3. Highway Network

3.1 Introduction

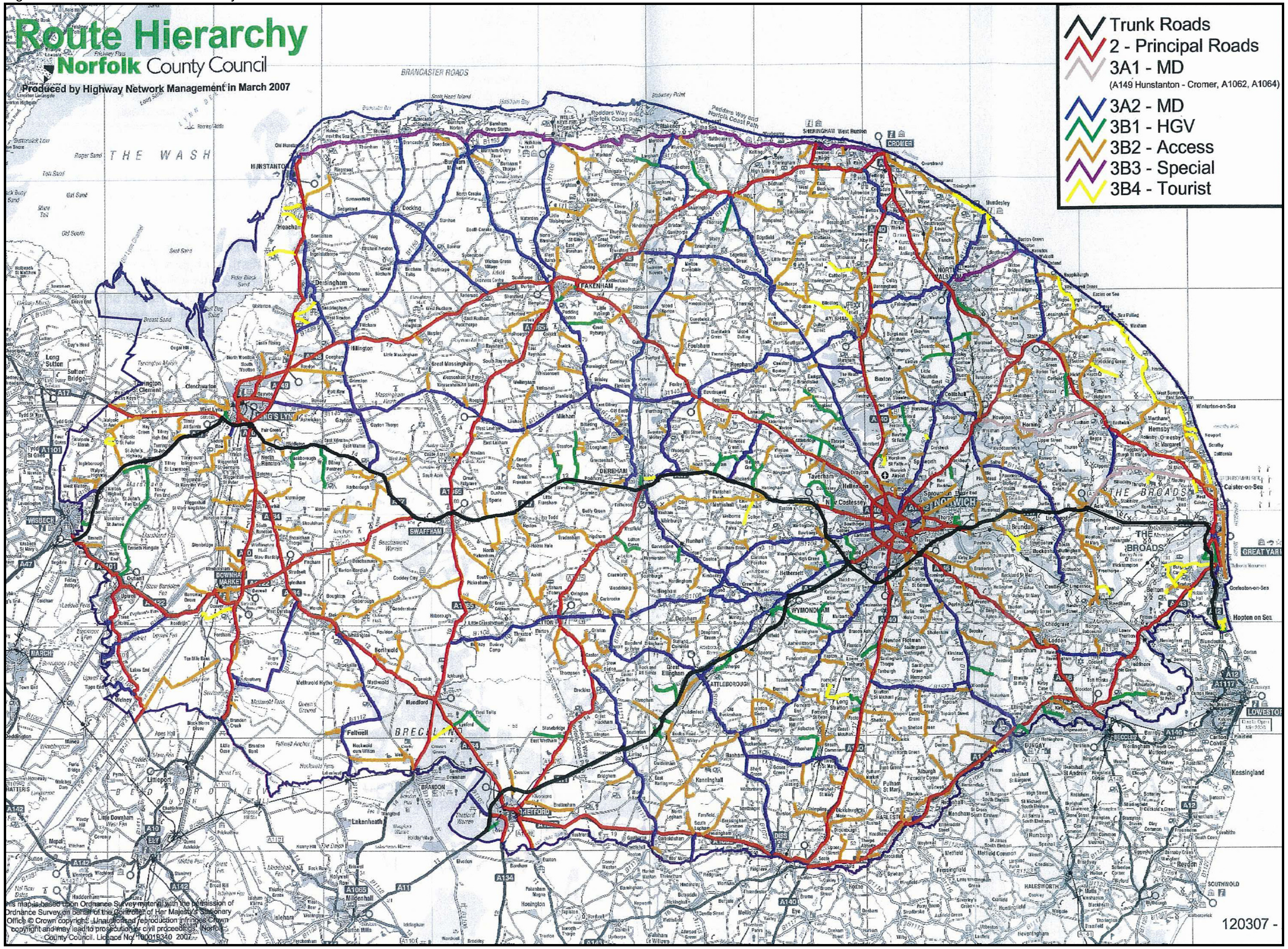
A route Hierarchy for the whole of Norfolk has been created to encourage drivers to use the most appropriate route according to their destination and the type of vehicle being used. This has been developed to enable targeting of resources, for example in highways maintenance. The hierarchy consists of:

- Trunk Routes;
- Principal Routes – used to carry the majority of through traffic;
- Main Distributor Routes– used for the distribution of more local traffic, particularly between Principal Routes;
- HGV routes – used to distribute traffic to specific areas associated with freight delivery (generally industrial estates);
- Local Access Routes – linking the more significant communities with Trunk and Principal Routes, Main Distributor Routes and HGV routes;
- Special routes; and
- Tourist routes – links the recognised tourist attractions with all other types of routes.

Norwich has two major trunk roads that lead directly to and from the city. These are the A11 that connects Norwich to Thetford, Cambridge and London and the A47 which bypasses Norwich to the south and links Great Yarmouth to the east with Kings Lynn and Peterborough to the west.

There are 7 principal roads that lead directly into the city centre, the A1151 and A140 from the North, connecting Cromer to the city, the A1042 connecting the city to the A47 and the East, and the A146 and A140 to the South connecting Norwich to Ipswich and Beccles. The A1074 links into the A47 in the west and the A1067 to the northwest. Figure 3.1 shows the route hierarchy in Norfolk.

Figure 3.1: Norfolk Route Hierarchy



Source: Norfolk County Council

Table 3.1 shows the road length for the NPA, categorised by National road class and by class as contained in the Norfolk Route Hierarchy

Table 3.1: Road Length by Norfolk Route Hierarchy Road Class

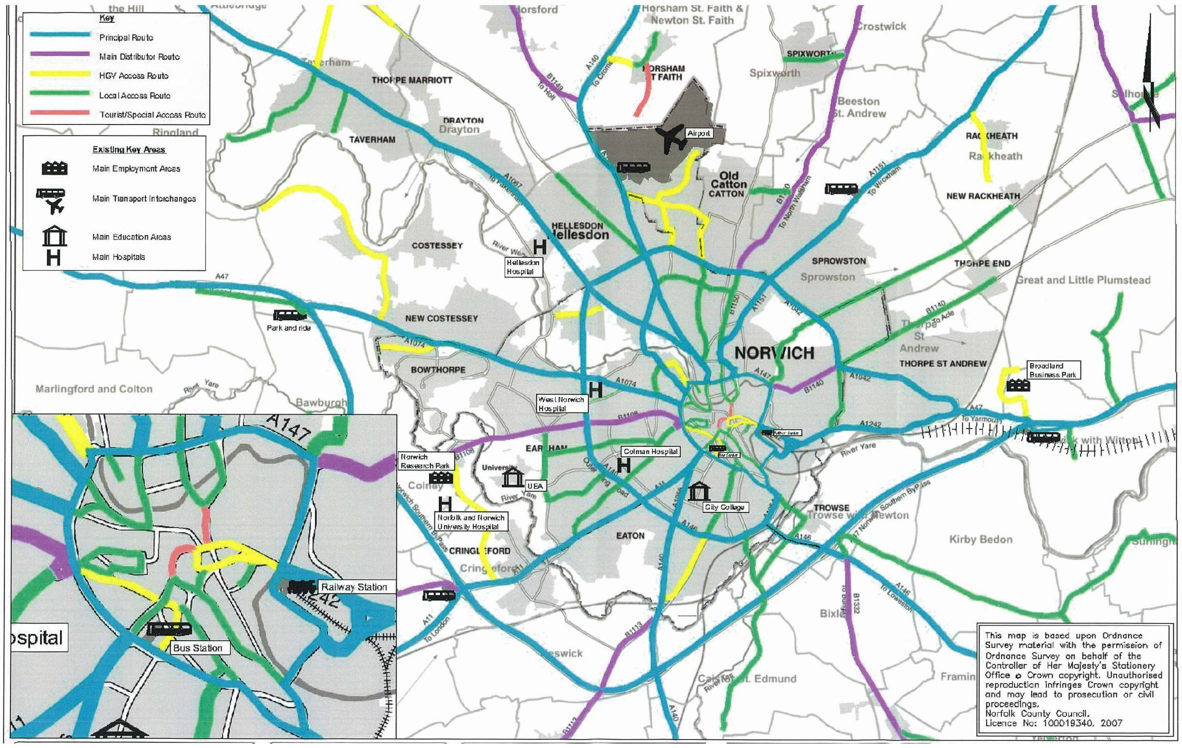
National Road Class	NCC Route Hierarchy Classification	Length (km)
A	Trunk Road	67.2km
A	Principal Road	108.5km
B	Main Distributor	65.4km
C	HGV	31.3km
C	Access	73.4km
C	Tourist	6.1km
C	Urban	1122.6km
U	Others	26.1km
	Total	1645.8km

Source: Norfolk County Council

The measurements in Table 3.1 reflect the fact that Norwich and its environs have a large number of residential streets as well as semi-rural roads which fall within the NPA.

It is understood that historically Norwich City Council has not developed any form of route hierarchy and that the council therefore requested that NCC develop a hierarchy in the short term. The Short Term Route Hierarchy shown in Figure 3.2 is based on the existing situation and addresses the level of traffic currently using the key radial routes into the city centre, as well as the principal radial routes around it. This has developed into a hierarchy of 12 Principal Routes including the A47, the A140, the A11 and both the Inner and Outer Ring Roads.

Figure 3.2: Short Term Route Hierarchy



Source: Norfolk County Council

Below this, there are seven Main Distributor Roads which tend to be either secondary radial routes such as the B1150 North Walsham Road, or roads which spur off the Principal Routes. Beyond this there are numerous HGV Access Roads and Local Access Roads which provide a designated route to those areas of principal interest to freight hauliers including the Airport and its associated industrial and commercial units, Broadland Business Park, the Hospital and Norwich Research Park.

3.2 Network Description

The following network description is broken down into 'Trunk Roads' and 'County and City Roads' where each is discussed in terms of link standards, junction standards and traffic control measures. The County Road section also includes details relating to frontage land use, property access and on-street parking. Comments are limited to the network within the NPA.

3.2.1 Trunk Roads: the A11 and A47

3.2.1.1 Link Standards

Within the NPA the A11 and A47 are mainly high standard dual carriageway, however beyond the NPA the A47 is generally single carriageway for much of its length. A particular single carriageway section of the A47, to the west of Norwich between Easton and North Tuddenham, is congested in the AM peak period towards Norwich and in the PM peak away from Norwich. The Highways Agency recently introduced a safety scheme within this section at the A47 junction with Mattishall Road, replacing a simple priority junction with an at-grade roundabout junction. This junction is causing high levels of congestion in the AM peak as traffic on the mainline which was previously able to make ahead movements through the junction unimpeded, are now required to give way to traffic making a right turn from Mattishall Lane. This new congested location is resulting in traffic rat running through adjacent minor roads. The Highways Agency is now considering the introduction of part time signals to try to reduce congestion in the AM peak at the junction.

3.2.1.2 Junction Standards

On the dual carriage way sections of Trunk Road the junctions are generally grade separated or of reasonably good standard, having adequate visibility for traffic turning from the minor arms onto the mainline, and having acceptable levels of capacity for current levels of traffic.

The single carriageway roads are characterised by many small junctions and minor turnings. Junction standards are generally poor and of a lower standard than the dual carriageway sections, which affects traffic flows and general highway safety

3.2.1.3 Traffic Control Measures

On the Trunk Road network most junctions are roundabouts or priority junctions. At the junction of the A47 with the A11, traffic signals control the roundabout. These signals were introduced in 2005 as part of a junction improvement scheme which increased the number of lanes on the approach to and on the circulatory carriageway of the junction. The traffic signals are to the Highways Agency's latest standard and use the Micro processor Optimised Vehicle Actuation system (MOVA).

3.2.2 County and City Roads

3.2.2.1 Link standards

Norwich has 12 radial routes which provide access in all directions from the city. Unusually for a major city, the principal radial routes are of poor quality. There are very few lengths of dual carriageway on the radial routes, some sections are single carriageways with three lanes, but most have two lane sections. Table 3.2 details the dual carriageway by National road class that is present in the NPA.

Table 3.2: Dual Carriageway Lengths in the NPA by National Road Class

Road Class	Total Length	Dual Carriageway Length	% of Total
A Roads	108.4km	15.4km	14.2%
B Roads	60.6km	0.2km	0.3%
C Roads	354.4km	1.1km	0.3%
U Roads	849.4km	0.0km	0.0%
Total	1372.8km	16.7km	1.2%

Source: Norfolk County Council

There are a number of principal radial routes that include bus only lanes, which are also shared with taxis and cyclists. On approaches to the city via the A11 radial, the bus lanes are also used by freight operators as part of the freight consolidation delivery service.

The Inner and Outer Ring Roads around Norwich are of a similar standard to the radial routes detailed above. The Inner Ring Road is limited to 30mph for its entire length, with the Outer Ring Road limited to a mix of 30mph and 40mph sections. All sections of the Inner Ring Road are within built-up areas of the city, with the Outer Ring Road passing through a mix of housing, employment and retail areas.

Routes across the city centre within the Inner Ring Road are all single carriageway with a mix of one-way sections that are two or three lanes in width. There is also a bus only area at Castle Meadow and bus lanes are present, as discussed in section 5.

3.2.2.2 Junction standards

The County and City roads associated with the main road network reflect the medieval street pattern that forms a large part of the network in the centre of Norwich, with the majority of junctions being significantly constrained by ancient buildings thereby removing any opportunity for capacity at many junctions to be increased through enlarging the junction geometry or adding additional lanes on congested roads. Consequently, few junctions are of modern standards with the majority formed in a piecemeal approach over many decades. Within Norwich, the constraint on land in the vicinity of junctions has led to many being signal controlled, with their layouts adapted as far as possible to cope with traffic volumes and vehicle sizes. However, many of the junctions have been upgraded to include pedestrian and cycle crossing facilities in order to provide coherent pedestrian and cyclist routes wherever possible. The difficulties of providing such a network however are further discussed in section 6.1.

3.2.2.3 Traffic Control Measures

Traffic signal junctions and traffic signal crossings are commonly used on radial routes. Traffic signal systems are used because they control traffic as well as providing opportunity for pedestrians, cyclists and vulnerable road users to cross roads with high volumes of traffic in a manner that is safe and convenient. They provide a method of control where space is at a premium, which is the case at most of the junctions on the radial routes and Ring Roads, but these layouts are limited in providing sufficient capacity due to the levels of delay that are inherent in a signalised junction.

3.2.2.4 Frontage Land use, Property Access and On Street Parking

The land uses adjacent to roads are important as they influence the types of road user behaviour on roads. Where there are groups of local shops it is usual to find loading and delivery activity and there is often demand for short term parking with insufficient provision and vehicle conflicts. High levels of activity by vulnerable users including pedestrians, cyclists and public transport users also tend to be common at these locations. In contrast, sections of road with industrial frontages tend to have less intense pedestrian activity and longer term parking need, but access for larger servicing vehicles may be a problem.

Main traffic routes which have residential properties without vehicle parking often have problems related to on street parking. A number of the major radial routes in Norwich suffer from this, particularly inside the Outer Ring Road. The A140 Holt Road, Aylsham Road, Sprowston Road and Dereham Road are examples in Norwich.

The type of access properties have on to a traffic route also influences behaviour and capacity as a result of traffic entering and exiting the flow of traffic on the main carriageway, notwithstanding the conflicts created between vehicles, cyclists and pedestrians. In addition, on street parking also influences traffic flow as it restricts the carriageway capacity, slowing traffic speeds and limiting the quantity of traffic that can pass down a road at any given time.

As outlined above, the radials and Ring Roads tend to pass through housing, commercial and retail areas and have a number of accesses to a wide range and number of properties. This can generate transient delays on the network due to the need for refuse collections and parking, and either by vehicles associated with off-street parking entering or leaving the highway, or associated with on-street parking which reduces the lane widths available to traffic, thereby reducing general traffic speeds.

3.3 Network Management Measures

3.3.1 Intelligent Transport Systems (ITS)

For many years Norfolk has employed technology to assist with traffic problems within the NPA. The Norfolk ITS centre has a number of systems which help support the development of the LTP, the organisational Service Plan and operational objectives to reduce congestion.

The ITS control room is manned from 7.30am to 6.30pm Monday to Friday with a dedicated operator during the periods 7:30am to 9:30am and 4:30pm to 6.30pm. The control room staff monitor all of the available systems and where possible take actions to rectify problems within their control. The staff also activate on site response from emergency crews and other agencies to assist with problems on the network. The following systems are deployed in Norfolk:

- Urban Traffic Control System- UTC/SCOOT in Norwich Kings Lynn and Great Yarmouth to control and monitor urban traffic signal installations
- Isolated traffic signal installations are used in Market Towns and rural areas

The County Council has also invested in remote monitoring systems that are used countywide for example, CCTV is used in Norwich, Kings Lynn and Great Yarmouth. Norfolk's ITS also shares pictures with the Norwich City Centre Public CCTV system for further details from across their network.

Signals not connected to the UTC/SCOOT system are connected to the Remote Monitoring System. This system allows faults at individual signal installations to be monitored and temporary corrective action to be taken, pending the attendance of a service engineer. Automatic fault reporting has been installed which allows faults to be passed through to the signal maintenance engineers 24 hours a day, 7 days a week, and guarantees a rapid response.

The ITS Control room also uses CCTV for traffic control and monitoring, and shares pictures with the Norwich City Centre Public CCTV Centre. There are 32 dedicated ITS cameras and a further 12 City Centre cameras that are regularly utilized to aid coverage.

In addition, there is a car park guidance system in Norwich, which provides monitoring and control of 24 on-street Variable Message Signs (VMS) across the city, primarily to advise drivers on the key radial and ring road routes about available parking spaces. This system links all the multi storey car parks in the city centre and the 6 Park and Ride sites. The VMS give information to drivers on the road network, thereby allowing drivers to make informed route choices en route, and information is also available at www.help2park.com to help journey planning and encourage modal shift.

3.3.2 Traffic Signals, UTC and SCOOT

Norfolk has over 360 sets of traffic signals which are linked to the ITS control room. The main technology used to improve network & junction efficiency is the SCOOT system: Split Cycle Offset Optimisation Technique. This system deals with networks of closely spaced signal junctions and operates continuously in real time to allocate green time at signalized junctions between approaches and to maintain linking where appropriate to reduce congestion and delay on the network. This system has been installed in Norwich, Kings Lynn and Great Yarmouth.

The Norwich Urban Traffic Control (UTC) system was introduced in 1979. The original system used a fixed time plan by time of day control system whereby sets of signal timings were calculated to give minimum delay for typical traffic conditions found within the network at different times of day and for the different days of the week. These timings, or plans, aimed to provide a sufficiently long green time for each approach to a signal controlled junction to handle all traffic and to give co-ordination between adjacent signals so that traffic traveling between signals is delayed as little as possible. The system was based upon typical historical traffic flows, and it was necessary to keep the plans up to date as traffic changes over the years and to provide many different plans for different traffic conditions. Until 1982 this form of control was the only type of centrally coordinated control approved by the Department for Transport.

A disadvantage of a UTC system is its reliance on hardware from a single supplier, meaning that once a system has been built using one supplier's hardware, any further enhancements or additions need to be created using the same. In order to change this reliance on single suppliers, the Urban Traffic Management and Control (UTMC) systems were brought forward by Department for Transport and Roads. This standard aimed to encourage and employ the best technical practice and support an open market model. The first development brought forward by NCC in transition from UTC to UTMC comprised the Norfolk Common Data Viewer which was developed in the mid 2000s.

A common data base or common data management facility is the key building block within any UTMC system as it allows data from different systems to be blended together to provide information. In accordance with UTMC principals Norfolk are represented on the UTMC specifications and standards working group.

The Norfolk Viewer is the generic name for the software developed to allow users to see the information held in the UTMC common data base and an initial viewer has been developed and deployed in ITS for the car park system, traffic signal faults and congestion monitoring. As more systems are modified to become strategic, more information and further functionality will be added to the viewer. The viewer is the platform for data to be shared and to provide real time information for the benefit of system operators, managers, the Highways Agency, the Police and emergency services, bus and freight operators, as well as the public and media.

During the 1980s, following trials in Glasgow and Coventry, a vehicle responsive system (SCOOT) was devised by the then Transport and Road Research Laboratory and approved by the Department for Transport for use by Highway Authorities. The principal objectives of SCOOT are to reduce stops, congestion and vehicle delays to levels below that obtained by the best fixed time system. SCOOT uses three control parameters to minimize the total delay to traffic on the network:

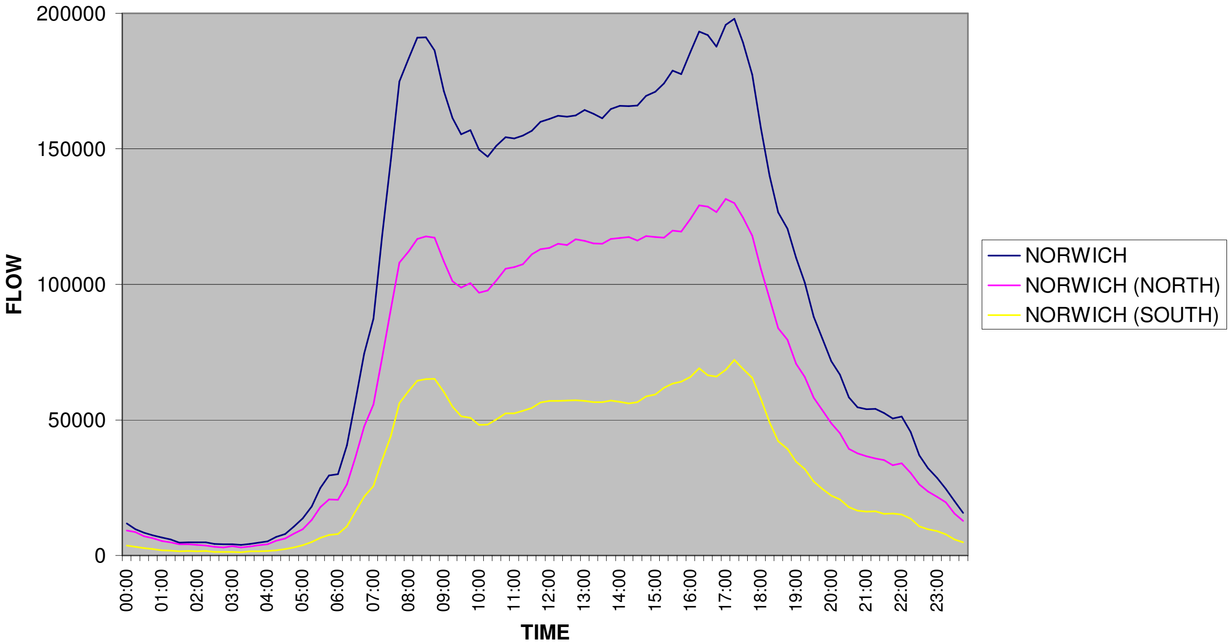
- **Split** – the proportion of the total time for which each approach has a green signal
- **Cycle** – the total length of time that the signals take to serve all approaches to a junction; and
- **Offset** – the relationship between the start of green to the main road at one signal to the start of green at the adjacent signal installation.

The SCOOT system attempts to minimize the total delay to traffic on the network by detecting the traffic flowing on the approaches to all signals in the network and adjusting the signal parameters by small amounts at frequent intervals. Trials in Glasgow and Coventry showed reductions in delay of between 12% and 27% over the previous use of fixed time plans.

NCC, as Highway Authority, has used this system in Norwich since 1989 and it was extended to cover Kings Lynn and Great Yarmouth in the mid 1990s. Today SCOOT is still acknowledged to be the world leading system for responsive coordinated traffic signal control.

Data has been obtained from NCC's ITS centre relating to the traffic flow profiles on a typical day within the Norwich UTC area as detailed in Figure 3.3. These profiles show that there are two peak periods for traffic flows within the area, typically starting from 7.30am until 8.45am and with a PM peak which is derived from a steadily increasing level of traffic from 11.00am until it peaks at around 4.30 and again at 5.30pm. The data for the UTC area has also been split between the northern area of Norwich and the southern. This demonstrates that there is significantly more traffic passing through the UTC apparatus in the northern area than the southern, as is to be expected given the presence of the A47 Southern Bypass which diverts much of the traffic in the south away from the city centre and junctions controlled by the UTC.

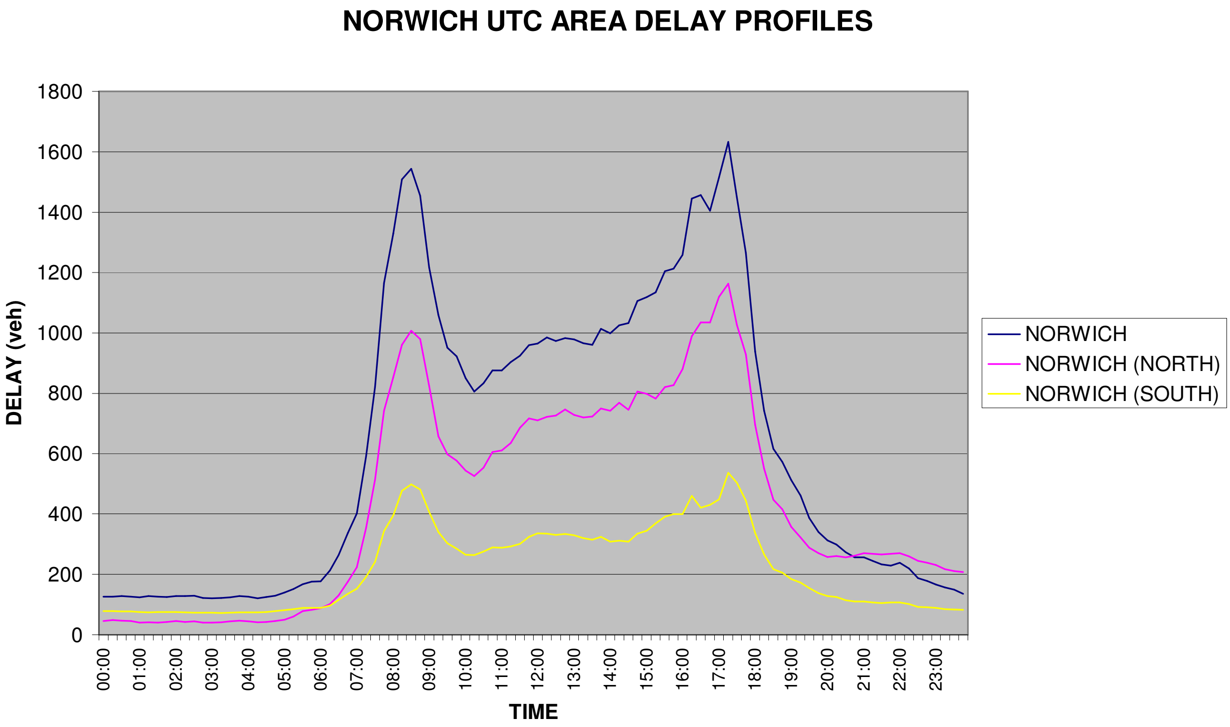
Figure 3.3: Norwich UTC Area Traffic Flow Profiles



Source: Norfolk County Council ITS

In addition to the data on the Norwich UTC area traffic flows, information on the area's delay profiles has also been obtained as detailed in Figure 3.4. This shows that there is a disparity in the delay profiles between the north and the south of the city, with the intensification of delay in the north commencing earlier and increasing at a faster rate than delay in the south of the city. It also demonstrates that in the inter peak period there is a slight fall at 2.30pm in the level of delay in the south of the city, to a level similar to that at 11.30am, until it rises to a PM peak at 5.15pm – 5.30pm which is at a similar level of delay as the AM peak. However, there is no such decrease in the inter peak apparent in the north of the city where traffic delay increases steadily throughout the day culminating in a PM peak at around 5.30pm when the level of delay is greater than that in the AM peak.

Figure 3.4: Norwich UTC Area Delay Profiles



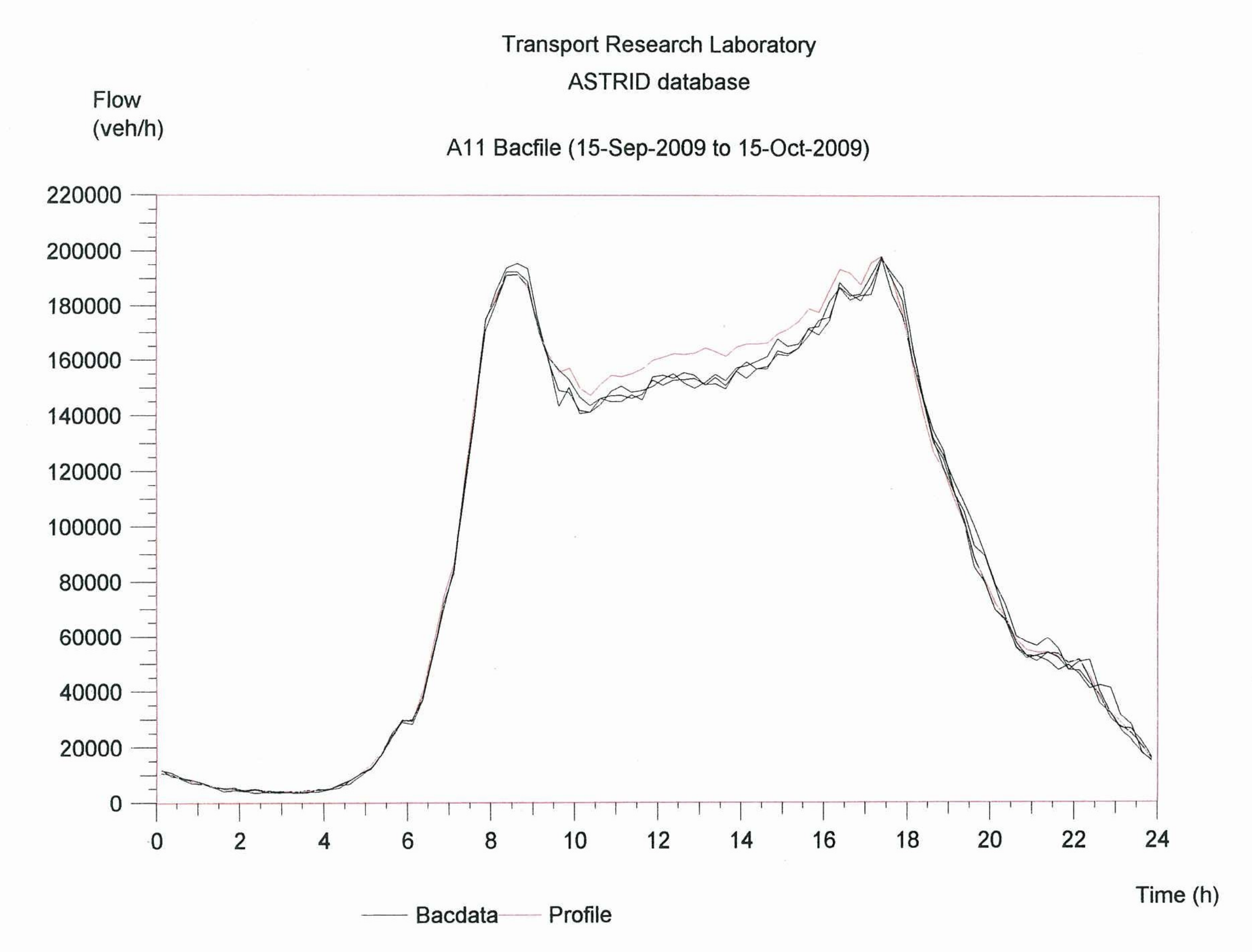
Source: Norfolk County Council ITS

Further data has been obtained showing information from the SCOOT system which operates in Norwich, and is shown in Figure 3.5 to Figure 3.8.

Figure 3.5 shows the behaviour of vehicle flow as registered by the SCOOT system on Mondays during the period 15 September to 15 October 2009 and Figure 3.6 shows the behaviour of vehicle delay as registered by the system during the same period. It can be seen from these figures that during the AM peak, traffic flows begin to rise rapidly from 6.00am with the AM peak being reached between 8.30am and 9.00am. Traffic flows then decline until around 10.00am when it is at approximately the same level as at 7.45am.

In terms of delay, the levels of delay experienced on the network increases after 6.00am inline with the traffic flows on the network, reaching a peak at around 8.30am. At 10.30am the level of delay on the network is approximately the same as the levels at 10.30am.

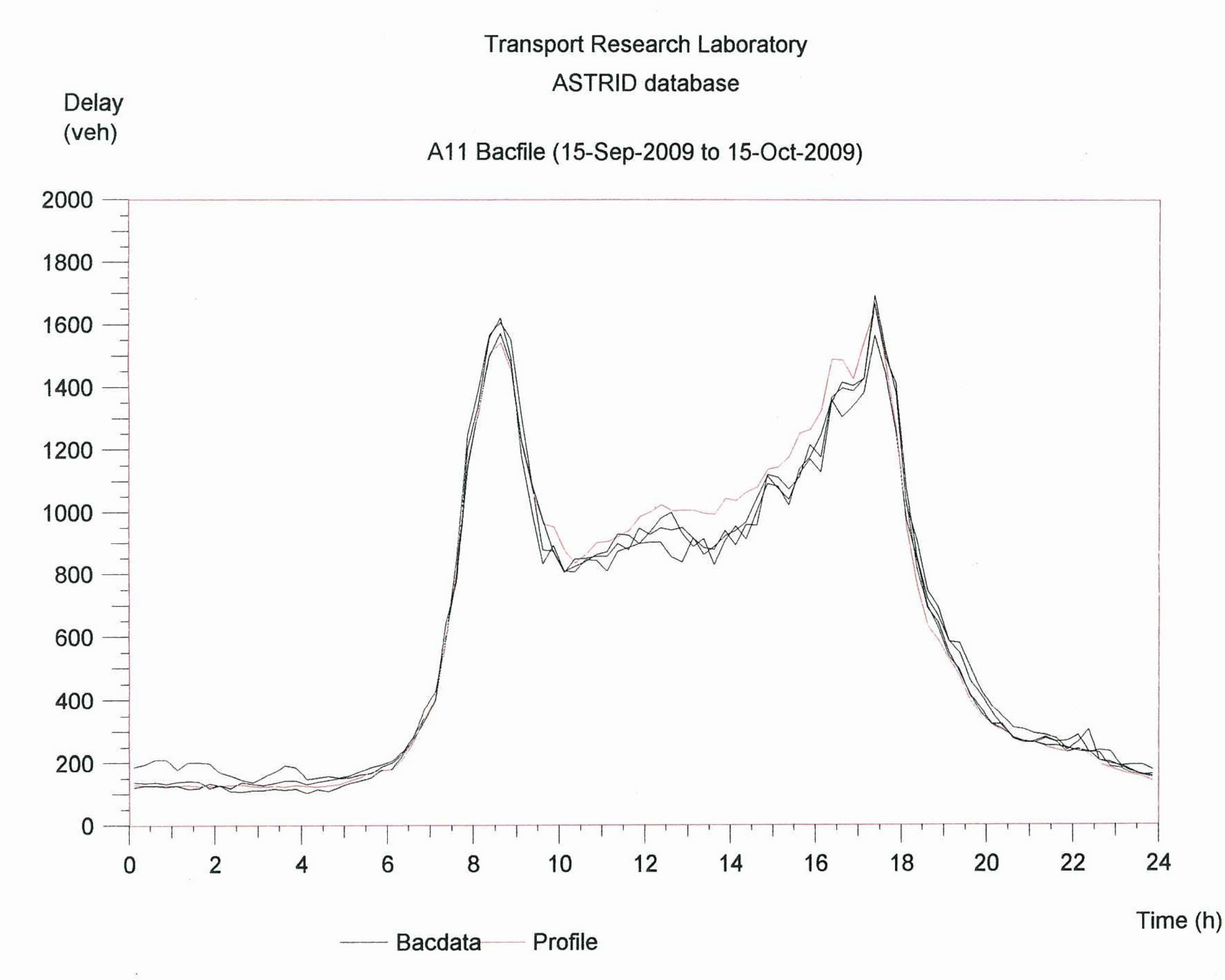
Figure 3.5: SCOOT Vehicle Flow Data – Mondays School Term Time



Source: TRL ASTRID Database

During the inter peak period it can be seen that following the fall in traffic levels to 10.00am, the traffic flows rise over the rest of the day. This pattern is mirrored by the levels of delay on the network.

Figure 3.6: SCOOT Vehicle Delay Data – Mondays School Term Time



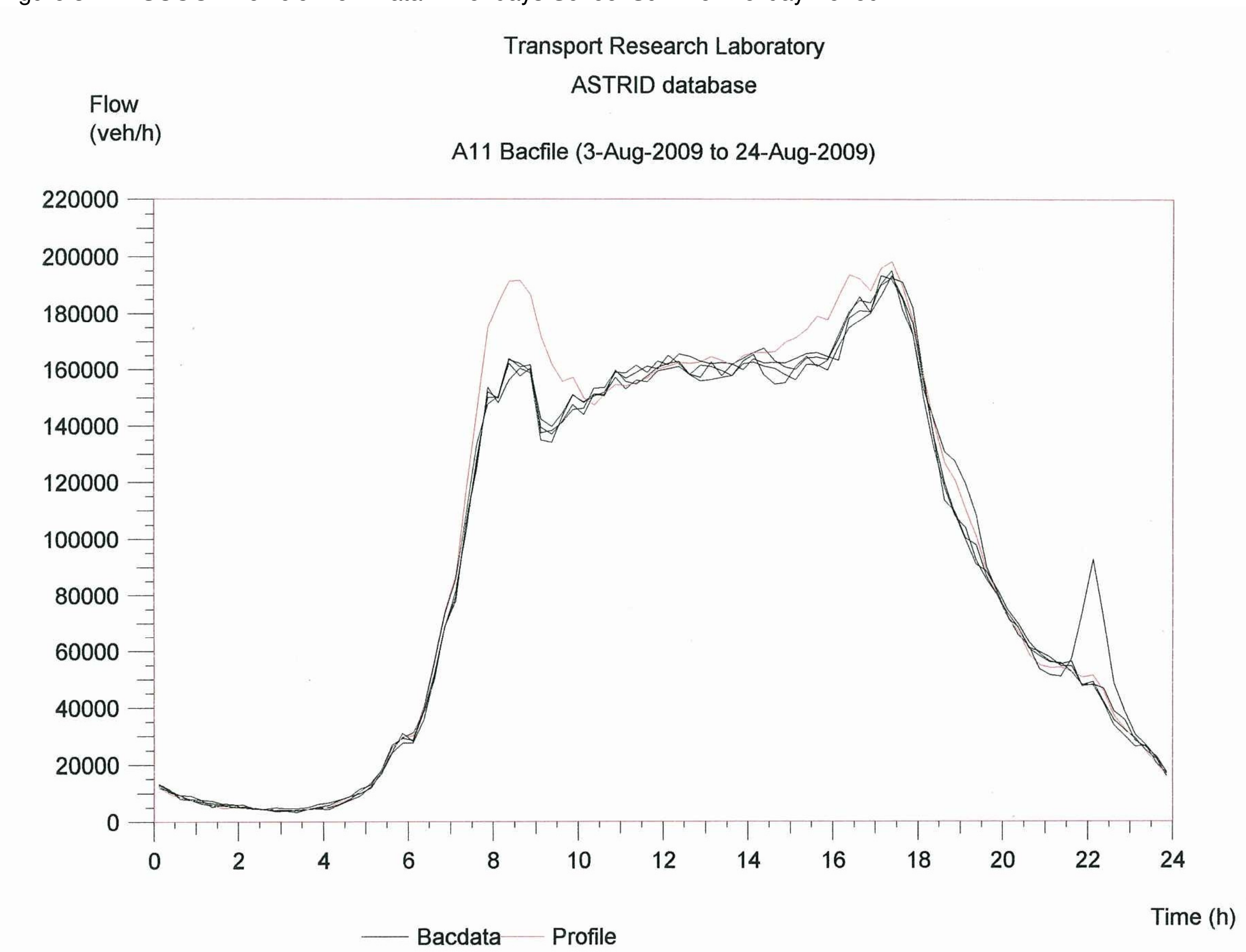
Source: TRL ASTRID Database

The Norwich PM peak can be described as a double peak, as shown in both the traffic flow and traffic delay graphs. The network flow peaks at 4.45pm and at 5.45pm, with the highest level of traffic being present on the network at 5.45pm. Network delay again shows a double peak at 4.45pm and 5.45pm. It is worth noting that the maximum network flow and delay occur at 5.45pm and that this peak is slightly higher than the AM peak.

The above description applies to a normal weekday in a neutral month during school term. Figure 3.7 and Figure 3.8 show the equivalent behaviour during Mondays between 3 August and 24 August 2009, during the school summer holiday period.

Figure 3.7 shows that, similarly to during the September periods, the traffic flow rises rapidly from 6.00am. However, unlike during school term time, the AM peak is subject to three crests in traffic flow between 7.30am and 8.45am, with the actual peak reached at 8.15am. There is then a decline in traffic flows until around 9.30am when levels of traffic begin to rise.

Figure 3.7: SCOOT Vehicle Flow Data – Mondays School Summer Holiday Period

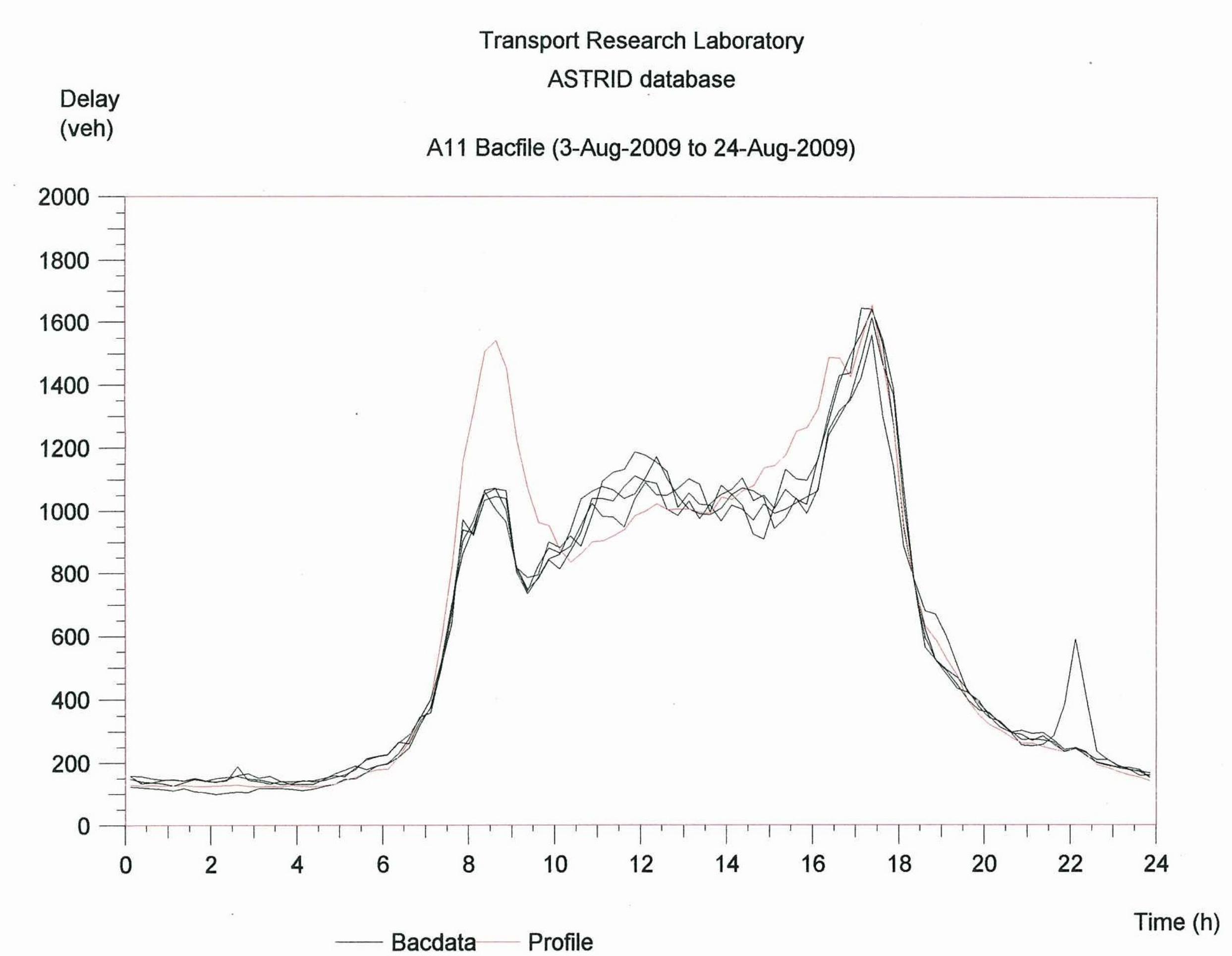


Source: TRL ASTRID Database

Figure 3.8 shows delay also beginning to rise after 6.00am reaching a peak between 8.15am and 8.45am before declining until approximately 9.15am when levels of delay are roughly equivalent to those at 7.45am. Comparing Figure 3.5 with Figure 3.7 shows that the AM peak period is considerably lighter in the school holiday periods than during term time.

Having reached its lowest day time level at 9.15am, traffic levels then rise over the inter peak period. Network delay behaves in a similar fashion. Comparing the SCOOT vehicle flow graphs it can be seen that network flow and delay are higher during the school term time AM peak, with some 195,000 vehicles being registered during term time and 165,000 during the summer holiday's AM peak. However, the PM peak is quite different as there are similar levels present during the school holidays (195,000 vehicles) as during term time (200,000).

Figure 3.8: SCOOT Vehicle Delay Data – Mondays School Summer Holiday Period



Source: TRL ASTRID Database

By comparing the graphs it can be seen that there is little difference in terms of delay and vehicle flows during the inter peak and PM peak periods, whether they occur during or outside of school term time. However, the AM peak period is markedly different, with a significant drop in overall traffic levels as well as a change in profile.

3.4 Network Operation

3.4.1 Transient Conditions

The highway network often suffers from disruption from temporary incidents including road traffic collisions, or vehicle breakdowns, road works which reduce the width of the carriageway or close sections of road, or planned events which may generate special traffic conditions which can disrupt the network.

Information about these disruptions is useful to network operators and those wishing to use the network as it enables choices on appropriate routes to be made in advance of the start of the journey, minimising the likelihood of the trip being disrupted by the event, and thereby reducing the level of congestion that may be experienced at this times at the locations concerned. The County Council is therefore investing in systems which allow information to be produced and published in real time, to give up to date and accurate information to network users so that they can avoid these congested areas and incidents.

3.4.2 Vehicle Journey Time Information

Data on road traffic speeds is collected by Traffic Master and distributed to local highway authorities under licence to allow the calculation of a new National Indicator for congestion: NI167. The new congestion national indicator asks for the calculation of average AM peak journey time per mile during the AM peak.

NCC has calculated its baseline (year 2007/08) AM peak of 7.30am-9.30am journey time for Norfolk as 3.41 minutes/mile which equates to 17.6mph. The Norfolk figure is based on the summation of links in Norwich, King’s Lynn and Great Yarmouth.

Table 3.3 shows an analysis of the links used to calculate a Norwich figure for three different time periods 7am to 10am, 7.30am to 9.30am and 8am to 9am. The journey speed calculated for the 8am – 9am time slice is the slowest at 14.5 mph which is consistent with the picture from the SCOOT system. The two hour period shows a slightly higher speed of 16.4mph with the three hour peak slightly higher again at 17.7mph.

Table 3.3: Calculation of Average AM Peak Journey Time for Norwich

Period	Indicator (min/mile)	Indicator (min:sec/mile)	Mph
7-10	3.39	3:23	17.70
7:30 - 9:30	3.65	3:39	16.44
8-9	4.13	4:08	14.53

Benchmarking of congestion is currently underway with the DfT due to publish congestion indices by April 2010. At the current time the NI167 data has been compared with information released relating to the network around Derby. This data is based on ITIS data which it is understood is no longer being distributed by DfT for calculation of the index. Norfolk’s journey time index is based on one year’s data from DfT using the Traffic Master data. Because there is only one year’s data and only one comparison, caution should be used in interpreting results. However the figures do show that the Norwich network appears to be slower than the Derby network by approximately 18% in 2007.

3.5 Principal and Main Distributor Roads

3.5.1 Current Picture

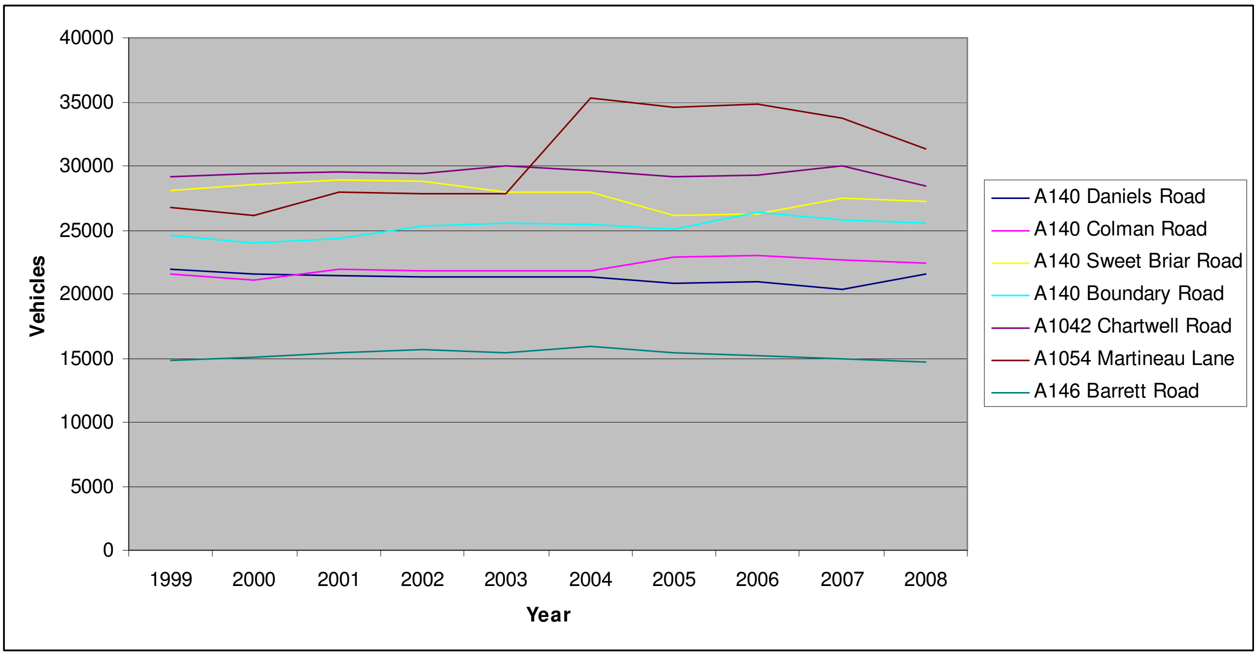
Data has been obtained from the Norfolk Transport Monitoring Report 2009 on the levels of traffic crossing the Inner and Outer Ring Road cordons over recent years. The locations of the Inner and Outer Ring Road cordon points are shown in Figure 3.11 and Figure 3.12 respectively. Inner Norwich is the largest urban area in the Region and is encircled by both Inner and Outer Ring Roads; these cordons are surveyed each year and the data indicates that in recent years traffic levels are declining, especially crossing the Inner Ring Road as shown in Figure 3.13 and Figure 3.14. These graphs have been taken directly from NCC’s Monitoring Report 2009 and show the variation in traffic flows crossing both cordons from 1998 to 2009.

Figures in the Monitoring Report for the Outer Ring Road cordon (Figure 3.13) and Inner Ring Road cordon (Figure 3.14), show a progressive downward trend since 1998. The marked decrease and recovery in the flows for the Outer Ring Road cordon between 1998 and 2001 is likely to have been caused by the September 2000 fuel crisis and this period is therefore excluded in the following analysis.

Figures for the Outer Ring Road cordon show an average decrease in traffic crossing the cordon of 0.8% per annum since 2002. Corresponding figures for the Inner Ring Road cordon show an average decrease in traffic crossing the cordon of 2.8% per annum since 2002.

However, further data on traffic flows on the Outer Ring Road, shown in Figure 3.9, provide more detail on how traffic has changed over various sections of the road. These figures show that the traffic flows travelling on the Outer Ring Road, rather than across it, have fluctuated very little for the majority of the sections, which taken alongside Figure 3.17, suggests that these sections are operating at capacity and that no additional traffic can be accommodated. However, the Martineau Lane section has experienced a 26.7% increase in traffic, rising from 27,868 vehicles in 2003 to 35,322 in 2004. Although the traffic flows have since declined to 31,346 in 2008, they are still 12.5% greater than in 2003.

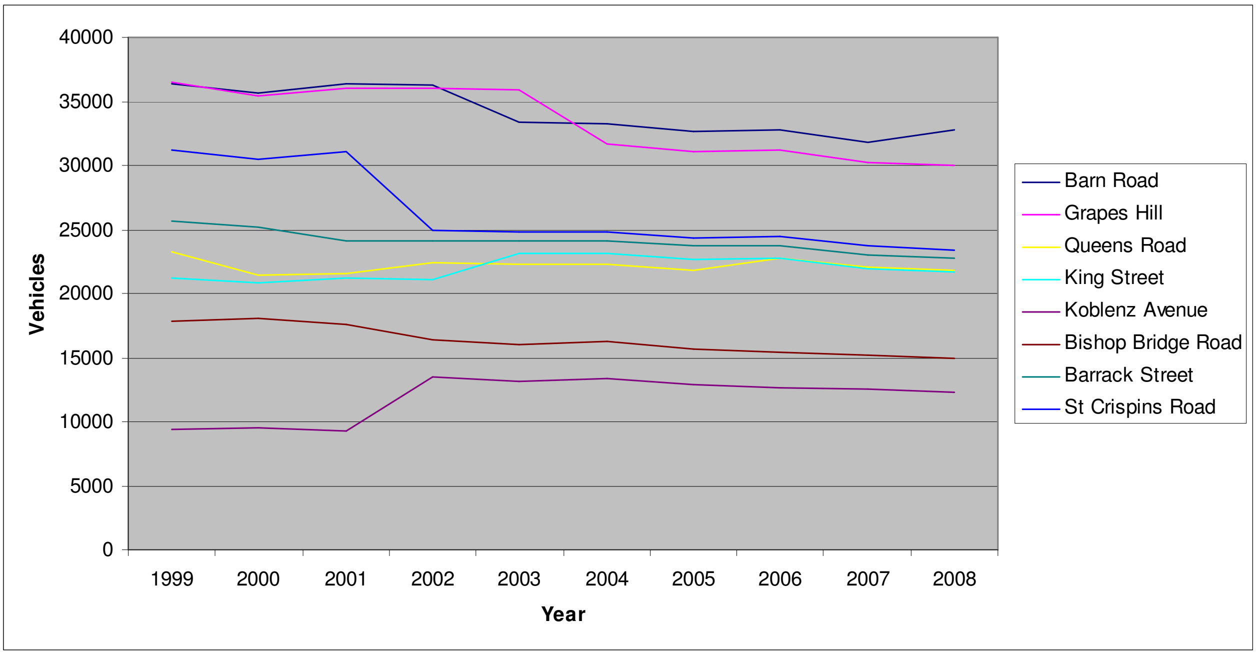
Figure 3.9: Outer Ring Road Circulatory Traffic Flows



Source: www.dft.gov.uk/matrix/

Similar information has also been obtained for the traffic flows on the Inner Ring Road as detailed in Figure 3.10. This data shows that the Inner Ring Road as a whole is subject to a slightly increased volume of traffic than in 1999, with Barn Road, Grapes Hill and St Crispins Road experiencing significant decreases in traffic flows. The fall in traffic at Grapes Hill occurred in 2003/04 and coincided with the opening of the Chapelfield Development.

Figure 3.10: Inner Ring Road Circulatory Traffic Flows



Source: www.dft.gov.uk/matrix/

Overall, these Figures demonstrate that although there has been a fall in traffic crossing both the Inner and Outer Ring Roads, the story with regard to the circulatory traffic is not straight forward, and that there have been significant rises and falls in the volume of traffic using various sections of both roads.

There are many possible reasons for these decreases in recorded traffic. It is considered that ongoing transport policies of providing more transport choices, including the development of Park & Ride and improvements to public transport, are likely to have contributed significantly to the decreases. This is borne out by the figures relating to historic levels of use of the Park & Ride facilities at the Airport and at Postwick, as detailed at Figure 5.4 and Figure 5.5.

Other influences may be changes to car parking spaces and charges including the introduction of on street controlled parking alongside number of Controlled Parking Zones (CPZs) where parking is controlled using permits.

The above figures which are based on vehicle counts are not considered to be indicative of decreases in the numbers of people travelling into the city, which is a combination across all transport modes.

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Figure 3.11: Norwich Inner Ring Road Cordon

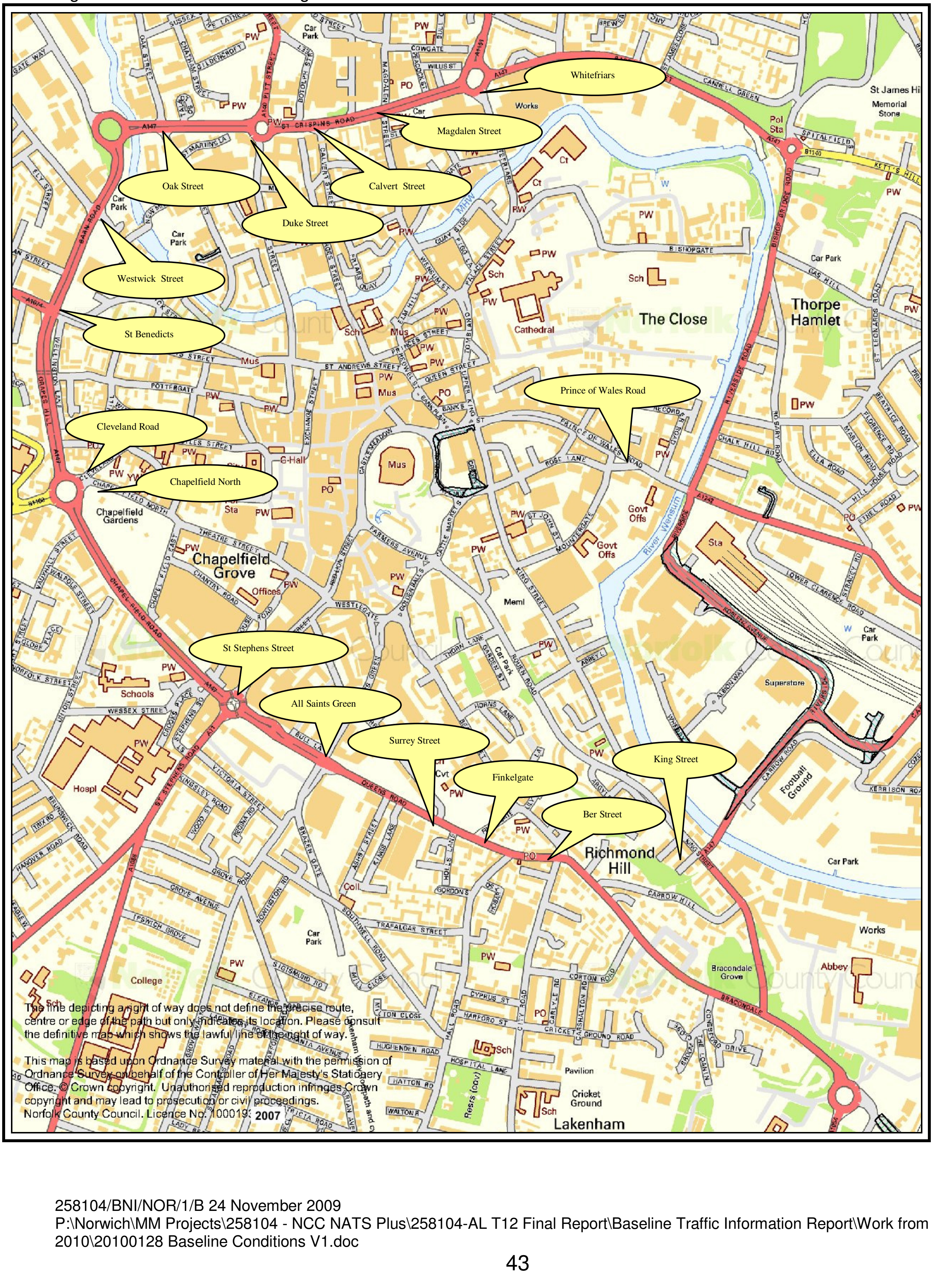
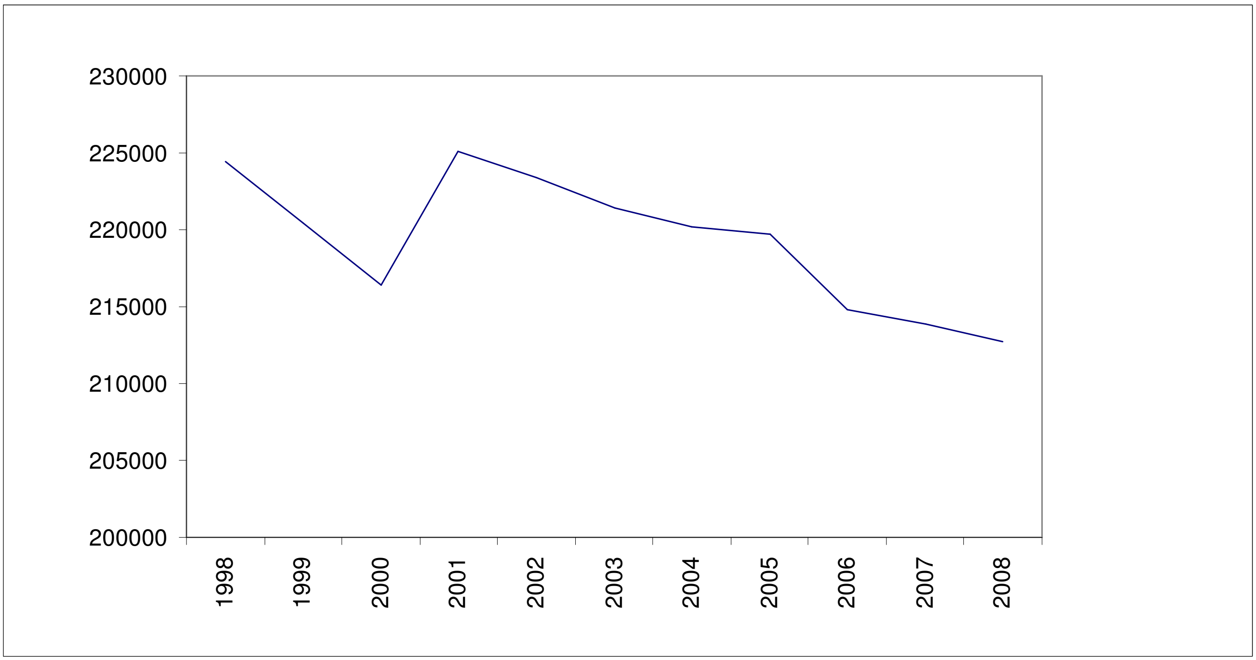


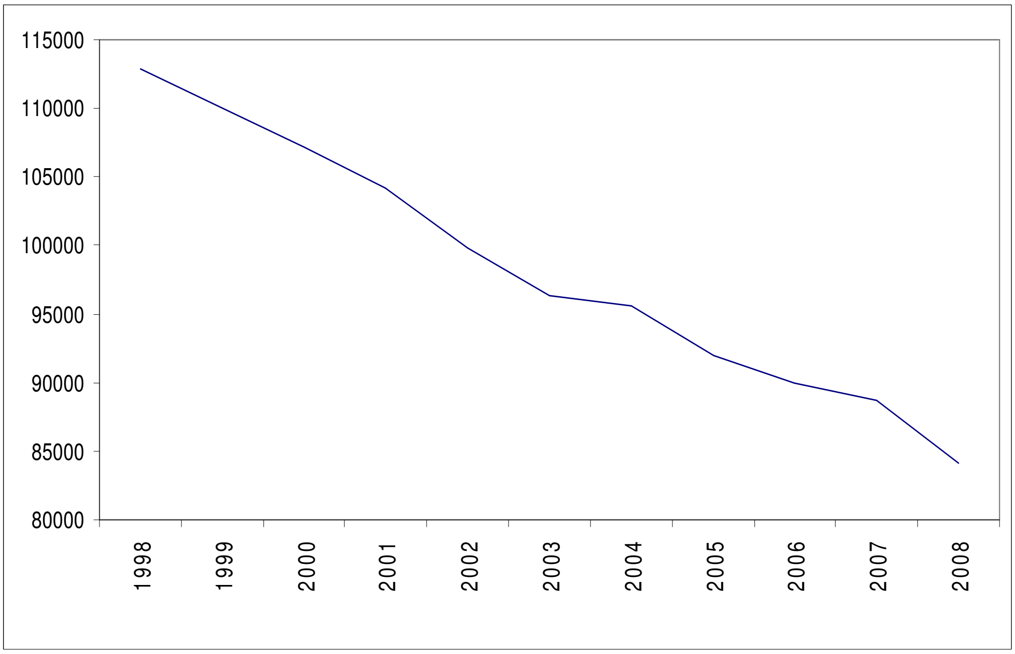
Figure 3.12: Norwich Outer Ring Road Cordon

Figure 3.13: Outer Ring Road Cordon Traffic Count Data



Source: Norfolk Transport Monitoring Report 2009 (Norfolk County Council, 2009, p.5)

Figure 3.14: Inner Ring Road Cordon Traffic Count Data



Source: Norfolk Transport Monitoring Report 2009 (Norfolk County Council, 2009, p.7)

Several factors have contributed to the period of sustained reduction in traffic crossing both the Inner and Outer Ring Road. From 2001 the fall coincided with the opening of Costessey Park & Ride. After this, additional Park & Ride sites were opened in 2003, 2004 and 2005, which will have contributed to the continuous downward trend over this period. More details on numerous Park & Rides are provided at section 5.2. In addition to Park & Ride there have been numerous schemes in the NPA over recent years which have improved accessibility for non-car modes, making the city a more attractive environment for travel by these modes:

St Faiths Lane junction with Fifers Lane – junction modification scheme, changing the junction's priority working to reduce congestion. This resulted in a reduction in carriageway capacity because of the incorporation of pedestrian facilities into the improvement scheme to provide opportunities for use of alternative modes.

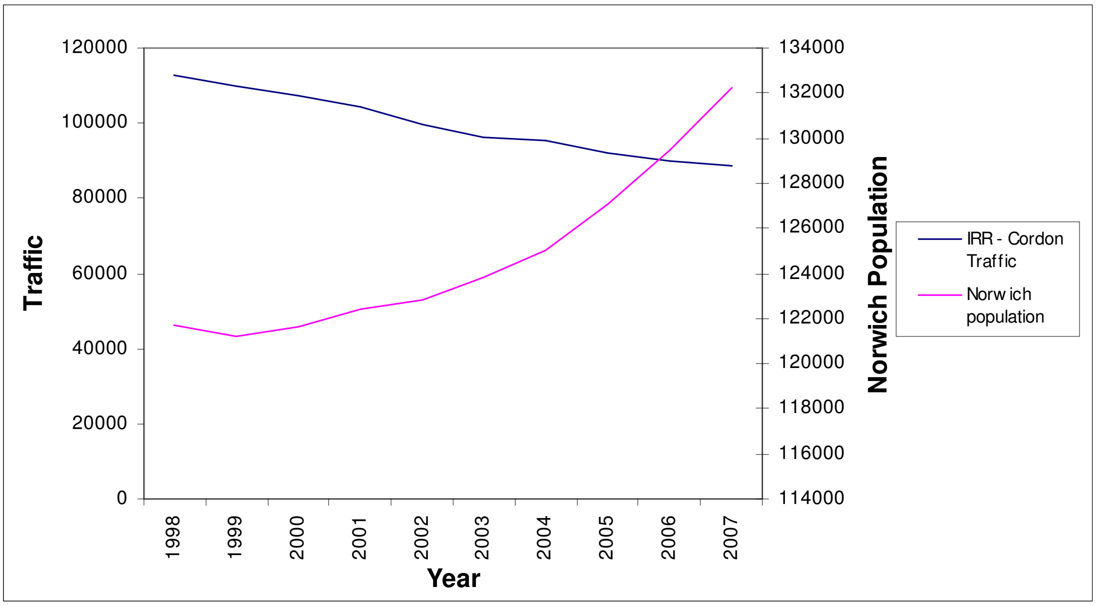
The Public Transport Major, which was mainly delivered in 2005/06, included the construction of a state of the art bus station and a series of linked signalised junctions and pedestrian crossings. This has improved conditions and safety for pedestrians using Prince of Wales Road. Linking of green waves on signals along Prince of Wales Road and Rose Lane has also reduced travel speeds to below 20mph. This as a measure in itself reduced the overall capacity of the road, but additionally carriageway space was removed in order to provide wider footways to either side. Overall, the capacity of Prince of Wales Road was reduced through this scheme. Use of available road space has enabled a bus lane to be provided on Rose Lane with advanced signalling enabling priority. Castle Meadow was designated a bus only zone and accessibility to St Stephens Street enhanced through a bus contraflow via Red Lion Street. This has improved bus reliability and journey times.

St Georges Street – a section of St Georges Street has been stopped up to vehicular traffic and has been repaved and hard landscaped to create a more pedestrian and cyclist friendly environment. This was delivered alongside a change to the traffic management on the surrounding network, including Elm Hill, resulting in the removal of this vehicular link between St Andrews Plain and Colegate.

Another contributing factor to the reduction in peak hour traffic may also have been through the increasing use of employment areas on the periphery of Norwich for example, Broadland Business Park, St Andrews Business Park and Sweetbriar Road Industrial Estate. The relocation of businesses from the city to these areas will have resulted in a reduction in traffic crossing the Ring Roads, for example the relocation of Bertrams from Rosary Road, just to the east of the Inner Ring Road, to Broadland Business Park.

Figure 3.13 and Figure 3.14 indicate that the decrease in levels of traffic crossing the Inner Ring Road cordon has been achieved against a rising trend in the Norwich population levels as demonstrated by Figure 3.15

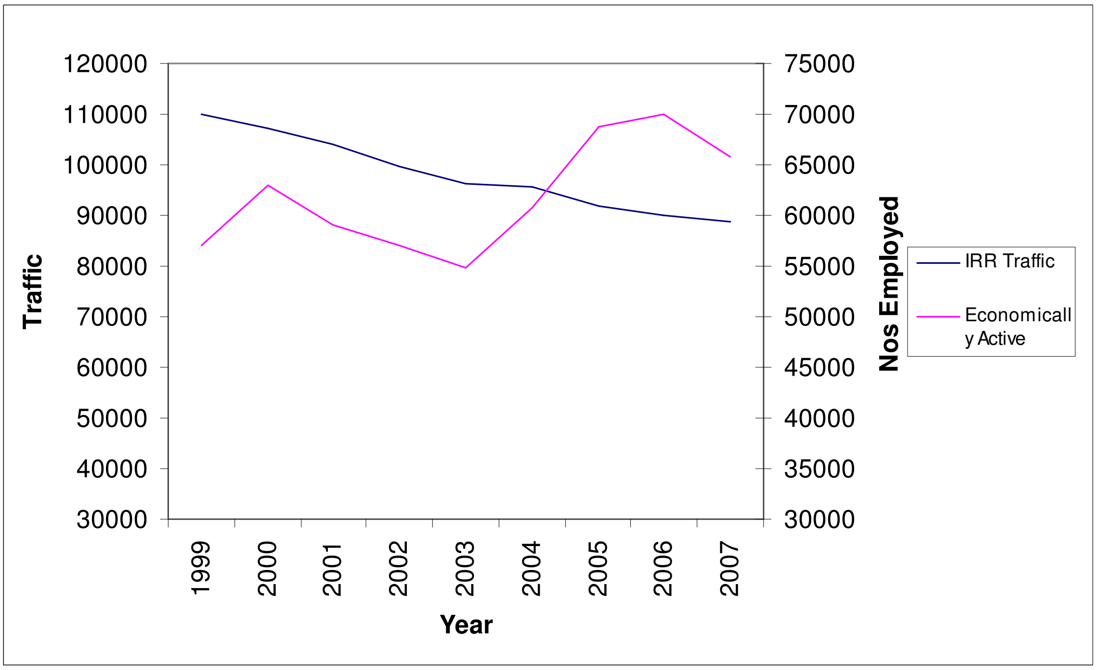
Figure 3.15: Traffic Crossing Inner Ring Road Cordon / Norwich Population



Source: Norfolk Monitoring Report 2009

This fall of traffic volumes against an increase in population is also corroborated by the comparison against economically active people in Norwich as demonstrated in Figure 3.16

Figure 3.16: Traffic Crossing the Inner Ring Road Cordon / Economically Active People in Norwich



Source: Norfolk Monitoring Report 2009

Figure 3.16 shows that since 1999 the numbers of economically active people in Norwich have increased by around 15,000 until the decline from 2007 which coincides with the start of the national recession. An increase in economically active people in Norwich, as well as its total population, indicates that total travel demand into and within Norwich has increased over this time period, but the findings of the survey would suggest that this increased demand is being at least partially accommodated by modes of transport other than the private car, or that it is the result of the dispersal of employment to locations, for example Broadland Business Park, beyond the Outer Ring Road. In addition, there has been a dispersal of employment sites from locations within the Inner Ring Road to those beyond the Outer Ring Road, such as Broadland Business Park. The decrease in traffic crossing the Inner Ring Road cordon has been steady since 1999, with a brief plateau in the fall in 2003.

However whilst the above indicates a reduction of traffic on the Ring Roads, traffic has increased elsewhere. Traffic surveys conducted on an annual basis as part of the work carried out for the Norfolk Traffic Monitoring reports show that there has been a general rising trend in traffic flows on the network away from the city.

Table 3.4: Year on Year Traffic Flows Outside Norwich

Year	A1151 Wroxham	A140 Hevingham	A1067 Bawdeswell	A47 North Tuddenham	Average 3 Sites	Average 4 Sites
1998	11640	11448	n/a	16992	13360	n/a
1999	11510	11543	7851	18691	13914	12399
2000	11138	11830	7926	16454	13141	11837
2001	10877	12036	8037	20039	14317	12747
2002	10194	12526	8286	20833	14517	12959
2003	10295	12570	8461	21373	14746	13175
2004	10498	12807	8541	22064	15123	13477
2005	10378	12934	8548	22045	15119	13476
2006	10843	13164	8780	22265	15424	13763
2007	10869	13334	8854	22143	15449	13800
2008	10719	12666	8448	22021	15135	13464
% Change	-7.91%	+10.64%	+7.61%	+29.60%	+13.29%	+8.59%

Source: Norfolk County Council

In addition to the data provided in Table 3.4, further survey data has been obtained for 7 sites in Norwich. These surveys were conducted in 2001 or 2002 with a resurvey in 2006 and the results are shown in Table 3.5.

Table 3.5: Traffic Survey Data Results – 2002 & 2006

Location	2001/2002 Results	2006 Results	% Change
Newmarket Road (inside IRR)	13980	13119	-6%
Yarmouth Road (east of Pound Lane mini-roundabout)	21119	21034	0%
Plumstead Road (Between Dussindale Drive and Thorpe End village)	7306	8689	19%
Aylsham Road (inside IRR)	16931	14278	-16%
Drayton Road (Inside ORR)	12839	13640	6%
Dereham Road (Inside IRR)	12382	11609	-6%
Wroxham Road (to the north of P&R roundabout)	9358	10171	9%

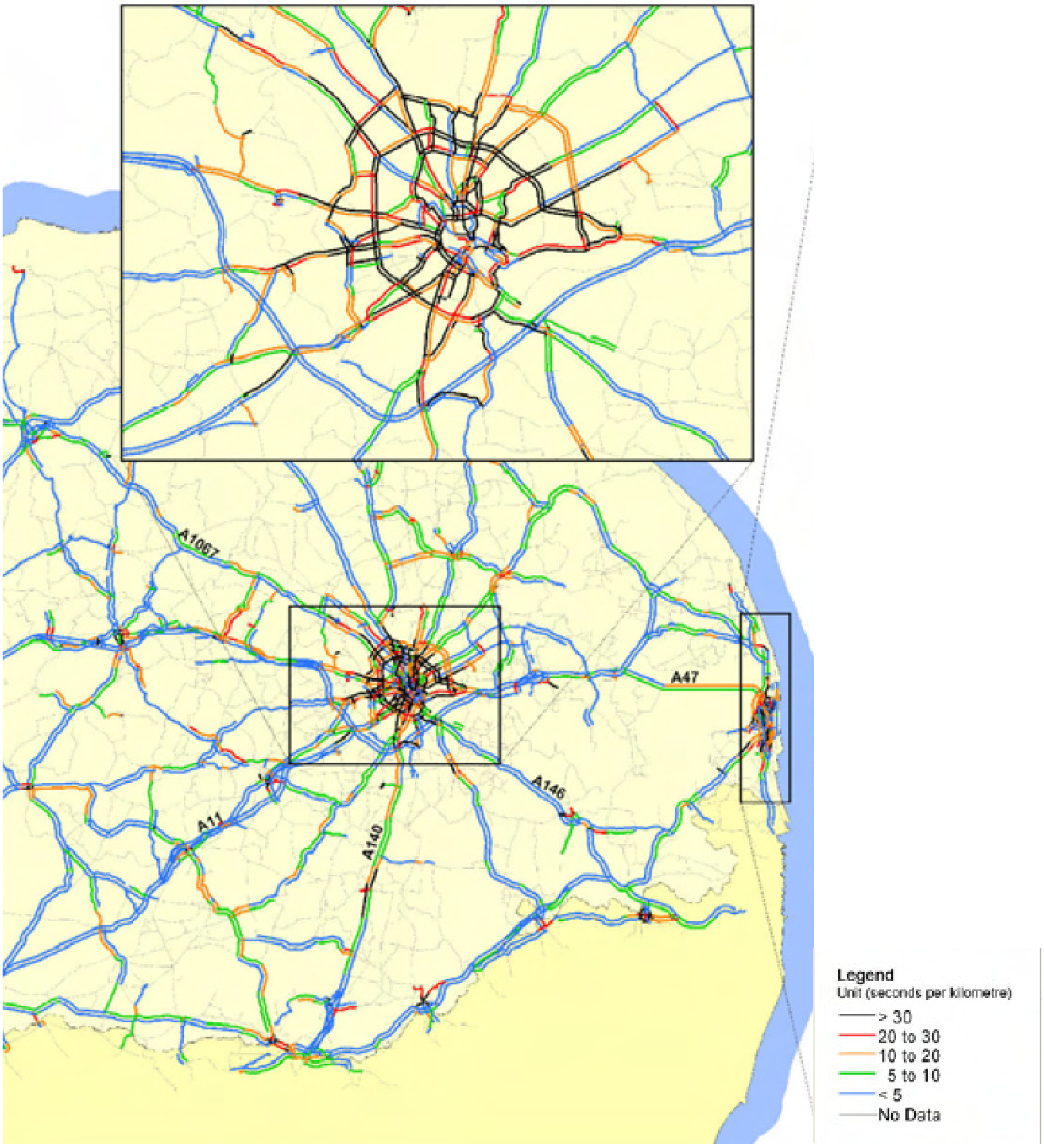
Table 3.5 shows that traffic levels varied considerably between 2002 and 2006 on these radial routes, with Plumstead Road being subject to the highest level of increase at 19% and Drayton Road and Wroxham Road also having increased traffic flows between the two years.

Despite the changes in traffic flows on the Ring Roads since 1998, it is apparent that general levels of traffic congestion and associated delays and journey times have nevertheless been high over the same period.

An example of the delay that the network is subject to is provided by the map in Figure 3.17. This has been created based on ITIS Holdings floating vehicle data and shows the average delay in the AM period from 0700 to 1000 hours in 2004. ITIS Holdings create datasets using vehicle fleets from several large national logistics and road based companies, fitted with tracking equipment. Data is sent to a central point at a minimum of 1 minute intervals throughout the day, providing time and location information. This data is then used to create average speed data for the network used by these vehicles.

The delay is then calculated by comparing times/speeds within the AM period with those for free flow conditions and is presented in pictorial form for ease of interpretation. Unfortunately data from years since 2004 is not available in this format and therefore a comparison cannot be made. However, Figure 3.17 does confirm anecdotal evidence and the views on congestion expressed by stakeholders and the public in consultation exercises as it shows that in 2004 the maximum level of delay was recorded on the majority of both the Inner and Outer Ring Roads and the inbound sections of all radial routes including Plumstead Road, Salhouse Road, Wroxham Road and North Walsham Road. It also shows that all of the northern radial routes were subject to the highest level of delay even to the north of the Outer Ring Road and particularly on the roads which link the radials beyond the Outer Ring Road, such as Fifers Lane, Middletons Lane and Broad Lane in the vicinity of Rackheath.

Figure 3.17: Average AM Peak Delay



Source: Norfolk County Council – Local Transport Plan

This Figure also corroborates the view that despite the reduction in traffic flows on the Inner and Outer Ring Roads that are identified in Figure 3.13 and Figure 3.14 these roads are subject to levels of congestion in the peak hours which are affecting the traffic flows along them. This is particularly evident for Barn Road, Grapes Hill and St Crispins Road which experienced a fall in traffic before or around 2004, and yet continued to operate with significant delay being incurred to road users.