Appendix B

METHODOLOGY

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Methodology

1.1 Base Model

1.1.1 The Saturn model was obtained from Mott Gifford and consists of an average am peak hour between 0700 and 0900 on a weekday in 2004. The Saturn highway network is shown on **Figure 6.1**.

1.1.2 The following steps were taken:

- Traffic count data between 2004 and 2006 was obtained from the TRADS database and other information supplied by the Harbour Authorities and Hampshire CC.
- The Saturn modelled flows were compared with counts in 2004 and 2006 to check the suitability of the model for assessment of the LDF proposals.
- A number of slip road Saturn flows did not compare well with actual counts and suggested that improvements to the Saturn matrix or network would be required.
- In order to check the trip patterns within the Saturn model the 2001 Census Home to Work data was analysed to produce an independent am peak matrix of movements between each zone in the study area.
- Various model runs were then undertaken replacing sections of the Saturn model matrix with data obtained from the census.
- By an iterative process it was concluded that the best fit with actual counts could be obtained from a matrix containing data both from the original Saturn matrix and from the census matrix. The census data appears to give a more detailed picture of shorter distance movements and improved some of the modelled flows away from the strategic highway network. A better comparison was also obtained on some of the motorway slip roads.

1.1.3 The 'goodness of fit' of modelled flows to counts is tested using the GEH statistic as recommended in the Design Manual for Roads and Bridges. In general individual links should have a GEH statistic of less than 5 for 85% of the network. The table below shows the comparison of actual counts with the original Saturn model and also with the adjusted matrix incorporating data from the 2001 census.

Count	SSTM	GEH	2006 Base	GEH	Count	SSTM	GEH	2006 Base	GEH
1530	1069	13	1567	1	435	529	4	794	14
1190	1002	6	1048	4	243	210	2	293	3
1353	1489	4	1200	4	2205	2897	14	2738	11
957	819	5	602	13	2338	2609	5	2606	5
1154	1655	13	1766	16	3861	3743	2	3387	8
707	783	3	830	4	3743	3962	4	3628	2
749	673	3	556	8	3201	3304	2	3673	8
373	342	2	327	2	3897	4623	11	4333	7
1045	420	23	618	15	4912	4904	0	4834	1
1560	1641	2	1702	4	4661	4145	8	4462	3
1034	1280	7	1296	8	3596	4903	20	5190	24
2953	2715	4	2899	1	3386	3997	10	4635	20
1545	1872	8	1952	10	891	583	11	538	13
1523	1621	2	1478	1	1386	1458	2	1187	6
1177	1527	10	1347	5	2067	2475	9	1990	2
997	997	0	887	4	2370	2739	7	2137	5
1635	2082	10	1588	1	789	895	4	802	0
2305	3190	17	3179	17	539	741	8	438	5
867	894	1	900	1	359	628	12	412	3
754	829	3	1044	10	689	846	6	655	1
656	509	6	805	6	2780	2186	12	2515	5
679	703	1	501	7	2023	1852	4	1882	3
494	198	16	250	13					

Table 6.1 Comparison of Counts to Saturn Modelled Flows

1.1.4 The count sites shown on **Figure 6.2** represent a mix of highway links on the strategic and local network and incorporate a number of motorway slip roads. In the original 'validated' Saturn model shown as 'SSTM' in **Table 6.1** some 22 of the 45 links have a GEH statistic at or below 5. In the adjusted version (which incorporates data from the census) 25 links have a statistic at or below 5. The blue shaded boxes represent links where an improvement in fit has been made.

1.1.5 Although neither sets of data reach the theoretical test of 85% at or below 5 it can be seen that an improvement in fit has been achieved with specific improvement at Junction 9 of the M27. Additional improvement may be possible with the use of matrix estimation techniques but at this stage this has not been undertaken.

1.1.6 The Saturn model has already been used by the Highways Agency to assess the need for the motorway climbing lanes, based on a Validation Report prepared by WSP. As the 'goodness of fit' has been improved it is considered that the model is also suitable for testing the strategic impacts of the LDF proposals.

1.2 Trip Generation

1.2.1 In the majority of transport studies TRICS trip rates are used relating to a specific development site; however this is not the case for this assessment. As the study area covers four local authorities it was considered essential that the trip rates should be adjusted to take account of the differing travel characteristics in each area (zone). Within dense urban areas vehicle trip rates are generally lower than in more rural locations where public transport is less frequent. There is also a tendency for a greater proportion of walk and cycle movements in urban areas which reduces the need to travel by car.

1.2.2 The adjustment to trip rates was undertaken using the 2001 Census data for Home to Work trips as follows:

- A GIS analysis was undertaken to convert census data from output areas to the 362 zone system used in the Saturn model.
- Key Statistics Table 16 of the National Census was used to derive the total number of houses and flats in each zone at the time of the 2001 Census.
- Key Statistics Table 18 from the National Census was then used to provide a value for the percentage of social housing which was present in any given zone.
- The two sets of tables provide sufficient information to determine the number of private and rented (social) houses and the number of private and rented flats in each zone.
- The proportion of social housing should be taken into consideration as trip rates for social and privately owned property are very different.
- By use of the 'standard' TRICS trip rates it was possible to predict the number of vehicle trips generated by the four house types, namely private and rented houses and private and rented flats in each zone.

1.2.3 The TRICS rates used were as follows:

Industrial and Retail Trip Rates from TRICS Database Weekday		(TRICS 2008a) per 100 sq m GFA		
Use	**Time Period**	**Arrivals**	**Departures**	**Total**
Office & Research	**07:00-09:00 Av hour**	0.956	0.139	1.095
Business Park	**16:00-18:00 Av hour**	0.168	0.936	1.104
B1 (c)	**07:00-09:00 Av hour**	0.403	0.141	0.544
Light Industrial	**16:00-18:00 Av hour**	0.153	0.385	0.538
B2 Industrial	**07:00-09:00 Av hour**	0.312	0.122	0.434
	16:00-18:00 Av hour	0.113	0.282	0.395
B8 Distribution	**07:00-09:00 Av hour**	0.259	0.136	0.395
	16:00-18:00 Av hour	0.134	0.247	0.381
Retail Park	**07:00-09:00 Av hour**	0.369	0.176	0.545
	16:00-18:00 Av hour	1.404	1.510	2.913
Retail Foodstore	**07:00-09:00 Av hour**	1.445	1.016	2.461
	16:00-18:00 Av hour	3.684	3.340	7.024
Average Retail Park and	**07:00-09:00 Av hour**	0.907	0.596	1.503
Foodstore	**16:00-18:00 Av hour**	2.544	2.425	4.968

Table 6.2 Industrial and Retail Trip Rates

Housing Trip Rates from TRICS Database Weekday		(TRICS 2008a)		
Use	**Time Period**	**Arrivals**	**Departures**	**Total**
Houses Private	**07:00-09:00 Av hour**	0.095	0.378	0.473
Residential	**16:00-18:00 Av hour**	0.346	0.187	0.532
Houses for Rent	**07:00-09:00 Av hour**	0.099	0.188	0.287
Residential	**16:00-18:00 Av hour**	0.276	0.213	0.489
Flats Private	**07:00-09:00 Av hour**	0.029	0.160	0.188
Residential	**16:00-18:00 Av hour**	0.140	0.071	0.211
Flats for Rent	**07:00-09:00 Av hour**	0.050	0.108	0.158
Residential	**16:00-18:00 Av hour**	0.125	0.091	0.215

Table 6.3 Housing Trip Rates

1.2.4 At this stage the analysis assumes that an 'average TRICS trip rate' applies to every zone within the study area. As mentioned above there are clearly very different travel characteristics across the study area with some zones in densely populated urban centres and other zones with easy access to the motorway network. Some areas are therefore likely to have trip rates 'above average' and others 'below average'. The trip rates were calibrated as follows:

- The census Home to Work data was analysed using GIS to determine the total home to work vehicle trips from each zone in the study area. These trips were then factored using data from the census and from the DfT to produce total outbound journeys (for all purposes) from each zone. The trips were produced for the am peak period based on an average hour between 0700 and 0900.

- The census derived matrix produces a total number of trips from the home (origin zone) of the trip and a total number of trips arriving at the employment (destination zone) end of the trip.

- For the home (origin) it was possible to calculate a vehicle trip rate from the census data based on the number of dwellings in each zone. This was then compared with the trip generation based on TRICS trip rates. A factor was then derived for each zone to calibrate the TRICS trip rates against the census data. As expected within the urban areas TRICS rates had to be 'factored down' to match with census data and in the more rural areas (with good access to the M27) TRICS rates had to be 'factored up'.

- For the destination (employment) end of the trip it was possible to undertake a similar process using the 'working population' data from the census and TRICS vehicle trip rates based on employees. A very similar trend was found with employment areas in the central urban zones attracting less vehicle trips than predicted using 'average TRICS rates' and zones close to the motorway tending to attract greater number of trips.

- **Appendix C** provides a detailed breakdown of the 'calibrated TRICS data' and final trip generation to and from each zone based on the proposed housing and employment projections. This is shown for both the am and pm situations.

- The percentage increase in trips resulting from the 2016 and 2026 development scenarios are also shown in **Appendix C** compared with the 2006 base year flows.

1.3 Growth

1.3.1 Growth factors used in this assessment were based on the national road traffic forecast 2008. As the assessment is based on the peak period it was considered that 'low growth' was appropriate rather than 'central growth' which is used for daily predictions. NRTF factors were based on those applicable to 'urban major roads' and 'urban motorways'.

1.3.2 The NRTF growth factors were then adjusted by use of the TEMPRO trip end data which provides data at ward level. The TEMPRO data was used to adjust the NRTF data based on the ratio of the local TEMPRO growth to National TEMPRO growth.

1.3.3 The table below shows the final factors used with GB, Isle of Wight, South East and South West representing mainly long distance routes based on NRTF 'urban motorway' growth. All other trips were based on the adjusted 'urban major road' NRTF growth.

TEMPRO adjusted NRTF Low Growth Factors				
	2006 – 2016 Adjusted NRTF Low		2006 – 2026 Adjusted NRTF Low	
Area	Origin	Destination	Origin	Destination
Chichester	1.061	1.078	1.159	1.203
East Hampshire	1.031	1.052	1.054	1.119
Eastleigh	1.112	1.112	1.288	1.289
Fareham	1.086	1.105	1.219	1.267
GB	1.094	1.094	1.229	1.229
Gosport	1.111	1.108	1.271	1.274
Hampshire (N)	1.060	1.059	1.142	1.137
Havant	1.070	1.094	1.159	1.236
Isle of Wight	1.125	1.035	1.334	1.111
London	1.112	1.091	1.260	1.217
New Forest	1.047	1.086	1.107	1.213
Portsmouth	1.148	1.114	1.378	1.292
South East	1.099	1.119	1.243	1.281
South West	1.096	1.096	1.248	1.248
Southampton	1.133	1.108	1.342	1.271
Test Valley	1.054	1.070	1.130	1.166
Winchester	1.055	1.090	1.142	1.221

Table 6.4 Growth Factors

1.3.4 Growth was applied to the matrix firstly based on origin totals and then based on column totals.

1.3.5 A Furness 'balancing process' was then used to ensure that row totals and column totals were equalised.

1.4 Trip Distribution

1.4.1 The aim of trip distribution is to take a total number of trips generated by a particular area or zone and distribute those trips to all destination areas as close to the 'real world' situation as possible. Trips may go to any zone in the model including the origin zone.

1.4.2 Distributed trips can be recorded in a matrix. The matrix is created by either rows or columns but creates two distributions per zone; one shows trips leaving a zone going everywhere, the other shows trips coming from everywhere to a zone. **Figure 6.3** below gives a simple illustration of this principal.

Matrix	Zone 1	Zone 2	Zone 3	Zone 4	Total
Zone 1	10	5	50	25	90
Zone 2	16	25	37	96	174
Zone 3	23	20	14	23	80
Zone 4	89	53	27	96	265
Total	138	103	128	240	

Distribution from a zone to everywhere

Rows	Zone 1	Zone 2	Zone 3	Zone 4	Total
Zone 1	11.1%	5.6%	55.6%	27.8%	100%
Zone 2	9.2%	14.4%	21.3%	55.2%	100%
Zone 3	28.8%	25.0%	17.5%	28.8%	100%
Zone 4	33.6%	20.0%	10.2%	36.2%	100%

Distribution from everywhere to a zone

Columns	Zone 1	Zone 2	Zone 3	Zone 4
Zone 1	7.2%	4.9%	39.1%	10.4%
Zone 2	11.6%	24.3%	28.9%	40.0%
Zone 3	16.7%	19.4%	10.9%	9.6%
Zone 4	64.5%	51.5%	21.1%	40.0%
Total	100%	100%	100%	100%

Figure 6.3: Example trip matrix and display of two distributions contained

1.4.3 The basis for this assessment is the 2004 base vehicle trip matrix in the Solent Strategic Transport Model (SSTM) which is a SATURN traffic model. This matrix gives the distribution of trips from an origin zone to a destination zone.

1.4.4 The home to work Census data contains the origin and destination of each trip as well as the mode of travel. In order to compare the distribution of the 2001 home to work Census data with the distribution contained in the 2004 SATURN matrix, it was necessary to analyse only trips made as a car driver or motorcycle driver. This gives the trips to work as vehicle trips.

1.4.5 A comparison of the distribution found in the 2001 Census home to work data with the 2004 SATURN distribution revealed that there are significant differences between the two. The 2001 Census, although not necessarily 100% accurate, represents a large dataset of survey data and therefore is considered to be of good quality.

1.4.6 As mentioned in the 'Base Model' section of the chapter it was decided that the most appropriate matrix of trips would be obtained by a combination of the Saturn model and the census Home to Work vehicle trips. For trips with origins or destinations within the Saturn study area the matrix was adjusted and uses 50% of the Saturn trip pattern. The other 50% is based on the Home to Work trips travelling in the morning peak.

1.4.7 In each of the future year situations there will be alterations to the number of houses and amount of employment present in each zone. In order to take full account of the possible change in trip distribution a gravity model is required.

1.4.8 For the purposes of this assessment, a negative exponential method has been applied. This takes account of the distance between zones which empirical evidence shows has a substantial effect on the number of trips between each origin and destination. The negative exponential applies a factor to the trip distance which reduces the 'gravitational pull' of large

employment sites when they are a significant distance from the origin. The formula used is shown below:

Trips between two zones = Total trip generation x percent of total trips to the destination zone

The percentage to each zone is determined from the Gravity Model which has the following form:

$$\text{Percentage to each zone} = \frac{\text{(Attraction Factor x exp(-beta x drive distance)}}{\text{[sum of (Attraction Factor x exp(-beta x drive distance)] for all destin. zones}}$$

- The attraction factor was represented by the total trips attracted to each zone and beta is a coefficient which provides the 'best fit' with the trip patterns in the base 2006 matrix.

1.4.9 The comparison of the gravity model distribution with the distribution of trips in the combined Saturn and Census base matrix gave robust results for zones close to and far away from the origin.

1.5 Matrix Production

1.5.1 The production of the future year trip matrices was undertaken in two stages. The first produces a base year matrix at 2016 and 2026 with assumed zero growth in traffic generated in the study area of Portsmouth, Havant, Fareham and Gosport and the second takes accounts of the LDF planned housing and employment projections. The two sets of matrices were produced as follows:

Base 2016 and 2026

- Apply growth to those zones outside of the study area based on TEMPRO adjusted NRTF factors (described previously). Apply zero growth in the study area.

- Use the gravity model to take account of the greater attraction of employment outside of the study area, eg, in Southampton where growth in employment has been taken into account. Although trips starting in the study area remain fixed the greater attraction of destinations outside of the study area results in a decline in the number of trips attracted into the study area. This technique confirms that a lack of LDF development would result in an outflow of vehicle trips to the surrounding areas where job opportunities have been increased.

- The resulting 'Furnessed' vehicle matrix indicates a significant shift to destinations outside of the study area with nearly all internal zones showing a fall in trip destinations.

- Apply growth to the separate heavy goods vehicle (HGV) matrix.

Development Matrices for 2016 and 2026

- Apply growth to those zones outside of the study area based on TEMPRO adjusted NRTF factors (described previously). Add the predicted origin and destination trips shown in the 'Trip Generation' section based on the LDF projections.

- Use the gravity model to take account of the employment opportunities in the study area as well as those predicted outside of the study area. As job opportunities are relatively

close to the new housing areas the gravity model technique reduces the outflow to surrounding areas and increases the destinations within the study area,

- The Furness balancing method is applied to ensure that predicted trip generations correspond with trip attractions. The resulting matrix shows the beneficial effects of locating employment close to the proposed housing areas with a substantial increase in internal study area trips as opposed to trips leaving the study area for destinations (for example) in Southampton.

1.6 Effect of Public Transport Improvements

1.6.1 The proposed public transport enhancements of Bus Rapid Transit (BRT) and Premium Bus Network (PBN) were taken into account as follows:

- The effects of the PBN and improvements in frequency related to development proposals was taken into account by increasing the number of bus passengers by 15%. This was undertaken using the census home to work data using a combination of the vehicle movements between each zone and the corresponding bus passenger numbers between each zone.

- For each zone to zone movement it was possible to derive a relationship between the number of occupants travelling in cars and the number of passengers travelling by bus. It was also possible to see where travelling by bus is not presently an option either due to distance or more practically by a lack of suitable bus route.

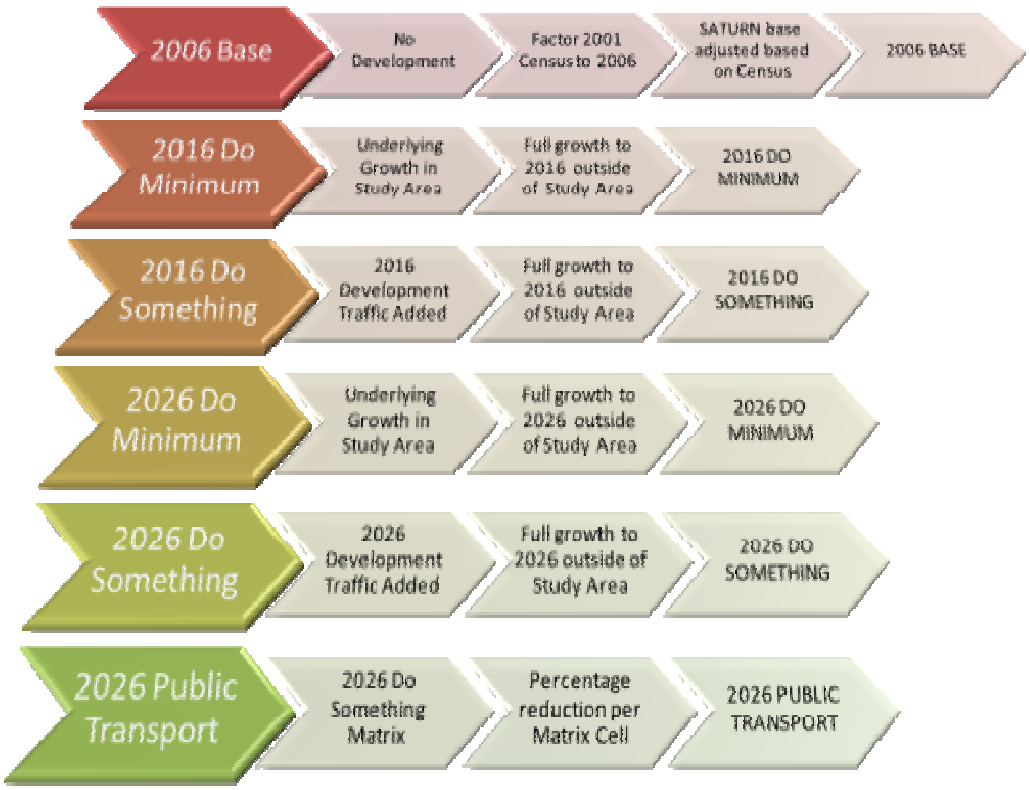
- For those zone to zone movements where travel by bus is an option a matrix of bus passenger movements was derived from the 2026 vehicle matrix. This was then factored up by 15% to calculate the additional passengers that could arise from the PBN.

- A corresponding reduction in vehicle trips was then calculated based on the average number of occupants in a car for each zone to zone movement. For the PBN and other assumed bus improvements it was calculated that 612 vehicle movements could be removed from the study area road network in the am peak period.

- The effects of the Bus Rapid Transit network have been assessed on the assumption that for trips starting and finishing within 600 metres of a BRT bus stop 20% of vehicle drivers and their occupants would transfer to the new service.

- The analysis of this effect was undertaken using a GIS technique which determined the proportion of each zone within 600 metres of a bus stop. A matrix of vehicle trips with both an origin and destination close to the new routes was then produced and the number (20%) transferring to the BRT determined. It was calculated that 813 vehicle movements could be removed from the study area in the am peak period. The combined effects of the PBN and BRT represents a reduction of 1.65% in the total vehicle movements with both an origin and destination within the study area.

1.6.2 In summary the Base and Future trip patterns have been produced as shown in the flow diagram below.



1.6.3 In order to be able to understand the results of the future trip patterns, reduced 17 x 17 versions of the 362 zone matrices are shown in **Appendix D.** Careful inspection of these matrices will show the effects of the various development strategies on the number of trips generated in each of the four authorities. The matrices are shown as follows:

1 Base 2006 am cars **Total 104148 trips**

2 Base 2006 am HGV **Total 5361 trips**

3 Base 2006 am cars with trips re-distributed to take account of growth outside of the study area in 2016. This is a theoretical case which allows for the effect of zero growth in the study area and growth in employment outside of the study area. It can be seen that trips arriving in the study area would be reduced and would transfer to destinations outside of the study area. Total 104148 trips

4 Base 2016 am with growth outside of the study area only. **Total 109722 trips**

5 Base 2016 HGV with NRTF low growth outside of the study area. **Total 5710 trips**

6 Base 2006 am cars with trips re-distributed to take account of growth outside of the study area in 2026. This is a theoretical case which allows for the effect of zero growth in the study area and growth in employment outside of the study area. It can be seen that trips arriving in the study area would be reduced and would transfer to destinations outside of the study area. **Total 104148 trips**

7 Base 2026 am with growth outside of the study area only. **Total 118163 trips**

8 Base 2026 HGV with NRTF low growth outside of the study area. **Total 6248 trips**

9 Development 2006 am cars with trips re-distributed to take account of growth inside and outside of the study area in 2016. This is a theoretical case which allows for the effect of LDF development growth in the study area and growth in employment outside of the study area. It can be seen that trips arriving in the study area are broadly similar to the 2006 Base indicating that LDF proposed employment would discourage trips to employment outside of the study area. **Total 104148 trips**

10 Development 2016 am with growth inside and outside of the study area. **Total 117276 trips**

11 Development 2006 am cars with trips re-distributed to take account of growth inside and outside of the study area in 2026. This is a theoretical case which allows for the effect of LDF development growth in the study area and growth in employment outside of the study area. It can be seen that trips arriving in the study area are broadly similar to the 2006 Base indicating that LDF proposed employment would discourage trips to employment outside of the study area**. Total 104148 trips**

12 Development 2026 am with growth inside and outside of the study area. **Total 132514 trips**

13 Reduction in trips due to Premium Bus Network. **Total 612 trips.**

14 Reduction in trips due to Bus Rapid Transit**. Total 813 trips.**

15 Development 2026 am with growth inside and outside of the study area and taking account of reduction in trips due to PBN and BRT. **Total 131089 trips**