3.6 Future Situation

The standard of the highway network is only likely to change as development takes place. Most development results in changes to the access arrangements in its vicinity, often requiring the introduction of new signalised junctions which, depending on their location, may be brought into the SCOOT system.

Since the NATS study of 1989 – 1991, investment in facilities which aid the movement of pedestrians, cyclists and public transport have been prioritised by NCC and consequently the County Council's capital improvement programme in the NPA is focussed on these modes. Junction improvement schemes are generally used to maintain capacity for vehicles whilst enhancing facilities for alternative modes of transport.

A major factor in any future work on the network will be to maximise the current network. NCC is continuing to invest in real time Intelligent Transport Systems to improve the performance and image of public transport modes whilst ensuring that the operation of the highway network is optimised.

Information on existing and forecast future conditions has been obtained from the NATS transport model which includes both highway and public transport models. Variable Demand Modelling has been carried out in accordance with the Department for Transport's (DfT's) Transport Appraisal Guidance (TAG guidance). The model is based on 2006 traffic information, and has been validated against 2006 traffic data. Model base year 2006 results are used as a proxy for current conditions. Forecasts have been produced for the years 2016 and 2031.

The NATS model has been used to produce forecasts for a 'Core Scenario', in accordance with DfT's TAG guidance on forecasting (TAG Unit 3.15.5). Full details of the Core Scenario are included in the report "Norwich Northern Distributor Route – Major Scheme Business Case – Sensitivity Tests for DfT – Core Scenario: December 2009", and some details have been reproduced below. The Do Minimum scenario for this test acts as a reference point for the future year, and as such it includes schemes and measures that have been implemented between 2006 (the base year) and 2009, as well as those schemes post-2009 which are classified as 'near certain' or 'more than likely'. Future growth for the Core Scenario comprises Joint Core Strategy defined housing and business development up to 2016 and TEMPRO for growth up to 2031.

This model is being used in forecasting the traffic scenarios that are likely to arise in the NATS area in the years 2016 and 2031. A series of results have been obtained from the Core Scenario Do Minimum test, relating to the operation of the network as a whole. Table 3.6 provides details of the average speeds for the base year 2006, and those forecast for 2016 and 2031. These average speeds are across the network as a whole as it is included in the NATS model, and not for any specific geographical area. Numbers and percentages throughout this section have been rounded to aid clarity of presentation.

Table 3.6: Network Average Speeds – Do Minimum

Scenario	Year	Average speed (km/h)			% Difference from Base Year		
		AM	IP	PM	AM	IP	PM
Base year	2006	49	57	52	-	-	-
Core Scenario	2016	45	56	50	-8%	-1%	-4%
	2031	41	55	47	-16%	-3%	-9%

Table 3.6 shows that in the Do Minimum scenario, the average traffic speeds in the area are forecast to reduce by around 8% in the AM peak between 2006 and 2016, and by up to 16% between 2006 and 2031. This significant reduction in peak hour speed results from increases in peak hour traffic volumes and consequent delay. Small reductions in average speed in the inter peak period are forecast, of 1% between 2006 and 2016 and of 3% between 2006 and 2031. These reductions in the inter peak speed result from increases in traffic flows and consequent delay that are forecast across the day as a whole.

Details on the forecast changes in trip length and Passenger Car Unit (PCU) kilometres travelled on the network have also been obtained from the NATS model and are summarised in Table 3.7.

Table 3.7: Network PCU Kilometres – Do Minimum

Scenario	Year	PCU kms			% Difference from Base Year		
		AM	IP	PM	AM	IP	PM
Base year	2006	1068498	738836	1038919	-	-	-
Core Scenario	2016	1300040	926560	1257485	22%	25%	21%
	2031	1606576	1174127	1548240	50%	59%	49%

The term PCU is used to assess the impact of transport schemes, and is based around the impact that may be anticipated associated with a single passenger car, so that a passenger car is equivalent to 1 PCU and other vehicles have a PCU equivalent depending on their typical size and speed. Table 3.8 details the standard PCU equivalents for the principal vehicle types.

Table 3.8: PCU Factors by Vehicle Type

Vehicle Type	PCU Factor
Car	1.0
Light Goods Vehicle	1.0
Rigid Goods Vehicle	1.9
Articulated Goods Vehicle	2.9
Public Service Vehicle	2.5

Source: Transport Analysis Guidance Unit 3.9.5

Table 3.7 shows that there is forecast to be a significant change in the number of PCU kilometres on the network, rising from 1,068,498 in 2006 AM peak to 1,606,576 in the 2031 AM peak, equating to an increase of 50%. A higher proportional increase is forecast in the inter peak, with a 59% increase in PCU kilometres in this time period between the two years. The amount of delay is likely to be a product not only of the reduced average vehicle speeds on the network, but also of the increase average journey length. Average trip lengths are detailed in Table 3.9.

Table 3.9: Network Trip Lengths – Do Minimum

Scenario	Year	Average Trip Lengths (km)			% Difference from Base Year		
		AM	IP	PM	AM	IP	PM
Base year	2006	17	17	17	-	-	-
Core Scenario	2016	18	18	19	7%	9%	8%
	2031	19	19	20	12%	17%	14%

In the 2006 base year, the average trip length is around 17km in all peaks, which is forecast to rise to around 18km in the 2016 AM peak and inter peak and to around 19km in the 2016 PM peak. In the 2031 DM, the average trip length is forecast to increase to 19km in the AM peak (i.e. an increase of 12%) and inter peak (i.e. an increase of 17%) and to 20km (i.e. an increase of 14%) in the PM peak.

The forecast total numbers of PCU trips on the network are shown in Table 3.10.

Table 3.10: Summary of Trip Totals (PCUs) – Do Minimum

Scenario	Year	Total Trips (PCUs)			% Difference from Base Year		
		AM	IP	PM	AM	IP	PM
Base year	2006	64480	44560	59441	-	-	-
Core Scenario	2016	73174	51040	66518	13%	15%	12%
	2031	86346	60587	77563	34%	36%	30%

Table 3.10 shows that in the 2006 base year, the AM peak is subject to the highest level of traffic, with 64,480 trips occurring, as compared with the 59,441 trips that are indicated on the network during the PM peak. This is forecast to increase significantly in the future years, by 13% in 2016 to 73,174 trips in the AM peak, and by 34% in 2031 to 86,346 trips during the AM peak.

As well as increased numbers of trips, increases in average trip lengths are forecast, of for example 8% in the PM peak from 17km in 2006 to 19km in 2016. Increased trip numbers and lengths are forecast to result in slower average traffic speeds on the network, which are forecast to fall between 2006 and 2016 by 8% in the AM peak from 49kph in 2006 to 45kph in 2016 and by 19.5% to 41kph in the 2031 AM peak. This reduction in speed indicates an increase in delay and therefore in congestion on the network over this time period.

A measure of traffic conditions on the highway network for junctions is given by the percentage of volume over capacity (V/C). The volume (v) is the actual traffic flow and the capacity (c) is the theoretic maximum traffic flow which is expressed in terms of PCUs per time period per junction. However, depending on local conditions, the actual capacity of a junction may be more or less than the capacity assumed at the site. In some cases actual flows may exceed the theoretical capacity of a junction may lead to V/C ratios in excess of 1. The practical capacity of a junction is often assumed to be 90% of the theoretical capacity, as this is typically an indicator of a level of queuing and delay being present at the junction that adversely affects its efficient operation. Data on V/C has been extracted from the NATS model and forecast numbers of highway junctions operating with a V/C greater than 90% are detailed in Table 3.11.

Table 3.11: Changes in Junctions with V/C over 90%

Year	Time Period	Number of junctions with V/C 90-100%	Number of junctions with V/C >100%	Total
2006	AM	8	1	9
2016	AM	14	2	16
2031	AM	20	8	28

Table 3.11 demonstrates that the growth forecast for the NPA is likely to have an effect on the number of junctions operating over capacity. Based on the Core Scenario model, there is likely to be over a 200% increase in the number of junctions operating with a V/C greater than 90%, from 9 in 2006 to 28 in 2031. This degree of change is illustrated in Figure 3.18 to Figure 3.20 which also show the geographical locations of the junctions in all forecast years, which are likely to operate with a V/C greater than 90%.

Figure 3.18: 2006 Base Year AM Peak Junction Volume / Capacity

Source: NATS Model Output

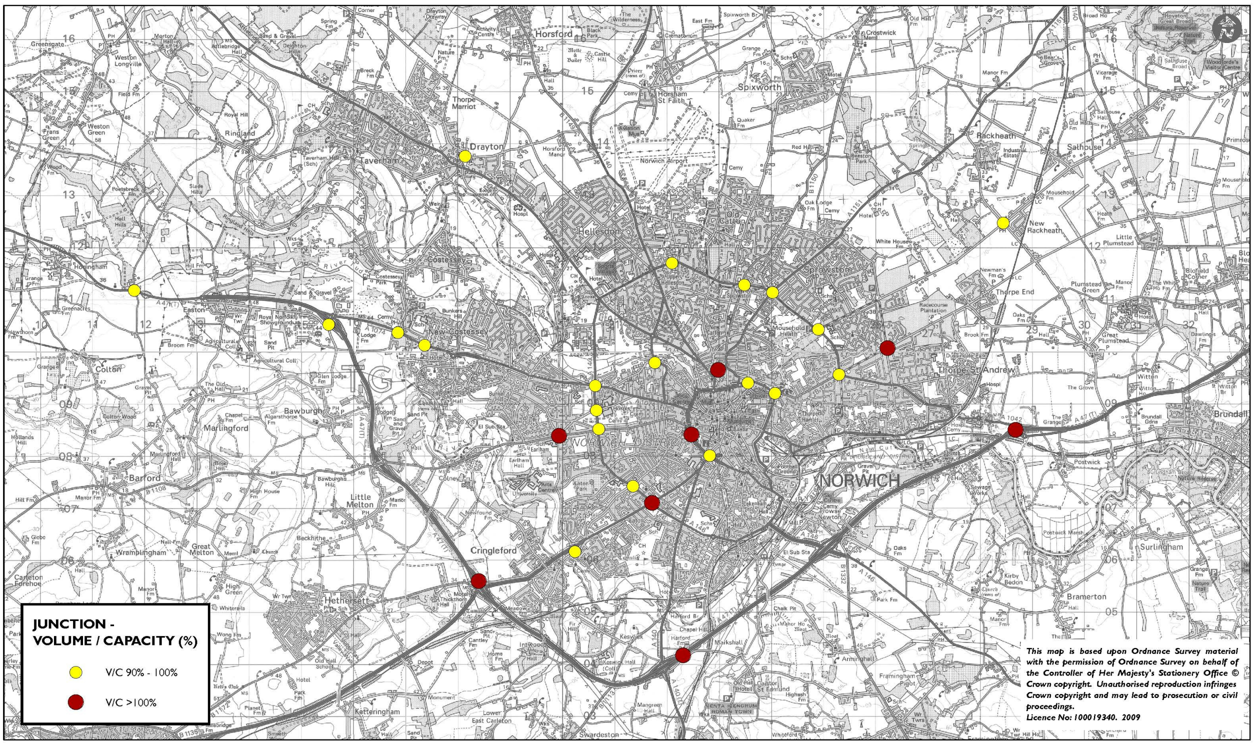
Figure 3.19: 2016 Do Minimum AM Peak Junction Volume / Capacity

Source: NATS Model Output

Figure 3.18 and Figure 3.19 clearly show that all of the junctions operating over 90% V/C in 2006 are located on the Inner or Outer Ring Roads. This changes through to 2016 as, although the majority of junctions over 90% are located on the ring roads, there are four junctions operating between 90% - 100% located beyond the Outer Ring Road. In addition, one junction located to the north of the Inner Ring Road, which operates with a V/C of less than 90% in 2006 is likely to operate at over 100% in 2016.

In 2031, key junctions are forecast to be operating over capacity on both Ring Roads as well as at locations on the A47. In addition, radial routes are likely to operate over capacity, with junctions on Dereham Road, Salhouse Road and Thorpe Road all operating with V/Cs greater than 90%.

Figure 3.20: 2031 Do Minimum AM Peak Junction Volume / Capacity



Source: NATS Model Output

Data relating to the V/C at junctions on the network has also been interrogated in order to produce data on the quantity of queuing that is forecast to take place in the future. The NATS model output indicates that in the AM peak, the total quantity of queuing across the network as a whole, was approximately 17 kilometres in the 2006 Baseline scenario. This is likely to increase by over 50% to 26km in 2016, before doubling to 40km in 2031. In 2031, the vast majority of this queuing (27km) is forecast to be due to junctions operating with a V/C greater than 100%.

Even in the inter peak period it is probable that there will be a significant increase in queuing on the network, from approximately 7km in 2006, to around 15km in 2031. The inter peak profile of queuing is likely to be somewhat different to that in the AM peak with around half of the queues being attributed to junctions operating with a V/C less than 75% and a third attributed to those operating with a V/C greater than 100%.

In addition to the data relating to V/Cs at junctions, information on link V/Cs has also been extracted from the NATS model. This demonstrates that in the 2006 AM peak the model includes 23km of links with a V/C greater than 100%. This quantity increases in the 2016 scenario to 34km and is over 3 times the 2006 level in 2031 at 71km. Even in the inter peak period a quadrupling of links operating with a V/C greater than 100% is forecast from 4km in the 2006 inter peak to 16 km in 2031.

Overall, the information relating to queue lengths across the network, as well as the length of links operating with a V/C greater than 100%, further demonstrates that the background growth in traffic forecast to 2016 and 2031 will have a significant impact on the operation of the network as a whole.

These Figures provide an overview of the degree of change between the baseline and the future years, the NATS model does not indicate how individual junctions may operate under those conditions. To provide this, outputs from the strategic model have been examined and details on the operation of several junctions are provided,

- A140/A1042/A1402 Boundary Junction – this is a signalized gyratory and the most important intersection on the northern Outer Ring Road as it provides access to the city centre to the south and the Norwich International Airport to the north., In the AM peak the model shows the main movements into the gyratory are saturated. The inbound on the A140 Cromer Road, the westbound ahead movement on the A1042 Outer Ring Road and the eastbound left turn on the A140 are operating at or close to, 95% capacity. The last movement takes traffic both for northern destinations and around the gyratory for the city centre.

  The Reepham Road approach is saturated over 100%, as too is the Aylsham Road outbound. The A1402 Aylsham Road gets a relatively low green time from the signals, because only approximately 600 vehicles are on that arm compared to nearly 1200 on Cromer Road, 950 on the Outer Ring Road westbound. It means that queues may not clear each time the signals are green.

  In the PM peak the intersection in the model is even more congested on key turns. Inbound movements on Cromer Road and on Reepham Road remain close to 100% of capacity. Although flows are around two thirds of the traffic flows in the AM peak, the green time given to these movements also reduces proportionally.

  There are small decreases in efficiency on the Outer Ring Road arms compared to the AM peak because, whilst the flows are similar, the outbound flow on Aylsham Road is 60% higher and therefore is given more green time. Even so, the main ahead movement to the north remains above 100% saturation and the queuing on average does not clear each green time.

- A147 King Street-Bracondale/A1054 Bracondale Junction - Whilst the overall efficiency of the junction can appear high because the A1054 Outer Ring Road Bracondale to A147 Inner Ring Road Bracondale route receives green time for two out of the three signal stages, all other movements are at, or above, saturation point in the AM peak.

  In the PM Peak, the movements south on to Outer Ring Road Bracondale and the right turn from Bracondale to King Street are oversaturated, but the Inner Ring Road movements have less pressure than in the AM peak.

  Although flows from King Street to Bracondale on the Outer Ring Road are only slightly lower than the reverse movement in both peaks and has longer green time, the King Street arm becomes congested earlier. This is because the capacity is impaired by the right turn from King Street to Bracondale on the Inner Ring Road.

  Although Bracondale southbound from the Inner Ring Road to the Outer Ring Road has quite high PM peak traffic flows, its green time is squeezed by the need to service the other two main movements at cycle times over 100 seconds. A longer cycle time is only likely to lead to more queuing.

- B1108 Earlham Fiveways - Earlham Fiveways roundabout on the B1108 is an unconventionally constructed junction. In the AM peak the roundabout works inefficiently at 83% of capacity. This would mean at times during an average peak hour the junction becomes quite congested.

Over 400 vehicles make a straight ahead movement to or from Earlham Road, which means that these movements are unopposed. However, a minor road heavily used as a rat-run, Gipsy Lane, is the entry on the roundabout just before the Earlham Road (east) arm. This high flow for the relatively low capacity Gipsy Lane leads to a saturation rate of 96%. In turn this flow across the entry for Earlham Road east drives the saturation level over 80%.

The PM peak works more efficiently overall, but flows distribute in a more dispersed manner, perhaps reflecting less universally focussed destinations in the PM peak. Above 200 more vehicles are modelled to cross the Earlham Road (east) entry compared to the AM peak so that fewer vehicles use this approach. Gipsy Lane nears 90% saturation because of the amount of traffic using a relatively low capacity road.

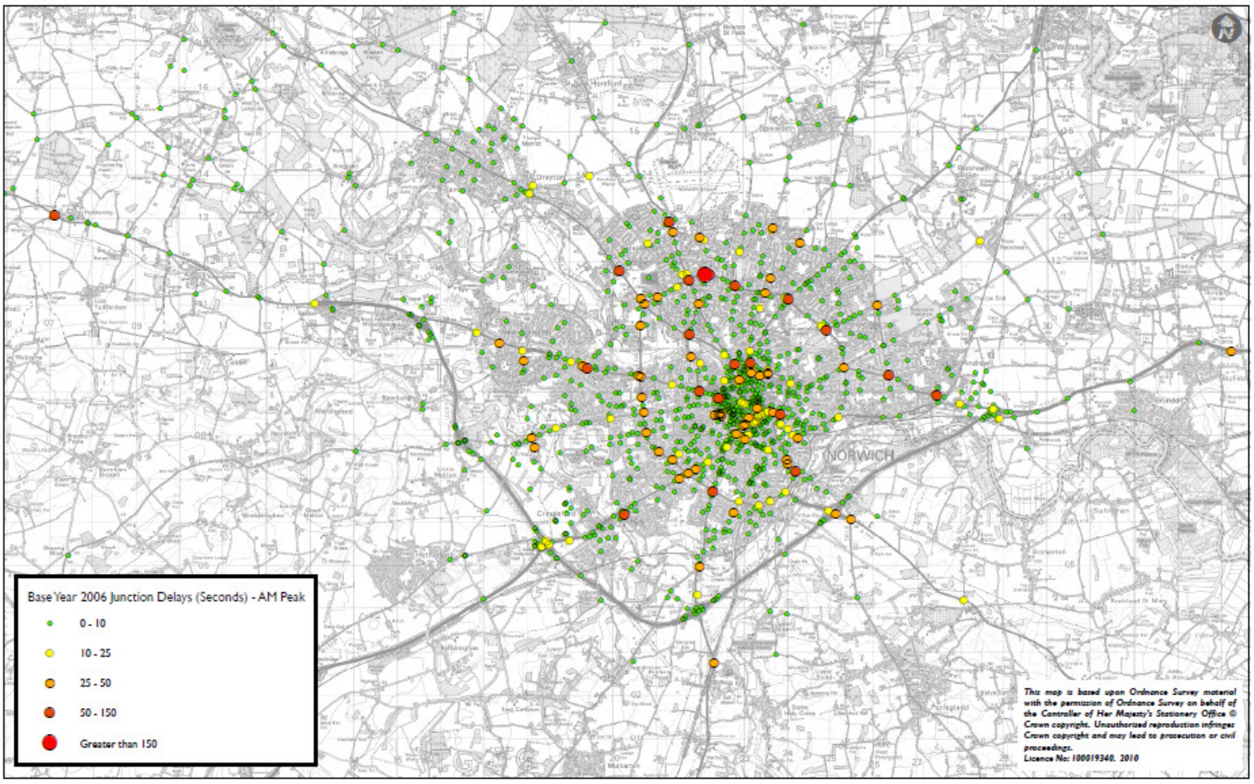
- A1074 Dereham Road/A147 IRR - In the AM peak the overall junction efficiency is 76% with a signal cycle time of 122 seconds. Within that operation, the two right turns out of Dereham Road to Grapes Hill and out of Barn Road into Dereham Road are over 100% saturated. Across the turns, the Barn Road approach is running at 96% saturation, even though with the green for the ahead/left and the green for the right only turns added together it gets 66% of the junctions green time. The queued traffic turning right from Barn Road may not pass through the junction in every cycle.

  The junction in the PM peak operates overall at 81% of its capacity. The left turn from Dereham Road to Barn Road carries a similar amount of traffic in the PM as the AM in the model, but because the other turns have less traffic and the Inner Ring Road arms have more, a shorter green time means it operates at over 100% of capacity.

  The right turn from Grapes Hill to St Benedicts Street also goes over 100% as the green time reduces to compensate for more time for the Barn Road/Dereham Road turn which replicates the UTC management of the junction. As the flows coming along Barn Road are greater than those coming down Grapes Hill, little extra green time can be spared for this arm and movements exceed 100% saturation.

Details on the change in delay at junctions in the AM peak between 2006, 2016 and 2031 are indicated on Figure 3.21 to Figure 3.26.

Figure 3.21: 2006 AM Peak Junction Delays



Source: NATS Model Output

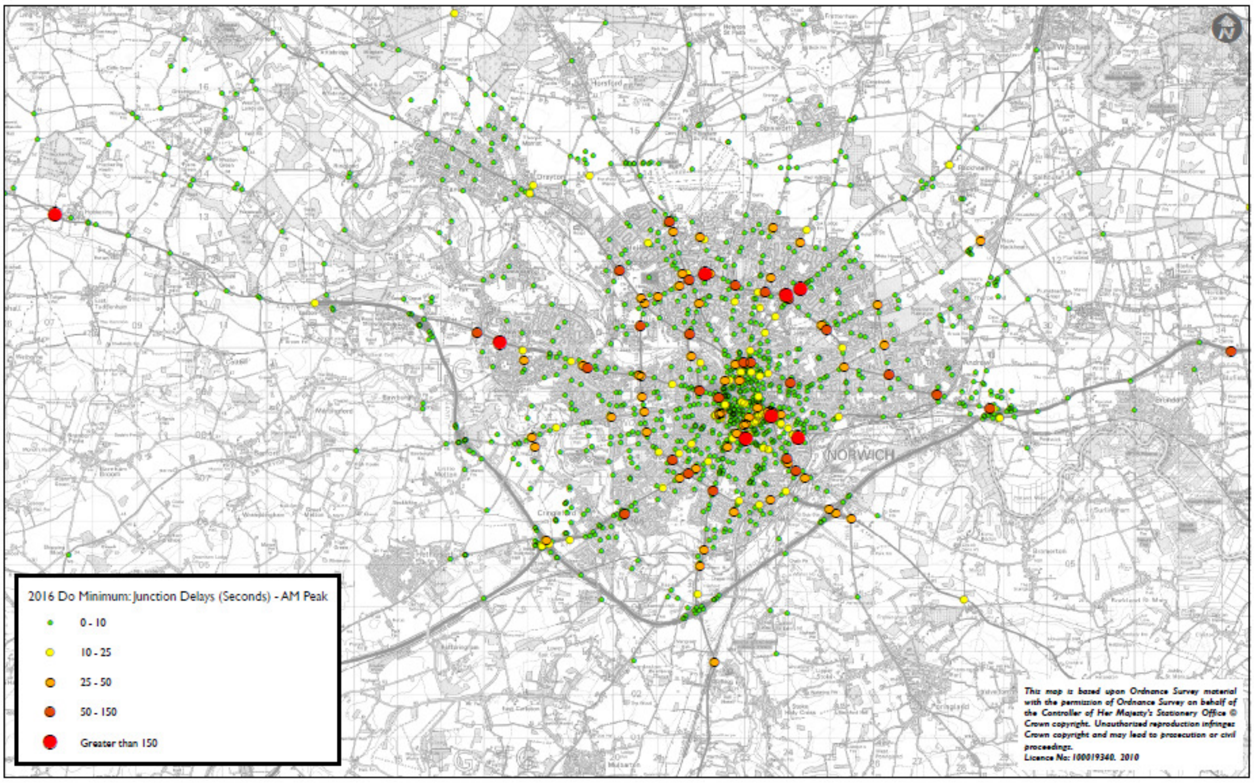
In the AM peak in 2031 it is evident from Figure 3.21 that all of the radial routes, except for the A1151 Wroxham Road, have at least one junction beyond the Outer Ring Road that is subject to total delay in the order of 25 – 50 seconds or more.

Figure 3.22: 2006 AM Peak Junction Delays – Inside Outer Ring Road

Source: NATS Model Output

Looking closer at the 2006 situation based on Figure 3.22 it can be seen that there are multiple junctions across the city subject to a period of delay in excess of 25 seconds, but also that there is a difference in the number of junctions that are adversely affected by delay in the north compared with the south of the city. Using a cut line of Earlham Road to the west and Thorpe Road to the east, there are 9 junctions operating with over 25 seconds delay to the south of the city either on or between the Outer Ring Road and the Inner Ring Road. To the north of the city there are 19 such junctions. In addition, the only junction in this scenario to be operating with a period of delay greater than 150 seconds is located in the north of the city.

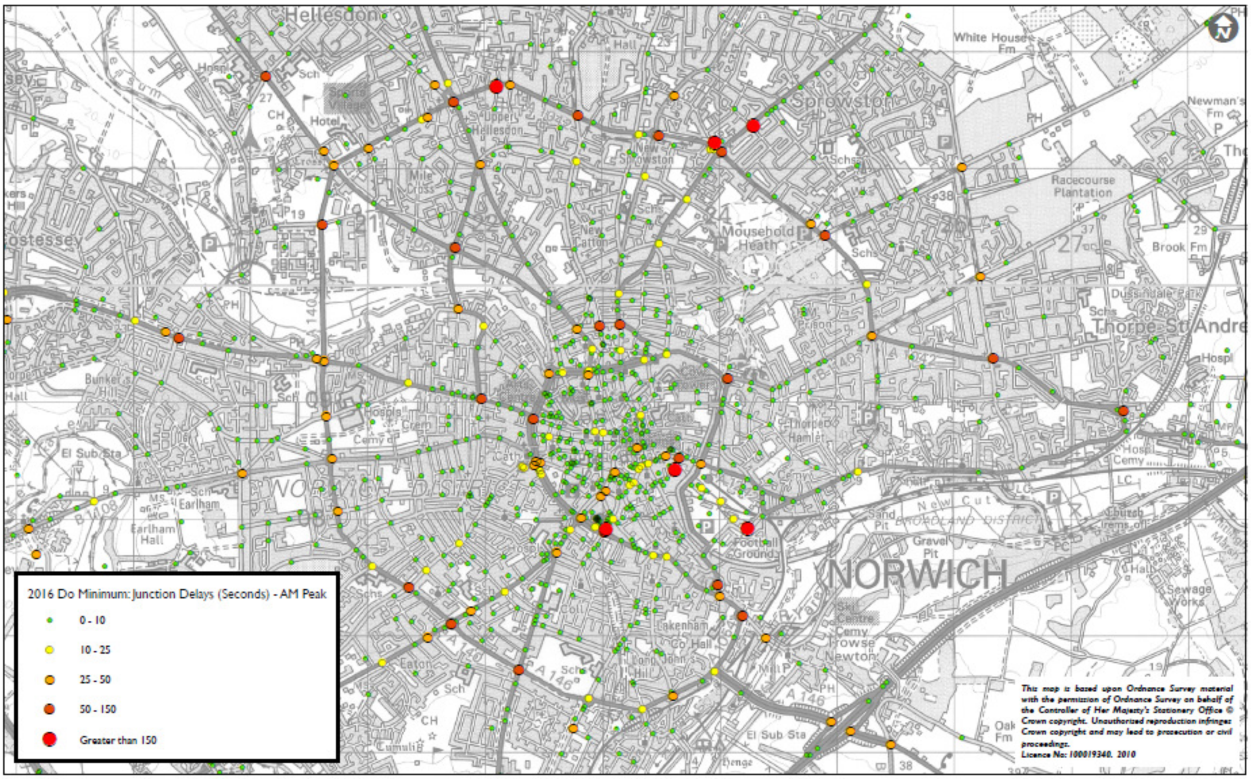
Figure 3.23: 2016 AM Peak Junction Delays



Source: NATS Model Output

Figure 3.23 shows that by 2016, the situation is likely to have worsened as is readily visible on the map through a clear reduction in the quantity of junctions indicated in green. It is probable that by this time all radial routes will have at least one junction beyond the Outer Ring Road subject to a level of delay in excess of 25 seconds. Radials providing access to the A47 such as Dereham Road may be subject to more junctions experiencing greater levels of delay, whilst to the north of the city there is evidence of progressive worsening of the operation of junctions linking the radial routes beyond the Outer Ring Road, for example at Rackheath and in Sprowston. This worsening of junctions formed by non-radial routes is not evident to the south of the city.

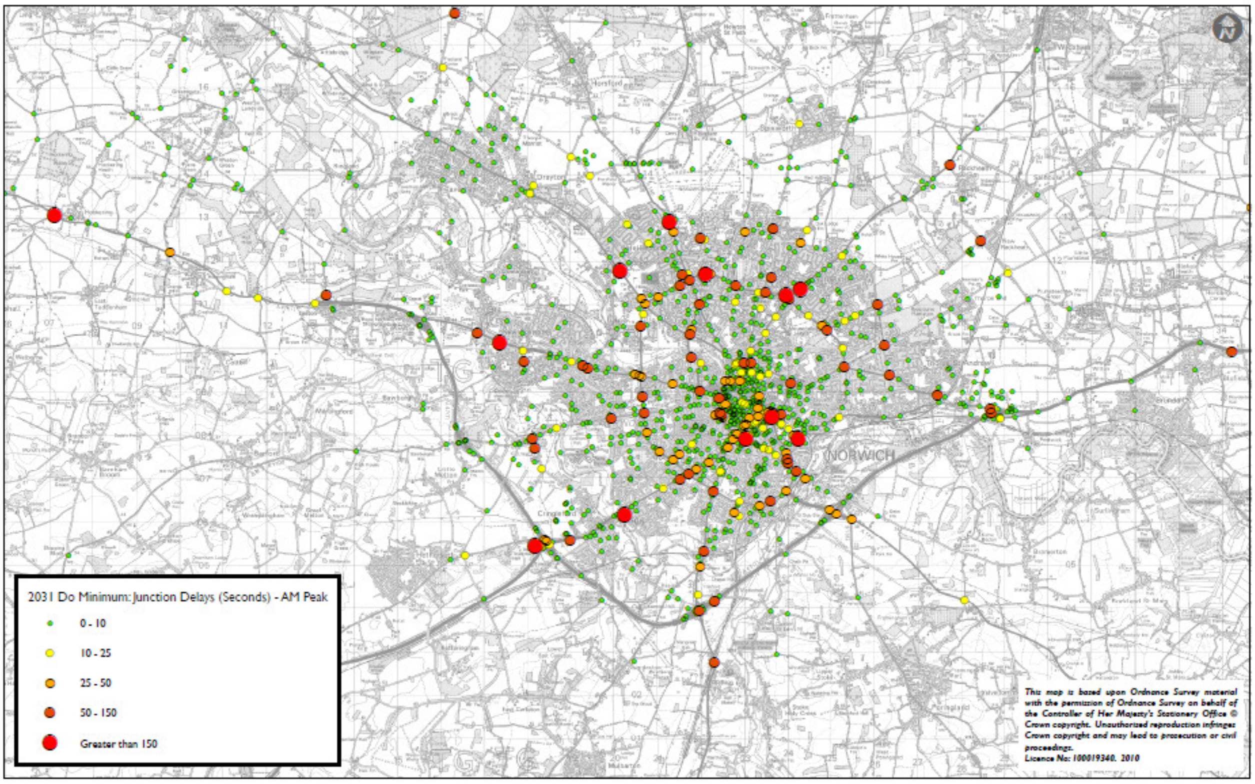
Figure 3.24: 2016 AM Peak Junction Delays – Inside Outer Ring Road



Source: NATS Model Output

In relation to the situation inside the Outer Ring Road, there is worsening evident between the 2006 situation and that of 2016. In particular there is likely to be an increase in the number of junctions on the Outer Ring Road operating with delay greater than 50 seconds. There is also evidence of the number of junctions with a period of delay greater than 150 seconds increasing, from 1 in the 2006 AM peak, to 3 in 2016.

Figure 3.25: 2031 AM Peak Junction Delays



Source: NATS Model Output

Figure 3.25 shows that by 2031 the situation in relation to junction delay is expected to be significantly worse than in 2016. Not only will five of the radials have at least one junction subject to delay in excess of 150 seconds, but many more junctions in the rural and residential areas may be subject to delay. This latter point is demonstrated by the prolific number of junctions identified by a green point on the plan, in particular on the roads between Drayton and Horsham St Faith, between Old Catton and the B1150 North Walsham Road, and between the A1151 at Rackheath and Thorpe End via New Rackheath.

This change in delay at junctions on residential and rural routes appears to be a phenomenon associated with the northern side of the city rather than the south, where the A47 Southern Bypass has junctions which will be subject to more delay, but where the residential and rural roads do not appear to be worsening.

Figure 3.26: 2031 AM Peak Junction Delays – Inside Outer Ring Road

Source: NATS Model Output

Inside the Outer Ring Road Figure 3.26 shows that the situation is likely to become considerably worse in the 2031 AM peak in three ways. Firstly, the overall number of junctions operating with in excess of 25 seconds delay is likely to increase further from 37 in 2016 to 44 in 2031. This may be the result of more junctions to the south of the city in particular operating with this level of delay. In addition, those junctions which are identified in 2016 as operating with over 25 seconds delay to the south and the north of the city are likely to worsen in 2031.

Finally, it is clear that the use of residential roads particularly in the north of the city, but also in the south, will create further delay at the adjoining junctions, particularly on Sprowston Road, Woodcock Road, Ipswich Road, Unthank Road and Dereham Road. This point is indicated by the reduction of junctions shown in green on the 2031 plan compared with that for 2006 and 2016.

Overall, the changes in junction delay across the network within the Outer Ring Road is detailed in Table 3.14.

Table 3.12: Junction Delay within the Outer Ring Road

Year	North of the City				South of the City				Total
	25-50s	50-150s	>150s	Total	25-50s	50-150s	>150s	Total	
2006	10	4	0	14	9	9	1	19	33
2016	7	7	1	15	10	10	2	22	37
2031	10	10	1	21	7	14	2	23	44

In addition to these details relating to the operation of junctions, information on existing and forecast journey times on the network has also been obtained from the NATS model. Three cross city centre radial routes have been identified; one running northwest to southeast, one running north – south, and the third running northeast to southwest as shown in Figure 3.27, Figure 3.28, and Figure 3.29. These routes have been chosen as they provide, when taken together, an indication of how the network as a whole may operate in the future. For the purpose of this exercise Plumstead Road has been included, which is classified as an Access Road under the Norfolk Route Hierarchy.

Figure 3.27: Cross City Route 1: Plumstead Road – Newmarket Road

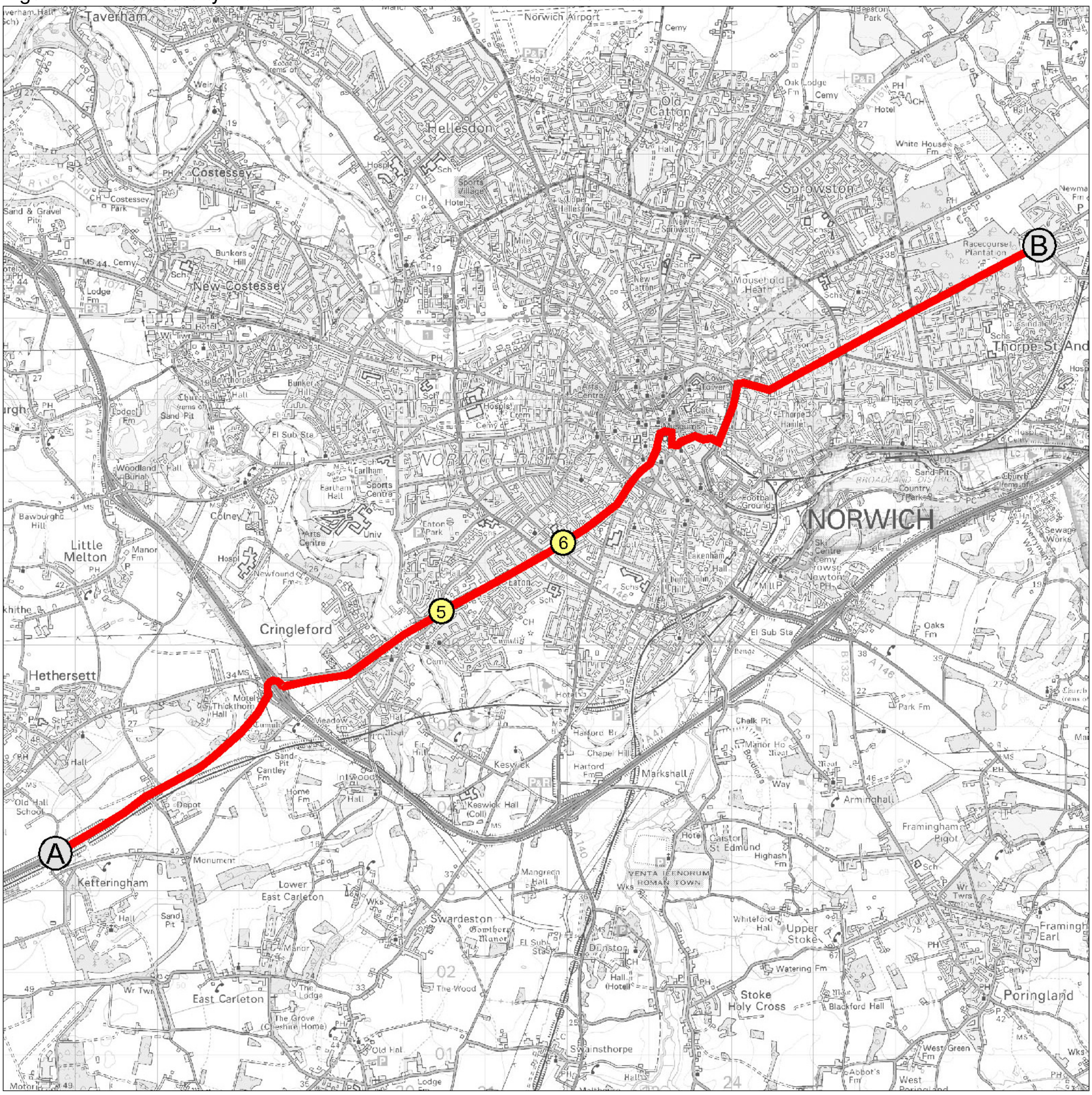


Figure 3.28: Cross City Route 2: North Walsham Road – Ipswich Road

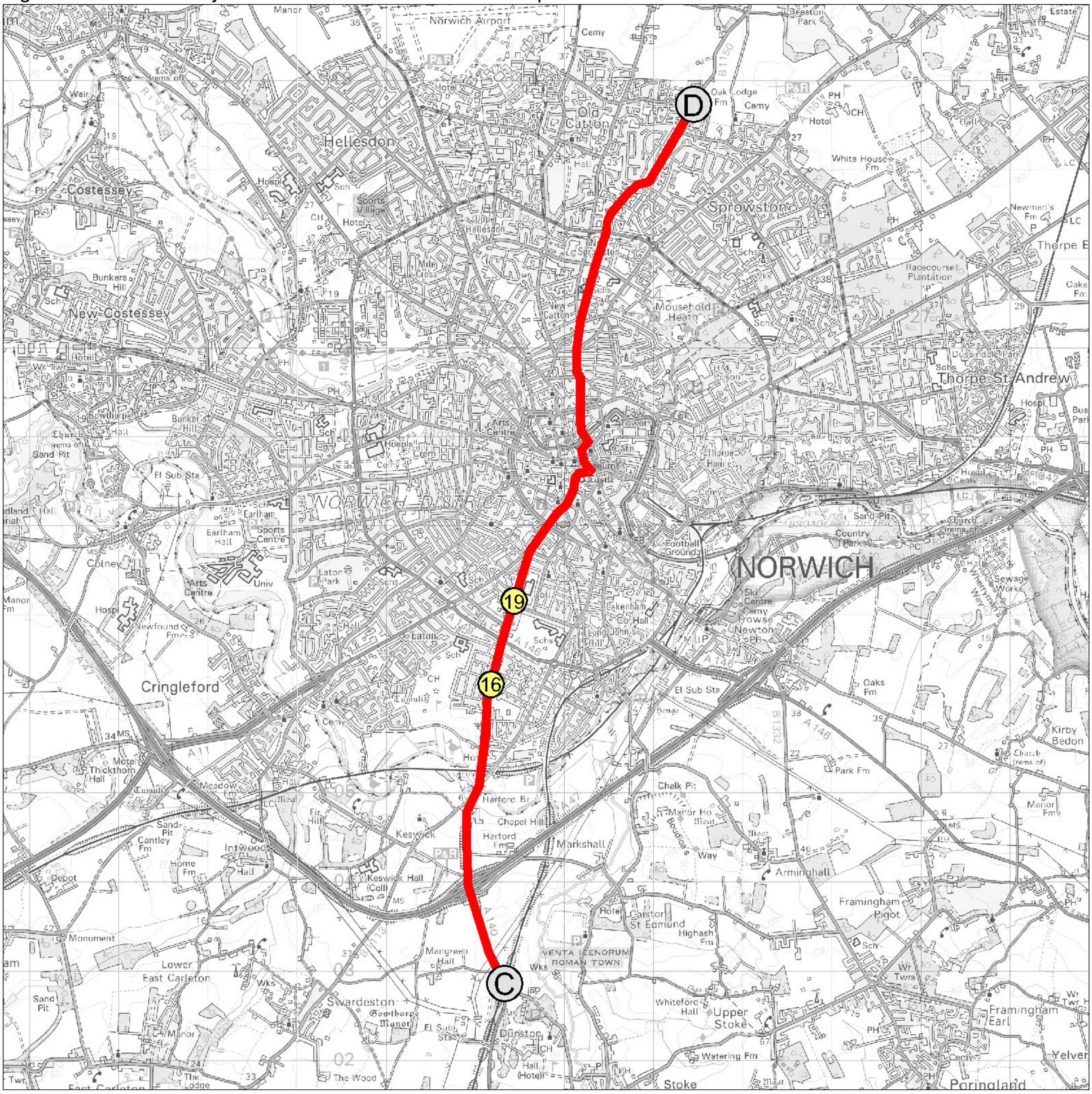
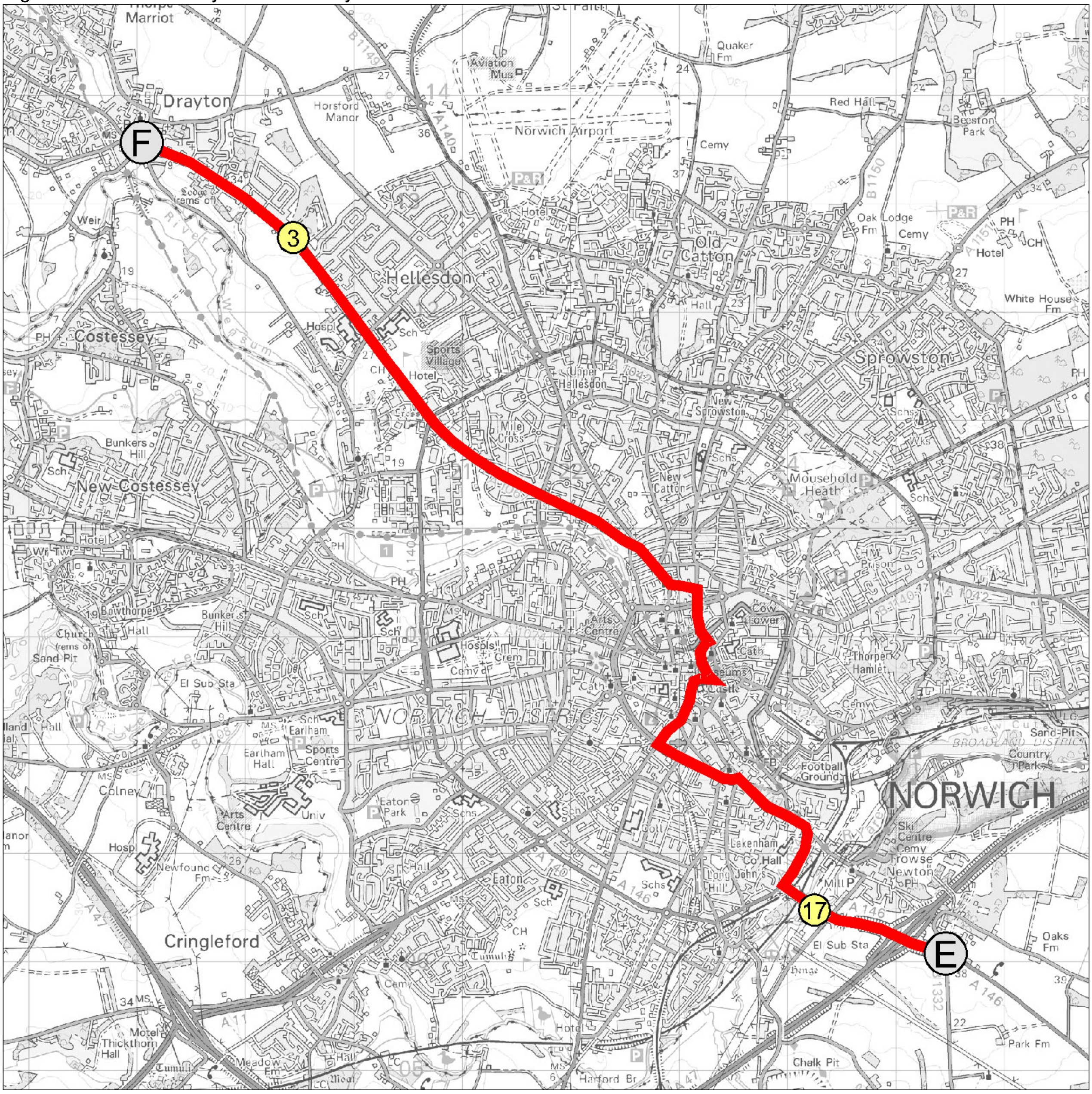


Figure 3.29: Cross City Route 3: Drayton Road – Loddon Road



Journey times for these routes have been taken from the NATS model in order to identify changes to journey times in the peak hours between the base year 2006, and forecast for the years 2016 and 2031. These are shown in Table 3.13.

Table 3.13: Peak Journey Time Information: Southbound Radial Routes

Route	Route Length	JT 2006 (mins)			JT 2031 (mins) and % Change against 2006					
		AM	IP	PM	AM	% Change	IP	% Change	PM	% Change
Plumstead Road – City Centre – Newmarket Road	14.3km	28	24	27	33	+17.9%	27	+12.5%	31	+14.8%
North Walsham Road – City Centre – Ipswich Road	11.4km	28	25	26	35	+25.0%	26	+4.0%	34	+30.8%
A1067 Drayton Road – City Centre – Loddon Road	12.6km	32	28	29	39	+21.9%	28	0.0%	35	+20.7%

Source: NATS Modelling Output Data

Table 3.13 shows that the journey times for all three routes are forecast to increase by up to 8 minutes between the 2006 base year and 2031.

Table 3.13 demonstrates that there is forecast to be significant increases in journey times on routes in the NPA in peak periods in future years. For some routes, a small improvement in journey times is forecast in the IP period, with up to a 6% reduction in journey times by 2016. However, peak periods are forecast to be subject to increased journey times, with up to a 31% increase in PM peak hour journey time on the route passing from North Walsham Road through the city centre and along Ipswich Road. The forecast decreases in journey time that are identified in the inter peak periods are likely to be due to relatively small changes in junction operation due to varying changes in flows on different entries, with consequent re-routing of traffic.

Information on changes in traffic flows at specific points on each of these routes has also been obtained. The locations selected are those designated by 5 and 6 in Figure 3.27, by 16 and 19 in Figure 3.28and by 3 and 17 in Figure 3.29.

Table 3.14: Changes in Traffic Flows at Points on Cross City Routes (PCUs)

Cross City Route	Ref	2006			2016			2031			% Change between 2006 & 2031		
		AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM
Plumstead Rd – Newmarket Rd	5	2421	1705	2330	2603	2193	2419	2714	2329	2517	6%	27%	13%
	6	932	702	811	1005	863	926	1019	903	1104	9%	29%	36%
North Walsham Rd – Ipswich Rd	16	1666	1263	1509	1498	1295	1562	1528	1417	1527	-8%	12%	1%
	19	719	469	525	703	572	737	721	604	798	0%	28%	52%
Drayton Rd – Loddon Rd	3	1072	965	1227	1090	1142	1410	1139	1221	1384	6%	27%	13%
	17	3405	2218	3397	3460	2558	3305	3307	2984	3627	-3%	35%	7%

Source: NATS Model Output

Table 3.14 shows that the changes in traffic flows that are forecast within the NPA between 2006 and 2031 are very variable. The majority of locations are likely to be subject to a change of +/- 10% in traffic flows, which is the degree of variability that any particular road may be subject to on a day to day basis. The fact that the traffic on these roads is not likely to change to a more significant degree, suggests that these roads are already operating close to or at capacity in the peak periods.

There are higher degrees of change at these locations in the inter peak period, which range from 12% on the North Walsham Road to Ipswich Road route, to 29% on the Plumstead Road to Newmarket Road route. Overall, Table 3.14 suggests that there is likely to be a large increase in traffic flows over the network as a whole, exemplified by the large degrees of change identified on several of the routes.

In addition to changes in traffic flow, data relating to changes in average vehicle speed has also been obtained for these references from the NATS model as detailed in

Table 3.15: Changes in Average Speed (kph) on Cross City Routes

		Plumstead Rd – Newmarket Rd		North Walsham Rd – Ipswich Rd		Drayton Rd – Loddon Rd	
Year	**Time Period**	5	6	16	19	3	17
2006	AM	55	40	55	39	44	52
	IP	55	40	55	39	51	52
	PM	55	40	55	38	50	45
2016	AM	55	38	52	37	44	50
	IP	55	38	55	35	49	52
	PM	55	37	53	33	45	30
2031	AM	55	38	52	38	42	52
	IP	55	38	53	35	48	50
	PM	55	37	53	33	45	25
% Reduction in speed between 2006 & 2031	AM	0%	5%	5%	3%	5%	0%
	IP	0%	5%	5%	10%	6%	4%
	PM	0%	8%	5%	13%	10%	44%

Source: NATS Model Output

Table 3.15 further demonstrates that the large quantity of traffic which is forecast in 2031 is likely to cause significant changes in average speed on the network. Although some of the locations selected on the cross city routes are likely to result in moderate reductions in speed, in the order of 5%, there are several locations and time periods when the degree of change may be in excess of 10% between 2006 and 2031. This suggests that the background growth in traffic in the interim years will cause significant and measurable delay to vehicles on roads across the network.

Overall, the NATS model results indicate that in future years the network is forecast to be subject to a significant increase in traffic, with subsequent large increases in the level of congestion experienced throughout the NPA. Increased delays are forecast to have a significant detrimental impact on the operation of the highway network in the NPA, as exemplified by the increases in journey times forecast in peak periods and the increasing number of links and junctions that are forecast to operate with high V/Cs in the future.

3.7 Benchmarking

The NATS models have been created for geographically exclusive areas and are time constrained, and as such are unique to particular situations. For this reason no benchmarking data is available against which the situation within the NPA can be compared.

3.8 Other Roads

3.8.1 Current Picture

Minor roads subject to rat running, i.e. vehicular use of inappropriate roads in order to avoid junctions on more appropriate roads which have congested operation, discussed in this section have been identified using local knowledge collected via local Parish Councils and NCC records. This information is supported wherever possible by historical traffic surveys that have been conducted in these areas. Where traffic surveys have been conducted on these roads in the past 5 years, weekday traffic flows are indicated in the same table.

Table 3.16: Existing Traffic Flows on the Identified Minor Roads

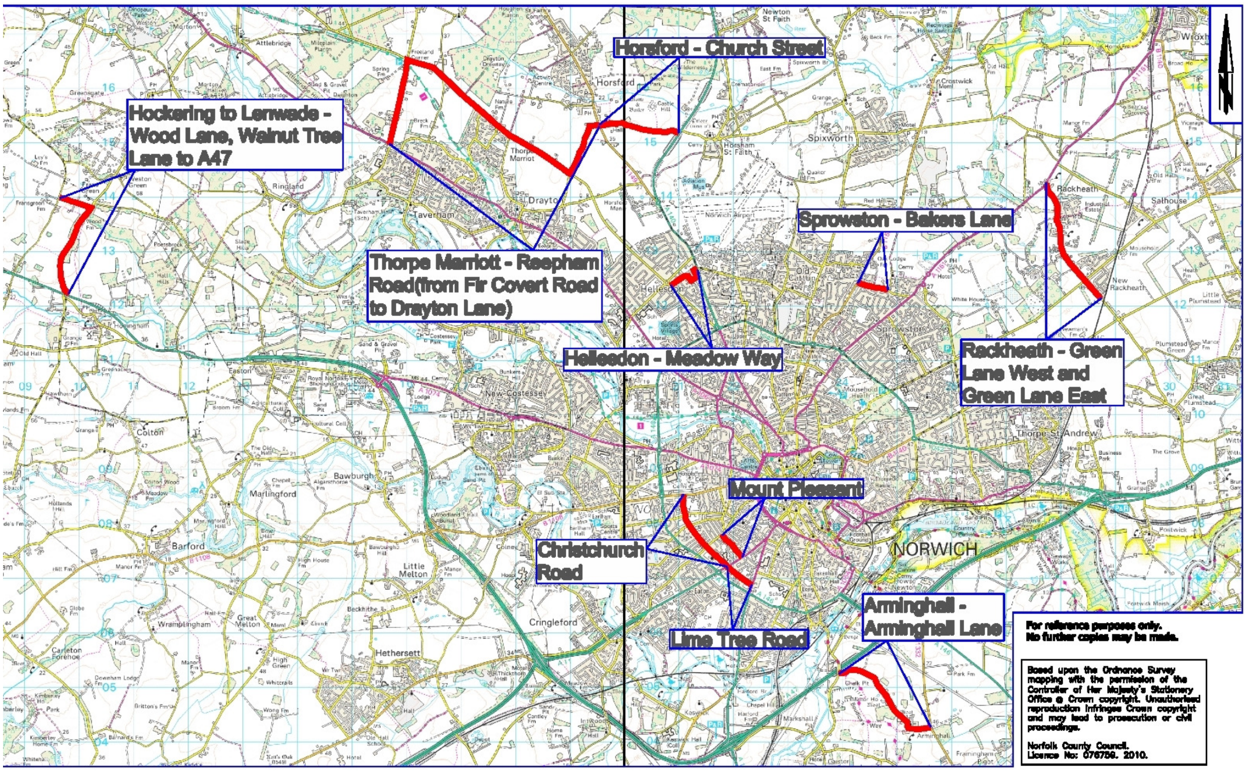
Roads	Existing 12hr Two Way Traffic Flows (based on existing survey data)	Traffic Survey date	AM Peak Hour two- ways flow	PM Peak Hour two- ways flow	Peak Traffic Flows as % of Daily Traffic Flows
Horsford – Church Street	5,149	2005	614	622	24%
Hellesdon – Meadow Way	1,422	2006	178	176	25%
Hockering to Lenwade – Wood Lane, Walnut Tree Lane to A47	2,705	2006	306	346	24%
Sprowston – Barkers Lane	8,244	2006	1,042	1,428	30%
Rackheath – Green Lane West and Green Lane East	4,051	2008	508	510	25%
Lime Tree Road	2,025	2006	308	339	32%
Christchurch Road	2,335	2008	396	282	29%
Mount Pleasant	1,405	2007	278	151	31%
Thorpe Marriott – Reepham Road (from Fir Covert Road to Drayton Road)	7,145	2008	825	856	24%
Arminghall – Arminghall Lane	638	2004	118	72	30%

Table 3.16 summarises two-way traffic count survey data that has been conducted on the minor roads over a 12 hour period from 7am to 7pm. The AM and PM peak hour traffic on any given road typically equates to around 18% or 19% of the 12 hour traffic flows.[12] That these roads are operating over the typical proportional levels suggests that these may be being used by inappropriate levels of peak hour traffic. Figure 3.30 shows that the minor roads that are affected by the high proportions of peak hour traffic are located in the south and the north of the city, with the majority of the sample roads located to the north.

[12] Traffic Distribution by time of day on all roads, Great Britain: 2008 (DfT, 2008)

Mott MacD

Figure 3.30: Minor Roads with High Peak Hour Traffic Proportions



Between 2004 and 2009 there have been 210 small highways schemes carried out within the NPA. The reasons and justification for these schemes have been collected in order to identify any strong themes or supporting evidence that may arise as a result, and these are contained in Table 3.17.

Table 3.17: Small Schemes Delivered in the NPA 2004 - 2009

Justification	2004	2005	2006	2007	2008	2009	Total	% of Total
Improving Road or Personal Safety	7	4	7	8	13	18	**57**	**27.1%**
Reducing Congestion	2	2	1	3	2	1	**11**	**5.2%**
Improving Accessibility	7	5		5	5	8	**30**	**14.3%**
Improving Ecology or the Environment	2	1		1	1	1	**6**	**2.9%**
Improvements Relating to the DDA	2		1	5	8	1	**17**	**8.1%**
Infrastructure Improvements	6	6		18	9	3	**42**	**20.0%**
To Cater for New School Development			1	1			**2**	**1.0%**
Pedestrian Crossings	3	3		1		6	**13**	**6.2%**
Tourism or Business Support		2	1				**3**	**1.4%**
Resulting from Travel Planning		6	4			5	**15**	**7.1%**
Resulting from a Request from the Public			1	1	2		**4**	**1.9%**
To Increase Mode Shift			2	6	2		**10**	**4.8%**
Total	**29**	**29**	**18**	**49**	**42**	**43**	**210**	**100%**

Source: Norfolk County Council

Table 3.17 shows that the majority of schemes implemented in the NPA between 2004 and 2009 have improving road or personal safety (27.1%) as their justification, with infrastructure improvements being the second most common reason for works (20.0%). These findings are of interest as they also demonstrate that mode shift is the justification for 11.9% of the works, with 25 schemes based around either this or Travel Planning, which has itself mode shift as its main focus. It also demonstrates that issues raised by members of the public are acted upon, with 4 schemes being implemented as a direct result of this course of action.

The table also shows that the reduction of congestion is a concern with 11 (5.2%) schemes specifically targeting this issue, and with a further 30 (14.3%) aiming at improving accessibility. This in itself may also be an indication of issues on the network if interventions are required to mitigate for example, high traffic flows which may act as a barrier to pedestrian and cycle movements.

However, the table does have limitations in that by virtue of attempting to designate a single justification for a scheme, there is scope to miss the fact that most schemes will have overlapping secondary considerations, for example in reducing congestion through improving the operation of a signalised junction, a scheme may also improve local infrastructure, increase mode shift through improvements to the pedestrian phases on the crossing and improve local air quality by creating better flowing traffic. The table should therefore be viewed with this limitation in mind.

In order to comply with PPG13, additional road space may be required in order that further infrastructure for sustainable transport may be delivered. However, the delivery of such schemes has a potential impact on existing infrastructure and streetscape:

- In providing new signal controlled pedestrian crossing facilities the signal cycle time on existing junctions will increase for vehicle users. For example, an additional 25 seconds onto the cycle time at the signals of Aylsham Road and Woodcock Road junction could equate to a decrease in throughput at the junction of approximately 250 vehicles per hour per lane. This would likely cause an increase in queuing associated with the junction.
- The conversion of existing carriageway space to bus lane can impact on the number of on-street car parking spaces available. For example, the provision of a bus lane on Aylsham Road between the Outer Ring Road and Glenmore Gardens would result in the loss of 55 on-street car parking spaces. This could potentially lead to displaced parking occurring on any nearby roads that are not subject to a Controlled Parking Zone.
- The provision of bus lanes also can potentially result in a loss of carriageway space and a consequent reduction in capacity at junctions through a reduction in saturation flow. For example, the loss on an inbound lane on the A146 equates a reduction of 1800 vehicles per hour per 3m wide lane.
- Any increase in road carriageway width to accommodate improvements would increase pedestrian crossing distances, potentially requiring the construction of a central refuge, requiring a further 2m width of road space for its implementation.
- One major area of ongoing work is the use of Intelligent Transport Systems (ITS) to reduce the effect of congestion and to help manage and control flows. Intelligent Transport systems are being used to help provide real time information to the public about network conditions.

3.8.2 Future Situation

In 2031, it is forecast that there will be an increase in traffic on these minor roads. The roads to the north will be more heavily trafficked, resulting in more junctions on these roads operating closer to capacity as indicated by higher V/Cs. This may decrease journey times for vehicles travelling on these roads, but is also likely to impact on residents and existing users of these roads.

3.8.3 Benchmarking

To analyse the trend of traffic flows in Norfolk, data have been collected and tabulated for Norfolk, Lincolnshire, Cumbria, Derbyshire and East of England.

Table 3.18: All Road (Minus Trunk Roads) Traffic Flows from 2002 to 2008 (million vehicle kilometres)

	2002	2003	2004	2005	2006	2007	2008
East of England	35,528	35,748	36,796	37,000	37,645	38,453	38,064
Norfolk	6,349	6,420	6,485	6,566	6,649	6,685	6,711
Cumbria	2,508	2,715	2,758	2,887	2,971	3,032	3,028
Lincolnshire	3,806	4,827	5,015	5,042	5,143	5,263	5,189
Derbyshire	3,886	4,549	4,615	4,802	4,779	4,838	4,742

Source: Department for Transport

These traffic flows can be compared per kilometre of minor road, i.e. B, C or U class roads in each county, through the calculation of a ratio of annual traffic flows per million vehicle kilometres divided by the number of kilometres of minor road present in each respective county. These results are detailed in Table 3.19.

Table 3.19: Traffic Flow Ratios

Area	Length of Minor Roads	Traffic Flows per Km (2002)	Traffic Flows per km (2008)	% Change
East of England	24,647.4km	1.44	1.54	6.9%
Norfolk	7,977.0km	0.79	0.84	6.3%
Lincolnshire	6,745.3km	0.56	0.77	37.5%
Cumbria	6,198.7km	0.40	0.49	22.5%
Derbyshire	3,352.6km	1.16	1.41	21.5%

Source: Road Lengths in Great Britain by local authority and road class: 2005 – 2008 (DfT, 2009)

Table 3.19 shows that Norfolk has a comparable ratio of traffic flows on its roads to those in the other counties, although it is somewhat less than that recorded in the East of England as a whole. However, since 2002, Norfolk has been subject to the lowest level of increase in traffic of all the areas. Lincolnshire has experienced a significant increase in traffic of 37.5% from 3,806 in 2002 to 5,189 in 2008, whereas Norfolk has been subject to only a 6.3% increase. This may differ from that in the comparator counties, but it does correlate with that recorded for the East of England.

3.9 Policy

PPG13 Transport at paragraph six states that "*In order to deliver the objectives of this guidance, when preparing development plans and considering planning applications, local authorities should:…*

- *give priority to people over ease of traffic movement and plan to provide more road space to pedestrians, cyclists and public transport in town centres, local neighbourhoods and other areas with a mix of land uses;…*
- *protect sites and routes which could be critical in developing infrastructure to widen transport choices for both passenger and freight movements".*

Paragraph 64 of PPG13 states that "Traffic management should be undertaken in a way which complements planning and transport objectives…

Well designed traffic management measures can contribute to planning objectives in a number of ways, including:

- *reducing community severance, noise, local air pollution and traffic accidents;*
- *promoting safe walking, cycling and public transport across the whole journey;…*
- *helping to avoid or manage congestion pressures which might arise in central areas from location policies…*

In taking decisions on the management of traffic authorities should ensure that they address the needs of all users. Within town centres and other areas with a mixture of land uses, priority should be given to people over traffic. Well designed pedestrianisation and pedestrian priority schemes generally prove popular and commercially successful, and local authorities should actively consider traffic calming and the reallocation of road space to promote safe walking and cycling and to give priority to public transport".

Targets on the proportion of roads where maintenance should be considered are included in the LTP with a target for 2010/11 being 3% of the principal road network and 32% of the unclassified road network. The results in 2008/09 identified a deterioration to 3.3% of the A road network and to 10% of B and C roads. The target of 32% for U class roads was achieved in 2008/09.

The LTP target of 3% of principal roads in 2010/11 is unlikely to be achieved without significant targeted investment. NI169 includes B and C roads as sub-divisions. The 2008/09 target of 8% was missed with a result of 10%. The LTP target of 10% may not be achieved.

3.10 Conclusions

Problems associated with traffic on Principal and Main Distributor roads:

- The NPA has a low standard of highways routes with few sections of modern dual carriageway.
- Norwich has a dense network of urban roads with frequent signalised junctions and pedestrian crossings. Most of these signalised junctions have been introduced within the historic street pattern to preserve the character of the city, which has been to the expense of traffic capacity.
- The County Council has been concerned about congestion in Norwich for many years and since 1989 has used SCOOT to provide the optimal network conditions.
- Real time systems to improve the performance of public transport have been used by the County Council since the late 1990s.
- Real time 'Intelligent Transport Systems' are being used to provide better information to promote modal choice within the Greater Norwich area.
- Although traffic flows have declined crossing the Inner and Outer Ring Roads, congested operation continues to take place.
- Evidence of little change in circulatory flows on sections of both Ring Roads suggests congested operation of these roads throughout the peak period. This may be indirect evidence of the spreading of the peak periods as commuters change their travel habits to try to avoid the traffic.
- The presence of congested operation on the highway network has also been evidence through looking at the 2004 AM peak delay. The greatest delay on the network is evident on the north and northeast sections of the Outer Ring Road and orbital routes running parallel beyond the Outer Ring Road. This information also illustrates the free-flowing nature of the A47 Southern Bypass. In addition, all of the northern radial routes were subject to the greatest level of delay, even to the north of the Outer Ring.
- In the future, the anticipated residential and commercial growth in the NPA will result in the average speed across the whole network being reduced as a result of a greater weight of traffic and a consequent increase in overall delay;
- This growth will also create a 50% increase in PCU kilometres on the network;

- There is an increase forecast the average trip length from 17km in 2006 to 18km in the 2016 AM peak and 19km in the 2031 AM peak and 20km in the 2031 PM peak. This latter increase is equivalent to a 14% increase in average trip length over the period;
- Anticipated growth in the NPA will increase the overall number of trips on the network by 34% from 64,480 trips in the AM peak in 2006 to 86,346 in 2031;
- This increase in trips, as well as the reassignment of traffic from congested junctions to those operating within capacity, will result in a change in the numbers of junctions operating with a V/C over 90% in the future. This has been shown as likely to increase from 9 in the 2006 AM peak, to 16 in 2016 and 28 in 2031;
- The combination of higher traffic levels and the consequent increase in congested working will lead to increased delay for vehicles on the network, borne out by an increase in journey time on southbound radial routes. The A1067 Drayton Road to the A146 via the city centre takes some 32 minutes in the 2006 AM peak but is set to increase to 39 minutes in the 2031 AM peak, equating to an increase of 20%.

The problems with the road traffic on 'Other Roads' are:

- Some roads have a higher than typical peak hour traffic as a proportion of the 12 hour total, suggesting their use as rat runs in peak periods;
- There is some evidence of rat running on roads to the north of the city, in particular on Barkers Lane in Sprowston which has had two-way traffic flows of 1,428 vehicles recorded in the PM peak and with total peak hour traffic equating to 30% of its 12 hour total, as well as at several locations in the west of the city;
- Investigation of small capital works implemented in the area has identified road or personal safety, improving infrastructure and improving accessibility as the principal reasons for these schemes.