0.4	0.6	10.7	4.8	7.3	B	A	A
	A47 S to Broadend W	S-W	21	21	21	0.0	49.0	57.0	0.0	0.4	0.6	2.7	5.0	5.6	A	A	A
	Broadend E to A47 S	E-S	52	52	52	71.4	34.5	44.3	1.0	0.3	0.3	11.0	5.8	5.6	B	A	A
	Broadend E to A47 N	E-N	30	30	30	71.4	34.5	44.3	1.0	0.3	0.3	28.7	5.9	6.1	D	A	A
	Broadend E to Broadend W	E-W	76	76	76	71.4	34.5	44.3	1.0	0.3	0.3	28.4	6.8	6.8	D	A	A
	Total		2033	2032	2033	88.8	49.0	57.0	0.4	0.3	0.4	7.2	5.2	5.7	A	A	A

			PM Peak														
			Volume			Max Queue			Avg Queue (m)			Delay (s)			LOS		
Junction	Movement	Direction	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
Broadend	Broadend W to A47 S	W-S	54	53	53	96.9	36.5	36.6	2.3	0.2	0.2	34.9	3.5	4.5	D	A	A
	Broadend W to A47 N	W-N	56	55	55	96.8	36.5	36.6	2.3	0.2	0.2	18.6	4.3	5.0	C	A	A
	Broadend W to Broadend E	W-E	62	61	61	96.9	36.5	36.6	2.3	0.2	0.2	36.2	4.2	5.1	E	A	A
	A47 N to A47 S	N-S	823	823	823	0.0	42.8	98.0	0.0	0.3	0.6	3.7	5.4	6.0	A	A	A
	A47 N to Broadend E	N-E	45	45	44	0.0	42.8	98.0	0.0	0.3	0.6	3.3	5.6	6.2	A	A	A
	A47 N to Broadend W	N-W	14	14	14	0.0	42.8	98.0	0.0	0.3	0.6	8.1	5.8	6.6	A	A	A
	A47 S to A47 N	S-N	898	898	899	0.0	30.7	41.6	0.0	0.1	0.4	3.4	4.9	5.5	A	A	A
	A47 S to Broadend E	S-E	29	29	29	0.0	30.7	41.6	0.0	0.1	0.4	7.4	6.1	6.3	A	A	A
	A47 S to Broadend W	S-W	120	120	120	0.0	30.7	41.6	0.0	0.1	0.4	2.6	5.1	5.8	A	A	A
	Broadend E to A47 S	E-S	17	17	17	0.0	10.2	10.5	0.0	0.0	0.0	4.5	2.9	2.4	A	A	A
	Broadend E to A47 N	E-N	4	4	4	0.0	10.2	10.5	0.0	0.0	0.0	14.7	2.9	3.9	B	A	A
	Broadend E to Broadend W	E-W	4	4	4	0.0	10.2	10.5	0.0	0.0	0.0	13.4	3.8	3.4	B	A	A
	Total		2125	2124	2125	96.9	42.8	98.0	0.6	0.1	0.3	5.7	5.1	5.6	A	A	A

Appendix D. 2031 Proposed Comparison Results

Broadend Junction 2031 Comparison Results

			AM Peak														
			Volume			Max Queue			Avg Queue (m)			Delay (s)			LOS		
Junction	Movement	Direction	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
Broadend	Broadend W to A47 S	W-S	70	69	69	122.3	33	31.2	4.1	0.3	0.2	40.3	4.4	5.2	E	A	A
	Broadend W to A47 N	W-N	68	69	68	122.2	33	31.2	4.1	0.3	0.2	22.7	4.2	5.5	C	A	A
	Broadend W to Broadend E	W-E	41	41	41	122.3	33	31.2	4.1	0.3	0.2	42.1	4.2	5.4	E	A	A
	A47 N to A47 S	N-S	1012	1011	1011	0.0	53.8	50.9	0.0	0.4	0.7	6.0	6.2	6.8	A	A	A
	A47 N to Broadend E	N-E	22	22	22	0.0	53.8	50.9	0.0	0.4	0.7	4.6	5.7	6.4	A	A	A
	A47 N to Broadend W	N-W	21	21	21	0.0	53.8	50.9	0.0	0.4	0.7	8.9	6.9	8.2	A	A	A
	A47 S to A47 N	S-N	802	802	802	0.0	87.0	75.5	0.0	0.7	1.2	4.6	5.7	6.5	A	A	A
	A47 S to Broadend E	S-E	8	9	8	0.0	87.0	75.5	0.0	0.7	1.2	14.2	6.6	7.5	B	A	A
	A47 S to Broadend W	S-W	23	23	23	0.0	87.0	75.5	0.0	0.7	1.2	3.5	5.7	6.5	A	A	A
	Broadend E to A47 S	E-S	52	52	52	107.4	42.3	43.0	3.0	0.5	0.5	19.6	6.9	6.8	C	A	A
	Broadend E to A47 N	E-N	34	34	34	107.4	42.3	43.0	3.0	0.5	0.5	40.0	6.2	6.5	E	A	A
	Broadend E to Broadend W	E-W	89	89	89	107.4	42.3	43.0	3.0	0.5	0.5	43.1	7.7	7.6	E	A	A
	Total		2241	2240	2239	122.3	87.0	75.5	1.8	0.5	0.6	10.1	5.9	6.6	B	A	A

			PM Peak														
			Volume			Max Queue			Avg Queue (m)			Delay (s)			LOS		
Junction	Movement	Direction	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2	DM	DS1	DS2
Broadend	Broadend W to A47 S	W-S	56	54	54	151.2	37.7	26.4	10.9	0.3	0.2	70.2	4.7	5.2	F	A	A
	Broadend W to A47 N	W-N	82	79	79	151.2	37.7	26.4	10.8	0.3	0.2	43.5	4.8	5.4	E	A	A
	Broadend W to Broadend E	W-E	70	67	67	151.2	37.7	26.4	10.9	0.3	0.2	63.0	5.2	5.9	F	A	A
	A47 N to A47 S	N-S	869	869	869	0.0	36.3	61.9	0.0	0.4	0.6	3.8	5.7	6.2	A	A	A
	A47 N to Broadend E	N-E	43	43	43	0.0	36.3	61.9	0.0	0.4	0.6	3.6	5.9	6.5	A	A	A
	A47 N to Broadend W	N-W	24	24	24	0.0	36.3	61.9	0.0	0.4	0.6	8.3	6.4	7.4	A	A	A
	A47 S to A47 N	S-N	901	901	901	0.0	61.6	51.7	0.0	0.2	0.5	3.5	5.1	5.8	A	A	A
	A47 S to Broadend E	S-E	28	28	28	0.0	61.6	51.7	0.0	0.2	0.5	7.9	5.4	6.0	A	A	A
	A47 S to Broadend W	S-W	141	141	141	0.0	61.6	51.7	0.0	0.2	0.5	2.8	5.5	6.3	A	A	A
	Broadend E to A47 S	E-S	17	17	17	0.0	10.8	17.4	0.0	0.0	0.0	5.6	3.1	2.9	A	A	A
	Broadend E to A47 N	E-N	3	3	3	0.0	10.8	17.4	0.0	0.0	0.0	14.9	3.5	2.6	B	A	A
	Broadend E to Broadend W	E-W	6	6	6	0.0	10.8	17.4	0.0	0.0	0.0	23.0	4.8	5.3	C	A	A
	Total		2241	2233	2233	151.2	61.6	61.9	2.7	0.2	0.4	8.8	5.3	5.9	A	A	A

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Appendix B – Workshop Comments

	Wisbech East Junction	Impact on Congestion and Emissions	Impact on A47 Journey Time Reliability	Access to / from A47	Impact on Safety	Making use of Existing Infrastructure	Impact on Local Environment	Could it be considered Controversial?	Potential for Sustainable Transport Provision	Other Considerations
1	Left in / Left Out	A47 would remain free flowing	No impact	Very poor access onto network for side roads	Potential for u-turning / illegal right turns within junction	Regression from the existing junction	Minimal land take	Would probably not be considered acceptable by local safety lobby		
		Additional traffic u-turning would add pressure onto already congested junctions			May be difficult to merge onto the A47		Little visible impact on the landscape			
		Additional emissions from u-turning traffic			Conflict from right turning traffic removed					
2	Priority Junction	A47 remains free flowing	No impact	Poor access for right turning traffic	Does not address existing safety concerns - A47 very straight and fast from that perspective	Excellent - uses existing junction	Minimal land take	Would not be considered acceptable by local safety lobby		
					- Additional development will increase pressure the junction					
2a	Enhanced Priority Junction (Single lane dualling)		A47 remains free flowing		Provision of right turn lane would make the junction safer and more visible - plus more visible for	Largley uses existing junction	Minimal	Unlikely to satisfy local safety concerns	Could add in a pedestrian island with the right turn lanes - safety would be a concern	
						Some land take may be required				
3	Simple Roundabout	Adds congestion onto A47	Significant impact on free flow of A47	Very good - all movements catered for	Introduces an obstacle on the main line - increased risk of rear end shunts	Land take required	Impact on local housing - large piece of infrastructure - more noise / emissions		Could add crossing points onto approaches and exits - would be safety concerns	Very constrained space available - difficult to fit in this location
		Increase in congestion and emissions	Will slow traffic on the A47 - potential safety benefits from this perspective		Would reduce the opportunity to overtake		Would require lighting - impact on housing			Cost of re-location (land take required) against benefits of the junction (development)
4	Enhanced Roundabout (discussed with above)									Would definitely require a new location - additional cost
5	Overbridge with Slip Roads	Little impact on congestion	A47 remains free flowing	Not great - traffic required to merge onto A47	Merges with A47 will be difficult - but there is no physical impediment to the	No use of existing infrastructure	Impact on landscape - visibility in surrounding area	May be public acceptability issues with local residents - visually intrusive	Overbridge could be designed to accommodate footpath / cycleway	Financial viability of structures will be an issue
							Significant land take required			Increased maintenance liability
										Risk of bridge strikes closing the network - network resilience issue
6	Signalised Junction	Creates congestion	Significant delay to mainline flow	Would provide good access onto the A47 for the side arms	High speed road - would require a lot of advanced warning	Would require land take	Visibility of signals on local landscape	Would not be popular with through traffic / HGVs etc	Could add pedestrian phases - but would increase delay and safety concern	CCC do not want any additional signals - maintenance liability
		Increase in emissions from standing traffic								HE do not any signals - additional maintenance liability
										May be more cost effective from the developers point of view - but the maintenance liability is then passed onto the local highway

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Appendix C – Cost Summary

Wisbech Access Study 10/04/2017

BER2

Broadend Road Roundabout - Option 2

Highways Only

Construction Assumptions;

Carriageway	s/c	40	15.00	Footpath	25	12.00
	b/c	60	15.00		65	15.00
	rd b	200	40.00			
	sub base	450	37.50		260	25.00
	Capping l:	400	40.00			
	terram	0	3.00			
		1150			350	
	exc & CA		35.00			30.00
			185.50			82.00

Exc & realign drainage ditch	2016	m3	55.00	110,880.00
Form new verge	4776	m2	35.00	167,160.00
BO exstg carriageway & reinstate	118	m2	55.00	6,490.00
Excavate & construct new carriageway areas	1994	m2	185.50	369,887.00
Excavate & construct footway areas	225	m2	82.00	18,450.00
Plane & resurface carriageway	6893	m2	25.00	172,325.00
BO & replace kerbs	1900	m	120.00	228,000.00
Carriageway kerbs	2000	m	33.00	66,000.00
RAB kerbs	200	m	133.00	26,600.00
Alter existing junctions	2	item	35,000.00	70,000.00
Carriageway drainage & alterations	1	allow	12,000.00	12,000.00
Street lighting & alterations	1	allow	185,000.00	185,000.00
Duct provision	1	alow	41,250.00	41,250.00
Surveys	1	item	35,000.00	35,000.00
Landscaping	1	item	47,760.00	47,760.00
Signs & lines	1	allow	40,000.00	40,000.00
				1,596,802.00

Prelims

Land Acquisition	528	m2	12.50	6,600.00
Demolition		m2		-
Design	10%			159,680.20
Staff, supervision, accommodation	20%			319,360.40
Traffic Management	16	weeks	4,500.00	72,000.00
Traffic Management on trunk road	20	weeks	10,000.00	200,000.00
				2,361,042.60
Add Contingency & Optimism Bias	45%			1,062,469.17
				3,423,511.77

Risks/Assumptions

Soil conditions (contamination etc)
Vandalism
Assume drainage connects onto existing arterial SW.
Assumes street lights reconnected to existing supplies.
Assumes site cleared by others.
No allowance for new building

Assumes clear site.
Works carried out in one continuous visit

Includes 1800m2 of carriageway construction for 'bus station'