


Norwich Northern Distributor Road

Major Scheme Business Case
Sensitivity Tests for DfT

Part NNDR from A140 to A47(T)
Volume 1 – Main Report

December 2009
Norfolk County Council

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Summary

The Department for Transport (DfT) asked Norfolk County Council (NCC) to carry out and report on traffic modelling and economic assessment for a scheme comprising part of the Norwich Northern Distributor Route, from the junction with the A140 near Norwich International Airport, to the junction with the A47(T) at Postwick, referred to as the Part NNDR scheme.

The proposed NNDR (Core Scenario) scheme, termed the Full NNDR, runs from the A1067 in the northwest to the A47(T) in the east, while the Part NNDR scheme runs from the A140 in the north to the A47(T) in the east.

This work is in addition to a range of sensitivity tests which have been carried out in order to better understand uncertainties associated with the analysis undertaken for the Major Scheme Business Case for the NNDR.

Full details of the assessment of the Part NNDR from A140 to A47(T), including details of model results, and details of the results of the economic assessment, are given in this report.

The results indicate that, with the Part NNDR scheme, numbers of trips are forecast to generally increase by small amounts compared to the situation without the scheme, by approximately 50 trips in the AM peak in 2031; and lengths of trips are forecast to generally increase by up to 2% in both 2016 and 2031. Total network distance travelled by vehicles, expressed as PCU kilometres, is forecast to increase significantly without the scheme, by up to up to 59% in 2031. With the Part NNDR scheme, additional increases of up to 3% over base year are forecast.

Average speeds are forecast to reduce without the scheme, by up to 16% below base year 2006 speeds in 2031, with maximum reductions occurring in the AM peak period. The Part NNDR scheme is forecast to mitigate these reductions, so that the reduction in the AM peak in 2031 is forecast to be 13%. In the interpeak period in 2031 the average network speed with the Part NNDR scheme is forecast to be 56 km/h; which is almost the same as the average speed of 57 km/h in the base year 2006.

The Part NNDR scheme with associated traffic management measures is forecast to result in a reduction of traffic on most radial links, but increases on some sections of the A147 Inner Ring Road, one section of the A47(T) Southern Bypass, and some sections of radials used to access the new road.

Examination of trip data by sector shows that, in all peaks, the largest increase in the number of trips occurs in the outer sectors of the study area, representing rural areas, and the decrease in demand in Norwich is compensated by the increase in number of trips in the outer sectors.

The Part NNDR Scenario has a positive Cost Benefit Ratio (BCR) of 4.6 which categorises the scheme as “High Value for Money” in accordance with the DfT’s Value for Money guidance. This is significantly lower than the BCR for the Core Scenario of 6.1. The proposed Full NNDR scheme in the Core Scenario extends to the A1067 in the west, bringing additional benefits to traffic in the northwest sector of the network and additional relief to built up areas.

Incremental analysis indicates that the extension to the A1067 represents very high value for money.

1. Introduction

The Norwich Northern Distributor Route (NNDR) scheme promoted by Norfolk County Council (NCC) includes a new highway to the north and east of Norwich, running from the A1067 Fakenham Road to the northwest of Norwich to the A47(T) Yarmouth Road at Postwick to the east. The scheme also includes complementary measures comprising traffic management measures in the city centre and the northern and western suburbs. Their aim is to manage traffic volumes and speeds on the existing highway network, and to benefit sustainable transport modes such as walking, cycling and public transport.

The Department for Transport (DfT) asked NCC to carry out and report on traffic modelling and economic assessment for a shortened scheme, based on that part of the NNDR running from a junction with the A140 near Norwich International Airport, to the junction with the A47(T) at Postwick. This is shown in **Figure A.1** in **Appendix A.**

DfT also asked NCC to carry out a range of sensitivity tests. These included the formulation and testing of a new Core Scenario for the NNDR. The assessment of the curtailed scheme is based on the new Core Scenario, full details of which are given in the Core Scenario report (December 2009).

This report is written for readers familiar with the DfT's Transport Analysis Guidance, including the Expert units.

Numbers and percentages in the report have been rounded to aid clarity of presentation.

The report text, tables, figures and maps can be made available in larger font/ format on request.

2. Do Minimum

The Do Minimum network is identical to that used for the Core Scenario, and is detailed in the Core Scenario report.

Future growth is also identical to that used for the Core Scenario, and is detailed in the Core Scenario report.

3. Do Something

The shortened scheme has been added to the Do Minimum network.

The junction with the A140 has been amended from that in the full NNDR. A sketch plan is shown in **Figure B.1** in **Appendix B.**

The complementary measures for the full NNDR scheme, comprising traffic management measures in the city centre, plus the northern and western suburbs, have been retained with the Part NNDR scheme.

4. Model Results

4.1 Network Wide

All references made to 2016 DS or 2031 DS within the commentary in this section relate solely to results for the Part NNDR. The 2016 DM and 2031 DM situation, without the scheme in place, is identical to that for the Core Scenario. Where results are also shown for the Core Scenario (Full NNDR) in the tables and figures within this section, this is provided for comparison purposes.

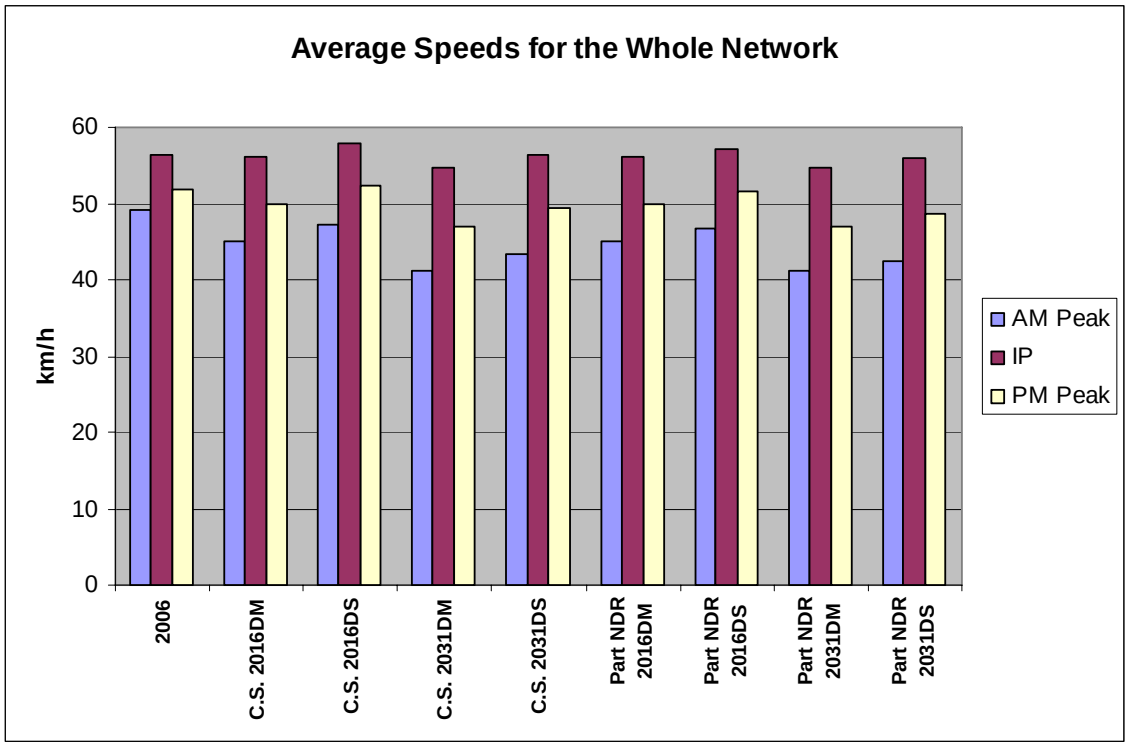
4.1.1 Average Speeds

Table 4.1 contains average speeds over the whole network (in km/h) together with percentage changes in respect to the 2006 base year. A bar chart showing the average speeds for the whole network is presented in **Figure 4.1**.

Table 4.1: Network Average Speeds

Scenario	Year	Average speed (km/h)			% Difference from Base Year		
		AM	IP	PM	AM	IP	PM
Base year	2006	49	57	52	-	-	-
Core Scenario	2016DM	45	56	50	-8%	-1%	-4%
	2016DS	47	58	52	-4%	2%	1%
	2031DM	41	55	47	-16%	-3%	-9%
	2031DS	43	57	49	-12%	0%	-5%
Part NNDR	2016DM	45	56	50	-8%	-1%	-4%
	2016DS	47	57	52	-5%	1%	-1%
	2031DM	41	55	47	-16%	-3%	-9%
	2031DS	43	56	49	-13%	-1%	-6%

Figure 4.1: Average Speeds for the Whole Network



In the 2006 model base year, the average speeds in the AM and PM peaks are around 50km/h, rising to around 57km/h in the interpeak period. The largest decrease in speed from the base year is in 2031 DM in the AM peak, where the speed drops to 41km/h (i.e. a decrease of 16%). In the 2016 DS in the IP, there is an increase in speed of 1km/h from the base year (i.e. an increase of 2%).

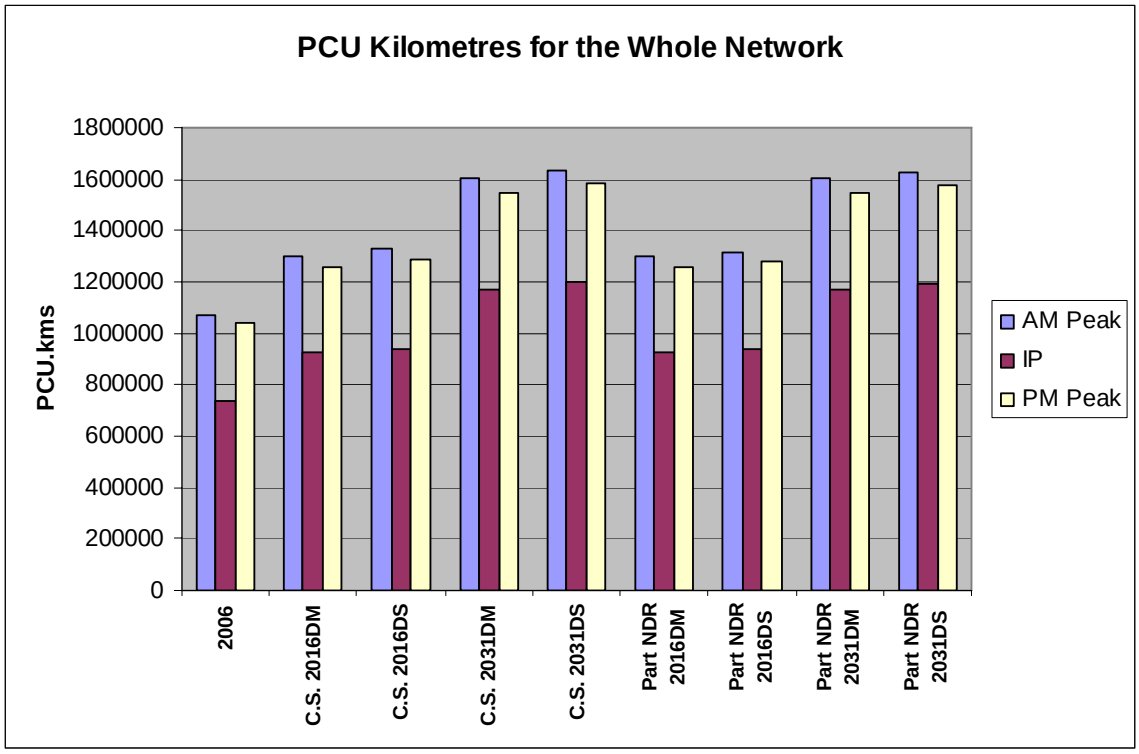
4.1.2 PCU Kilometres and Trip Lengths

Table 4.2 contains PCU.kms over the whole network and **Figure 4.2** shows the same information in a bar chart.

Table 4.2: Network PCU Kilometres

Scenario	Year	PCU.kms			% Difference from Base Year		
		AM	IP	PM	AM	IP	PM
Base year	2006	1068498	738836	1038919	-	-	-
Core Scenario	2016DM	1300040	926560	1257485	22%	25%	21%
	2016DS	1326814	942226	1290247	24%	28%	24%
	2031DM	1606576	1174127	1548240	50%	59%	49%
	2031DS	1636695	1197795	1583278	53%	62%	52%
Part NNDR	2016DM	1300040	926560	1257485	22%	25%	21%
	2016DS	1318463	933110	1280564	23%	27%	23%
	2031DM	1606576	1174127	1548240	50%	59%	49%
	2031DS	1623366	1191321	1575938	52%	61%	52%

Figure 4.2: Network PCU Kilometres



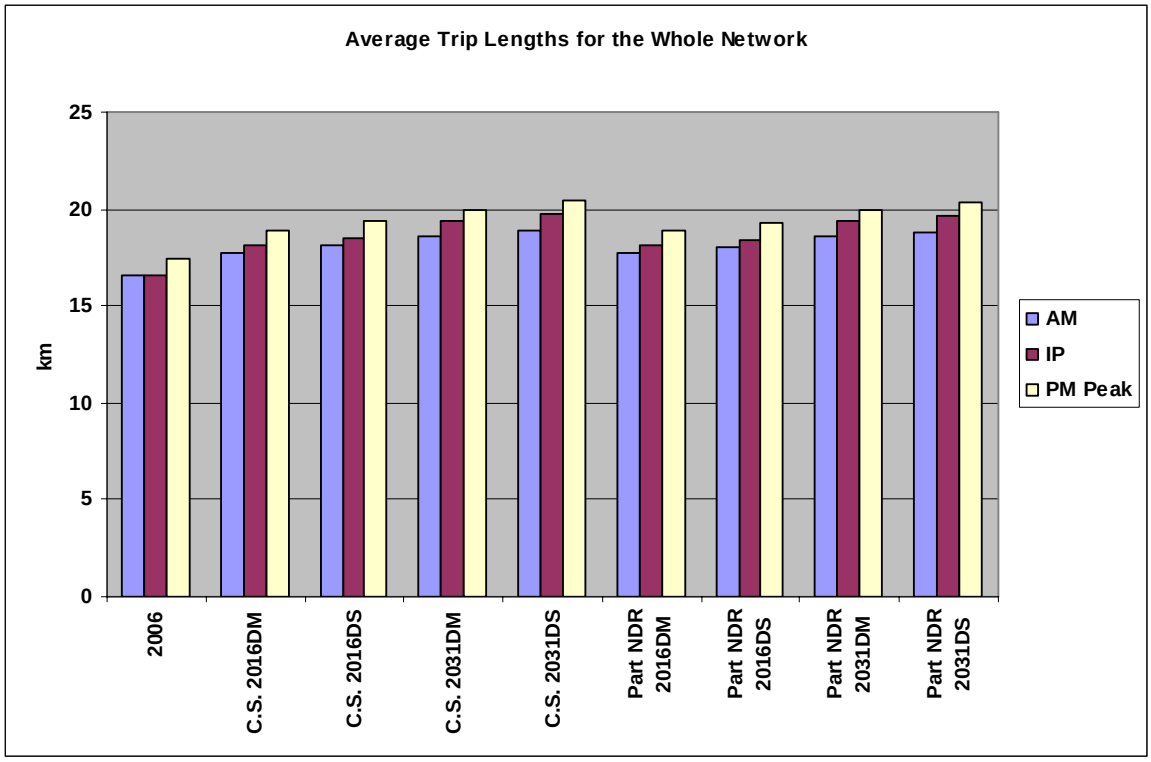
The PCU.kms in all future years increase from the 2006 base year. The largest increases are seen in the 2031 DS scenario: 52% in the PM peak and 61% in the IP. In the 2016 DS, the PCU.kms increase by between 23% in the AM and PM peaks to 27% in the IP. The increase in PCU.kms in the future DM runs are about 3% lower than the DS runs for both 2016 and 2031 forecasting years and in all modelled periods.

Table 4.3 contains average trip lengths (km) over the whole network and **Figure 4.3** shows the average trip lengths for the whole network.

Table 4.3: Network Trip Lengths (km)

Scenario	Year	Average Trip Lengths (km)			% Difference from Base Year		
		AM	IP	PM	AM	IP	PM
Base year	2006	17	17	17	-	-	-
Core Scenario	2016DM	18	18	19	7%	9%	8%
	2016DS	18	18	19	9%	11%	11%
	2031DM	19	19	20	12%	17%	14%
	2031DS	19	20	20	14%	19%	17%
Part NNDR	2016DM	18	18	19	7%	9%	8%
	2016DS	18	18	19	9%	11%	10%
	2031DM	19	19	20	12%	17%	14%
	2031DS	19	20	20	13%	19%	16%

Figure 4.3: Average Trip Lengths for the Whole Network



In the 2006 base year, the average trip length is around 17km in all peaks, which rises to around 18km in the 2016 AM Peak and IP and to around 19km in the PM peak for both the DM and the DS scenarios. In the 2031 DM, the average trip length increases to 19km in the AM peak (i.e. an increase of 12%) and IP (i.e. an increase of 17%) and to 20km (i.e. an increase of 14%) in the PM peak. The corresponding figures for the 2031 DS are 19km, 20km and 20km respectively (i.e. increases of 13%, 19% and 16%).

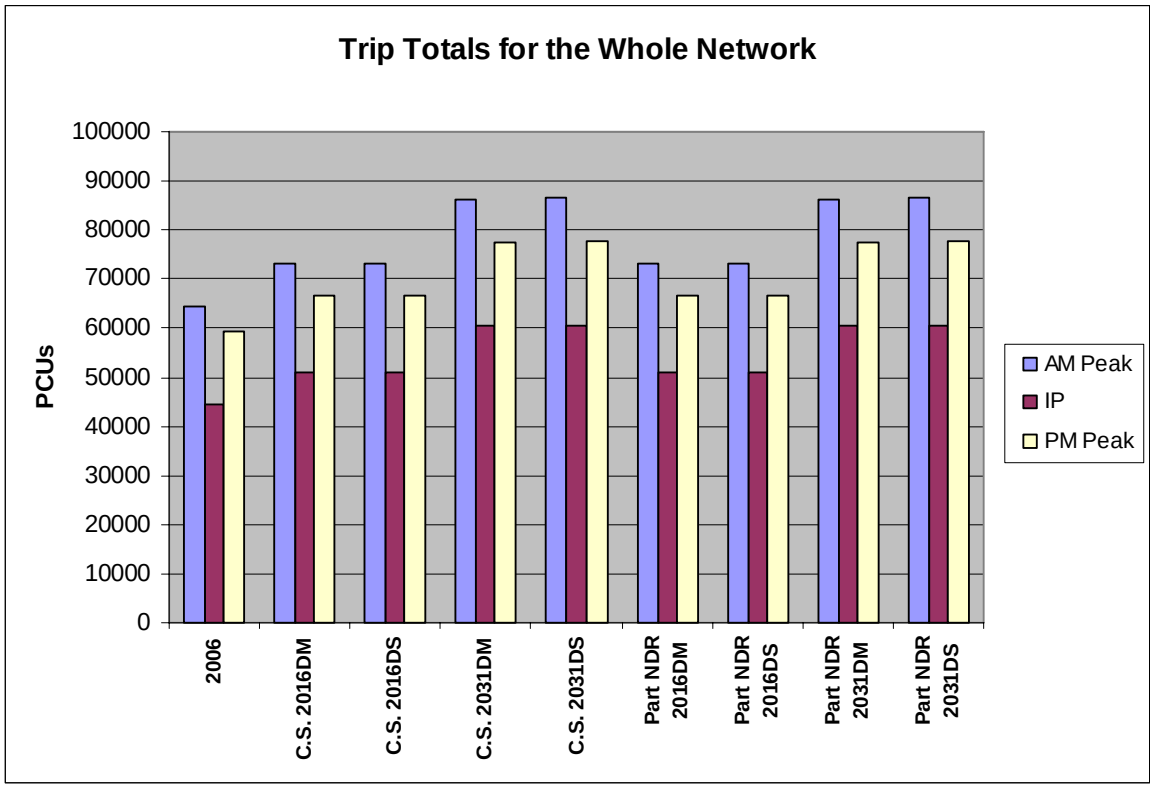
4.1.3 Total Trips

Table 4.4 contains total trips (in PCUs) over the whole network and **Figure 4.4** shows the trip totals for the whole network.

Table 4.4: Summary of Trip Totals (PCUs)

Scenario	Year	Total Trips (PCUs)			% Difference from Base Year		
		AM	IP	PM	AM	IP	PM
Base year	2006	64480	44560	59441	-	-	-
Core Scenario	2016DM	73174	51040	66518	13%	15%	12%
	2016DS	73229	51035	66558	14%	15%	12%
	2031DM	86346	60587	77563	34%	36%	30%
	2031DS	86414	60578	77599	34%	36%	31%
Part NNDR	2016DM	73174	51040	66518	13%	15%	12%
	2016DS	73211	51032	66556	14%	15%	12%
	2031DM	86346	60587	77563	34%	36%	30%
	2031DS	86400	60576	77608	34%	36%	31%

Figure 4.4: Trip Totals for the Whole Network



In the 2006 base year, the trip totals are 64,480, 44,560 and 59,441 for the AM peak, IP and the PM peak respectively. This shows that in the base year, the AM peak had the largest amount of traffic. The same pattern is true for future scenarios. In the 2016 AM peak, the trip totals increase from base year to 73,174 (i.e. an increase of 13%) in 2016 DM and to 73,211 (i.e. an increase of 14%) in 2016 DS. The corresponding figures for the 2031 DM and DS runs are 86,346 (i.e. an increase of 34%) and 86,400 (i.e. an increase of 34%).

4.2 Links

4.2.1 Traffic Flows

Traffic flows for the AM, IP and PM periods in the 2006 base year and the forecast years 2016 and 2031 are shown for selected key roads in **Tables C.1** and **C.2** of **Appendix C** and their locations are shown on a map in **Figure C.1**. Differences between traffic flows forecast for the DM and DS are also shown.

The Part NNDR from A140 to A47(T) is forecast to generally have relatively small effects on traffic flows on the A1067 through Taverham in both 2016 and 2031 forecasting years, with the exception of the interpeak period in 2016 where an increase of 167 PCUs above the Do Minimum, representing some 11%, is forecast. This is a significant difference from the full NNDR, including the link from the A1067 to the A140, which is forecast to result in large traffic reductions through Taverham.

As for the full scheme, the Part NNDR is forecast to result in significant increases in traffic flows on the A147 Inner Ring Road (IRR) in the southeast quadrant. In 2016, the introduction of the Part NNDR causes an increase of 411 PCUs in the PM peak, 442 PCUs in the IP and 648 PCUs in the PM peak over the Do Minimum levels for the same year. The corresponding figures for the 2031 forecasting year are 217, 477 and 628 respectively. Increases are also forecast on the A47(T) Southern Bypass in the southeast quadrant in the IP and PM peak periods, of up to 704 PCUs in the 2031 PM peak over the Do-Minimum levels.

Overall, the Part NNDR scheme with associated traffic management measures is forecast to result in a reduction of traffic on many radial links, but with the exception of the A1067 (which would be relieved by the full NNDR). As for the full scheme, the Part NNDR is forecast to result in increases on some sections of the A147 IRR, one section of the A47(T) Southern Bypass, and some sections of radials used to access the new road. Increases on the IRR are assumed to result from the city centre traffic management measures. Increases on the A47(T) Southern Bypass are assumed to result from north/south movements using the eastern section of the NNDR.

4.3 By Sector

4.3.1 Trips

Tables D.1 to **D.33** contain trip totals by sector for the 2006 base year and for the forecasting years 2016 and 2031. **Figure D.1** shows NATS model sectors.

In the 2006 base year, trip totals for the AM peak, IP and the PM peak are 64,526 PCUs, 44,680 PCUs and 59,501 PCUs respectively (see **Table D.1** to **D.3**). In the 2016 DM reference case (i.e. pre-DIADEM), the number of trips increases to 74,120, 51,262 and 67,190 respectively (see **Tables D.4** to **D.6**). The DM trip totals (i.e. post-DIADEM) are 73,258, 51,074 and 66,596 (see **Tables D.7** to **D.9**).

Tables D.10 to **D.12** show the differences in trip totals by sector between the pre-DIADEM (i.e. reference case) and post-DIADEM in the 2016 DM. In all peaks, the largest increases in the number of trips occur in the outer sectors of the study area, representing rural areas. The decrease in demand in Norwich is compensated by the increase in number of trips in the outer sectors. The same pattern is repeated for the 2016 DS scenario (see **Tables D.25** to **D.27**).

Tables D.13 to **D.15** show the 2031 Reference Case and **Tables D.16** to **D.18** show the DM trip totals (i.e. post DIADEM). The differences between the two scenarios (i.e. post-DIADEM minus pre-DIADEM) are shown in **Tables D.19** to **D.21**. As in the 2016 DM forecasting year, in 2031 DM, the largest increases in the number of trips occurs in the outer sectors of the study area, representing rural areas. The decrease in

demand in Norwich is compensated by the increase in number of trips in the outer sectors. The same pattern is repeated for the 2031 DS scenario (see **Tables D.31** to **D.33**).

Tables D.25 to **D.27** show the differences in trip totals by sector between the 2016 DS and the Reference Case and **Tables D.31** to **D.33** show the same results for the 2031 forecasting year. As for the DM scenario, in all peaks, the largest increase in the number of trips occurs in the outer sectors of the study area, representing rural areas, and the decrease in demand in Norwich is compensated by the increase in number of trips in the outer sectors.

4.3.2 PCU Kilometres

Information on PCU kilometres is shown in **Tables E.1** to **E.27**.

In the 2016 DM in the AM peak, the PCU.kms have increased in the range of 6% to 43% from the base year (see **Table E.7**). In the 2031 DM during the same period, these increases are in the range of 22% to 86% (see **Table E.13**). In the 2016 DM IP, increases in PCU.kms from the base year range between 5% and 42% (see **Table E.8**) and in 2031 the range varies between 24% and 104% (see **Table E.14**). For the 2016 DM PM peak, increases in PCU.kms vary from the base year vary by between 3% to 37% (see **Table E.9**) and in the 2031 forecasting year, the range varies between 21% to 89% (see **Table E.15**).

In the 2016 DS in the AM peak, the PCU.kms are increased in the range of 5% to 47% from the base year (see **Table E.19**) and in the 2031 DS during the same period, the increases in PCU.kms are in the range of 21% to 86% (see **Table E.25**) . In the 2016 DS IP, increases in PCU.kms from the base year are in the range of 5% to 42% (see **Table E.20**) and in 2031 the range is between 23% and 105% (see **Table E.26**). In the 2016 DS PM peak, the PCU.kms vary between -1% to 38% from the base year (see **Table E.21**) and in 2031 the range varies between 17% and 89% (see **Table E.27**).

5. Economics

5.1 Economic Assessment

Economic assessment has been carried out in accordance with DfT advice in TAG Unit 3.5 The Economy Objective. The cost benefit analysis was carried out using the DfT's Transport Users Benefit Appraisal Software TUBA (v1.7c) using vehicle / passenger trips, trip distance and trip time matrices from the SATURN highway and VISUM Public Transport (PT) models.

The assessment has been carried out in accordance with the assessment of the Core Scenario, and for the same assessment period of 2016 to 2075.

5.2 Costs

Costs of the Part NNDR from A140 to A47(T) were supplied by Norfolk County Council, as was the Quantified Risk Assessment (QRA). These were allocated to spend years. Optimism bias of 25% was applied.

Costs at 2009 Q3 levels are in **Table 5.1**.

Table 5.1: Part NNDR costs at 2009 Q3 levels

Year	Works	QRA	Land (inc fees)	Development, management & supervision
2009/10	£2,696,938	£399,548	£972,820	£2,718,000
2010/11	£15,025,598	£2,018,322	£1,000,000	£1,060,000
2011/12	£2,838,711	£429,144	£500,000	£1,000,000
2012/13	£4,731,186	£715,241	£1,200,000	£500,000
2013/14	£22,187,629	£3,354,233	£3,935,000	£1,000,000
2014/15	£22,284,587	£3,331,127	£7,100,000	£1,000,000
2015/16			£1,000,000	
Total	£69,764,649	£10,247,615	£15,707,820	£7,278,000
				£102,998,084
			Total	

Additional costs for complementary traffic management measures in the city centre and northern and western suburbs (£1.7m) and for an extension to the Park and Ride site at Postwick (4.1m) have been included.

Inflation has been treated in the same way as for the Core Scenario. Costs for future maintenance have been derived in accordance with those for the MSBC, but based on the revised programme and revised scheme extent.

5.3 Results – Summary

The results are summarised below in **Table 5.2**. The TUBA Transport Economic Efficiency (TEE), Public Accounts and Analysis of Monetised Costs and Benefits (AMCB) tables are presented in **Table F.1** in **Appendix F**.

Table 5.2: Part NNDR from A140 to A47(T) Economic Assessment Summary

Scenario	Present Value of Benefits (PVB, £m)	Present Value of Costs (PVC, £m)	Net Present Value (NPV, £m)	Benefit / Cost Ratio (BCR)
Part NNDR	397.374	86.762	310.612	4.6
Core Scenario	533.724	87.172	446.552	6.1

The Part NNDR from A140 to A47(T) has a positive Benefit Cost Ratio (BCR) of 4.6 which categorises the scheme as "High Value for Money" in accordance with the DfT's Value for Money guidance. The BCR for the Core Scenario is included above to aid comparison.

5.4 Incremental Analysis

An incremental analysis has been carried out in accordance with the DfT's Design Manual for Roads and Bridges (DMRB) Volume 13 Section 1 Part 3 Chapter 2 'Economic Assessment of Road Schemes'. The results are shown in **Table 5.3**.

Table 5.3: Incremental Analysis

Scenario	Present Value of Benefits (PVB, £m)	Present Value of Costs (PVC, £m)	Net Present Value (NPV, £m)	Benefit / Cost Ratio (BCR)
Part NNDR	397.374	86.762	310.612	4.6
Core Scenario	533.724	87.172	446.552	6.1
Incremental: Core Scenario – Part NNDR	136.350	0.410	135.940	332.6

The results of the incremental analysis indicate that the inclusion of the section of scheme from A140 to A1067 represents very high value for money.

5.5 Results by Sector

TUBA sectors are illustrated in **Figure F.1** in **Appendix F**. Time benefits by sector of origin are given in **Table F.2** in **Appendix F**. The sector benefits as a percentage are shown in **Table F.3** in **Appendix F.** These indicate that there are significant disbenefits associated with the city centre traffic management measures (Sector 1).

Relatively low benefits are associated with the urban area inside the Outer Ring Road to the south-west, south-east and north-east (Sectors 2 to 4), the suburban area to the south-east (Sector 8) and the south west (Sector 7), and the external sector representing the rest of the UK (Sector 18).

A medium of level of benefits is found for the north-west urban area inside the Outer Ring Road (Sector 5), the suburban area stretching around Norwich from the south-west to the north-east (Sectors, 6, 10 and 11) and for the rural areas to the north and south-east (Sectors 12, 15).

Relatively high benefits are associated with the suburban area to the east of Norwich (Sector 9) as well as the rural areas to the west and north-west (Sectors 13 and 14) and to the north-east (Sector 16 and 17).

5.6 TUBA Warning Messages

For further details see **Appendix G**.

6. Conclusions

A Part NNDR from the A140 to the A47(T) has been assessed along with a revised Core Scenario. The Do Minimum situation, without the scheme in place, is identical to that for the Core Scenario.

The Do Something situation, with the scheme, includes the NNDR highway from the A140 to the A47(T) plus associated complementary traffic management measures. The section of the full NNDR scheme from the A1067 to the A140 has been omitted and the junction with the A140 has been amended as illustrated in **Figure B.1** in **Appendix B**. The complementary traffic management measures have been included as for the Core Scenario.

Model runs have been carried out using the transport model and methods used for work for the NNDR MSBC, with Variable Demand Modelling in accordance with DfT's TAG advice.

The results indicate that, without the Part NNDR scheme, numbers and lengths of trips are forecast to increase in future, by up to 36% and 17% respectively above base year 2006 values in 2031. With the Part NNDR scheme, numbers of trips are forecast to generally increase by small amounts compared to the situation without the scheme, by approximately 50 trips in the AM peak in 2031; and lengths of trips are forecast to generally increase by up to 2% in both 2016 and 2031. Total network distance travelled by vehicles, expressed as PCU kilometres, is forecast to increase significantly without the scheme, by up to up to 59% in 2031. With the Part NNDR scheme, additional increases of up to 3% over base year are forecast.

Average speeds are forecast to reduce without the scheme, by up to 16% below base year 2006 speeds in 2031, with maximum reductions occurring in the AM peak period. The Part NNDR scheme is forecast to mitigate these reductions, so that the reduction in the AM peak in 2031 is forecast to be 13%. In the interpeak period in 2031 the average network speed with the Part NNDR scheme is forecast to be 56 km/h; which is almost the same as the average speed of 57 km/h in the base year 2006.

The proposed part NNDR scheme with associated traffic management measures is forecast to result in a reduction of traffic on most radial links, but increases on some sections of the A147 Inner Ring Road, one section of the A47(T) Southern Bypass, and some sections of radials used to access the new road.

Economic assessment of the Part NNDR scheme indicates that disbenefits associated with the city centre traffic management measures are forecast. However, these are forecast to be greatly outweighed by significant benefits associated with the suburban areas to the north, and the rural areas to the east, north and west.

The Part NNDR Scenario has a positive Cost Benefit Ratio (BCR) of 4.6 which categorises the scheme as "High Value for Money" in accordance with the DfT's Value for Money guidance. This is significantly lower than the BCR for the Core Scenario of 6.1. The proposed Full NNDR scheme goes as far as the A1067 bringing in additional benefits to the traffic wishing to reach the North West sector of the network.

The results of the incremental analysis indicate that the inclusion of the section of scheme from A140 to A1067 represents very high value for money.