The Norfolk County Council (Norwich Northern Distributor Road (A1067 to A47(T))) Order

5.5 Transport Assessment

Planning Act 2008

Infrastructure Planning

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

PINS Reference Number: *TR010015*

Document Reference: *5.5*

Regulation Number: *5(2)(q)*

Author: *Mott MacDonald*

Revision	Date	Description
0	8th January 2014	Revision for submission

Mott MacDonald Internal Audit			
Revision	**Originator**	**Checked By**	**Approved By**
0	M Olley	C McKay	C White G Kelly

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties

MM filing ref: MM-*233906 DP01-Doc-009*

Table of Contents

1 Key Summary

1.1 Summary

1.1.1 This TA contains the following chapters:

- **Chapter 2**: objectives for the NDR scheme, description of the discussions with the Highway Authorities to agree the scope and extent (in terms of number of junctions to be assessed) of this TA.
- **Chapter 3**: scheme description
- **Chapter 4**: national and local policy context
- **Chapter 5**: existing network conditions
- **Chapter 6**: sustainable transport considering the following modes: bus, Park & Ride, coaches, rail, non-motorised users
- **Chapter 7**: transport modelling outputs and how they are used in this TA
- **Chapter 8**: traffic impact assessment for on-line, other junctions with NDR at Postwick and off-line junctions
- **Chapter 9**: wider impacts including impacts on strategic movements, suburban and City Centre impacts, journey times and effects on people
- **Chapter 10**: high level analysis of Personal Injury Collisions (PIC) and analysis of cluster sites for the principal route network
- **Chapter 11**: assessment of construction traffic impact
- **Chapter 12**: how NDR mitigates against existing problems and future problems arising and any mitigation required for NDR

1.2 Conclusions

1.2.1 The transport modelling and appraisal work has demonstrated that the Do Minimum network would be inadequate to accommodate traffic generation produced by the high levels of employment and residential growth planned for greater Norwich and lead to a substantial deterioration in operational

performance, transport journey times and reliability, thus reducing the economic competitiveness of the City. This would be accompanied by a further deterioration in traffic conditions on inappropriate routes, reductions in operational performance for bus services and worsening conditions for walking and cycling. There would be an increasing risk of worsening road safety as traffic would continue to grow on inappropriate routes and queues may extend onto the high speed A47(T) dual carriageway.

1.2.2 The following junctions were assessed in detail in this TA:

- All 14 on-line junctions along the NDR;
- Six other junctions with NDR at Postwick; and
- Five off-line junctions: A47(T) Trowse, A146 / Martineau Lane, Bracondale / King Street, Crostwick Junction (North Walsham Road / Crostwick Lane / Rackheath Lane), Rackheath Junction (Wroxham Road / Green Lane West)

1.2.3 The policy chapter concludes that the NDR scheme is considered complementary to the relevant key policies and guidance and is aligned with national and local policy.

1.2.4 The conclusions on sustainable transport are as follows:

- Bus: the NDR and its associated complementary measures are predicted to reduce congestion on the core network, thereby reducing bus journey times as demonstrated in this report. The complementary measures in the City Centre include road closures therefore giving priority to buses. These should lead to more reliable public transport and encourage greater usage.
- 18 of the current bus services would cross the route of the proposed NDR. The majority of these would be unaffected by the scheme with any minor impacts being mitigated against by benefitting from reduced traffic levels on radial routes and the Outer Ring Road.
- Park & Ride: the six Park & Ride sites and their bus services are likely to benefit from reductions in congestion along key corridors by the introduction of the NDR. Furthermore, the introduction of signals at the

Postwick Park & Ride junction allows prioritisation of Park & Ride bus services.

- Rail: rail services will not be directly affected by the NDR. The NDR is likely to however have a beneficial impact on journey times to and from the main rail station.
- Non-motorised users (NMU): one of the main aims of the NDR is to enable the removal of through traffic from the city centre and the introduction of walking and cycling improvements.
- There are a number of rights of way that are affected by the NDR. Detailed mitigation measures are set out for each of them.
- The NDR scheme also includes approximately 25km of new pedestrian / cycle links along the route within the landscape strip. These would link to existing facilities and enhance the walking and cycling networks.

1.2.5 The results presented in this TA are based on a number of iterations, with detailed junction modelling being carried out and the results then fed back into the strategic model with traffic being re-assigned. The testing has shown that with increasing capacity provided at the NDR junctions, the demand along the NDR also grew. Therefore, it is apparent that a careful balance needs to be struck between providing sufficient capacity to meet the objectives of the scheme without encouraging unnecessary or longer motorised journeys.

1.2.6 The junction assessments presented in this TA demonstrate that the NDR approach arms have capacity levels below the desirable maximum level of 85% capacity in 2017 except for the southbound approach to the Postwick NE roundabout and the New Link Bridge approaching the Park & Ride signalised junction. In 2032, a number of the approaches show capacity levels that are above the 85% level but below their theoretical maximum threshold of 100% except for the southbound approach to the Postwick NE roundabout and the New Link Bridge approaching the Park & Ride signalised junction. There is a small number of side roads and non-NDR links that are above the desirable level in 2017 and above the theoretical level in 2032. The resulting queues are deemed to be acceptable.

1.2.7 The junction layouts presented in this TA are considered to be the best possible balance between relieving the existing network whilst ensuring acceptable conditions on this new part of the network. It does however mean that there are likely to be some very limited queues and delays on

some approaches to a small number of the on-line junctions during the morning and evening peak periods in 2017 when the road would be opened to traffic.

1.2.8 The existing Postwick Park & Ride roundabout junction is forecast to experience substantial queues and delays on Yarmouth Road in both peak periods in both 2017 and 2032. With NDR and the signal junction improvement, the theoretical capacity limit is exceeded in 2032 PM peak, but the queues and delays on Yarmouth Road reduce significantly in the DS scenario with the introduction of signals. Furthermore, the proposed signal junction allows Park & Ride bus services being prioritised via dedicated signal control.

1.2.9 Theoretical capacity is also exceeded at Martineau Lane / A146 and Bracondale / King Street junctions. The results demonstrate that this is not due to the NDR but background traffic growth with over-capacity levels similar in the DM and DS scenarios. Thus the NDR scheme itself does not significantly affect these junctions.

1.2.10 The wider effects of the NDR are considered. The results demonstrate that the NDR reduces traffic levels and congestion on orbital roads, the Outer Ring Road and the radial routes in the north and northeast of Norwich. Journey times along key highway and public transport routes would be significantly reduced through the introduction of NDR. City Centre through traffic would be reduced by the NDR and its complementary measures, leading to lower traffic levels inside the Inner Ring Road than in the 2012 base.

1.2.11 The high level safety review that was undertaken demonstrates that 62 (70%) out of the identified 89 accident cluster sites are predicted to experience lower flows due to NDR, which is considered likely to have an overall beneficial effect given the established relationship between traffic flow levels and accident risk.

1.2.12 Construction traffic impacts are unlikely to be severe and a range of mitigation measures will assist in reducing any temporary impacts to acceptable levels.

1.2.13 Overall, the NDR scheme would deliver benefits in terms of materially improving highway conditions in Norwich overall and meet the relevant policy objectives without creating any unacceptable effects.

2 Introduction

2.1 Scheme Background

2.1.1 Mott MacDonald (MM) has been appointed by Norfolk County Council (NCC) to assist with the development and appraisal of the Norwich Northern Distributor Road, known as the NDR or referred to as the Scheme.

2.1.2 The Scheme would be a dual carriageway all-purpose strategic distributor road, to be classified as the A1270 Principal Road, which would link the A1067 Fakenham Road near Attlebridge, to the A47 Trunk Road (T) at Postwick. This will be over a length of approximately 20.4km.

2.1.3 The NDR is a project of national significance which requires a Development Consent Order (DCO) under the Planning Act 2008 and this formal planning process began in early 2013. It is currently anticipated that the process will be completed in time for the NDR scheme to start construction in 2015 and to be opened in 2017.

2.1.4 This document is one of a number that support the DCO, each of which has its own unique document number, and should therefore be read in conjunction with the other documentation. The proposed layout of the NDR is shown in the General Arrangement Plans contained in document number 2.6, whilst the full needs case for the NDR is explained in the **Statement of Reasons** (document 4.1) and the **Environmental Statement** (document 6.1).

2.1.5 This report uses traffic data and results from forecasts of NATS transport model. These are contained in the **Traffic Forecasting Report** (document reference 5.6).

2.2 Structure of Report

2.2.1 The structure of this Transport Assessment is as follows:

- **Chapter 1**: Key Summary
- **Chapter 2:** Introduction

- **Chapter 3:** Scheme Description
- **Chapter 4:** Policy Context
- **Chapter 5:** Existing Network Description
- **Chapter 6:** Sustainable Transport
- **Chapter 7:** Transport Modelling Inputs and DM Appraisal
- **Chapter 8:** Traffic Impact Assessment
- **Chapter 9:** Wider Effects of NDR
- **Chapter 10:** Road Safety Review
- **Chapter 11:** Construction Traffic Assessment
- **Chapter 12:** Mitigation
- **Chapter 13:** Conclusions

2.3 Objectives

2.3.1 The objectives for the NDR scheme are as follows.

- reduce traffic levels and congestion on the existing road network both within the urban area and beyond to the north;
- facilitate journeys that are currently difficult and require traffic to use roads that are unsuitable for the type and volume of traffic that is currently accommodated;
- provide access to and help to deliver, planned and potential areas of growth, and enable those areas to be free of the need to incorporate provision for extraneous traffic;
- provide improved transport connectivity, including with the national strategic road network, for existing and future areas of residential and employment development, Norwich International Airport and the wider area of North and North East Norfolk;

- increase the opportunities for improving provision for public transport and other sustainable forms of transport and for improving traffic management within the City Centre, thereby encouraging modal shift, and
- improve traffic related environmental conditions for residents in the northern suburbs of Norwich and outlying villages, whilst minimising the adverse environmental impacts of the NDR.

2.4 Discussions with Highway Authorities / Agreement on Scope

2.4.1 A first draft of the TA scoping report was issued in April 2013. Following this, a meeting was held with NCC Highway officers on 1 May 2013 during which the report was discussed. A revised TA scoping report was issued in June 2013 which is included in **Appendix A**.

2.4.2 At the time of writing the TA scoping report, the Norwich Area Transportation Strategy (NATS) transport model which has been developed since 2002, was being updated for the purposes of this NDR submission using fresh survey data collected in 2012. This was done to strengthen the model with up to date data and for the model data to be used in this TA.

2.4.3 The NATS model was updated in accordance with WebTAG 3.19 guidance. It is considered adequate to use this model for high level assessment, to understand where network problems exist, to give a general understanding of the nature and scale of these problems, and to consider impacts on junctions when comparing scenarios (existing, Do Minimum (DM) and Do Something (DS)).

2.4.4 In addition to the above information that can be obtained from the NATS model, detailed junction assessments are used in this TA to understand the performance of individual junctions during peak hours.

2.4.5 The discussions with the Highway Authority centred around the suitability of the NATS model results and where more detailed junction assessments would be required. The first draft of the scoping report contained a “list of junctions that potentially require assessment”. Further to consideration of preliminary model outputs and looking at which junctions would be adversely impacted upon by the introduction of NDR, and further discussions with NCC, the number of junctions was reduced to those presented in the revised

scoping report. Subsequently, this was further reviewed by NCC officers based on updated traffic flows obtained from the NATS model and agreement was reached on testing the following junctions:

- All 14 On-line junctions along the NDR;
- Six other junctions with NDR at Postwick; and
- Five off-line junctions: A47(T) / A146 Trowse, A146 / Martineau Lane, Bracondale / King Street, Crostwick junction (B1150 North Walsham Road / Crostwick Lane / Rackheath Lane), Rackheath junction (A1151 Wroxham Road / Green Lane West)

2.4.6 The table below contains the off-line junctions presented in the scoping report (revision B) including NCC officers' comments regarding the need for detailed assessment. These comments are based on discussions held on 12 June 2013, a subsequent email dated 14 June 2013 and further considerations dated 25 June 2013 that are summarised in a note contained in **Appendix B**.

Table 2.1 Off-line Junctions

Junction	Detailed assessment required / NCC comments
A140 Boundary Road / Reepham Road / Cromer Road / A1042, A1042 Mile Cross Lane / St Faith Road / Catton Grove Road, A1042 Salhouse Road / Gurney Road	NO: The Outer Ring Road junctions are considered to immediately benefit from the NDR with model data demonstrating reduced flows at all those junctions.
A1067 Fakenham Rd / Fir Covert Road	NO: This junction is likely to be converted to signals by a supermarket proposal and possibly before the NDR is built. In addition, model data shows that NDR would reduce traffic levels through this junction.
B1150 North Walsham Road / Crostwick (Crostwick Junction)	YES: An improvement is proposed at this junction in connection with NDR. This should be assessed in detail.
B1150 North Walsham Road / White Woman Lane	NO: Model data demonstrates that NDR would reduce traffic levels at this junction.

Junction	Detailed assessment required / NCC comments
A1151 Wroxham Road / Muck Lane	NO: It is likely that Muck Lane will be a key access point for the Rackheath development but this is currently not reflected in the model as access details will not be fully known for many years. If Muck Lane does become a key access point, an improvement at this junction is likely to be required in the future but essentially as a consequence of the large development traffic levels predicted by 2032, not due to the NDR. Further assessment in this TA which examines NDR impacts is therefore not required.
A1151 Wroxham Road / Green Lane West (Rackheath Junction)	YES: similar to the above junction, exact access points for the Rackheath development are not yet known. A safety improvement is however proposed for this junction in connection with NDR and detailed assessment should therefore be included in the TA.
Salhouse Road / Green Lane West	NO: similar to the above two junctions, improvements are likely to be required in the future as a consequence of large traffic flow increases due to development, not NDR.
Plumstead Road / Woodside Road	NO: Model data demonstrates that NDR would reduce traffic levels at this junction.
A146 / Martineau Lane	YES: despite the moderate increases in flows shown at this junction, it was ultimately agreed to carry out detailed modelling for this junction.
Bracondale / King Street	YES: despite the moderate increases in flows shown at this junction, it was ultimately agreed to carry out detailed modelling for this junction.
A47(T) / A146 Trowse	YES: despite the moderate increases in flows shown at this junction, it was ultimately agreed to carry out detailed modelling for this junction.
A47(T) / A140 Harford	NO: Model data demonstrates that NDR would reduce traffic levels at this junction.
A47(T) / A11(T) Thickthorn	NO: Model data demonstrates that NDR would reduce traffic levels at this junction.
A47(T) / B1108 Watton Road	NO: Model data demonstrates that NDR would reduce traffic levels at this junction.

Junction	Detailed assessment required / NCC comments
A47(T) / A1074 Longwater	NO: Model data demonstrates that NDR would reduce traffic levels at this junction.

2.4.7 Confirmation was subsequently received from HA by email dated 17 July 2013 that out of the five junctions with the A47(T) for which the HA is responsible, only Postwick and Trowse junctions would have to be assessed in detail in this TA.

2.4.8 The agreed total number of off-line junctions is therefore the five junctions as referred to in paragraph 2.4.2, two of which are strategic junctions and the remaining three are within the control of NCC, the local highway authority.

2.5 Study Area

2.5.1 The study area is in line with the fully modelled area as per the NATS model, a figure of which is included in **Appendix C.1** of this TA.

2.5.2 The **Highway Local Model Validation Report (Highway LMVR)** provides a definition of the modelled areas as below.

2.5.3 Two main areas have been defined within the model in line with WebTAG guidance. The areas are as follows:

- **Fully Modelled Area** – this is the area over which proposed interventions have influence, subdivided into:
    - *Area of Detailed Modelling* – the area in which significant impacts of interventions are certain. Modelling in this area is characterised by representation of all trip movements, small zones and, detailed network representation with junction modelling (including flow metering and blocking back)
    - *Rest of Fully Modelled Area* – this is the area over which the impacts of interventions are considered to be quite likely, but relatively weak in magnitude. This area is characterised by representation of all trip movements, somewhat larger zones and less network detail than the area of detailed modelling with speed/flow modelling.

- **External Area** – the impacts of interventions can be assumed to be negligible here. In terms of detail it would be expected that the network represents a large proportion of the rest of Great Britain, with only a partial representation of demand – i.e. external to external movements through the FMA; large zones; skeletal network and fixed speed modelling.

3 Scheme Description

3.1 Introduction

3.1.1 The Norwich Northern Distributor Road, known as the NDR or referred to as the Scheme, is a dual carriageway all-purpose strategic distributor road, to be classified as the A1270 Principal Road, which would link the A1067 Fakenham Road, near Attlebridge, to the A47 Trunk Road (T) at Postwick. This will be over a length of approximately 20.4km. Refer to the General Arrangement Plans in document number 2.6.

3.1.2 A detailed scheme description is provided in the **Environmental Statement** (document 6.1) in Chapter 2.

4 Policy Context

4.1 Policy Fit

4.1.1 In the following sections the national, local planning and local transport policy and guidance that are relevant to the NDR scheme application are presented and summarised.

4.1.2 The NDR is key to the Norwich Area Transportation Strategy (NATS – see **Section 4.5** below for more detail), allowing the development of a modern, sustainable transport system for Norwich, including Bus Rapid Transit and facilities for cyclists and pedestrians. Government support for the road is conditional up progress of City Centre measures.

4.1.3 The purpose of the NDR is explained in the Needs Case which is included in the **Environmental Statement** (doc ref 6.1). It also sets out the reasoning and justification as to why the NDR scheme is needed. This TA chapter should be read in conjunction with the Needs Case.

4.2 Norwich's City Deal

4.2.1 It was agreed in February 2013 that work should start on negotiating a City Deal for Greater Norwich as part of the Cabinet Office's programme to work with 20 towns and cities as a second wave of City Deals. Since this time, a great deal of work has been done with Broadland, Norfolk County and South Norfolk Council partners on a plan to develop a greater Norwich approach. It is anticipated that the Deal will be announced on 12 December 2013.

4.2.2 The Greater Norwich City Deal has three strands: Skill, Business support and Infrastructure. Through a coordinated approach to the 3 strands the City Deal promotes increased economic growth.

4.2.3 The infrastructure strand identifies the timely delivery of NDR and NATS as important key to achieving our economic growth Aspirations. The City Deal governance will focus the partners' combined efforts to ensure the required infrastructure including the NDR is delivered.

4.3 National Policy Context

National Planning Policy Framework

4.3.1 National Planning Policy Framework (NPPF) was published on 27th March 2012 setting out the Government's planning policies, how these are expected to be applied, and which must be taken into account as material planning considerations in planning decisions. It is of note that the NPPF supersedes the majority of previous National Planning Guidance including (but not limited to) PPG13: Transport, PPS4: Planning for Sustainable Economic Growth, PPG24: Planning and Noise, PPS25: Development and Flood Risk.

4.3.2 The need to deliver sustainable development underlies the NPPF through the mutually dependent economic, social and environmental roles. Within the Core Planning Principles (para 17) planning decisions should be generally plan-led, empowering local people to shape their surroundings with succinct local and neighbourhood plans setting out a positive vision for the future of the area. The need to proactively drive and support sustainable economic development and to objectively identify and then meet the housing, business and other development needs for an area are stressed.

4.3.3 Sustainability also involves:

- Securing high quality design;
- Ensuring a good standard of amenity supporting the transition to a low carbon future in a changing climate taking full account of flood risk;
- Promoting mixed use developments;
- Recognising that some open land can perform many functions (such as for wildlife, recreation and flood risk mitigation).

4.3.4 Importantly the last 2 bullet points in paragraph 17 require developments to influence patterns of growth to make the fullest possible use of public transport, walking and cycling, and take account of and support local strategies to improve health, social and cultural well-being, and to deliver sufficient community and cultural facilities and services to meet local needs. A key tool to facilitate sustainable transport is via a Travel Plan. Paragraph 29 of NPPF states that: "*Transport policies have an important role to play in facilitating sustainable development but also in contributing to wider sustainability and health objectives. Smarter use of technologies can reduce the need to travel. The transport system needs to be balanced in favour of sustainable transport modes, giving people a real choice about how they*

travel. However, the Government recognises that different policies and measures will be required in different communities and opportunities to maximise sustainable transport solutions will vary from urban to rural areas."

4.3.5 NPPF Paragraph 31 also identifies that: "Local authorities should work with neighbouring authorities and transport providers to develop strategies for the provision of viable infrastructure necessary to support sustainable development, including large scale facilities such as rail freight interchanges, roadside facilities for motorists or transport investment necessary to support strategies for the growth of ports, airports or other major generators of travel demand in their areas."

4.3.6 NPPF Paragraph 32 requires all developments that generate significant amounts of movement to be supported by a Transport Statement or Transport Assessment. It continues that plans and decisions should take account of whether:

- "the opportunities for sustainable transport modes have been taken up depending on the nature and location of the site, to reduce the need for major transport infrastructure";
- "safe and suitable access to the site can be achieved for all people"; and
- "improvements can be undertaken within the transport network that cost effectively limit the significant impacts of the development. Development should only be prevented or refused on transport grounds where the residual cumulative impacts of development are severe."

4.3.7 NPPF Paragraph 37 seeks to achieve a balance of land uses within the area so that people can be encouraged to minimise journey lengths for: employment, shopping, education and other activities.

4.3.8 Based on the above review of NPPF, it is considered that the implementation of NDR is in line with the policies set out in this document.

The Future of Transport - A Network for 2030

4.3.9 The 'Future of Transport - A Network for 2030' White Paper published in July 2004 sets out the Government's aspirations to meet the shared priority for transport. It recognises that a transport network is needed that can meet the challenges of a growing economy and the increasing demand for travel, but can also achieve its environmental objectives. This means providing a coherent transport network with:

- The road network providing a more reliable and freer flowing service for both personal and freight travel, with people able to make informed choices about how and when they travel.
- The rail network providing a fast, reliable and efficient service, particularly for inter-urban journeys and commuting into large urban areas.
- Bus services which are reliable, flexible, convenient and tailored to local needs.
- Making walking and cycling a real alternative for local trips.
- Ports and Airports providing improved international and domestic links.

4.3.10 Paragraph 10 of the white paper refers to the strategy of improving and enhancing road networks by:

- Providing new capacity where it is needed, assuming that any environmental and social costs are justified;
- Locking in the benefits of new capacity through various measures
- Government leading the debate on road pricing and its capacity to lead to better choices for motorists;
- Better management, exploiting the potential of new technology to avoid problems and deal with them rapidly if they occur; and
- Use of new technology to keep people informed both before and during their journey.

4.3.11 Based on the above review of the White Paper, it is considered that the implementation of NDR is in line with the aims set out in this document.

Local Transport White Paper 2011

4.3.12 The Local Transport White Paper titled Creating Growth, Cutting Carbon – Making Sustainable Local Transport Happen was published by DfT in January 2011. It contains the following four key statements in its executive summary:

- “Our vision is for a transport system that is an engine for economic growth, but one that is also greener and safer and improves quality of life in our communities.”
- “Encouraging sustainable local transport choices depends on local solutions”
- “The Government has already taken significant steps to hand back responsibility for developing local solutions in planning and the economy to the local level”
- “In addition, we also recognise that there are some initiatives that benefit from a single national approach”

4.3.13 The government considers that investment in transport is not enough in itself but that measures need to be put in place enabling people to make the right transport choices.

4.3.14 The paper also advocates the decentralisation of power to the more local level and to enable local delivery of schemes and measures. A number of funding options for transport schemes have been put in place such as the Local Sustainable Transport Fund (LSTF).

4.3.15 Within the paper, the government is making a number of specific national commitments to enhance the sustainability of local transport. These include amongst others: commitment to active travel, making public transport more attractive, to enable sustainable transport options, to base investment decisions on carbon implications and to tackle congestion.

4.3.16 Based on the above review of the White Paper, it is considered that the implementation of NDR is in line with the key statements and national commitments set out in this document.

Action for Roads 2013

4.3.17 The Action for Roads – A Network for the 21st Century was published by DfT in July 2013. It contains the following four key headings in its executive summary:

- "The growing challenge" referring to the vital importance of the road network and its importance in providing economic benefits. It goes on to underline the importance of making "best use of the network we have" and "to plan ahead to help the economy grow".
- "Transforming strategic roads" where the document refers to the upgrade and maintenance of the strategic road network.
- "Managing our roads" referring to the key conclusions of the Cook Review which provides funding certainty and a reorganisation of the Highways Agency.
- "Supporting local roads" referring to the decentralisation of decision making.

4.3.18 Based on the review of the above paper, it is considered that the implementation of NDR is in line with the four key headings set out in this document.

National Policy Statement for the National Road and Rail Networks (NPS) – Consultation Draft

4.3.19 A draft version of the NPS was presented for consultation in December 2013. The document sets out "the Government's vision and policy for the future development of nationally significant infrastructure projects on the national road and rail networks." (paragraph 1.1, page 5). With five key chapters, the document sets out the importance of road and rail infrastructure in terms of economic growth, sustainability, accessibility and assessment principals.

4.3.20 The NPS makes reference to the National Strategy Framework for Road Safety (Department for Transport, May 2011). This document "sets out the strategic framework for road safety and the package of policies … to reduce deaths and injuries ..." (paragraph 1.3, page 13). Across six chapters, trends, empowering local citizens, education, targeted enforcement and sanctions and casualty forecasts are detailed. The document does not provide any guidance on how to undertake safety reviews.

4.3.21 Based on the review of the above paper which is still a consultation draft, it is considered that the implementation of NDR is in line with the vision and policy set out in this document.

4.4 Local Planning Policy context

Joint Core Strategy

4.4.1 Following the Joint Core Strategy's (JCS) adoption in March 2011, it was subject to a legal challenge which resulted in certain parts of the JCS being remitted and treated as not having been adopted. Norfolk County Council with Broadland District Council, Norwich City Council and South Norfolk Council, working as the Greater Norwich Development Partnership (GNDP), submitted the remitted parts of the JCS to the Secretary of State for independent examination in February 2013. The Inspector reported in November 2013 that the remitted JCS (with some further modifications) was sound. The Councils have indicated that the remitted JCS is likely to be adopted in January 2014.

4.4.2 The JCS sets out the long-term vision and objectives for the area, including strategic policies for steering and shaping development. It identifies broad

locations for new housing and employment growth and changes to transport infrastructure and other supporting community facilities, as well as defining areas where development should be limited. It helps co-ordinate and deliver other services and related strategies.

4.4.3 The JCS forms part of each council's Local Plan. Subsequent documents will be produced by the individual authorities that will provide more detailed development management policies and will also allocate sites for new developments.

4.4.4 Based on the review of the above strategy, it is considered that the implementation of NDR is in line with the vision and objectives set out in this document.

Norwich Northern City Centre Area Action Plan

4.4.5 On 30 March 2010 Norwich City Council adopted the Northern City Centre Area Action Plan (NCCAAP). This document now forms part of the planning policy framework for the council and will be used when determining planning applications in this part of the city.

4.4.6 The NCCAAP contains policies and proposals for the regeneration of the area and redevelopment of specific sites over the period 2008-16. The NCCAAP area is that bounded by the River Wensum, Bakers Road, Magpie Road, Bull Close Road, and Whitefriars.

4.4.7 The northern city centre area is Norwich City Council's priority area for regeneration. The area is likely to see significant change as several new developments come forward in the next few years. This area action plan sets out proposals and policies to bring about the regeneration of the area up to 2016. The largest new development is the prospective redevelopment of the Anglia Square complex and the adjoining vacant sites.

4.4.8 The NCCAAP sets out the vision and objectives for the area. It emphasises that the plan has been developed consistently with existing adopted local plan policies (the City of Norwich replacement local plan) and the Joint core strategy.

4.4.9 The plan aims to encourage a mix of development, cultural & leisure activities, promoting a mix of development, specifically:

- Encourage a balance of housing, with family housing included in the redevelopment schemes brought forward

- Promote mixed use development in the core of the northern city centre area, reinvigorating its economy by providing jobs as well as housing
- Encourage cultural and leisure activities in the area
- Strengthen its local distinctiveness from the rest of the city centre
- Improve the area's shopping offer, including the range of small independent shops

4.4.10 To help inform and shape the plan, consultation and sustainability appraisal were carried out throughout the plan's production. Two stages of formal consultation on the content of the plan were held; the issues and options stage in summer 2006 and the referred options in winter 2007-08.

4.4.11 In winter 2008-09 the regulation 27 consultation on soundness took place and to address issues raised a further consultation was held on the focused changes in late spring 2009. The area action plan is scheduled to be regularly reviewed to ensure that it remains consistent with the Joint Core Strategy as the JCS evolves.

4.4.12 Whilst the NCCAAP is predominantly a development focused planning framework, it does make reference to specific infrastructure and transport related measures, namely:

- Improvements to traffic circulation to address air quality issues in the St Augustine's Street area;
- Make major improvements to the public realm in the NCCAAP area;
- Enhance pedestrian and cycle movement by provision of new pedestrian crossing facilities, and
- Creation of new pedestrian and cycle links throughout the area.

4.4.13 Improvements to traffic circulation and reduction in air pollution are required in order to implement the air quality strategy and address the reasons for the designation of an air quality management area in St Augustine's Street.

4.4.14 The area action plan's proposals relating to traffic circulation are in accordance with the Norwich area transportation strategy (NATS)7 action plan and the Local transport plan (LTP), and as such, whilst not directly part of the NDR scheme, will play a part in the overall transportation strategy for the area.

4.5 Local Transport Policy Context

Norfolk's Third Local Transport Plan (2011 to 2026)

4.5.1 Norfolk's Third Local Transport Plan (LTP) was adopted in March 2011. Known as 'Connecting Norfolk', LTP3 sets out the County's strategy and policy framework for delivery of transportation schemes up to 2026. It will be used as a guide for transport investment and considered by other agencies when determining planning or delivery decisions.

4.5.2 Connecting Norfolk's vision is to develop a transport system that allows residents and visitors a range of low carbon options to meet their transport needs and attracts and retains business investment in the county. Six strategic aims underpin this vision:

- Maintaining and managing the highway network
- Delivering sustainable growth
- Enhancing strategic connections
- Reducing emissions
- Improving road safety
- Improving accessibility

4.5.3 This will be done by:

- Making the best use of what Norfolk has to facilitate reliable journeys
- Reducing the need to travel
- Influencing others and ensuring transport is integrated into development plans
- Working with communities and Norfolk's partners to seek new solutions and new ways of delivering
- Lobbying for and pursuing improvements to Norfolk's strategic transport network.

4.5.4 Connecting Norfolk identifies the Norwich Northern Distributor Road as a key tool to facilitate and deliver the above objectives and aims, noting specifically that it will:

- Play a significant role in delivering the significant growth in Norfolk during the life of Connecting Norfolk
- Enhance strategic connections by facilitating strategic access to north-east Norfolk and Norwich Airport

4.5.5 Based on the above review of the LTP, it is considered that the implementation of NDR is in line with the aims and objectives set out in this document.

Norwich Area Transportation Strategy (NATS)

4.5.6 The most recent iteration of the Norwich Area Transportation Strategy (NATS) was adopted by the local authorities in 2004. The transport strategy was designed to help deliver the growth that will happen within the Norwich Area and address the problems, such as congestion. The strategy should ensure that Norwich develops as a sustainable urban community, with a transport system that meets its needs. The strategy promotes travel choice, recognising the need to maintain the economic health of the Norwich Area, and does not propose radical restrictions on vehicular access. It carries forward the previous policy of accommodating the growth in number of trips by means other than the car. NATS4 will achieve this through promotion and improvements of other modes, including public transport.

4.5.7 A Northern Distributor Road is identified as an important element to enable growth within and around Norwich. The strategy states that a new road will be delivered in conjunction with other measures, to lock in the benefits, and that the road will allow the full package of NATS interventions to be delivered.

4.5.8 NATS has been successful to date in controlling the way Norwich has developed its transport infrastructure and this has included provision of the nationally recognised Park & Ride facilities and the award winning bus station. However the success of NATS is likely to be compromised in the future if significant efforts are not made to continue to deliver its objectives.

4.5.9 The main aims of NATS4 are to:

- Promote a vibrant city centre, and other commercial centres, by improving accessibility for people and goods;
- Cater for the travel consequences arising from growth aspirations. In particular, accommodate transport needs arising from future growth of the airport and the cluster of the Norwich Research Park, University and hospitals at Colney;
- Maximise transport choice for all travellers;
- Reduce social exclusion through transport solutions and promote equal access to jobs, goods and services;
- Enhance access for non-car modes, promote sustainable means of travel, minimise the length of trips and encourage reduced car-use through land use policies, layout of development and promotion of travel plans;
- Improve integration and interchange;
- Reduce the need to travel;
- Minimise congestion and delays for all modes of transport by improving the efficiency of the transport network;

- Reduce CO2 emissions from transport by encouraging sustainable modes of travel and vehicles using fuels derived from renewable sources or waste;
- Promote the use of alternative modes of transport and less polluting fuels, particularly within Air
- Quality Management Areas;
- Minimise noise, vibration and visual intrusion from transport, particularly in the public, urban open spaces in the historic city centre;
- Implement transport solutions that protect open space, wildlife habitats and water resources;
- Maximise safety and security for everyone;
- Minimise the number and severity of road traffic accidents.

4.5.10 In March 2010, NCC agreed a NATS Implementation Plan (NATSIP) for the future vision of NATS and what that would consist of, in particular in respect of delivering improvements for public transport, walking and cycling. The NATSIP was agreed following extensive consultation in 2009, whereby 160,000 booklets were distributed showing the most significant proposals for improving transport within the Norwich area and a series of exhibitions were held.

4.5.11 In addition to the NDR, the proposals considered in the NATSIP included public transport Bus Rapid Transit Corridors, Core Bus Route improvements, bus ticketing and bus facility improvements, measures to reduce the dominance of traffic in certain areas of the City Centre and improvements to the walking and cycling network and facilities.

4.5.12 More recently, in November 2013, an updated Implementation Plan was adopted taking into account progress with scheme delivery. The update outlined the relationship between NATS schemes and the wider growth and development agenda taking account of the implications of emerging funding opportunities including the Community Infrastructure Levy. The major difference between the NATSIP adopted in 2010 and the update was in the phasing of delivery of the schemes.

4.5.13 The implementation of NDR being an intrinsic part of the above strategy, it is considered that the scheme is entirely in line with the aims set out in this document.

4.6 Alignment with National and Local Policy

4.6.1 The implementation of the NDR scheme as part of the NATS strategy have been considered for their alignment with National and Local policies. The NDR scheme is considered to be fully in line with the key policies and guidance set out earlier in this section.

5 Existing Network Description

5.1 Route Network Hierarchy

5.1.1 A route Hierarchy exists for the whole of Norfolk. This identifies roads according to their function and level of use. It was developed by NCC to manage the highway network and to enable measures to be implemented to encourage road users to use the most appropriate routes. The hierarchy consists of:

- Trunk Roads;
- 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) from Principal Routes and Main Distributor Routes;
- Local Access Routes – linking the more significant communities with Trunk and Principal Routes, Main Distributor Routes and HGV routes; and
- Tourist Routes – links the recognised tourist attractions with all other types of routes.

5.1.2 NCC's existing route Hierarchy is shown in **Appendix C.2** of this TA. It will need to be updated to reflect the provision of the NDR and the resulting changes to the highway network.

5.2 Description of Key Routes

5.2.1 The key routes described below are shown in **Appendix C.2** and **C.3**.

5.2.2 The **A47(T)** is a trunk road within Norfolk County Council's Route Hierarchy. It is the main east west route across northern East Anglia connecting Great Yarmouth on the eastern coastline via the southern side of Norwich to the A1 at Peterborough for onward journeys to the north. The A47(T) is a trunk road as far as the A1. Within the study area the A47(T) is largely dual carriageway with grade separated junctions.

5.2.3 The main route that spans across the radial routes is the Norwich **Outer Ring Road** (A1042/A140/A146). This road is predominantly single carriageway, comprising many signalised junctions.

5.2.4 The **A147 Inner Ring Road** is classed as a Principal Route within NCC's Route Hierarchy. Generally, the western side of the ring road between

A1151 and Finklegate is dual carriageway with 2 traffic lanes in each direction. The eastern side is mainly single carriageway.

5.2.5 Norwich has 12 radial routes which provide access from all directions to the city. Most of them are single carriageway with few sections of dual carriageway; some sections comprise a total of three lanes, for example to provide a bus only lane in a single direction. These are also shared with taxis and cyclists. On approaches to the city via the A11 radial route, the bus lanes are also used by freight operators as part of the freight consolidation delivery service.

5.2.6 The paragraphs below provide an overview of the radial routes.

5.2.7 The **A1067** Drayton High Road / Fakenham Road is classified as a Principal Route within NCC's Route Hierarchy. It links the A147 Inner Ring Road on the north-western side of Norwich with the A148 near Fakenham.

5.2.8 **Reepham Road** is a Local Access Route within NCC's Route Hierarchy from the Outer Ring Road to Hellesdon. Within the study area of this TA the route is single carriageway.

5.2.9 The **A140** Aylsham Road / Cromer Road / Holt Road is classified as a Principal Route within NCC's Route Hierarchy. The A140 runs between the A14 north of Ipswich to Cromer on the coastline via the western side of Norwich. Within the study area, the route is predominantly single carriageway with at-grade junctions. Additional traffic lanes are present on approach to the main junctions on the route.

5.2.10 The **B1149** Holt Road is classified as a Main Distributor Route within the NCC's Route Hierarchy. The route runs from its junction with the A140 and continues until it meets the A148 at Holt. Within the study area of this TA the route is single carriageway.

5.2.11 The **B1150** Constitution Hill / North Walsham Road is classified as a Main Distributor Route within the NCC's Route Hierarchy. The route starts at the junction with the A1151 on the north side of the City Centre and continues in a generally northbound direction until it meets the A149 in North Walsham. Within the study area of this TA, the route is single carriageway.

5.2.12 The **A1151** Wroxham Road / Sprowston Road is classified as a Principal Route within NCC's Route Hierarchy. The route starts at the junction with the A147 (Inner Ring Road) on the northern side of Norwich City Centre and continues in a generally north-eastbound direction until it becomes the A149.

Within the study area of this TA the route is single carriageway. There is an inbound bus lane from Recreation Ground Road to the approach of its junction with the ORR.

5.2.13 **Salhouse Road** is classified as a Local Access Route within NCC's Route Hierarchy between the A1042 Outer Ring Road and Rackheath. Within the study area of this TA the route is single carriageway.

5.2.14 The **B1140** Plumstead Road is classified as a Local Access Route within NCC's Route Hierarchy between the Inner Ring Road and Outer Ring Road. Beyond the Outer Ring Road it is classified as a Local Access Route to Thorpe End. Within the study area of this TA the route is single carriageway.

5.2.15 The **A1242** Thorpe Road / Yarmouth Road is classified as a Principal Route within NCC's Route Hierarchy. The route commences at the Inner Ring Road and continues in an easterly direction. At its junction with the Outer Ring Road it becomes the **A1042** from where it continues to the A47(T) at Postwick. Between the City Centre and Postwick, Yarmouth Road is single carriageway except for a short section of dual carriageway south of the Postwick junction with the A47(T).

5.2.16 The **A146** Loddon Road is classified as a Principal Route within NCC's Route Hierarchy. The route commences at Norwich's Outer Ring Road and continues in a south easterly direction to form a junction with the A47(T) and continues to Lowestoft. To the north of the A47(T), the A146 is dual carriageway, while to the south it is single carriageway.

5.2.17 The **A140** Ipswich Road is classified as a Principal Route within NCC's Route Hierarchy. The route commences at Norwich's Outer Ring Road and continues in a southerly direction to form a junction with the A47(T) and continues to the A14 and Ipswich. Within the study area of this TA the route is single carriageway.

5.2.18 The **A11** Newmarket Road / St Stephens Road is classified as a Principal Route within NCC's Route Hierarchy. The route commences at Norwich's Inner Ring Road and continues in a south westerly direction to form a junction with the A47(T). Beyond this, the A11(T) extends via Newmarket to the M11. Within the study area of this TA the route is largely single carriageway. However, from a point approximately half way between the Outer Ring Road and the A47(T), the A11 to the west is dual carriageway. Along the A11, there are two inbound bus lanes (Unthank Road to approach

with ORR junction, Mt Pleasant to approach with IRR junction) and one outbound bus lane (Mt Pleasant to approach with ORR junction).

5.2.19 The **B1108** Earlham Road / Watton Road is classified as a Main Distributor Route within NCC's Route Hierarchy. The route commences at Norwich's Inner Ring Road and continues in a westerly direction to form a junction with the A47(T). To the west of this, Watton Road extends via Hingham and Watton. Within the study area of this TA the route is predominantly single carriageway. There is an inbound bus lane between Heigham Grove and the approach to IRR.

5.2.20 The **A1074** Dereham Road is classified as a Principal Route within NCC's Route Hierarchy. The route commences at Norwich's Inner Ring Road and extends to the north west to form a junction with the A47(T) at Longwater. Within the study area of this TA the route is predominantly single carriageway. There is an inbound bus lane between Gurney Road and the approach to the Outer Ring Road and an inbound bus lane between Orchard Street and the approach to the Inner Ring Road.

5.2.21 The Inner Ring Road is limited to 30mph for its entire length, while the speed limit along the Outer Ring Road comprises a mixture of 30mph and 40mph sections. All sections of the Inner Ring Road are within built-up areas of the city; the Outer Ring Road passes through a mix of housing, employment and retail areas.

5.2.22 Routes across the city centre within the Inner Ring Road are all single carriageway comprising one-way sections.

5.3 Description of Key Junctions

5.3.1 Along the dual carriageway sections of the A47(T), junctions are generally grade separated or of good standard and provide adequate visibility for traffic turning from the minor arms onto the mainline. They provide acceptable levels of capacity for current levels of traffic at all but the Postwick interchange.

5.3.2 The single carriageway roads are characterised by many small junctions and minor turnings.

5.3.3 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 to be

increased through enlarging the junction geometry or adding additional lanes on congested roads. Such junctions do not have the scope to be radically altered to meet increased demand and hence only minor improvements have been possible. Within Norwich, the constraint on land in the vicinity of junctions has led to many becoming signal controlled, comprising layouts which have been adapted as far as possible to cope with traffic volumes and vehicle sizes. Many of the junctions have been upgraded to include pedestrian and cycle crossing facilities in order to provide coherent routes for vulnerable road users wherever possible.

5.3.4 The existing junctions that are assessed within **Chapter 8** of this TA are:

- A47(T) / A146 Trowse Junction
- A146 / Martineau Lane
- A147 Bracondale / King Street
- N1150 North Walsham Road / Rackheath Lane (Crostwick Junction)
- A1151 Wroxham Road / Green Lane West (Rackheath Junction)

A47(T) / A146 Trowse

Photo 5.1 Existing Junction Layout – A47(T) / A146 South-Eastern Junction

Source: Mott MacDonald Ltd, 24 October 2013, for location see Appendix C.3

5.3.5 The intersection of the A47(T) / A146 Loddon Road is a four arm grade separated traffic signal controlled junction. The A47(T) runs north-east to south-west; the A146 runs north-west to south-east and is dual carriageway in the vicinity of this junction. To the north-west and south-east of the A47(T), its slip roads form two signal controlled junctions with the A146. The two arms of the A146 comprise three lanes, but on approach to each junction, vehicles turning left to the A47(T) are provided with a short flared left turning

lane, which bypasses the traffic signals and is priority controlled. Vehicles turning right to the A47(T) are provided with a two lane flared right turning facility, which is signal controlled. The A47(T) off-slips each comprise two lanes, which widen on approach to the junction to provide a total of four lanes, including two for the left turn. All arms of the junction are subject to national speed limit. The eastern arm of the A47(T) and both arms of the A146 form a bus route.

5.3.6 The junction model results for the existing scenario, detailed within **Chapter 8** of this TA, show that this junction currently operates within capacity limits during the AM and PM peak hours. During the AM peak hour, the heaviest queuing occurs at the junction of the A146 (northbound approach) and A47(T) westbound off-slip, for inbound movements to the City. During the PM peak hour, the heaviest queuing occurs at the junction of the A146 (southbound approach) and the A47(T) eastbound off-slip, for outbound movements from the City.

A1054 Martineau Lane / A146 Trowse Bypass

Photo 5.2 Existing Junction Layout – Martineau Lane / Trowse Bypass

Source: Mott MacDonald Ltd, 23 October 2013, for location see Appendix C.3

5.3.7 The intersection of the A1054 / A146 is a three arm traffic signal controlled junction. The A1054 Martineau Lane forms the north-eastern arm, the A146 (link to the A47(T)) forms the south-eastern arm and A146 Martineau Lane forms the western arm. A short distance to the west of the junction, the A146 Martineau Lane becomes Barrett Road. The A1054 Martineau Lane provides a single lane in the southbound direction, which on approach to the junction widens to form two lanes for the left turn to the A146 and two lanes for the

ahead movement to the A146 Barrett Road. The A146 (link to the A47(T)) is a dual carriageway, comprising two lanes in each direction and is subject to a 40mph speed limit on the approach to the junction where the highway flares to provide two lanes for the left turn towards the A146 Barrett Road and the two lanes on the main carriageway form the right turn towards the A1054 Martineau Lane. The A146 Barrett Road comprises a single lane in each direction, which on approach to the junction flares locally to provide a single lane for the ahead movement to the A1054 Martineau Lane and two lanes for the right turn towards the A146 (link to the A47(T)). The links forming the junction are subject to a 40mph speed limit, however a signed change of speed limit from 30mph is located a short distance to the south-west of the junction along A146 Barrett Road. Traffic signal controlled pedestrian crossing facilities are provided on the A146 (link to the A47(T)) approach and the A146 Barrett Road approach. The A146 (link to A47(T)) and A1054 Martineau Lane form a bus route.

5.3.8 The junction model results for the existing scenario, detailed within **Chapter 8** of this TA, show that this junction currently operates within capacity limits during the AM peak hour, but at capacity limits during the PM peak hour, which results in a significant queue occurring on the left turn from Martineau Lane (westbound) during the PM peak hour.

A147 Bracondale / King Street

Photo 5.3 Existing Junction Layout – Bracondale / King Steet

Source: Mott MacDonald Ltd, 23 October 2013, for location see Appendix C.3

5.3.9 The intersection of A147 King Street / A147 Bracondale is a three arm traffic signal controlled junction. Bracondale runs east-west, while King Street

extends north-south. The A147 Bracondale is a bus route and all three arms of the junction form cycle routes, namely the Outer Circuit and NCN Route 1. No signal controlled pedestrian facilities are provided at this junction despite this being a main route out of the city centre to County Hall.

5.3.10 The junction model results for the existing scenario, detailed within **Chapter 8** of this TA, show that this junction currently operates well above capacity limits during the AM peak hour, but within capacity limits during the PM peak hour, though regular observation shows that it also frequently overcapacity in the PM peak. Significant queuing occurs on the right turn approach from Bracondale (East) in both peak hours. This is most problematic during the AM peak hour, when the inbound queue can extend back as far as the County Hall roundabout to the south. King Street nears capacity during the AM peak and hence significant queuing occurs on this approach. Substantial queuing also occurs on the Bracondale (West) approach in the AM peak hour, because the junction as a whole is over capacity.

North Walsham Road / Rackheath Lane (Crostwick Junction)

Photo 5.4 Existing Junction Layout – North Walsham Road / Rackheath Lane

Source: Mott MacDonald Ltd, 22 October 2013, for location see Appendix C.3

5.3.11 The intersection of the B1150 North Walsham Road / Crostwick Lane / Rackheath Lane is a four arm staggered priority controlled ghost island junction. North Walsham Road forms the northern and southern arms of the junction. Crostwick Lane forms the western arm and Rackheath Lane forms the eastern arm, separated by approximately 20m. Each of the arms of the junction comprises a single lane approach; however the ghost island along North Walsham Road accommodates short storage lanes in each direction

for right turning vehicles. North Walsham Road is subject to a 50mph speed limit and Rackheath Lane a 60mph speed limit. Crostwick Lane is subject to a 30mph speed limit and vehicles greater than 7.5 tonnes in weight are prohibited from using this road, except for loading.

5.3.12 The junction model results for the existing scenario, detailed within **Chapter 8** of this TA, show that this junction currently operates well within capacity limits during the AM and PM peak hours and hence there are no operational issues.

A1151 Wroxham Road / Green Lane West (Rackheath Junction)

Photo 5.5 Existing Junction Layout – Wroxham Road / Green Lane West

Source: Mott MacDonald Ltd, 22 October 2013, for location see Appendix C.3

5.3.13 The intersection of the A1151 Wroxham Road / Green Lane West is a three arm priority controlled junction. Wroxham Road forms the north-eastern and south-western arms of the junction, while Green Lane West extends to the south east and forms the minor arm. Each arm of the junction comprises a single lane approach. Wroxham Road is subject to a 50mph speed limit, while Green Lane West is subject to a 40mph speed limit. The required 2.4m x 160m visibility to the left from Green Lane West is obscured by the presence of vegetation along the north side of Wroxham Road. In mitigation, road signage is present warning eastbound motorists of the likelihood of traffic turning ahead. The provision of adequate visibility at this junction is reliant upon the vegetation being regularly maintained. Green Lane West and the northern arm of Wroxham Road form a bus route.

5.3.14 The junction model results for the existing scenario, detailed within **Chapter 8** of this TA, show that this junction currently operates within capacity limits

during the AM and PM peak hours and hence there are no operational issues. However, the right turn out from Green Lane West approaches limits of capacity during the PM peak hour, which results in a small queue developing.

5.4 Airport Surface Access

5.4.1 Norwich International Airport is located 4 miles to the north of Norwich city centre with access provided by the **A140** Aylsham Road / Cromer Road / Holt Road and via the Outer Ring Road. There is presently no direct connection to the Strategic Road Network linking the airport to the A47(T).

5.4.2 A Park and Ride facility located at the airport provides a link to Norwich City Centre; bus service 603 provides a regular service. First Eastern and National coach services also serve the airport.

5.4.3 The airport currently has a throughput of over 400,000 passengers per year. 70% of passengers originate from the Norfolk area, 25% originate from Norwich itself. Currently 73% of passengers arrive by car, 20% by taxi and with the remainder using other public transport. Forecast for passenger growth is 6% per annum over the next 10 years.

5.4.4 Airlines operating from the airport include Flybe, KLM, Eastern Airways and bmi regional. These airlines offer flights to UK airports including the Channel Islands and to European destinations such as the Balearics and Canaries with several of the destinations being seasonal.

5.4.5 The airport is also an important location in connection with the off-shore industry with helicopter flights having increased significantly (Norwich Airport website stating “some 40 departures on a daily basis to the platforms offshore”, as of May 2012). On the same page it is stated that total passenger numbers have increased from just over 29,000 in 2002/03 to over 77,000 in 2011/12.

5.4.6 Norwich Airport is also an increasingly important business location with the first phase of the Norwich Aeropark having been permitted in July 2013 providing employment and industrial facilities for Air Livery aircraft painting firm including the company’s headoffice.

6 Sustainable Transport

6.1 Bus

6.1.1 Norwich is comparatively well served by bus services with a range of service providers including Anglianbus, First Norfolk & Suffolk, Konectbus, Norfolk Green and Sanders.

6.1.2 Most bus and coach services run from Norwich bus station and/or from Castle Meadow as shown in the key bus route map which is included in **Appendix C.4**. In addition, Norwich has six Park & Ride sites run by Norfolk County Council using colour-coded buses, making Norwich's Park & Ride scheme one of the largest bus-based UK operations, providing over 5000 parking spaces.

6.1.3 The majority of public bus services operate in the urban areas and run mainly on radial routes into / out of the city centre, with many routes providing cross-city links. These offer good frequency services within the built-up areas during the day and in the evenings, although these can be hampered by traffic congestion in peak periods. The bus route linking the Norfolk and Norwich University Hospital and the University of East Anglia (UEA) to the railway station via Norwich city centre operates 24 hours a day.

6.1.4 Most services operate on radial routes. This may result in passengers having to change buses within the centre for journeys around the city, making trips more time consuming and potentially costly. Outside of the built-up area there are services to the surrounding market towns, but these tend to run on much lower frequencies.

6.1.5 There are a number of interchange points for onward bus or pedestrian journeys with the main ones in the city centre being on-street in Castle Meadow, St Stephens Street and at Anglia Square, and off-street at the bus and railway stations and at Park & Ride sites. Interchange points are also present at the airport, the hospital and UEA. A new bus station in Norwich city centre was opened in 2005 as part of a £10m major project that involved improved public transport links (including a bus priority route) between the bus and railway station.

6.1.6 The main bus services on the core network in the NDR corridor are highlighted in the key bus route map which is included in **Appendix C.4.**

6.1.7 The introduction of the NDR would result in a total of 18 public bus services needing to cross the proposed corridor, these use the following routes:

- 1 service travels along the existing A1067 Fakenham Road (X29)
- 2 services travel along the B1149 Holt Road (36 & 45);
- 5 services travel along Cromer Road (2, 43, 44, 44a & X44)
- 3 services travel along Buxton Road; (210, 13 & 13c)
- 1 service travels along the B1150 North Walsham Road (55)
- 2 services travel along the A1151 Wroxham Road; and (14a & 36)
- 1 service travels along Salhouse Road (53)
- 3 services travel along Plumstead Road (14, 14a, 51*).

**Note – Service #51 routes along both Salhouse Road and Plumstead Road, but for the purposes of this exercise has been included only once.*

6.2 Park & Ride

6.2.1 A key aspect of public transport/parking provision for Norwich is Park & Ride. Norfolk County Council operates 6 Park & Ride sites located on the main routes into the City Centre at the following sites:

- Thickthorn Park & Ride service 601
- Harford Park & Ride service 602
- Airport Park & Ride service 603
- Costessey Park & Ride service 604
- Postwick Park & Ride service 605/606
- Sprowston Park & Ride service 605/606

6.2.2 These sites provide almost 5,000 spaces and more than 3 million passengers use Park & Ride in Norwich each year. The Park & Ride scheme also operate a School Run scheme where school pupils can use the bus service (£1.10 return ticket), who can be accompanied by an adult who purchase a 1p chaperone ticket. Bus services operate at a frequency of approximately every 12-15 minutes (every 20 minutes from the Costessey site) between 07:00 and 19:00 hours Monday to Saturday.

6.3 Coaches

6.3.1 Many visitors to Norwich arrive by coach, with the main coach station in Norfolk being at the bus station on Surrey Street. National Express coaches run 10 daily services between Norwich and London Victoria coach station, of which 5 are direct services. National Express airport coach services include stops at Stanstead airport, London Heathrow, and Gatwick airports. A direct daily service also operates to Birmingham.

6.4 Rail

6.4.1 Norwich rail station is situated on the eastern side of Norwich city centre and serves local and national rail services provided by East Midlands Trains and Greater Anglia. All rail services start or end at Norwich rail station. Local services operate to Lowestoft (hourly), Great Yarmouth (hourly, half hourly at peak times) and Sheringham (hourly). National services provide access to London (Liverpool Street) on a half hourly frequency and Manchester, Liverpool, Nottingham on an hourly frequency (Monday to Saturday). Cambridge is served by one service per hour (Monday to Saturday) with a further service to Cambridge via Ely.

6.4.2 There are also a number of rail stations in the wider Norwich area which provide local rail services. These include Salhouse which is located off A1151 Norwich Road/Salhouse Road, and is situated approximately 1 mile north-east of the proposed NDR. Salhouse station offers services to Norwich and Sheringham. Brundall Gardens station is located to the east of Postwick, west of Brundall Village and is situated approximately 1 mile east of the proposed NDR. Brundall Gardens offers services to Norwich, Great Yarmouth and Lowestoft, via outlying stations such as Buckenham, Cantley, Acle and Reedham.

6.5 Non-motorised User Provision

6.5.1 As well as the vehicle based public transport options it is also important that the provision for Non-Motorised Users or NMUs is considered, as many people will rely on these modes in order to reach a public transport mode for onward travel. Travel by non-motorised modes is also more sustainable and should be encouraged, indeed Norwich has one of the highest rates of sustainable commuting patterns in the UK. The proposed NATS measures aim at improving conditions for these users.

6.5.2 Much has been done by Norfolk County Council, Norwich City Council and Sustrans to provide convenient and safe routes for NMUs, including for pedestrians, cyclists and equestrian users.

6.5.3 As detailed in the TA scoping study, the TA identifies which NMU routes will be directly impacted upon (intersected or severed) by the NDR and / or the mitigation measures proposed. This following section details the existing provision and **Section 6.12** outlines the proposed mitigation measures.

6.5.4 A number of Public Rights of Way (PRoW) comprising of 4 restricted byways, 1 bridleway and 2 footpaths are proposed to be intersected and

subsequently severed by the NDR. In addition 1 permissive footpath is to be intersected by the NDR. Details of these are given in **Table 6.1.**

Table 6.1 PRoW / Permissive paths

Reference	Type	Description
Attlebridge (RB3)	Restricted byway	A track passable by vehicles linking the A1067 to Deighton Hills, which then continues as a restricted byway to Broad Lane, Attlebridge.
Drayton (RB6)	Restricted byway	A track that links Reepham Road with Dog Lane, Horsford and links with footpath to Drayton Drewray.
Horsford (RB7)	Restricted byway	A track that links the B1149 Holt Road with Drayton Lane.
Horsford (RB5)	Restricted byway	A track that links Reepham Road to Dog Lane, Horsford and also links with CRF3 to Horsford village.
Spixworth (BR1) / Horsham St Faith & Newton St Faith (BR6)	Bridleway	Runs from Quaker Lane to the perimeter fence of Norwich Airport.
Great and Little Plumstead (FP5)	Footpath	Links Low Road to Smee Lane. It forms part of Broadland Great and Little Plumstead circular walk.
Postwick (FP2)	Footpath	Links Smee Lane to the A1042 Yarmouth Road.
Marriott's Way	Permissive path	Runs along former rail line linking Norwich to Aylsham via Reepham. Forms part of national cycle route 1.
Grange Farm Spixworth Bridleway	Footpath, bridleways & private bridleways	Network of tracks providing access around Grange Farm linking Quaker Lane and Spixworth to Spixworth Hall, Grange Farm and Hog Bog Lane.

Source: Taken from Environmental Statement Chapter 12

6.6 Cycle Routes

6.6.1 In 2011 20% of adults in Norwich City Council's area cycled at least once per week, the fifth highest of any local authority in England. In 2011 6% per cent of adults usually travelled to work by bicycle, the sixth highest local authority percentage. The County Council want to build on these high levels and are committed to providing a good quality network of cycle routes in and around Norwich.

6.6.2 In June 2012 NCC and Norwich City Council launched a Norwich Cycle Map which is organised around five core radial routes called pedalways that cross the city, passing through the centre and out to villages within cycle commuting distance. There are also two circular pedalways (inner and outer) and numerous local routes.

6.6.3 During the 2012 public consultation NCC had various requests for improved walking and cycling facilities. As a result a strategy was developed extending the Norwich Cycle Map network out to the NDR and beyond to identify the walking and cycling corridors and to prioritise the consultation requests. The strategy was published as part of the February/March 2013 public consultation.

6.6.4 The Norwich cycle network consists of on and off road facilities, the main cycleways in Norwich include:

6.6.5 **Lakenham Way.** This is a popular cycleway that follows the route of the railway line, providing a direct traffic-free route into the centre of Norwich. As well as providing a direct route for commuters, it is a green and pleasant route which allows leisure cyclists to stop and enjoy the views.

6.6.6 **Marriotts's Way.** This is one of the most popular cycleways in the county and forms part of the National Cycle Network (Route 1). It follows the route of the former railway line from Norwich to Reepham. The route has been greatly improved in recent years, including the Dragon Crossing Bridge. The path has two distinct characters. The first section is urban with links to nearby communities, giving easy access to the city centre so is ideal for commuting and it used by up to 400 cyclists per day. The second section is rural and heads into the countryside.

6.6.7 **Hethersett/Thickthorn Cycleway.** This is a 1.8km cycleway between Hethersett and Thickthorn. The path goes around the southern side of the

city, around the Norfolk and Norwich University Hospital, the University of East Anglia and the nearby Research Park.

6.6.8 Two purpose built cycle routes would be directly affected by the NDR and are described in **Table 6.2.**

Table 6.2 Cycle Routes intersected by NDR

Reference	Type	Description
Spixworth to Old Catton.	**Purpose built cycleway**	This is approximately 2km of surfaced route along Buxton Road separated from the main carriageway by the verge and hedge. The route is well used by both pedestrians and cyclists for journeys to work and for visiting the amenities in the respective villages.
Horsham St Faith to Norwich Airport.	**Purpose built cycleway**	This is approximately 1.5km route from Horsham village centre to Norwich airport roundabout (A140 junction with B1149) using a closed road and purpose built link.

Source: Taken from Environmental Statement Chapter 12

6.6.9 The construction of the NDR with the extensive improvements to NMU provision in the form of approximately 25km of new links that connect to the existing cycle and pedestrian networks, is likely to provide benefits to cyclists. Furthermore, the NDR results in traffic being removed from local roads as demonstrated in **Chapter 9** of this report, making those roads a more conducive environment for walking and cycling. The effect of the NDR measures proposed for those Public Rights of Way and cycle routes intersected by the NDR are discussed later in the following sections.

6.7 Most Likely Future Sustainable Transport Provision

6.7.1 The NDR aims to reduce congestion on strategic routes and enable the removal of through traffic from the city centre. This should free up road space, reduce congestion and hence reduce journey times and improve reliability for public transport, as well as making a more conducive environment for travel by sustainable transport including walking and cycling.

6.7.2 In order to manage traffic volumes and speeds on the wider highway network, the NDR scheme includes a range of complementary traffic management measures aimed at reducing congestion which should also

benefit sustainable transport modes. Details of how the NDR will affect sustainable transport provision are discussed in the following sections.

6.8 Bus

6.8.1 The NATS Bus strategy highlights the need for seamless journeys, better interchange, and that the development of public transport should be accompanied by increasing levels of traffic restraint to improve urban environments. It is recognised that bus travel is often only easy for trips made into the city centre, and other trips may require a change of bus. The NATS strategy aims to improve the reliability and overall quality of public transport by:

- Encouraging investment from operators;
- Improving infrastructure and waiting facilities;
- Providing real-time information at strategic interchange points;
- Developing initiatives with operators to educate and inform public transport users and reduce their fear of crime;
- Developing and monitoring a Quality Bus Partnership for the Norwich Area to underpin the improvements funded by the Public Transport Major;
- Maintaining dialogue with the rail industry stakeholders;
- Tackling congestion to improve bus reliability; and
- Provision of Bus Priority Measures which will focus on the core bus network.

6.8.2 The NDR should assist in meeting the objectives outlined within the public transport strategy. The provision of the NDR is predicted to reduce congestion on the core network, thereby reducing bus journey times and increasing reliability as demonstrated by data included in **Chapter 9** of this report. The NDR as part of NATS will also allow other parts of the strategy to be delivered with more ease, including the delivery of public transport improvements.

6.9 Bus Services Directly Affected by NDR

6.9.1 It is anticipated that with the introduction of the NDR, bus services should achieve journey time savings due reduced traffic levels and associated delay on many of the key routes which currently experience congestion at peak times. Journey times along 5 key bus corridors supporting this statement have been extracted from the NATS model and are presented in **Chapter 9** of this report.

6.9.2 Only a very small proportion of the existing bus services would have their route changed as a result of the NDR, details of which are given below. This

minor impact however, should be offset against the benefit from reduced traffic levels.

6.9.3 Based on the current level of service provision, 18 public bus services would cross the route of the proposed NDR. Of these, the majority would remain unaffected by the scheme introduction.

6.9.4 The bus services that currently use the A1067 Fakenham Road would continue to do so but would have to pass through the proposed Fakenham Road Roundabout. Journey times presented in **Chapter 9** of this report demonstrate that this minor change to the route does not have a significant impact on journey times and is offset by reduced traffic flows on Fakenham Road between the new junction and the City Centre resulting in reduced journey times along this corridor overall.

6.9.5 The B1149 Holt Road will be converted to a restricted route to the north of the NDR route and Horsford. Services that currently run along Holt Road would divert on to NDR to travel between the Drayton Lane and the Cromer Road Roundabouts before re-joining Holt Road. This would extend the route distance by approximately 500m.

6.9.6 Services that currently use Cromer Road (A140) will pass through the NDR 'dumb-bell' roundabout junction. This minor change to the route would be unlikely to have any significant impact on journey times.

6.9.7 At Spixworth Road / Buxton Road services using this route would be unaffected as they would make use of the proposed bridge crossing over the NDR corridor.

6.9.8 Services that use North Walsham Road would make use of the proposed at-grade junction with NDR (North Walsham Road Roundabout).

6.9.9 On Wroxham Road (A1151), services using this route would make use of the proposed at-grade junction with NDR (Wroxham Road Roundabout). This minor change to the route would be unlikely to have any significant impact on journey times.

6.9.10 Services that use Salhouse Road at the point it intersects with the NDR would make use of the proposed at-grade junction (Salhouse Road Roundabout). This minor change to the route would be unlikely to have any significant impact on journey times.

6.9.11 On Plumstead Road, bus services using this route will pass under the NDR, but will travel through a new roundabout (off-set) junction linking to the

proposed Plumstead Road roundabout. This minor change to the route would be unlikely to have any significant impact on journey times.

6.9.12 The route of the NDR in relation to the above bus routes is presented in **Appendix C.5**. This also shows any diversions to bus routes. However, it must be noted that the precise diversion / re-routing of services will ultimately be the decision of the bus operators.

6.10 Park & Ride Services

6.10.1 The Park & Ride sites on the south side of the city or inside the NDR corridor will not be affected by the NDR scheme. The Postwick Park & Ride is an exception; the proposed signal junction would provide a dedicated access and egress that will enable priority to be given to Park & Ride buses.

6.11 Rail

6.11.1 Rail services will not be directly affected by the NDR. The NDR will cross over the Norwich to Sheringham railway line on a bridge. The NDR could help to improve vehicular, pedestrian, and cycle movements to the rail stations and provide improved links to the rail station via other public transport modes such as bus.

6.12 Proposed NMU Provision

6.12.1 As previously mentioned, one aim of the NDR is to remove traffic making orbital movements from unsuitable roads. This should have the following benefits for NMUs:

- Reduce congestion on strategic routes to the north of the city;
- Reduce noise, air pollution and accidents for communities in the northern suburbs of Norwich and outlying villages;
- Enable the removal of through traffic from the city centre and the implementation of widespread pedestrianisation/bus priority measures (as part of the NATS implementation plan).

6.12.2 The direct impact the NDR will have on Public Rights of Way (PRoW), Permissive Routes and Cycle Routes is discussed in the following section, along with measures proposed to mitigate any severance that might be caused by the NDR.

6.12.3 As detailed in **Chapter 3** a number of new bridges are proposed in order to maintain access for NMUs. These include:

- A new bridge to carry Marriott's Way over the NDR;

- A new bridge at Bell Farm (NMUs and agricultural use only);
- A new bridge at Buxton Road over the NDR (for all traffic);
- A new bridge at Middle Road over the NDR (for all traffic); and
- A new bridge to carry Newman Road over the NDR (NMU / PMA only).

6.13 Effect of NDR on Existing PRoW/Permissive Paths and Cycle Routes

6.13.1 The impact of the proposed scheme has been considered on each of the existing PRoW, permissive paths and cycleways which will be intersected by the NDR and mitigation measures to address the severance of paths. These are all shown in the **General Arrangement Plans** (document ref 2.6).

Table 6.3 Severance /Mitigation of PRoW, Permissive Routes and Cycleways

Reference	Degree of Severance	Mitigation measures
Attlebridge (RB)	The scheme would sever the track between A1067 and Deighton Hills.	Clear sight lines and refuge are to be provided at the crossing point incorporated as part of the Fakenham Road roundabout.
Drayton (RB6)	Path would terminate at proposed Reepham Road roundabout rather than Reepham Road.	The path would link to a new path on the southern side of the NDR, improving connectivity to Marriott's Way and Thorpe Marriott. The path will be to cycleway standard.
Horsford (RB5)	Dual carriageway road severs track north of Reepham Road.	A new overbridge will be provided suitable for all NMUs, with the by-way surface improved.
Spixworth (BR1)/ Horsham St Faith & Newton St Faith (BR6)	Dual carriageway road severs bridleway between Quaker Lane and the airport perimeter fence.	Alternative NMU routes would be provided both to the north and south of the NDR, with the provision of cycleways, footpaths and a bridleway to link St Faiths Road and Quaker Lane to NDR crossing points at Buxton Road and the Airport roundabout, where the NDR can be crossed.

Reference	Degree of Severance	Mitigation measures
Great and Little Plumstead (FP5)	Dual carriageway road severs footpath south of Low Road.	NMUs can pass along Low Road to the south of the proposed NDR to gain access. Whilst there would be some severance for NMUs, there would also be new amenity provided in the form of bridleways to the north and south of the NDR which provide connections east/ west and enabling the NDR to be crossed at Middle Road.
Postwick (FP2)	Dual carriageway slip severs footpath north of A47(T).	Footpath diversion is to be provided to cross the slip road to the east of junction with A47(T).
Marriott's Way	Dual carriageway will pass under Marriott's Way which will be raised up on a new 'green' bridge.	A new bridleway is to be provided for NMUs from Beck Farm Lane. Marriott's Way is to be raised up on a new 'Green Bridge'.
Grange Farm Spixworth Bridleway	Dual carriageway would sever link to Spixworth, the majority of network would be unaffected.	A new link is to be provided from Quaker Lane to Bullock Hill on north side of NDR which would maintain continuity of network.
Spixworth to Old Catton cycleway	Dual carriageway will pass under Buxton Road and the cycleway on a bridge.	Cycleway is to be maintained on a gradient over the NDR.
Horsham St Faith to Norwich Airport cycleway	Dual carriageway will pass under route on a bridge, cyclists will need to cross slip roads exit from roundabout.	A segregated route is to be maintained on a bridge over the NDR but with 2 slip road crossings.

Source: Taken from Environmental Statement Chapter 12

6.13.2 More detail on the scheme impact on PRoW / bridleways and cycleways can be found in Chapter 12 of the **Environmental Statement**.

6.13.3 In addition, as part of NDR, approximately 25km of new pedestrian/cycle links are proposed to be provided along the route within the landscape strip suitable for use by pedestrians, cyclists and equestrians. The new links provided for use by pedestrians, cyclists and equestrians would be provided along the route generally within the landscape strip. These new links are shown on the **General Arrangement Plans** (document ref 2.6) and include:

- A new link will be created to join Fir Covert Road to the Drayton restricted byway (RB6). This would run parallel to the north side of the NDR. The route would be accessible for pedestrians, cyclists and equestrians. A link would be provided onto Marriott's Way.
- To the east of Fir Covert Road, a new bridleway will be created along the south side of the NDR to link with Marriott's Way and Breck Farm Lane which itself will be stopped up where NDR crosses this link. To the north of the NDR, Marriott's Way is linked by a bridleway spur to Furze Lane, which itself will be stopped up where NDR crosses this link.
- A new link will be created to join the existing bridleway from Quaker Lane, Spixworth to Bullock Hill Horsham St Faith. This would run along the northern side of the NDR and would be accessible for pedestrians, cyclists and equestrians.
- A new link to join Beeston Lane just to the east of Manor Farm cottages to Salhouse Road, Rackheath. This would run parallel to the west side of the NDR but would be separated from it by a landscape strip. The route would be accessible for pedestrians, cyclists and equestrians.
- A new link will be created to join Plumstead Road, Rackheath to Low Road, Great and Little Plumstead. This would run parallel to the east side of the NDR but would be separated from it by a landscape strip. The route would be accessible for pedestrians, cyclists and equestrians.
- A new bridleway will be provided to the east of the scheme which would link Smee Lane to the Business Park roundabout and further south, as well as providing links to the north to Middle Road.
- A new link will be created on the stopped up eastbound A47(T) sliproad at Postwick.
- Cycle tracks around the periphery of proposed roundabouts on existing radial roads with NDR will provide uncontrolled crossings for users.
- At Postwick, the Park & Ride signalised junction would include a signal controlled crossing with on-demand phases for pedestrians and cyclists.

6.13.4 Details of the various cycleway proposals can be found in Chapter 12 of the **Environmental Statement**.

6.13.5 In addition to the above links, the following roads would have access restrictions imposed to improve their usability for NMUs. These would then provide sections to link to the new routes described above:

- Quaker Lane would become access only, thus improving the usability of the roads for NMUs. It would provide a link to the existing Buxton Road cycleway and the new Buxton Road overbridge over the NDR which would be of sufficient width to accommodate a shared use footway / cycletrack.
- Access only restrictions would be imposed on Beeston Lane and will be promoted as a quiet access for NMUs. Thereby improving the usability of this link for NMUs.

6.13.6 The complementary traffic management measures to be implemented throughout the city would be likely to have a positive impact on pedestrian and cyclist facilities. This will be achieved by reducing the severance caused by vehicular traffic within the city centre which would allow easier pedestrian and cycle movements, increasing general security through higher pedestrian/cycle activity.

7 Transport Modelling Inputs and DM Appraisal

7.1 Introduction

7.1.1 The TA relies on data produced from by the Norwich Area Transportation Strategy (NATS) transport model. The NATS transport model has been developed since 2002, with a number of versions created over the years for the assessment of NDR and other transport measures in the Greater Norwich area. It is a multi-modal transport model with highway assignment, public transport assignment and demand model components. The development of the transport model and its use in forecasting for the NDR Scheme are described in detail in the reports summarised in the following sections.

7.1.2 Data from the model was used to appraise the current and Do Minimum (DM) network conditions. This is included in **Section 7.8** below.

7.2 Survey Report

7.2.1 The model was updated for the purposes of this NDR submission using fresh survey data collected in 2012. The Survey Report describes the surveys and the purposes that the data would be applied to in producing the latest version of the NATS transport model.

7.3 Highway Local Model Validation Report (Highway LMVR)

7.3.1 This report describes the development of the highway traffic assignment model covering Norwich and the surrounding area using the 2012 survey data. The methods used for developing the traffic demand trip matrices are explained and the development and checking of the way the highway network is represented in the model are described. The model was developed in accordance with WebTAG 3.19 guidance and the report defines the detailed and fully modelled areas of the highway network. It reports on the calibration and validation of the model against the acceptability guidelines in WebTAG.

7.4 Public Transport Local Model Validation Report (PT LMVR)

7.4.1 This report describes the public transport assignment model developed for Norwich. It includes details on the bus and rail services that are represented in the model and how the model has been updated to a 2012 base year. The model is compared with calibration and validation guidelines in WebTAG.

7.5 Traffic Forecasting Report

7.5.1 Forecasts of highway and public transport modes of travel were prepared for Norwich. These accounted for the large scale residential and business development and proposed transport improvements, which are identified in the Traffic Forecasting Report. Forecast demand for the developments was assessed using a standard trip generation database called TRICS, with trip distribution derived from the synthetic gravity model produced for Norwich. The forecasts were controlled to growth contained in the Department for Transport's (DfT) forecasting databases in TEMPRO and RTF 2013 and then reductions were applied to new developments to account for travel planning measures. Variable demand modelling responses have also been applied in accordance with WebTAG 3.10. The resulting forecasts are set out in the Traffic Forecasting Report with data tables and graphics to provide an easy understanding of the forecast scenarios.

7.6 Economic Appraisal Report

7.6.1 The transport economics were assessed using the DfT software TUBA, developed by Mott MacDonald, with travel costs skimmed from the NATS transport model. In addition, wider economic benefits were assessed with WITA, software developed by Mott MacDonald for DfT; accident benefits were assessed with COBA; and reliability benefits were assessed with Mott MacDonald's bespoke software. Results are compiled and explained in an Economic Appraisal Report.

7.7 Modelling Inputs to TA Work

7.7.1 The highway assignment model, developed in SATURN software, was interrogated and turning movements were extracted for all on-line, Postwick and off-line junctions assessed in this TA for the following scenarios:

- 2017 Do Minimum (DM)
- 2017 Do Something (DS)
- 2032 Do Minimum (DM)
- 2032 Do Something (DS)

7.7.2 These turning movements were used to carry out the detailed junction assessments as presented in **Chapter 8** of this report.

7.7.3 Results presented in the **Traffic Forecasting Report** were used to present the wider impacts of the NDR in **Chapter 9** of this TA. In particular, information from the Traffic Forecasting Report on the following was used and included in the following TA sections:

- Strategic traffic movements (**Section 9.2**)
- Wider impacts to the west of Norwich (**Section 9.3**)
- Suburban traffic impacts (**Section 9.4**)
- City centre traffic impacts (**Section 9.5**)
- NATS model statistics on traffic queues (**Section 9.6**)
- City centre through traffic (**Section 9.7**)
- Highway journey times (**Sections 9.8**)
- Public transport journey times (**Section 9.9**)
- Effects on people (**Section 9.10**)

7.8 Do Minimum (DM) Appraisal

7.8.1 The data presented in **Chapters 8 and 9** of this TA demonstrates that:

- The existing junction configuration at Postwick presently leads to substantial delays and queuing with queues reaching the A47(T) westbound diverge slip road (refer to paragraph 8.6.33).
- Background growth would exacerbate this situation with delays and queues increasing. In the 2017 AM peak the queues would extend back onto the A47(T) westbound diverge slip road, approaching the diverge area at the start of the slip road, and thus there will be a high risk of queues conflicting with high speed traffic on the A47(T) (refer to paragraph 8.6.33).
- The planned city centre improvement measures require a significant reduction in city centre through traffic for their implementation to be successful. Cross city centre traffic is significant and this is predicted to increase in future years at the outer cordons (refer to paragraph 9.7.3).
- Existing orbital routes already carry significant amounts of traffic due to the lack of a strategic provision such as the A47(T) to the south of Norwich (refer to paragraph 9.2.1). This traffic is predicted to increase in future years. A number of these roads (shown in **Appendix C.6**) are inappropriate for the amount of traffic they carry presently or in the future. They have numerous minor junctions, considerable frontage access to residential properties, they are narrow in places, there are schools located on a number of these roads and, especially at these locations, they have 20mph zones and traffic calming to reduce vehicle speeds. Also, increased traffic flows adversely affect residential amenity and walking and cycling on and adjacent to these roads. Reductions in traffic are required to bring them in line with the route hierarchy and to allow for efficient allocation of resources for the maintenance of the transport network.
- Developer link roads would carry significant amounts of strategic through traffic movements in the DM scenarios despite them being designed to act as urban high street serving walking and cycling movements as well as traffic access for the developments, or as local development distributor roads. With the flows predicted (refer to paragraph 9.4.2 herein and Figure I.2 in the **Traffic Forecasting Report**), they would not be able to perform their desired role.

- Highway and public transport journey times on key routes are predicted to increase in future years, on some routes significantly. The increases are illustrated below in Figures 7.1 to 7.4 for the peak hour journey times in base and forecast years (see also paragraphs 9.8.2 and 9.9.3).

Figure 7.1 Average Highway Journey Times, AM Peak

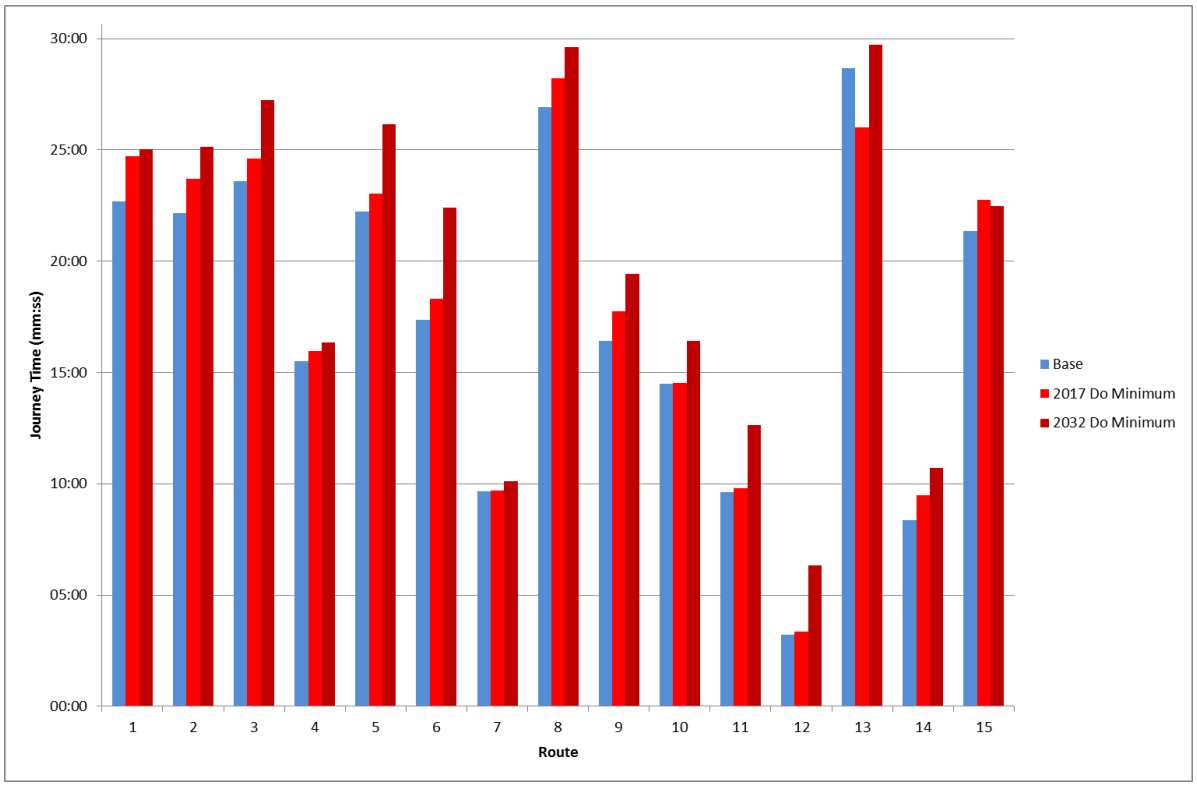


Figure 7.2 Average Highway Journey Times, PM Peak

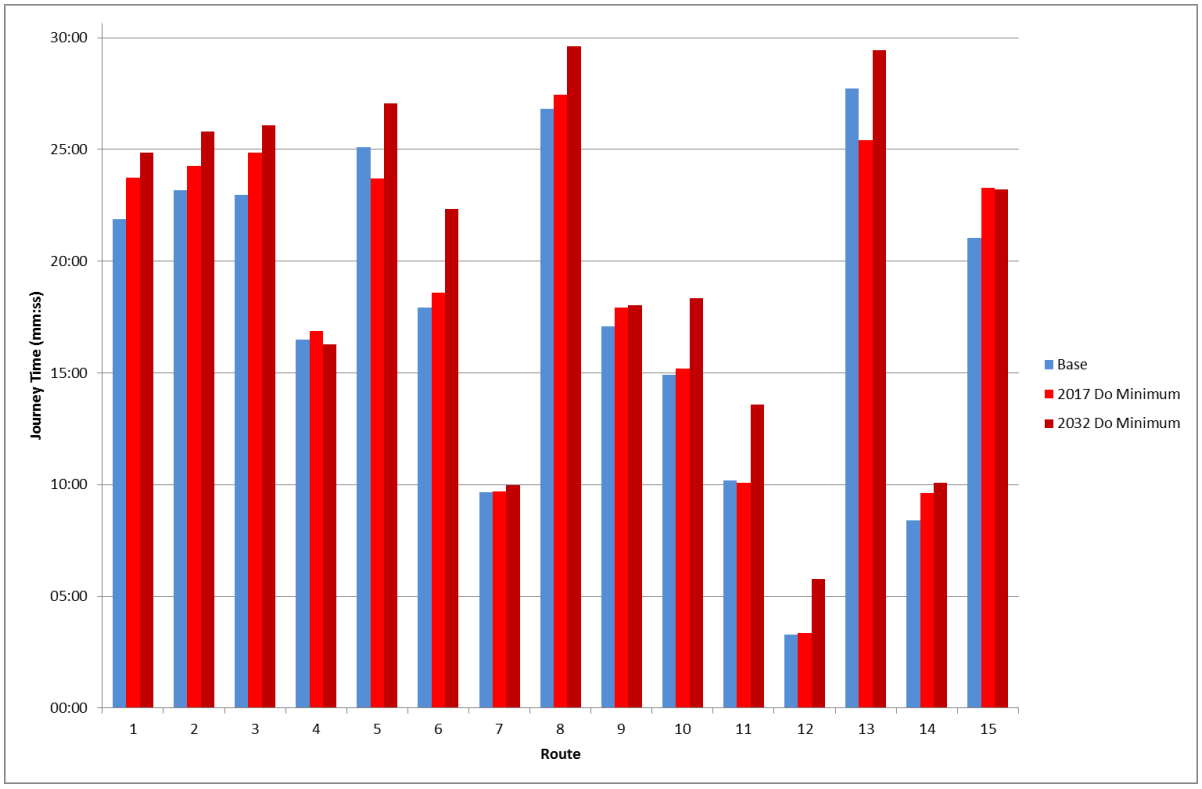


Figure 7.3 Average Public Transport Journey Times, AM Peak

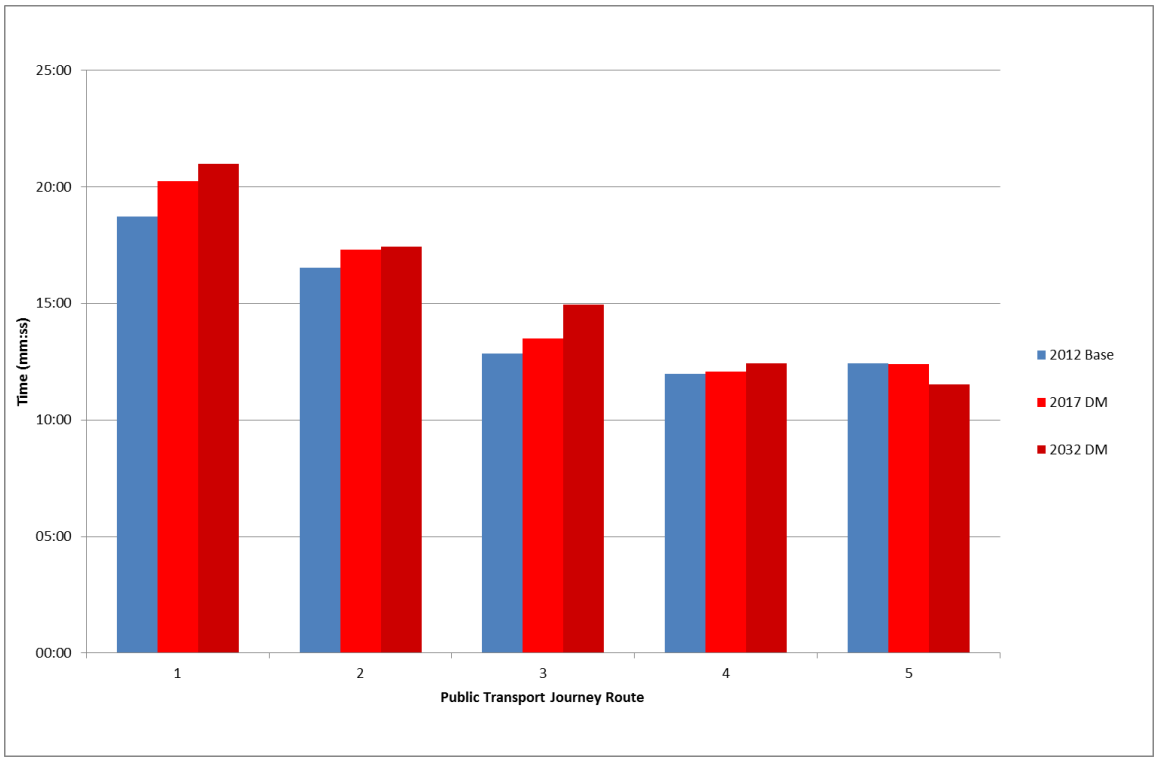
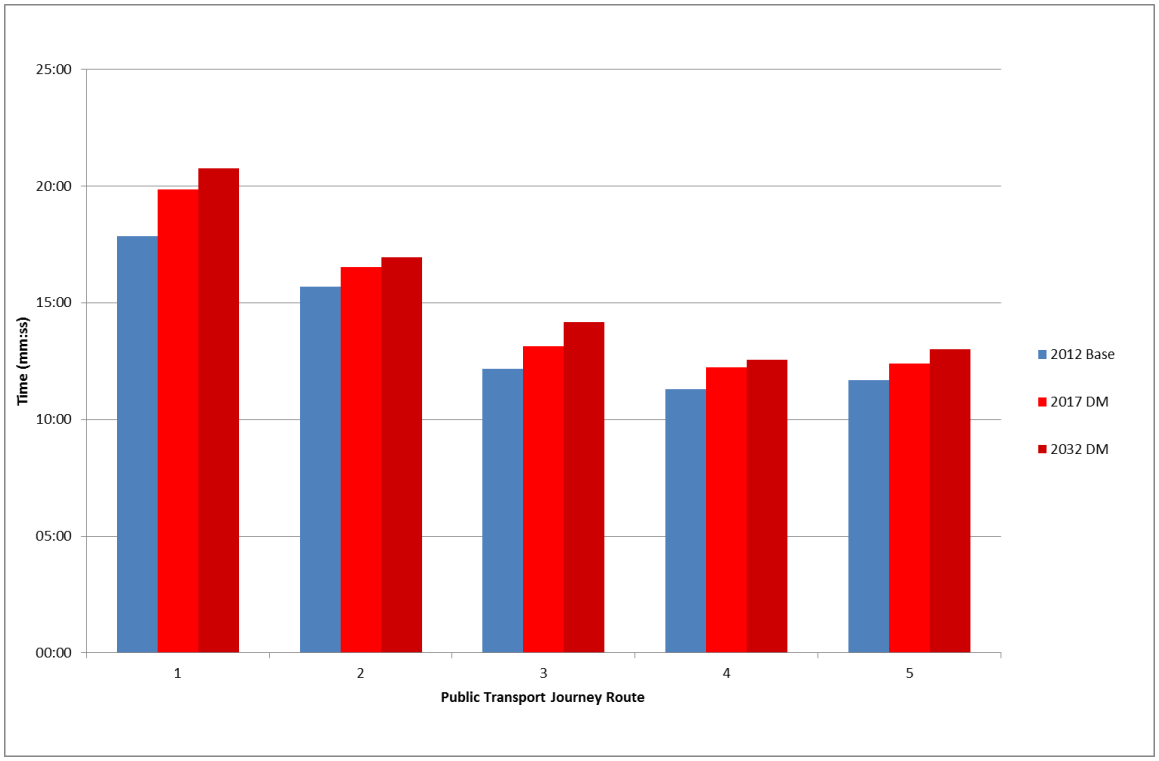


Figure 7.4 Average Public Transport Journey Times, PM Peak



7.8.2 The deterioration of the network performance in the DM is further demonstrated by overall NATS model statistics on traffic queues (see **Section 9.6**) which show increases of 19% and 32% in the AM and PM peaks respectively and 13% in the interpeak in 2017. Larger increases occur of 51% and 79% in 2032 in the AM and PM peaks as well as 49% in the interpeak.

7.8.3 The deterioration in the network performance as illustrated by the large increases in queuing shows that the transport conditions will worsen considerably in the forecast years in the DM. Whilst the queuing at Postwick is very clearly unacceptable insofar as it would extend back to the diverge area of the westbound slip road, the overcapacity queuing and delays to traffic on the Principal and Main Distributor routes in and around Norwich are mitigated to an extent by strategic orbital traffic being displaced to other existing roads or new developer link roads that are inappropriate for this type of traffic. In Norfolk County Council's Route Hierarchy Principal Routes should be of a minimum width of 7.3m with a design speed of 100 kph and Main Distributor Routes should be a minimum width of 6.5m with a design speed of 80 kph. The roads that run through suburban areas with traffic calming measures and 20 mph zones past schools do not meet these standards, nor do narrow country lanes. The tables below show the

changes in traffic on the urban and rural roads, the route hierarchy designation and route characteristics.

Table 7.1 AADT Traffic Flows along inappropriate urban routes

Route	**2012 AADT Traffic Flows**	**2017 AADT Traffic Flows (DM Scenario)**	**2032 AADT Traffic Flows (DM Scenario)**	**Route Hierarchy Type**	**Features**	**Area Type**
1. Middleton's Lane (locations A10 and A83)	8,900 – 9,600	10,200 - 10,400	11,400 - 11,300	Not categorised	2 schools with 20mph zones and traffic calming, shared cycleway / footway, pedestrian refuge islands	Suburban with individual accesses to properties along the whole length
2. Fifers Lane / St Faith's Road / Church Street (location A11)	10,600	11,700	12,600	Local access	School on Church St with 20mph zones and traffic calming	Suburban with individual accesses to properties along 25% of route
3. White Woman Lane (location A13)	3,900	3,000	3,500	Local access	School with 20mph zones and traffic calming, shared cycleway / footway	Suburban with individual accesses to properties along 25% of route

Route	**2012 AADT Traffic Flows**	**2017 AADT Traffic Flows (DM Scenario)**	**2032 AADT Traffic Flows (DM Scenario)**	**Route Hierarchy Type**	**Features**	**Area Type**
4. Barkers Lane / Church Lane (location A14)	6,400	3,100	3,400	Not categorised	Pedestrian refuge islands	Suburban with individual accesses to properties along 50% of route
5. Blue Boar Lane (location A75)	13,000	13,400	12,200	Not categorised	Shared cycleway/ footway along part of route, signal controlled pedestrian crossing, no footway on route through woodland area	Suburban/ rural with individual accesses to properties along 15% of route
6. Woodside Road (location A20)	11,800	13,000	11,600	Not categorised	Pedestrian refuges, some on street parking and parking in dedicated laybys	Suburban with individual accesses to properties along 30% of route

7.8.4 Traffic flows are forecast to reduce on White Woman Lane and Barkers Lane / Church lane, but at the expense of the traffic reassigning onto the new developer link roads. However the already high traffic flows on the other routes would increase in 2017. Reductions are forecast on Blue Boar Lane

and Woodside Road in 2032 as traffic would reassign to the new developer link road between Plumstead Road and Salhouse Road, however traffic on these routes would still remain high and would continue to increase on Middleton's Lane and Fifers Lane / St Faith's Lane / Church Street. None of these routes is categorised as Principal or Main Distributor routes, and as the table shows three of the routes have Schools located alongside with 20 mph zones and traffic calming, and they all have accesses to properties, to varying degrees. The levels of traffic are not compatible with the NCC Route Hierarchy and with the routes' characteristics. These impacts are therefore considered to be severe and unacceptable.

Table 7.2 AADT Traffic Flows along inappropriate rural routes

Route	2012 AADT Traffic Flows	2017 AADT Traffic Flows (DM Scenario)	2032 AADT Traffic Flows (DM Scenario)	Route Hierarchy Type	Width on Traffic Count Section	Area Type
7. B1145 and A1067 to the A140 via Reepham and Cawston (location 10)	3,700	4,100	5,500	Main distributor	5 to 6m	Rural
8. B1354 between A140 and Hoveton via Coltishall / (location 7)	4,300	4,800	6,800	Main distributor	5 to 5.5m	Rural
9. Spixworth Road / Church Lane/ Buxton Road / Crostwick Lane between the A140 and B1150 North Walsham Road (location 12)	5,700	6,800	9,400	Not categorised	6 to 6.5m	Rural

Route	2012 AADT Traffic Flows	2017 AADT Traffic Flows (DM Scenario)	2032 AADT Traffic Flows (DM Scenario)	Route Hierarchy Type	Width on Traffic Count Section	Area Type
10. Church Road / Broad Lane / Green Lane West through Great Plumstead (location 11)	3,500	6,200	9,800	Local access / Not categorised	4.5 to 5m	Rural
11. Woodbastwick Road / B1140 Low Road and Bell Lane through Salhouse (location 6)	2,500	4,300	5,800	Local access / Not categorised	5m	Rural
12. Green Lane/Green Lane North between the A1042 Yarmouth Road and the C874 Plumstead Road (location A23)	7,700	0[1]	0[1]	Not categorised	4.5 to 5m	Rural

[1]Green Lane/Green Lane North would be closed once the Brook Farm/Laurel Farm developer link road is operational

7.8.5 The rural routes generally carry lower traffic flows than the urban routes. Two of the routes are designated as main distributors, although they do not meet the desirable standard of a minimum road width of 6.5m and pass through rural villages, but are designated in the absence of better standard routes. All of the routes have narrow carriageways and thus are inappropriate for the type of traffic that should be using Principal or Main Distributor routes in the NCC Route Hierarchy. The difference here is that they experience very large increases in traffic due to the displacement of traffic away from the increasingly congested urban network in forecast years in the DM. This results in significant increases in traffic flows between the base year 2012 and 2017, especially on the routes to the east of Norwich, and then substantial increases to 2032 with traffic flows more than doubling

on some of the routes. There are already concerns that the existing base year traffic is unacceptable on these routes, so such large increases are considered to be a severe impact.

7.8.6 In addition to the data extracted from the NATS model, bus data has been obtained from the automatic vehicle location (AVL) bus tracking system. The data demonstrates that fewer buses from the north and east of Norwich into the city centre are generally on-time compared to buses from the south and west. For the three corridors considered (Catton Grove, Cromer Road, Wroxham Road), average on-time performance at bus stops in the AM peak was between 55% and 86% and between 65% and 80% in the interpeak periods, which are well below the Traffic Commissioners on-time target of 95%.

7.8.7 The above demonstrates that the limitations of the existing road network affect bus performance and the ability for the highway authority to work with bus operators to deliver public transport facilities within the City. The scope for further improvements, such as Bus Rapid Transit (BRT) on Dereham Road, is limited.

7.8.8 The transport modelling and appraisal work has demonstrated that the Do Minimum network would be inadequate to accommodate traffic generation produced by the high levels of employment and residential growth planned for greater Norwich and lead to a substantial deterioration in operational performance, transport journey times and reliability, thus reducing the economic competitiveness of the City. The inadequacy of the existing road network will lead to increasing congestion on the urban network in forecast years which will result in displacing traffic onto developer link roads and rural routes, whilst traffic levels would remain high on existing inappropriate urban routes past Schools. The further deterioration in traffic conditions on inappropriate routes is considered to produce severe impacts that are unacceptable. This would be accompanied by reductions in operational performance for bus services and worsening conditions for walking and cycling. There would be an increasing risk of worsening road safety as traffic would continue to grow on inappropriate routes and queues may extend onto the high speed A47(T) dual carriageway.

8 Traffic Impact Assessment

8.1 Junctions to be assessed

8.1.1 During the scoping exercise it was agreed that 25 junctions be assessed as part of the NDR scheme. These are divided into three categories: the 'on-line', 'Postwick' and 'off-line' junctions. The junctions and their layout are presented in **Table 8.1**.

8.1.2 The 'on-line' junctions are represented by 14 junctions and are located along the NDR route. All 'on-line' junctions are new. Therefore, they do not exist in the Do Minimum (DM) scenario, i.e. the scenario without the NDR. They are only assessed in the Do Something (DS) scenario, i.e. with NDR.

8.1.3 The 'Postwick' junctions are represented by six junctions and form part of the NDR scheme. Two of the junctions are new and do not exist in the DM scenario. Four of these junctions are existing junctions all of which will however experience layout changes.

8.1.4 Five 'off-line' junctions have been tested in detail. Further detail on all the junctions considered and how agreement was reached on these five is presented in **Chapter 2** of this report. These are all existing junctions that exist in the present network. The description refers to the existing layout as DM (Do-Minimum) scenario and proposed layout for the future assessment years as DS (Do-Something) scenario. The DS scenario takes into account the operation of the NDR.

Table 8.1 NDR Junction Layout for DM/DS scenarios

	DM scenario	DS scenario
	On-line	
01 Fakenham Road	n/a	Roundabout – 4 arms
02 Fir Cover Road	n/a	Roundabout – 4 arms
03 Reepham Road	n/a	Roundabout – 4 arms
04 Drayton Lane	n/a	Roundabout – 4 arms
05 Holt Rd/Drayton Ln	n/a	Roundabout – 3 arms
06 Cromer Road South	n/a	Roundabout – 5 arms
07 Cromer Road North	n/a	Roundabout – 5 arms
08 Airport	n/a	Roundabout – 3 arms
09 North Walsham Road	n/a	Roundabout – 4 arms
10 Wroxham Road	n/a	Roundabout – 5 arms

	DM scenario	DS scenario
11 Salhouse Road	n/a	Roundabout – 4 arms
12 Plumstead Road North	n/a	Roundabout – 3 arms
13 Plumstead Road South	n/a	Roundabout – 3 arms
14 Business Park	n/a	Roundabout – 3 arms
	Postwick	
15 Broadland Gate	n/a	Roundabout – 3 arms
16 Peachman Way	Roundabout – 4 arms	Roundabout – 4 arms
17 Postwick NW	Roundabout – 4 arms	Roundabout – 4 arms
18 Postwick NE	n/a	Roundabout – 4 arms
19 Oak's Lane	Roundabout – 4 arms	Roundabout – 4 arms
20 Park&Ride (P&R)	Roundabout – 4 arms	Signalised junction
	Off-line	
21 A47(T)/A146 Trowse	Signalised junction	Signalised junction
22 Martineau Lane	Signalised	Signalised
23 Bracondale Lane	Signalised	Signalised
24 Rackheath Lane	Priority junction- 4 arms staggered	Priority junction - 3 arms
25 Wroxham Rd/Green Ln W	Priority junction – 3 arms	Priority junction – 3 arms relocated from existing

8.1.5 In addition to the above, existing junctions are assessed with existing flows. This is called the *existing scenario.* The layouts with which the assessments were carried out, are presented in **Table 8.2.**

Table 8.2 NDR Junction Layout for Existing scenario

	Existing scenario
	On-line
	n/a
	Postwick
21 Broadland Gate	n/a
22 Peachman Way	Roundabout – 3 arms
23 Postwick NW	Roundabout – 5 arms
24 Postwick NE	n/a
25 Oak's Lane	Priority junction - 3 arms

	Existing scenario
26 Park&Ride (P&R)	Roundabout – 4 arms
	Off-line
31 A47(T)/A146 Trowse	Signalised junction
43 Rackheath Lane	Priority junction – 4 arms staggered
45 Wroxham Rd/Green Ln W	Priority junction - 3 arms
49 Martineau Lane	Signalised
50 Bracondale Lane	Signalised

8.1.6 The wider impacts of NDR are presented in **Chapter 9** of this document.

8.2 Junction Information

8.2.1 All 25 junctions described above are contained in the NATS model covering Norwich and surrounding areas. The model is further referred to in **Chapter 7** of this report.

8.2.2 Turning flows for all 'on-line' junctions are entirely derived from the SATURN model. For the 'Postwick' and 'off-line' junctions, traffic counts were undertaken in 2012 and 2013. The existing situation is modelled for those junctions and presented in this report. Future flows are taken from the SATURN model. Cross-checks with existing flows have been carried out and found to be reasonable. The SATURN model has been calibrated and validated as per **Highway Local Model Validation Report (LMVR)** (document ref 5.9).

8.2.3 Junction layouts are based on the General Arrangement Plans (document ref 2.6). Drawings for all junctions assessed in this section are included in **Appendix D**.

8.2.4 The geometries and signal control and timing information for each junction are included in **Appendix E**.

8.3 Junction Assessments

8.3.1 The junctions presented in **Table 8.1** have been assessed for the DM and the DS scenarios where applicable. It should be noted that the 'on-line' junctions only exist for the DS scenario as part of the NDR scheme, and therefore have not been assessed for the DM scenario. Off-line junctions have also been assessed with the existing flows.

8.3.2 The DM scenario assumes background growth on the existing network, but also takes into account committed development and future highway measures which are non-dependant on NDR.

8.3.3 Growth in background traffic levels is as assumed in the SATURN model, please refer to the **Traffic Forecasting Report** (document ref 5.6).

8.3.4 The DM committed development traffic has been identified in agreement with Norfolk County Council; details are set out in the **Traffic Forecasting Report**.

8.3.5 The highway measures included are set out in the **Traffic Forecasting Report**.

8.3.6 The DS scenario assumes that the NDR scheme will be added to the DM scenario. Any additional highway measures are set out in the **Traffic Forecasting Report**.

8.3.7 Turning flows for both the DM and DS scenarios have been extracted from the SATURN model. These flows are presented in **Appendix F**.

8.3.8 Off-line junctions have been assessed with existing flows based on surveys undertaken in 2012 and 2013.

8.3.9 The future assessment years are 2017 and 2032. These represent year of opening of the scheme and 15 years thereafter.

8.3.10 Detailed junction assessments have been carried out for the AM and PM peak hours in line with the SATURN model peak hours. The AM peak hour is 08:00-09:00 hours and the PM peak hour is 17:00-18:00 hours.

8.3.11 Junctions 8 software (which includes ARCADY8) has been used to model the existing and proposed roundabout layouts. The Roundabout Module has been used to calculate junction capacity and delays. The results show the values for the RFC, queues and the delays for each arm. The synthesised profile within this module has been used because SATURN outputs hourly flows which take no account of peaks within the hour.

8.3.12 PICADY 5.1 (Priority junction CApacity and DelaY) software has been used to model the existing and proposed priority junctions. The results show values for the RFC, queues and the delays for each arm. As above, a synthesised profile has been used because SATURN outputs hourly flows which take no account of peaks within the hour.

8.3.13 The RFC output from Junctions 8 and PICADY is known as the Ratio of Flow to Capacity, and is the primary measure of an arm performance. An RFC of below 0.85 suggests a junction will operate within capacity. An RFC of 0.85 to 1.0 suggests a junction is over its desired capacity but below theoretical capacity, whilst an RFC in excess of 1.0 suggests a junction will be in excess of theoretical capacity. All results shown are in Passenger Car Units (PCUs).

8.3.14 LinSig 3.0 (Linear Signal Analysis) software has been used to model the existing and proposed signal controlled junctions. Output from LinSig refers to Degree of Saturation % (DoS%, which is equivalent to RFC for roundabouts) as the primary measure of performance. A DoS of below 90% suggests a junction will operate within capacity. A DoS of 90% to 100% suggests a junction is over desired capacity but within its theoretical capacity, whilst a DoS in excess of 100% suggests a junction will be in excess of theoretical capacity.

8.4 Junction Summary Results

8.4.1 The results of all junction assessments are summarised in **Tables 8.3** to **8.8,** and show the maximum values for RFC/DoS, queues and delays computed at each junction.

8.4.2 Detailed assessment results are provided in **Section 8.5** for the 'on-line' junctions, **Section 8.6** for the 'Postwick' junctions and **Section 8.7** for the 'off-line' junctions.

8.4.3 **Table 8.3** and **Table 8.4** show maximum RFC and DoS at each junction for the DM and DS scenarios during the AM and PM peak.

Table 8.3 All Junctions - Maximum AM RFC and DoS

	AM - Max RFC and DoS				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
	On-line				
01 Fakenham Road				0.45	0.52
02 Fir Covert Road				0.30	0.55
03 Reepham Road				0.41	0.57
04 Drayton Lane				0.87	1.09
05 Holt Rd/Drayton Ln				0.55	0.51
06 Cromer Road South				0.62	0.86
07 Cromer Road North				0.70	0.98
08 Airport				0.51	0.87
09 North Walsham Road				0.89	1.10

	AM - Max RFC and DoS				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
10 Wroxham Road				0.75	0.99
11 Salhouse Road				0.79	0.95
12 Plumstead Road North				0.27	0.40
13 Plumstead Road South				0.85	0.98
14 Business Park				0.59	0.87
	Postwick				
15 Broadland Gate				0.85	0.95
16 Peachman Way	0.47	0.48	0.71	0.84	1.01
17 Postwick NW	0.52	0.54	0.66	0.87	0.88
18 Postwick NE				0.95	1.02
19 Oaks Lane				0.71	0.75
20 Park&Ride (P&R)	1.00	1.00	1.03	96.1%	94.8%
	Off-line				
21 A47(T)/A146 Trowse	80.1%	85.2%	94.1%	87.9%	93.9%
22 Martineau Lane	72.7%	85.9%	91.7%	88.9%	92.9%
23 Bracondale	97.5%	106.3%	107.7%	105.6%	107.5%
24 Crostwick Junction	0.339	0.273	0.370	0.466	0.480
25 Rackheath Junction	0.450	0.445	0.841	0.315	0.770

Table 8.4 All Junctions - Maximum PM RFC and DoS

	PM - Max RFC and DoS				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
	On-line				
01 Fakenham Road				0.41	0.52
02 Fir Covert Road				0.33	0.51
03 Reepham Road				0.47	0.64
04 Drayton Lane				0.79	0.96
05 Holt Rd/Drayton Ln				0.47	0.44
06 Cromer Road South				0.79	0.97
07 Cromer Road North				0.50	0.61
08 Airport				0.49	0.79
09 North Walsham Road				0.61	0.83
10 Wroxham Road				0.77	0.95
11 Salhouse Road				0.75	0.97
12 Plumstead Road North				0.37	0.40
13 Plumstead Road South				0.79	0.88
14 Business Park				0.71	0.95
	Postwick				
15 Broadland Gate				0.34	0.55

	PM - Max RFC and DoS				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
16 Peachman Way	0.49	0.51	0.76	0.54	0.67
17 Postwick NW	0.78	0.79	0.71	0.69	1.06
18 Postwick NE				0.96	0.69
19 Oaks Lane				0.49	0.34
20 Park&Ride (P&R)	0.99	1.00	1.03	93.8%	120.0%
	Off-line				
21 A47(T)/A146 Trowse	80.6%	82.9%	89.0%	81.7%	89.5%
22 Martineau Lane	90.7%	110.7%	118.1%	117.2%	118.4%
23 Bracondale	79.6%	100.0%	101.9%	92.9%	106.6%
24 Crostwick Junction	0.475	0.253	0.387	0.387	0.501
25 Rackheath Junction	0.760	0.467	1.249	0.262	0.768

8.4.4 **Table 8.5** and **Table 8.6** show maximum queues (in PCUs) at each junction for the DM and DS scenarios during the AM and PM peak hours, respectively.

Table 8.5 All Junctions - Maximum AM Queues (PCU)

	AM - Max queue (PCU)				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
	On-line				
01 Fakenham Road				1	1
02 Fir Covert Road				0	1
03 Reepham Road				1	1
04 Drayton Lane				6	39
05 Holt Rd/Drayton Ln				1	1
06 Cromer Road South				2	6
07 Cromer Road North				2	18
08 Airport				1	6
09 North Walsham Road				7	53
10 Wroxham Road				3	28
11 Salhouse Road				4	15
12 Plumstead Road North				0	1
13 Plumstead Road South				6	26
14 Business Park				1	7
	Postwick				
15 Broadland Gate				6	13
16 Peachman Way	1	1	2	5	31
17 Postwick NW	1	1	2	6	7
18 Postwick NE				14	45

	AM - Max queue (PCU)				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
19 Oaks Lane				2	3
20 Park&Ride (P&R)	113	163	100	24	24
	Off-line				
21 A47(T)/A146 Trowse	11	12	21	14	20
22 Martineau Lane	18	22	27	24	28
23 Bracondale	35	71	65	74	77
24 Crostwick Junction	1	0	1	1	1
25 Rackheath Junction	1	1	4	0	4

Table 8.6 All Junctions - Maximum PM Queues (PCU)

	PM - Max queue (PCU)				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
	On-line				
01 Fakenham Road				1	1
02 Fir Covert Road				1	1
03 Reepham Road				1	2
04 Drayton Lane				4	13
05 Holt Rd/Drayton Ln				1	1
06 Cromer Road South				4	20
07 Cromer Road North				1	7
08 Airport				1	4
09 North Walsham Road				2	5
10 Wroxham Road				3	10
11 Salhouse Road				15	13
12 Plumstead Road North				1	1
13 Plumstead Road South				4	7
14 Business Park				2	17
	Postwick				
15 Broadland Gate				1	1
16 Peachman Way	1	1	3	1	2
17 Postwick NW	3	4	2	2	19
18 Postwick NE				16	2
19 Oaks Lane				1	1
20 Park&Ride (P&R)	25	70	70	17	57
	Off-line				
21 A47(T)/A146 Trowse	12	13	21	12	16
22 Martineau Lane	26	107	142	135	149
23 Bracondale	19	46	53	28	57
24 Crostwick Junction	1	0	0	1	1

	PM - Max queue (PCU)				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
25 Rackheath Junction	3	1	36	0	3

8.4.5 **Table 8.7** and **Table 8.8** show maximum delays (sec) at each junction, for the DM and DS scenarios during the AM and PM peak hours, respectively.

Table 8.7 All Junctions - Maximum AM Delay (sec)

	AM - Max delay (s)				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
	On-line				
01 Fakenham Road				3	3
02 Fir Covert Road				5	7
03 Reepham Road				5	9
04 Drayton Lane				28	170
05 Holt Rd/Drayton Ln				5	5
06 Cromer Road South				5	15
07 Cromer Road North				8	56
08 Airport				4	12
09 North Walsham Road				26	170
10 Wroxham Road				9	43
11 Salhouse Road				8	39
12 Plumstead Road North				4	5
13 Plumstead Road South				17	36
14 Business Park				4	14
	Postwick				
15 Broadland Gate				15	34
16 Peachman Way	4	5	10	14	71
17 Postwick NW	5	5	6	26	20
18 Postwick NE				29	74
19 Oaks Lane				17	21
20 Park&Ride (P&R)	444	648	524	96	115
	Off-line				
21 A47(T)/A146 Trowse	37	44	56	46	64
22 Martineau Lane	64	55	53	56	57
23 Bracondale	113	211	232	165	229
24 Crostwick Junction	18	18	19	22	25
25 Rackheath Junction	22	21	64	25	78

Table 8.8 All Junctions - Maximum PM Delays (sec)

	PM - Delay (s)				
	DM scenario			DS scenario	
	Existing	2017	2032	2017	2032
	On-line				
01 Fakenham Road				3	4
02 Fir Covert Road				5	7
03 Reepham Road				5	7
04 Drayton Lane				17	59
05 Holt Rd/Drayton Ln				5	5
06 Cromer Road South				10	45
07 Cromer Road North				7	38
08 Airport				3	8
09 North Walsham Road				8	22
10 Wroxham Road				10	38
11 Salhouse Road				15	70
12 Plumstead Road North				4	4
13 Plumstead Road South				6	11
14 Business Park				12	23
	Postwick				
15 Broadland Gate				4	5
16 Peachman Way	6	5	11	6	7
17 Postwick NW	7	8	8	7	166
18 Postwick NE				38	7
19 Oaks Lane				9	7
20 Park&Ride (P&R)	160	386	515	67	383
	Off-line				
21 A47(T)/A146 Trowse	38	62	49	48	51
22 Martineau Lane	58	231	341	329	346
23 Bracondale	52	108	150	84	211
24 Crostwick Junction	19	14	20	22	31
25 Rackheath Junction	43	21	402	23	92

8.5 'On-line' Junction results

8.5.1 This section of the TA presents more detailed results for each on-line junction expanding on the results presented in the summary tables above.

8.5.2 The DS proposed layouts and the geometry for the NDR 'on-line' junctions are presented in **Appendix D** and **Appendix E**. The turning flows derived from the SATURN model are presented in **Appendix F**. The full outputs from

the computer analyses for the 'on-line' junctions are presented in **Appendix G**.

01 Fakenham Road

8.5.3 Fakenham Road junction is proposed to be a 4-arm roundabout. Dual carriageway 2-lane approach with minor flaring is proposed for the NDR westbound. Single carriageway approach with flaring to two-lane entry is proposed for Fakenham Road northbound and single carriageway approach with flaring to three-lane entry for Fakenham Road eastbound. The fourth arm is an access to 'Attlebridge and Lagoon', and has not been modelled due to low traffic volumes.

8.5.4 **Table 8.9** presents the results for the operation of Fakenham Road roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.9 Fakenham Road – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	01 Fakenham Roundabout – 2017 DS					
NDR - WB	0	2	0.32	0	2	0.32
Fakenham Road NB	0	2	0.10	0	3	0.10
Fakenham Road EB	1	3	0.45	1	3	0.41
Access to Attlebridge/Lagoon	0	0	0	0	0	0
	01 Fakenham Roundabout – 2032 DS					
NDR - WB	1	3	0.44	1	3	0.42
Fakenham Road NB	0	3	0.11	0	3	0.13
Fakenham Road EB	1	3	0.52	1	4	0.52
Access to Attlebridge/Lagoon	0	0	0	0	0	0

8.5.5 The results show that the junction would operate within capacity in 2017 and 2032. Minimal delays and queues are predicted.

02 Fir Covert Road

8.5.6 Fir Covert Road junction is proposed to be a 4-arm roundabout. Two-lane approach with flaring to three-lane entry is proposed on both NDR westbound and eastbound. Single carriageway approach with flaring to two-lane entry is proposed on Fir Covert Road northbound and southbound.

8.5.7 **Table 8.10** presents the results for the operation of Fir Covert Road roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.10 Fir Covert Road – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	02 Fir Covert Roundabout – 2017 DS					
NDR – WB	0	2	0.30	1	2	0.33
Fir Covert Road NB	0	4	0.25	0	5	0.33
NDR – EB	0	2	0.28	0	2	0.28
Fir Covert Road SB	0	5	0.30	0	4	0.19
	02 Fir Covert Roundabout – 2032 DS					
NDR – WB	1	3	0.45	1	3	0.47
Fir Covert Road NB	1	7	0.55	1	7	0.51
NDR – EB	1	2	0.36	1	2	0.38
Fir Covert Road SB	1	7	0.40	0	5	0.24

8.5.8 The results show that the junction would operate within capacity in 2017 and 2032. Maximum delays are on Fir Cover Road NB of 5 seconds in 2017 and 7 seconds in 2032, and minimal queues are predicted.

03 Reepham Road

8.5.9 The Reepham Road junction is proposed to be a 4-arm roundabout. Two-lane approach with flaring to three-lane entry is proposed on both NDR westbound and eastbound. Single carriageway approach with two-lane entry is proposed on both Reepham Road northbound and southbound

8.5.10 **Table 8.11** presents the results for the operation of Reepham Road roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.11 Reepham Road – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	03 Reepham Roundabout – 2017 DS					
NDR – WB	1	2	0.40	1	3	0.47
Reepham Road NB	0	5	0.20	0	5	0.19
NDR – EB	1	2	0.36	1	2	0.36
Reepham Road SB	1	6	0.41	0	5	0.31

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
03 Reepham Roundabout – 2032 DS						
NDR – WB	1	3	0.56	2	4	0.64
Fir Covert Road NB	1	6	0.34	0	7	0.30
NDR – EB	1	4	0.57	1	3	0.52
Fir Covert Road SB	1	9	0.53	1	6	0.36

8.5.11 The results show that the junction would operate within capacity in 2017 and 2032. Maximum delays are 6 seconds on Reepham Road SB in 2017 and 9 seconds on Fir Cover Road SB in 2032. Maximum queues are 2PCUs (6m/lane) on NDR WB in 2032.

04 Drayton Lane

8.5.12 The Drayton Lane junction is proposed to be a 4-arm roundabout. Two-lane approach with flaring to three-lane entry is proposed on both NDR westbound and eastbound. Single carriageway approach flaring to two-lane entry is proposed for Drayton Lane northbound and southbound.

8.5.13 **Table 8.12** presents the results for the operation of Drayton Lane roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.12 Drayton Lane – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
04 Drayton Roundabout – 2017 DS						
NDR – WB	1	3	0.52	1	4	0.59
Drayton Lane NB	2	9	0.62	4	17	0.79
NDR – EB	1	4	0.55	1	3	0.52
Drayton Lane SB	6	28	0.87	1	7	0.46
04 Drayton Roundabout – 2032 DS						
NDR – WB	2	5	0.68	3	7	0.77
Drayton Lane NB	5	22	0.83	13	59	0.96
NDR – EB	4	8	0.81	2	6	0.70
Drayton Lane SB	39	170	1.09*	1	10	0.56
*Note: whilst the above table shows over capacity on Drayton Lane SB in 2032 AM, a further test has indicated that a slight adjustment of flare / entry width reduces the RFC to under 1.0 with delays and queues also being reduced. Such a change, for which sufficient land is available, could be implemented by the highways authority should monitoring show increased delays at this junction.						

8.5.14 The results show that the junction would operate below its theoretical capacity in 2017 during both peaks and 2032 PM peak. Maximum delays are 28 seconds on Drayton Lane SB in 2017 and 59 seconds on Drayton Lane NB in 2032. Maximum queues are 6PCUs (23m, based on 2PCUs stored in flare) on Drayton Lane NB in 2017 and 13PCUs (63m, based on 2PCUs stored in flare) in 2032.

8.5.15 During the 2032 AM peak, Drayton Lane SB is predicted to exceed its theoretical capacity, with maximum queues of 39PCUs (213m, based on 2PCUs stored in flare) and a delay of 2.8 minutes. However, this queue only occurs for 30 minutes of the assessed 1.5 hour period (peak hour plus 15 minutes either side). Queues dissipate within the peak half hour and the junction operates below its desirable threshold (RFC below 0.85) either side of this peak half hour. All other arms operate with an RFC of below 0.85 at all times during the morning peak hour.

05 Holt Road/Drayton Lane

8.5.16 The Holt Road/Drayton Lane junction is proposed to be a 3-arm roundabout. Single carriageway approach with flaring to two-lane entry is proposed on all approaches to the roundabout.

8.5.17 **Table 8.13** presents the results for the operation of Holt Road/Drayton Lane roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.13 Holt Road/Drayton Lane – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	05 Holt Road/Drayton Roundabout – 2017 DS					
Holt Road NB	0	0	0	0	0	0
NDR – Holt Road EB	1	4	0.37	1	5	0.47
Holt Road SB	1	5	0.55	0	4	0.31
	05 Holt Road/ Drayton Roundabout – 2032 DS					
Holt Road NB	0	0	0	0	0	0
NDR – Holt Road EB	1	4	0.38	1	5	0.44
Holt Road SB	1	5	0.51	0	4	0.31

8.5.18 The results show that the junction would operate within capacity in 2017 and 2032. Maximum delays are 5 seconds on the NDR EB in 2017 and 2032. minimal queues are predicted to develop.

06 Cromer Road South

8.5.19 Cromer Road South junction is part of a proposed grade separated junction with the NDR. The junction itself is proposed to be a 5-arm roundabout. One-lane approach with flaring to two-lane entry is proposed for the NDR westbound diverge and Holt Road NB. Dual carriageway with two-lane entry is proposed for the Bridge Link Road SB.

8.5.20 The Manor Park Access Road arm of the junction is a minor access road and has not been included in the SATURN model but has been included in the junction model. The Manor Park Access Road is proposed a single carriageway with minor 1-lane flaring at entry. Due to the low volume of traffic, no flows have been allocated for this arm.

8.5.21 The NDR westbound merge (exit only from the roundabout) has not been shown in the results table.

8.5.22 **Table 8.14** presents the results for the operation of Cromer Road South roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.14 Cromer Road South – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	06 Cromer Road South Roundabout – 2017 DS					
NDR – WB Diverge	0	5	0.31	0	4	0.23
Holt Road NB	1	4	0.55	4	10	0.79
Bridge Link Road SB	2	4	0.62	1	3	0.47
	06 Cromer Road South Roundabout – 2032 DS					
NDR – WB Diverge	2	10	0.67	1	7	0.46
Holt Road NB	6	15	0.86	20	45	0.97
Bridge Link Road SB	2	4	0.63	2	5	0.68

8.5.23 The results show that the junction would operate within its desirable capacity in 2017 and below its theoretical capacity in 2032. Maximum delays and queues are on Holt Road NB. Maximum delays are 10 seconds in 2017 and 45 seconds in 2032. Minimal queues would occur on Holt Road NB in 2017, with 20PCUs (75m, based on 7PCUs stored in flare) in 2032. However, this queue only occurs for 30 minutes of the assessed 1.5 hour period (peak hour plus 15 minutes either side). Queues dissipate within the peak half hour and the junction operates below its desirable threshold (RFC below 0.85)

either side of this peak half hour. All other arms operate with an RFC of below 0.85 at all times during the evening peak hour.

07 Cromer Road North

8.5.24 Cromer Road North junction is the other half of the grade separated junction with the NDR. It is proposed to be a 5-arm roundabout. Dual carriageway with two-lane entry is proposed for the Bridge Link Road northbound. One-lane approach with flaring to two-lane entry is proposed on NDR eastbound diverge and Cromer Road southbound. The access from New Home Lane is proposed a single carriageway approach and entry to the roundabout. The development accessed via this road will not be implemented by 2017. The road therefore does not carry any traffic in 2017 and has only been included in the 2032 assessment.

8.5.25 The NDR eastbound merge (exit only from the roundabout) has not been shown in the results table.

8.5.26 **Table 8.15** presents the results for the operation of Cromer Road North roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.15 Cromer Road North – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	07 Cromer Road North Roundabout – 2017 DS					
Bridge Link Road NB	0	2	0.33	1	3	0.47
NDR - EB Diverge	1	6	0.51	1	7	0.50
Cromer Road SB	2	8	0.70	1	5	0.50
	07 Cromer Road North Roundabout – 2032 DS					
Bridge Link Road NB	1	4	0.60	1	4	0.59
NDR - EB Diverge	3	17	0.78	1	10	0.61
Cromer Road SB	18	56	0.98	1	6	0.58
New Home Lane	0	8	0.29	7	38	0.88

8.5.27 The results show that the junction would operate within its desirable capacity in 2017 and below its theoretical capacity in 2032 PM peak. Maximum delays and queues are on Cromer Road SB with 8 seconds in 2017 and 56 seconds in 2032. Maximum queues are 2PCUs (6m, based on 1 PCU stored in flare) in 2017 and 18PCUs (69m, based on 6 PCU stored in flare) in 2032. However, this queue only occurs for 30 minutes of the assessed 1.5 hour period (peak hour plus 15 minutes either side). Queues dissipate

within the peak half hour and the junction operates below its desirable threshold (RFC below 0.85) either side of this peak half hour. All other arms operate with an RFC of below 0.85 at all times during the morning peak hour.

08 Airport

8.5.28 The Airport junction is part of the NDR Scheme and is represented in the SATURN model as a roundabout. However it has not been fully modelled with the two NDR arms only carrying traffic. Once implemented, the third arm will provide access to Norwich Aeropark and act as an emergency access to the airport.

8.5.29 In addition to the ARCADY model runs with the flows derived from the SATURN model, sensitivity testing has been carried out by overlaying the predicted development flows as per the "Norwich Aeropark – Environmental Statement Addendum Volume 3 – Updated Transport Assessment, June 2013". This document was produced by Iceni Projects Ltd on behalf of Wrenbridge Norwich Airport LLP. Table 5.3 on page 36 of the document provides the following proposed trips:

Table 8.16 Norwich Aeropark Proposed Trips

	Arrivals	Departures
0700 – 0800	160	19
1600 – 1700	13	103

8.5.30 It was assumed that half the trips would arrive from the east, half from the west along the NDR with the same distribution for departures. The trips were then added to the SATURN model flows in both 2017 and 2032.

8.5.31 Dual carriageway approach and two-lane entry are proposed for both NDR eastbound and westbound.

8.5.32 **Table 8.17** presents the results for the operation of Airport roundabout during the AM and PM peak hours, for the DS scenario based on the SATURN model flows. **Table 8.18** presents the results with Norwich Aeropark development trips taken into consideration.

Table 8.17 Airport – Summary results (SATURN model flows)

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	08 Airport Roundabout – 2017 DS					
NDR – WB	1	3	0.46	1	3	0.48
NDR – EB	1	4	0.55	1	3	0.47
	08 Airport Roundabout – 2032 DS					
NDR – WB	3	7	0.76	2	5	0.67
NDR – EB	5	9	0.83	3	7	0.78

Table 8.18 Airport – Summary results (SATURN model flows plus Norwich Aeropark development flows)

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	08 Airport Roundabout – 2017 DS					
NDR – WB	1	3	0.51	1	3	0.49
Access to Aeropark	0	4	0.02	0	4	0.12
NDR – EB	1	4	0.59	1	3	0.48
	08 Airport Roundabout – 2032 DS					
NDR – WB	4	9	0.81	2	5	0.68
Access to Aeropark	0	5	0.03	0	6	0.15
NDR – EB	6	12	0.87	4	8	0.79

8.5.33 The results show that the junction would operate within capacity in 2017 and 2032, both with SATURN model flows only as well as with added Norwich Aeropark development flows. Maximum delays and queues are on NDR EB. Maximum delays are 4 seconds in 2017 and 12 seconds in 2032. Maximum queues are 6PCUs (17m/lane) in 2032 with minimal queues in 2017.

09 North Walsham Road

8.5.34 The North Walsham Road junction is proposed to be a 4-arm roundabout. Two lane dual carriageway approach with flaring to three-lane entry is proposed for the NDR eastbound and westbound. Single carriageway on approach with flaring to two-lane entry is proposed on North Walsham Road northbound and southbound.

8.5.35 **Table 8.19** presents the results for the operation of North Walsham roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.19 North Walsham – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	09 North Walsham Roundabout – 2017 DS					
NDR – WB	1	3	0.52	2	4	0.61
North Walsham Road NB	1	5	0.38	1	8	0.56
NDR – EB	1	3	0.49	1	3	0.47
North Walsham Road SB	7	26	0.89	1	6	0.56
	09 North Walsham Roundabout – 2032 DS					
NDR – WB	3	5	0.74	4	7	0.80
North Walsham Road NB	2	12	0.68	3	16	0.75
NDR – EB	3	6	0.76	4	7	0.78
North Walsham Road SB	53	170	1.10*	5	22	0.83
*Note: whilst the above table shows over capacity on North Walsham Road SB in 2032 AM, a further test has indicated that a slight adjustment of flare / entry width reduces the RFC to under 1.0 with delays and queues also being reduced. Such a change, for which sufficient land is available, could be implemented by the highways authority should monitoring show increased delays at this junction.						

8.5.36 The results show that the junction would operate below its theoretical capacity in 2017 during both peak hours and in 2032 PM peak. Maximum delays are 26 seconds on North Walsham Road SB in 2017 and 22 seconds in 2032. Maximum queues are 7PCUs (23m, based on half the queue stored in flare which could accommodate 4PCU) in 2017 and 5PCUs (17m, based on half the queue stored in flare) in 2032.

8.5.37 During 2032 AM peak, the North Walsham Road SB arm is exceeding its theoretical capacity, with maximum queues of 53PCUs (282m, based on 4PCUs stored in flare) and a delay of 2.8 minutes. However, this queue only occurs for 30 minutes of the assessed 1.5 hour period (peak hour plus 15 minutes either side). Queues dissipate within the peak half hour and the junction operates below its desirable threshold (RFC below 0.85) either side of this peak half hour. All other arms operate with an RFC of below 0.85 at all times during the morning peak hour.

10 Wroxham Road

8.5.38 The Wroxham Road junction is proposed to be a 5-arm roundabout. Two-lanes on approach with flaring to three-lane entry is proposed on both NDR northbound and southbound. Single carriageway approach with flaring to two-lane entry is proposed on Wroxham Road eastbound and westbound.

8.5.39 The Access Track to the Sewage Farm arm is a minor access only and has not been included in the SATURN model and therefore has not been included in the junction model.

8.5.40 **Table 8.20** presents the results for the operation of Wroxham roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.20 Wroxham – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	10 Wroxham Roundabout – 2017 DS					
NDR – WB	2	4	0.62	3	6	0.77
Wroxham Road NB	1	5	0.39	1	10	0.59
NDR – EB	3	6	0.75	2	4	0.63
Wroxham Road SB	3	9	0.73	1	5	0.54
	10 Wroxham Roundabout – 2032 DS					
NDR – WB	6	10	0.86	16	27	0.95
Wroxham Road NB	3	16	0.73	6	38	0.88
NDR – EB	28	43	0.99	10	18	0.92
Wroxham Road SB	11	33	0.94	8	24	0.90

8.5.41 The results show that the junction would operate within its desirable capacity in 2017 and below its theoretical capacity in 2032 PM peak. Maximum delays are 10 seconds on Wroxham Road NB in 2017 and 43 seconds on NDR EB in 2032. Minimal queuing occurs in 2017 with the maximum queue in 2032 on NDR EB of 28PCUs (63m/lane, based on 6PCU stored in flare). However, this queue only occurs for 30 minutes of the assessed 1.5 hour period (peak hour plus 15 minutes either side). Queues dissipate within the peak half hour and the junction operates below its desirable threshold (RFC below 0.85) either side of this peak half hour.

11 Salhouse

8.5.42 The Salhouse Road junction is proposed to be a 4-arm roundabout. Two-lane dual carriageway approach with flaring to three-lane entry is proposed on both NDR northbound and southbound. Single carriageway approach with flaring to three-lane entry is proposed on Salhouse Road westbound. Single carriageway approach with flaring to two-lane is proposed on Salhouse Road eastbound.

8.5.43 **Table 8.21** presents the results for the operation of Salhouse roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.21 Salhouse – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	11 Salhouse Roundabout – 2017 DS					
NDR – NB	1	3	0.60	3	5	0.75
Salhouse Road EB	1	7	0.50	3	15	0.73
NDR – SB	4	6	0.79	2	3	0.63
Salhouse Road WB	1	8	0.58	0	3	0.27
	11 Salhouse Roundabout – 2032 DS					
NDR – NB	4	7	0.82	9	15	0.90
Salhouse Road EB	8	39	0.91	13	70	0.97
NDR – SB	15	21	0.95	6	9	0.86
Salhouse Road WB	9	36	0.92	3	11	0.77

8.5.44 The results show that the junction would operate within its desirable capacity in 2017 and below its theoretical capacity in 2032. Maximum delays are 15 seconds on Salhouse Road EB in 2017 and 70 seconds in 2032. Maximum queues are 4PCUs (11m/lane, based on 1PCU stored in flare) on NDR SB in 2017 and 15PCUs (29m/lane, based on 5PCUs stored in flare) in 2032.

12 Plumstead Road North

8.5.45 The Plumstead Road North junction is proposed to be a 3-arm roundabout. Single carriageway approach with two-lane entry is proposed on all approaches to the roundabout.

8.5.46 **Table 8.22** presents the results for the operation of Plumstead North roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.22 Plumstead North – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	12 Plumstead Road North Roundabout – 2017 DS					
NDR Link Road NB	0	3	0.26	1	4	0.37
Plumstead Road EB	0	4	0.27	0	4	0.25
Plumstead Road WB	0	4	0.25	0	4	0.18

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	12 Plumstead Road North Roundabout – 2032 DS					
NDR Link Road NB	0	3	0.20	1	4	0.40
Plumstead Road EB	0	4	0.16	0	4	0.19
Plumstead Road WB	1	5	0.40	0	3	0.20

8.5.47 The results show that the junction would operate within capacity in 2017 and 2032. Maximum delays are 4 seconds on all arms in 2017 and 5 seconds on Plumstead Road WB in 2032. Minimal queues are predicted.

13 Plumstead Road South

8.5.48 The Plumstead Road South junction is proposed to be a 3-arm roundabout. Single carriageway approach with two-lane entry is proposed for the NDR Link Road southbound. Two lane dual carriageway approach with flaring to three-lane entry is proposed on NDR southbound and northbound.

8.5.49 A further arm is to be provided at the junction, but this is for a track access only and therefore has not been included in the junction model.

8.5.50 **Table 8.23** presents the results for the operation of Plumstead South roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.23 Plumstead South – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	13 Plumstead Road South Roundabout – 2017 DS					
NDR – NB	1	3	0.53	4	6	0.79
NDR – SB	6	8	0.85	2	4	0.67
NDR Link Road SB	2	17	0.69	1	6	0.36
	13 Plumstead Road South Roundabout – 2032 DS					
NDR – NB	3	5	0.75	7	11	0.88
NDR – SB	26	35	0.98	2	5	0.71
NDR Link Road SB	4	36	0.80	0	5	0.21

8.5.51 The results show that the junction would operate within its desirable capacity in 2017 and below its theoretical capacity in 2032. Maximum delays are 17 seconds on NDR SB in 2017 and 36 seconds in 2032 on NDR Link Road. Maximum queues are 6PCUs (11m/lane, based on 2PCUs stored in flare) on

NDR SB in 2017 and 26PCUs (63m/lane, based on 5PCUs stored in flare) in 2032.

14 Business Park

8.5.52 The Business Park junction is proposed to be a 3-arm roundabout linking the NDR to the Business Park. Two lane dual carriageway approach and entry are proposed on both NDR southbound and northbound. Single carriageway approach with flaring to two-lane entry is proposed on Broadland Gate Link Road eastbound. Two segregated left filter lanes are proposed at this junction, one on the NDR southbound approach, and the second on the NDR northbound approach to Broadland Gate Link Road.

8.5.53 **Table 8.24** presents the results for the operation of Business Park roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.24 Business Park – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	14 Business Park Roundabout – 2017 DS					
NDR – NB	1	4	0.59	2	5	0.71
Broadland Gate Link Road EB	0	4	0.17	2	12	0.64
NDR – SB	0	2	0.20	0	2	0.06
	14 Business Park Roundabout – 2032 DS					
NDR – NB	7	14	0.87	17	28	0.95
Broadland Gate Link Road EB	1	7	0.36	5	33	0.86
NDR – SB	0	2	0.30	0	2	0.28

8.5.54 The results show that the junction would operate within its desirable capacity in 2017 and below its theoretical capacity in 2032. Maximum delays are 12 seconds on Broadland Gate Link Road EB in 2017 and 19 seconds in 2032. Maximum queues are 2PCUs (6m/lane) on NDR Business Park Link Road NB in 2017 and 7PCUs (17m/lane, based on 2PCUs stored in flare) in 2032.

8.6 'Postwick' Junction Results

8.6.1 The DS proposed layouts and the geometry for the NDR 'Postwick' junctions are presented in **Appendix D and E**.

8.6.2 Full output results for the 'Postwick' junctions are presented in **Appendix G** along with traffic flows derived from the SATURN model contained in **Appendix F**.

15 Broadland Gate

8.6.3 The Broadland Gate junction is a new junction providing access to the Broadland Gate development located south of the Business Park roundabout.

8.6.4 In the DS scenario, Broadland Gate junction is proposed to be a 3-arm roundabout linking to the NDR to the east and to Peachman Way to the west. Single carriageway approach with flaring to two-lane entry is proposed on all approaches to the roundabout. There is also a segregated left filter lane on the westbound approach into the development which is proposed to give way to traffic exiting the roundabout.

8.6.5 **Table 8.25** presents the results for the operation of Broadland Gate roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.25 Broadland Gate – ARCADY Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	15 Broadland Gate Roundabout – 2017 DS					
New Access to Development	0	4	0.01	0	2	0.01
Broadland Gate Link Road EB	0	3	0.11	1	4	0.34
Broadland Gate Link Road WB	6	15	0.85	0	3	0.14
	15 Broadland Gate Roundabout – 2032 DS					
New Access to Development	0	5	0.11	0	4	0.23
Broadland Gate Link Road EB	0	3	0.18	0	4	0.33
Broadland Gate Link Road WB	13	34	0.95	1	5	0.55

8.6.6 The results show that the junction would operate within its desirable capacity in 2017 and below its theoretical capacity in 2032. Maximum delays are 15 seconds on Broadland Gate Link Road WB in 2017 and 34 seconds in 2032. Maximum queues are 6PCUs (23m, based on 2PCUs stored in flare) on Broadland Gate Link Road WB in 2017 and 13PCUs (63m, based on 2 PCUs stored in flare) in 2032.

8.6.7 The results of the assessment for the give-way left filter lane is presented in **Table 8.26** below. The assessment has only been carried out for the AM

peak in 2032 DS as this is the critical period with inbound flows being significantly greater in the AM peak than the PM peak. In 2017, development flows are minimal due to the development not being fully implemented.

Table 8.26 Broadland Gate – PICADY Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	15 Broadland Gate Roundabout – 2032 DS					
Left filter lane into the development	1	10	0.524			

8.6.8 The results show that there are sufficient gaps in the traffic exiting the roundabout for left filter lane traffic to emerge.

16 Peachman Way

8.6.9 The Peachman Way junction is an existing 3-arm roundabout linking Broadland Way and Peachman Way. Single carriageway approach with minor flaring to two-lane entry is present on Peachman Way eastbound and southbound. Two lane dual carriageway approach and entry are present on Broadland Way northbound.

8.6.10 This junction has been included in the SATURN model in the DM and DS scenarios. The DM and DS scenarios have been assessed with the Broadland Gate development, which is being accessed via this roundabout in form of a fourth arm to the existing roundabout in both scenarios. The proposed fourth arm is Broadland Gate Link Road westbound, which links to the NDR via Broadland Gate roundabout. Single carriageway approach with flaring to two-lane entry is proposed on this arm.

8.6.11 **Table 8.27** presents the results for the operation of Peachman Way roundabout during the AM and PM peak hours, for the Existing, DM and DS scenarios.

Table 8.27 Peachman Way – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	16 Peachman Way Roundabout – 2012					
Broadland Way NB	1	3	0.38	0	2	0.28
Peachman Way EB	0	3	0.13	1	6	0.49
Peachman Way SB	1	4	0.47	0	4	0.32
	16 Peachman Way Roundabout – 2017 DM					
Broadland Way NB	0	2	0.31	0	2	0.18
Peachman Way EB	1	5	0.48	1	5	0.51
Peachman Way SB	0	3	0.01	0	3	0.01
Broadland Gate Link Road WB	0	3	0.01	0	3	0.05
	16 Peachman Way Roundabout – 2032 DM					
Broadland Way NB	1	4	0.52	1	3	0.41
Peachman Way EB	2	10	0.71	3	11	0.76
Peachman Way SB	1	7	0.48	0	0	0
Broadland Gate Link Road WB	0	4	0.17	1	6	0.49
	16 Peachman Way Roundabout – 2017 DS					
Broadland Way NB	0	2	0.15	0	2	0.20
Peachman Way EB	0	3	0.18	1	6	0.54
Peachman Way SB	0	0	0	0	0	0
Broadland Gate Link Road WB	5	14	0.84	0	3	0.15
	16 Peachman Way Roundabout – 2032 DS					
Broadland Way NB	0	2	0.15	0	2	0.19
Peachman Way EB	1	5	0.42	1	6	0.55
Peachman Way SB	0	0	0	0	0	0
Broadland Gate Link Road WB	31	71	1.01	2	7	0.67

8.6.12 The results show that the junction would operate within its desirable capacity in 2017 and 2032 DM scenarios, with ample spare capacity. In the DS scenario, the junction operates within capacity in 2017 and 2032 PM peak.

8.6.13 In comparison with 2012 existing scenario, the DM scenario has maximum delays of 5 seconds (no change from 2012) on Peachman Way EB in 2017 and 11 seconds in 2032 (slight increase from 2012). Maximum queues are 3PCUs (12m, based on 1PCU stored in flare) on Peachman Way EB in 2032, and minimal queues in 2017 (no change from 2012). The DS scenario has maximum delays of 14 seconds on Broadland Gate Link Road WB in 2017 and 8 seconds on Peachman Way EB in 2032. Maximum queue is 5PCUs (17m, based on 2PCUs stored in flare) on Broadland Gate Link Road WB in 2017 and 2PCUs (12m) on Peachman Way EB in 2032 PM peak.

8.6.14 Broadland Gate Link Road WB experiences a high volume of traffic during the AM peak hour in 2032 DS scenario as a result of the NDR and changed layout at the A47(T) Postwick junction. As a result, it exceeds its theoretical capacity fractionally, with maximum queues of 31PCUs (161m, based on 3PCUs stored in flare) and delays of 1.2 minutes. However, the extent of this queue does not obstruct the operation of Broadland Gate roundabout, and it only occurs for 30 minutes of the assessed 1.5 hour period (peak hour plus 15 minutes either side). The queue dissipates within the peak half hour and the junction operates below its desirable threshold (RFC below 0.85) either side of this peak half hour. All other arms operate with an RFC of below 0.85 at all times during the morning peak hour.

17 Postwick North-West

8.6.15 Postwick NW roundabout is the northern part of the existing Postwick grade separated junction. The roundabout itself is an existing 5-arm roundabout linking Broadland Way, A47(T) and A1042 Yarmouth Road. Single carriageway approach with flaring to two-lane entry is present on Postwick Bridge northbound. Two lane dual carriageway approach and entry are present on Broadland Way southbound and A1042 Yarmouth Road eastbound. Two-lane approach and entry is present on the A47(T) eastbound diverge. Left turn filter lanes are present from A47(T) eastbound diverge onto A1042 Yarmouth Road and from Broadland Way southbound diverge onto the A47(T) eastbound merge.

8.6.16 In the DS scenario, Postwick NW junction is proposed as a 4-arm roundabout, with the two existing filter lanes closed off. A new eastern access/egress from the Postwick NW roundabout is proposed for the Broadland Gate development. Single carriageway approach with flaring to two-lane entry would remain unchanged on Postwick Bridge northbound. Broadland Gate Development Access road would also be a one-lane approach with flaring to two lanes. Unchanged two lane dual carriageway approaches and entries would be present on A1042 Yarmouth Road eastbound and Broadland Way southbound.

8.6.17 **Table 8.28** presents the results for the operation of Postwick NW roundabout during the AM and PM peak hours, for the existing, DM and DS scenarios.

Table 8.28 Postwick NW – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
17 Postwick NW Roundabout – 2012 Existing						
Postwick Bridge Link Road NB	1	5	0.52	1	3	0.33
A47(T) EB Diverge	0	3	0.31	0	2	0.20
A1042 Yarmouth Road EB	1	3	0.46	3	7	0.78
Broadland Way SB	1	3	0.40	1	6	0.54
17 Postwick NW Roundabout – 2017 DM						
Postwick Bridge Link Road NB	1	5	0.54	1	4	0.44
A47(T) EB Diverge	0	3	0.25	0	2	0.18
A1042 Yarmouth Road EB	1	3	0.47	4	8	0.79
Broadland Way SB	1	3	0.34	1	6	0.52
17 Postwick NW Roundabout – 2032 DM						
Postwick Bridge Link Road NB	0	3	0.31	1	3	0.36
A47(T) EB Diverge	1	3	0.38	1	3	0.36
A1042 Yarmouth Road EB	2	5	0.65	2	6	0.71
Broadland Way SB	2	6	0.66	2	8	0.69
17 Postwick NW Roundabout – 2017 DS						
Postwick Bridge Link Road NB	6	26	0.87	2	7	0.63
A1042 Yarmouth Road EB	1	2	0.36	2	5	0.69
Broadland Way SB	2	5	0.64	1	4	0.39
Broadland Gate Access Road	0	5	0.02	0	5	0.07
17 Postwick NW Roundabout – 2032 DS						
Postwick Bridge Link Road NB	4	20	0.82	1	6	0.50
A1042 Yarmouth Road EB	1	3	0.46	3	6	0.77
Broadland Way SB	7	16	0.88	8	24	0.90
Broadland Gate Access Road	0	8	0.21	19	166	1.06

8.6.18 The results show that the junction would operate within its desirable capacity for the DM scenario and below its theoretical capacity for the DS scenario in 2017 and 2032 except for Broadland Gate Access Road in 2032 DS PM.

8.6.19 In the DM scenario, maximum delays occur on Yarmouth Road EB very slightly increasing from 7 seconds in 2012 to 8 seconds in 2017. Maximum delays in 2032 are 8 seconds on Broadland Way southbound. Maximum queues are 3PCUs (12m/lane) on Yarmouth Road EB in 2012 and 4PCUs (12m/lane) in 2017. Minimal queues are predicted in 2032.

8.6.20 In the DS scenario, the maximum delays are 26 seconds on Postwick Bridge Link Road NB in 2017 and 2.8 minutes on Broadland Gate Access Road in 2032. Maximum queues are 6PCUs (23m, based on 2PCUs stored in flare)

on Postwick Bridge Link Road NB in 2017 and 19PCUs (98m, based on 2PCUs stored in flare) on Broadland Gate Access Road in 2032. This arm is the access / egress from the proposed Broadland Gate development. The development has two access points; the northern one being from Broadland Gate roundabout. Traffic has the option of using either of these access and egress points. Assessments presented in **paragraph 8.6.6** show that there are minimal queues and delays at the northern access in 2032.

18 Postwick NE

8.6.21 Postwick NE is a proposed new 5-arm roundabout. The roundabout links the A47(T), Business Park Link Road and the P&R junction via the New Bridge Link. Two lane dual carriageway approach and entry are proposed for the NDR Business Park Link Road southbound. Two lane dual carriageway approach and entry are proposed on the A47(T) EB Diverge. A left filter lane is also proposed from the A47(T) EB Diverge northward to NDR Business Park Link Road. Single carriageway one-lane approach with flaring to two-lane entry is provided for the New Bridge Link northbound. There is also a minor fifth arm at this roundabout which is not modelled due to low traffic volumes.

8.6.22 **Table 8.29** presents the results for the operation of Postwick NE roundabout during the AM and PM peak hours, for the DS scenario.

Table 8.29 Postwick NE– Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	18 Postwick NE Roundabout – 2017 DS					
New Bridge Link NB	1	3	0.35	1	4	0.56
A47(T) EB Diverge	0	2	0.09	0	3	0.23
Business Park Link Road SB	14	29	0.95	16	38	0.96
	18 Postwick NE Roundabout – 2032 DS					
New Bridge Link NB	1	3	0.38	1	4	0.50
A47(T) EB Diverge	0	3	0.31	0	3	0.17
Business Park Link Road SB	45	74	1.02	2	7	0.69

8.6.23 The results show that the junction would operate below its theoretical capacity in 2017 and 2032 PM peak. Maximum delays are 38 seconds on Business Park Link Road SB in 2017 and 7 seconds in 2032, as a result of reduction in flows in the PM peak. The maximum queue is 16PCUs

(46m/lane) on Business Park Link Road SB in 2017 and 2PCUs (6m/lane) in 2032.

8.6.24 Business Park Link Road SB experiences a high volume of traffic during the AM peak hour in 2032 due to the NDR. As a result, it exceeds its theoretical capacity fractionally, with a total maximum queue of 45PCUs (132m/lane) and maximum queuing delays of 1.2 minutes. However, the extent of this queue does not obstruct the operation of the Business Park roundabout, and it only occurs for 30 minutes of the assessed 1.5 hour period (peak hour plus 15 minutes either side). The queue dissipates within the peak half hour and the junction operates below its desirable threshold (RFC below 0.85) either side of this peak half hour. All other arms operate with an RFC of below 0.85 at all times during the morning peak hour.

19 Oak's Lane

8.6.25 Oak's Lane junction is an existing 'T' priority junction. It links Oak's Lane to the A1042 Yarmouth Road. Single carriageway approach and entry is present on all approaches. The present junction experiences queuing along Yarmouth Road through this junction in peak hours as shown below in the assessments for the P&R junction. PICADY cannot model such queuing back. Furthermore it is considered that the relatively low volumes of traffic from Oak's Lane can presently find sufficient gaps in this queue to emerge from Oak's Lane. The existing situation with the priority junction has therefore not been modelled in this TA.

8.6.26 In the DS scenario, Oak's Lane is proposed to be a 4-arm roundabout linking the A1047 Yarmouth Road eastbound and westbound to a new P&R access and existing Oak's Lane. Single carriageway approach with flaring to three-lane entry is proposed on Yarmouth Road westbound. Single carriageway approach and entry is proposed on P&R access road and Oak's Lane, whilst Yarmouth Road eastbound is flaring into two lanes on entry.

8.6.27 **Table 8.30** presents the results for the operation of Oak's Lane junction during the AM and PM peak hours, for the DM and DS scenarios.

Table 8.30 Oak's Lane Roundabout – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	19 Oak's Lane Roundabout – 2017 DS					
Park & Ride Access Road	0	0	0	0	7	0.25
A1042 Yarmouth Road WB	0	3	0.07	0	3	0.08
A1042 Yarmouth Road EB	2	6	0.71	1	4	0.49
Oak's Lane	1	17	0.38	0	9	0.24
	19 Oak's Lane Roundabout – 2032 DS					
Park & Ride Access Road	0	0	0	0	6	0.32
A1042 Yarmouth Road WB	0	3	0.12	1	3	0.08
A1042 Yarmouth Road EB	3	8	0.75	1	3	0.34
Oak's Lane	1	21	0.41	0	7	0.19

8.6.28 The results show that the proposed roundabout would operate within capacity in 2017 and 2032. Maximum delays are 17 seconds on Oak's Lane in 2017 and 21 seconds in 2032. The total maximum queue is 2PCUs (6m, based on 1PCU stored in flare) on A1042 Yarmouth Road EB in 2017 and 3PCUs (11m, based on 1PCU stored in flare) in 2032.

20 Park & Ride

8.6.29 Park & Ride (P&R) is the southern half of the Postwick grade separated junction. The roundabout itself is an existing 4-arm roundabout, linking P&R, A1042 Yarmouth Road and A47(T). Single carriageway approach with flaring to two-lane entry is present on the existing Bridge Link Road southbound, the A1042 Yarmouth Road westbound, and the Park & Ride Access Road. The fourth arm is the westbound merge to A47(T).

8.6.30 The DM scenario has been assessed using the Entry Lane Analysis mode within Junction 8 software, to model each lane allowed movements. The allowed movements are defined for each lane, based on the actual road markings. The exit and circulating lanes are not included in the lane usage analysis.

8.6.31 In the DS scenario, the P&R roundabout becomes a signalised junction to allow for the NDR to be connected to this point of the network. A New Link Bridge is proposed north-east of the existing roundabout linking to the new Postwick NE roundabout. The three-lane southbound carriageway widens to a total of five lanes plus one bus-only lane at the stopline. Yarmouth Road widens to three lanes at the stopline. The P&R exit has a single lane at the

stopline. The A47(T) merge is maintained from all directions in form of a two-lane exit from the junction. The existing Postwick Bridge widens from one lane southbound to three lanes plus one bus-only lane at the stopline.

8.6.32 **Table 8.31** and **Table 8.32** present the results for the operation of Park & Ride junction during the AM and PM peak hours, for the existing, DM and DS scenarios.

Table 8.31 Park & Ride Roundabout – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	20 P&R Roundabout – 2012 Existing					
P&R access road	0	0	0	0	2	0.13
Postwick Bridge SB	1	3	0.53	4	10	0.83
A1042 Yarmouth Rd WB	113	444	1.00	25	160	0.99
	20 P&R Roundabout – 2017 DM					
P&R access road	0	0	0	0	3	0
Postwick Bridge SB	1	3	0.57	4	9	0.82
A1042 Yarmouth Rd WB	163	648	1.00	70	386	1.00
	20 P&R Roundabout – 2032 DM					
P&R access road	0	0	0	0	4	0.27
Postwick Bridge SB	6	14	0.87	23	42	0.97
A1042 Yarmouth Rd WB	100	524	1.03	70	515	1.03

8.6.33 The results show that the existing roundabout is exceeding its theoretical capacity in 2012, with AM peak queues extending back on the A1042 Yarmouth Road WB approach by around 650m towards the A47(T) westbound diverge slip road. In 2017 DM AM peak the conditions deteriorate with significant delays of up to 10.8 minutes and long queues of 163PCUs or 937m forecast on A1042 Yarmouth Road WB which would extend back onto the A47(T) westbound diverge slip road, approaching the diverge area at the start of the slip road, and thus there will be a high risk of queues conflicting with high speed traffic on the A47(T). In 2032 DM AM peak the conditions here improve, but only due to the constraints further west on the Yarmouth Road corridor such that traffic reassigns, but even so the queue length forecast is 100 PCU.

Table 8.32 Park & Ride Signals– Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	DoS (%)	Queue (PCU)	Delay (sec)	DoS (%)
	20 P&R Signals – 2017 DS					
A1047 Yarmouth Rd ahead	24	56	94.0	12	40	77.5
A1047 Yarmouth Rd right	8	25	53.2	17	51	88.9
Postwick Bridge right/ahead	6	19	60.9	17	22	84.9
Postwick Bridge right	5	32	41.4	13	30	74.1
New Link Bridge ahead/left	1	12	6.7	1	18	9.8
New Link Bridge right	21	75	96.1	16	66	93.8
A47(T) on-slip ahead	14	9	43.9	10	10	43.6
P&R left	0	36	4.4	0	24	1.5
Postwick Bridge NB ahead	4	5	64.0	9	11	78.4
Postwick Bridge SB L/ahead	10	96	91.1	14	67	93.1
PRC for all lanes	-6.8 %			-4.2 %		
	20 P&R Signals – 2032 DS					
A1047 Yarmouth Rd ahead	24	61	94.8	57	383	120.0
A1047 Yarmouth Rd right	11	30	65.6	26	174	104.2
Postwick Bridge right/ahead	14	39	86.9	31	28	93.8
Postwick Bridge right	11	49	80.9	27	31	91.0
New Link Bridge ahead/left	1	11	11.6	2	31	16.4
New Link Bridge right	19	59	92.4	7	61	75.9
A47(T) on-slip ahead	15	9	46.7	6	13	43.4
P&R left	0	37	4.7	0	12	0.9
Postwick Bridge NB ahead	2	4	55.2	16	72	98.5
Postwick Bridge SB L/ahead	9	115	91.5	6	19	60.5
PRC for all lanes	-5.3 %			-33.4 %		

8.6.34 The results show that the proposed signalised junction would operate within its theoretical capacity in 2017 (both peaks) and 2032 AM peak with all arms showing DoS values of below 100%. Maximum delays are 2 minutes on Postwick Bridge SB, with maximum queues of 24PCUs (138m) on Yarmouth Road.

8.6.35 In the PM peak in 2032DS, the junction would work above its theoretical capacity with DoS values above 100% on the Yarmouth Road arm. Maximum delays are 6.4 minutes with maximum queues of 57PCUs (328m). Comparing these results with those for the existing roundabout junction, this represents a significant improvement on the Yarmouth arm where queues are predicted to reach up to 845m (163PCU) with delays of up to 10.8 minutes (see **Table 8.31**). Importantly, Park & Ride bus services have

dedicated signal control and can be prioritised at the proposed signal junction.

8.7 Off-line junctions

8.7.1 The DM and DS proposed layouts for the NDR 'Off-line' junctions are presented in **Appendix D**.

8.7.2 Full output results for the 'Off-line' junctions are presented in **Appendix G** along with traffic flows derived from the SATURN model presented in **Appendix F**.

21 A47(T)/A146 Trowse Junction

8.7.3 The A47(T)/A146 Trowse junction is a signalised grade separated junction. It links the A47(T) east and west to the A146 north and south.

8.7.4 Three-lane approach with flaring to four-lane entry is present on the A146 northbound and southbound. Three lanes are dedicated to proceed onto the A146, and the forth lane allows vehicles onto the A47(T) WB and EB. Two-lane approach with flaring to four-lane entry is present on the A47(T) WB and EB Diverge roads. The four lanes are equally split to proceed on the A146 westbound and eastbound directions.

8.7.5 **Table 8.33** presents the results for the operation of A47(T)/A146 Trowse junction during the AM and PM peak hours, for the existing, DM and DS scenarios. The junction is formed by two sub-junctions, the Trowse A47(T) westbound off-slip (the south eastern junction) titled J1 in the results below, and the Trowse A47(T) eastbound off-slip (the north western junction) titled J2 in the results below.

Table 8.33 A47(T)/A146 Trowse – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	DoS (%)	Queue (PCU)	Delay (sec)	DoS (%)
	21 A47(T)/A146 Trowse Signals – 2013					
J1: A146 SB ahead	5	12	37.4	7	9	55.8
J1: A146 NB ahead / left	10	29	80.1	6	27	63.6
J1: A146 SB right	8	37	72.1	7	21	73.6
J1: A47(T) WB off-slip left	2	27	22.7	6	34	50.3
J1: A47(T) WB off-slip ahead / R	11	38	79.4	8	37	65.6

	AM			PM		
	Queue (PCU)	Delay (sec)	DoS (%)	Queue (PCU)	Delay (sec)	DoS (%)
J2: A146 SB ahead / left	6	29	49.9	12	33	80.1
J2: A146 NB ahead	7	14	61.6	5	18	42.3
J2: A146 NB right	6	20	64.8	5	34	77.3
J2: A47(T) EB off-slip left	6	31	48.0	3	26	24.5
J2: A47(T) EB off-slip ahead / R	9	37	71.3	11	38	80.6
PRC for all lanes	12.4 %			11.6 %		
	21 A47(T)/A146 Trowse Signals – 2017 DM					
J1: A146 SB ahead	5	10	40.3	6	11	58.4
J1: A146 NB ahead / left	12	30	84.3	8	32	72.6
J1: A146 SB right	10	42	85.2	8	29	80.1
J1: A47(T) WB off-slip left	2	31	23.6	3	31	32.0
J1: A47(T) WB off-slip ahead / R	11	44	82.6	10	40	77.4
J2: A146 SB ahead / left	9	26	64.0	13	26	82.6
J2: A146 NB ahead	7	9	63.2	6	7	45.3
J2: A146 NB right	5	31	69.8	5	62	82.9
J2: A47(T) EB off-slip left	6	34	55.1	4	34	44.2
J2: A47(T) EB off-slip ahead / R	9	39	72.5	10	47	82.5
PRC for all lanes	5.6 %			8.6 %		
	21 A47(T)/A146 Trowse Signals – 2032 DM					
J1: A146 SB ahead	5	14	45.9	6	12	62.0
J1: A146 NB ahead / left	21	43	94.1	9	39	83.0
J1: A146 SB right	12	53	91.4	11	31	87.1
J1: A47(T) WB off-slip left	3	31	27.4	4	31	42.0
J1: A47(T) WB off-slip ahead / R	15	56	91.8	14	49	89.0
J2: A146 SB ahead / left	13	32	76.7	21	36	92.7
J2: A146 NB ahead	9	8	65.0	8	7	49.5
J2: A146 NB right	8	23	80.4	4	36	72.3
J2: A47(T) EB off-slip left	6	37	62.9	7	38	68.0
J2: A47(T) EB off-slip ahead / R	9	43	76.3	12	55	88.3
PRC for all lanes	-4.5 %			-3.0 %		
	21 A47(T)/A146 Trowse Signals – 2017 DS					
J1: A146 SB ahead	5	15	39.3	6	13	58.9
J1: A146 NB ahead / left	14	35	87.9	8	33	73.3
J1: A146 SB right	9	43	83.2	8	31	78.6
J1: A47(T) WB off-slip left	3	29	26.4	4	29	33.9
J1: A47(T) WB off-slip ahead / R	14	46	88.0	12	40	81.7
J2: A146 SB ahead / left	9	26	61.5	12	24	82.4
J2: A146 NB ahead	8	8	64.8	7	7	47.7
J2: A146 NB right	5	22	65.9	6	48	80.3
J2: A47(T) EB off-slip left	7	38	63.7	5	36	50.8
J2: A47(T) EB off-slip ahead / R	8	40	68.8	10	47	81.1

	AM			PM		
	Queue (PCU)	Delay (sec)	DoS (%)	Queue (PCU)	Delay (sec)	DoS (%)
PRC for all lanes	2.3 %			9.9 %		
	21 A47(T)/A146 Trowse Signals – 2032 DS					
J1: A146 SB ahead	5	16	44.9	7	20	66.2
J1: A146 NB ahead / left	20	46	93.9	10	51	88.3
J1: A146 SB right	13	64	93.8	10	35	86.9
J1: A47(T) WB off-slip left	3	30	28.3	5	24	41.9
J1: A47(T) WB off-slip ahead / R	16	52	91.3	16	40	89.5
J2: A146 SB ahead / left	12	33	75.6	13	28	86.2
J2: A146 NB ahead	9	8	65.7	9	13	57.3
J2: A146 NB right	8	20	79.5	5	38	81.0
J2: A47(T) EB off-slip left	8	39	72.0	6	34	58.7
J2: A47(T) EB off-slip ahead / R	8	41	72.2	11	44	83.0
PRC for all lanes	-4.4 %			0.6 %		

8.7.6 The results show that the junction operates within capacity under existing conditions (2013) and in 2017 in DM and DS in both AM and PM peaks. It also operates within capacity in 2032 DS PM peak. In all these scenarios, the PRC value is positive with the Degree of Saturation (DoS) on all arms below 90%.

8.7.7 In 2032 DM AM and PM peak, and 2032 DS AM peak, the assessment shows negative PRC values. The Degree of Saturation (DoS) values are however below 100% which would suggest that the junction is below its theoretical capacity.

8.7.8 Comparing DM with DS would indicate that the junction performs marginally better in DS in 2017 PM and in 2032, with a slightly better performance in 2017 DM AM compared to 2017 DS AM. It is therefore concluded that the NDR has a neutral to very marginally positive impact on this junction.

22 A146/Martineau Lane

8.7.9 The A146/Martineau Lane is an existing 3-arm signalised junction. It links the A146 dual carriageway running north-south from the A47(T) interchange, the Martineau Lane to the east and west.

8.7.10 The A146 is a dual carriageway, with two lanes provided for each of the left and right turning movements at the stop line. Martineau Lane eastbound is a single carriageway with 2-lane running on approach to signals for the right turning into A146, and 1-lane for travelling ahead. Martineau Lane

westbound is a single carriageway with 2-lane running on the approach to the signals for both the left and ahead turning movement.

8.7.11 **Table 8.34** presents the results for the operation of A146/Martineau Lane junction during the AM and PM peak hours, for the existing, DM and DS scenarios.

Table 8.34 A146/Martineau Lane – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	DoS	Queue (PCU)	Delay (sec)	Dos
	22 A146/Martineau Lane Signals – 2013 Existing					
Martineau Lane WB left	4	8	46.9	26	29	90.7
Martineau Lane WB ahead	5	64	71.2	4	58	61.9
Martineau Lane EB ahead	12	43	71.6	5	22	31.5
Martineau Lane EB right	7	52	72.7	16	53	90.1
A146 right	18	23	72.5	10	27	54.4
A146 left	2	4	32.4	2	4	27.1
PRC for all lanes	23.8 %			-0.7 %		
	22 A146/Martineau Lane Signals – 2017 DM					
Martineau Lane WB left	10	16	70.1	107	230	110.7
Martineau Lane WB ahead	2	55	37.7	2	55	39.0
Martineau Lane EB ahead	4	24	24.4	3	18	20.3
Martineau Lane EB right	13	49	85.9	77	231	110.2
A146 right	22	38	85.9	14	35	70.3
A146 left	3	4	46.6	3	4	43.0
PRC for all lanes	4.6 %			-23.0 %		
	22 A146/Martineau Lane Signals – 2032 DM					
Martineau Lane WB left	18	21	82.3	142	324	116.9
Martineau Lane WB ahead	1	53	23.2	2	54	30.4
Martineau Lane EB ahead	3	23	18.4	2	16	14.6
Martineau Lane EB right	15	56	90.1	120	341	118.1
A146 right	27	47	91.7	22	57	91.0
A146 left	4	4	49.2	3	4	47.9
PRC for all lanes	-1.9 %			-31.3		
	22 A146/Martineau Lane Signals – 2017 DS					
Martineau Lane WB left	10	16	69.4	135	302	115.4
Martineau Lane WB ahead	2	56	40.4	2	56	41.7
Martineau Lane EB ahead	4	24	25.9	4	17	21.3
Martineau Lane EB right	14	53	88.8	113	329	117.2
A146 right	24	42	88.9	16	41	79.1
A146 left	4	4	50.8	3	4	44.3
PRC for all lanes	1.3 %			-30.2 %		

	AM			PM		
	Queue (PCU)	Delay (sec)	DoS	Queue (PCU)	Delay (sec)	Dos
	22 A146/Martineau Lane Signals – 2032 DS					
Martineau Lane WB left	20	22	85.2	149	346	118.4
Martineau Lane WB ahead	1	53	22.5	2	55	37.7
Martineau Lane EB ahead	4	24	23.4	3	16	19.1
Martineau Lane EB right	16	57	90.9	119	330	117.4
A146 right	28	50	92.9	25	72	95.3
A146 left	4	4	49.4	4	5	52.7
PRC for all lanes	-3.3 %			-31.6 %		

8.7.12 The results show that the junction operates within capacity under existing conditions (2013) in the AM peak. In the PM peak, it is near capacity with a slightly minus PRC value. The Degree of Saturation (DoS) values are however well below 100% which would suggest that the junction is below its theoretical capacity.

8.7.13 For future AM peaks, the results show that the junction would be within or near capacity with positive PRC values for 2017 DM and DS. In 2032, the PRC values for both DM and DS are slightly negative. However, all DoS values are below 100% indicating that the junction would perform below its theoretical capacity.

8.7.14 For future PM peaks, the results show that the junction would be significantly over capacity in both assessment years and in both DM and DS.

8.7.15 The performance of the junction would appear to be unaffected in a significant way by the NDR with the differences in performance being very similar for DM and DS in both 2017 and 2032. Based on the relatively benign effects predicted by modelling, it is considered that no improvement to this existing junction is required as part of the NDR DCO.

23 A147 Bracondale/King Street

8.7.16 The A147 Bracondale/King Street is an existing 3-arm signalised junction. It links King Street running north-south to Bracondale running in a north westerly to south easterly direction. The two roads form the most south-eastern corner of the Inner Ring Road. All approach roads are single carriageway with the one-lane approaches flaring to two lanes at the stopline. There are no geometric changes for the DS scenario.

8.7.17 **Table 8.35** presents the results for the operation of A147 Bracondale/King Street junction during the AM and PM peak hours, for the existing, DM and DS scenarios.

Table 8.35 A147 Bracondale/King Street – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	23 A147Bracondale/King Street Signals – 2013 Existing					
Bracondale East ahead	8	7	49.5	4	4	40.2
Bracondale East right	35	69	97.5	19	31	79.6
Bracondale West left	6	51	57.1	9	48	68.5
Bracondale West ahead	19	113	97.2	13	52	77.6
King Street left / right	23	39	93.3	13	23	68.9
PRC for all lanes	-8.3 %			13.1 %		
	23 A147Bracondale/King Street Signals – 2017 DM					
Bracondale East ahead	7	8	41.9	6	6	41.9
Bracondale East right	57	168	105.9	40	90	100.0
Bracondale West left	14	95	92.6	19	108	97.0
Bracondale West ahead	32	211	106.3	10	51	71.1
King Street left / right	71	126	104.6	46	73	99.5
PRC for all lanes	-18.1 %			-11.1 %		
	23 A147Bracondale/King Street Signals – 2032 DM					
Bracondale East ahead	7	8	42.7	6	5	44.8
Bracondale East right	63	192	107.6	43	102	101.1
Bracondale West left	18	137	99.2	26	150	101.9
Bracondale West ahead	33	232	107.7	11	51	73.0
King Street left / right	65	100	102.6	53	100	101.7
PRC for all lanes	-19.6 %			-13.2 %		
	23 A147Bracondale/King Street Signals – 2017 DS					
Bracondale East ahead	7	8	41.8	7	6	44.3
Bracondale East right	55	165	105.6	28	48	92.9
Bracondale West left	8	56	70.3	13	84	89.4
Bracondale West ahead	26	158	102.3	12	67	83.3
King Street left / right	74	132	105.0	26	36	91.6
PRC for all lanes	-17.4 %			-3.2 %		
	23 A147Bracondale/King Street Signals – 2032 DS					
Bracondale East ahead	7	8	43.3	7	6	44.2
Bracondale East right	56	171	106.0	57	164	105.7
Bracondale West left	15	102	94.3	34	211	106.6
Bracondale West ahead	34	229	107.5	13	56	79.4
King Street left / right	77	156	106.8	37	68	98.6

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
PRC for all lanes	-19.5 %			-18.5 %		

8.7.18 The results show that the junction operates within capacity in the PM peak in 2013 (existing scenario) and is already at its theoretical capacity in the 2013 AM peak with DoS values at or very near 100%. With the flow increases predicted for 2017 and 2032, the junction will be significantly over capacity in both peak periods in 2017 and 2032 with very long queues building up on all arms blocking back to the upstream junctions.

8.7.19 The results would appear marginally better for 2017 DS compared to 2017 DM in both AM and PM. For 2032, there is no discernible difference between DM and DS in the AM peak. In the PM peak, the junction would appear to operate marginally better in the DM compared to DS. This could potentially be attributed to the city centre measures that are proposed in connection with NDR which remove traffic from within the Inner Ring Road pushing it onto the Ring Road.

8.7.20 Given the fact that a degree of congestion is exhibited at this junction in the existing scenario and that the effects of background traffic growth appear to be more significant than the effects of implementing the NDR, it is considered that no improvement to this existing junction is justified as part of the NDR DCO.

24 B1150 North Walsham Road / Rackheath Lane (Crostwick Junction)

8.7.21 The B1150 North Walsham Road / Rackheath Lane junction (also called Crostwick Junction) is an existing 4-arm staggered priority junction. The B1150 North Walsham Road forms the through road with Rackheath Lane to the east and Crostwick Lane to the west. North Walsham Road is a single carriageway with Ghost Island for the right-turning movements into both side roads. Rackheath Lane and Crostwick Lane are single carriageways.

8.7.22 In the DS scenario, the junction is proposed to form a 3-arm priority junction. The existing Rackheath Lane access is closed off, and the right-turn lane for Crostwick Lane is to be extended.

8.7.23 **Table 8.36** presents the results for the operation of B1150 North Walsham/Rackheath Lane junction during the AM and PM peak hours, for the existing, DM and DS scenarios.

Table 8.36 Crostwick Junction – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	24 B1150/Rackheath Ln Staggered – 2012 Existing					
Crostwick Lane left / ahead	1	10	0.339	0	18	0.288
Crostwick Lane right turn	0	16	0.298	0	10	0.182
Rackheath Lane left/ahead	0	10	0.240	1	11	0.378
Rackheath Lane right turn	0	18	0.220	0	19	0.318
N Walsham Road SB right	0	7	0.249	0	13	0.475
N Walsham Road NB right	0	10	0.298	0	7	0.200
	24 B1150/Rackheath Ln Staggered – 2017 DM					
Crostwick Lane left / ahead	0	8	0.211	0	10	0.253
Crostwick Lane right turn	0	13	0.093	0	14	0.200
Rackheath Lane left/ahead	0	11	0.273	0	7	0.178
Rackheath Lane right turn	0	18	0.160	0	13	0.157
N Walsham Road SB right	0	7	0.194	0	8	0.198
N Walsham Road NB right	0	10	0.261	0	7	0.210
	24 B1150/Rackheath Ln Staggered – 2032 DM					
Crostwick Lane right turn	0	7	0.187	0	11	0.264
Crostwick Lane left / ahead	0	14	0.073	0	20	0.387
Rackheath Lane left/ahead	1	12	0.370	0	8	0.219
Rackheath Lane right turn	0	19	0.124	0	17	0.299
N Walsham Road SB right	0	8	0.274	0	8	0.225
N Walsham Road NB right	0	9	0.224	0	7	0.207
	24 B1150/Rackheath Ln Priority – 2017 DS					
Crostwick Lane right turn	1	22	0.466	1	22	0.387
Crostwick Lane left / ahead	0	0	0.000	0	0	0.000
N Walsham Road SB right	0	0	0.000	0	0	0.007
	24 B1150/Rackheath Ln Priority – 2032 DS					
Crostwick Lane right turn	1	25	0.480	1	31	0.501
Crostwick Lane left / ahead	0	0	0.000	0	0	0.000
N Walsham Road SB right	0	0	0.004	0	0	0.007

8.7.24 The results show that the junction operates well within desirable capacity in all scenarios, with no queuing or congestion concerns. The maximum RFC in the AM peak is 0.480 (2032 DS scenario) and 0.501 in the PM peak (2032 DS scenario).

8.7.25 The results for the 2017 and 2032 DM assessments show very slightly better values than existing. The 2012 existing flows were actual counts whereas future flows have been extracted from the strategic SATURN model. Comparing the flows would suggest that flows on the mainline would increase over time due to background growth but flows on the side roads would not.

8.7.26 The 2017 and 2032 DS assessments show a further slight improvement by stopping up Rackheath Lane. This improvement scheme should have a beneficial impact on road safety at this junction due to the elimination of one side road.

25 A1151 Wroxham Rd/Green Lane West (Rackheath Junction)

8.7.27 The A1151 Wroxham Rd/Green Lane West junction (also called Rackheath Junction) is an existing 3-arm priority junction. It links the A1151 Wroxham Road to the Green Lane West. Both A1151 and Green Lane West are single carriageways and all traffic movements are permitted.

8.7.28 In the DS scenario, the 3-arm priority junction is proposed to be relocated to the south to gain better visibility, and to provide a ghost island for the right turning movements from A1151 NB into Green Lane West. The existing northern access to Green Lane W will be closed off, and a new turning head for refuse and delivery vehicles will be installed.

8.7.29 **Table 8.37** presents the results for the operation of A1151/Green Lane W junction during the AM and PM peak hours, for the existing, DM and DS scenarios.

Table 8.37 Rackheath Junction – Summary results

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	25 A1151/Green Lane W Priority – 2013 Existing					
Green Lane W right turn	1	22	0.450	3	43	0.760
Green Lane W left turn	0	11	0.250	1	22	0.442
Wroxham Road right turn	1	14	0.361	0	10	0.202
	25 A1151/Green Lane W Priority – 2017 DM					
Green Lane W right turn	1	21	0.445	1	21	0.467
Green Lane W left turn	0	11	0.249	0	10	0.230
Wroxham Road right turn	0	12	0.258	0	10	0.225

	AM			PM		
	Queue (PCU)	Delay (sec)	RFC	Queue (PCU)	Delay (sec)	RFC
	25 A1151/Green Lane W Priority – 2032 DM					
Green Lane W right turn	3	64	0.766	26	402	1.238
Green Lane W left turn	4	50	0.841	36	386	1.249
Wroxham Road right turn	2	19	0.593	7	49	0.825
	25 A1151/Green Lane W Priority – 2017 DS					
Green Lane W right turn	0	25	0.050	0	23	0.095
Green Lane W left turn	0	10	0.221	0	9	0.262
Wroxham Road right turn	0	12	0.315	0	9	0.186
	25 A1151/Green Lane W Priority – 2032 DS					
Green Lane W right turn	0	78	0.088	0	92	0.165
Green Lane W left turn	3	26	0.739	3	30	0.768
Wroxham Road right turn	4	29	0.770	3	28	0.728

8.7.30 The results show that the junction is operating within desirable capacity in both existing and 2017 scenarios, and 2032DS, with minimal queuing and no congestion concerns. The maximum RFC in the AM peak is 0.841 in 2032DM with a maximum predicted queue of four PCUs. The maximum RFC in the PM peak is 0.768 in 2032DS with a maximum predicted queue of three PCUs.

8.7.31 In the 2032 DM PM scenario, the results show that the junction would be significantly over capacity with congestion and queuing concerns on Green Lane West with vehicles wishing to exit experiencing delays due to insufficient gaps on the mainline.

8.7.32 The improved junction performance in 2032DS compared to 2032DM is due to quite significant flow changes at this junction in connection with NDR. A flow comparison shows that mainline flows significantly increase in the DS feeding traffic to and from NDR, whereas flows on Green Lane significantly decrease leading to an improved junction performance. This reduction is due to the NDR being a faster, more convenient route for orbital movements taking traffic off the existing orbital roads such as Green Lane West.

8.7.33 NDR has a significantly beneficial impact at this junction.

8.8 Summary

8.8.1 The results presented in this section of the TA show that all NDR approaches of the on-line junctions are below the desirable 85% threshold in 2017 and below their theoretical capacity of 100% in 2032 except for the Postwick NE southbound NDR approach to this junction which has an RFC of 0.95 in 2017DS AM peak and 1.02 in 2032DS AM peak.

8.8.2 Some non-NDR approaches reach 90% in 2017 and two approaches, Drayton Lane SB and North Walsham Road SB, exceed 100% in 2032 (both in the AM peak). These could be mitigated through slight adjustments to flare and entry width if monitoring showed a need for this. In addition to these two approaches, values of over 100% are predicted at Peachman Way roundabout on the Broadland Gate Link Road WB approach (AM peak) and at Postwick NW roundabout on the development egress (PM peak).

8.8.3 The existing Postwick Park & Ride roundabout junction is forecast to experience substantial queues and delays on Yarmouth Road in both peak periods in both 2017 and 2032. In the 2017 AM peak the queues would extend back onto the A47(T) westbound diverge slip road, approaching the diverge area at the start of the slip road, and thus there will be a high risk of queues conflicting with high speed traffic on the A47(T). With NDR and the signal junction improvement, the desirable capacity limit is exceeded in 2032 PM peak, but the queues and delays on Yarmouth Road reduce significantly in the DS scenario with the introduction of signals.

8.8.4 Theoretical capacity is also exceeded at Martineau Lane / A146 and Bracondale / King Street junctions. The results presented demonstrate that this is however not due to NDR but background traffic growth with over-capacity levels similar in the DM and DS scenarios.

8.8.5 The information presented in this TA is a result of a number of iterations, with detailed junction modelling being carried out and the results then fed back into the strategic model with traffic being re-assigned. The testing has shown that with increasing capacity provided at the NDR junctions, the demand along the NDR also grows. Therefore, it is apparent that a careful balance needs to be struck between providing sufficient capacity to meet the objectives of the scheme without encouraging unnecessary or longer motorised journeys.

8.8.6 The standard of the NDR and its junctions has been developed by NCC by determining an appropriate level of provision to attract sufficient traffic onto

the new road to achieve its objectives, within a reasonable and fully justified budget. There is additional demand in the network that would potentially re-assign if larger or grade separated junctions were constructed. However, NCC is looking to provide an optimum solution and within this, a decision has had to be made between the ever increasing cost of larger junctions, compared to the benefits accruing across the rest of the network. It is considered that providing free flow conditions at all times at the expense of other improvements in the city and county is not the appropriate balance. Hence accepting some limited congestion during the peak 30 minutes of demand in order to maintain the cost of the scheme within an affordable budget is considered to make the best use of public resources.

9 Wider Effects of NDR

9.1 Introduction

9.1.1 **Chapter 8** of this report assesses the immediate impacts of NDR and the conditions along the NDR itself as well as the Postwick junctions which are part of the extended scheme. Impacts on the affected off-line junctions (see **Chapter 2** of this document) are also addressed in **Chapter 8**.

9.1.2 The NDR has impacts beyond these immediate junctions, particularly to the north and east of Norwich, but also across the whole network.

9.1.3 These impacts are presented in the **Traffic Forecasting Report** (document ref 5.6) and summarised in this Section of the TA. Figures I.1 to I.3 of the **Traffic Forecasting Report** present AADT traffic flows along the proposed route and for other existing locations in the network. The figures contain existing traffic flows as well as DM and DS traffic flows for 2017 and 2032.

9.2 Impact on Strategic Movements

9.2.1 In the absence of the NDR in the DM a number of routes are used inappropriately to serve strategic orbital traffic movements. Five of these key routes are shown in Figure 9.1 below which shows that the levels of traffic on these routes are forecast to increase substantially in the DM. In fulfilling its objective of improving local and national connectivity across the northern part of Norwich and access to/from the proposed new development areas to the north-east of Norwich, the existence of the NDR influences these strategic route choices.

9.2.2 For traffic from Lowestoft and the east, there is a switch from the A146 and the A149 to the A47(T) via Postwick and NDR to the North East Growth Triangle. These flow changes are presented in Figure I.4 of the **Traffic Forecasting Report**. In 2017 the model forecasts an estimated 1100 PCU switching per day (AADT) and 2500 PCU (AADT) in 2032 away from the A146 and the A149 to the A47(T). This represents a reduction on A146 of 4% and 7% respectively for 2017 and 2032(site 2 in Figure I.4), a reduction of 4% and 11% on the A149 (site 4) and an increase on A47(T) between

Great Yarmouth and Acle of 4% and 8% respectively in 2017 and 2032 (site 1).

9.2.3 To the east of Norwich, the NDR results in orbital traffic reducing on existing routes between the A47(T) and Wroxham Road via Church Road / Broad Lane / Green Lane West through Great Plumstead and Woodbastwick Road / B1140 Low Road / Bell Lane through Salhouse. The first route experiences reductions of 4100 AADT (66%) in 2017 and 7100 (72%) in 2032 (site 11 in Figure I.4), and the second route 3000 AADT (70%) in 2017 and 3900 (67%) in 2032 (site 6).

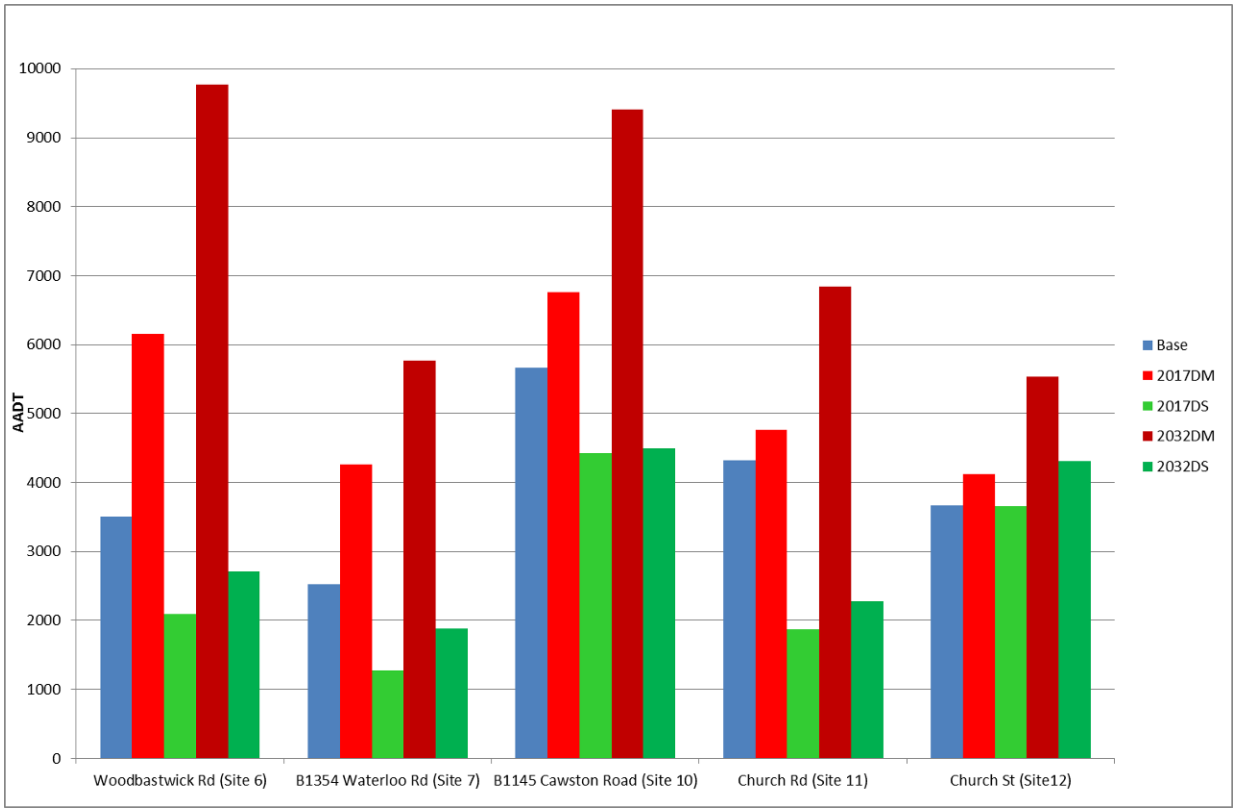
9.2.4 To the west of Norwich the NDR results in an increase of traffic on Fakenham Road due to reassignment from Kings Lynn and surroundings. The increase amounts to 1900 AADT (18%) in 2017 and 2900 AADT (22%) in 2032 (site 9 in Figure I.4).

9.2.5 As a consequence of the above, the model indicates reductions in traffic on the A47(T) west of Dereham Road junction of 800 AADT (3%) in 2017 and 400 AADT (1%) in 2032 (site 8 in Figure I.4) and reductions on routes to the north as explained below:

- To the north west, flows on the B1145 Bawdeswell / Fakenham Road and Aylsham via Reepham reduce by 400 AADT (10%) in 2017 and 1200 AADT (22%) in 2032 (site 10 in Figure I.4).
- Flows on the A1151 Norwich Road between Reepham and Hoveton via Buxton Road / Cawston Road / B1354 Coltishall Road reduce by 2900 AADT (60%) in 2017 and 4500 AADT (66%) in 2032 (site 7 in Figure I.4). This route presently carries a significant amount of orbital traffic despite its poor standard.
- Flows on Spixworth Road / Crostwick Lane via Spixworth reduce by 2400 AADT (35%) in 2017 and 4900 AADT (52%) in 2032 (site 12 in Figure I.4).

9.2.6 The above demonstrates that the NDR successfully reduces flows on orbital routes around Norwich which presently carry strategic traffic. A graphical representation of these numbers in presented in **Figure 9.1** below. A number of these links are outside the fully modelled area, so base flows may not be fully represented but changes in traffic would be.

Figure 9.1 Comparison of AADT Traffic Flows on Inappropriate Routes



9.3 Wider Impacts to the West of Norwich

9.3.1 The model runs have been analysed to understand the impact of NDR on traffic levels on routes between the A1067 (Fakenham Road) and the A47(T). The NDR runs between the A1067 west of Taverham and extends to the A47(T) at Postwick junction east of Norwich. Concern has been expressed that because the NDR does not extend to the A47(T) in the west, traffic will increase on routes between the A1067 and the A47(T).

9.3.2 To assess this, modelled traffic flows on an imaginary line running between the A1067 and the A47(T) have been investigated. The results are presented in **Table 9.1**.

Table 9.1 Modelled daily traffic flows on routes between the A1067 and the A47(T)

24 hour two-way flows	2012	2017 DM	2017 DS	2032 DM	2032 DS	NDR change 2017	NDR change 2032
Low Road	4000	4600	4000	4900	4100	-13%	-16%
Costessey Lane	3300	4000	3800	4800	4900	-5%	2%
Taverham Lane	5700	5700	4700	6200	4700	-18%	-24%
Ringland Road	3600	4900	3500	8000	6300	-29%	-21%
C167 Weston Longville	1400	1700	3300	3100	5500	94%	77%
C173 Lenwade to Hockering	3000	3400	3500	3300	3600	3%	9%
Total	**21000**	**24300**	**22800**	**30300**	**29100**	**-6%**	**-4%**

9.3.3 The above shows that the NDR leads to a decrease in daily traffic on the above routes that connect the A1067 with the A47(T) to the west of Norwich of 6% in 2017 and 4% in 2032.

9.3.4 Traffic levels on the three key routes between Taverham and Costessey (Costessey Lane, Taverham Lane and Ringland Road) are predicted to reduce significantly, except for Costessey Lane where the predicted reduction is relatively small in 2017 and traffic levels are predicted to increase by 2% in 2032.

9.3.5 Low Road provides an alternative route into the west of Norwich that avoids the A1067. Traffic levels are predicted to significantly decrease on this route with the NDR in place.

9.3.6 Further out from Norwich however, traffic levels are predicted to increase significantly on the C167 through Weston Longville and slightly on the C173 between Lenwade and Hockering with the NDR in place. Presently the flows on this route are significantly lower than any of the parallel routes compared in **Table 9.1** reflecting the character of this route through Weston Longville where it is a single file lane.

9.3.7 To address existing HGV problems on routes between the A1067 and the A47(T), a route is presently being upgraded to accommodate such traffic. This route runs from Lenwade and uses the C173 in the north and the C167 Wood Lane in the south. Additional traffic management and / or signage should be used to encourage all traffic onto this improved HGV route to avoid Weston Longville and Hockering in future years; the HGV

improvements thereby also being a solution to any increase in traffic on these two routes due to NDR.

9.4 Suburban Traffic Impacts

9.4.1 There are a number of routes in the northeastern suburbs of Norwich that experience significant reductions in flow levels due to the NDR. These are presented in **Table 9.2** below (negative figures indicate reductions with NDR).

9.4.2 The table also presents the results for the developer link roads. These are links that are assumed to be provided as part of the developments proposed within the JCS. These are designed to act either as urban high streets to serve walking and cycling movements as well as traffic access for the developments or as local development distributor roads. In the absence of the NDR, these link roads would carry high levels of traffic flows of up to 17300 AADT forecast for 2032 that are incompatible with their intended purposes. The NDR substantially reduces flows on these link roads.

Table 9.2 NDR Impact on Routes NE of Norwich and Link Roads

Route / Link Road	2017 AADT change (DS – DM)	2032 AADT change (DS – DM)
Thorpe St Andrew area		
Yarmouth Road (West)	-3700 (-13%)	-2000 (-6%)
Route via Thunder Lane / Woodside Road / Blue Boar Lane between Thorpe St Andrew and Sprowston	-4300 (-33%)	-3300 (28%)
A1042 Outer Ring Road (north east quadrant, at A1042 Mousehold Lane)	-4000 (-16%)	-4000 (-15%)
C283 Salhouse Road	-1100 (-8%)	-1600 (-10%)
A1151 Wroxham Road	-2900 (-15%)	-3600 (-16%)
Old Catton area		
A1042 Outer Ring Road (Chartwell Road)	-3700 (-13%)	-4700 (-15%)
B1150 North Walsham Road	-2000 (-18%)	-3600 (-27%)
St Faiths Road	-2600 (-17%)	-3000 (-19%)

Route / Link Road	2017 AADT change (DS – DM)	2032 AADT change (DS – DM)
Hellesdon area		
A140 Boundary Road / Outer Ring Road	-2100 (-9%)	-1500 (-6%)
A140 Cromer Road north of ORR	-3600 (-21%)	-3300 (-18%)
A1067 Drayton Road	-1400 (-7%)	-2000 (-10%)
Reepham Road	1600 (16%)	700 (7%)
Middleton's Lane (between Cromer Road and Reepham Road)	-1100 (-11%)	-1300 (-11%)
Drayton area		
School Road (north of Fakenham Road)	-2000 (-18%)	-2400 (-19%)
Fakenham Road (north of School Road)	-2600 (-26%)	-2600 (-23%)
Link Roads		
Beyond Green (between B1150 N Walsham Road and A1151 Wroxham Road)	-3500 (-42%)	-6100 (-45%)
White House Farm (between A1151 Wroxham Road and Salhouse Road)	600 (27%)	-3600 (-32%)
Salhouse Road to Plumstead Road (only in place in 2032)	n/a	-3400 (-23%)
Brook Farm / Laurel Farm link road	-4000 (-78%)	-8700 (-67%)

9.4.3 The above table shows that on a number of routes traffic levels are predicted to significantly reduce due to the NDR. The table contains both sections of the Outer Ring Road as well as a number of radial routes into and out of Norwich.

9.5 City Centre Traffic Impacts

9.5.1 Traffic impacts in the city centre will be a combination of impacts resulting from the NDR and complementary traffic management measures in the city centre that would be introduced should the NDR scheme proceed and which have been included in the NATS model. The traffic management measures effect restrictions to general traffic crossing the city centre and thus it is forecast that traffic movements would be displaced onto the Inner Ring Road. The changes are presented in **Table 9.3** below and are also shown in Figure I.5 in the **Traffic Forecasting Report**.

Table 9.3 Flow Changes on Inner Ring Road

Route / Road	Site	2017 AADT change (DS – DM)	2032 AADT change (DS – DM)
Carrow Road	13	200 (1%)	2200 (8%)
A147 Chapelfield Road	14	200 (1%)	1100 (4%)
A147 Grapes Hill Road	15	-400 (-1%)	3000 (9%)
A147 St Crispins Road (west)	16	-400 (-1%)	-2200 (-6%)
A147 St Crispins Road (east)	17	No change	800 (3%)

9.5.2 The above table shows mixed results with small changes in 2017 and generally increases in 2032 on the Inner Ring Road as a result of the city centre measures displacing through traffic to it. Given the through and cross city traffic reductions that result from the NDR as explained in the next section, the increases on the Inner Ring Road in 2032 are much lower than they would otherwise be.

9.6 Traffic Queues

9.6.1 A comparison of the overall queues within the SATURN network has been undertaken and the results are presented in **Figures 9.2 and 9.3** below.

Figure 9.2 AM Queue Statistics

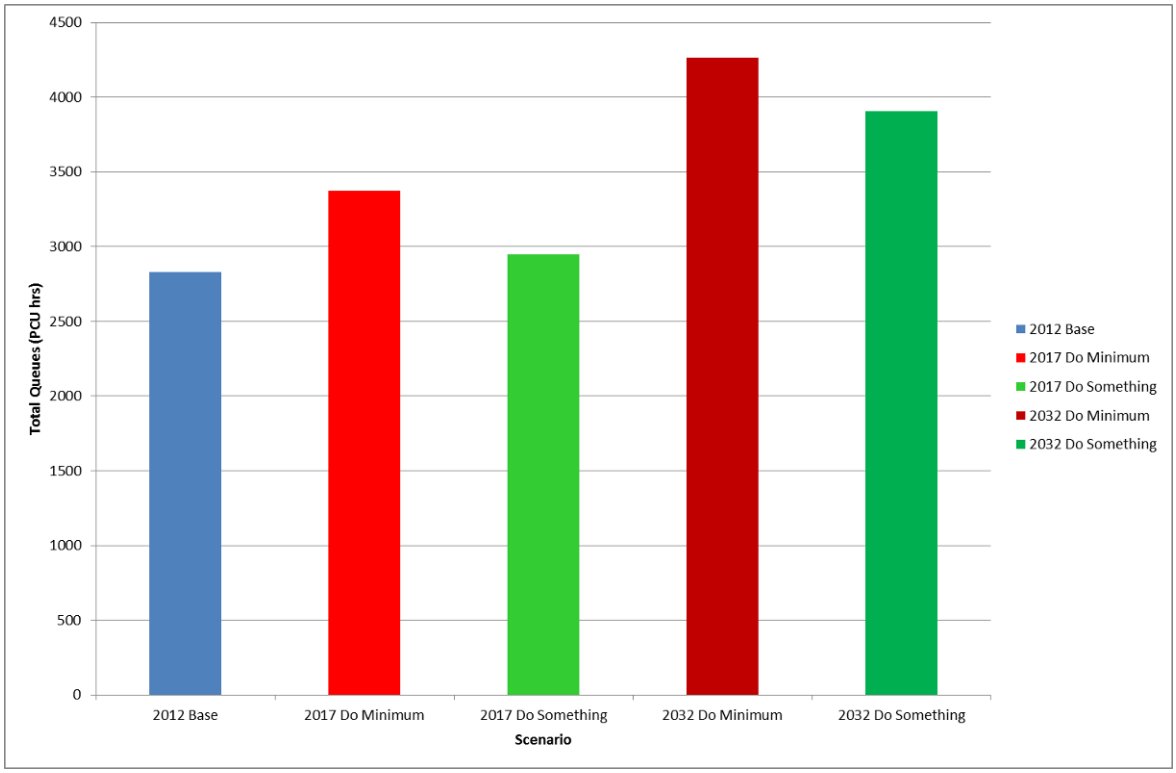
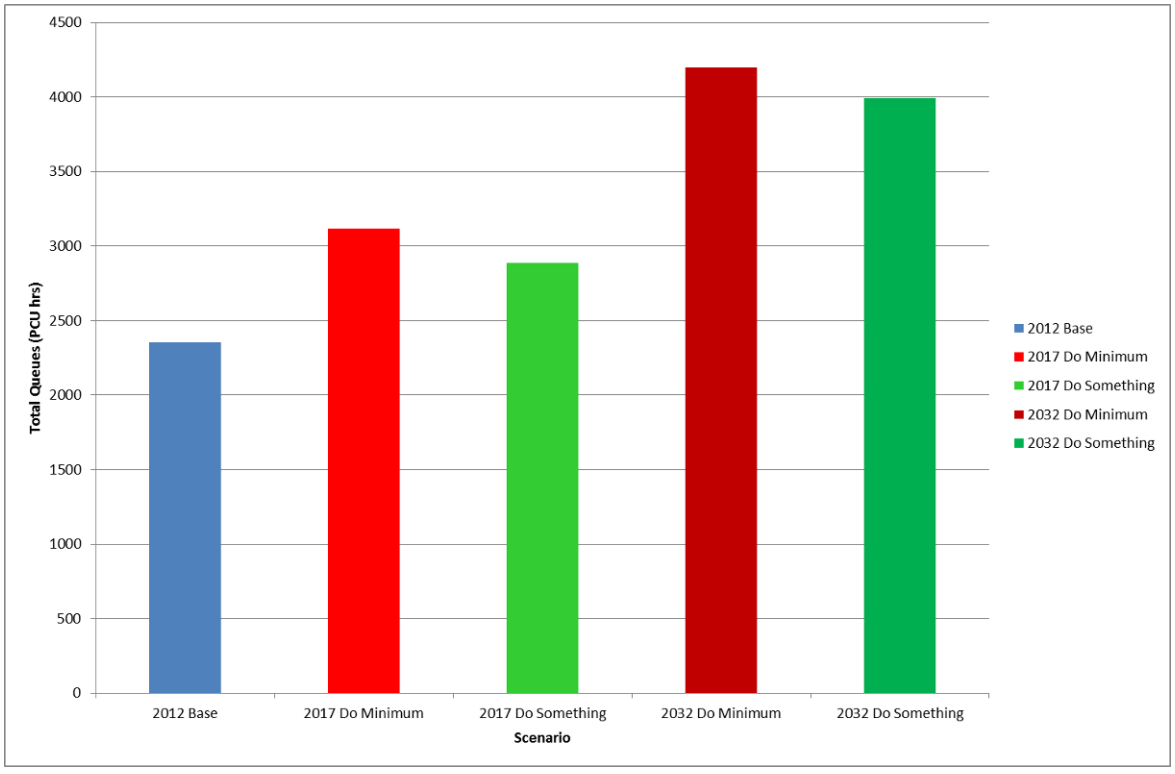


Figure 9.3 PM Queue Statistics



9.6.2 The above shows increases of 19% and 32% in the AM and PM peaks respectively and 13% in the interpeak in 2017 when comparing DM with Base. Larger increases of 51% and 79% occur in 2032 in the AM and PM peaks as well as 49% in the interpeak when comparing DM with Base.

9.6.3 When comparing DM with DS, queues reduce by 13% and 7% in the AM and PM peaks respectively in 2017, and 8% and 5% in 2032.

9.7 City Centre Through Traffic

9.7.1 City centre through traffic has been calculated in the **Traffic Forecasting Report** by establishing three cordons as follows:

- Inner Ring Road, Inner Cordon: just inside the Inner Ring Road (IRR)
- Inner Ring Road, Outer Cordon: just outside the Inner Ring Road (IRR)
- Outer Ring Road, Outer Cordon: just outside the Outer Ring Road (ORR)

9.7.2 **Table 9.4** below presents the cordon results.

Table 9.4 Cordon Traffic

Through trips	2012 Base	2017 DM	2017 DS	2032 DM	2032 DS
IRR, Inner Cordon	9477	8159	6787 (-17%)	9236	4726 (-49%)
IRR, Outer Cordon	77825	82152	78369 (-5%)	88368	80352 (-9%)
ORR, Outer Cordon	68117	73691	63421 (-14%)	79151	66780 (-16%)

9.7.3 The above table shows that in the DM whilst the city centre through traffic is restrained as a result of the measures that have been implemented, there is significant growth in the through or cross city traffic using the Inner Ring Road (6% to 2017 and 14% to 2032) and the Outer Ring Road (8% to 2017 and 16% to 2032).

9.7.4 The NDR and the complementary city centre traffic management measures are predicted to reduce cordon crossing traffic at all three cordons thereby

addressing one of the aims of the NDR which is to decrease the amount of traffic and congestion that in part is due to travel through and across the city. The reductions are most significant at the Inner Ring Road, inner cordon. This likely to be due to the complementary measures which would be felt most prominently at this cordon. The measures and NDR are predicted to lead to through traffic levels inside the Inner Ring Road of below 2012 base in 2017 and almost half of base levels in 2032. **Figures 9.4 to 9.6** below visualise the numbers presented in **Table 9.4** above.

Figure 9.4 Traffic at Inner Ring Road, Inner Cordon

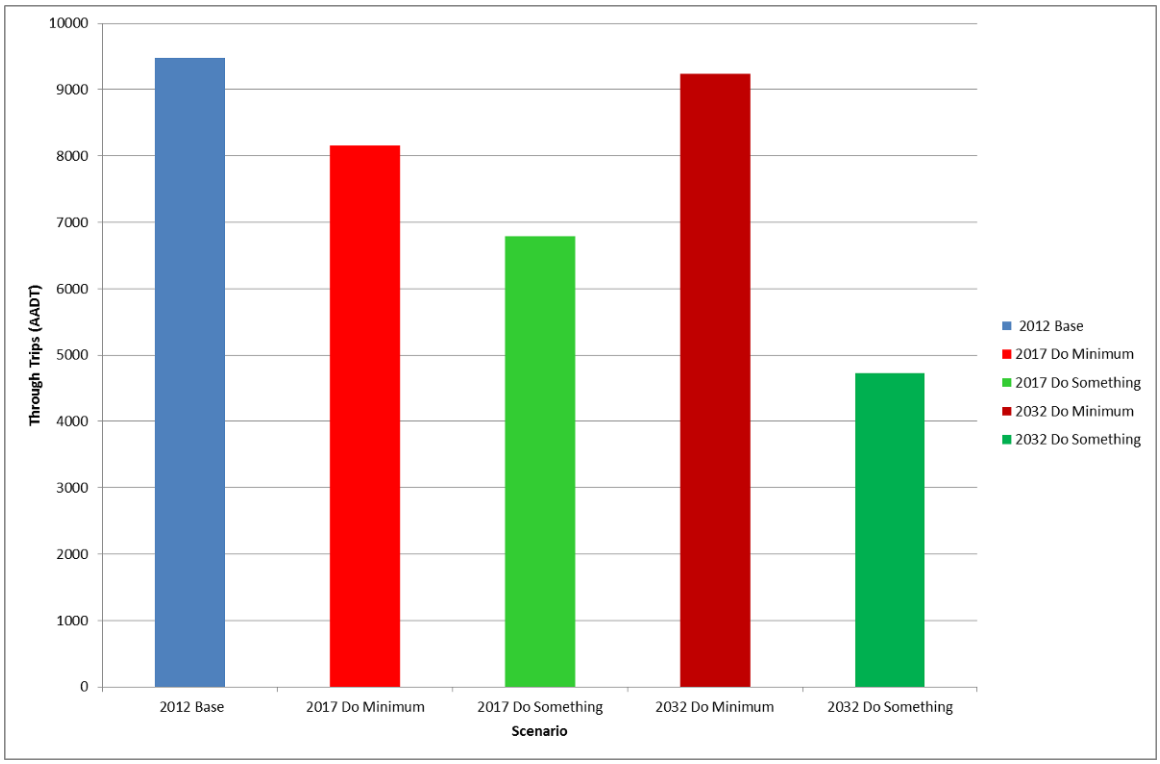


Figure 9.5 Traffic at Inner Ring Road, Outer Cordon

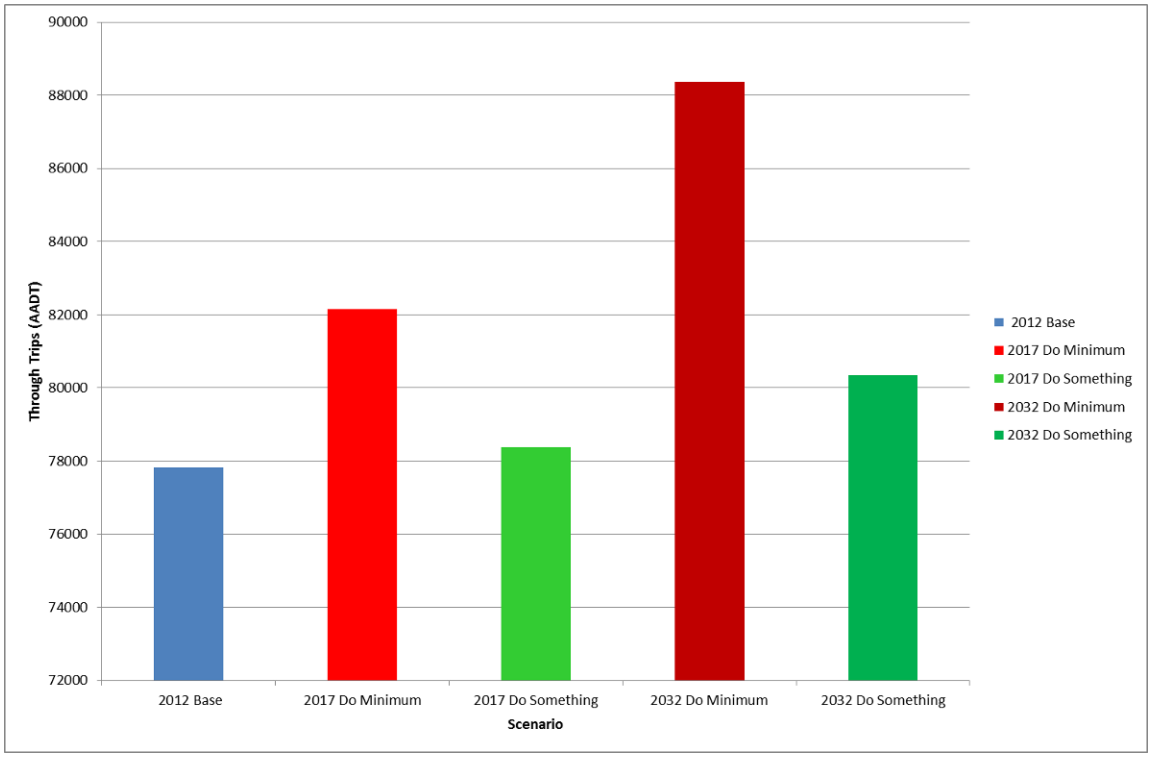
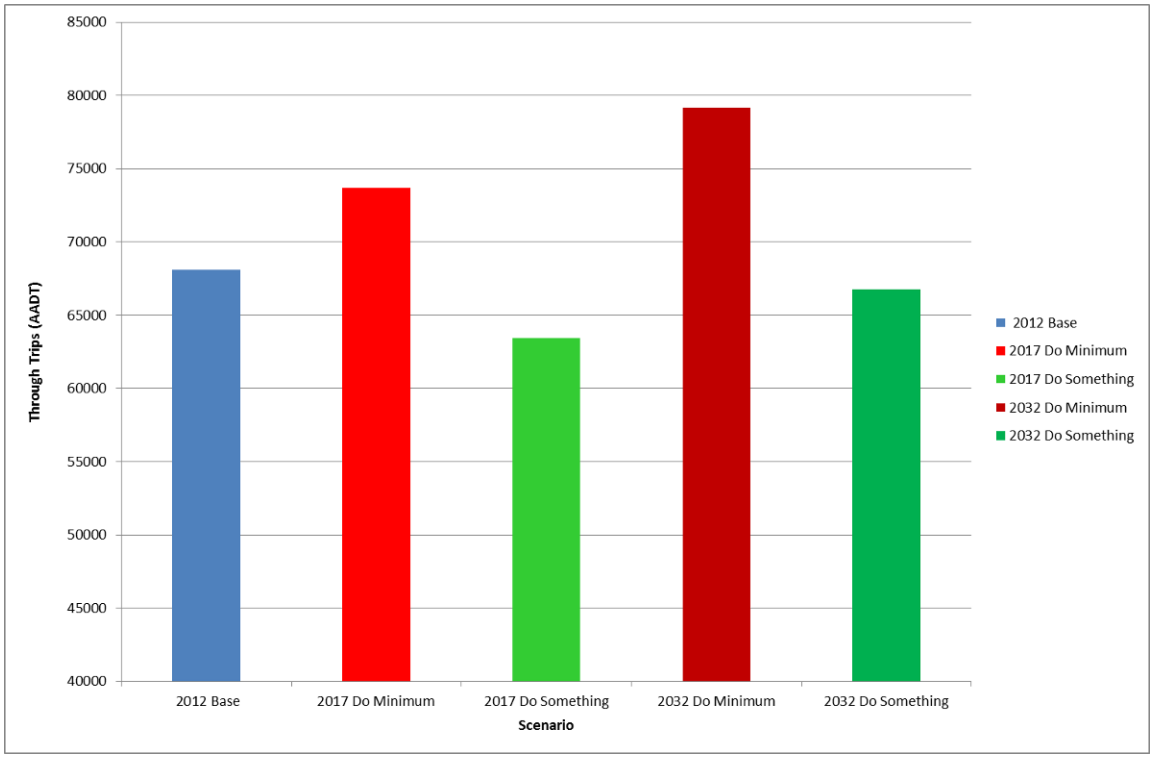


Figure 9.6 Traffic at Outer Ring Road, Outer Cordon



9.8 Highway Journey Times

9.8.1 Highway journey times between six locations across the city have been examined and compared between scenarios. The detailed results are presented in the **Traffic Forecasting Report**. **Figure 9.7** and **Figure 9.8** below show a comparison of average highway journey times for the AM peak and PM peak respectively. These are arithmetic means of the journey time for both directions. These Figures show the journey times for the base year and for Do Minimum and Do Something scenarios for the forecast years. Journey times are presented for the following nine routes:

1: A47(T) West – Airport

2: A11(T) (Thickthorn roundabout) – Airport

3: A47(T) East (Brundall) – Airport

4: Fakenham Road – Airport

5: A47(T) West – Rackheath

6: A11(T) (Thickthorn roundabout) – Rackheath

7: A47(T) East (Brundall) – Rackheath

8: Fakenham Road – Rackheath

9: Airport – Rackheath

10: A47(T) West – Broadland Gate

11: A11(T) – Broadland Gate

12: A47(T) East (Brundall) – Broadland Gate

13: Fakenham Road – Broadland Gate

14: Rackheath – Broadland Gate

15: Airport – Broadland Gate

Figure 9.7 AM Average Highway Journey Times

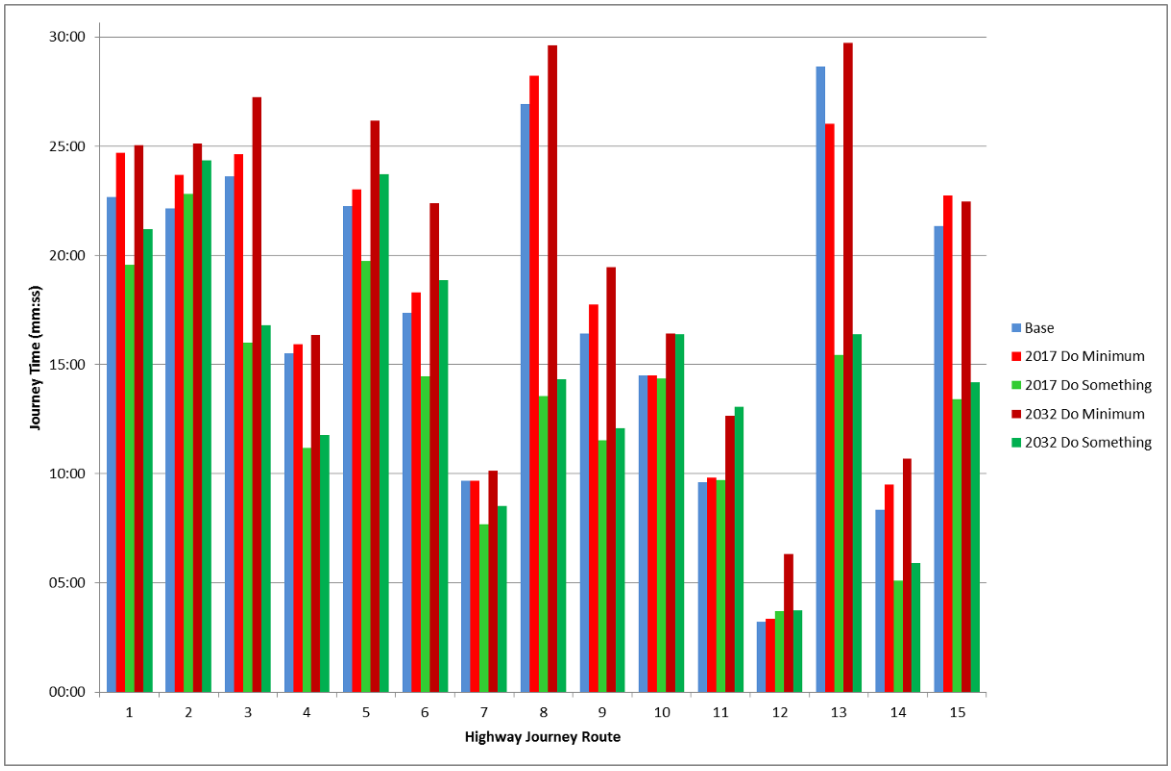
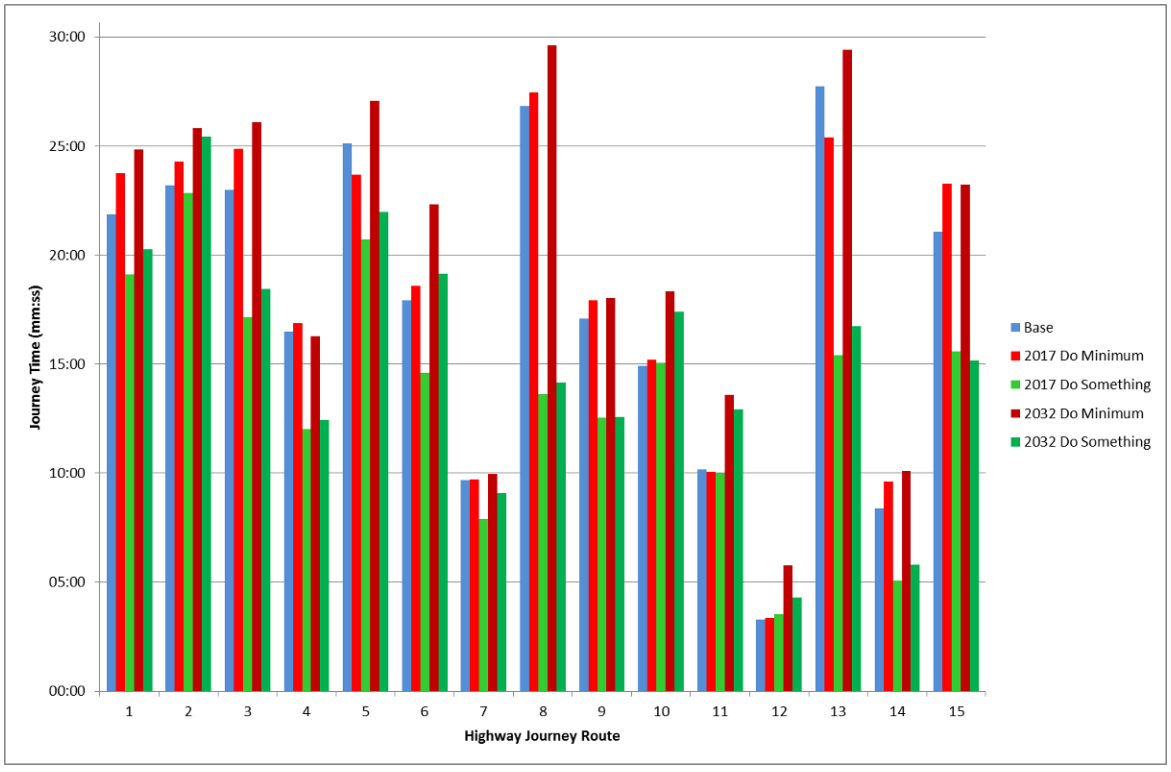


Figure 9.8 PM Average Highway Journey Times



9.8.2 The Figures show that in nearly all cases the journey times will increase with the DM forecasts, with journeys between the trunk road and the Airport rising to around 25 minutes. The Figures also show that with NDR there would be substantial reductions in journey times between the trunk road network and the Airport, with journey times from the A47(T) East reducing by around one third. In addition the journey times for orbital movements between Fakenham Road, Airport, Rackheath and Broadland Gate reduce by between 30% and 50% in 2017 and by between 29% and 52% in 2032. This data demonstrates that NDR would substantially improve access times between the strategic highway network and the planned development locations in the JCS plan and would provide a significant improvement for orbital movements to the north of the City between the proposed major development locations.

9.8.3 Overall the above figures demonstrate that journey times on key routes linking the strategic road network with the main development areas and airport, are predicted to significantly decrease both in 2017 and 2032 when comparing DS with DM and that DS journey times are in most cases predicted to be lower than existing 2012 base journey times.

9.9 Journey Times on Public Transport Routes

9.9.1 For the 2017 and 2032 AM and the PM peaks, journey times on five public transport routes carrying high patronage levels into the city have been examined and compared between scenarios. These do not account for stopping times for bus services, but serve to show the changes in running times. The five routes are:

1. Fakenham Road / Drayton High Road to Fakenham Road / Fir Covert Road junction
2. Cromer Road to Holt Road / Cromer Road junction
3. Wroxham Road to Wroxham Road / Green Lane West junction
4. Plumstead Road to Plumstead Road / Broad Lane junction
5. Yarmouth Road to Postwick NW Roundabout

9.9.2 Figure K.1 in Appendix K of the **Traffic Forecasting Report** shows the five routes. **Figures 9.9 to 9.12** below show the graphical representation of journey times for the DM and the DS scenarios. Total journey times and

calculated journey time savings and journey time reliability are presented in the **Traffic Forecasting Report**.

Figure 9.9 Inbound AM Peak Public Transport Journey Times

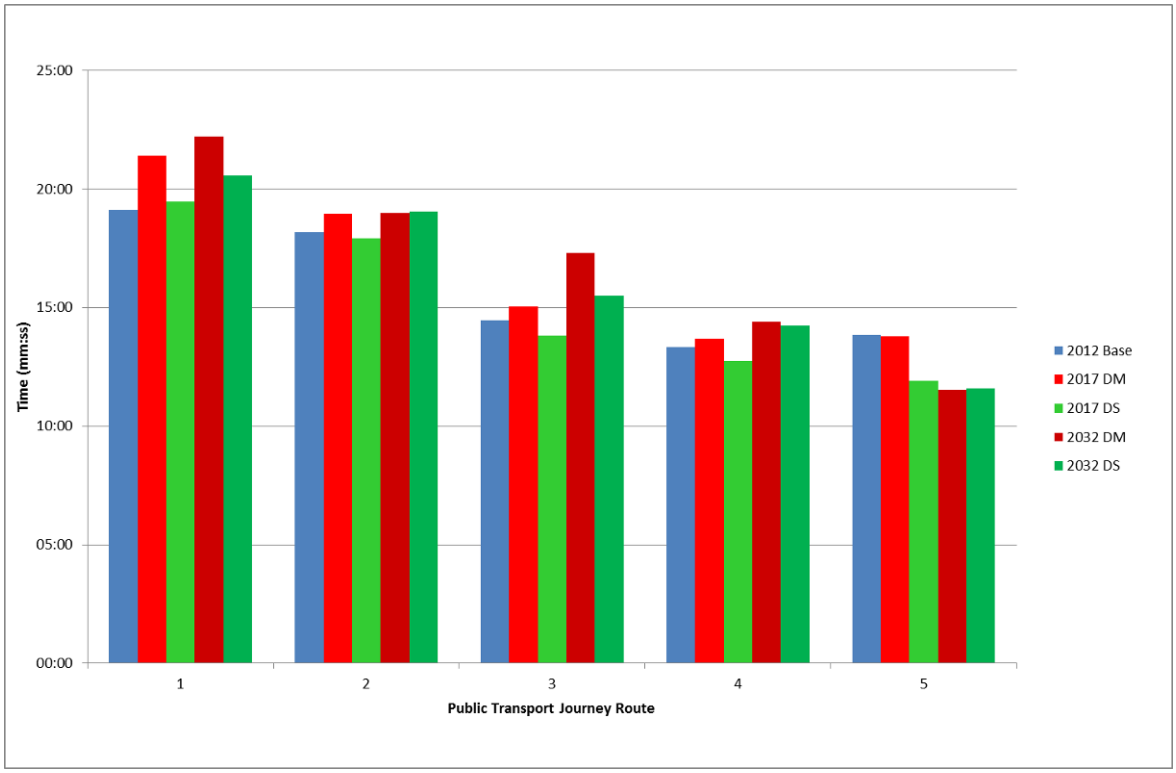


Figure 9.10 Outbound AM Peak Public Transport Journey Times

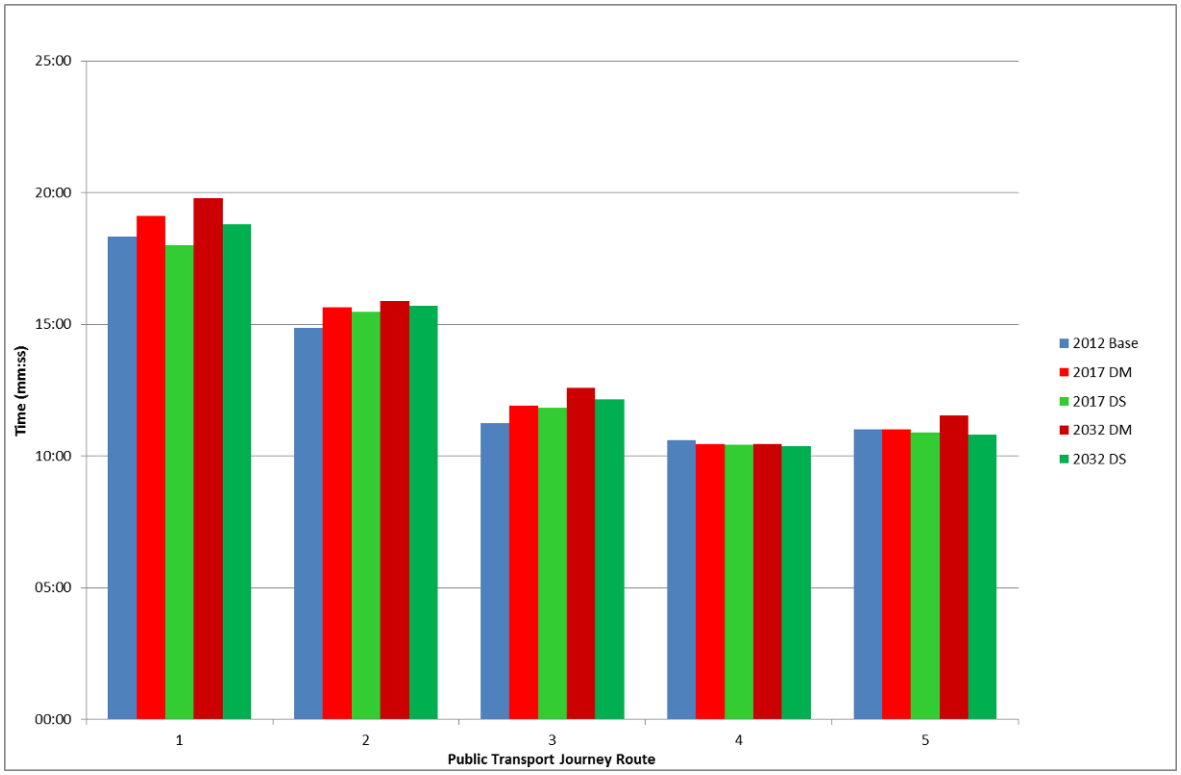


Figure 9.11 Inbound PM Peak Public Transport Journey Times

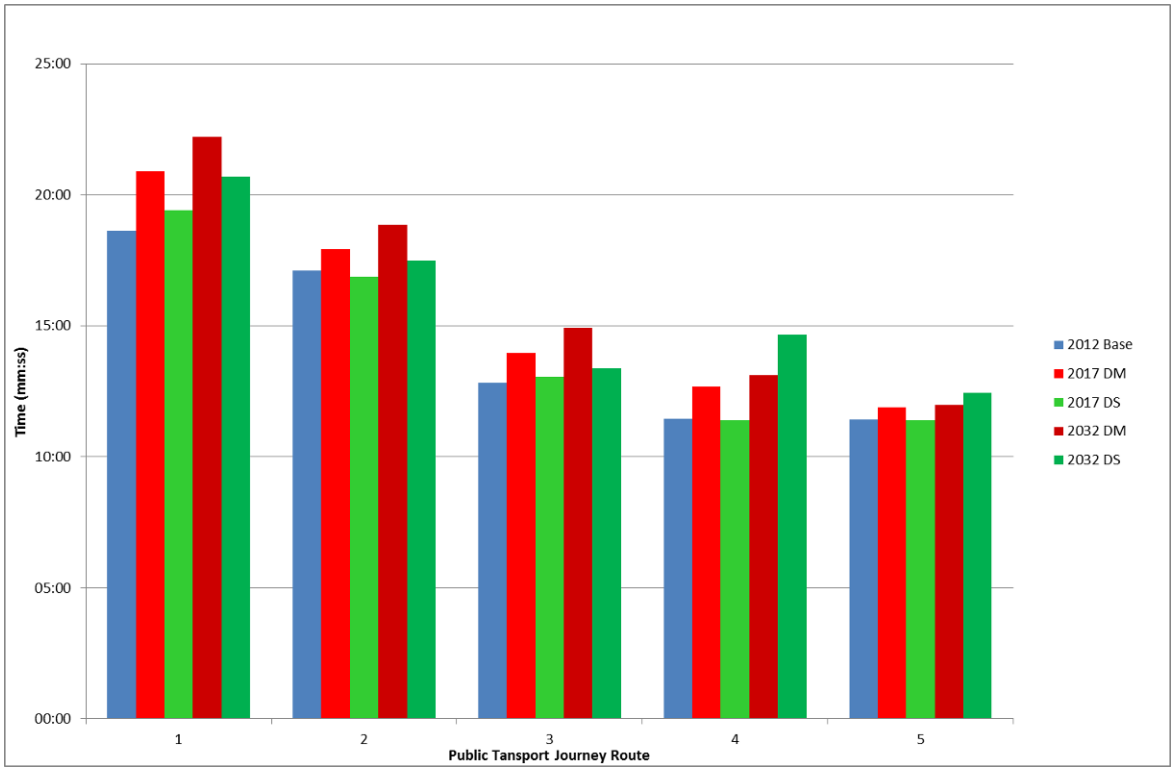
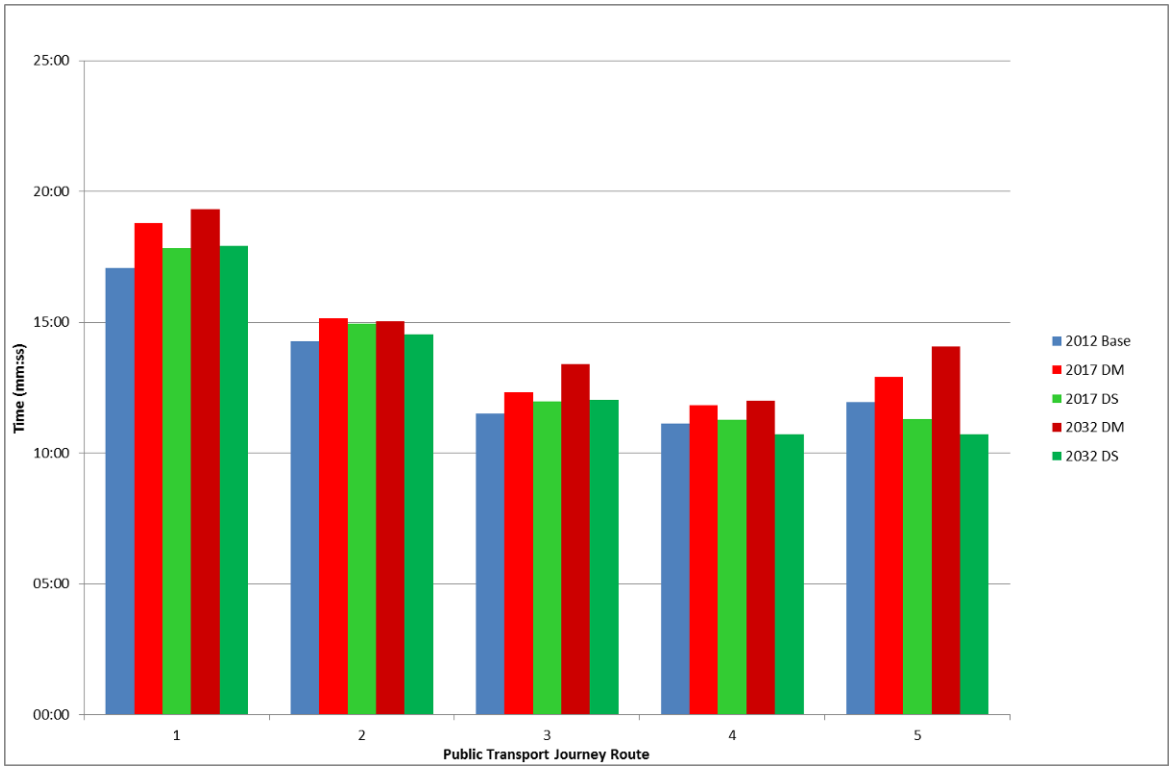


Figure 9.12 Outbound PM Peak Public Transport Journey Times



9.9.3 The figures demonstrate the following:

- The journey times in the DM increase in the forecast years on all routes and will be accompanied by further reductions in journey time reliability
- 2017 AM peak journey times into the city centre reduce by between 5% and 14% with the NDR
- 2017 PM peak journey times out of the city centre reduce by between 1% and 13% with the NDR

9.9.4 Journey time changes in 2032 are more affected by the complementary city centre measures.

- 2032 AM peak journey times into the city centre change by between a 1% increase to a 11% reduction in journey times with the NDR
- 2032 PM peak journey times out of the city centre reduce by between 3% and 24%

9.9.5 The information presented in the **Traffic Forecasting Report** demonstrates that in all the above scenarios, journey time reliability improves with NDR.

9.10 Effects on People

9.10.1 The **Traffic Forecasting Report** presents the effects on people by considering the number of dwellings within 50m of roads with a Volume to Capacity ratio of over 90% in both AM and PM peaks. This provides a good indication as to how many residents are affected by daily peak hour congestion. The results extracted from the **Traffic Forecasting Report** are presented in **Table 9.5** below.

Table 9.5 Number of dwellings within 50m of roads with V/C >90%

Properties affected	2012 Base	2017 DM	2017 DS	2032 DM	2032 DS
AM	3922	5676	4456 (-21%)	6824	4989 (-27%)
PM	2973	4432	4123 (-7%)	5587	5163 (-8%)

9.10.2 The above table shows that the number of dwellings impacted upon by roads that are at or nearing capacity would be significantly reduced particularly in the AM peak by the introduction of the NDR scheme. This a high-level headline figure with the effects of NDR on all travellers more fully assessed in **ES chapter 12, Effects on All Travellers** (document ref 6.1a).

9.11 Economic Appraisal

9.11.1 An economic appraisal has been carried out for the Scheme (see **Economic Appraisal Report**, document ref 5.7). This assesses the transport benefits of the Scheme, amongst other aspects, and compares these with the Scheme costs. The appraisal in accordance with standard Department for Transport methods and values shows that the benefits are above 4 times the Scheme costs. This means the Scheme represents very high value for money.

9.11.2 The majority of the transport benefits arise from time savings. These are broken down in the appraisal into three categories: shorter (less than 2 minutes), medium (2-5 minutes) and longer (more than 5 minutes). For the appraisal of the Scheme, the time benefits in these three categories are 26%, 29% and 44% respectively. This shows that the scheme has a large effect on transport times and efficiency, with the vast majority of the time savings comprising medium and longer time savings.

10 Road Safety Review

10.1 Introduction

10.1.1 This section of the TA presents a high-level analysis of Personal Injury Collision (PIC) data relating to the proposed NDR scheme. It provides information on PICs and accident cluster sites to inform the TA with regards to safety aspects relating to the NDR. The data used for TA purposes is the most recent available 5-year period and contains accident data for the fully modelled area.

10.1.2 The proposed route, the NDR, has not been considered in this section. Cost Benefit Analysis (COBA) considers the costs of accidents. This analysis is carried out in the **Economic Appraisal report** (document ref 5.7).

10.1.3 The following tasks have been completed as part of the initial desk top study:

- Production of an overview of PICs that have occurred in the defined study area/period;
- Analysis of the PIC data to identify individual accident cluster sites, within the defined study area/period.

10.1.4 In a second step, flow changes between the Do Minimum (DM, without NDR) and Do Something (DS, with NDR) resulting from the SATURN model runs were then related to the accident cluster sites.

At accident cluster sites where the SATURN model is predicting an increase in traffic flows due to the NDR, it is proposed that more detailed investigation is to be carried out outside of this TA:

- To determine whether there are any patterns or trends relating to the accidents that have occurred at the cluster site, and;
- If deemed necessary, identify possible road safety remedial measures to reduce the number and/or severity of collisions occurring at the site.

10.1.5 It should be noted that the Local Highway Authority is obligated to conduct regular monitoring of traffic accidents and will continually seek to improve road collision statistics by using a number of casualty reduction techniques, including targeted road safety remedial measures at identified accident cluster sites. The more detailed investigation as described above should be carried out within the regular monitoring with appropriate measures, if required, being implemented prior to opening of NDR.

10.2 Methodology

PIC data and analysis

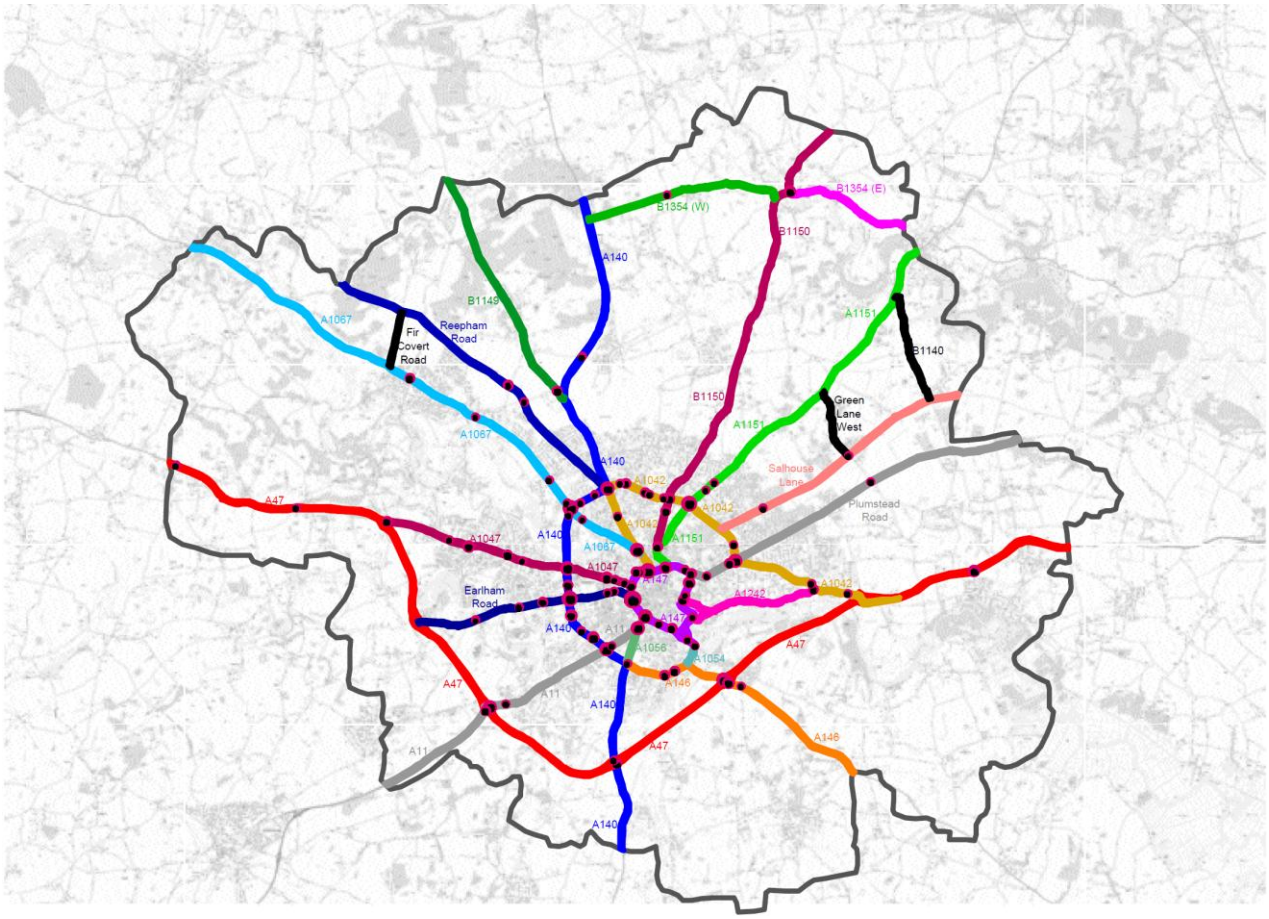
10.2.1 This report presents the results of the analysis for the latest five years of Personal Injury Collision (PIC) data available between 01/07/2008 and 30/06/2013.

10.2.2 The analysis has been completed using the KeyACCIDENT analysis software package, with Police STATS 19 data. These statistics refer to personal injury records on public roads which became known to the police. Figures for deaths refer to people who sustained injuries which caused death less than 30 days after the accident.

10.2.3 The PIC data has been obtained from Norfolk County Council (NCC, the local Highway Authority), who are provided with a copy of the Police data for their own analysis. The geographical area of the data provided, has been specified by Mott MacDonald, and uses a predefined boundary known as the 'Fully Modelled Area'.

10.2.4 This study analyses the PICs that were recorded on one of 23 road sections, which are considered to be the principal routes within the NDR scheme area as shown in **Figure 10.1**. A polygon search area has been created for each route as shown in **Table 10.1**.

Figure 10.1 The Study area, showing the principal route network and the 'Fully Modelled Area' boundary



Source: Mott MacDonald Ltd (not to scale)

Table 10.1 List of principal routes within the study area

Ref		Route/Road name	Start coordinates	End coordinates	Approximate Length (m)
	A	A1042	629762, 308519	622882, 309247	12058
	B	A1074	615571, 310673	622406, 308867	7132
	C	A1054	623963, 306713	624179, 307172	512
	D	A1056	622290, 306724	622608, 307730	1055
	E	A1067	610219, 318255	622630, 309812	15321
	F	A11	615604, 303345	622809, 308006	8755
	G	A1151	630354, 318143	623358, 309368	11986
	H	A1242	627483, 308773	A - 623850, 308470 B - 624113, 307995	4482
	I	A140	621073, 319579	622151, 301540	20272
	J	A146	628609, 303684	622288, 306718	7510

Ref		Route/Road name	Start coordinates	End coordinates	Approximate Length (m)
	K	A147	624179, 307172	624003, 307357	6874
	L	A47(T)	609589, 312277	634558, 309934	31236
	M	B1140	629734, 316892	630711, 314046	3133
	N	B1149	617323, 320144	620565, 314051	7015
	O	B1150	627924, 321474	623134, 309907	13133
	P	B1354(w)	621226, 319020	626419, 319601	5539
	Q	B1354(e)	626794, 319782	629991, 318860	3541
	R	B1108	616492, 307850	622437, 308471	6322
	S	Fir Covert Road	616052, 316474	615698, 314949	1567
	T	Green Lane West	627740, 314228	628439, 312487	1967
	U	Plumstead Road	633178, 312945	624080, 309209	10082
	V	Reepham Road	614422, 317223	621736, 311588	9444
	W	Salhouse Lane	631508, 314157	624913, 310437	7674

Source: Mott MacDonald

Cluster site analysis

10.2.5 Cluster site identification is shown in **Section 10.4** of this report. Cluster site analysis is a useful tool to determine the location of concentrated recorded PICs within a large area. Once a cluster site is identified, further investigation may be required to determine if there are any specific accident causes that form significant patterns or trends which can be attributed to the road environment.

10.2.6 As there are no recognised parameters for ‘a cluster site’, the criteria used for this analysis has been agreed with the Local Highway Authority, based on some preliminary investigative work.

10.2.7 This analysis has been completed by interrogating the PIC data using the *Cluster Site Analysis* function in the KeyACCIDENT software package. This function searches the data using a ‘Floating Cursor Algorithm’ based on the grid reference of each accident. A circle of user specified radius, in this case 50m, is cast from each accident and any other accidents contained within the circle are included in the total. If the total number of accidents is greater than, or equal to the specified minimum number of accidents (five in this case) and, if the searching radius of any one accident contains another accident, then this search area is increased and the process carried out repetitively until no more accidents fall within the search area. Thus the cluster site is defined. The size of the resulting cluster site is related to the location and number of PICs identified within it.

10.2.8 It should be noted that given that accidents are generally not precisely located; the accident cluster selection should only be seen as the initial interrogation process. Once the most accident prone sites have been identified, further, more detailed accident analysis is usually carried out to determine the exact locations of accidents and the likely causes. This cluster analysis provides however an initial overview of where the greatest accident spots are located in the network.

10.3 Overview of Personal Injury Collisions

10.3.1 Within the principal routes study area and during the 5 year period between 01/07/2008 and 30/06/2013, a total of 1,833 collisions have been recorded, resulting in 3,281 casualties. Of these, 26 PICs (1.4%) have been classified as Fatal, 214 (11.7 %) as Serious and 1,593 (86.9%) as Slight. This severity breakdown is similar to that found in the reference data of the national average statistics across all roads in 2012 (Calculated from Reported Road Casualties Great Britain: 2012 Annual Report, DfT 2013).

Table 10.2 GB Road accident severity

ALL GB ROADS 2012		**Study Area Roads**
Accident Severity	**%**	**%**
Fatal	1.1	**1.4**
Serious	14.4	**11.7**
Slight	84.5	**86.9**
Total	100	**100**

Source: RRCGB 2012: Table RAS10002 Reported accidents and accident rates by road class and severity, Great Britain

10.3.2 **Table 10.3** summarises the PIC data analysed within the principal route network study area.

Table 10.3 Summary overview of the PIC data

Accident frequencies	**Number**
Total number of accidents	1833
Fatal accidents	26
Serious accidents	214
Casualty frequencies	
Total number of casualties	2427
Fatally injured casualties	26
Seriously injured casualties	245
Accidents by type	
Involved at least one pedestrian injury	210
Involved at least one child injury	139
Only involved one vehicle	386
Involved three or more vehicles	233
Involved at least one HGV/LGV	174
Dry	1,267
Wet/Flood	522
Ice/Snow	44
Occurred in daylight	1,369
Occurred at night on an unlit road	113
Not at a Junction	535
At or within 20m of junction	1,298
At a private drive junction	78
At a T junction	498
At a crossroads	226
At a roundabout	317
At a slip road	31
All accidents - At least one vehicle skidded	471
Wet roads - At least one vehicle skidded	190
Accidents - involved vehicles	
Number of involved vehicles	3,590
Pedal Cycles	323
Two-wheeled motor vehicles	352

Light goods vehicle	122
Heavy goods vehicle	80
Bus or coach	56
Male drivers/riders (all ages)	2293
Male drivers/riders under 25 years old	489
Male drivers /riders over 59 years old	358
Female drivers/riders (all ages)	1297
Female drivers/riders under 25 years old	266
Female drivers/riders over 59 years old	135
Vehicle manoeuvres	
Parked	59
Waiting to go ahead	263
Stopping	457
Turning right	441
Waiting to turn right	65
Overtaking a moving vehicle	110
Going ahead on a bend	83
Going ahead - other	1,649
Changing lane (left or right)	98
Skidded, jack-knifed or overturned	517
Vehicle left carriageway	337
Accidents by Road Classification	
A Road	1,415
B Road	249
C Road	151
Unclassified	18

Source: Mott MacDonald

10.4 Cluster Site Identification

10.4.1 This section details the accident cluster sites identified within the principal route network study area.

10.4.2 As mentioned previously in **Section 10.3**, a cluster site has been defined as an area where five or more PICs occurring within the five year period, within a 50m radius of each other have been recorded. The total radius size of the

cluster site area is dependant on the number and location of PICs within it as explained in paragraph 10.2.7.

10.4.3 A keyplan showing the locations of all the cluster sites is shown in **Appendix H.**

10.4.4 **Table 10.4** is a list that describes each of the 89 cluster sites identified in the vicinity of the principal route network using collision data for the 5 year period of 01/07/2008 to 30/06/2013. It should be noted that in some instances, a cluster site may include collisions that have occurred on more than one road.

Table 10.4 List of cluster sites identified

Ref	Location	Coordinates		Cluster site area	PICs (01/07/2008 to 29/06/2013)				Casualties	
		X	Y	Radius (m)	Total	Fatal	Serious	Slight	Total	KSI
A	**A1042**									
A-001	Jct with A1067	622571	309851	127	**23**	0	1	22	***24***	1
A-002	Jct with Glenmore Grds	622034	310784	56	**5**	0	0	5	***5***	0
A-003	Jct with Mason Rd	622093	311699	56	**5**	0	0	5	***6***	0
A-004	Jct with Weston Rd	622247	311708	79	**10**	0	4	6	***10***	4
A-005	Jct with St Faiths Rd	622789	311452	79	**10**	0	1	9	***11***	1
A-006	Jct with Oak Lane	622919	311396	56	**5**	0	0	5	***11***	0
A-007	Jct with St Clements Hill	623306	311292	56	**5**	0	1	4	***7***	1
A-008	Jct with Rider Haggard Rd	625257	310002	56	**5**	0	1	4	***6***	1
A-009	Jct with Dussindale Drive	627406	308925	56	**5**	0	1	4	***5***	1
A-010	Jct with Old Chapel Way	628414	308652	56	**5**	0	0	5	***5***	0
B	**A1074**									
B-001	Jct with Orchard Street	622221	308942	66	**7**	0	0	7	***9***	0
B-002	Jct with Old Palace Rd	621945	309029	66	**7**	0	1	6	***9***	1

Ref	Location	Coordinates		Cluster site area	PICs (01/07/2008 to 29/06/2013)				Casualties	
		X	Y	Radius (m)	Total	Fatal	Serious	Slight	Total	KSI
B-003	Jct with Nelson Street	621731	309075	97	**16**	0	5	11	***16***	5
B-004	Jct with Larkman Lane	619382	309556	56	**5**	0	0	5	***9***	0
B-005	Jct with Norwich Rd	618964	309719	87	**12**	0	0	12	***15***	0
B-006	Bowthorpe Park Rbt	617892	309955	103	**17**	0	2	15	***20***	2
B-007	Jct with Richmond Rd	617355	310133	56	**5**	1	0	4	***8***	1
B-008	A47(T) (East Rbt)	615617	310658	87	**6**	0	1	5	***8***	1
C	**A1054**									
-		-	-	-	**-**	-	-	-	**-**	-
D	**A1056**									
-		-	-	-	**-**	-	-	-	**-**	-
E	**A1067**									
E-001	Jct with Whiffler Rd	621049	310702	66	**7**	0	1	6	***8***	1
E-002	Jct with Hellesdon Park Rd	620615	311155	66	**7**	0	2	5	***9***	2
E-003	Jct with Hospital Lane	620124	311795	56	**5**	0	1	4	***6***	1
E-004	Jct with Drayton High Rd/Low Rd	618079	313547	56	**5**	0	0	5	***5***	0
E-005	Jct with Breck Farm Lane	616250	314622	79	**10**	0	3	7	***11***	3
F	**A11**									
F-001	Jct with A1056	622595	307696	139	**23**	0	4	19	***26***	4
F-002	Jct with Lime Tree Rd	621872	307206	61	**6**	0	0	6	***10***	0
F-003	Cringleford Rbt	618927	305582	56	**5**	0	1	4	***5***	1
F-004	South-east of A47(T) Rbt	618352	305389	83	**11**	1	0	7	***9***	1
G	**A1151**									

Ref	Location	Coordinates		Cluster site area	PICs (01/07/2008 to 29/06/2013)				Casualties	
		X	Y	Radius (m)	Total	Fatal	Serious	Slight	Total	KSI
G-001	A1042 Rbt	624014	311148	152	**21**	1	3	17	***22***	4
G-002	Near jct with Allens Avenue	624476	311520	56	**5**	0	1	4	***6***	1
G-003	Jct with Carnnerby Lane	624713	311715	66	**8**	0	0	8	***10***	0
H	**A1242**									
H-001	Jct with A1042 Rbt	627467	308751	83	**6**	0	1	5	***6***	1
I	**A140**									
I-001	Jct with Horsham St Faith	621040	315215	56	**5**	0	1	4	***6***	1
I-002	Jct with A1042	621744	311567	132	**17**	1	0	16	***18***	1
I-003	West of Overbury Rd jct	621396	311386	66	**7**	0	1	6	***9***	1
I-004	Jct with Whiffler Rd	620998	311172	56	**6**	0	0	6	***6***	0
I-005	Jct with A1067	620721	311015	154	**21**	0	1	20	***29***	1
I-006	South of A1067 jct	620669	310821	66	**7**	0	0	7	***13***	0
I-007	Jct with A1074	620616	309353	125	**13**	0	0	13	***22***	0
I-008	Jct with Bowthorpe Rd	620642	308878	87	**12**	0	2	10	***14***	2
I-009	B1108 Rbt	620699	308513	150	**19**	0	0	19	***20***	0
I-010	Jct with The Avenues	620744	308046	103	**19**	0	3	16	***19***	3
I-011	Jct with South Park Avenue	621030	307605	56	**5**	0	0	5	***5***	0
I-012	Jct with Unthank Rd	621345	307419	112	**21**	0	0	21	***36***	0
I-013	Jct with A11	621711	307100	132	**15**	0	1	14	***17***	1
J	**A146**									
J-001	Jct with Mansfield Lane	623337	306370	75	**9**	0	1	8	***12***	1
J-002	Jct with Long John Hill	623600	306489	79	**10**	0	2	8	***14***	2

Ref	Location	Coordinates		Cluster site area	PICs (01/07/2008 to 29/06/2013)				Casualties	
		X	Y	Radius (m)	Total	Fatal	Serious	Slight	Total	KSI
J-003	Jct with B1332	625456	306079	61	**6**	1	3	2	***13***	6
K	**A147**									
K-001	Jct with A1054	624180	307199	56	**5**	0	0	5	***6***	0
K-002	Jct with Kings Street	623972	307361	61	**6**	0	1	5	***7***	1
K-003	Jct with Carrow Rd	624108	307994	61	**5**	0	1	4	***7***	1
K-004	Jct with Thorpe Rd	623834	308466	79	**10**	0	2	8	***13***	2
K-005	Jct with St Matthews/Chalk Hill Rd	623904	308605	66	**7**	0	1	6	***8***	1
K-006	Jct with Rosary Rd	624018	308940	94	**16**	0	3	13	***16***	3
K-007	Ketts Hill Rbt	624069	309201	75	**8**	0	0	8	***8***	0
K-008	East of Gilders Way jct	623900	309310	56	**5**	0	0	5	***6***	0
K-009	A1151 Rbt	623359	309363	94	**12**	0	0	12	***13***	0
K-010	A1402 Rbt	622867	309263	146	**21**	0	3	18	***25***	4
K-011	Jct with Oak Street	622654	309256	71	**8**	0	0	8	***10***	0
K-012	Barn Road Rbt	622546	309244	75	**9**	0	0	9	***9***	0
K-013	Jct with A1074	622399	308858	79	**7**	0	1	6	***7***	1
K-014	Jct with B1100 Rbt	622436	308476	184	**40**	0	4	36	***48***	4
K-015	A11 Rbt	622785	308008	139	**28**	0	2	26	***30***	2
K-016	Jct with Ashby Street	623171	307812	56	**5**	0	1	4	***5***	1
K-017	Jct with City Rd (Richmond Hill)	623532	307684	71	**8**	0	0	8	***8***	0
L	**A47(T)**									
L-001	Jct with Wood Lane	609762	312203	56	**5**	1	0	4	***7***	2
L-002	Jct with Church Ln Rbt (Easton)	613104	311022	61	**6**	0	0	6	***9***	0
L-003	A11 Jct	618477	305500	135	**15**	0	0	15	***17***	0

Ref	Location	Coordinates		Cluster site area	PICs (01/07/2008 to 29/06/2013)				Casualties	
		X	Y	Radius (m)	Total	Fatal	Serious	Slight	Total	KSI
L-004	A140 Jct	622003	303915	79	**5**	0	0	5	***5***	0
L-005	Jct with A146 (E)	625106	306178	94	**8**	0	0	8	***11***	0
L-006	Jct with A146 (W)	624974	306254	122	**13**	0	1	11	***21***	1
L-007	Jct with Cucumber Lane	631931	309263	94	**14**	1	0	13	***21***	1
M	**B1140**									
-		-	-	-	**-**	-	-	-	***-***	-
N	**B1149**									
N-001	Manor Farm Jct	620350	314268	79	**10**	1	1	8	***12***	2
O	**B1150**									
O-001	Jct with Wall Road	623362	310930	87	**12**	0	0	12	***15***	0
O-002	A1042 Rbt	623450	311277	106	**10**	0	2	8	***10***	2
P	**B1354 (W)**									
P-001	Jct with Buxton Rd	623401	319709	56	**5**	0	0	5	***7***	0
Q	**B1354 (E)**									
Q-001	Jct with B1150	626820	319792	94	**9**	0	0	9	***9***	0
R	**B1108**									
R-001	Jct with Mill Hill Rd	621937	308708	66	**8**	0	2	6	***10***	2
R-002	Jct with Park Lane	621752	308665	66	**7**	1	0	6	***11***	1
R-003	Gypsy Lane Rbt	619942	308415	79	**10**	0	1	9	***10***	1
R-004	Jct with Wilberforce Rd	619288	308266	66	**7**	0	0	7	***12***	0
R-005	Jct with Norwich Research Park	618082	307910	56	**5**	0	1	4	***7***	1
S	**Fir Covert Road**									
		-	-	-	**-**	-	-	-	***-***	-
T	**Green Lane West**									
T-001	Jct with Slippers Bottom	628440	312476	56	**5**	0	1	4	***5***	1

Ref	Location	Coordinates		Cluster site area	PICs (01/07/2008 to 29/06/2013)				Casualties	
		X	Y	Radius (m)	Total	Fatal	Serious	Slight	Total	KSI
U	**Plumstead Road**									
U-001	Jct with Britannia Rd	624503	309130	56	**5**	0	0	5	***5***	0
U-002	Jct with Valleyside Rd	625135	309478	71	**8**	0	1	7	***8***	1
U-003	Jct with A1042	625294	309561	127	**18**	0	0	18	***18***	0
U-004	Jct with Broad Lane	629059	311746	61	**6**	0	1	5	***11***	2
V	**Reepham Road**									
V-001	Jct with Hall Lane	619433	313967	61	**6**	0	3	3	***9***	3
V-002	Jct with Drayton Lane	618992	314426	75	**9**	0	0	9	***12***	0
W	**Salhouse Road**									
W-001	Jct with Blue Boar Ln/Thunder Ln	626074	311012	56	**5**	0	1	4	***6***	1

Source: Mott MacDonald

10.5 Flow Changes at Cluster Sites

10.5.1 Difference plots were obtained from the NATS model and related to the accident cluster site locations. Where cluster sites occur along links, the flows relate to AADT link flows. For cluster sites at junctions, the total inflow into the junction was considered.

Table 10.5 Difference in Flow Changes between DM and DS

		2017				2032			
Ref	Location	DM AADT Flows	DS AADT Flows	Diff.	% Diff	DM AADT Flows	DS AADT Flows	Diff.	% Diff
A	**A1042**								
A-001	Jct with A1067	25321	24457	-863	-3%	26087	24348	-1740	-7%
A-002	Jct with Glenmore Grds	12446	12415	-31	0%	12546	11726	-820	-7%
A-003	Jct with Mason Rd	26209	22269	-3941	-15%	28492	24470	-4022	-14%

		2017				2032			
Ref	Location	DM AADT Flows	DS AADT Flows	Diff.	% Diff	DM AADT Flows	DS AADT Flows	Diff.	% Diff
A-004	Jct with Weston Rd	27083	22682	-4401	-16%	29519	24823	-4696	-16%
A-005	Jct with St Faiths Rd	36416	31000	-5416	-15%	39692	33216	-6475	-16%
A-006	Jct with Oak Lane	29650	25987	-3663	-12%	32858	28150	-4707	-14%
A-007	Jct with St Clements Hill	32699	29499	-3200	-10%	35991	31484	-4507	-13%
A-008	Jct with Rider Haggard Rd	17968	14507	-3461	-19%	17263	14206	-3057	-18%
A-009	Jct with Dussindale Drive	24207	18595	-5612	-23%	25644	21100	-4543	-18%
A-010	Jct with Old Chapel Way	29487	25551	-3935	-13%	32686	30844	-1843	-6%
B	**A1074**								
B-001	Jct with Orchard Street	18791	18823	32	0%	18442	19281	839	**5%**
B-002	Jct with Old Palace Rd	22413	22536	123	**1%**	22333	22992	658	**3%**
B-003	Jct with Nelson Street	15850	16029	179	**1%**	15190	15250	60	0%
B-004	Jct with Larkman Lane	33415	32677	-738	-2%	34126	32769	-1357	-4%
B-005	Jct with Norwich Rd	28326	27746	-580	-2%	28490	27618	-872	-3%
B-006	Bowthorpe Park Rbt	25158	24448	-710	-3%	27529	26789	-740	-3%
B-007	Jct with Richmond Rd	17486	16508	-978	-6%	20771	20014	-757	-4%
B-008	A47(T) (East Rbt)	25933	24807	-1127	-4%	31816	30699	-1117	-4%
E	**A1067**								
E-001	Jct with Whiffler Rd	14634	14211	-422	-3%	14914	13464	-1449	-10%
E-002	Jct with Hellesdon Park Rd	25704	24273	-1431	-6%	28712	26710	-2002	-7%
E-003	Jct with Hospital Lane	25395	23466	-1929	-8%	26700	24130	-2570	-10%

		2017				2032			
Ref	Location	DM AADT Flows	DS AADT Flows	Diff.	% Diff	DM AADT Flows	DS AADT Flows	Diff.	% Diff
E-004	Jct with Drayton High Rd/Low Rd	16760	14665	-2094	-12%	17146	14326	-2820	-16%
E-005	Jct with Breck Farm Lane	9335	7221	-2114	-23%	9995	8344	-1651	-17%
F	**A11**								
F-001	Jct with A1056	22634	22372	-262	-1%	24930	24339	-590	-2%
F-002	Jct with Lime Tree Rd	17399	17660	261	1%	19137	19809	673	**4%**
F-003	Cringleford Rbt	39362	39553	192	0%	49360	49672	313	**1%**
F-004	South-east of A47(T) Rbt	22571	22632	61	0%	29012	28826	-186	-1%
G	**A1151**								
G-001	A1042 Rbt	46045	40180	-5865	-13%	49789	43478	-6311	-13%
G-002	Near jct with Allens Avenue	17077	14244	-2833	-17%	20808	17538	-3271	-16%
G-003	Jct with Carnnerby Lane	18166	15379	-2787	-15%	22001	18841	-3161	-14%
H-001	**A1242**								
H-001	Jct with A1042 Rbt	28533	23178	-5355	-19%	31129	26897	-4233	-14%
I	**A140**								
I-001	Jct with Horsham St Faith	19674	18824	-850	-4%	23826	20606	-3220	-14%
I-002	Jct with A1042	47553	43035	-4517	-9%	50568	46199	-4369	-9%
I-003	West of Overbury Rd jct	23169	20758	-2412	-10%	25434	23703	-1731	-7%
I-004	Jct with Whiffler Rd	24627	22620	-2007	-8%	26748	25220	-1528	-6%
I-005	Jct with A1067	43977	41500	-2478	-6%	47577	45123	-2454	-5%
I-006	South of A1067 jct	28662	27723	-939	-3%	31120	31419	299	**1%**

		2017				2032			
Ref	Location	DM AADT Flows	DS AADT Flows	Diff.	% Diff	DM AADT Flows	DS AADT Flows	Diff.	% Diff
I-007	Jct with A1074	45565	44847	-718	-2%	47964	47650	-314	-1%
I-008	Jct with Bowthorpe Rd	33959	32981	-978	-3%	37467	36963	-504	-1%
I-009	B1108 Rbt	37307	36883	-424	-1%	39922	39130	-792	-2%
I-010	Jct with The Avenues	20630	19798	-832	-4%	22388	20925	-1463	-7%
I-011	Jct with South Park Avenue	19215	18586	-628	-3%	19981	19079	-902	-5%
I-012	Jct with Unthank Rd	28989	28303	-686	-2%	31593	30413	-1180	-4%
I-013	Jct with A11	40058	40005	-54	0%	43493	43081	-412	-1%
J	**A146**								
J-001	Jct with Mansfield Lane	15025	15435	409	**3%**	16356	15999	-356	-2%
J-002	Jct with Long John Hill	20698	21763	1066	**5%**	22734	23801	1067	**5%**
J-003	Jct with B1332	34009	33290	-719	-2%	38044	36635	-1409	-4%
K	**A147**								
K-001	Jct with A1054	39428	39865	437	**1%**	42228	42703	475	**1%**
K-002	Jct with Kings Street	39294	38730	-564	-1%	41555	41327	-228	-1%
K-003	Jct with Carrow Rd	25143	25221	78	0%	26717	28289	1573	**6%**
K-004	Jct with Thorpe Rd	21102	20790	-312	-1%	21531	20335	-1196	-6%
K-005	Jct with St Matthews/Chalk Hill Rd	14323	13941	-382	-3%	15212	15103	-109	-1%
K-006	Jct with Rosary Rd	16966	16368	-598	-4%	17915	18817	902	**5%**
K-007	Ketts Hill Rbt	35097	34487	-609	-2%	36605	38046	1441	**4%**
K-008	East of Gilders Way jct	24789	24532	-257	-1%	26042	29821	3778	**15%**
K-009	A1151 Rbt	40168	39940	-229	-1%	41284	40738	-547	-1%
K-010	A1402 Rbt	44883	44478	-405	-1%	47019	47546	528	**1%**
K-011	Jct with Oak	38819	37974	-845	-2%	40734	39339	-1396	-3%

		2017				2032			
Ref	Location	DM AADT Flows	DS AADT Flows	Diff.	% Diff	DM AADT Flows	DS AADT Flows	Diff.	% Diff
	Street								
K-012	Barn Road Rbt	39928	39460	-469	-1%	41763	41911	148	0%
K-013	Jct with A1074	48267	47650	-616	-1%	49178	51020	1842	**4%**
K-014	Jct with B1100 Rbt	49928	49756	-171	0%	51480	51694	215	0%
K-015	A11 Rbt	37727	38478	751	**2%**	38731	41151	2420	**6%**
K-016	Jct with Ashby Street	24517	25700	1183	**5%**	24048	27074	3025	**13%**
K-017	Jct with City Rd (Richmond Hill)	22933	23566	633	**3%**	23197	24299	1102	**5%**
L	**A47(T)**								
L-001	Jct with Wood Lane	29616	27366	-2249	-8%	36823	34447	-2375	-6%
L-002	Jct with Church Ln Rbt (Easton)	34934	32179	-2754	-8%	44610	41859	-2752	-6%
L-003	A11 Jct	68268	68921	653	**1%**	86872	87889	1017	**1%**
L-004	A140 Jct	36245	36740	495	**1%**	45117	45869	752	**2%**
L-005	Jct with A146 (E)	44466	44891	426	**1%**	51669	51323	-345	-1%
L-006	Jct with A146 (W)	48474	50335	1861	**4%**	56288	58260	1972	**4%**
L-007	Jct with Cucumber Lane	43509	45397	1888	**4%**	50836	51631	794	**2%**
N	**B1149**								
N-001	Manor Farm Jct	13121	0	-13121	-100%	14195	0	-14195	-100 %
O	**B1150**								
O-001	Jct with Wall Road	11119	9728	-1391	-13%	11818	8721	-3097	-26%
O-002	A1042 Rbt	41635	36273	-5361	-13%	45281	38380	-6901	-15%
P	**B1354 (W)**								
P-001	Jct with Buxton Rd	4768	1873	-2894	-61%	6840	2282	-4558	-67%

		2017				2032			
Ref	Location	DM AADT Flows	DS AADT Flows	Diff.	% Diff	DM AADT Flows	DS AADT Flows	Diff.	% Diff
Q	**B1354 (E)**								
Q-001	Jct with B1150	22275	19922	-2353	-11%	26703	23391	-3311	-12%
R	**B1108**								
R-001	Jct with Mill Hill Rd	13142	13455	313	2%	14151	13469	-682	-5%
R-002	Jct with Park Lane	12669	12916	247	2%	13262	12778	-484	-4%
R-003	Gypsy Lane Rbt	30234	29917	-317	-1%	33412	32685	-726	-2%
R-004	Jct with Wilberforce Rd	24090	23658	-431	-2%	29064	28355	-709	-2%
R-005	Jct with Norwich Research Park	26490	25822	-668	-3%	36402	35701	-701	-2%
T	**Green Lane West**								
T-001	Jct with Slippers Bottom	12224	8770	-3454	-28%	18083	16707	-1376	-8%
U	**Plumstead Road**								
U-001	Jct with Britannia Rd	15743	16518	775	5%	15628	16350	722	**5%**
U-002	Jct with Valleyside Rd	13857	14834	976	7%	14058	15136	1078	**8%**
U-003	Jct with A1042	34089	31960	-2129	-6%	34584	32408	-2176	-6%
U-004	Jct with Broad Lane	8180	4643	-3537	-43%	10506	5286	-5221	-50%
V	**Reepham Road**								
V-001	Jct with Hall Lane	14780	16696	1916	13%	16891	18038	1147	**7%**
V-002	Jct with Drayton Lane	10261	16059	5798	56%	11875	17052	5177	**44%**

		2017				2032			
Ref	Location	DM AADT Flows	DS AADT Flows	Diff.	% Diff	DM AADT Flows	DS AADT Flows	Diff.	% Diff
W	**Salhouse Road**								
W-001	Jct with Blue Boar Ln/Thunder Ln	21008	17222	-3786	-18%	25620	22475	-3145	-12%

10.5.2 **Table 10.5** shows the flow differences at the 89 accident cluster site locations for both 2017 and 2032 comparing DS with DM. The flows presented are taken from the SATURN model and these are Annual Average Daily Traffic (AADT) flows.

10.5.3 The SATURN model outputs show the flow of traffic is expected to reduce across the majority of the accident cluster site areas (at 62 sites in both 2017 and 2032). It is considered that where traffic levels will fall, there is likely to be a reduction in the occurrence of PICs. This conclusion is based on the assessment of accidents contained in Chapter 4 of the COBA manual, which relates the occurrence of accidents to the volumes of traffic passing through a junction or along a highway link road.

10.5.4 At seven accident cluster sites in 2017 and at three sites in 2032 there is no change in traffic flow expected.

10.5.5 Within the model outputs for the year 2017, traffic flows are predicted to increase across 20 of the cluster site locations (shown in the table above as red % numbers). In 2032, there are 24 cluster sites with flow increases (shown as bold % numbers). It should be noted that the SATURN model only predicts significant rises in traffic flows (increases of 5% or more) at 6 sites in 2017 and at 12 sites in 2032. In most cases these increases can be taken as low enough not to have a significant impact on PICs at these locations.

10.5.6 Notwithstanding this, the 20 accident cluster sites where the SATURN model has predicted an increase percentage in traffic flow for 2017 will continue to be monitored on a quarterly basis alongside all of the cluster sites in Norfolk. This regular investigation of the detailed accident records will determine whether the road environment was a factor and what, if any, measures could be implemented to improve road safety.

10.5.7 The junction of Reepham Road with Drayton Lane is the one that experiences the highest increase in flows in 2017 from DM to DS (56%).

The layout of this junction will however significantly change in the DS. In the DM, this is a crossroad with Reepham Road being the mainline carrying the majority of traffic. In the DS, this junction will take the form of a 3-arm priority junction with Drayton Lane becoming the mainline providing the connection from the NDR a short distance to the north into Norwich. The present cluster site is therefore unlikely to reflect the future situation at this junction.

10.5.8 The junction of Reepham Road with Hall Lane experiences the second highest increase in flows in 2017 from DM to DS (13%). The traffic patterns at this junction will however significantly change in the DS. In the DM, Holly Lane and Hall Lane form a staggered crossroads with Reepham Road and there is a relatively high cross flow. In the DS, Holly Lane is severed by the NDR and this junction will effectively behave like a 3-arm priority junction as the fourth arm will only serve the premises on Holly Lane itself. The present cluster site is therefore unlikely to reflect the future situation at this junction.

10.6 Conclusions

10.6.1 Given the extensive nature of the study area, this part of the TA is necessarily a high level assessment looking at trends and potential for change following construction of the NDR rather being a detailed accident remediation study.

10.6.2 The PIC data for the principal route network study area has been analysed and cluster site identification has been undertaken. In total 89 cluster sites were identified in the five year study period 01/07/2008 to 30/06/2013, which was the latest data available at the time of writing this TA chapter.

10.6.3 The severity breakdown resulting from the analysis is broadly in line with UK national average statistics across all roads in 2012 (Calculated from Reported Road Casualties Great Britain: 2012 Annual Report, DfT 2013).

10.6.4 A flow comparison was carried out at the 89 cluster sites. The impact of NDR is presented in **Table 10.5** based on the comparison of AADT flows obtained from the SATURN model (DS Vs. DM AADT flows). This reveals that:

- 62 sites (out of 89) are predicted to experience lower flows due to NDR. It can therefore be concluded that this may lead to a reduction in the occurrence of PICs.

- Seven site (2017) and three sites (2032) are predicted to experience no change in traffic with the NDR likely to have no impact in road safety terms.
- 20 sites (2017) and 24 sites (2032) are predicted to experience higher flows due to NDR but with a couple of exceptions, the increases in traffic flow are below the more stringent 10% threshold of significance given in published guidance on the environmental assessment of traffic impacts. In the worst case analysed the accident record of the junction is good and considered unlikely to change significantly as a consequence of the increase in traffic predicted.
- Further investigation of the detailed accident records at these 20 cluster sites will be conducted as part of regular quarterly monitoring by the council. This will determine whether the road environment was a factor and whether any measures could be implemented to improve road safety at these locations.

10.6.5 Overall it can be concluded that the NDR is likely to have a beneficial impact at nearly 70% of all existing cluster sites (62 out of 89).

11 Construction Traffic Assessment

11.1 Summary of Construction Methodology

11.1.1 The Norwich Northern Distributor Road (NDR) Construction Methodology was produced by Birse Civil Balfour Beatty in April 2013. The document is included in the **Environmental Statement** in Volume 2, Chapter 2 Section A.

11.1.2 The report is structured as follows:

- Introduction
- Pre-construction Works
- Construction of the NDR
- Construction Logistics
- Construction Programme
- Utilities Diversions
- Complementary Transport Measures

11.1.3 The construction of the NDR is programmed for construction between 2015 and 2017. A construction programme has been produced by Birse Civil. This is included in the above Appendix to the **Environmental Statement**. The following programme overview is provided in the report:

- Ecological works: months -12 and 1
- Advance drainage works: months 1 to 6
- Main earthworks: months 1 to 21
- Construction of structures: months 1 to 24
- Construction of pavements: months 8 to 24
- Landscaping: months 8 to 33

11.1.4 The report states that “the programme of construction works has regard to best practice and takes into account the need to avoid, where practicable, disruption to local communities and the environmental effects of construction”. It continues that “working hours will reflect the need to complete the construction works as quickly and effectively as possible, whilst minimising the disturbance to local communities. Earthworks operations have been programmed between 07:00 and 19:00 Monday to Friday and 07:00 and 13:00 on Saturdays. Extended hours of working will be limited to those required to construct tie-ins to side roads and those subject to the requirements of Network Rail at Rackheath. All working hours will be discussed and agreed with the Environmental Health Officer (EHO)”.

11.1.5 The main compound will be located at Norwich Airport with satellite compounds at Drayton Lane, Buxton Road, Plumstead Road and Postwick. The Construction Methodology does not provide any detailed information about what activities will take place at these compounds. The location of the compounds is shown on the drawings “Norwich Northern Distributor Road General Arrangement Plan” (12 sheets, document ref 2.6).

11.1.6 It is anticipated that during the summer months (April to September) up to 55 staff and 120 operatives would be employed on NDR construction activities. Accommodation for staff not living locally will be provided at the main Airport compound.

11.1.7 The report states that in addition to staff transport, there will be up to 75 deliveries per day during peaks of construction activities. These will be predominantly 20 tonne eight wheeled wagons and *“we will endeavour to restrict any deliveries until after 07:00”*.

11.1.8 The report states that “the philosophy developed for the delivery of materials to the NDR scheme and the subsequent movement throughout the site has been developed based on the logistics of the site and discussion with NCC on the suitability of the County Roads for delivery vehicles. At several locations we have indicated the requirement for plant crossings, either temporary (concrete crossing points) or permanent (signal controlled) that are required for transporting earthworks and other materials along the route. At several locations we have envisaged these only being approved during off peak periods”.

11.1.9 The report goes on to state that wheel washing facilities and road sweeping equipment will be provided and used to ensure the roads will be kept clean and clear of mud and debris.

11.1.10 The following roads will be used for access:

- Fakenham Road (eastbound access from existing highway)
- Reepham Road
- Drayton Lane
- Holt Road
- Cromer Road (eastbound access to main compound)
- Buxton Road
- North Walsham Road
- Wroxham Road
- Newman Road (to offices and bridge site only)
- Salhouse Road
- Plumstead Road
- Low Road
- Postwick (westbound access from new northern roundabout)

11.1.11 The above shows that most radial routes to the north and east of Norwich will be used for access to the construction site. Whilst these routes are presently carrying heavy goods vehicles (HGVs), they all run through the built up areas of Norwich and through some of the villages to the north and east of Norwich. The impact on each of these routes should be further considered once more detailed information about construction traffic is available to demonstrate the suitability of all the access roads and to ensure any construction impacts are being minimised. An initial assessment assuming a worst case has been carried out in the section below.

11.1.12 Access along the construction site will be either via the westbound or eastbound carriageway depending on programme.

11.1.13 Deliveries to the construction site from across the network will mainly comprise of drainage aggregates, concrete, temporary materials for the construction of bridges and bituminous materials. Waste material will be stored at the compounds in accordance with Birse's Site Waste

Management Plan (SWMP) with re-use of materials being optimised, thereby minimising the amount of waste produced and disposed in land fill off site. Existing concrete will be broken up and stored in the main compound, then reused as subbase.

11.1.14 Any abnormal loads such as bridge beam deliveries will be subject to the normal process for such loads and route choices and special arrangements will be agreed with the DfT abnormal loads division and the affected highway authorities as required.

11.2 Construction Traffic Assessment

11.2.1 As explained in the section above, the Construction Methodology does not provide any detail about the routes these 75 deliveries per day will use to get to / from the construction sites. However it can be reasonably assumed that they would be relatively well-spread out during the course of a working day. As a working assumption, it is estimated that up to approximately 20% of deliveries would arrive during any single hour in the approximately 8-10 hour working day.

11.2.2 Assuming 20% of staff and operatives live temporarily in accommodation on the site and also work at the main compound, and that modal share of the remaining workforce will be on average 1.2 personnel per vehicle, a likely traffic generation of approximately 117 inbound trips during the morning and the same outbound in the evening can be assumed.

11.2.3 As an estimate of the impact on the radial routes likely to be used for construction access, in what is considered to be a worst case scenario of 50% of operatives and deliveries being to a specific location along a less heavily trafficked radial route, this would generate 59 inbound staff and operative movements and 15 HGV delivery movements in the peak hour.

11.2.4 Existing daily traffic flows are provided for most of the roads referred to in **paragraph 1.1.10** above in Figures I.1 and I.2 in Appendix I of the **Traffic Forecasting Report** (document ref 5.6). Buxton Road and Salhouse Road show the lowest existing AADT flows of 5400. AM peak hour traffic flows for these roads are contained in Tables I.1 and I.2 of the same appendix. **Table 11.1** below presents existing AM peak hour and predicted 2017DM AM peak hour traffic flows for Buxton Road and Salhouse Road and compares them

to the assumed worst case construction traffic. The table also contains HGV numbers extracted from the NATS model.

Table 11.1 Comparison of 2012, 2017 flows and Construction traffic

Road		2012 Base AM peak two-way flows	2017 DM AM peak two-way flows	Difference 2017DM vs 2012	Construction traffic
Buxton Road	Veh	660	560	-100	74
	HGV	8	27	+19	15
Salhouse Road	Veh	540	720	+180	74
	HGV	13	13	0	15

11.2.5 The above numbers demonstrate that the assumed worst case construction traffic which would temporarily occur on Salhouse Road is significantly lower than the predicted flow increases between Base and 2017DM. The numbers do however show, that HGV movements on this road would approximately double. On Buxton Road there is a predicted reduction in peak hour traffic when comparing 2017DM with Base as a result of the Rackheath developer link road. The assumed worst case construction traffic would therefore increase total flows on this road above existing and 2017DM traffic levels. In terms of HGV movements however, the predicted 2017DM HGV movements are broadly similar to those that would occur with the assumed construction traffic (8+15).

11.2.6 The perceived impact of the assumed worst case construction traffic is likely to be noticeable due to HGV volumes predicted to treble on Buxton Road and double on Salhouse Road, and overall vehicle volumes predicted to increase by 11% on Buxton Road and 14% on Salhouse Road. The impact on link and junction capacity however is considered not significant given the greater overall predicted flow increases on Salhouse Road in 2017DM and the greater HGV movements on Buxton Road in 2017DM.

11.2.7 During the construction phase, any potential impacts should be regularly reviewed by NCC and suitable measures should be considered where practical to minimise any impacts. These measures are likely to include a traffic management committee including NCC and local residents groups, regular newsletters, drop-in events, a web-site and a staffed hot-line to deal with urgent matters arising.

11.3 Conclusions

11.3.1 Due to the short programme, the construction of the NDR will be progressed in parallel at a number of locations along its length. This will require access to construction sites via existing roads as described in the section above.

11.3.2 The **Construction Methodology** report provides information on likely working hours, number of heavy goods (HGV) movements to the construction sites and staff numbers.

11.3.3 Little detailed information has been presented to date regarding the amount of construction traffic using the individual roads as identified in **Section 11.1**. In the absence of this information, an estimated worst case assessment of the impact of this traffic on these roads has been carried out in **Section 11.2** above and shows that the impact will be no more than 14% of hourly flows in the morning peak hour. HGV movements are predicted to increase significantly leading to a noticeable perceived impact of the construction traffic. The increase of HGV movements on Buxton Road and total flow increases on Salhouse Road is however no greater than the predicted 2017DM flows. Link and junction capacities along these roads are therefore considered not to be significantly affected by the assumed construction traffic. In general the impact is considered likely to be much less than this.

11.3.4 A range of mitigation measures is likely to be adopted to deal with construction traffic impacts in terms of the planning of the works, providing information to residents and dealing with specific matters as they arise. Prior to construction commencing, the detailed impacts will have to be considered and measures such as lorry routing agreements and/or limiting working hours on routes that are impacted, will have to be agreed to minimise any impacts.

12 Mitigation

12.1 Direct Mitigation

12.1.1 The NDR scheme in itself is a direct mitigation to address the growing traffic problems in and around Norwich as described in **Section 7.8** of this TA. As demonstrated in the **Needs Case** which is included in the **Environmental Statement** and model data included in **Chapter 9** in this document, the NDR achieves the following:

- The NDR improves local and national connectivity across the northern part of Norwich as demonstrated in **Section 9.2** of this report.
- The NDR improves strategic connections to and from the Airport and the proposed new development areas to the northeast of Norwich. The highway journey times presented in **Section 9.7** of this report show significant improvements in journey times. In most cases, journey times in 2032DS are predicted to be below 2012 base levels.
- The NDR reduces traffic levels and congestion on the Outer Ring Road and the radial routes in the north and northeast of Norwich as presented in **Section 9.4**.
- The NDR reduces traffic levels on orbital roads in the north and northeast of Norwich. The character of these roads is predominantly urban high street providing local access to communities including by walking and cycling. It is considered that they are not appropriate for carrying large volumes of through traffic. Information presented in **Section 9.4** demonstrates that traffic levels on these routes reduce significantly with the introduction of NDR.
- The NDR reduces non-essential traffic through the city centre as presented in **Section 9.6**.
- Public transport journey times on key routes into and out of the City Centre reduce significantly with the introduction of NDR as demonstrated in **Section 9.8**.

- The NDR reduces the impact on people as demonstrated in **Section 9.9** by reducing the number of dwellings being exposed to roads operating at over 90%capacity.

12.1.2 The NDR will carry a significant amount of traffic of up to approximately 46,000 vehicles per day. The junctions along the route have been assessed in detail in **Chapter 8** of this TA. In 2017, all NDR approach arms show capacity levels below the desirable level of 85% capacity. However, in 2032 a number of these junctions show capacity levels that are above this level but below their theoretical threshold of 100%.

12.1.3 The results presented in this TA are based on a number of iterations, with detailed junction modelling being carried out and the results then fed back into the strategic model with traffic being re-assigned. The testing has shown that with increasing capacity provided at the NDR junctions, the demand along the NDR was growing. It would therefore appear that a careful balance needs to be struck between supply and demand.

12.1.4 The junction layouts presented in this TA are considered to be the best possible balance between relieving the existing network whilst ensuring acceptable conditions on this new part of the network. It does however mean that there are likely to be some very limited queues and delays on some approaches to a small number of the on-line junctions during the morning and evening peak periods in 2017 when the road would be opened to traffic.

12.2 Indirect Mitigation

12.2.1 The implementation of NDR also allows for indirect mitigation to take place elsewhere. Below is a list of city centre NATS measures and other network improvements that are facilitated by the NDR scheme:

- Golden Ball Street and Farmers Avenue two-way
- Removal of general traffic except buses, taxis and cyclists from Red Lion Street
- Full closure of Westlegate
- Removal of general traffic except buses, taxis and cyclists from Prince of Wales Road (except eastern section)
- Bus only on Prince of Wales Road and Agricultural Hall Plain

- Removal of some non-bus, taxi or cycle through traffic from Tombland - occurs as a consequence of the sum of the other measures
- Wroxham Road / Green Lane (Rackheath Junction) junction improvement
- Thorpe End: Traffic Management on Plumstead Road as per Parish Plan (two mini-roundabouts and a pedestrian crossing)
- North Walsham Road / Crostwick Lane (Crostwick Junction) junction improvement

12.2.2 The Rackheath and Crostwick junction improvements are required to mitigate against the NDR impact due to the main roads at these junctions carrying increased traffic. The remainder are improvement schemes that can be implemented because of the beneficial impact of NDR and are targeted at mitigating existing deficiencies including improving conditions for public transport, pedestrians and cyclists.

13 Conclusions

13.1 Summary

13.1.1 This TA presents the objectives for the NDR scheme in **Chapter 2**. The chapter continues to describe the discussions with the Highway Authorities to agree the scope and extent (in terms of number of junctions to be assessed) of this TA.

13.1.2 A detailed scheme description is included in this TA in **Chapter 3** and the policy context is set out in **Chapter 4**. Subsequent chapters deal with the existing network conditions (**Chapter 5**) and sustainable transport (**Chapter 6**). This section considers the following modes: bus, Park & Ride, coaches, rail, non motorised users.

13.1.3 Transport modelling outputs and how they are used in this TA are described in **Chapter 7**, and section 7.8 explains how the Do Minimum network would be inadequate to accommodate the forecast traffic. The results of the traffic impact assessment are presented in **Chapter 8** of this TA with the wider impacts of the scheme described in **Chapter 9**. This section contains information from the **Traffic Forecasting Report** (document ref 5.6) which also supports the **Needs Case**.

13.1.4 A high level analysis of Personal Injury Collisions (PIC) has been carried out in **Chapter 10** of this TA. This firstly considers the PIC data by route and then goes on to analyse cluster sites for the principal route network.

13.1.5 The Construction Methodology produced by Birse has been reviewed and an initial assessment of construction traffic impact has been carried out with the findings presented in **Chapter 11** of this TA.

13.1.6 **Chapter 12** of this TA considers mitigation; that being mitigation achieved by the NDR itself and the measures that are part of the scheme as well as mitigation required for NDR.

13.2 Conclusions

13.2.1 The transport modelling and appraisal work has demonstrated that the Do Minimum network would be inadequate to accommodate traffic generation produced by the high levels of employment and residential growth planned for greater Norwich and lead to a substantial deterioration in operational performance, transport journey times and reliability, thus reducing the economic competitiveness of the City. This would be accompanied by a further deterioration in traffic conditions on inappropriate routes, reductions in operational performance for bus services and worsening conditions for walking and cycling. There would be an increasing risk of worsening road safety as traffic would continue to grow on inappropriate routes and queues may extend onto the high speed A47(T) dual carriageway.

13.2.2 Detailed discussions with the Highway Authority and consideration of headline figures from the traffic model led to the agreement that the following junctions should be assessed in detail:

- All 14 on-line junctions along the NDR;
- Six other junctions with NDR at Postwick; and
- Five off-line junctions: A47(T) Trowse, A146 / Martineau Lane, Bracondale / King Street, Crostwick Junction (North Walsham Road / Crostwick Lane / Rackheath Lane), Rackheath Junction (Wroxham Road / Green Lane West)

13.2.3 The policy chapter concludes that the NDR scheme is considered complementary to the relevant key policies and guidance and is aligned with national and local policy.

13.2.4 The conclusions following the sustainable transport chapter are as follows:

- Bus: the NDR and its associated complementary measures are predicted to reduce congestion on the core network, thereby reducing bus journey times as demonstrated in this report. The complementary measures in the City Centre include road closures therefore giving priority to buses. These should lead to more reliable public transport and encourage greater usage.
- 18 of the current bus services would cross the route of the propose NDR. The majority of these would be unaffected by the scheme with any minor

impacts being mitigated against by benefitting from reduced traffic levels on radial routes and the Outer Ring Road.

- Park & Ride: the six Park & Ride sites and their bus services are likely to benefit from reductions in congestion along key corridors by the introduction of the NDR. Furthermore, the introduction of signals at the Postwick Park & Ride junction allows prioritisation of Park & Ride bus services.

- Rail: rail services will not be directly affected by the NDR. The NDR could however have a beneficial impact on journey times to and from the main rail station.

- Non motorised users (NMU): one of the main aims and achievements of the NDR is to remove traffic from orbital routes in the north and northeast of Norwich. These routes are meant to act as urban high streets to serve walking and cycling movements. The introduction of the NDR enables them to fulfil this role thereby benefitting non motorised users.

- There is a number of rights of way that are being impacted by the NDR. **Table 6.3** in this TA is setting out detailed mitigation measures for each of them.

- The NDR scheme also includes approximately 25km of new pedestrian / cycle links along the route within the landscape strip. These would link to existing facilities and enhance the walking and cycling networks.

13.2.5 The results presented in this TA are based on a number of iterations, with detailed junction modelling being carried out and the results then fed back into the strategic model with traffic being re-assigned. The testing has shown that with increasing capacity provided at the NDR junctions, the demand along the NDR also grew. Therefore, it is apparent that a careful balance needs to be struck between providing sufficient capacity to meet the objectives of the scheme without encouraging unnecessary or longer motorised journeys.

13.2.6 The junction assessments presented in this TA demonstrate that the NDR approach arms have capacity levels below the desirable maximum level of 85% capacity in 2017 except for the southbound approach to the Postwick NE roundabout and the New Link Bridge approaching the Park & Ride signalised junction. In 2032, a number of the approaches show capacity levels that are above the 85% level but below their theoretical maximum

threshold of 100% except for the southbound approach to the Postwick NE roundabout and the New Link Bridge approaching the Park & Ride signalised junction. There is a small number of side roads and non-NDR links that are above the desirable level in 2017 and above the theoretical level in 2032. The resulting queues are deemed to be acceptable.

13.2.7 The junction layouts presented in this TA are considered to be the best possible balance between relieving the existing network whilst ensuring acceptable conditions on this new part of the network. It does however mean that there are likely to be some very limited queues and delays on some approaches to a small number of the on-line junctions during the morning and evening peak periods in 2017 when the road would be opened to traffic.

13.2.8 The existing Postwick Park & Ride roundabout junction is forecast to experience substantial queues and delays on Yarmouth Road in both peak periods in both 2017 and 2032. With NDR and the signal junction improvement, the theoretical capacity limit is exceeded in 2032 PM peak, but the queues and delays on Yarmouth Road reduce significantly in the DS scenario with the introduction of signals. Furthermore, the proposed signal junction allows Park & Ride bus services being prioritised via dedicated signal control.

13.2.9 Theoretical capacity is also exceeded at Martineau Lane / A146 and Bracondale / King Street junctions. The results demonstrate that this is not due to the NDR but background traffic growth with over-capacity levels similar in the DM and DS scenarios. Thus the NDR scheme itself does not significantly affect these junctions.

13.2.10 The wider effects of the NDR are considered. The results demonstrate that NDR reduces traffic levels and congestion on orbital roads, the Outer Ring Road and the radial routes in the north and northeast of Norwich. Journey times along key highway and public transport routes would be significantly reduced through the introduction of NDR. City Centre through traffic would be reduced by the NDR and the complementary measures leading to traffic levels inside the Inner Ring Road of below 2012 base.

13.2.11 The high level safety review that was undertaken demonstrates that 62 (70%) out of the identified 89 accident cluster sites are predicted to experience lower flows due to NDR, which is considered likely to have an overall beneficial effect given the established relationship between traffic flow levels and accident risk.

13.2.12 Construction traffic impacts are unlikely to be severe and a range of mitigation measures will assist in reducing any temporary impacts to acceptable levels.

13.2.13 Overall, the NDR scheme would deliver benefits in terms of improving highway conditions in Norwich overall and meet the relevant policy objectives without creating any unacceptable effects.

14 Glossary

AADT	Annual Average Daily Traffic
AM	Morning Peak Period
ARCADY	Assessment of Roundabout Capacity And DelaY
COBA	Cost Benefit Analysis
DCO	Development Consent Order
DfT	Department for Transport
DM	Do Minimum
DoS (%)	Degree of Saturation (%)
DS	Do Something
EEP	East of England Plan
EHO	Environmental Health Officer
ES	Environmental Statement
GNDP	Greater Norwich Development Partnership
GVA	Gross Value Added
HA	Highways Agency
HGV	Heavy Goods Vehicle
IEMA	Institute of Environmental Management & Assessment
IRR	Inner Ring Road
JCS	Joint Core Strategy for Greater Norwich
LDF	Local Development Framework
LGV	Light Goods Vehicle
LinSig	Linear Signal Analysis

LLP	Limited Liability Partnership
LMVR	Local Model Validation Report
LNG	Liquidised Natural Gas
LSTF	Local Sustainable Transport Fund
LTP	Local Transport Plan
MM	Mott MacDonald
NATS	Norwich Area Transportation Strategy
NCC	Norfolk County Council
NCN (Route 1)	National Cycle Network
NDR	Norwich Northern Distributor Road
NMUs	Non-Motorised Users
NPPF	National Planning Policy Framework
NSIPs	Nationally Significant Infrastructure Projects
ORR	Outer Ring Road
P&R	Park & Ride
PCU	Passenger Car Units
PIC	Personal Injury Collision
PICADY	Priority junction CApacity and DelaY
PMA	Proposed Private Means of Access
PPG/PPS	Planning Policy Guidance/ Planning Policy Statement
PRC	Practical Reserve Capacity
PRoW	Public Rights of Way
PM	Evening Peak Period
RFC	Ratio of Flow to Capacity

RTF 2013	Road Transport Forecasts 2013
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SWMP	Site Waste Management Plan
T	Trunk Road
TA	Transport Assessment
TEMPRO	Trip End Model Presentation Program
TRICS	Trip Rate Information Computer System
TUBA	Transport User Benefit Appraisal
UEA	University of East Anglia
WITA	Wider Impacts in Transport Appraisal
WebTAG	Department for Transport Analysis Guidance