Appendix B

Traffic Analysis Report

Report No. 14369/TR/WN02
August 2007

SALLINS BYPASS

BYPASS OPTIONEERING ANALYSIS - TRAFFIC REPORT

Kildare County Council
Áras Chill Dara,
Devoy Park, Naas,
Co Kildare
Ireland

SALLINS BYPASS

BYPASS OPTIONEERING ANALYSIS - TRAFFIC REPORT

CONTROLLED DOCUMENT

Gifford Document No:	**14369/TR/WN02**		
Status:		*Copy No:*	
	Name	*Signature*	*Date*
Prepared by:	V.Ballorin		10/8/07
Checked:	K. Dudley		10/8/07
Gifford Approved:	J. Reeves		10/8/07

Revision Record					
Rev.	*Date*	*By*	*Summary of Changes*	*Chkd*	*Aprvd*

Kildare County Council
Áras Chill Dara,
Devoy Park, Naas,
Co Kildare
Ireland

Gifford
Carlton House
Ringwood Road
Woodlands
Southampton
SO40 7HT

SALLINS BYPASS

BYPASS OPTIONEERING ANALYSIS - TRAFFIC REPORT

C O N T E N T S

Page

FIGURES

APPENDICES

1. INTRODUCTION

1.1 This report has been produced by **Gifford** on behalf of Fehily Timoney Gifford for **Kildare County Council** and seeks to establish a preferred route alignment for the proposed Sallins Bypass in terms of forecast diversion of traffic from Sallins.

1.2 Sallins is a small town (approximately 4,000 residents) which straddles the R407. The R407 is a key route for travel through the local region which carries both long distance and local traffic. Routes R403 Prosperous Road/ Dublin Road and the R407 Sallins Road all merge at Clane to the north of Sallins and bring traffic south through the town of Sallins to neighbouring Naas and destinations beyond. It is envisaged that a bypass on one side of the town would be able to carry the long distance component of this traffic and significantly reduce the amount of traffic which travels through the centre of Sallins.

1.3 In all, seven route alignments are proposed, of which four lie to the west of Sallins and three lie to the east. These proposed alignments are shown on **Figure 1**.

1.4 This report uses a forecasting technique to quantify the amount of traffic which will be removed from the R407 through Sallins with the implementation of each of the bypass options. This report then goes on to make recommendations on the preferred corridor/ route option and on the highway standard of the proposed bypass.

1.5 It should be noted that this report and analysis have been limited to the data and the pre-determined timescales. In particular, the analysis has been based on a one-day 12-hour Roadside Interview Survey and Manual Classified Count both undertaken in May 2007. Whilst May is a neutral month in traffic terms, it only represents a snapshot of the travel patterns in the area. Furthermore, the magnitude of traffic diversion presented in this report should be taken as a broad indication only. In the absence of any further traffic flow information for the R407 through Sallins and the surrounding network, it has not been possible to assess the daily and monthly variations in traffic and complete the assessment.

1.6 Another key limitation has been the absence of any forecast traffic matrix. Given the significant amount of development and infrastructure planned in the Naas area, consideration of future travel pattern demands would need to be incorporated into the final recommendation. The recommendations in this report make reference to this forecast development scenario but the magnitude of impact could not be quantified at this stage.

1.7 The recommendations from this analysis have also been reached independently to any other objectives or criteria for assessment and purely rely on the findings of the traffic relief analysis. The recommendations set out in this report should therefore be reviewed as part of a more comprehensive optioneering analysis.

1.8 Following this introductory section, this report comprises the following:

- **Section 2** outlines the methodology and data used for the assessment;
- **Section 3** presents the results of the assessment and estimate traffic relief in Sallins for each bypass option;
- **Section 4** recommends the preferred sub-option of the bypass;
- **Section 5** indicates the required highway standard for the bypass;
- **Section 6** concludes and summarises all findings.

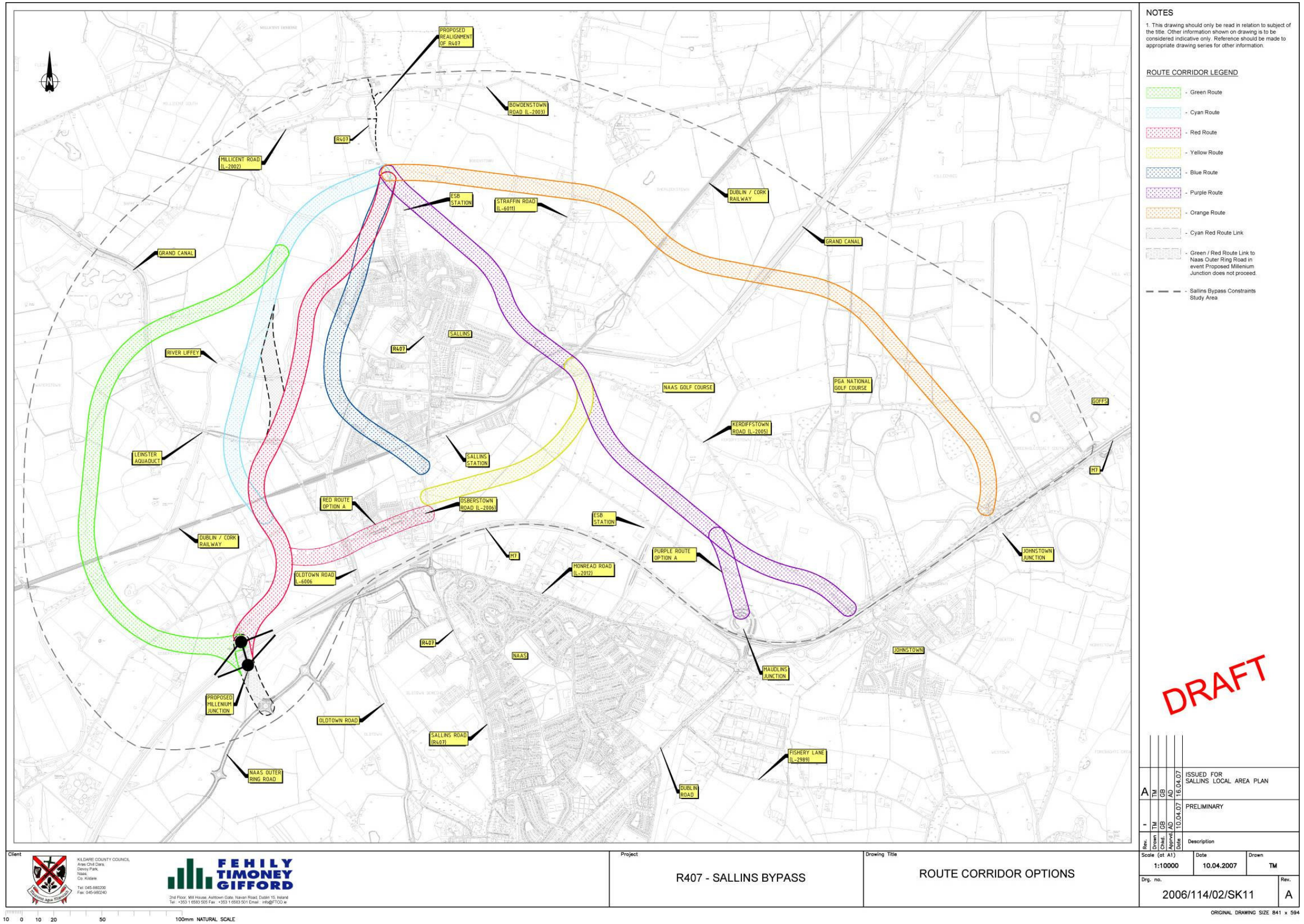
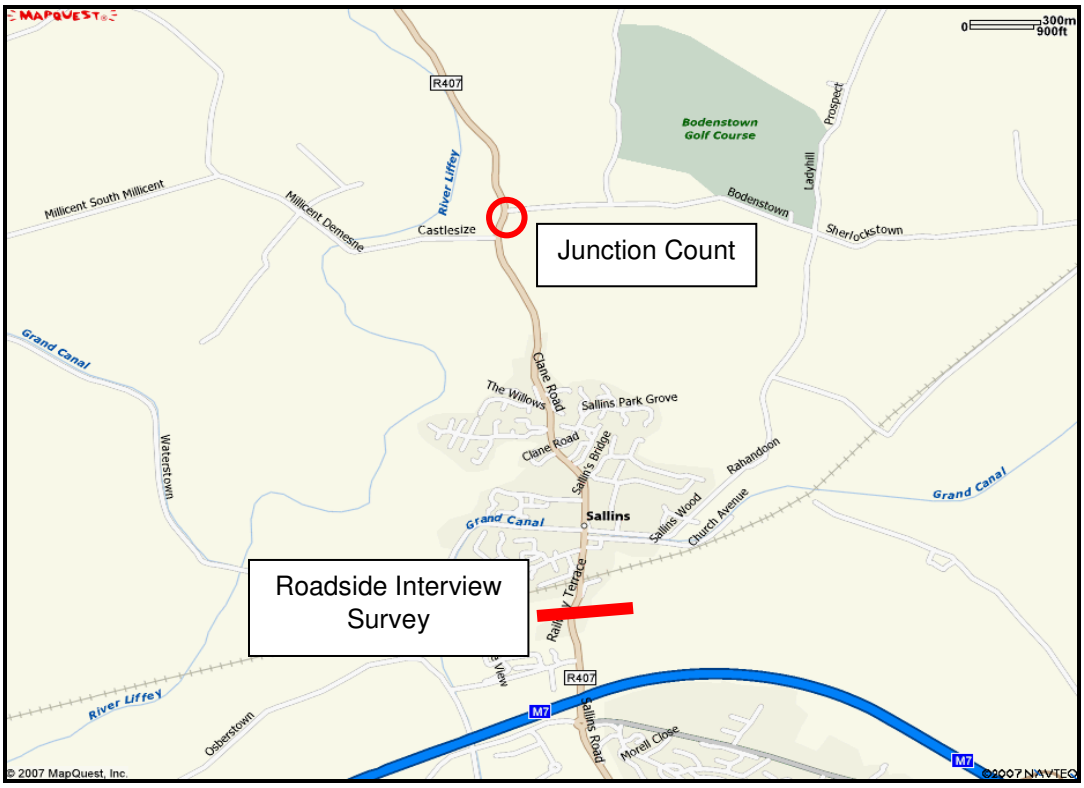


Figure 1 Bypass Options – Proposed Alignments

2. METHODOLOGY

2.1 Traffic Data

2.1.1 A Roadside Interview survey (RSI) was undertaken for a 12-hour period (0700-1900) on Tuesday 29th May 2007 on the R407 between Hunter's Wood and Oldbridge, south of Sallins. In addition, a Manual Classified Count (MCC) was undertaken simultaneously at the R407 Clane Road/Bodenstown Road junction north of Sallins. The location of the RSI and MCC survey sites is shown on **Figure 2**.



(Map – mapquest.com)

Figure 2 Location of Survey Sites

2.1.2 The RSI data provides trip origin and destination (O-D) information for a sample of trips which use the R407. The MCC data which was collected has been used to growth this sample for each of the 12 hours of the survey, in order to represent the distribution of trips to be found on the R407 in a neutral month.

2.1.3 The RSI sample rate is shown in **Table 1** below. The RSI captured a total of 3,140 trips, which represents 18.6% of total trips using the R407 during the 12 hour survey period.

Table 1 - RSI sampling rate

	MCC	RSI	Sample %
Northbound	8,364	1,614	19.3%
Southbound	8,523	1,526	17.9%
Total	16,887	3,140	18.6%

2.1.4 The relationship between the RSI levels and the MCC flows by hour is illustrated on **Figure 3**.

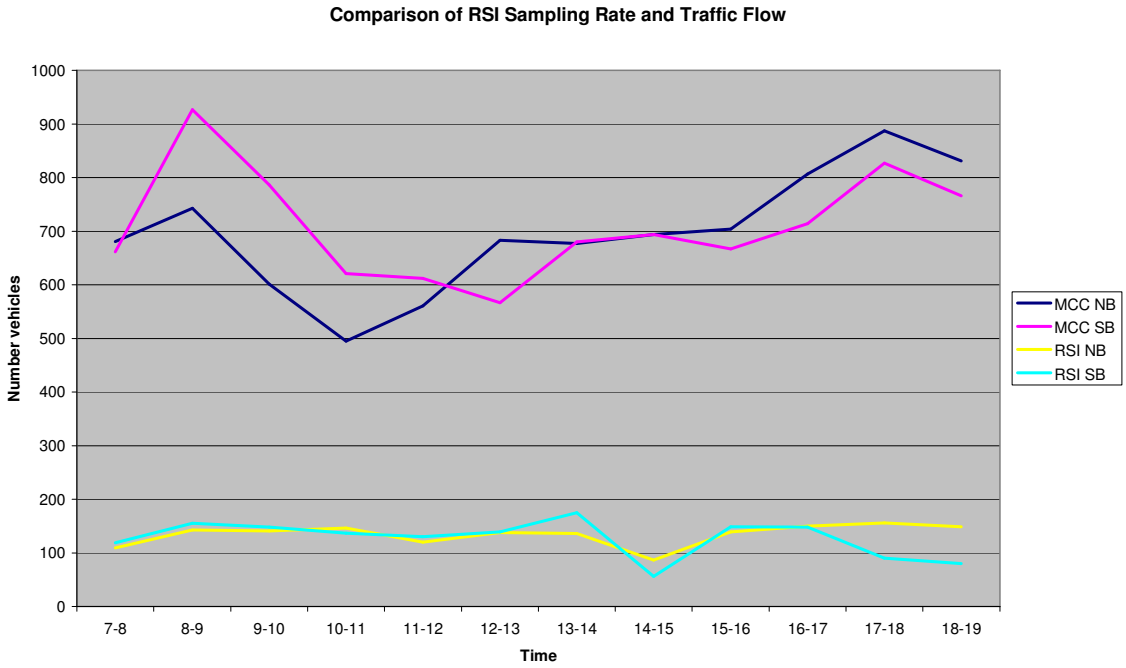


Figure 3 Comparison of RSI Levels with MCC Flows

2.1.5 It can be seen from **Figure 3** that the average number of questionnaires recorded during the RSI survey remained broadly similar through the day (except for a small decline during the 1400 to 1500 hours period). On the other hand, the MCC count clearly identifies morning and evening peak periods between 0800-0900 hours and 1700-1800 hours respectively. It has therefore been necessary to growth the RSI data by the associated hourly ratio to obtain an accurate representation of the pattern of flow throughout the day.

2.1.6 In deriving the O-D matrix for each bypass options, the hourly data recorded by the RSI has been growthed using the observed hourly flows from the MCC.

2.2 Zoning

2.2.1 Each of the origins and destinations surveyed in the RSI has been allocated to a number of zones. Zone selection has been based on the principle that traffic assignment (and therefore traffic pattern) to and from a zone will be along the same corridor for any trips within the zone.

2.2.2 This resulted in the zoning structure identified on **Figure 4**. This constitutes 11 zones as described in **Table 2** below:

Figure 4 Zoning Plan

Table 2 – Zoning structure

Zone Ref.	Description
A	Clane and immediate areas north of Sallins
B	Sallins
C	Naas and Johnstown
D	Inner north-west quadrant
E	Inner north-east quadrant
F	Inner south-west quadrant
G	Inner south-east quadrant
H	Outer north-west quadrant
I	Outer north-east quadrant
J	Outer south-west quadrant
K	Outer south-east quadrant

2.2.3 Initial analysis of origin/destination data using the above zoning matrix highlighted that 57-60% of all trips have destination/origin in the neighbouring town of Naas (Zone C). The existing local highway network is such that a driver can enter/leave Naas from the north via three different route options and it has therefore been necessary to further subdivide zone C representing Naas and Johnstown. As a result, 5 more zones have been identified within Zone C (Zones C1 to C5) as shown on **Figure 5**.

Figure 5 – Refined Zone C

2.2.4 These zones allow for traffic to be apportioned to various corridors, in particular the R445 Dublin Road, the R407 Sallins Road and the recently partially completed Naas Outer Ring Road. This refined zoning ensures that the existing land use attraction/generation areas within Naas are accurately represented in the assessment. It appeared in particular that a number of trips from external zones to Naas were made to the industrial estate and business parks to the north east of the town. These areas are currently accessed from the M7 Maudlins interchange.

2.2.5 Within Zone C, there were a number of O-D pairs with no street name and could not therefore be allocated specifically to any one zone within Zone C. The magnitude of these trips is:

- 850 destinations in Naas (southbound) of which 222 have no street name;
- 892 origins in Naas (northbound) of which 46 have no street name

2.2.6 Whilst the northbound data is not significant, in order to account for the large proportion of unidentified southbound trips to the zone, these were assigned to Zone C2 which represents the central areas of Naas. This allocation was chosen so that these destinations did not bias the results to either bypass as trips to Zone C2 would likely use either bypass option.

2.2.7 Using RSI survey data, a trip matrix has been prepared by coding each RSI record with an origin and destination zone. This RSI trip matrix is shown in both absolute and proportional format for northbound, southbound and two-way movements in **Appendix A**.

2.2.8 Applying each hourly sample rate shown on **Figure 3** to the RSI matrix gives the MCC O-D matrix as shown in **Appendix B**. This MCC O-D matrix has been used to derive the preferred bypass option.

2.2.9 The MCC trip matrix shows that approximately 13% of trips on the R407 are local trips with origin in Sallins and Destination in Naas. A similar pattern is observed in the northbound direction. These local trips will not make use of any of the proposed bypass options and will continue to use the R407.

2.2.10 The main destinations and origins are zones A (Clane and north of Sallins), B (Sallins), C2 (Central Naas) and I/J the outer north-east and south-west quadrants.

3. BYPASS OPTIONEERING

3.1.1 A straightforward technique has been employed to assess the relative merits of a western or eastern bypass option. Local knowledge has been used to make basic assumptions for each origin-destination pair regarding the possibility and/or likelihood of using either a western or eastern bypass option.

3.1.2 Basic assumptions on the likely use of either bypass options have been made. These can be broadly summarised as follows:

- Traffic travelling from zones B to A and B to C will remain on Sallins Road corridor;
- Traffic travelling to Zone C2 will use either bypass option;
- Any areas located to the west of Naas will choose to use the western bypass;
- Any areas located to the east of Naas (and currently using the M7 Maudlins Interchange) will use the eastern bypass option.

3.1.3 This subjective analysis is summarised by 'likelihood matrices' as shown in **Tables 3a** and **3b** below. These matrices are comprised of values of 1 where a trip between the OD pair is deemed possible and likely. Where an OD pair would make no use of the bypass option, no score has been attributed. It should be noted that a score of 0.5 has been given where a trip for an OD pair can use either a western or eastern bypass option.

Table 3a – 'Likelihood matrix' for an eastern bypass option

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K
A			1	0.5			1				1				1
B											1				1
C1	1							1	1			1	1		
C2	0.5								1				1		
C3															
C4															
C5	1							1	1			1	1		
D			1				1				1				1
E			1	1			1				1				1
F															
G	1	1						1	1			1	1		
H			1				1				1				1
I			1	1			1				1				1
J															
K	1	1						1	1			1	1		

Table 3b – 'Likelihood matrix' for a western bypass option

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K
A				0.5	1	1				1				1	
B										1				1	
C1															
C2	0.5							1				1			
C3	1							1	1			1	1		
C4	1								1						
C5															
D				1	1					1				1	
E					1	1				1				1	
F	1	1						1	1			1	1		
G															
H				1	1					1				1	
I					1	1				1				1	
J	1	1						1	1			1	1		
K															

3.1.4 **Table 3a** above demonstrates that trips between 49 O-D pairs currently would be likely to divert onto an eastern bypass. By comparison, trips between 45 O-D pairs would be likely to divert onto a western bypass option. However, this does not reflect the volumes of traffic carried between each O-D pair. Multiplying the MCC trip matrix with a 'likelihood matrix' will identify the observed trips considered likely to use either a western or eastern bypass option, and nullify the entry for OD pairs which were not considered likely. This process will generate a trip matrix for each bypass option showing the number of trips which are likely to divert from the R407 through Sallins. The resulting 2-way trip matrices are shown in **Tables 4a** and **4b** in the pages overleaf.

3.1.5 In summary, a western bypass option is predicted to divert more vehicles from Sallins than an eastern bypass option. **Table 5** below highlights 2-way diverted flow and percentage relief to Sallins across a 12 hour period.

Table 5 Forecast diversion from Sallins for western and eastern bypass options

Existing MCC on R407	Western Bypass		Eastern Bypass	
	Diverted Flow	% relief	Diverted Flow	% relief
16,887	**6,204**	**36.74%**	4,868	28.83%

3.1.6 Despite a large number of trips between zones B-A and B-C remaining along Sallins Road, a number of trips will be removed from the Sallins Road corridor following the introduction of a western Sallins bypass. This is summarised in **Table 6**.

Table 6 Analysis of Existing R407 (existing traffic only)

Locations	**Average Annual Daily Traffic (AADT)**				
	Existing	**With Western Bypass**		**With Eastern Bypass**	
			% relief		% relief
R407 / North of L2002 (Millicent Road)	15617	-	-	-	-
R407 / South of L2002 (Millicent Road)	17578	11374	35%	12710	27%
R407 / North of L2006 (Osberstown Road)	24169	17965	26%	19301	20%
R407 / South of L2006 (Osberstown Road)	23814	17610	26%	18946	20%
L2002 (Millicent Road)	3902	-	-	-	-
L2003 (Bodenstown Road)	2180	-	-	-	-
L2006 (Osberstown Road)	3849	-	-	-	-

Table 4a – Estimated trip matrix for use of eastern bypass

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	Total	%
A			281	322			11				66				77	**756**	**16%**
B											71				132	**203**	**4%**
C1	372							69	35			125	364			**965**	**20%**
C2	318								71				471			**860**	**18%**
C3																**0**	**0%**
C4																**0**	**0%**
C5	8							5								**22**	**0%**
D			146													**146**	**3%**
E			6	68												**73**	**2%**
F																**0**	**0%**
G	55	30						4				25	10			**125**	**3%**
H			151								37				77	**266**	**5%**
I			246	691			21				40				96	**1095**	**22%**
J																**0**	**0%**
K	101	107						22				54	74			**356**	**7%**
Total	**855**	**136**	**830**	**1081**	**0**	**0**	**32**	**100**	**106**	**0**	**214**	**212**	**918**	**0**	**383**	**4868**	
%	**18%**	**3%**	**17%**	**22%**	**0%**	**0%**	**1%**	**2%**	**2%**	**0%**	**4%**	**4%**	**19%**	**0%**	**8%**		

Note: Figures do not add up due to rounding

Table 4b – Estimated trip matrix for use of western bypass

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	**Total**	
A				322	91					161				274		**848**	**14%**
B										352				386		**738**	**12%**
C1																**0**	**0%**
C2	318							120				247				**685**	**11%**
C3	62								19			39	156			**276**	**4%**
C4	13												8			**21**	**0%**
C5																**0**	**0%**
D				262	32											**294**	**5%**
E					12					15				31		**57**	**1%**
F	119	282						5	10			64	199			**679**	**11%**
G																**0**	**0%**
H				224	48					56				202		**531**	**9%**
I					126					194				464		**783**	**13%**
J	218	298						32	21			155	567			**1291**	**21%**
K																**0**	**0%**
Total	**729**	**580**	**0**	**808**	**309**	**0**	**0**	**157**	**51**	**778**	**0**	**505**	**930**	**1357**	**0**	**6204**	
%	**12%**	**9%**	**0%**	**13%**	**5%**	**0%**	**0%**	**3%**	**1%**	**13%**	**0%**	**8%**	**15%**	**22%**	**0%**		

Note: Figures do not add up due to rounding

3.2 Sensitivity Test Matrices

3.2.1 As detailed in the previous section, assumptions were made with regards to the assignment of the O-D data within Zone C2 which had no street names. Given that these represent some 26% of the total southbound destination within Naas, sensitivity test matrices were produced to ensure that the assumption made to assign these to Zone C2 would not significantly bias the results towards a particular bypass. In effect, the data with no street name was allocated to a separate zone (Zone X) which could either divert to the western or eastern bypass options as a whole. The matrices are reproduced in **Appendix C** and the results can be summarised as:

Table 3 Results of Sensitivity Test Matrices

Total Flow Diversion*	OD data allocation to:		
	Zone C2	Zone X	Difference
Eastern Bypass	899	974	+75
Western Bypass	1138	1230	+92

* based on RSI data and therefore not factored to MCC levels

3.2.2 **Table 3** demonstrates that even if all non-identified trips were to divert to an eastern bypass option, the diversion rate to this option would be 974 trips, which is still lower than the estimated levels of traffic diverting to a western bypass using the 50/50 split assumption (1138 trips). It is therefore concluded that the assignment of the non-identified O-D data to Zone C2 does not affect the recommendations for a western bypass.

3.3 Forecast Trip Making

3.3.1 The quantitative basis for this study has taken no account of changes to patterns of trip making in the future. This is an important consideration since the justification for, and benefits of, a Sallins Bypass will vary into the future.

3.3.2 The most significant change to the local region will be the Millennium Park development and the construction of the Naas Outer Ring Road. **Figure 6** shows the Millennium Park proposals together with the planned alignment of the Naas Outer Ring Road.

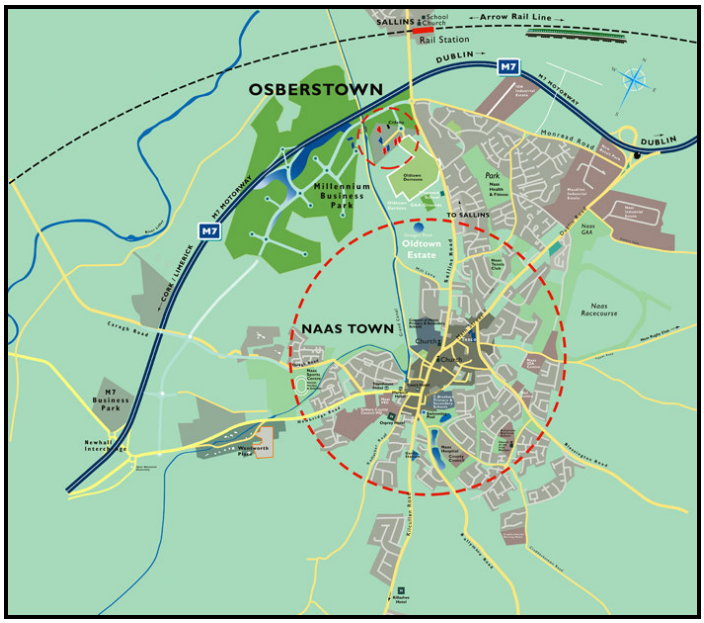


Figure 6 Millennium Park Proposals (including Naas Outer Ring Road)

3.3.3 Construction of the latter has already started but a review of the existing infrastructure has determined that currently only a short section of the Naas Outer Ring Road has been implemented. Once completed, it is expected that the Naas Outer Ring Road will link to the R445 Newbridge Road, in addition to some local connections to the Oldtown Demesne and the R409 Halverstown. The Naas Outer Ring Road may also connect with the M7, although this is presently only at proposal stage. If this connection were to be implemented, it would directly connect to three of the four alignment options for the western bypass, and this coupled with development along the Naas Outer Ring Road would significantly increase the level of benefit derived from a western bypass option.

3.3.4 Whilst no forecast matrix has been taken into account in this analysis to reflect the Millennium Park proposals, it is expected that as these trips would likely use a western bypass option, the potential attractiveness of a western bypass option would be strengthened in future, especially if a direct connection to the M7 is created linking the M7, Naas Outer Ring Road and the western bypass. It should be noted, however, that due to the lack of information concerning the Millennium Park proposals, our assessment of its impact is purely speculative and based on first principles.

3.4 Recommendations

3.4.1 Even using the existing O-D matrix, a western option would provide greater relief of traffic through Sallins than an eastern bypass option. If consideration is taken of the potential further traffic relief following development of the Millennium Park, it is expected that a western bypass option would relieve additional level of traffic flows through Sallins in future.

3.4.2 The analysis presented in this report therefore recommends that a western bypass option is preferred to an eastern bypass option in traffic terms.

4. SELECTION OF INDIVIDUAL ROUTE OPTION

4.1 The assessment undertaken has concluded that a western bypass option would be the most effective in diverting traffic away from Sallins. Four western bypass alignments exist as shown on **Figure 1**, namely green, cyan, red and blue.

4.2 In traffic terms, the alignment needs to present a favourable journey time over the existing route through Sallins, and assuming a similar speed and road standard for all alignments, distance and connectivity become important factors.

4.3 It has been previously stated that a connection with the M7 and Naas Outer Ring Road will present greater trip making opportunity for users of the bypass, which discounts the innermost blue alignment. Of the remaining alignment options, the red or cyan options seem more favourable over the green alignment, based on shorter distances. From a traffic standpoint there is little difference between these routes.

4.4 Based upon this limited analysis, it would be recommended that in traffic terms, the red or cyan route be taken forward as the preferred alignment for the Sallins bypass.

5. REQUIRED HIGHWAY STANDARD

5.1 Technical Advisory Note TA 47/97 from the UK Highways Agency document Design Manual for Road and Bridges (DMRB) has been used to determine the appropriate design standard for the Sallins bypass.

5.2 Table 2.1 of TA 47/97 recommends the following AADT for S2, WS2 and D2AP road standards:

Table 6 – Recommended AADT thresholds for carriageway standards (from TA 47/97, DMRB)

Carriageway Standard	Opening Year AADT	
	Min	Max
Single lane (S2)	Up to 13,000	
Wide single (WS2)	6,000	21,000
Dual (D2AP)	11,000	39,000

5.3 Estimated 12 hour two-way flow on a western bypass option was stated as 6,204 vehicles. Conversion factors for 12 hour flows to 24-hour AADT have been extracted from COBA (DMRB Volume 13, Section 1, Part 4) using the information attached in **Appendix D**.

5.4 The 12 hour flows have factored as follows:

- AADT = ((F*1.15) * M)/365
- Where M = 316 + (33 * 1.1) = 352.3
- Giving AADT = 6,886 veh/day

5.5 A single (S2) or wide single (WS2) carriageway would be sufficient to accommodate the levels of traffic using the bypass. It should be noted that this recommendation does not take account of the potential future traffic flows which may use the bypass once the Millennium Park development is in place. In the absence of any traffic generation data, it is not possible to establish whether a single carriageway would still be able to accommodate the forecast levels of traffic in future.

6. CONCLUSIONS

6.1 The objective of this report was to establish a preferred route alignment for the proposed Sallins Bypass on the basis of potential diversion of trips from the R407 Sallins Road.

6.2 In total, seven potential route alignments are proposed, and a straightforward technique has been used to estimate whether alignments lying to the west or to the east of Sallins produce the greatest diversion of trips from the R407.

6.3 The result of this analysis was that a western bypass option would remove the most traffic from Sallins due to the greater trip opportunity afforded by its connectivity to the M7 and Naas Outer Ring Road, particularly with the future context of the Millennium Park development.

6.4 Of the western route alignments, the red and cyan routes emerged as the preferred alignments due to connections with the M7 and Naas Outer Ring Road, coupled with likely reduced journey times when compared to the remaining green route option.

6.5 Consideration of the estimated AADT of a future year in conjunction with DMRB Technical Advisory Note TA 47/97 has concluded that an S2 or WS2 class of road is a sufficient design standard.

APPENDICES

APPENDIX A

APPENDIX A - O-D MATRIX - RSI RESULTS

NORTHBOUND

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	Total	%
A	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**0%**
B	5	8	0	0	0	0	0	1	2	0	0	0	5	1	1	**23**	**1%**
C1	71	129	0	0	0	0	0	13	7	0	0	24	69	2	0	**315**	**20%**
C2	121	186	0	0	0	0	0	21	15	0	0	46	90	5	0	**484**	**30%**
C3	12	34	0	0	0	0	0	0	4	0	0	7	29	0	0	**86**	**5%**
C4	3	10	0	0	0	0	0	0	0	0	0	2	2	0	0	**17**	**1%**
C5	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	**4**	**0%**
D	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	**4**	**0%**
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
F	23	54	0	0	0	0	0	1	2	0	0	12	36	1	0	**129**	**8%**
G	11	4	0	0	0	0	0	1	0	0	0	5	2	0	0	**23**	**1%**
H	1	12	0	0	0	0	0	0	1	0	0	2	8	0	0	**24**	**2%**
I	36	66	0	0	0	0	0	24	2	0	0	16	15	0	0	**159**	**10%**
J	44	57	0	0	0	0	0	6	4	0	0	29	106	3	0	**249**	**16%**
K	20	20	0	0	0	0	0	4	0	0	0	10	15	1	0	**70**	**4%**
Total	**348**	**582**	**0**	**3**	**0**	**1**	**0**	**72**	**37**	**0**	**0**	**154**	**377**	**13**	**1**	**1588**	
	22%	**37%**	**0%**	**0%**	**0%**	**0%**	**0%**	**5%**	**2%**	**0%**	**0%**	**10%**	**24%**	**1%**	**0%**		

SOUTHBOUND

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	Total	%
A	0	0	51	118	16	0	2	0	0	28	13	2	24	50	15	**319**	**21%**
B	0	1	107	214	30	0	4	0	0	62	11	8	49	64	22	**572**	**38%**
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
D	0	0	25	50	6	5	0	0	0	0	0	0	0	0	0	**86**	**6%**
E	0	0	1	14	2	0	0	0	0	3	0	2	1	6	0	**29**	**2%**
F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
G	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	**2**	**0%**
H	0	3	26	42	9	0	0	0	0	10	7	5	11	38	15	**166**	**11%**
I	0	5	44	119	17	0	4	0	0	31	7	4	7	82	17	**337**	**22%**
J	0	0	1	1	1	0	0	0	0	1	0	0	0	1	0	**5**	**0%**
K	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	**3**	**0%**
Total	**0**	**10**	**256**	**560**	**81**	**5**	**10**	**0**	**0**	**135**	**38**	**21**	**92**	**242**	**69**	**1519**	
	0%	**1%**	**17%**	**37%**	**5%**	**0%**	**1%**	**0%**	**0%**	**9%**	**3%**	**1%**	**6%**	**16%**	**5%**		

TOTAL (TWO-WAY)

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	Total	%
A	0	1	51	118	16	0	2	0	0	28	13	2	24	50	15	**320**	**10%**
B	5	9	107	214	30	0	4	1	2	62	11	8	54	65	23	**595**	**19%**
C1	71	129	0	0	0	0	0	13	7	0	0	24	69	2	0	**315**	**10%**
C2	121	186	0	0	0	0	0	21	15	0	0	46	90	5	0	**484**	**16%**
C3	12	34	0	0	0	0	0	0	4	0	0	7	29	0	0	**86**	**3%**
C4	3	10	0	0	0	0	0	0	0	0	0	2	2	0	0	**17**	**1%**
C5	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	**4**	**0%**
D	0	0	25	53	6	6	0	0	0	0	0	0	0	0	0	**90**	**3%**
E	0	0	1	14	2	0	0	0	0	3	0	2	1	6	0	**29**	**1%**
F	23	54	0	0	0	0	0	1	2	0	0	12	36	1	0	**129**	**4%**
G	11	5	0	1	0	0	0	1	0	0	0	5	2	0	0	**25**	**1%**
H	1	15	26	42	9	0	0	0	1	10	7	7	19	38	15	**190**	**6%**
I	36	71	44	119	17	0	4	24	2	31	7	20	22	82	17	**496**	**16%**
J	44	57	1	1	1	0	0	6	4	1	0	29	106	4	0	**254**	**8%**
K	20	20	1	1	0	0	0	4	0	0	0	10	15	2	0	**73**	**2%**
Total	**348**	**592**	**256**	**563**	**81**	**6**	**10**	**72**	**37**	**135**	**38**	**175**	**469**	**255**	**70**	**3107**	
%	**11%**	**19%**	**8%**	**18%**	**3%**	**0%**	**0%**	**2%**	**1%**	**4%**	**1%**	**6%**	**15%**	**8%**	**2%**		

APPENDIX B

APPENDIX B - O-D MATRIX - GROWTHED RSI RESULTS to MCC TOTALS

NORTHBOUND

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	Total	%
A	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**	**0%**
B	27	44	0	0	0	0	0	5	10	0	0	0	30	5	6	**128**	**2%**
C1	372	700	0	0	0	0	0	69	35	0	0	125	364	7	0	**1672**	**20%**
C2	635	956	0	0	0	0	0	120	71	0	0	247	471	27	0	**2528**	**30%**
C3	62	185	0	0	0	0	0	0	19	0	0	39	156	0	0	**461**	**6%**
C4	13	49	0	0	0	0	0	0	0	0	0	8	8	0	0	**78**	**1%**
C5	8	3	0	0	0	0	0	5	0	0	0	8	0	0	0	**25**	**0%**
D	0	0	0	15	0	5	0	0	0	0	0	0	0	0	0	**19**	**0%**
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
F	119	282	0	0	0	0	0	5	10	0	0	64	199	6	0	**685**	**8%**
G	55	25	0	0	0	0	0	4	0	0	0	25	10	0	0	**120**	**1%**
H	6	71	0	0	0	0	0	0	6	0	0	12	44	0	0	**139**	**2%**
I	189	353	0	0	0	0	0	124	9	0	0	82	78	0	0	**835**	**10%**
J	218	298	0	0	0	0	0	32	21	0	0	155	567	17	0	**1308**	**16%**
K	101	107	0	0	0	0	0	22	0	0	0	54	74	5	0	**361**	**4%**
Total	**1806**	**3078**	**0**	**15**	**0**	**5**	**0**	**386**	**182**	**0**	**0**	**819**	**2001**	**66**	**6**	8364	
%	**22%**	**37%**	**0%**	**0%**	**0%**	**0%**	**0%**	**5%**	**2%**	**0%**	**0%**	**10%**	**24%**	**1%**	**0%**		

SOUTHBOUND

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	Total	%
A	0	0	281	645	91	0	11	0	0	161	66	9	131	274	77	**1745**	**20%**
B	0	5	594	1164	213	0	21	0	0	352	71	45	274	381	127	**3246**	**38%**
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
D	0	0	146	247	32	32	0	0	0	0	0	0	0	0	0	**458**	**5%**
E	0	0	6	68	12	0	0	0	0	15	0	9	5	31	0	**145**	**2%**
F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
G	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	**10**	**0%**
H	0	18	151	224	48	0	0	0	0	56	37	28	58	202	77	**902**	**11%**
I	0	35	246	691	126	0	21	0	0	194	40	23	38	464	96	**1974**	**23%**
J	0	0	5	4	7	0	0	0	0	6	0	0	0	7	0	**28**	**0%**
K	0	0	5	4	0	0	0	0	0	0	0	0	0	7	0	**16**	**0%**
Total	**0**	**63**	**1434**	**3052**	**529**	**32**	**53**	**0**	**0**	**784**	**214**	**114**	**507**	**1365**	**377**	8523	
%	**0%**	**1%**	**17%**	**36%**	**6%**	**0%**	**1%**	**0%**	**0%**	**9%**	**3%**	**1%**	**6%**	**16%**	**4%**		

TOTAL (TWO-WAY)

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	Total	%
A	0	5	281	645	91	0	11	0	0	161	66	9	131	274	77	**1750**	**10%**
B	27	49	594	1164	213	0	21	5	10	352	71	45	304	386	132	**3373**	**20%**
C1	372	700	0	0	0	0	0	69	35	0	0	125	364	7	0	**1672**	**10%**
C2	635	956	0	0	0	0	0	120	71	0	0	247	471	27	0	**2528**	**15%**
C3	62	185	0	0	0	0	0	0	19	0	0	39	156	0	0	**461**	**3%**
C4	13	49	0	0	0	0	0	0	0	0	0	8	8	0	0	**78**	**0%**
C5	8	3	0	0	0	0	0	5	0	0	0	8	0	0	0	**25**	**0%**
D	0	0	146	262	32	36	0	0	0	0	0	0	0	0	0	**477**	**3%**
E	0	0	6	68	12	0	0	0	0	15	0	9	5	31	0	**145**	**1%**
F	119	282	0	0	0	0	0	5	10	0	0	64	199	6	0	**685**	**4%**
G	55	30	0	5	0	0	0	4	0	0	0	25	10	0	0	**130**	**1%**
H	6	90	151	224	48	0	0	0	6	56	37	40	102	202	77	**1040**	**6%**
I	189	388	246	691	126	0	21	124	9	194	40	105	117	464	96	**2809**	**17%**
J	218	298	5	4	7	0	0	32	21	6	0	155	567	23	0	**1336**	**8%**
K	101	107	5	4	0	0	0	22	0	0	0	54	74	11	0	**377**	**2%**
Total	**1806**	**3141**	**1434**	**3067**	**529**	**36**	**53**	**386**	**182**	**784**	**214**	**933**	**2508**	**1431**	**383**	16887	
%	**11%**	**19%**	**8%**	**18%**	**3%**	**0%**	**0%**	**2%**	**1%**	**5%**	**1%**	**6%**	**15%**	**8%**	**2%**		

APPENDIX C

APPENDIX C - BYPASS DIVERSION TOTALS

Using data to Zone C2

EASTERN BYPASS OPTION

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	**Total**	**%**
A	0	0	51	59	0	0	2	0	0	0	13	0	0	0	15	**140**	**16%**
B	0	0	0	0	0	0	0	0	0	0	11	0	0	0	23	**34**	**4%**
C1	71	0	0	0	0	0	0	13	7	0	0	24	69	0	0	**184**	**20%**
C2	61	0	0	0	0	0	0	0	15	0	0	0	90	0	0	**166**	**18%**
C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C5	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	**3**	**0%**
D	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	**25**	**3%**
E	0	0	1	14	0	0	0	0	0	0	0	0	0	0	0	**15**	**2%**
F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
G	11	5	0	0	0	0	0	1	0	0	0	5	2	0	0	**24**	**3%**
H	0	0	26	0	0	0	0	0	0	0	7	0	0	0	15	**48**	**5%**
I	0	0	44	119	0	0	4	0	0	0	7	0	0	0	17	**191**	**21%**
J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
K	20	20	0	0	0	0	0	4	0	0	0	10	15	0	0	**69**	**8%**
Total	**164**	**25**	**147**	**192**	**0**	**0**	**6**	**19**	**22**	**0**	**38**	**40**	**176**	**0**	**70**	**899**	
%	**18%**	**3%**	**16%**	**21%**	**0%**	**0%**	**1%**	**2%**	**2%**	**0%**	**4%**	**4%**	**20%**	**0%**	**8%**		

WESTERN OPTION BYPASS

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	**Total**	**%**
A	0	0	0	59	16	0	0	0	0	28	0	0	0	50	0	**153**	**13%**
B	0	0	0	0	0	0	0	0	0	62	0	0	0	65	0	**127**	**11%**
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C2	61	0	0	0	0	0	0	21	0	0	0	46	0	0	0	**128**	**11%**
C3	12	0	0	0	0	0	0	0	4	0	0	7	29	0	0	**52**	**5%**
C4	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**5**	**0%**
C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
D	0	0	0	53	6	0	0	0	0	0	0	0	0	0	0	**59**	**5%**
E	0	0	0	0	2	0	0	0	0	3	0	0	0	6	0	**11**	**1%**
F	23	54	0	0	0	0	0	1	2	0	0	12	36	0	0	**128**	**11%**
G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
H	0	0	0	42	9	0	0	0	0	10	0	0	0	38	0	**99**	**9%**
I	0	0	0	0	17	0	0	0	0	31	0	0	0	82	0	**130**	**11%**
J	44	57	0	0	0	0	0	6	4	0	0	29	106	0	0	**246**	**22%**
K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
Total	**143**	**111**	**0**	**154**	**50**	**0**	**0**	**28**	**10**	**134**	**0**	**94**	**173**	**241**	**0**	**1138**	
%	**13%**	**10%**	**0%**	**14%**	**4%**	**0%**	**0%**	**2%**	**1%**	**12%**	**0%**	**8%**	**15%**	**21%**	**0%**		

APPENDIX C - Sensitivity Test Matrices

Using data to Zone X

EASTERN BYPASS OPTION

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	X	**TOTAL**	**%**
A	0	0	51	31	0	0	2	0	0	0	13	0	0	0	15	56	**168**	**17%**
B	0	0	0	0	0	0	0	0	0	0	11	0	0	0	23	0	**34**	**3%**
C1	71	0	0	0	0	0	0	13	7	0	0	24	69	0	0	0	**184**	**19%**
C2	56	0	0	0	0	0	0	0	13	0	0	0	79	0	0	0	**148**	**15%**
C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C5	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	**3**	**0%**
D	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	17	**42**	**4%**
E	0	0	1	10	0	0	0	0	0	0	0	0	0	0	0	4	**15**	**2%**
F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
G	11	5	0	0	0	0	0	1	0	0	0	5	2	0	0	1	**25**	**3%**
H	0	0	26	0	0	0	0	0	0	0	7	0	0	0	15	16	**64**	**7%**
I	0	0	44	81	0	0	4	0	0	0	7	0	0	0	17	38	**191**	**20%**
J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**	**0%**
K	20	20	0	0	0	0	0	4	0	0	0	10	15	0	0	1	**70**	**7%**
X	10	0	0	0	0	0	0	1	2	0	0	4	11	1	0	0	**29**	**3%**
TOTAL	**169**	**25**	**147**	**122**	**0**	**0**	**6**	**20**	**22**	**0**	**38**	**44**	**176**	**1**	**70**	**134**	**974**	
%	**17%**	**3%**	**15%**	**13%**	**0%**	**0%**	**1%**	**2%**	**2%**	**0%**	**4%**	**5%**	**18%**	**0%**	**7%**	**14%**		

WESTERN BYPASS OPTION

	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	X	**TOTAL**	**%**
A	0	0	0	31	16	0	0	0	0	28	0	0	0	50	0	56	**181**	**15%**
B	0	0	0	0	0	0	0	0	0	62	0	0	0	65	0	0	**127**	**10%**
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
C2	56	0	0	0	0	0	0	20	0	0	0	42	0	0	0	0	**118**	**10%**
C3	12	0	0	0	0	0	0	0	4	0	0	7	29	0	0	0	**52**	**4%**
C4	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	**5**	**0%**
C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0%**
D	0	0	0	36	6	0	0	0	0	0	0	0	0	0	0	17	**59**	**5%**
E	0	0	0	0	2	0	0	0	0	3	0	0	0	6	0	4	**15**	**1%**
F	23	54	0	0	0	0	0	1	2	0	0	12	36	0	0	0	**128**	**10%**
G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**	**0%**
H	0	0	0	26	9	0	0	0	0	10	0	0	0	38	0	16	**99**	**8%**
I	0	0	0	0	17	0	0	0	0	31	0	0	0	82	0	38	**168**	**14%**
J	44	57	0	0	0	0	0	6	4	0	0	29	106	0	0	1	**247**	**20%**
K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**	**0%**
X	10	0	0	0	0	0	0	1	2	0	0	4	11	1	0	0	**29**	**2%**
TOTAL	**148**	**111**	**0**	**93**	**50**	**0**	**0**	**28**	**12**	**134**	**0**	**94**	**184**	**242**	**0**	**134**	**1230**	
%	**12%**	**9%**	**0%**	**8%**	**4%**	**0%**	**0%**	**2%**	**1%**	**11%**	**0%**	**8%**	**15%**	**20%**	**0%**	**11%**		

APPENDIX C - differences

EASTERN BYPASS OPTION																	
	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	X	**TOTAL**
A	0	0	0	-28	0	0	0	0	0	0	0	0	0	0	0	56	**28**
B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
C2	-5	0	0	0	0	0	0	0	-2	0	0	0	-11	0	0	0	**-18**
C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	**17**
E	0	0	0	-4	0	0	0	0	0	0	0	0	0	0	0	4	**0**
F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	**16**
I	0	0	0	-38	0	0	0	0	0	0	0	0	0	0	0	38	**0**
J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
X	10	0	0	0	0	0	0	1	2	0	0	4	11	1	0	0	**29**
TOTAL	**5**	**0**	**0**	**-70**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**4**	**0**	**1**	**0**	**134**	**75**

WESTERN BYPASS OPTION																	
	A	B	C1	C2	C3	C4	C5	D	E	F	G	H	I	J	K	X	**TOTAL**
A	0	0	0	-28	0	0	0	0	0	0	0	0	0	0	0	56	**28**
B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
C2	-5	0	0	0	0	0	0	-1	0	0	0	-4	0	0	0	0	**-10**
C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
D	0	0	0	-17	0	0	0	0	0	0	0	0	0	0	0	17	**0**
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	**4**
F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
H	0	0	0	-16	0	0	0	0	0	0	0	0	0	0	0	16	**0**
I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	**38**
J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
X	10	0	0	0	0	0	0	1	2	0	0	4	11	1	0	0	**29**
TOTAL	**5**	**0**	**0**	**-61**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**11**	**1**	**0**	**134**	**92**

APPENDIX D

12 Hour Traffic Flow Input, E-Factors

9.8 The default values held within the program assume that if a 12 hour flow is input it represents an average 12 hour (0700 - 1900) weekday (Mon - Fri) flow in the month specified. The program will then convert the flows to a 16 hour equivalent by the application of an E-FACTOR and then follow the procedure used if a 16 hour flow were input. The default E-factors are independent of the month and Seasonality Index, the defaults held in the program for the different Network Classifications are given in Table 9/1. The facility exists for the user to input a local E-Factor.

Network Classification		E-FACTOR
Motorway	(MWY)	1.15
Built-up Trunk	(TBU)	1.15
Built-up Principal	(PBU)	1.15
Non Built-up Trunk	(TNB)	1.15
Non Built-up Principal	(PNB)	1.15

Table 9/1: E Factors

16 Hour Traffic Flow Input, M-Factors

9.9 The default parameters held in the program assume that if 16 hour flow is entered it represents an average 16 hour (0600-2200) weekday (Mon-Fri) flow in the month specified, excluding periods affected by Bank Holidays. The 16 hour flow is converted within the program to 'Annual All Vehicle Flow' by the application of an M-Factor. These factors vary with the month in which the count was taken and by Seasonality Index. The COBA program calculates the M-factor based on the relationship M = a + (b x SI) where the parameters 'a' and 'b' for each month are given in Table 9/2. The program contains defaults for all months but a warning will be printed if the data is not for a neutral month (April, May, June, September and October). The straight line relationships for the neutral months are shown graphically in Figure 9/2.

Month (month number)		Parameter		M-FACTOR		
		a	b	SI = 1.0	SI = 1.25	SI = 1.5
January	(1)	126	276	402	471	541
February	(2)	105	261	366	431	496
March	(3)	149	244	394	455	516
April	(4)	287	73	360	378	397
May	(5)	316	33	349	357	367
June	(6)	408	-57	351	337	323
July	(7)	512	-163	350	309	268
August	(8)	639	-287	353	281	209
September	(9)	445	-102	343	318	292
October	(10)	297	61	358	373	389
November	(11)	268	121	389	419	449
December	(12)	285	130	415	448	480

Table 9/2: Variation of M-Factor with Seasonality Index (SI)