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

5.12 Traffic and Economic Appraisal of NDR Alternatives

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1 Key Summary

1.1.1 Funding approval for the Norwich Northern Distributor Road (NDR) was sought in 2011 through the Department for Transport's (DfT) Development Pool process. A business case was developed and submitted in accordance with the guidance in the Treasury Green Book. Ministerial decisions were made in December 2011 to award funding.

1.1.2 The NDR is a project of national significance which requires a Development Consent Order (DCO) under the Planning Act 2008. The submission was made in January 2014.

1.1.3 The Transport Assessment for the Scheme is set out in submission Document Ref. 5.5. This included an operational assessment of the Scheme design with traffic forecasts based on the full implementation of JCS, as set out in the Traffic Forecasting Report Document Ref. 5.6. The forecasts were based on the transport model described in the Highway and Public Transport Local Model Validation Reports (Document Refs. 5.9 and 5.10). The transport assessment concluded that the Scheme design is considered to be the best possible balance between relieving the existing network whilst ensuring acceptable conditions on this new part of the network.

1.1.4 The Economic Appraisal Report (Document Ref. 5.7) shows that the Scheme would deliver very high value for money (VfM), the Benefit Cost Ratio (BCR) value exceeding 4, according to DfT's VfM criteria. In addition the Land Use and Economic Development Report (Document Ref. 10.3) sets out the substantial benefits of jobs, GVA and infrastructure investment that the Scheme would help to bring to the City.

1.1.5 Traffic and economic assessments for four of the Alternatives listed in Section 3.10.13 of the Environmental Statement (Document Ref 6.1) have been carried out using the latest version of the Transport Model (Alternative 4 was not tested as its traffic impacts and economic appraisal would be very similar to the DCO Scheme). These assessments provide comparative quantitative information on the same basis as that provided for the Scheme in the Traffic Forecasting Report (Document Ref 5.6) and the Economic Appraisal Report (Document Ref 5.7). The results assessments are presented in this report.

1.1.6 **The DCO Scheme** delivers a BCR of 4.17 (inclusive of accident benefits) and a BCR of 5.33 when WEBs and JTR are included. Both of these represent very high value for money (BCR above 4) according to DfT's VfM criteria.

1.1.7 **Alternative 1** (single carriageway NDR) provides the required transport connections, but the lower standard means that there would be a poorer operational performance compared with the DCO Scheme. The forecast traffic flows on a number of the single carriageway links are forecast to be substantially higher than the economic flow range upper limit in TA46/97 of 13,000 AADT for a single carriageway road in the opening year. This reduces the attractiveness of the route for some journeys so that there is less relief of existing routes. The analysis shows less relief on inappropriate routes and for cross city traffic using the Outer Ring Road. The economic appraisal shows a much lower level of benefits than the DCO Scheme resulting in a BCR of 2.42 with accidents and 2.67 with JTR benefits and WEBs included.

1.1.8 **Alternative 2** (dual carriageway NDR between Postwick Junction and A140) will not provide the connectivity for journeys west of the A140 and thus will not relieve roads and communities to the west of the A140. In some cases there would be traffic increases, especially on a minor road Hall Lane between the A140 Cromer Road junction and the A1067 which is an inappropriate route for the forecast increases in traffic. The economic appraisal shows a lower level of benefits than the DCO Scheme due to the lack of improved transport connections west of the A140 with a BCR of 3.81 including accidents. The benefits are increased with the inclusion of JTR and WEBs to give a BCR of 4.11, but the level of these additional benefits is much lower than calculated for the DCO Scheme due to the poorer connectivity provided by the Alternative.

1.1.9 **Alternative 3** (single / dual carriageway NDR) provides the required transport connections, but the lower standard west of the A140 Cromer Road means that there would be a poorer operational performance compared with the DCO Scheme. The forecast traffic flow on the Holt Road – Cromer Road single carriageway link is forecast to be substantially higher than the economic flow range upper limit in TA46/97 of 13,000 AADT for a single carriageway road in the opening year. This together with the A140 at grade junction reduces the attractiveness of the route for some journeys so that there is less relief of existing routes. The analysis shows less relief on inappropriate routes in the northwest sector. The economic appraisal shows a lower level of benefits than the DCO Scheme resulting in a BCR of 3.68 with accidents and 4.84 with JTR benefits and WEBs included.

1.1.10 **Alternative 5** (developer link roads) singularly fails to reduce traffic on inappropriate routes and relieve the existing network. Whilst the Alternative includes the city centre traffic management measures the reductions of cross

city centre traffic are much smaller compared with the DCO Scheme, especially for trips crossing the Outer Ring Road Cordon. The junction analyses show that North Walsham Road and Wroxham Road junctions would operate substantially over their theoretical capacity with long queues and delays, with delays of over 10 minutes at North Walsham Road Junction in the 2032 AM peak and 5 minutes in the 2032 PM peak. On these grounds the developer link roads would not operate satisfactorily and they would cause particularly severe difficulties in implementing the proposed shared use high street-type design envisaged in the development proposals. The delays would also mean that the Alternative would fail to meet the improved transport connectivity objective for the Scheme. The economic appraisal results highlight that the performance of Alternative 5 is especially poor and does not offer good value for money. The Alternative produces economic disbenefits as any benefits of the extended link roads are outweighed by the reduced performance due to overcapacity and due to the effects of introducing city centre traffic management measures without significant traffic relief being provided by the Alternative. The calculated BCR is -11.42 with accidents included and even worse with JTR and WEBs giving -20.34 although the BCR is not a meaningful term when the benefits are negative.

1.1.11 The table below provides a summary of the economic appraisal results.

Scenario	Brief Description	BCR (including accidents)	BCR (also including WEBs and JTR)
DCO Scheme		4.17	5.33
Alternatives			
Alternative 1	Single carriageway NDR	2.42	2.67
Alternative 2	NDR terminating at A140	3.81	4.11
Alternative 3	Dual NDR to A140 and single west of A140	3. 68	4.84
Alternative 5	Developer links extending in place of NDR	-11.42	-20.34

Notes: A detailed description of Alternatives can be found in DCO Document Reference 6.1

1.1.12 In addition to the Alternatives tested, an option comprising significant improvements to public transport provision has been appraised, and details of this are presented in Appendix B. The results indicate that such an option would not meet the Scheme objectives or deliver good value for money. The calculated BCR is -34.42 with accidents included and even worse with JTR and WEBs giving -46.22, although the BCR is not a meaningful term when the benefits are negative.

2 Introduction

2.1 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(T) Trunk Road 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 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 reference 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 Ref. 2.6, whilst the full needs case for the NDR is explained in the Statement of Reasons (Document Ref. 4.1) and the Environmental Statement (Document Ref. 6.1).

2.1.5 Funding approval for the NDR was sought in 2011 through the Department for Transport's (DfT) Development Pool process. A business case was developed and submitted in accordance with the guidance in the Treasury Green Book. Ministerial decisions were made in December 2011 to award funding.

2.1.6 The NDR DCO submission was submitted on 8th January 2014 and has been accepted for examination by the planning inspectorate on 4th February 2014.

2.2 Purpose and Layout of Report

2.2.1 This report provides traffic and economic assessments for four of the Alternatives listed in Section 3.10.13 of the Environmental Statement (Document Ref 6.1). The assessments have used the latest version of the Transport Model and comparative quantitative information is set out on the

same basis as that provided for the Scheme in the Traffic Forecasting Report (Document Ref 5.6) and the Economic Appraisal Report (Document Ref 5.7).

2.2.2 The report sets out to provide:

- A review of the traffic impact of the Alternative and, where appropriate, operational assessments.
- An assessment of the safety impact using COBA.
- An assessment of economic benefits for consumer and business users from Alternatives based on the variable demand model (VDM) forecasts and the likely expenditure profile during the assessment period where appropriate.
- An assessment of the scheme Value for Money (VfM) under these Alternatives based on the corresponding VDM model outputs and the latest available costs of the Alternatives. The Guidance on Value for Money describes the criteria used to determine the VfM of various types of schemes.

2.2.3 The methodology used to produce the economic appraisal is described in detail in DCO submission Document Ref. 5.7. This methodology was retained for these Alternative tests.

2.2.4 This report contains the following sections after the current introductory section:

- Section 3 – describes the methodology and the details of the Alternatives;
- Section 4 – contains scheme costs of Alternatives;
- Section 5 to 8 – includes traffic, operational, safety and economic assessment results of each Alternative assessed;
- Section 9 – presents conclusions from the Alternative appraisals.

2.2.5 Supporting information is included in Appendices in Section 10. Appendix B contains the results for the assessment of an option that includes significant improvements to public transport provision.

2.2.6 Sections 11 and 12 contain Abbreviations and Glossary.

3 Methodology and Description of Alternatives

3.1 Methodology

3.1.1 The DCO submission appraisal was based on an updated NATS transport model rebased to 2012 with variable demand forecasts for the NDR proposed opening year of 2017 and design year of 2032. The forecasts assumed full JCS growth both with and without the Scheme. The DCO Scheme comprised both NDR and Postwick.

3.1.2 For this testing of the Alternatives the same transport model and forecast assumptions were used as applied to the appraisal of the DCO Scheme in the submission.

3.1.3 For each Alternative economic and safety appraisals have been carried out. As with the DCO submission, the economic appraisal calculates TUBA benefits, wider economic benefits (using WITA) and journey time reliability benefits. Safety appraisal was based on COBA.

3.1.4 The costs of the Alternatives are shared between local authority, central government and private sector as appropriate depending on the Alternative.

3.1.5 In addition a review of traffic impacts of each Alternative has been carried out and, where appropriate, operational assessment of key junctions has been undertaken. Analysis of cross city traffic has been undertaken for the two cases where this would be most affected, for Alternatives 1 and 5.

3.1.6 The following assumptions are made for the analysis of all the Alternatives:

- The Do Minimum for each Alternative will be identical to that for the DCO submission.
- All Alternative schemes include Postwick and the proposed city centre measures.
- All assignments are based on full JCS traffic as reference demand.
- Each Alternative will be subject to variable demand modelling so the reference demand will be adjusted according to the forecast travel costs due to each Alternative.

3.2 Alternatives to the DCO Scheme

3.2.1 Alternatives to the DCO Scheme have been examined and more details on these can be found in Document Reference 6.1. Table 3.1 summarises key assumptions and the appraisal required; the Alternative numbering system corresponds with Document Reference 6.1.

Table 3.1: Summary of Requirements – Alternatives to the DCO Scheme

Alternative	Modelling required	Appraisal required
Alt1 – single carriageway standard along the entire DCO alignment	Coding DS highway network and running through demand model for 2017 and 2032	Economic and safety appraisal. Traffic forecast changes with DCO Operational assessment of key junctions
Alt2 – NDR terminating at A140	Coding DS highway network and running through demand model for 2017 and 2032	Economic and safety appraisal. Traffic forecast changes with DCO Operational assessment of key junctions
Alt3 – NDR dual carriageway to A140 then single carriageway west of A140	Coding DS highway network and running through demand model for 2017 and 2032	Economic and safety appraisal. Traffic forecast changes with DCO Operational assessment of key junctions
Alt 4 – Single carriageway NDR between Fir Covert Road and A1067	This Alternative is a relatively small change from the DCO Scheme and therefore has not been retested.	-
Alt5 – Developer link roads extending to A140 in place of NDR	Coding DS network and running through demand model for 2017 and 2032	Economic and safety appraisal. Traffic forecast changes with DCO Operational assessment of key developer junctions

3.2.2 Document Reference 6.1 contains plans of the highway Alternatives and indicative diagrams are shown in the AADT diagrams in the Appendices to this report.

4 Costs of Alternatives

4.1.1 The costs for the Alternatives have been provided by NCC and are summarised in Table 4.1 below. Costs for Alternatives 1, 2 and 3 are allocated to central and local governments while the costs for Alternative 5 are allocated to local government and private sector. It is assumed that developer links will be adopted by the local highway authority once completed, hence maintenance and operation costs will pass to the local authority.

Table 4.1: Summary Costs of Alternatives

Cost type	Cost (£m) in 2013Q1 prices				
	DCO Scheme	Alt1	Alt2	Alt3	Alt5
Investment costs					
Construction	110.2	90.4	82.3	102.8	37.7
Land	22.0	19.4	14.7	20.7	2.4
Preparation	7.8	9.0	8.2	10.3	3.8
Supervision	1.3	1.1	1.0	1.2	0.4
Total investment Cost	141.3	119.9	106.2	135.0	44.3
Other costs					
Maintenance	27.8	12.3	16.8	20.7	5.5
Operation	15.9	15.2	10.9	15.2	1.4

Notes: These are initial costs before adjusting for construction price inflation and optimism bias
.

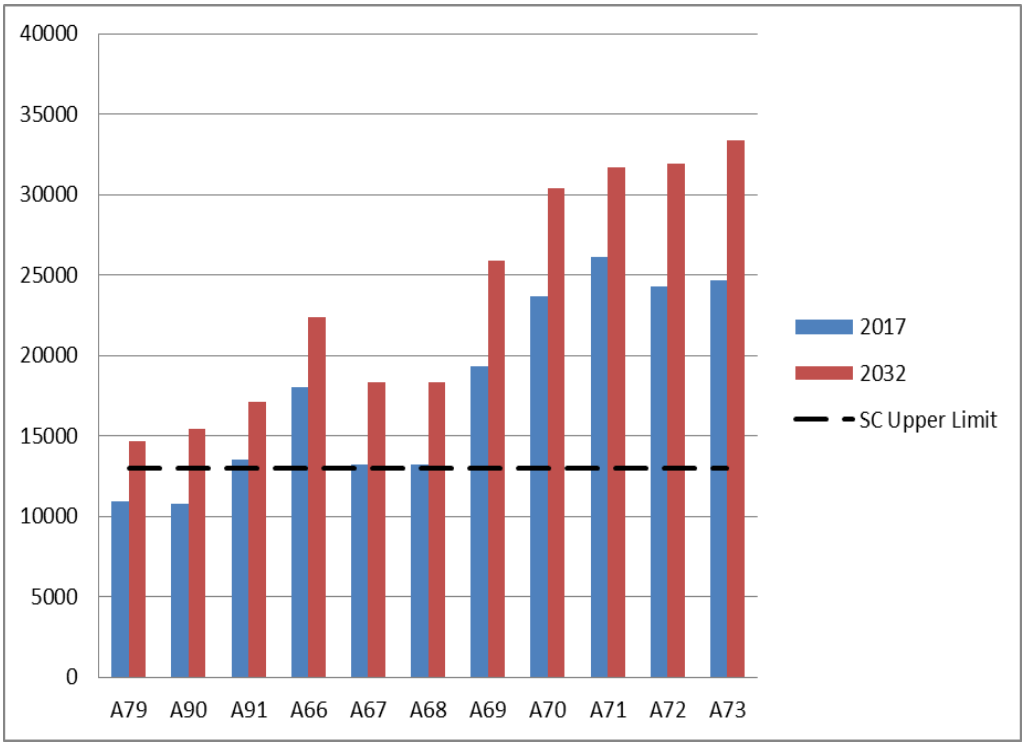
4.1.2 Costs were adjusted as per Document Reference 5.7 before inputting into TUBA. It should also be noted that the profiles of costs in calendar years input into TUBA for all the Alternatives were derived by assuming a similar proportionate profile to that used for the DCO scheme.

5 Traffic and Economic Assessment Results for Alternative 1 (single carriageway NDR)

5.1 Traffic Analysis Results

5.1.1 Figure 5.1 shows the forecast AADTs for the single carriageway sections of Alternative 1 between locations A79 and A72, as well as for the Postwick business park link A73 which is a dual carriageway standard.

Figure 5.1: Alternative 1 AADT on Online Sections



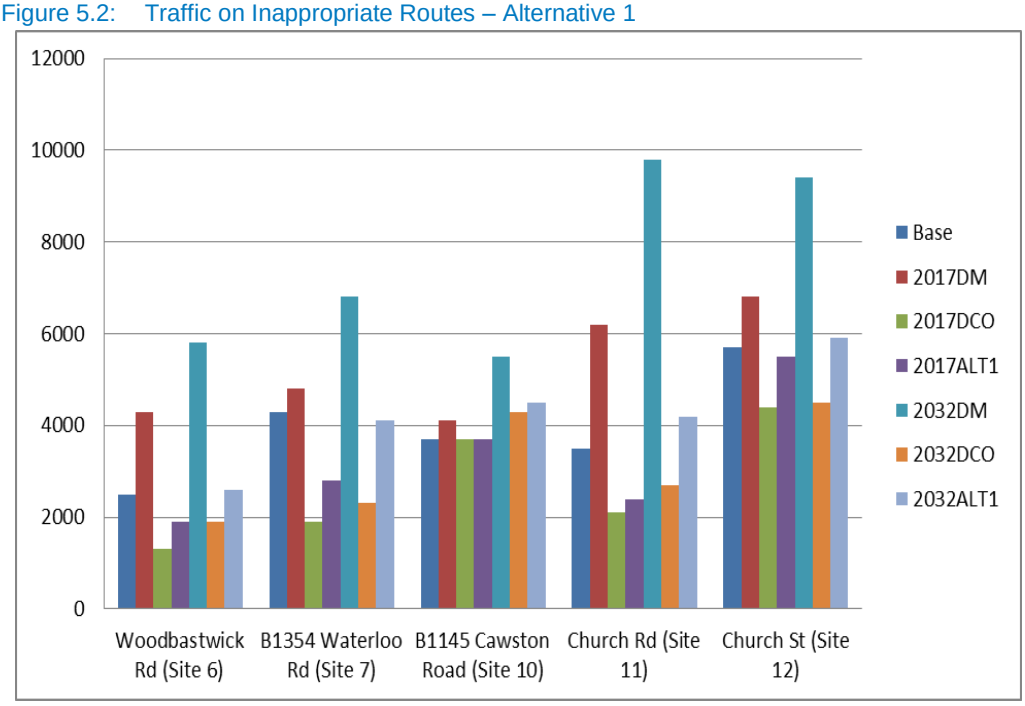
Notes: A79: Fakenham Road - Fir Covert Road Link, A90: Fir Covert Road - Reepham Road Link, A91: Reepham Road - Holt Road Link, A66: Holt Road - Cromer Road Link, A67: Cromer Road - Airport Link, A68: Airport - North Walsham Road Link, A69: North Walsham Road - Wroxham Road Link, A70: Wroxham Road - Salhouse Road Link, A71: Salhouse Road - Plumstead Road Link, A72: Plumstead Road - Postwick Hub Link and A73: Postwick Hub - A47 Link.

5.1.2 The traffic forecasts for the Alternative 1 online sections vary between 10,900 AADT at the western end (at the A1067) and 24,700 towards the eastern end (at Postwick/the A47) in the opening year of 2017. Most of the sections contain traffic flows close to or higher than the economic flow range upper limit in TA46/97 of 13,000 AADT for a single carriageway road in the opening year. Whilst Alternative 1 will meet the transport connections objective, the lower standard means that there would be a poorer operational performance

of Alternative 1 compared with the DCO scheme due to over capacity of the single carriageway and thus reduced attractiveness, so that a proportion of traffic will remain on the existing network. A significant traffic increase (an average increase of 1/3 of the 2017 AADT level) is also forecast between 2017 and 2032 and all the sections would have a poorer operational performance in 2032.

5.1.3 Figure 5.2 shows traffic levels on inappropriate routes with Alternative 1.

Figure 5.2: Traffic on Inappropriate Routes – Alternative 1



5.1.4 This shows that Alternative 1 is not capable of reducing traffic levels at these locations to the same degree as the DCO Scheme. The Woodbastwick Road and Church Road routes are, for example, forecast to have reductions in two way AADT flows of 2,400 (56%) and 3,800 (61%) respectively in 2017 in comparison with the traffic flows that would otherwise occur in the 'Do Minimum' scenario. In 2032 the reduction is 3,200 (55%) and 5,600 (57%) respectively. In the DCO scenario the reductions would be higher at these two sites: 3,000 (70%) and 4,100 (66%) in 2017 and 3,900 (67%) and 7,100 (72%) in 2032 respectively.

5.1.5 Table 5.2 below shows city centre through traffic across three cordons. More details on these cordons can be found in Document Reference 5.6. The table shows that traffic crossing the city centre Inner Ring Road cordons is reduced

by a similar degree with Alternative 1 compared with the DCO Scheme. This is achieved by the combination of the city centre measures that are assumed to be implemented in both cases as well as the NDR route providing relief for strategic through movements. However the city centre traffic crossing the outer cordon is reduced significantly more with the DCO Scheme, with the single carriageway Alternative 1 being a less attractive route for some journeys that would continue to use the Outer Ring Road.

Table 5.1: City Centre Through Traffic (AADT)

Cordon*	2012	2017			2032		
		DM	DCO Scheme	ALT1	DM	DCO Scheme	ALT1
Inner Ring Road Inner Cordon	9,477	8,159	6,787 (-17%)	6,985 (-14%)	9,236	4,726 (-49%)	4,734 (-49%)
Inner Ring Road Outer Cordon	77,825	82,152	78,369 (-5%)	78,469 (-4%)	88,368	80,352 (-9%)	80,325 (-9%)
Outer Ring Road Outer Cordon	68,117	73,691	63,421 (-14%)	65,784 (-11%)	79,151	66,780 (-16%)	69,664 (-12%)

Notes: *More details on Cordons can be found in Document Reference 5.6

5.1.6 Graphical presentations of these results are shown in Figure 5.3 and Figure 5.4. This illustrates that Alternative 1's fulfilment of the Scheme objectives is limited by the attractiveness of its single carriageway.

Figure 5.3: Through Traffic Crossing Cordons in 2017 – Alternative 1

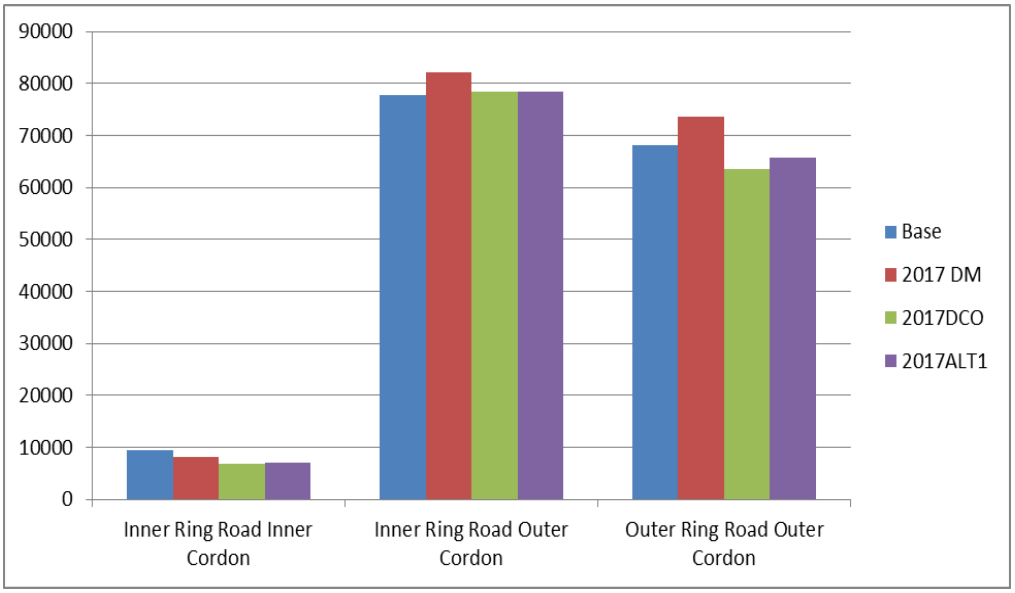
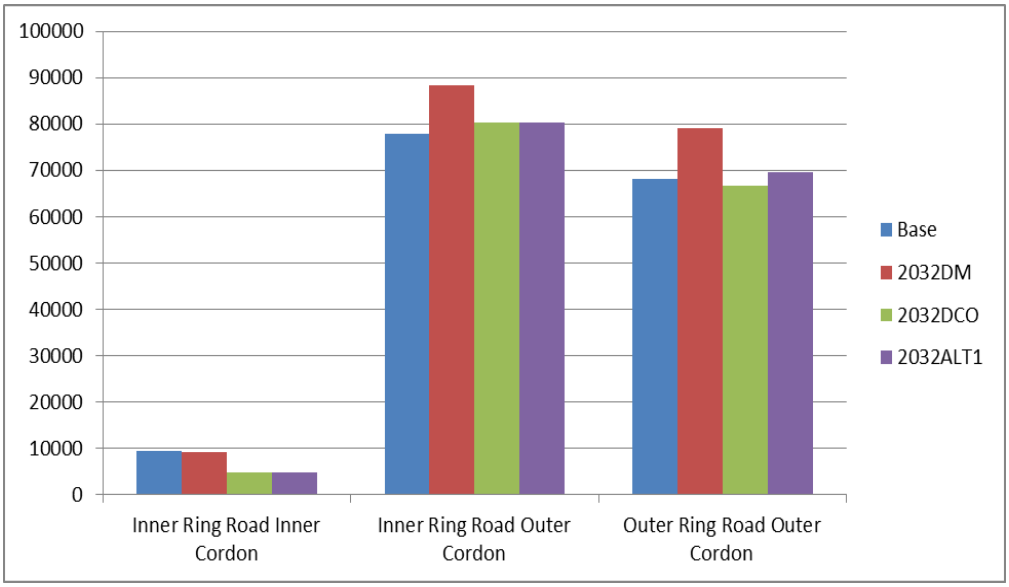


Figure 5.4: Through Traffic Crossing Cordons in 2032 – Alternative 1



5.2 Junction Analyses

5.2.1 Table 5.2 to Table 5.4 compare maximum RFC/DoS values, queues and delays for online NDR and Postwick junctions between the DCO Scheme and Alternative 1 for 2032DS AM and PM peaks. Overall the results are not dissimilar to those of the DCO submission. The single carriageway with flaring to two lanes at junctions as tested within Alternative 1 leads to a significantly lower amount of traffic attracted to the NDR and its side roads with reductions of over 25% in traffic for example on Drayton Road.

5.2.2 The results show that between Fakenham Road and North Walsham Road, the attraction of NDR is reduced to a level that leads to the junctions performing better in Alternative 1 than in the DCO scenario. Cromer Road junction however is not directly comparable, with the junction in Alternative 1 comprising an at-grade roundabout and the DCO Scheme providing a grade-separated junction. For Wroxham Road and Salhouse Road junctions, the results show that despite the lane reduction along the NDR, these two junctions are still sufficiently attractive to lead to results in excess of theoretical capacity in 2032.

5.2.3 The layout of the Business Park junction in Alternative 1 is the same as in the DCO with the north-south ahead filter lane along the NDR and the left filter lane from NDR to Broadland Gate Link in place, with the only change being the NDR southbound approach being one lane rather than two lanes. Due to

the reduction in flows, the junction therefore operates significantly better in Alternative 1.

Table 5.2: Junction Operational Assessment Results_Alternative 1 – 2032 Max RFC/DoS

Junction	AM		PM	
	DCO Scheme	Alternative 1	DCO Scheme	Alternative 1
Online junctions				
Fakenham Road	0.52	0.52	0.52	0.48
Fir Covert Road	0.55	0.52	0.51	0.55
Reepham Road	0.57	0.58	0.64	0.54
Drayton Lane	1.09	0.81	0.96	0.80
Holt Road/Drayton Lane	0.51	0.50	0.44	0.43
Cromer Road South	0.86	-	0.97	-
Cromer Road North	0.98	-	0.61	-
Cromer Road	-	0.77	-	0.86
Airport	0.87	0.58	0.79	0.54
North Walsham Road	1.10	0.82	0.83	0.83
Wroxham Road	0.99	1.01	0.95	0.95
Salhouse Road	0.95	1.03	0.97	1.04
Plumstead Road North	0.40	0.34	0.40	0.16
Plumstead Road South	0.98	0.97	0.88	0.85
Business Park	0.87	0.56	0.95	0.57

Notes: The Ratio of Flow to Capacity (RFC) output from ARCADY/PICADY is the primary measure of a junction arm performance of a roundabout/priority junction. RFC less than 0.85 indicates that a junction arm operates within capacity. RFC greater than 0.85 but less than 1.0 indicates that a junction arm is over its desired capacity but below theoretical capacity. Any RFC greater than 1.0 indicates that a junction arm is in excess of its theoretical capacity.

Degree of Saturation (DoS) output form LINSIG is the primary measure of performance of a signalised junction. DoS less than 90% indicates that a junction arm operates within capacity. DoS greater than 90% but less than 100% indicates that a junction arm is over its desired capacity but below theoretical capacity. Any DoS greater than 100% indicates that a junction arm is in excess of theoretical capacity.

Table 5.3: Junction Operational Assessment Results_Alternative 1 – 2032 Max Queue (PCUs)

Junction	AM		PM	
	DCO Scheme	Alternative 1	DCO Scheme	Alternative 1
Online junctions				
Fakenham Road	1	1	1	1
Fir Covert Road	1	1	1	1
Reepham Road	1	1	2	1
Drayton Lane	39	4	13	4
Holt Road/Drayton Lane	1	1	1	1
Cromer Road South	6	-	20	-
Cromer Road North	18	-	7	-
Cromer Road	-	3	-	6
Airport	6	1	4	1
North Walsham Road	53	4	5	5

Junction	AM		PM	
	DCO Scheme	Alternative 1	DCO Scheme	Alternative 1
Wroxham Road	28	28	10	13
Salhouse Road	15	43	13	43
Plumstead Road North	1	1	1	0
Plumstead Road South	26	20	7	5
Business Park	7	1	17	1

Table 5.4: Junction Operational Assessment Results_Alternative 1 – 2032 Max Delay (sec)

Junction	AM		PM	
	DCO Scheme	Alternative 1	DCO Scheme	Alternative 1
Online junctions				
Fakenham Road	3	4	4	4
Fir Covert Road	7	6	7	5
Reepham Road	9	6	7	6
Drayton Lane	170	17	59	12
Holt Road/Drayton Lane	5	5	5	4
Cromer Road South	15	-	45	-
Cromer Road North	56	-	38	-
Cromer Road	-	10	-	14
Airport	12	5	8	4
North Walsham Road	170	13	22	13
Wroxham Road	43	72	38	37
Salhouse Road	39	91	70	99
Plumstead Road North	5	4	4	4
Plumstead Road South	36	42	11	13
Business Park	14	4	23	6

5.3 Safety Analysis Results

5.3.1 Table 5.5 show that there would be a fewer personal injury accidents saved compared with the DCO Scheme submission analysis. An important change is a significant increase in fatalities and no savings in serious casualties. Consequently overall the cost benefit analysis for Alternative 1 shows a small accident disbenefit of £0.842m.

Table 5.5: Accident Benefits – Alternative 1

60 Year Appraisal Period		Scenario	
		DCO Scheme	Alternative 1
		Do Minimum	
Number of PIAs		70,984	70,984
Casualties	Fatal	1,890	1,890
	Serious	12,597	12,597
	Slight	91,490	91,490
Accident Costs		5,999,332	5,999,332
		Do Something	
Number of PIAs		69,944	70,044
Casualties	Fatal	1,898	1,926
	Serious	12,488	12,598
	Slight	90,226	90,206
Accident Costs		5,958,113	6,000,174
		Accident Benefits	
Number of PIA savings		1,041	940
Casualties	Fatal	-7	-36
	Serious	109	-1
	Slight	1,263	1,284
Accident Savings		41,219	-842

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

5.4 Economic Analysis Results

5.4.1 Table 5.6 below compares monetised costs and benefits including accident benefits for Alternative 1 against the DCO scheme.

Table 5.6: Analysis of Monetised Costs and Benefits – Alternative 1

Item	Accidents included (£000)	
	DCO Scheme	Alternative 1
Accidents (not assessed by TUBA)*	41,219	-842
Greenhouse Gases**	-22,756	-14,117
Economic Efficiency: Consumer Users (Commuting)	51,164	12,026
Economic Efficiency: Consumer Users (Other)	380,623	241,290
Economic Efficiency: Business Users and Providers	267,797	87,850
Wider Public Finances (Indirect Taxation Revenues)	55,270	34,895
Present Value of Benefits (PVB)	773,317	361,102
Broad Transport Budget Present Value of Costs (PVC)	185,542	149,386
OVERALL IMPACTS		

Item	Accidents included (£000)	
	DCO Scheme	Alternative 1
Net Present Value (NPV)	587,775	211,716
Benefit to Cost Ratio (BCR)	4.168	2.417

Notes: All monetary values are expressed in 2010 prices discounted to 2010
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7
**Greenhouse gas impacts were calculated using TUBA1.9.2 since there was a bug in TUBA 1.9.1

5.4.2 The results show that the Present Value of Benefits (PVB) of Alternative 1 is estimated to be £361m (inclusive of accident benefits), outweighing the £149m Present Value of Costs (PVC).

5.4.3 The Benefit Cost Ratio (BCR) of Alternative 1 is 2.42 including accidents. Under the DfT's value for money criteria, this represents a high value for money category.

5.4.4 Table 5.7 below compares summary economic appraisal results including wider impacts and journey time reliability for Alternative 1 against the DCO scheme.

Table 5.7: Summary of Economic Appraisal including Wider Benefits – Alternative 1

Item	Scenario also including WEBs and JTR (£000)	
	DCO Scheme	Alternative 1
Present Value of Benefits (PVB)	989,063	399,456
Present Value of Costs (PVC)	185,542	149,386
Net Present Value (NPV)	803,521	250,070
Benefit to Cost Ratio (BCR)	5.331	2.674

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

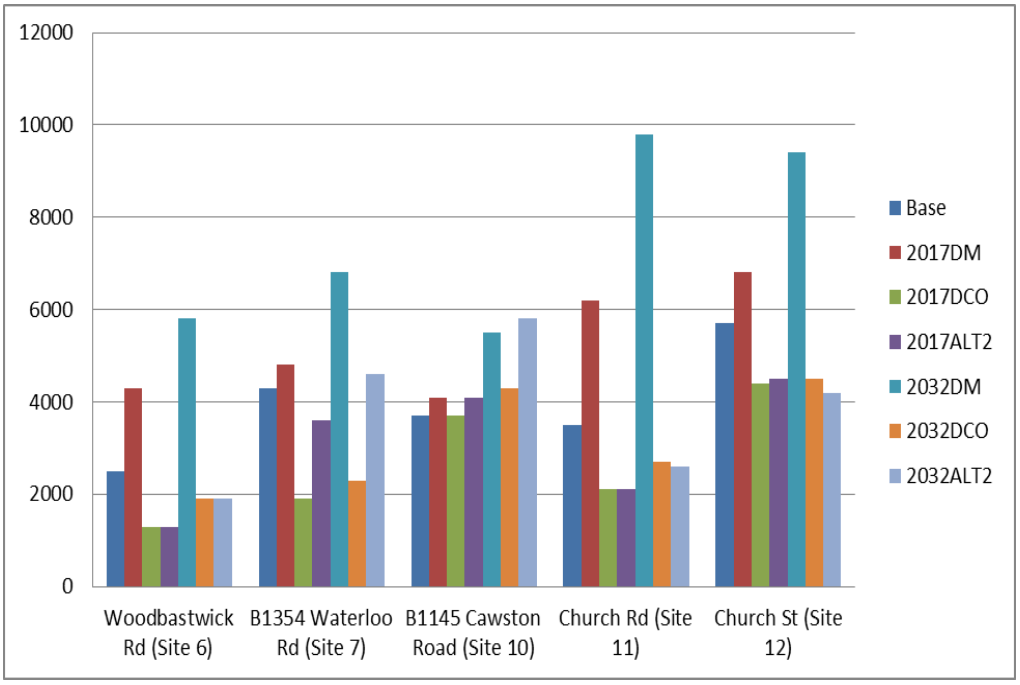
5.4.5 The Alternative 1 BCR is improved further to 2.67 once journey time reliability benefits (£2m) and wider economic benefits (£37m) are included in the appraisal, although these are substantially lower than the additional benefits for the DCO Scheme (£28m for JTR and £187m for WEBs). These additional benefits for Alternative 1 amount to £39m (2010 prices discounted to 2010). The inclusion of these benefits increases the BCR of Alternative 1 to a higher level within the high value for money category. However comparison with DCO scheme shows that Alternative 1 provides much lower BCR.

6 Traffic and Economic Assessment Results for Alternative 2 (dual carriageway NDR between Postwick Junction and A140)

6.1 Traffic Analysis Results

6.1.1 Figure 6.1 shows traffic levels on inappropriate routes with Alternative 2.

Figure 6.1: Traffic on Inappropriate Routes – Alternative 2



6.1.2 As shown in the above graph with Alternative 2, traffic conditions in the northwest sector (sites 7 and 10) will not be relieved as much as those in the northeast sector. The Waterloo Road route is, for example, forecast to have a reduction in two way AADT flow of 1,200 (25%) in 2017 in comparison with the traffic flow that otherwise would occur in the 'Do Minimum' scenario. In 2032 the reduction is 2,200 (32%). By contrast, in the DCO scenario, the reduction on the same site is 2,900 (60%) in 2017 and 4,500 (66%) in 2032 respectively.

6.1.3 Alternative 2 will not provide any relief to roads and communities to the west of the A140, and in some cases there would be increases. As an example the traffic levels on School Road in Drayton are forecast to increase from an AADT level in 2017 in the Do Minimum of 11,400 to 12,400 with Alternative 2.

Similarly in 2032 the traffic level in the Do Minimum of 12,600 AADT would increase to 13,400.

6.2 Junction Analysis

6.2.1 The key junction to consider in this case is the A140 Cromer Road junction which is grade separated in the DCO Scheme but provides an at grade terminal roundabout for Alternative 2; all other junctions on Alternative 2 are identical to the DCO Scheme junctions. Table 6.1 to Table 6.3 compare maximum RFC values, queues and delays for Cromer Road junctions between the DCO Scheme and Alternative 2 for 2032DS AM and PM peaks. The results show that the junction would operate within its theoretical capacity. The form of the junction is significantly different in Alternative 2 compared with the DCO Scheme and the results are therefore not directly comparable. However, RFC values and the levels of maximum queues and delays are similar in both scenarios.

Table 6.1: Junction Operational Assessment Results_Alternative 2 – 2032 Max RFC

Junction	AM		PM	
	DCO Scheme	Alternative 2	DCO Scheme	Alternative 2
Online junctions				
Cromer Road South	0.86	-	0.97	-
Cromer Road North	0.98	-	0.61	-
Cromer Road	-	0.96	-	0.89

Notes: See notes for Table 5.1 for more information on RFC

Table 6.2: Junction Operational Assessment Results_Alternative 2 – 2032 Max Queue (PCUs)

Junction	AM		PM	
	DCO Scheme	Alternative 2	DCO Scheme	Alternative 2
Online junctions				
Cromer Road South	6	-	20	-
Cromer Road North	18	-	7	-
Cromer Road	-	15	-	7

Table 6.3: Junction Operational Assessment Results_Alternative 2 – 2032 Max Delay (sec)

Junction	AM		PM	
	DCO Scheme	Alternative 2	DCO Scheme	Alternative 2
Online junctions				
Cromer Road South	15	-	45	-
Cromer Road North	56	-	38	-
Cromer Road	-	51	-	17

6.3 Safety Analysis Results

6.3.1 Alternative 2 safety analysis results in Table 6.4 shows that there would be fewer injury accident savings but with a change in the severity split overall of the casualty savings then there would be slightly higher safety economic benefits compared with the DCO Scheme.

Table 6.4: Accident Benefits – Alternative 2

60 Year Appraisal Period		Scenario	
		DCO Scheme	Alternative 2
		Do Minimum	
Number of PIAs		70,984	70,984
Casualties	Fatal	1,890	1,890
	Serious	12,597	12,597
	Slight	91,490	91,490
Accident Costs		5,999,332	5,999,332
		Do Something	
Number of PIAs		69,944	70,101
Casualties	Fatal	1,898	1,885
	Serious	12,488	12,465
	Slight	90,226	90,351
Accident Costs		5,958,113	5,951,053
		Accident Benefits	
Number of PIA savings		1,041	883
Casualties	Fatal	-7	6
	Serious	109	132
	Slight	1,263	1,139
Accident Savings		41,219	48,279

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

6.4 Economic Analysis Results

6.4.1 Table 6.5 below compares monetised costs and benefits including accident benefits for Alternative 2 against the DCO scheme.

Table 6.5: Analysis of Monetised Costs and Benefits – Alternative 2

Item	Accidents included (£000)	
	DCO Scheme	Alternative 2
Accidents (not assessed by TUBA)*	41,219	48,279

Item	Accidents included (£000)	
	DCO Scheme	Alternative 2
Greenhouse Gases**	-22,756	-17,981
Economic Efficiency: Consumer Users (Commuting)	51,164	17,438
Economic Efficiency: Consumer Users (Other)	380,623	273,670
Economic Efficiency: Business Users and Providers	267,797	143,940
Wider Public Finances (Indirect Taxation Revenues)	55,270	44,045
Present Value of Benefits (PVB)	773,317	509,391
Broad Transport Budget Present Value of Costs (PVC)	185,542	133,695
OVERALL IMPACTS		
Net Present Value (NPV)	587,775	375,696
Benefit to Cost Ratio (BCR)	4.168	3.810

Notes: All monetary values are expressed in 2010 prices discounted to 2010
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7
**Greenhouse gas impacts were calculated using TUBA1.9.2 since there was a bug in TUBA 1.9.1

6.4.2 The results show that the Present Value of Benefits (PVB) of Alternative 2 is estimated to be £509m (inclusive of accident benefits), outweighing the £134m Present Value of Costs (PVC). However the benefits are lower than those for the DCO Scheme reflecting the lack of improved transport connections west of the A140 Cromer Road and the Airport.

6.4.3 The Benefit Cost Ratio (BCR) of Alternative 2 is 3.81 including accidents. Under the DfT's value for money criteria, this represents a high value for money category.

6.4.4 Table 6.6 below compares summary economic appraisal results including wider impacts and journey time reliability for Alternative 2 against the DCO scheme.

Table 6.6: Summary of Economic Appraisal including Wider Benefits – Alternative 2

Item	Scenario also including WEBs and JTR (£000)	
	DCO Scheme	Alternative 2
Present Value of Benefits (PVB)	989,063	549,983
Present Value of Costs (PVC)	185,542	133,695
Net Present Value (NPV)	803,521	416,288
Benefit to Cost Ratio (BCR)	5.331	4.114

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

6.4.5 The Alternative 2 BCR is improved further to 4.11 once journey time reliability benefits (£9m) and wider economic benefits (£31m) are included in the

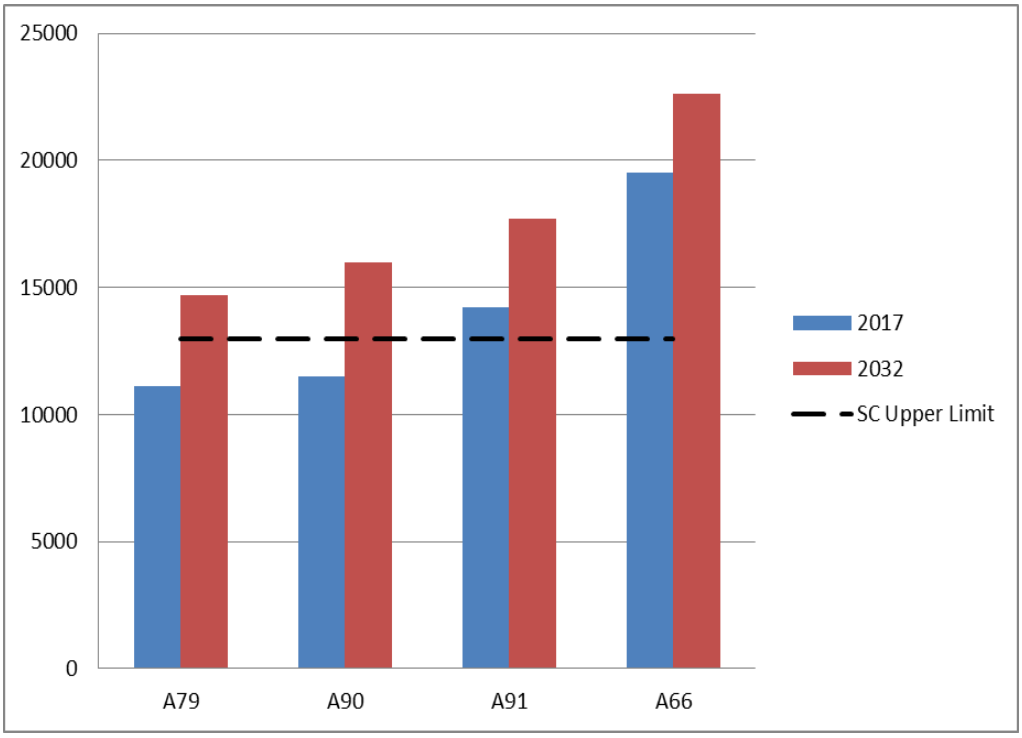
appraisal, although these are substantially lower than the additional benefits for the DCO Scheme (£28m for JTR and £187m for WEBs). These additional benefits for Alternative 2 amount to £40m (2010 prices discounted to 2010). The inclusion of these benefits increases the BCR from the High to the Very High value for money category.

7 Traffic and Economic Assessment Results for Alternative 3 (single / dual carriageway NDR)

7.1 Traffic Analysis Results

7.1.1 Figure 7.1 below shows the forecast Alternative 3 AADTs on the NDR single carriageway sections between A1067 and A140.

Figure 7.1: Alternative 3 AADT on Online Sections between A1067 and A140



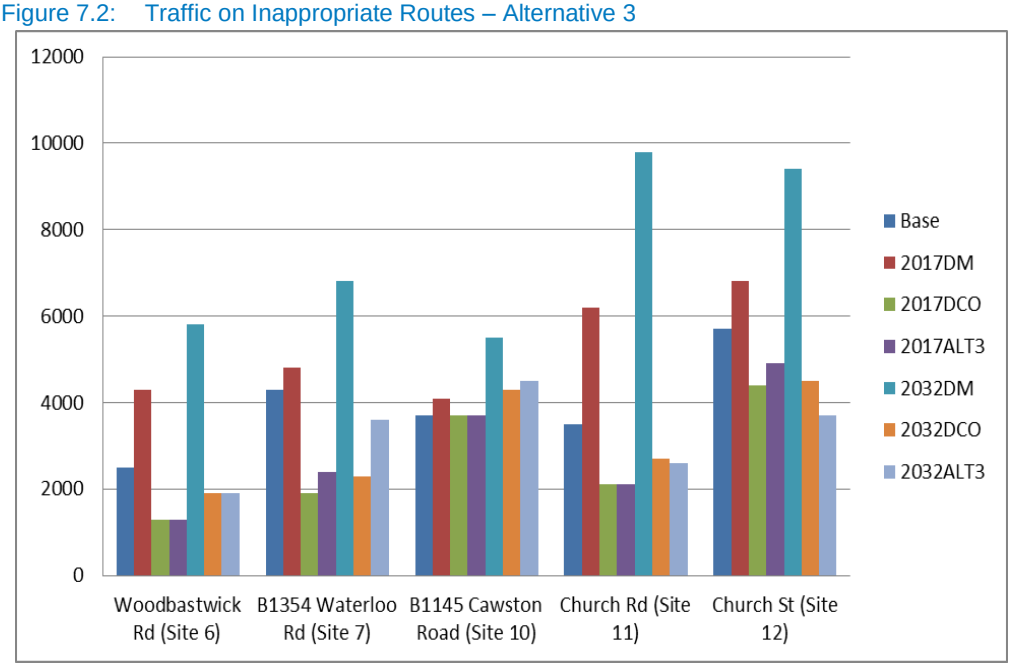
Notes: A79: Fakenham Road - Fir Covert Road Link, A90: Fir Covert Road - Reepham Road Link, A91: Reepham Road - Holt Road Link and A66: Holt Road - Cromer Road Link

7.1.2 The traffic forecasts on the single carriageway sections of Alternative 3 vary between 11,500 AADT between Fakenham Road and Fir Covert Road at the western end of the NDR and 19,500 AADT west of the A140 in the 2017 opening year. Traffic levels on Reepham Road – Holt Road link and Holt Road – Cromer Road link are higher than the economic flow range upper limit in TA46/97 of 13,000 AADT for a single carriageway road. In addition the Alternative requires a roundabout junction with the A140 Cromer Road to provide a safe transition between the single and dual carriageway sections of the Alternative. This would cause additional delays compared with the DCO Scheme and previous work concluded that the roundabout would need to be

upgraded by 2032 to a signal controlled hamburger-type junction in order to function effectively. Whilst Alternative 3 will meet the transport connections objective, the lower standard of the western section and the A140 junction means that there would be a poorer operational performance of Alternative 3 compared with the DCO scheme due to over capacity of the single carriageway and thus reduced attractiveness, such that a proportion of traffic will remain on the existing network. It can also be seen that further traffic increases are forecast for these locations between 2017 and 2032.

7.1.3 Figure 7.2 shows traffic levels on inappropriate routes with Alternative 3.

Figure 7.2: Traffic on Inappropriate Routes – Alternative 3



7.1.4 As shown in the above figure traffic conditions in the northwest sector (sites 7 and 10) will not be relieved as much as those in the northeast sector with Alternative 3. This trend is similar to the Alternative 2 but with more relief in this case. Taking Waterloo Road route as an example, it is forecast to experience a reduction in two way AADT flow of 2,400 (50%) in 2017 in comparison with the traffic flow that would otherwise would occur in the 'Do Minimum' scenario. In 2032 the reduction is 3,200 (47%). By contrast, in the DCO scenario, the reduction on the same site is 2,900 (60%) in 2017 and 4,500 (66%) in 2032 respectively.

Alternative 3 will provide relief to roads and communities to the west of the A140, but to a lesser degree than the DCO Scheme. The traffic levels on School Road in Drayton are forecast to reduce from an AADT level in 2017 in

the Do Minimum of 11,400 to 10,100 with Alternative 3 (9,400 with the DCO Scheme). Similarly in 2032 the traffic level in the Do Minimum of 12,600 AADT would reduce to 10,500 (10,200 with the DCO Scheme).

7.2 Junction Analyses

7.2.1 Table 7.1 to Table 7.3 compare maximum RFC/DoS values, queues and delays for online NDR junctions to the west of A140 between the DCO Scheme and Alternative 3 for 2032DS AM and PM peaks. The results show that the junctions generally perform very slightly better in Alternative 3 than in the DCO Scheme. This is due to the overall attractiveness of NDR being reduced due to it being a single carriageway to the west of A140 which results in slightly lower flows all along its length. The reductions in traffic flows on the junctions shown in Table 7.1 are however smaller in Alternative 3 than in Alternative 1 where the whole length of the NDR is single carriageway. Accordingly, the differences in results between Alternative 3 and the DCO Scheme are smaller than those for Alternative 1compared with the DCO Scheme.

Table 7.1: Junction Operational Assessment Results_Alternative 3 – 2032 Max RFC/DoS

Junction	AM		PM	
	DCO Scheme	Alternative 3	DCO Scheme	Alternative 3
Online junctions				
Fakenham Road	0.52	0.52	0.52	0.49
Fir Covert Road	0.55	0.54	0.51	0.59
Reepham Road	0.57	0.63	0.64	0.57
Drayton Lane	1.09	0.92	0.96	0.90
Holt Road/Drayton Lane	0.51	0.49	0.44	0.44
Cromer Road South	0.86	-	0.97	-
Cromer Road North	0.98	-	0.61	-
Cromer Road*	-	0.91	-	0.71

Notes: *Some arms of this roundabout are signalised in 2032, this junction therefore has been assessed in LINSIG

See notes for Table 5.1 for more information on RFC and DoS

Table 7.2: Junction Operational Assessment Results_Alternative 3 – 2032 Max Queue (PCUs)

Junction	AM		PM	
	DCO Scheme	Alternative 3	DCO Scheme	Alternative 3
Online junctions				
Fakenham Road	1	1	1	1
Fir Covert Road	1	1	1	1
Reepham Road	1	2	2	1
Drayton Lane	39	10	13	8

Junction	AM		PM	
	DCO Scheme	Alternative 3	DCO Scheme	Alternative 3
Holt Road/Drayton Lane	1	1	1	1
Cromer Road South	6	-	20	-
Cromer Road North	18	-	7	-
Cromer Road*	-	17	-	11

Notes: *Some arms of this roundabout are signalised in 2032

Table 7.3: Junction Operational Assessment Results_Alternative 3 – 2032 Max Delay (sec)

Junction	AM		PM	
	DCO Scheme	Alternative 3	DCO Scheme	Alternative 3
Online junctions				
Fakenham Road	3	4	4	4
Fir Covert Road	7	6	7	6
Reepham Road	9	6	7	7
Drayton Lane	170	31	59	23
Holt Road/Drayton Lane	5	5	5	5
Cromer Road South	15	-	45	-
Cromer Road North	56	-	38	-
Cromer Road*	-	38	-	28

Notes: *Some arms of this roundabout are signalised in 2032

7.3 Safety Analysis Results

7.3.1 Alternative 3 safety analysis results in Table 7.4 show that there would be a slight reduction in the number of personal injury accidents compared with the DCO Scheme submission analysis. However there is an increase in fatal and serious injury casualty types due to part of the scheme being a single carriageway standard. Hence overall there is a slight reduction in safety economic benefits compared with the DCO Scheme.

Table 7.4: Accident Benefits – Alternative 3

60 Year Appraisal Period		Scenario	
		DCO Scheme	Alternative 3
		Do Minimum	
Number of PIAs		70,984	70,984
Casualties	Fatal	1,890	1,890
	Serious	12,597	12,597
	Slight	91,490	91,490
Accident Costs		5,999,332	5,999,332
		Do Something	

Number of PIAs		69,944	69,866
Casualties	Fatal	1,898	1,901
	Serious	12,488	12,493
	Slight	90,226	90,055
Accident Costs		5,958,113	5,960,100
		Accident Benefits	
Number of PIA savings		1,041	1,118
Casualties	Fatal	-7	-11
	Serious	109	104
	Slight	1,263	1,435
Accident Savings		41,219	39,232

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

7.4 Economic Analysis Results

7.4.1 Table 7.5 below compares monetised costs and benefits including accident benefits for Alternative 3 against the DCO scheme.

Table 7.5: Analysis of Monetised Costs and Benefits – Alternative 3

Item	Accidents included (£000)	
	DCO Scheme	Alternative 3
Accidents (not assessed by TUBA)*	41,219	39,232
Greenhouse Gases**	-22,756	-20,815
Economic Efficiency: Consumer Users (Commuting)	51,164	26,483
Economic Efficiency: Consumer Users (Other)	380,623	306,744
Economic Efficiency: Business Users and Providers	267,797	212,603
Wider Public Finances (Indirect Taxation Revenues)	55,270	51,107
Present Value of Benefits (PVB)	773,317	615,354
Broad Transport Budget Present Value of Costs (PVC)	185,542	167,205
OVERALL IMPACTS		
Net Present Value (NPV)	587,775	448,149
Benefit to Cost Ratio (BCR)	4.168	3.680

Notes: All monetary values are expressed in 2010 prices discounted to 2010
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7
**Greenhouse gas impacts were calculated using TUBA1.9.2 since there was a bug in TUBA 1.9.1

7.4.2 The results show that the Present Value of Benefits (PVB) of Alternative 3 is estimated to be £615m (inclusive of accident benefits), outweighing the £167m Present Value of Costs (PVC).

7.4.3 The Benefit Cost Ratio (BCR) of Alternative 3 is 3.68 including accidents. Under the DfT's value for money criteria, this represents a High value for money category.

7.4.4 Table 7.6 below compares summary economic appraisal results including wider impacts and journey time reliability for Alternative 3 against the DCO Scheme.

Table 7.6: Summary of Economic Appraisal including Wider Benefits – Alternative 3

Item	Scenario also including WEBs and JTR (£000)	
	DCO Scheme	Alternative 3
Present Value of Benefits (PVB)	989,063	809,516
Present Value of Costs (PVC)	185,542	167,205
Net Present Value (NPV)	803,521	642,311
Benefit to Cost Ratio (BCR)	5.331	4.841

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

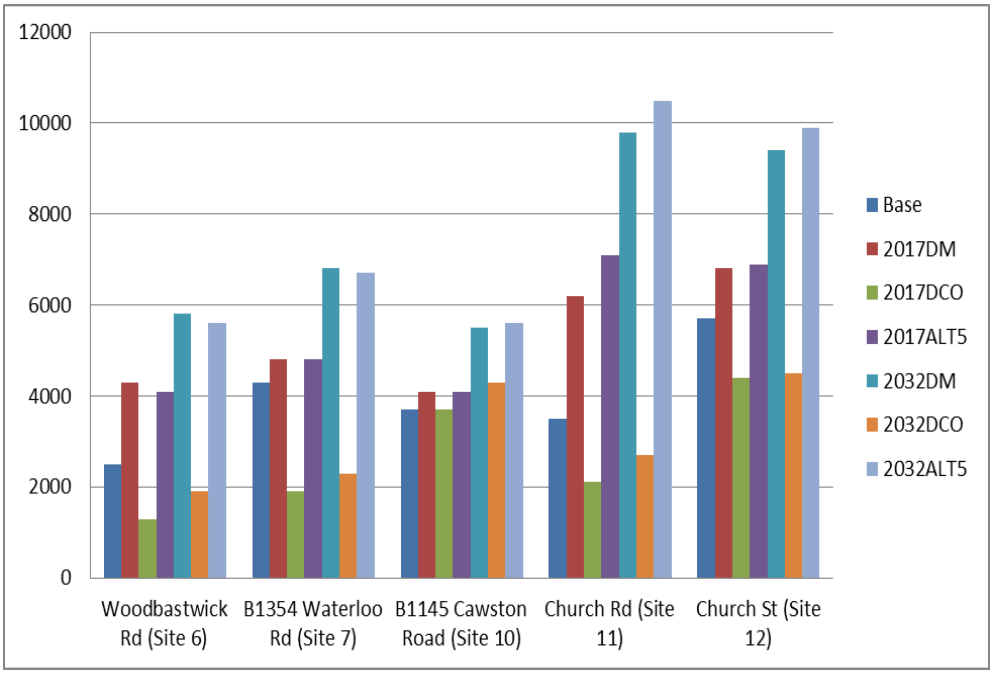
7.4.5 The BCR of Alternative 3 is improved further to 4.84 once journey time reliability benefits (£16m) and wider economic benefits (£178m) are included in the appraisal. These are lower than the additional benefits for the DCO Scheme (£28m for JTR and £187m for WEBs), but not to the same degree as the other Alternatives that have been tested in this report. These additional benefits amount to £194m (2010 prices discounted to 2010). The inclusion of these benefits increases the BCR to a higher level within the very high value for money category. However comparison with the DCO scheme shows that Alternative 3 provides an overall lower BCR.

8 Traffic and Economic Assessment Results for Alternative 5 (developer link roads)

8.1 Traffic Analysis Results

8.1.1 Figure 8.1 shows traffic levels on inappropriate routes for Alternative 5.

Figure 8.1: Traffic on Inappropriate Routes – Alternative 5



8.1.2 As shown in the above figure the traffic levels on the inappropriate routes would remain as high as in the Do Minimum or even increase. The Church Road and Church St routes are, for example, forecast to have a slight increase in two way AADT flows of 900 (15%) and 100 (1%) respectively in 2017 in comparison with the traffic flows in the 'Do Minimum' scenario. In 2032 the increase is 700 (7%) and 500 (5%) respectively. By contrast, in the DCO scenario, the reduction on these two sites are 4,100 (66%) and 2,400 (35%) in 2017 and 7,100 (72%) and 4,900 (52%) in 2032 respectively. These figures demonstrate the Alternative 5 is not capable of reducing traffic on these inappropriate routes and would singularly fail to meet this scheme objective.

8.1.3 Table 8.1 below shows city centre through traffic across three cordons. More details on these cordons can be found in Document Reference 5.6. The table shows that traffic crossing the city centre Inner Ring Road cordons is reduced

by a smaller degree with Alternative 5 compared with the DCO Scheme, mostly achieved by the city centre measures that are assumed to be implemented in both cases. However the city centre traffic crossing the outer cordon is reduced by a relatively small amount with Alternative 5 when compared with the reductions achieved by the DCO Scheme and thus there would be significant increases in this traffic over existing levels on the Outer Ring Road with Alternative 5 whereas with the DCO Scheme they are forecast to reduce.

Table 8.1: City Centre Through Traffic (AADT)

Cordon*	2012	2017			2032		
		DM	DCO Scheme	ALT5	DM	DCO Scheme	ALT5
Inner Ring Road Inner Cordon	9,477	8,159	6,787 (-17%)	7,467 (-8%)	9,236	4,726 (-49%)	4,970 (-46%)
Inner Ring Road Outer Cordon	77,825	82,152	78,369 (-5%)	81,058 (-1%)	88,368	80,352 (-9%)	83,413 (-6%)
Outer Ring Road Outer Cordon	68,117	73,691	63,421 (-14%)	70,119 (-5%)	79,151	66,780 (-16%)	76,613 (-3%)

Notes: *More details on Cordons can be found in Document Reference 5.6

8.1.4 A graphical presentation of these results are shown in Figure 8.2 and Figure 8.3.

Figure 8.2: Through Traffic Crossing Cordons in 2017 – Alternative 5

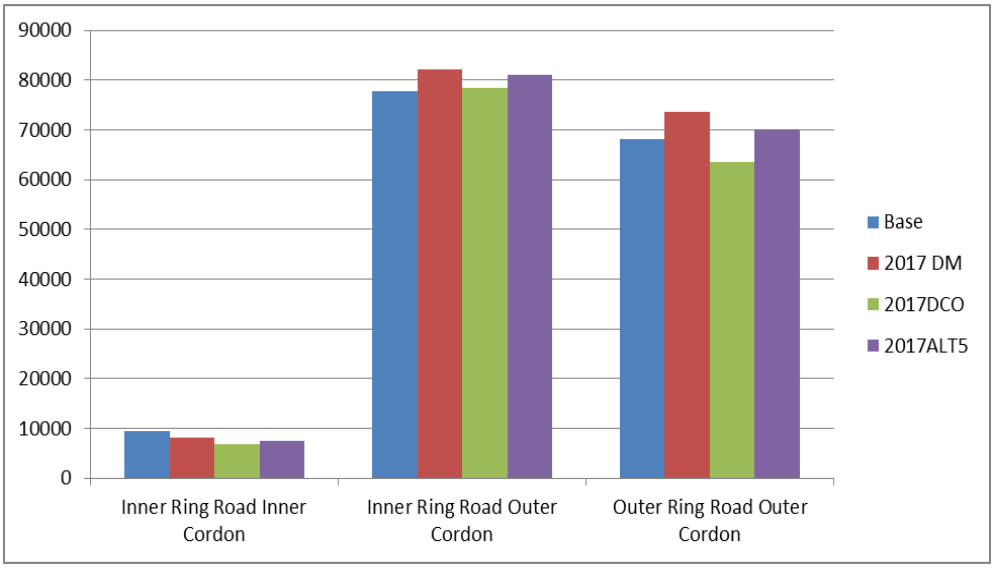
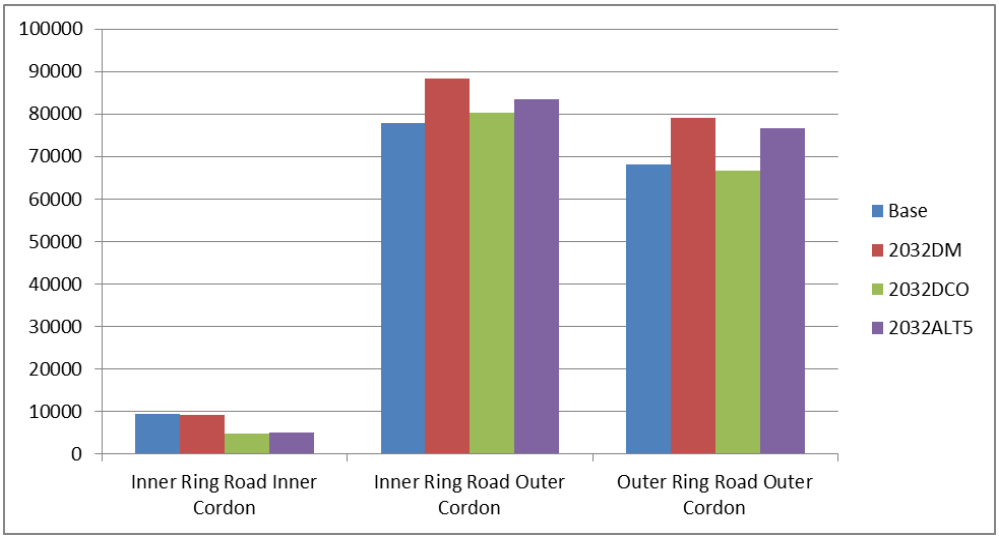


Figure 8.3: Through Traffic Crossing Cordons in 2032 – Alternative 5



8.2 Junction Analyses

8.2.1 Table 8.2 to Table 8.4 compare maximum DoS values, queues and delays for key developer link road signal-controlled junctions between the DCO Scheme and Alternative 5 for 2032DS AM and PM peaks. The results show that the junctions of Spixworth Main Street and St Faith Main Street (new or modified junctions in Alternative 5 so there are not comparable DCO Scheme results) would operate within desirable capacity in Alternative 5. However the junctions of North Walsham Road and Wroxham Road (coded with the developer's proposals) would operate substantially over their theoretical capacity with long queues and delays, with delays of over 10 minutes at North Walsham Road Junction in the 2032 AM peak, and 5 minutes in the 2032 PM peak. On these grounds the developer link roads would not operate satisfactorily and they would cause particularly severe difficulties in implementing the proposed shared use high street-type design envisaged in the development proposals. The delays would also mean that the Alternative would fail to meet the improved transport connectivity objective for the Scheme.

Table 8.2: Junction Operational Assessment Results_Alternative 5 – 2032 Max DoS

Junction	AM		PM	
	DCO Scheme	Alternative 5	DCO Scheme	Alternative 5
Developer junctions				
Spixworth Main Street*	-	85.3%	-	70.8%
St Faith Main Street*	-	81.7%	-	78.5%
North Walsham Road	92.4%	142.6%	73.6%	125.2%
Wroxham Road	77.7%	131.7%	76.6%	116.2%

Notes: All these are signalised junctions, *These refer to modified/new junctions in Alt5

See notes for Table 5.1 for more information on DoS

Table 8.3: Junction Operational Assessment Results_Alternative 5 – 2032 Max Queue (PCUs)

Junction	AM		PM	
	DCO Scheme	Alternative 5	DCO Scheme	Alternative 5
Developer junctions				
Spixworth Main Street	-	8	-	5
St Faith Main Street	-	5	-	9
North Walsham Road	22	149	13	67
Wroxham Road	16	84	18	77

Notes: All these are signalised junctions, *These refer to modified/new junctions in Alt5

Table 8.4: Junction Operational Assessment Results_Alternative 5 – 2032 Max Delay (sec)

Junction	AM		PM	
	DCO Scheme	Alternative 5	DCO Scheme	Alternative 5
Developer junctions				
Spixworth Main Street	-	97	-	48
St Faith Main Street	-	58	-	47
North Walsham Road	75	656	54	346
Wroxham Road	89	547	91	379

Notes: All these are signalised junctions, *These refer to modified/new junctions in Alt5

8.3 Safety Analysis Results

8.3.1 Alternative 5 safety analysis results in Table 8.5 show that there would be a small number of personal injury accidents saved but that the changes in the numbers of casualties would result overall in safety economic dis-benefits.

Table 8.5: Accident Benefits – Alternative 5

60 Year Appraisal Period		Scenario	
		DCO Scheme	Alternative 5
		Do Minimum	
Number of PIAs		70,984	70,984
Casualties	Fatal	1,890	1,890
	Serious	12,597	12,597
	Slight	91,490	91,490
Accident Costs		5,999,332	5,999,332
		Do Something	
Number of PIAs		69,944	70,949
Casualties	Fatal	1,898	1,896
	Serious	12,488	12,618
	Slight	90,226	91,463
Accident Costs		5,958,113	6,008,510
		Accident Benefits	
Number of PIA savings		1,041	35
Casualties	Fatal	-7	-6
	Serious	109	-21
	Slight	1,263	27
Accident Savings		41,219	-9,178

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

8.4 Economic Analysis Results

8.4.1 Table 8.6 below compares monetised costs and benefits including accident benefits for Alternative 5 against the DCO scheme.

Table 8.6: Analysis of Monetised Costs and Benefits – Alternative 5

Item	Accidents included (£000)	
	DCO Scheme	Alternative 5
Accidents (not assessed by TUBA)*	41,219	-9,178
Greenhouse Gases**	-22,756	-1,943
Economic Efficiency: Consumer Users (Commuting)	51,164	-26,732
Economic Efficiency: Consumer Users (Other)	380,623	58,284
Economic Efficiency: Business Users and Providers	267,797	-302,306
Wider Public Finances (Indirect Taxation Revenues)	55,270	3,420
Present Value of Benefits (PVB)	773,317	-278,455
Broad Transport Budget Present Value of Costs (PVC)	185,542	24,382
OVERALL IMPACTS		

Item	Accidents included (£000)	
	DCO Scheme	Alternative 5
Net Present Value (NPV)	587,775	-302,837
Benefit to Cost Ratio (BCR)	4.168	-11.421

Notes: All monetary values are expressed in 2010 prices discounted to 2010
* Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7
* *Greenhouse gas impacts were calculated using TUBA1.9.2 since there was a bug in TUBA 1.9.1

8.4.2 The results show that the Present Value of Benefits (PVB) of Alternative 5 is estimated to be £-278m (inclusive of accident benefits). A significant factor in this are the private sector costs of -£44m for the developer link roads which TUBA allocates as negative benefits rather than costs to public accounts as they are private sector funded. The Alternative also produces transport efficiency economic disbenefits as any benefits of the extended link roads are outweighed by the reduced performance due to overcapacity and due to the effects of introducing city centre traffic management measures without significant traffic relief being provided by the Alternative. Set against these PVB results is the £24m Present Value of Costs (PVC) to public accounts.

8.4.3 The Benefit Cost Ratio (BCR) of the scheme is -11.42 including accidents and does not represent good value for money.

8.4.4 Table 8.7 below compares summary economic appraisal results including wider impacts and journey time reliability for Alternative 5 against the DCO scheme.

Table 8.7: Summary of Economic Appraisal including Wider Benefits – Alternative 5

Item	Scenario also including WEBs and JTR (£000)	
	DCO Scheme	Alternative 5
Present Value of Benefits (PVB)	989,063	-495,814
Present Value of Costs (PVC)	185,542	24,382
Net Present Value (NPV)	803,521	-520,196
Benefit to Cost Ratio (BCR)	5.331	-20.335

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

8.4.5 The BCR of Alternative 5 deteriorates even further to -20.34 once journey time reliability benefits (£-30m) and wider economic benefits (£-187m) are included in the appraisal. These additional dis-benefits amount to £-217m (2010 prices discounted to 2010). The inclusion of these dis-benefits result in a further deterioration of the BCR although it should be noted that the BCR is not a meaningful term when the benefits are negative.

8.4.6 The economic appraisal results highlight that the performance of Alternative 5 is especially poor and does not offer good value for money. It should be noted however that the appraisal has not attempted to assess any development benefits that may arise with the link roads.

9 Conclusions

9.1.1 **The DCO Scheme** delivers a benefit-to-cost ratio (BCR) of 4.17 (inclusive of accident benefits) and a BCR of 5.33 when WEBs and JTR are included. Both of these represent very high value for money (BCR above 4) according to DfT's VfM criteria.

9.1.2 **Alternative 1** (single carriageway NDR) provides the required transport connections, but the lower standard means that there would be a poorer operational performance compared with the DCO Scheme. The forecast traffic flows on a number of the single carriageway links are forecast to be substantially higher than the economic flow range upper limit in TA46/97 of 13,000 AADT for a single carriageway road in the opening year. This reduces the attractiveness of the route for some journeys so that there is less relief of existing routes. The analysis shows less relief on inappropriate routes and for cross city traffic using the Outer Ring Road. The economic appraisal shows a much lower level of benefits than the DCO Scheme resulting in a BCR of 2.42 with accidents and 2.67 with JTR benefits and WEBs included.

9.1.3 **Alternative 2** (dual carriageway NDR between Postwick Junction and A140) will not provide the connectivity for journeys west of the A140 and thus will not relieve roads and communities to the west of the A140. In some cases there would be traffic increases, especially on a minor road Hall Lane between the A140 Cromer Road junction and the A1067 which is inappropriate route for the forecast increases in traffic. The economic appraisal shows a lower level of benefits than the DCO Scheme due to the lack of improved transport connections west of the A140 with a BCR of 3.81 including accidents. The benefits are increased with the inclusion of JTR and WEBs to give a BCR of 4.11, but the level of these additional benefits is much lower than calculated for the DCO Scheme due to the poorer connectivity provided by the Alternative.

9.1.4 **Alternative 3** (single / dual carriageway NDR) provides the required transport connections, but the lower standard west of the A140 Cromer Road means that there would be a poorer operational performance compared with the DCO Scheme. The forecast traffic flow on the Holt Road – Cromer Road single carriageway link is forecast to be substantially higher than the economic flow range upper limit in TA46/97 of 13,000 AADT for a single carriageway road in the opening year. This together with the A140 at grade junction reduces the attractiveness of the route for some journeys so that there is less relief of existing routes. The analysis shows less relief on inappropriate routes in the

northwest sector. The economic appraisal shows a lower level of benefits than the DCO Scheme resulting in a BCR of 3.68 with accidents and 4.84 with JTR benefits and WEBs included.

9.1.5 **Alternative 4** (single / dual carriageway NDR) has not been retested as it provides a small change to the DCO Scheme and therefore the traffic impacts and economic appraisal would be similar.

9.1.6 **Alternative 5** (developer link roads) singularly fails to reduce traffic on inappropriate routes and relieve the existing network. Whilst the Alternative includes the city centre traffic management measures the reductions of cross city centre traffic are much smaller compared with the DCO Scheme, especially for trips crossing the Outer Ring Road Cordon. The junction analyses show that North Walsham Road and Wroxham Road junctions would operate substantially over their theoretical capacity with long queues and delays, with delays of over 10 minutes at North Walsham Road Junction in the 2032 AM peak, and 5 minutes in the 2032 PM peak. On these grounds the developer link roads would not operate satisfactorily and they would cause particularly severe difficulties in implementing the proposed shared use high street-type design envisaged in the development proposals. The delays would also mean that the Alternative would fail to meet the improved transport connectivity objective for the Scheme. The economic appraisal results highlight that the performance of Alternative 5 is especially poor and does not offer good value for money. The Alternative produces economic disbenefits as any benefits of the extended link roads are outweighed by the reduced performance due to overcapacity and due to the effects of introducing city centre traffic management measures without significant traffic relief being provided by the Alternative. The calculated BCR is -11.42 with accidents included and even worse with JTR and WEBs giving -20.34 although the BCR is not a meaningful term when the benefits are negative.

10 Appendices

10.1 Appendix A – Traffic Flow Diagrams

10.1.1 Figure 10.1 to Figure 10.20 contain traffic flow information for Alternatives.

Figure 10.1: AADT Traffic Flows Western Section_Alternative 1

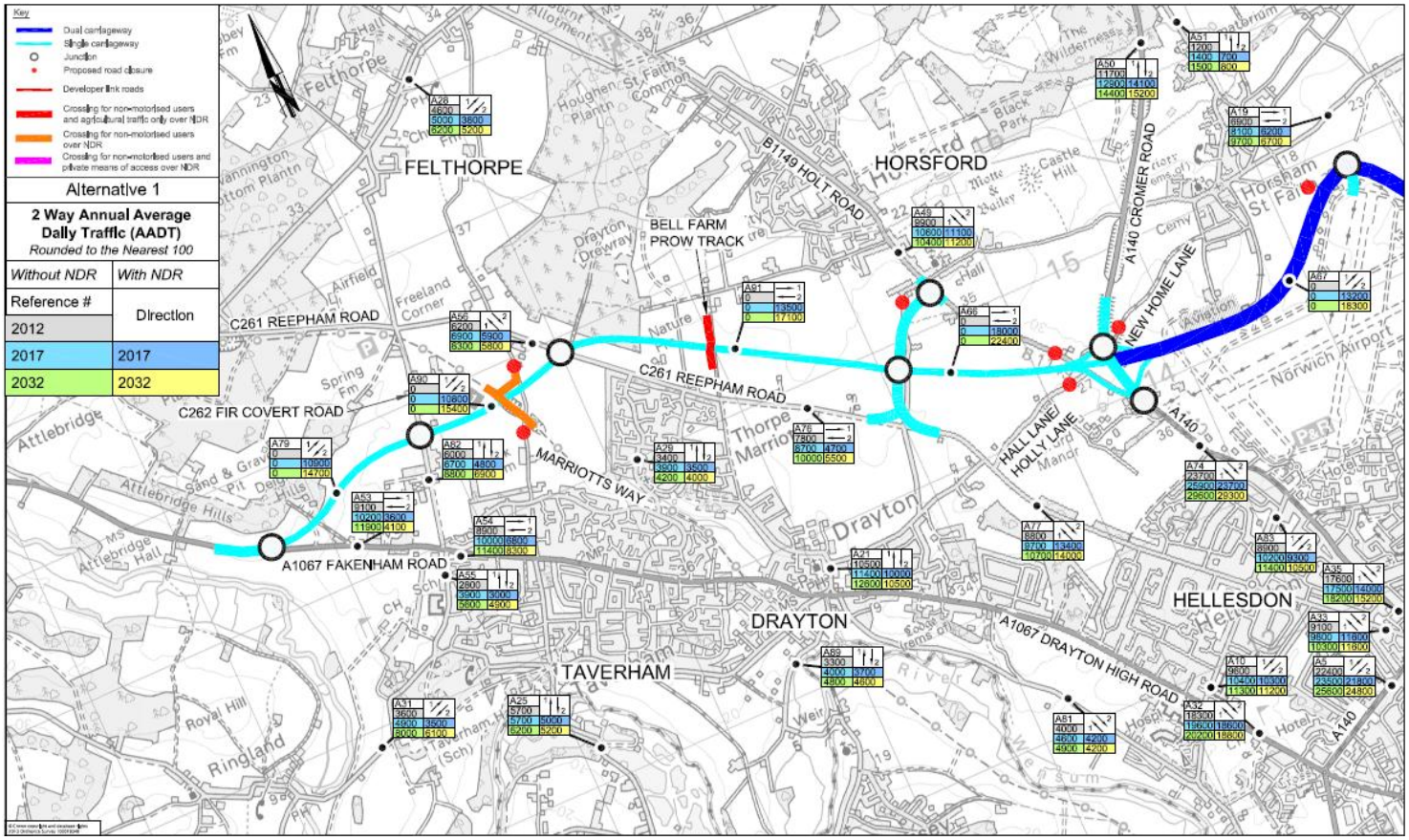


Figure 10.2: AADT Traffic Flows Eastern Section_Alternative 1

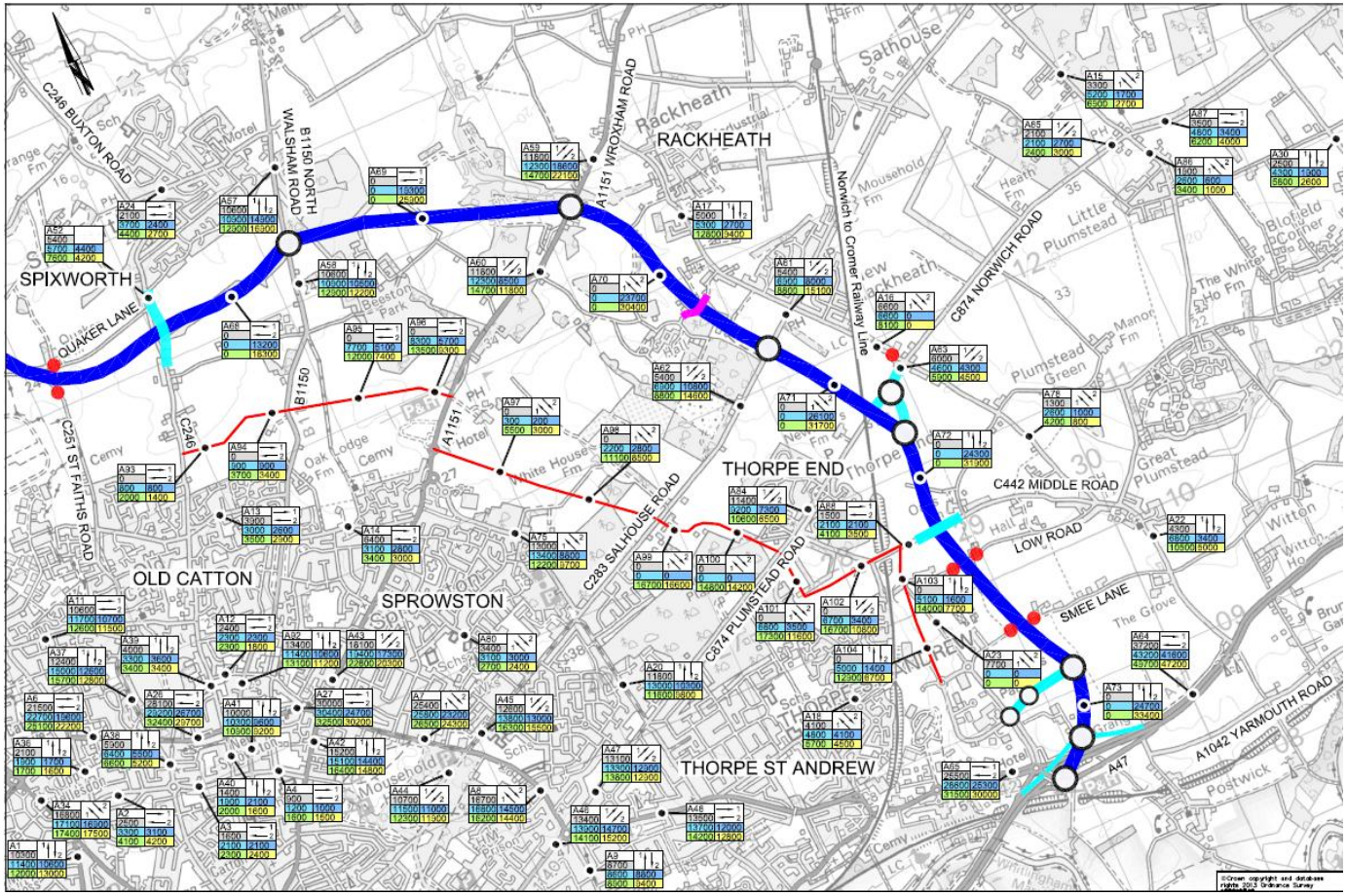


Figure 10.3: AADT Traffic Flows Wensum Valley Section_Alternative 1

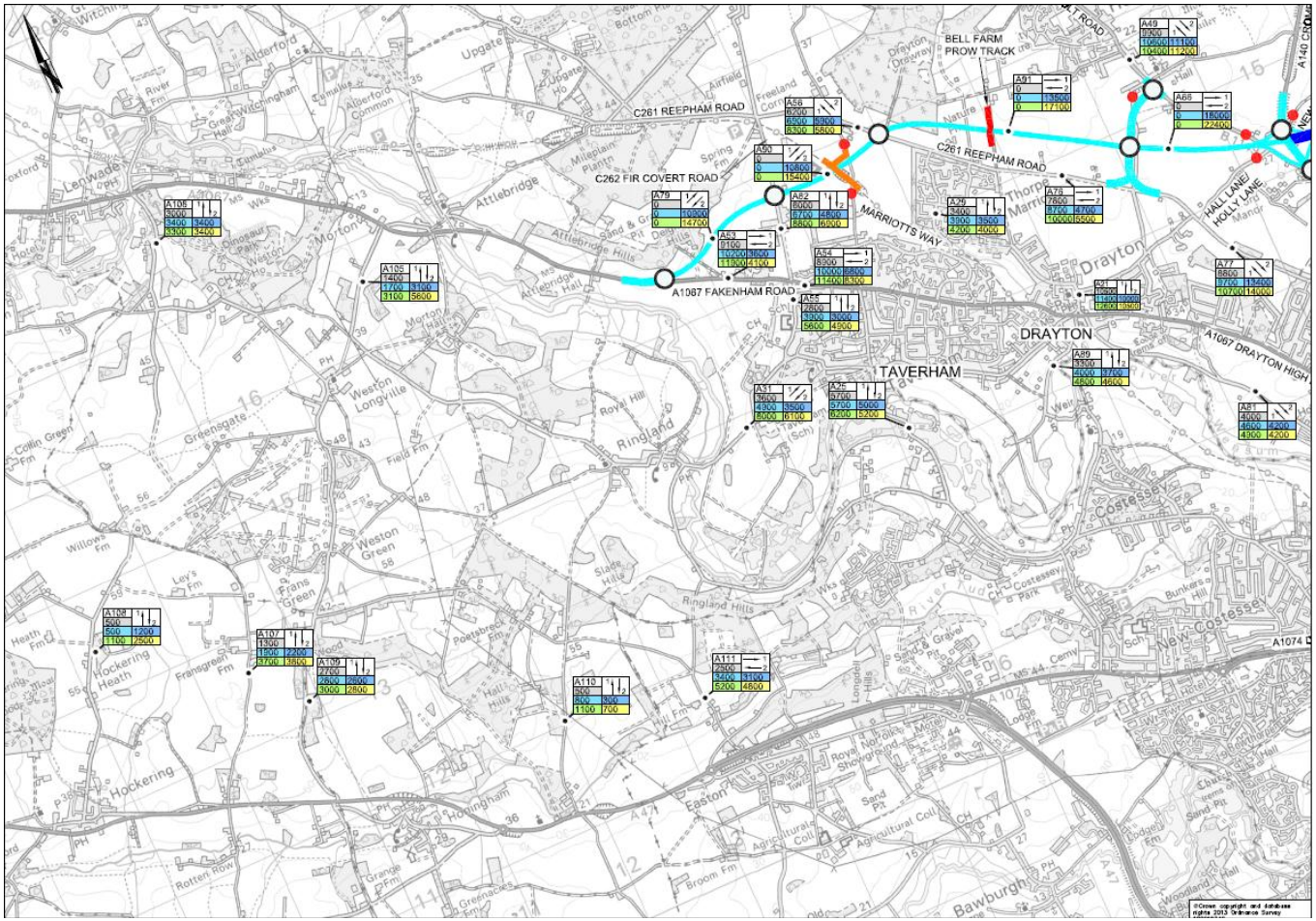


Figure 10.4: Strategic Traffic Movements_Alternative 1

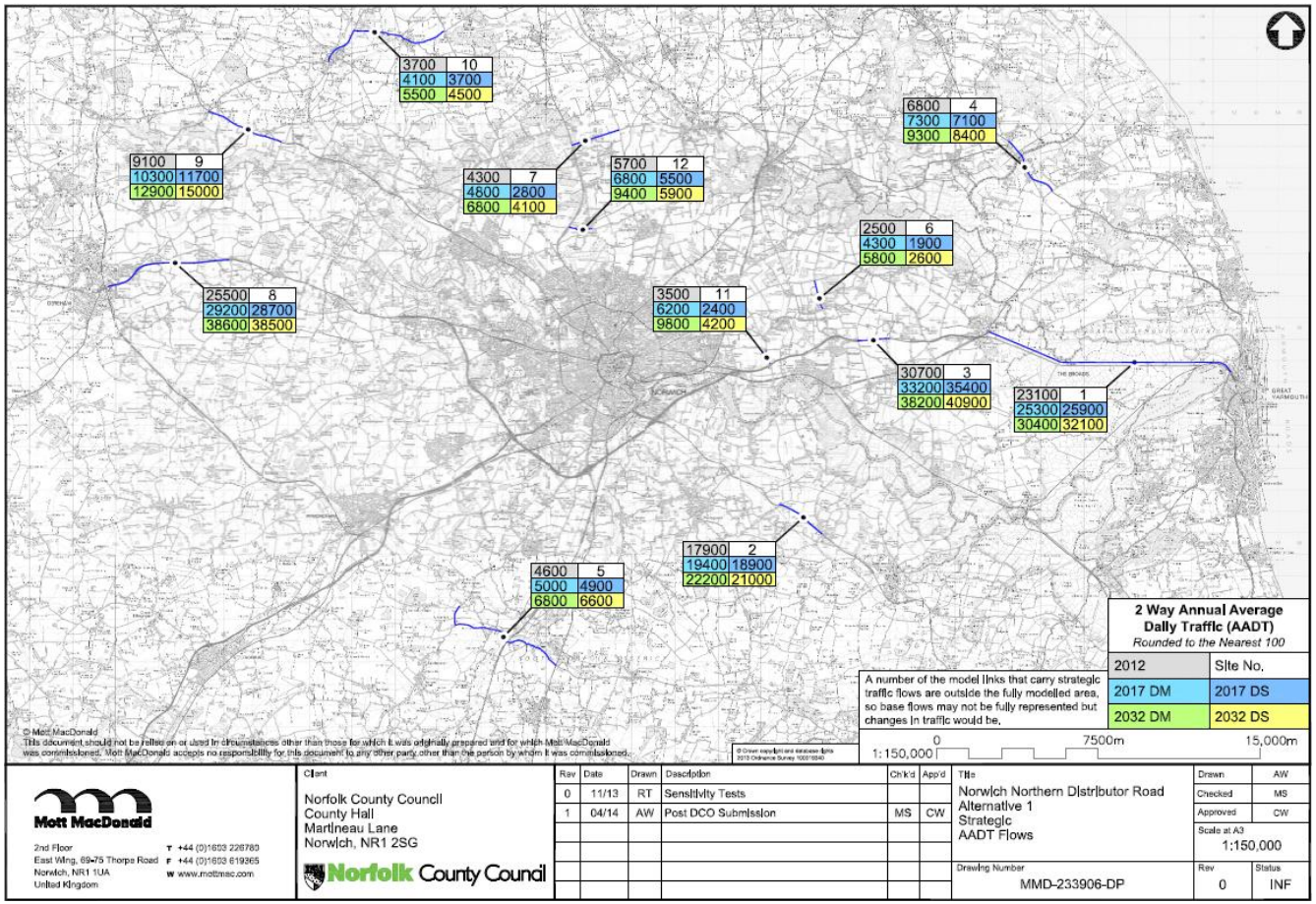


Figure 10.5: City Centre Traffic Impact_Alternative 1

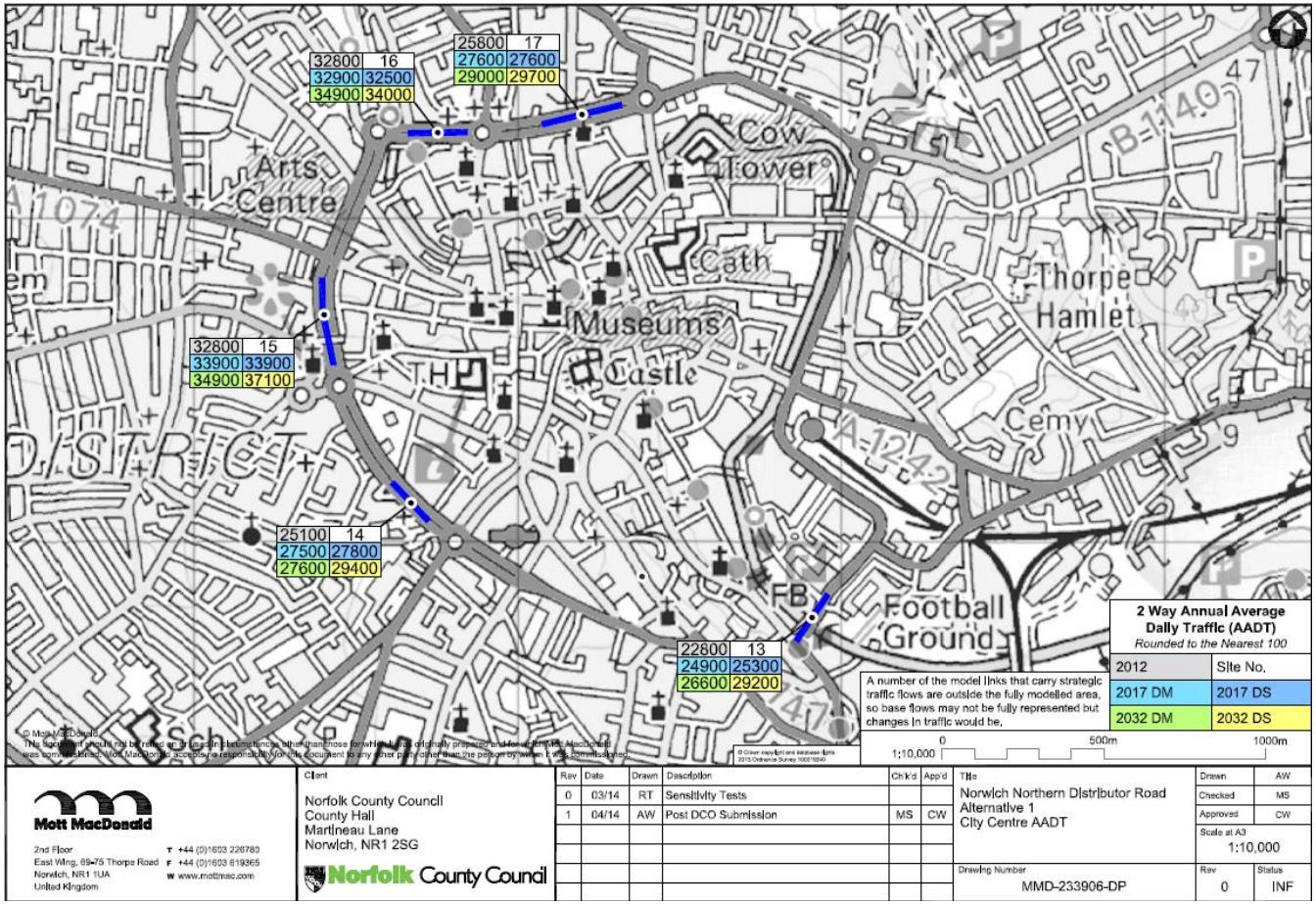


Figure 10.6: AADT Traffic Flows Western Section_Alternative 2

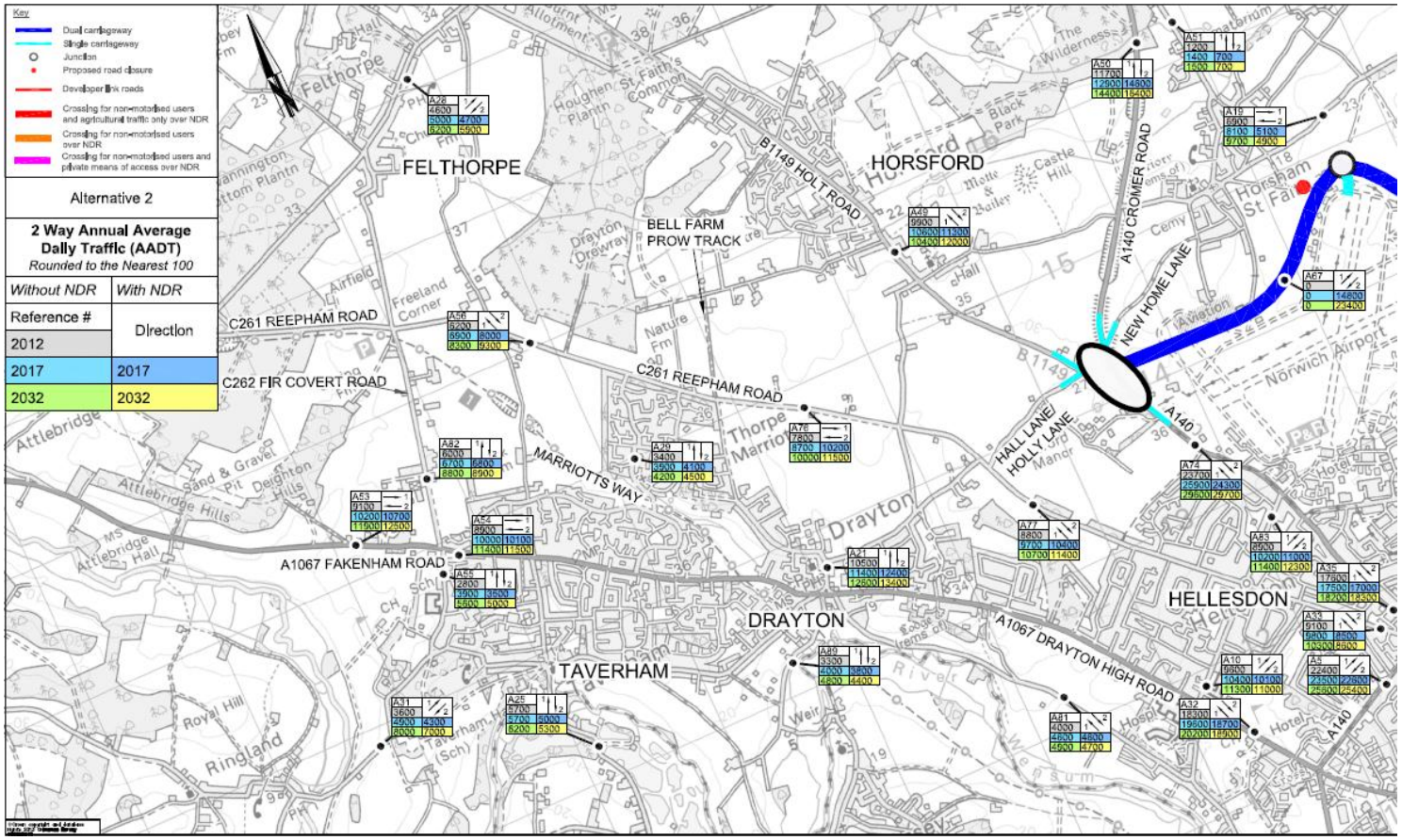


Figure 10.7: AADT Traffic Flows Eastern Section_Alternative 2

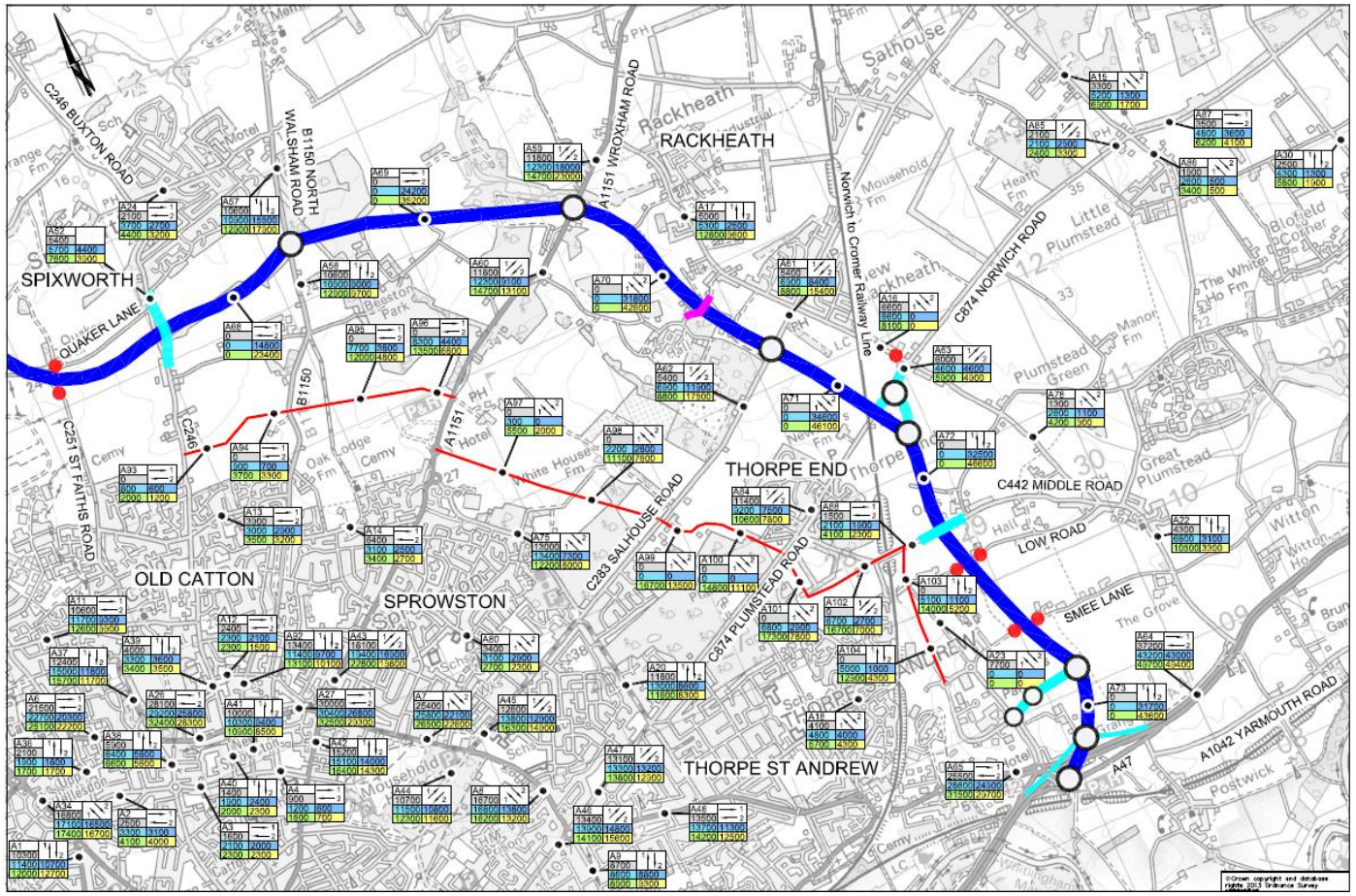


Figure 10.8: AADT Traffic Flows Wensum Valley Section_Alternative 2

Figure 10.9: Strategic Traffic Movements_Alternative 2

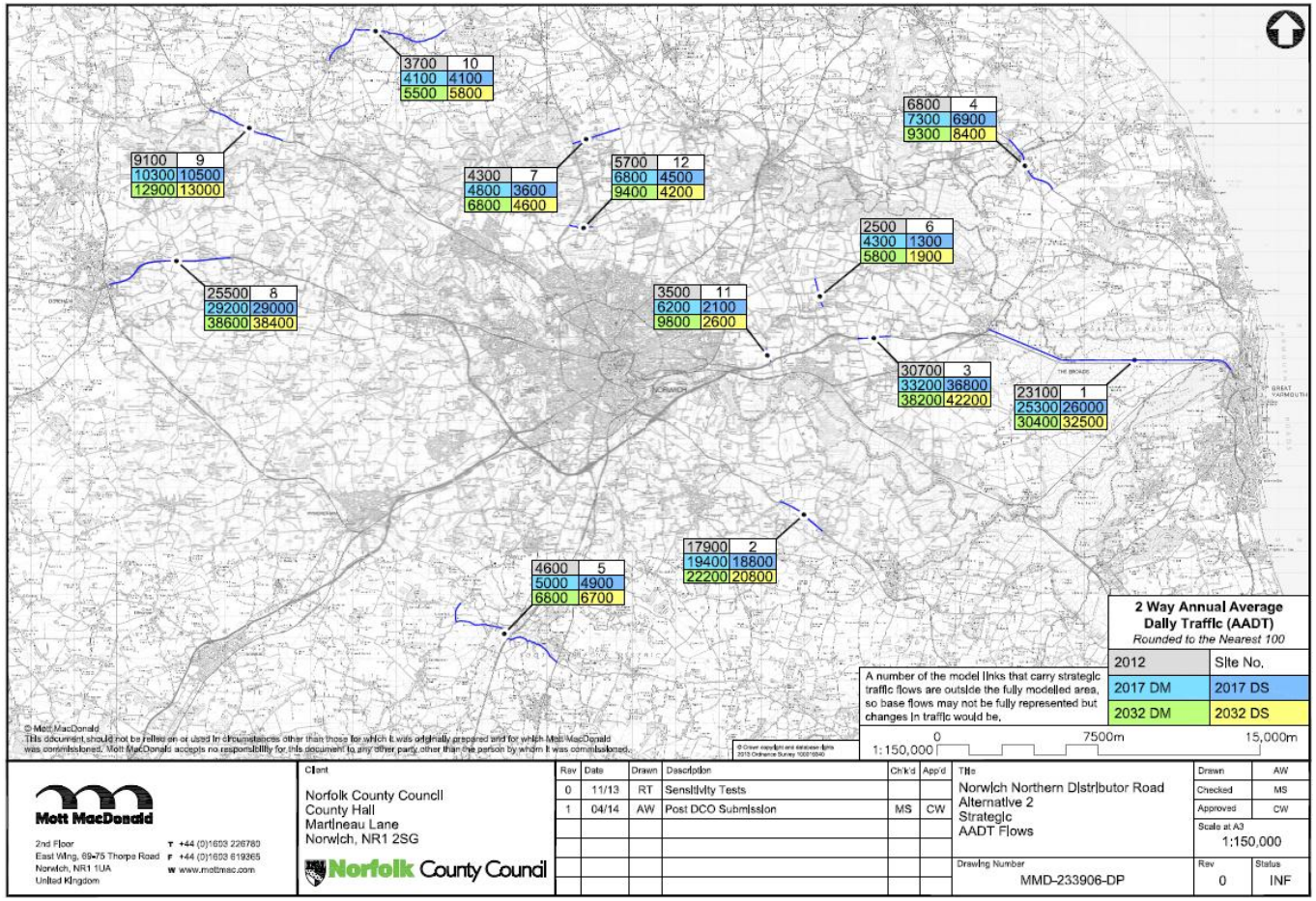


Figure 10.10: City Centre Traffic Impact_Alternative 2

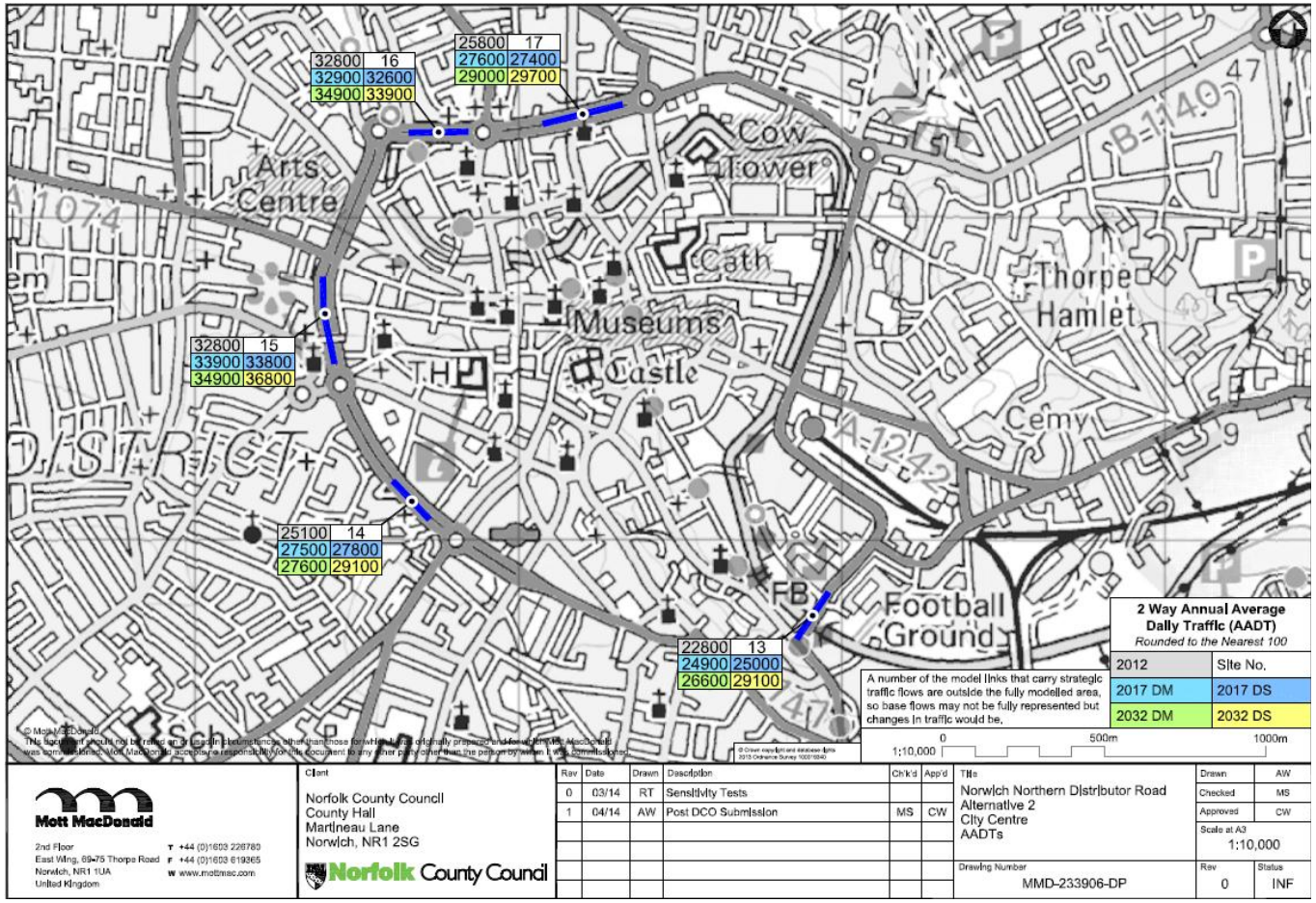


Figure 10.11: AADT Traffic Flows Western Section_Alternative 3

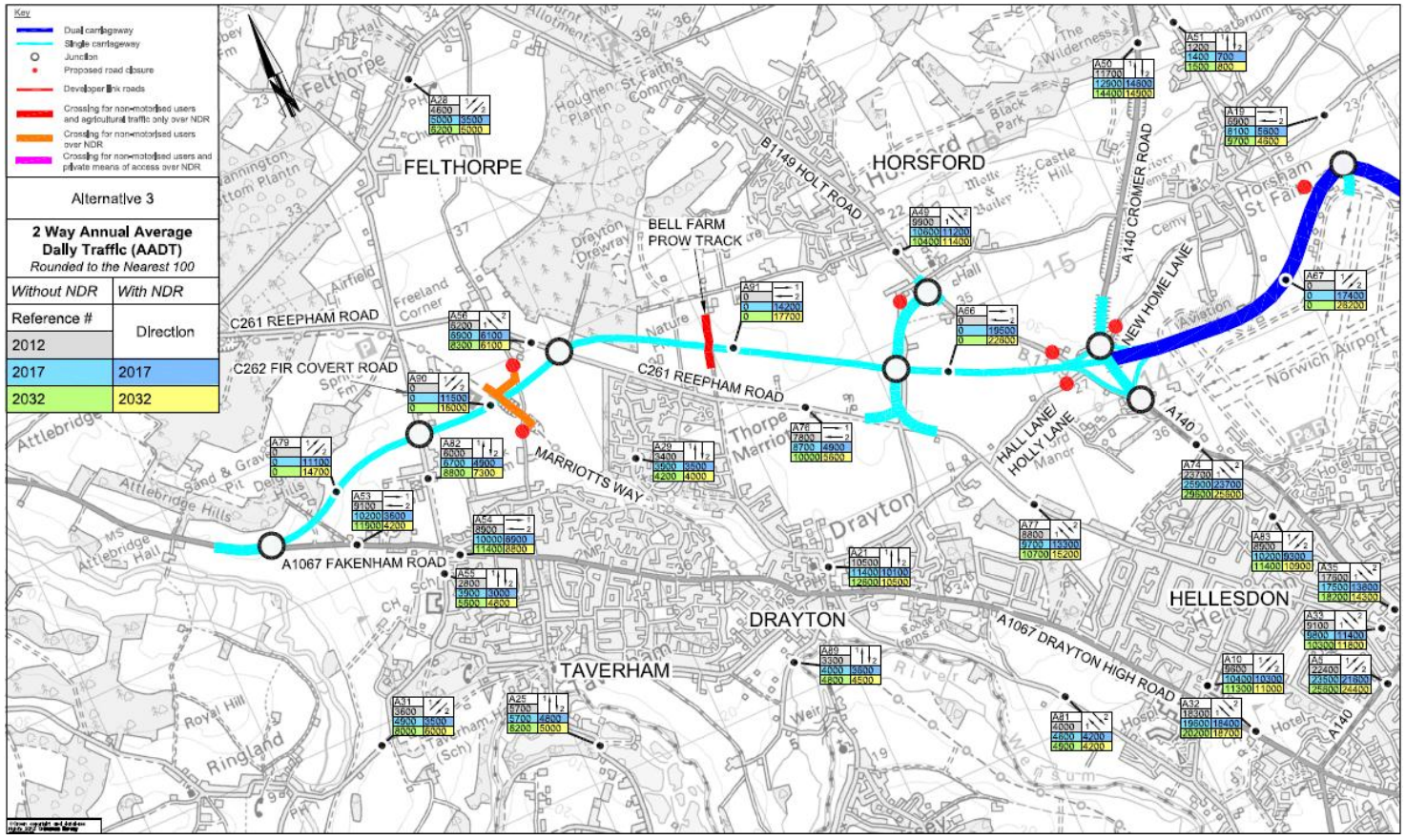


Figure 10.12: AADT Traffic Flows Eastern Section_Alternative 3

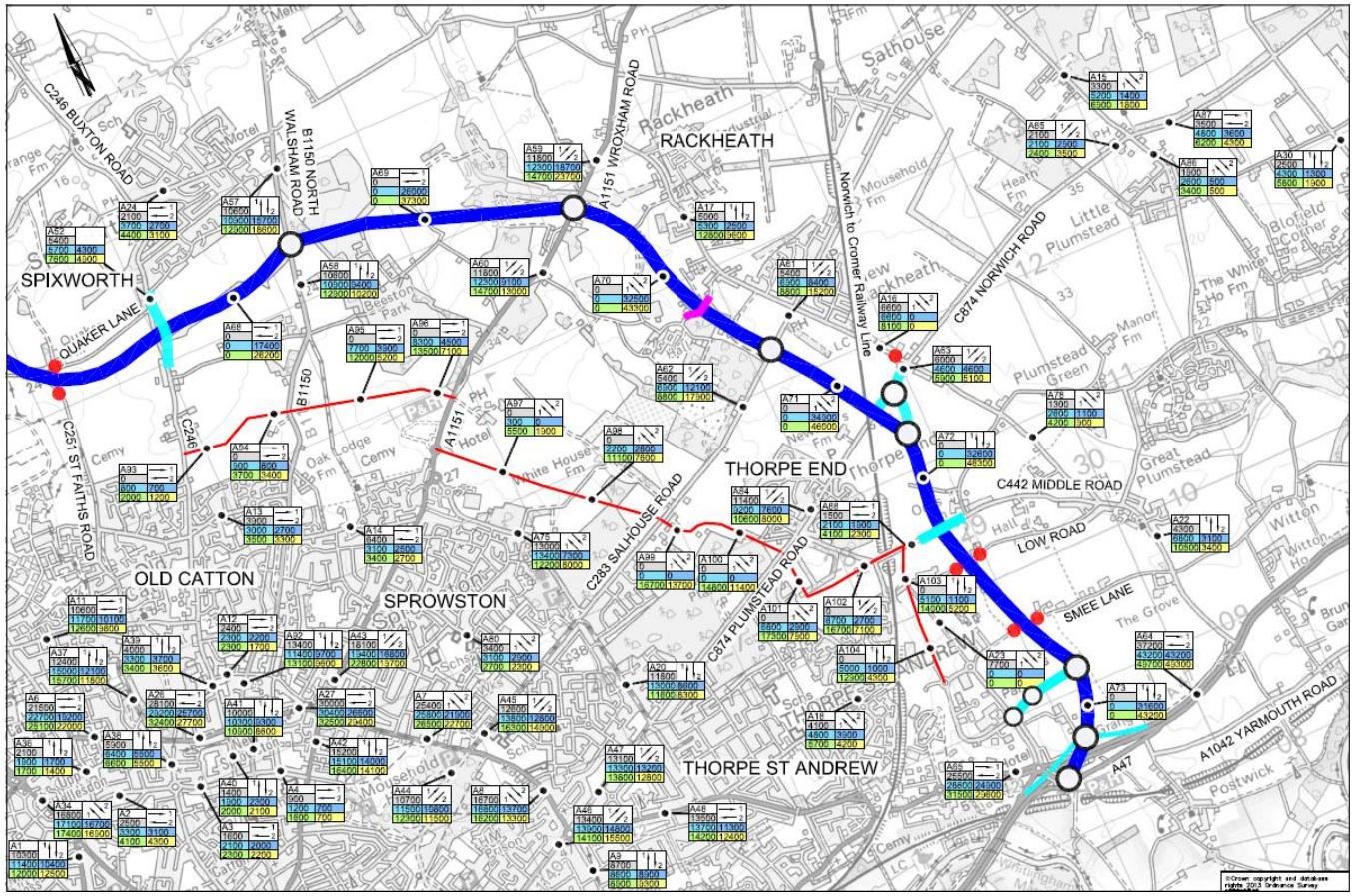


Figure 10.13: AADT Traffic Flows Wensum Valley Section_Alternative 3

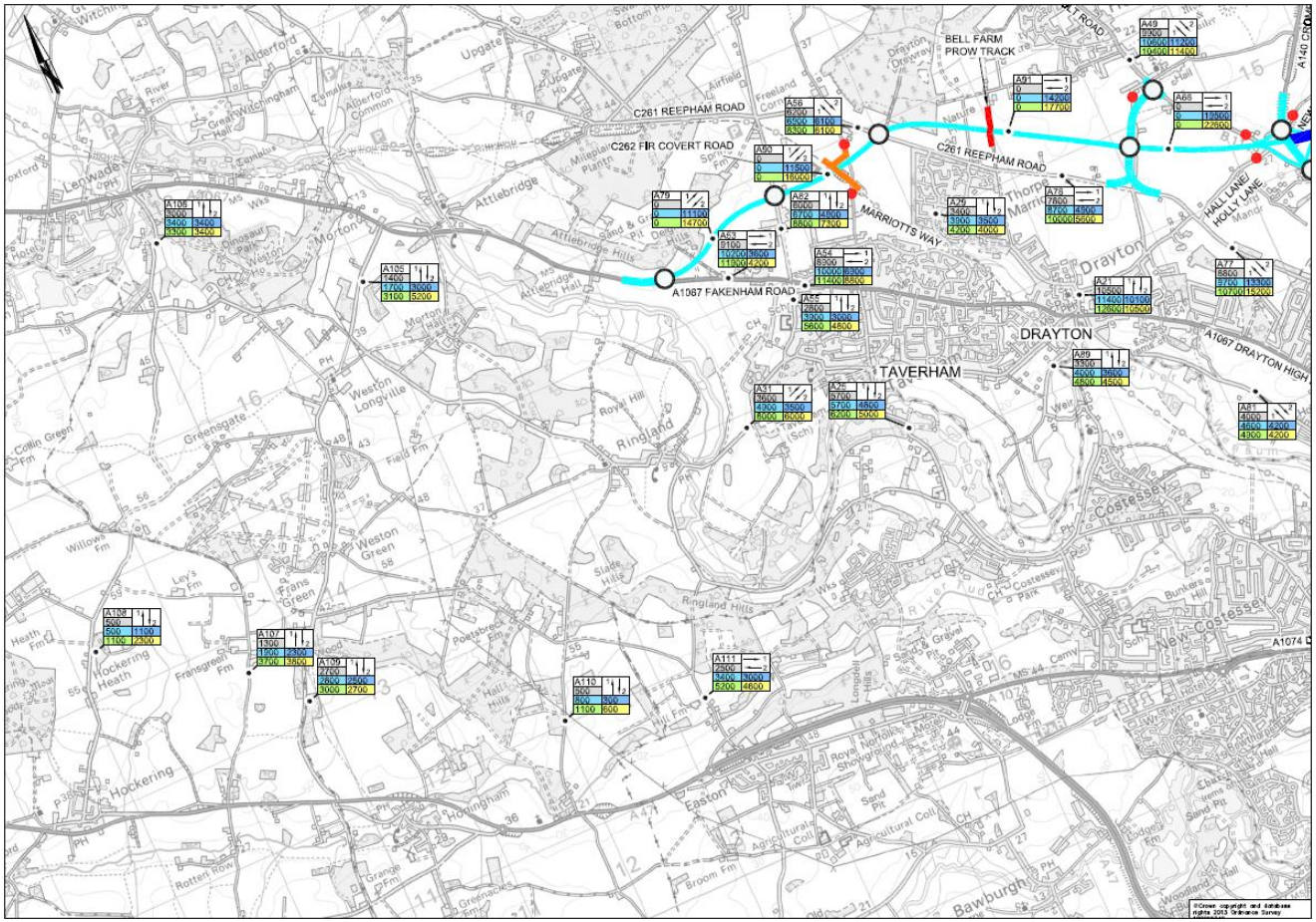


Figure 10.14: Strategic Traffic Movements_Alternative 3

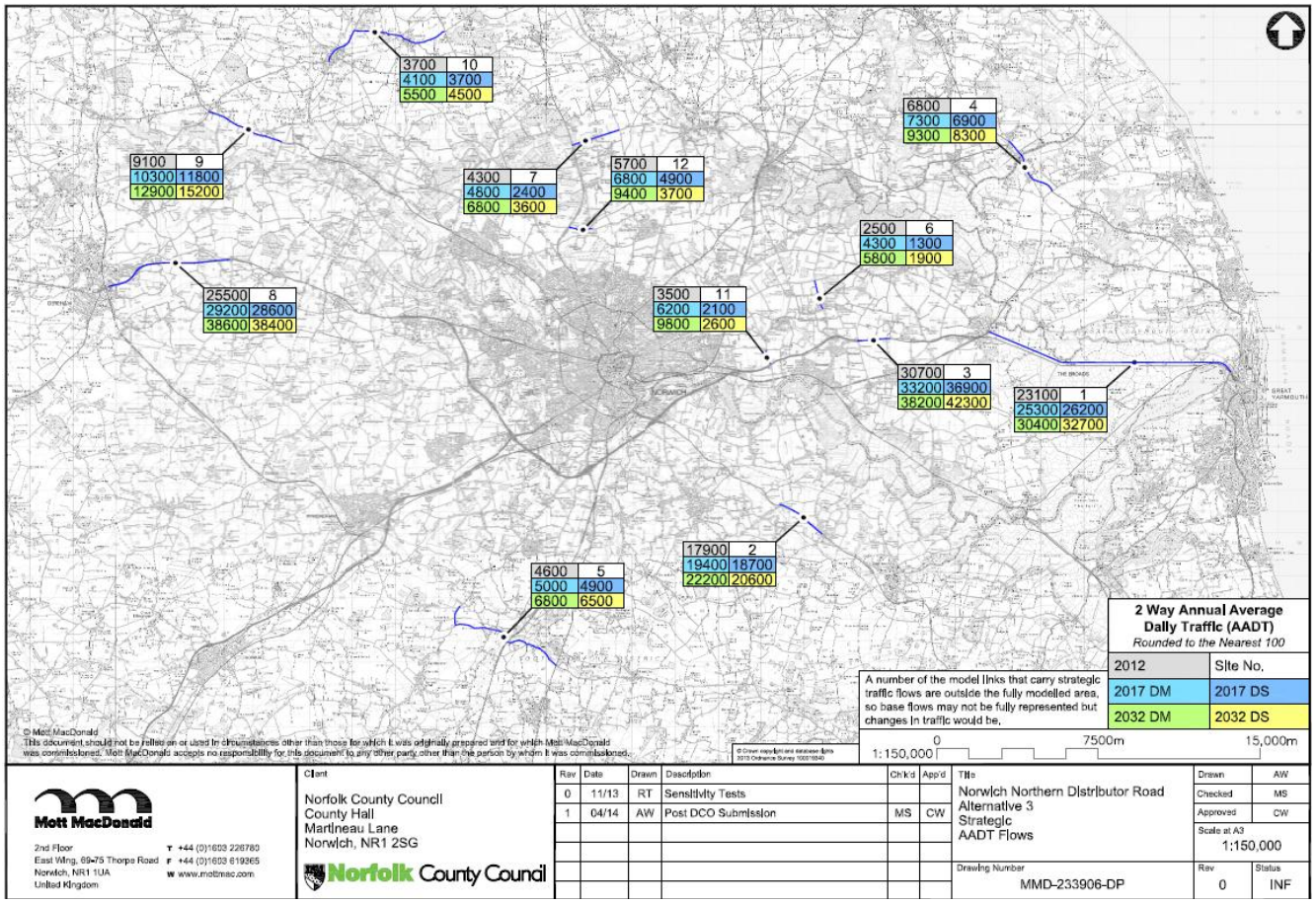


Figure 10.15: City Centre Traffic Impact_Alternative 3

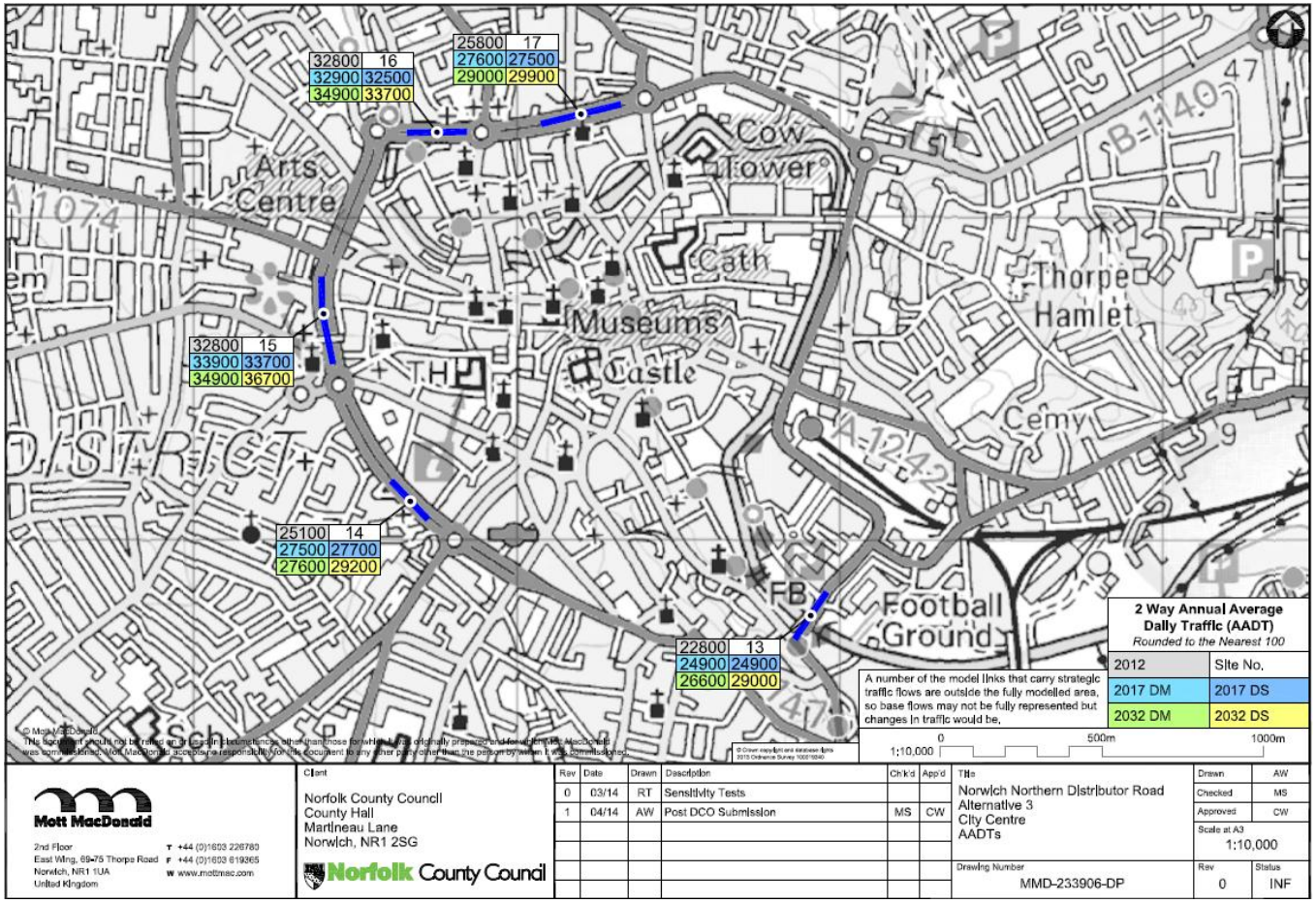


Figure 10.16: AADT Traffic Flows Western Section_Alternative 5

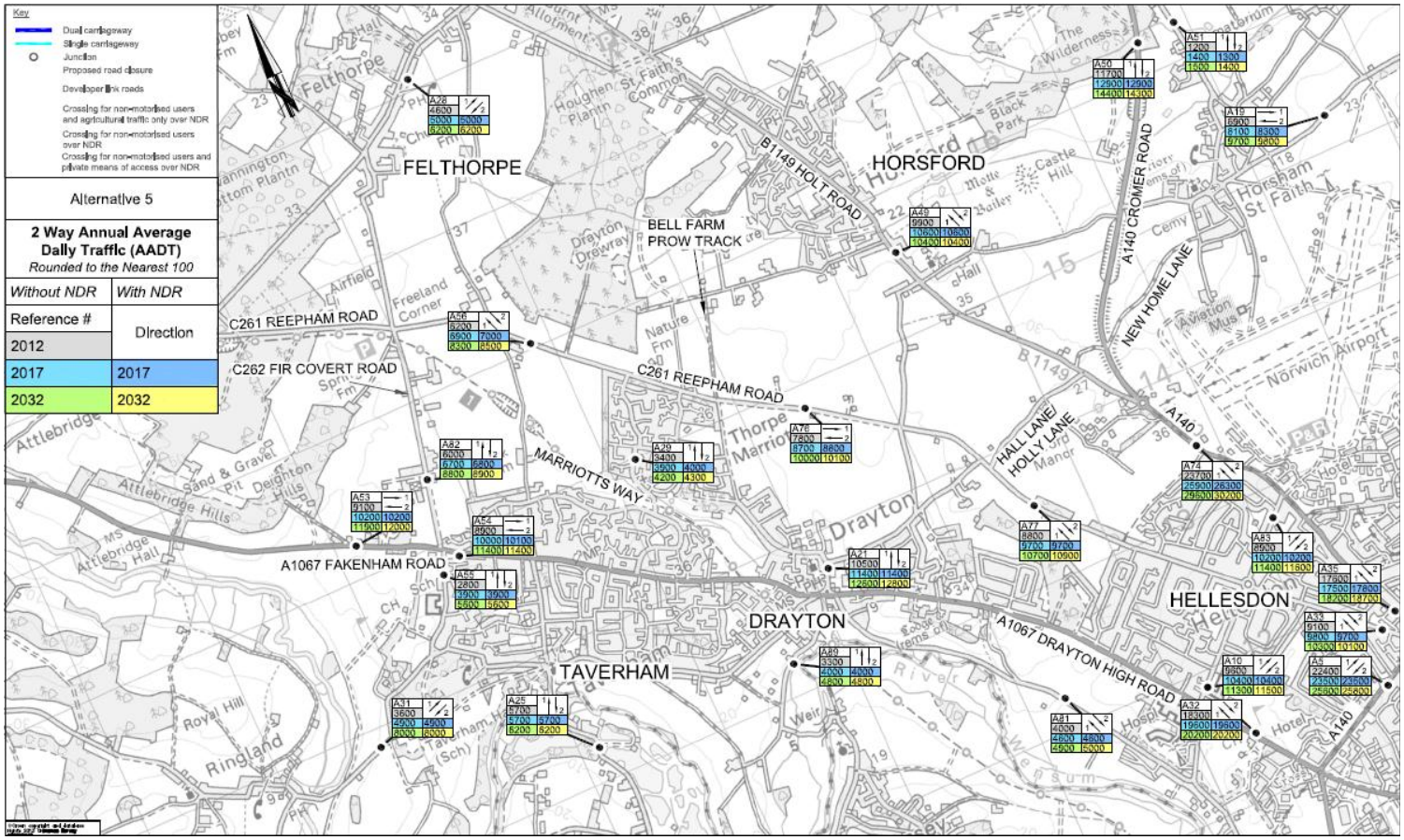


Figure 10.17: AADT Traffic Flows Eastern Section_Alternative 5

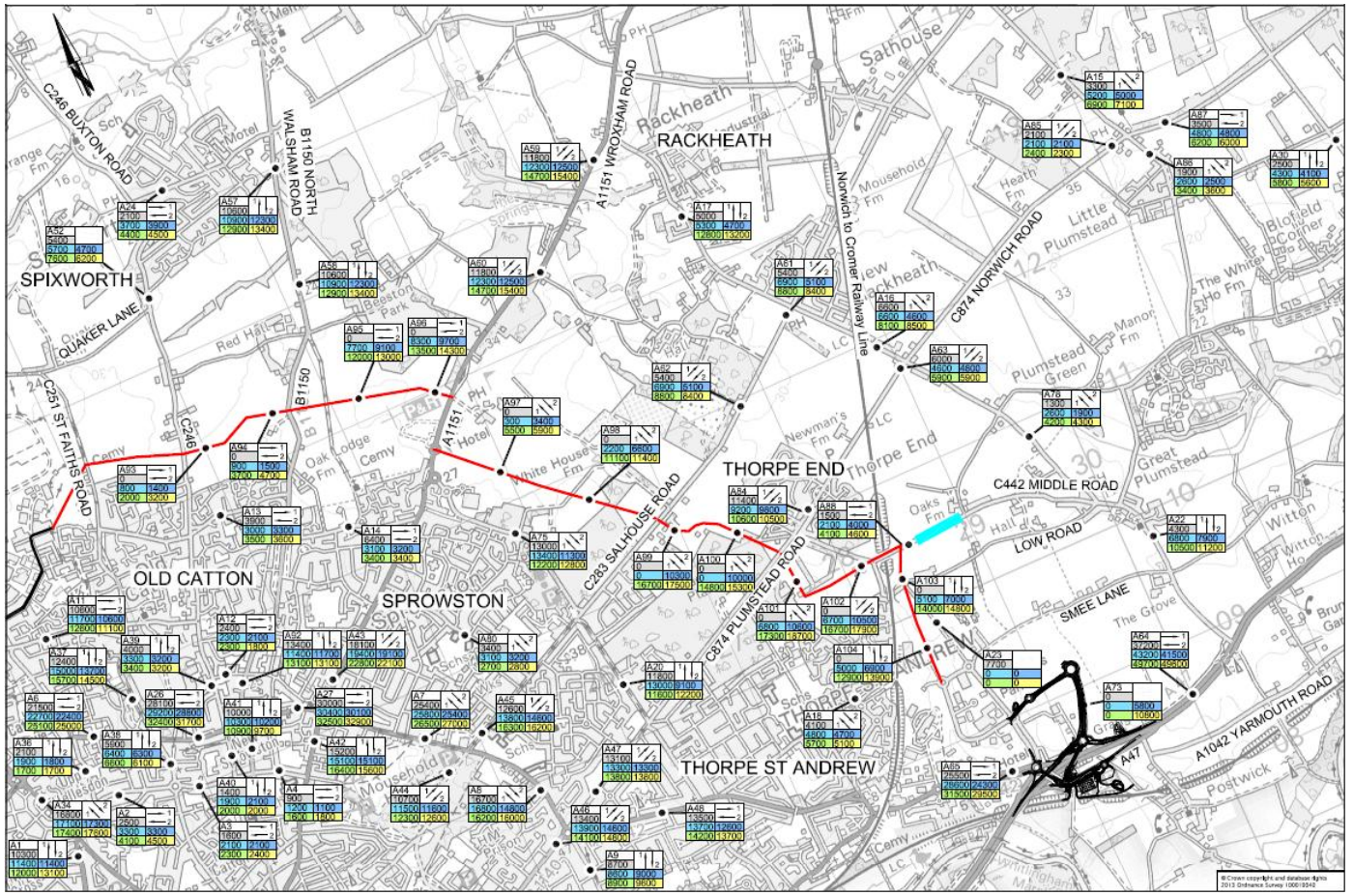


Figure 10.18: AADT Traffic Flows Wensum Valley Section_Alternative 5

Figure 10.19: Strategic Traffic Movements_Alternative 5

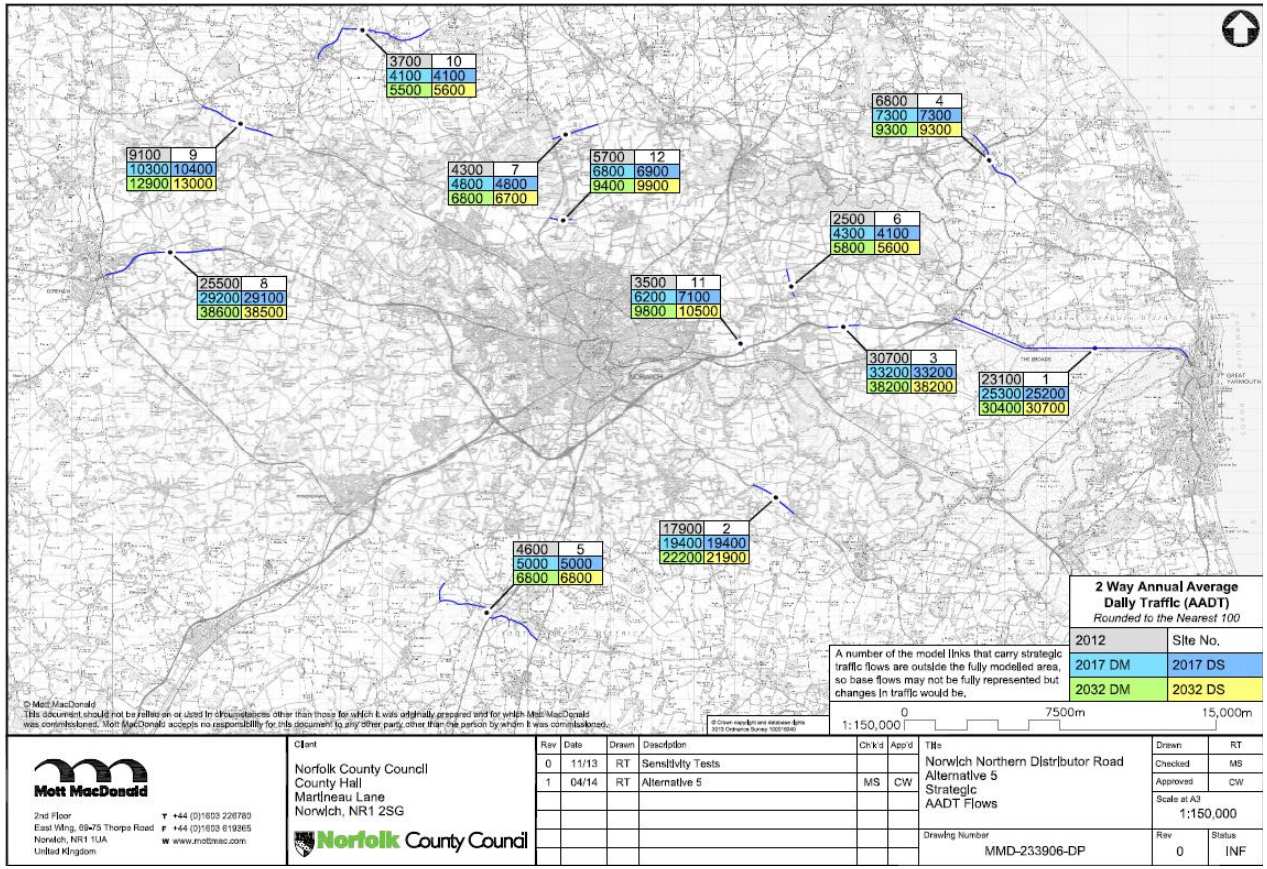
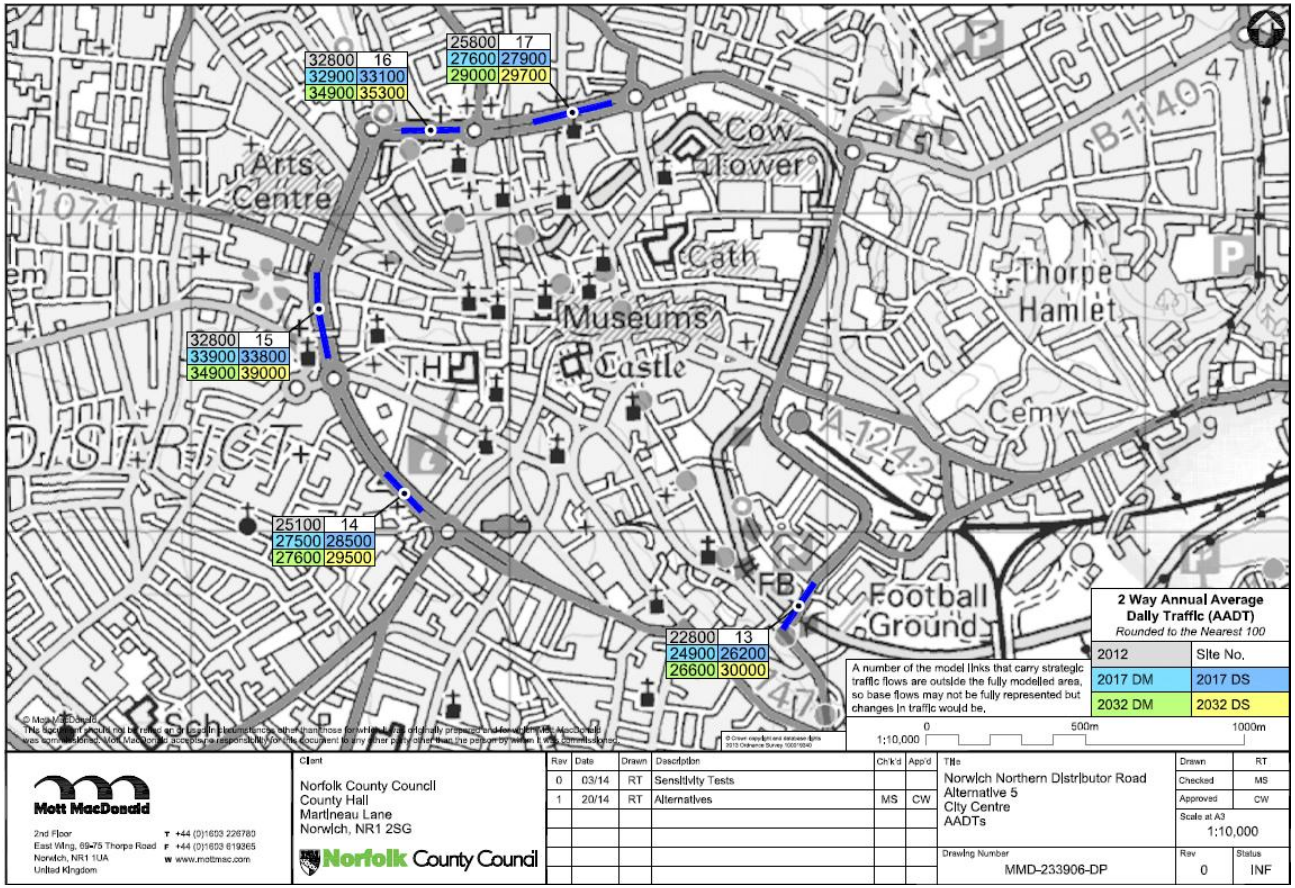


Figure 10.20: City Centre Traffic Impact_Alternative 5



10.2 Appendix B – Public Transport (PT) Option

Methodology

10.2.1 The DCO submission appraisal was based on an updated NATS transport model rebased to 2012 with variable demand forecasts for the NDR proposed opening year of 2017 and design year of 2032. The forecasts assumed full JCS growth both with and without the Scheme. The DCO Scheme comprised both NDR and Postwick.

10.2.2 In addition to the Alternatives tested, an option comprising significant improvements to public transport provision has been assessed. This PT Option comprises significant service improvements as well as quality enhancements and it has been combined with the extended developer link roads defined in Alternative 5.

10.2.3 The same transport model and forecast assumptions were used as applied to the appraisal of the DCO Scheme in the submission and the Alternatives.

10.2.4 Traffic and economic appraisals have been carried out for the PT Option. As with the DCO submission, the economic appraisal calculates TUBA benefits, wider economic benefits (using WITA) and journey time reliability benefits. The safety appraisal was based on COBA.

10.2.5 The costs of the PT Option are shared between the local authority and private sector, as appropriate.

10.2.6 A review of traffic impacts of the PT Option has been carried out and, where appropriate, operational assessment of key junctions has been undertaken.

10.2.7 The following assumptions are made for the analysis:

- The Do Minimum for the PT Option will be identical to that for the DCO Scheme submission.
- The PT Option includes the improvement at Postwick, the proposed city centre measures and the extended developer link roads defined in Alternative 5.
- All assignments are based on full JCS traffic as reference demand.
- The PT Option will be subject to variable demand modelling so the reference demand will be adjusted according to the forecast travel costs. This allows for trips switching between the modelled modes of transport.

Description of the PT Option

10.2.8 Table 10.1 summarises key assumptions and the appraisal required for the PT Option.

Table 10.1: Summary of the PT Option

Option	Modelling Required	Appraisal Required
PT Option (including developer link roads extending to A140 in place of NDR)	Coding DS PT and highway networks and running through demand model for 2017 and 2032 Assume 10min frequency throughout the day (0700-1900) for both core and BRT buses. No changes to fare structure. Assumed generalised time savings of 5min and 3.8min for BRT and core buses respectively for soft measures (see Table 3.2 for more details).	Economic and safety appraisal. Traffic forecast changes with DCO Operational assessment of key developer junctions Network performance assessment compared with the DCO scheme

10.2.9 The PT Option contains new Bus Rapid Transit (BRT) services and improvements to core bus routes. These routes are shown in Figure 10.21. In both cases the services are assumed to operate with a high frequency of every 10 minutes. For core bus routes existing services are recoded with the higher frequency, but the BRT services are assumed to be entirely additional to the existing public transport network. A new orbital bus is also added and assumed to operate with a high frequency of every 10 minutes and has a route via extended developer link roads between the Airport P&R and Postwick P&R and stops at major development locations. In total the service improvements would require around an additional 120 buses to be provided by the operators.

10.2.10 The developer link roads and junctions have been coded with proposed highway layouts set out in the developers planning application information.

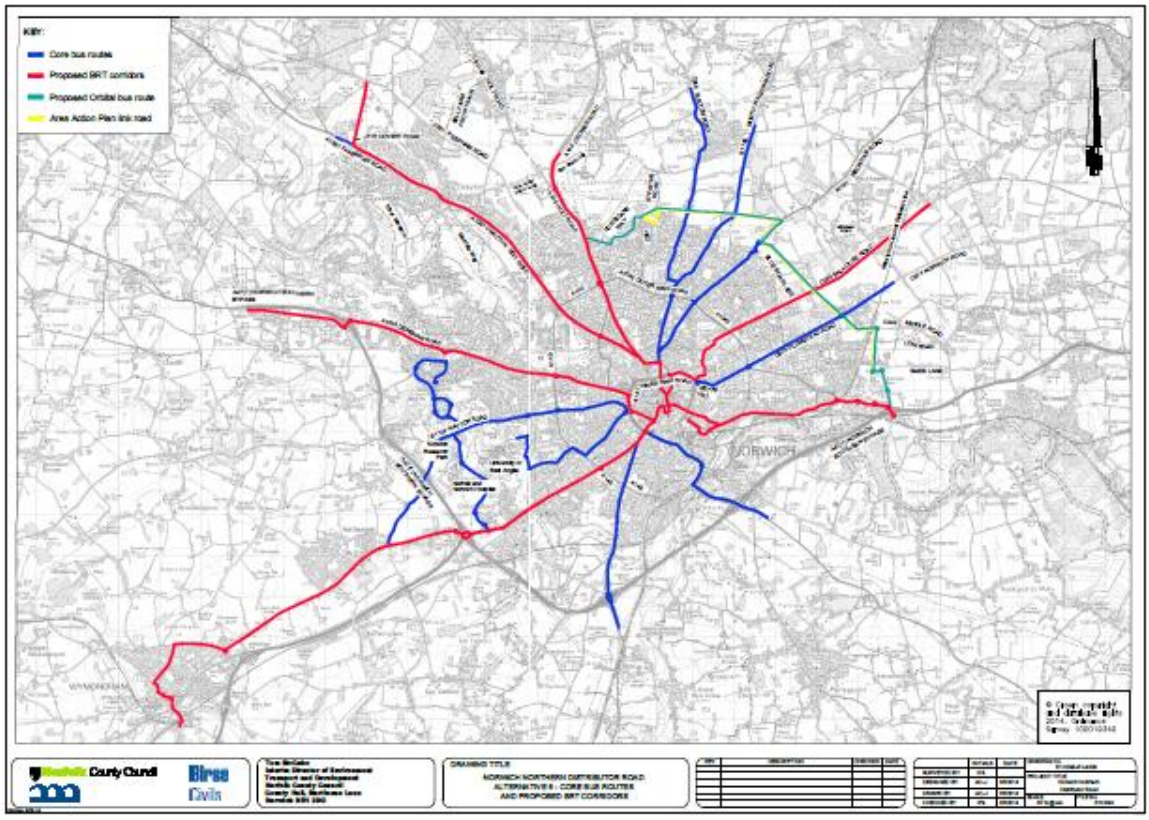
10.2.11 For the PT Option quality improvements are represented using generalised cost savings, in accordance with latest WebTAG guidance. Table 10.2 below shows the assumed generalised time savings for quality improvements for BRT, Core and orbital route buses. The individual savings are those recommended in WebTAG M3.2.

Table 10.2: Generalised Time Savings Assumed for Soft Quality Improvements

Soft Measure	WebTAG Savings* (mins)			Proposed Improvements?		Savings Assumed (mins)	
	Bus users	Car users	Overall	Core/Orbital bus	BRT	Core/Orbital bus	BRT
Audio Announcements	1.22			Yes	Yes	1.22	1.22
Climate Control	1.24			No	Yes	-	1.24
New Interchange Facilities	1.27			Yes	Yes	1.27	1.27
On-Screen Displays	1.90	0.89	1.29	Yes	Yes	1.29	1.29
Total savings						3.78	5.02

Notes: *WebTAG M3.2 Table M3.2.1

Figure 10.21: BRT and Core Bus Routes of the PT Option



PT Option Costs

10.2.12 The PT Option is assumed to include Alternative 5 with the extended developer link roads, so the costs comprise both the link roads and the PT services. The developer link roads in Alternative 5 allow for the orbital bus service to be defined.

10.2.13 The costs for the PT Option have been provided by NCC and are summarised in Table 10.3 below. Costs for the PT Option are allocated to both local government and private sector. It is assumed that the developer link roads will be adopted by the local highway authority once completed, hence the maintenance and operation costs will pass to the local authority. Otherwise the costs of implementing the link roads and expanding the bus fleet to provide the additional buses for the proposed service enhancements is allocated to the private sector.

Table 10.3: Summary Costs of the PT Option

Cost Type	Cost (£m) in 2013Q1 Prices	
	DCO Scheme	PT Option
Investment costs		
Construction	110.2	37.7
Land	22.0	2.4
Preparation	7.8	3.8
Supervision	1.3	0.4
Total investment Cost	141.3	44.3
Other costs		
Maintenance	27.8	5.5
Operation	15.9	1.4
Cost of buses*		1,211.9

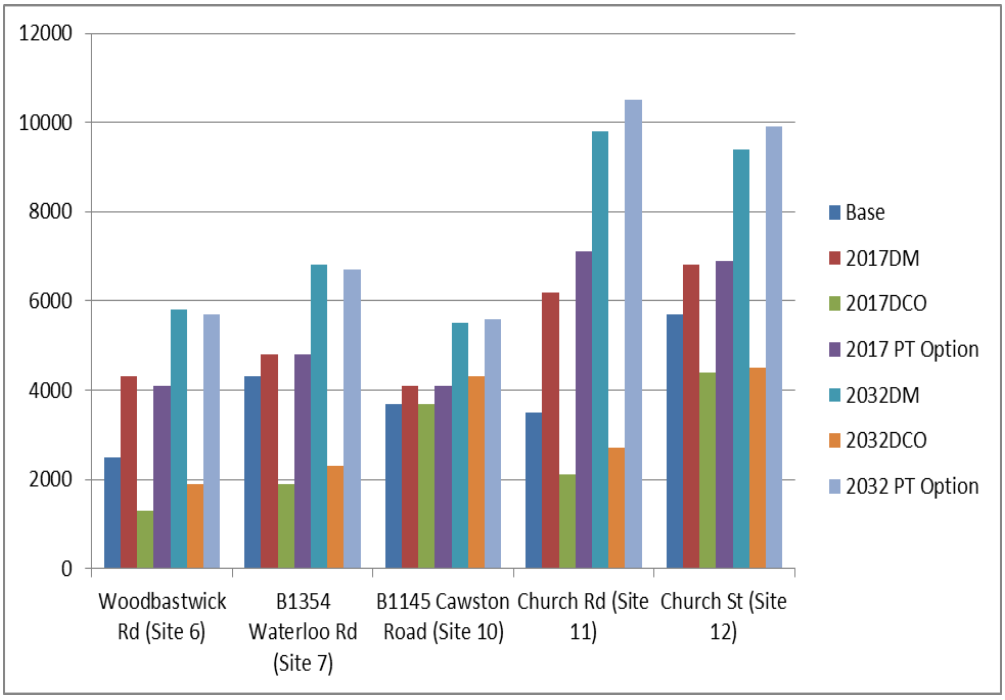
Notes: These are initial costs before adjusting for construction price inflation and optimism bias
*These include cost of buying buses, maintenance and operation costs. From the total cost mentioned above (£1211.9m), £1,084.5m of this is due to BRT and core bus operating costs over the 60 year appraisal period, the remainder is for bus procurement and maintenance.

10.2.14 Costs were adjusted as per Document Reference 5.7 before inputting into TUBA. It should also be noted that the profiles of construction costs in calendar years input into TUBA for the PT Option were derived by assuming a similar profile to that used for the DCO Scheme.

Traffic Analysis Results

10.2.15 Figure 10.22 shows traffic levels on inappropriate routes for PT Option.

Figure 10.22: Traffic on Inappropriate Routes – PT Option



10.2.16 As shown in the above figure the traffic levels on the inappropriate routes would remain as high as in the Do Minimum or even increase with the PT Option. The Church Road and Church St routes are, for example, forecast to have a slight increase in two way AADT flows of 900 (15%) and 100 (1%) respectively in 2017 in comparison with the traffic flows in the 'Do Minimum' scenario. In 2032 the increase is 700 (7%) and 500 (5%) respectively. By contrast, in the DCO scenario, the reduction on these two sites are 4,100 (66%) and 2,400 (35%) in 2017 and 7,100 (72%) and 4,900 (52%) in 2032 respectively. These figures demonstrate that the PT Option is not capable of reducing traffic on inappropriate routes.

10.2.17 Table 10.4 below contains city centre through traffic across three cordons. More details on these cordons can be found in Document Reference 5.6. The table shows that traffic crossing the city centre Inner Ring Road cordons is reduced by a smaller degree with the PT Option compared with the DCO Scheme, mostly achieved by the city centre measures that are assumed to be implemented in both cases. However the city centre traffic crossing the outer cordon is reduced by a relatively small amount with the PT Option when compared with the reductions achieved by the DCO Scheme and thus there would be significant increases in this traffic over existing levels on the Outer Ring Road with the PT Option whereas with the DCO Scheme they are forecast to reduce.

Table 10.4: City Centre Through Traffic (AADT) for PT Option

Cordon*	2012	2017			2032		
		DM	DCO	PT Option	DM	DCO	PT Option
Inner Ring Road Inner Cordon	9,477	8,159	6,787 (-17%)	7,428 (-9%)	9,236	4,726 (-49%)	5,025 (-46%)
Inner Ring Road Outer Cordon	77,825	82,152	78,369 (-5%)	81,105 (-1%)	88,368	80,352 (-9%)	83,606 (-5%)
Outer Ring Road Outer Cordon	68,117	73,691	63,421 (-14%)	70,117 (-5%)	79,151	66,780 (-16%)	76,584 (-3%)

Notes: *More details on Cordons can be found in Document Reference 5.6

10.2.18 Graphical presentations of these results are shown in Figure 10.23 and Figure 10.24.

Figure 10.23: Through Traffic Crossing Cordons in 2017 – PT Option

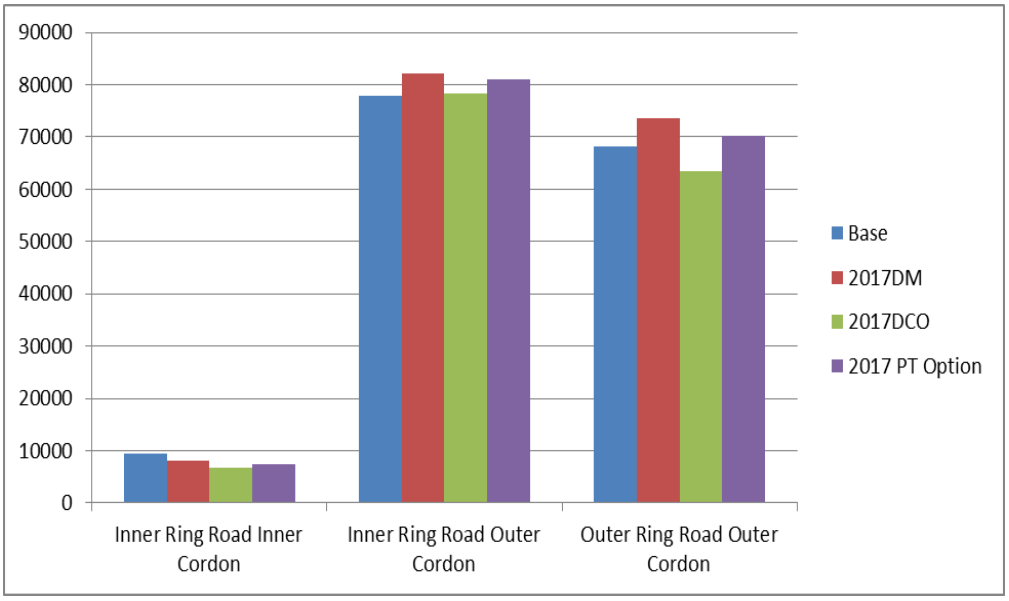
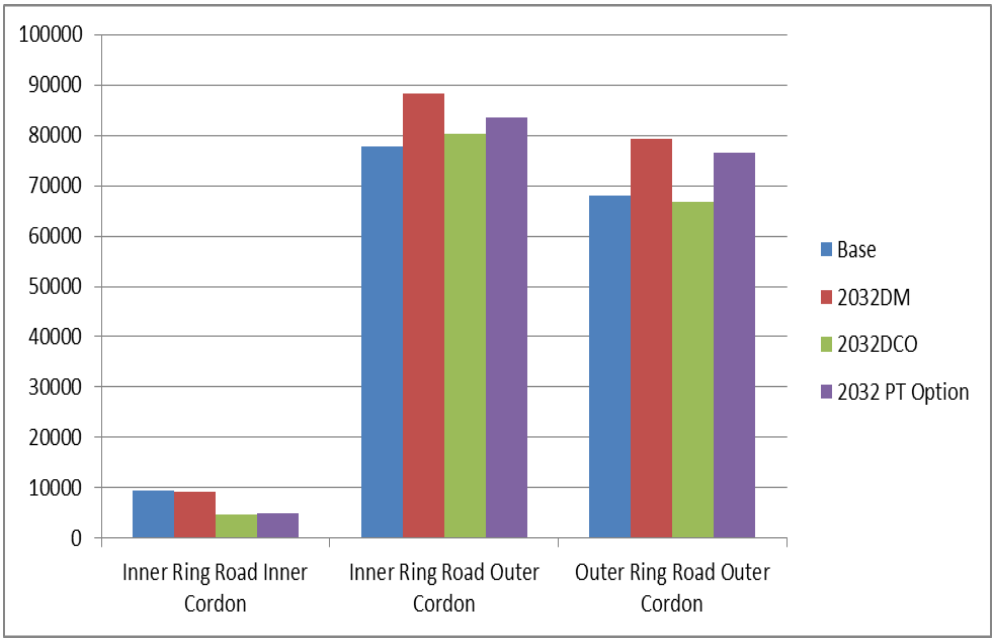


Figure 10.24: Through Traffic Crossing Cordons in 2032 – PT Option



Junction Analyses

10.2.19 Table 10.5 to Table 10.7 compare maximum DoS, maximum queue and delay for key developer link junctions between the DCO Scheme and the PT Option for 2032DS AM and PM peaks. The results show that the junctions of Spixworth Main Street and St Faith Main Street (new or modified junctions in the PT Option so they are not comparable with the DCO Scheme results) would operate within desirable capacity in the PT Option. However the junctions of North Walsham Road and Wroxham Road (coded with the developer's proposals) would operate substantially over their theoretical capacity with long queues and delays, with delays of over 9 minutes in the 2032 AM peak, and 4 minutes in the 2032 PM peak at these two junctions. On these grounds the developer link roads would not operate satisfactorily and they would cause particularly severe difficulties in implementing the proposed shared use high street-type design envisaged in the development proposals. The delays would also mean that the PT Option would fail to meet the improved transport connectivity objective for the Scheme.

Table 10.5: Junction Operational Assessment Results_PT Option – 2032 Max DoS

Junction	AM		PM	
	DCO	PT Option	DCO	PT Option
Developer junctions				
Spixworth Main Street*	-	84.3%	-	64.1%
St Faith Main Street*	-	81.3%	-	77.6%
North Walsham Road	92.4%	135.7%	73.6%	111.4%
Wroxham Road	77.7%	133.3%	76.6%	110.7%

Notes: All these are signalised junctions, *These refer to modified/new junctions in PT Option

Degree of Saturation (DoS) output form LINSIG is the primary measure of performance of a signalised junction. DoS less than 90% indicates that a junction arm operates within capacity. DoS greater than 90% but less than 100% indicates that a junction arm is over its desired capacity but below theoretical capacity. Any DoS greater than 100% indicates that a junction arm is in excess of theoretical capacity.

Table 10.6: Junction Operational Assessment Results_PT Option – 2032 Max Queue (PCUs)

Junction	AM		PM	
	DCO	PT Option	DCO	PT Option
Developer junctions				
Spixworth Main Street*	-	7	-	5
St Faith Main Street*	-	5	-	8
North Walsham Road	22	144	13	53
Wroxham Road	16	88	18	62

Notes: All these are signalised junctions, *These refer to modified/new junctions in PT Option

Table 10.7: Junction Operational Assessment Results_PT Option – 2032 Max Delay (sec)

Junction	AM		PM	
	DCO	PT Option	DCO	PT Option
Developer junctions				
Spixworth Main Street*	-	80	-	47
St Faith Main Street*	-	57	-	46
North Walsham Road	75	565	54	269
Wroxham Road	89	566	91	258

Notes: All these are signalised junctions, *These refer to modified/new junctions in PT Option

Safety Analysis Results

10.2.20 The PT Option safety analysis results in Table 10.8 show that there would be a small number of personal injury accidents saved but that the changes in the numbers of casualties would result overall in safety economic dis-benefits.

Table 10.8: Accident Benefits – PT Option

60 Year Appraisal Period		Scenario	
		DCO	PT Option
		Do Minimum	
Number of PIAs		70,984	70,984
Casualties	Fatal	1,890	1,890
	Serious	12,597	12,597
	Slight	91,490	91,490
Accident Costs		5,999,332	5,999,332
		Do Something	
Number of PIAs		69,944	70,957
Casualties	Fatal	1,898	1,898
	Serious	12,488	12,624
	Slight	90,226	91,479
Accident Costs		5,958,113	6,011,050
		Accident Benefits	
Number of PIA savings		1,041	27
Casualties	Fatal	-7	-8
	Serious	109	-27
	Slight	1,263	11
Accident Savings		41,219	-11,718

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

Economic Analysis Results

10.2.21 Table 10.9 below compares monetised costs and benefits including accident benefits for PT Option against the DCO scheme.

Table 10.9: Analysis of Monetised Costs and Benefits – PT Option

Item	Accidents Included (£000)	
	DCO	PT Option
Accidents (not assessed by TUBA)*	41,219	-11,718
Greenhouse Gases**	-22,756	-5,431
Economic Efficiency: Consumer Users (Commuting)	51,164	-38,950
Economic Efficiency: Consumer Users (Other)	380,623	-52,941
Economic Efficiency: Business Users and Providers	267,797	-827,699
Wider Public Finances (Indirect Taxation Revenues)	55,270	20,803
Present Value of Benefits (PVB)	773,317	-915,936
Broad Transport Budget Present Value of Costs (PVC)	185,542	26,611
OVERALL IMPACTS		

Item	Accidents Included (£000)	
	DCO	PT Option
Net Present Value (NPV)	587,775	-942,547
Benefit to Cost Ratio (BCR)	4.168	-34.419

Notes: All monetary values are expressed in 2010 prices discounted to 2010
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7
**Greenhouse gas impacts were calculated using TUBA1.9.2 since there was a bug in TUBA 1.9.1

10.2.22 The results show that the Present Value of Benefits (PVB) of the PT Option is estimated to be £-916m (inclusive of accident benefits). A major factor in this is the private sector costs which TUBA allocates as negative benefits rather than costs to public accounts as they are private sector funded. This includes the costs of the developer link roads and the additional bus services which amount to -£502. The PT Option also produces transport efficiency economic disbenefits as any benefits of the extended link roads and the bus services are outweighed by the reduced performance due to overcapacity and due to the effects of introducing city centre traffic management measures without significant traffic relief being provided by the PT Option. Set against these PVB results is the £27m Present Value of Costs (PVC) to public accounts.

10.2.23 The Benefit Cost Ratio (BCR) of PT Option is -34.42 including accidents which does not represent good value for money.

10.2.24 Table 10.10 below compares summary economic appraisal results including wider impacts and journey time reliability for PT Option against the DCO scheme.

Table 10.10: Summary of Economic Appraisal including Wider Benefits – PT Option

Item	Scenario also including WEBs and JTR (£000)	
	DCO	PT Option
Present Value of Benefits (PVB)	989,063	-1,230,045
Present Value of Costs (PVC)	185,542	26,611
Net Present Value (NPV)	803,521	-1,256,656
Benefit to Cost Ratio (BCR)	5.331	-46.223

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

10.2.25 The BCR of the PT Option deteriorates even further to -46.22 once journey time reliability benefits (£-30m) and wider economic benefits (£-284m) are included in the appraisal. These additional dis-benefits amount to £-314m (2010 prices discounted to 2010). The inclusion of these dis-benefits result in

a more negative BCR although it should be noted that the BCR is not a meaningful term when the benefits are negative.

10.2.26 The economic appraisal results highlight that the performance of the PT Option is especially poor and does not offer good value for money. It should be noted however that the appraisal has not attempted to assess any development benefits that may arise with the link roads.

Conclusion

10.2.27 **PT Option** (PT improvements and developer link roads) fails to reduce traffic on inappropriate routes and relieve the existing network. Whilst the it includes the improvements to PT services and city centre traffic management measures the reductions of cross city centre traffic are much smaller compared with the DCO Scheme, especially for trips crossing the Outer Ring Road Cordon. The junction analyses show that the junctions between the developer link roads and North Walsham Road and Wroxham Road would operate substantially over their theoretical capacity with long queues and delays, with delays of over 9 minutes in the 2032 AM peak and 4 minutes in the 2032 PM peak. On these grounds the developer link roads would not operate satisfactorily and they would cause particularly severe difficulties in implementing the proposed shared use high street-type design envisaged in the development proposals. The delays would also mean that the PT Option would fail to meet the improved transport connectivity objective for the Scheme. The economic appraisal results highlight that the performance of the PT Option is especially poor and does not offer good value for money. The Option produces transport efficiency economic disbenefits as any benefits of the extended link roads and the improvements to PT are outweighed by the reduced performance due to overcapacity and due to the effects of introducing city centre traffic management measures without significant traffic relief being provided by the Option. The calculated BCR is -34.42 with accidents included and even worse with JTR and WEBs giving -46.22, although the BCR is not a meaningful term when the benefits are negative.

11 Abbreviations

AADT	Annual Average Daily Traffic
ARCADY	Assessment of Roundabout Capacity and Delay software
AST	Appraisal Summary Table
ATC	Automatic Traffic Count
B1/B2/B8	Development categories: business (including office) / general industrial / storage and distribution
BAFB	The Best And Final funding Bid submitted by Norfolk County Council to the Department for Transport in 2011 for the combined Postwick and NDR schemes
BCIS	Building Cost Information Service
BCR	Benefit Cost Ratio
BGBP	Broadland Gate Business Park development
COBA	Cost Benefit Appraisal – software released by the Department of Transport that has been used to undertake an accident appraisal
DfT	Department for Transport
DIADEM	Dynamic Integrated Assignment and Demand Modelling - software released by the Department for Transport
DM	Do Minimum
DMRB	Design Manual for Roads and Bridges – a Highways Agency publication setting out guidance and good practice for design and appraisal of road schemes
DS	Do Something
EB	Employer's Business
GAP	Minimum gap (in seconds) accepted by a vehicle which gives way at priority junctions or traffic signals. Also a measure of Wardrop equilibrium assignment convergence
GAPR	As GAP above in relation to junctions but for entry onto roundabouts
GDP	Gross Domestic Product
GEH	A comparison statistic named after GE Havers
GIS	Geographic Information System - designed to capture, store, manipulate, analyse, manage, and present all types of geographical data
GNDP	Greater Norwich Development Partnership
GPS	Global Positioning System
GVA	Gross Value Added
HA	Highways Agency
HB	Home Based (trips)
HBEB	Home Based Employers' Business (trips)
HBO	Home Based Other (trips)
HBW	Home Based Work (commuter trips)
HGV	Heavy Goods Vehicle
IP	Inter-peak

JT	Journey Time
JCS	Joint Core Strategy
JTR	Journey Time Reliability
LGV	Light Goods Vehicle
LINSIG	Traffic signal analysis software
LMVR	Local Model Validation Report
MCC	Manual Classified Count (for a link)
MCTC	Manual Classified Turning Counts
ME	Matrix Estimation
NATS	Norwich Area Transportation Strategy
NCC	Norfolk County Council
NDR	Norwich Northern Distributor Road
NHB	Non-Home Based (trips)
NHBEB	Non-home-based Employer's Business
NHBO	Non-home-based Other
NPV	Net Present Value – given by subtracting the Present Value Costs (PVC) from Present Value Benefits (PVB)
NTEM	National Trip End Model – a database containing trip-end, journey mileage, car ownership and population/workforce planning data
NTM	National Transport Model
NTS	National Travel Survey
OD	Origin Destination
OE	Other Externalities
OGV	Other Goods Vehicle (sometimes called HGV)
OGV1	A sub-category of OGV. Includes all rigid vehicles over 3.5 tonnes gross vehicle weight with two or three axles
OGV2	A sub-category of OGV. Includes all rigid vehicles with four or more axles and all articulated vehicles
OP	Off-peak
PA	Production Attraction
PCU	Passenger Car Unit
PDL	Previously Developed Land
PG	Planning Gain
PIA	Personal Injury Accident
PPK	Pence Per Kilometre
PPM	Pence Per Minute
PT	Public Transport
PVB	Present Value Benefits – the stream of benefits over the appraisal period (60 years) that are converted to 2010 prices and discounted to 2010 to give a 'present value'
PVC	Present Value Costs – the costs of the scheme over the construction period as well as maintenance and operational costs that are converted to 2010 prices and discounted to 2010 to give a 'present

	value'
PYV	Present Year Validation
P&R	Park and Ride
QRA	Quantified Risk Assessment
RFC	Ratio of Flow to Capacity
RPI	Retail Price Index
RSI	Road Side Interview
RTF	Road Transport Forecasts
SATME2	Matrix estimation module of the SATURN software
SATURN	Simulation – Assignment model of Traffic on Urban Road Networks software
SRN	Strategic Road Network
TA	Transport Assessment
TEC	Transport Externality Cost
TRADS	Traffic flow Data System – the Highways Agency's database of traffic count data
TRICS	National Trip Generation database
TEMPRO	Trip End Model presentation Program is software released by the Department for Transport to allow detailed analysis of NTEM data
TUBA	Transport User Benefit Appraisal – software released by the Department for Transport that is used to assess transport user benefits of transport schemes
VDM	Variable Demand Modelling
VfM	Value for Money
VISUM	Transport modelling software used (in this case) for public transport modelling
VOC	Vehicle Operating Costs
VOT	Value Of Time
WEBs	Wider Economic Benefits
WebTAG	Web-based Transport Appraisal Guidance produced by the Department for Transport
WITA	Wider Impacts in Transport Appraisal

12 Glossary

Assignment	A process of loading a trip matrix onto routes through a network that accounts for travel costs on the network in identifying the optimum route choice for every trip
Buffer network	The external part of a highway network in which travel is represented by speed/ flow relationships or cruise speeds
Calibration	A process of adjusting the model input data or model parameters to improve the model and its validation
Convergence	An equilibrium between model outputs, in assignment between the flows and travel costs and in demand models between the demand and the costs from the supply model
Cost matrix	A table of travel costs for journeys that may include travel time, operating costs and charges such as tolls or fares
Cruise speeds	Average travel speed along a network link
Demand model	See variable demand model
Demand segment	Travel demand is divided into a number of segments for the purposes of applying different demand modelling procedures. The division is usually by trip purpose and whether the trips are home-based or non-home-based
DMRB	Design Manual for Roads and Bridges – a Highways Agency publication setting out guidance and good practice for design and appraisal of road schemes
Dependent development	Housing or commercial development that can only proceed with the implementation of a transport intervention
Discounting	Discounting is a technique used to compare costs and benefits that occur in different time periods. It is based on the principle known as time preference that people prefer goods and services now rather than later. This preference for goods and services now rather than later applies to both individuals and society. By applying a discount rate, streams of costs and benefits are reduced to their present values.
Do Minimum	The forecast scenario without the proposed transport scheme, but that includes committed transport network improvements and developments
Do Something	The Do Minimum network but with the proposed transport scheme and developments added
Generalised cost	A combination of time and money costs (operating costs and charges) that are expressed in time or money units which are used to represent the total travel costs for a journey within the assignment or demand models
Journey purpose	Trips are divided into different travel purposes, usually work (or commute), employers' business and other. These trip purposes have different generalised costs applied and different demand model responses
Matrix estimation	A process used to adjust an initial or 'prior' matrix so that the resulting assignment of the adjusted matrix matches count data as closely as possible
Network	A mathematical representation of a transport network in a supply-side assignment model, either a highway network which represents vehicle travel, or a public transport network that represents bus and rail services
Speed / flow relationships	Relationship between traffic speed and traffic flow on a network link

Reference trip matrix	A forecast reference matrix based on applying growth from national (or other) datasets, but before the application of adjustments due to the impact of how travel costs will change with growth in travel
User classes	Trips are aggregated into several user classes for the purposes of assignment. These usually represent different types of vehicle (e.g. car, HGV) and different trip purposes
Trip matrix	A table representing travel in a model area between land areas or zones
Validation	A process of comparing the model data with independent data
Variable demand modelling	A model that forecasts changes in travel behaviour such as trip frequency, choice of mode, time of travel and trip distribution
Zone	An area of land or development which is used in a transport model to aggregate individual households or commercial premises into a manageable number of units that can be used to represent journey patterns in the study area. Usually the zone size will be relatively small in the study area, but progressively larger further away from it.