VOLUME 12 TRAFFIC APPRAISAL OF ROADS SCHEMES
SECTION 2 TRAFFIC APPRAISAL ADVICE

PART 3

THE NATIONAL TRIP END MODEL

SUMMARY

This document describes the new National Trip End Model forecasts of planning data, car ownership, trip ends and constrained traffic growth which accompany the 1997 National Road Traffic Forecasts. The meaning and status of the figures is discussed, with a brief note on their application to traffic modelling. Results showing the distribution and composition of predicted car traffic growth are presented.

INSTRUCTIONS FOR USE

This is a new document to be inserted into the manual.

1. Insert document into Volume 12, Section 2.

2. Archive this sheet as appropriate

Note: A quarterly index with a full set of Volume Contents Pages is available separately from the Stationery Office Ltd.

DESIGN MANUAL FOR ROADS AND BRIDGES

THE HIGHWAYS AGENCY

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT FOR
NORTHERN IRELAND

The National Trip End Model

Summary: This document describes the new National Trip End Model which accompanies the 1997 National Road Traffic Forecasts

REGISTRATION OF AMENDMENTS

Amendment No	Page No	Initials & Date of incorporation of amendments	Amendment No	Page No	Initials & Date of incorporation of amendments

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PART 3

THE NATIONAL TRIP END MODEL

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Chapter

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1 Introduction & Context

1.1 WHAT IS THE NATIONAL TRIP END MODEL ?

1.1.1 The National Trip End Model (NTEM for short) provides a set of predictions of growth in car ownership and car traffic, with associated planning data projections, at any geographical level down to local authority districts. It forms a starting point for local forecasting procedures. It is a forecast of vehicle movements rather than a forecast of personal travel.

1.1.2 NTEM forms part of the same forecasting system as the 1997 National Road Traffic Forecasts (NRTF97), and uses many of the same components. This integrated forecasting system has three major outputs:

- NRTF national all-vehicle traffic forecasts, used by the overseeing organisation to inform policy decisions
- NTEM car trip end forecasts, used to supply growth factors to local road traffic models
- A methodology for simple road traffic growth forecasts for use in the absence of a local traffic model, known as "spot forecasts"

1.1.3 The NTEM models start from the basis that each one-way car trip has two trip ends - an origin end and a destination end. The models work by relating the number of trip origins and trip destinations in each area to a range of demographic and land use factors, such as the number of households with cars in each area, and the number of people employed in each area.

1.2 CONTEXT, MEANING AND STATUS OF THE FIGURES

1.2.1 The following paragraphs set out the context for the NTEM forecast.

1.2.2 Traffic growth will vary from road to road, and no forecast can be expected to accurately predict growth everywhere. Traffic levels depend on several different sets of factors:

1.2.3 The number of car trips originating in a district will depend for example on the number of people living there and the proportion of them who own cars. The number of car trips with a destination in a particular district will bear some relationship to employment in the district, among other factors. A district where employment and population are growing rapidly will, other things being equal, experience a high rate of trip end growth. NTEM is primarily a forecast of trip ends by purpose, and is designed to incorporate these sorts of effects.

1.2.4 Traffic growth on a particular road link depends on trip-end growth in the places that the road runs between, how well the link connects to other road links to form a network, and how congested various parts of the network become. The NTEM model "knows" nothing about which places are adjacent to which other places and which road links connect them - this would require a national network model - and therefore NTEM does not directly include these sorts of effects.

1.2.5 Local authorities may undertake various policies, either to attract employment (with attendant commuting trips) and/or shopping trips, or to deter various categories of car use. Local policies may affect trip origins, trip destinations, the linkage between them (which destinations are attractive from which origins), or routeing through the network. NTEM gives a robust national picture, and contains no assumptions about the success or failure of proposed local policy initiatives or individual development or infrastructure proposals. The underlying assumption is that the relationships between income, household structure, car ownership and car use - which have been observed over the period 1971 to 1991 and reviewed recently - continue to hold.

1.2.6 The Road Traffic Reduction Act, amongst other requirements, imposes a duty on local authorities to forecast traffic growth in their areas. These forecasts may differ from the NTEM figures for a number of reasons.

1.2.7 NTEM figures are not a target, nor a worst case, nor a negotiating position. NTEM should be seen as a useful starting point for forecasting - an impartial and consistent base case to which could be added local network effects, the impact of particular policies, or different levels of development from that assumed.

1.3 APPLICATION

1.3.1 Most roads carry a mixture of long-distance and short-distance trips, linking a wider range of origins and destinations. NTEM is designed for use in traffic studies where a base year matrix of trips between each origin and destination zone has been estimated. By applying NTEM trip end growth to each row and column of the matrix, a future year matrix can be easily produced.

1.3.2 The NRTF97/NTEM system predicts, based on past trends, that a proportion of the increase in car traffic will arise from drivers making longer trips. The reason for this trend is not immediately obvious, and may result from any of several factors, including income growth, congestion causing greater trip suppression for short trips, land-use considerations, road improvements, improvement in the quality of the in-vehicle environment, or simply cultural change. (It also predicts that a proportion of future demand for car travel in some regions will be diverted to nearer destinations, or suppressed altogether, as a result of increasing congestion).

1.3.3 Any local traffic model which uses trip end growth factors, whether or not it adjusts trip patterns in response to changes in journey costs in the modelled area, will fail to pick up the element of traffic growth resulting from any net demand for longer trips unless some adjustment is made. In order to account for this, NTEM includes constrained growth factors, which are closely tied to the NRTF97 capacity-constrained forecast, and replace the previous use of National Forecast Adjustment Factors. The simplest form of adjustment is to use these constrained NTEM growth factors as if they were trip-end growth factors, and **this procedure is recommended** unless more comprehensive models are available.

1.3.4 Historically, traffic growth has not been accompanied by an overall trend of falling speeds, although some individual locations have experienced increasing congestion and associated increases in journey times. This apparent paradox is the result of both adaptive behaviour by drivers - changing routes, time of travel, and destinations in order to avoid congestion - and patterns of development which take advantage of available capacity on less-congested routes.

1.3.5 Use of elasticity methods for scheme appraisal gives a first-order approximation to these effects. NTEM constrained forecasts are suitable as an input to elasticity methods, representing the level of growth to be expected if overall journey times increase in line with the NRTF97 prediction of declining journey speeds. The elasticity model will then modify this, reducing traffic growth where the network is more affected by congestion than NRTF97 predicts, and increasing growth where existing capacity, new infrastructure or other measures provide shorter journey times.

1.3.6 In using NTEM forecasts, it is important to avoid significant double-counting, either of traffic growth or traffic restraint. The accompanying demographic and land-use projections indicate what has been assumed about growth in population, households, workforce and employment within each district. If developments are modelled explicitly, which is advisable where they are likely to have a significant impact on traffic flows in the area of interest, then the background traffic growth rate for the relevant district or districts should be reduced accordingly, to avoid double-counting. Similarly, when modelling the action of congestion in restraining traffic growth, this needs to be applied after estimating the impact on demand of local restraint policies, so as not to double-count the effect.

2 Implementation

2.1 The NTEM forecasts are released in the form of a small computer program, TEMPRO version 3. TEMPRO interpolates between projection years, and calculates growth rates at district, county and regional level. It is controlled by either mouse or keyboard, and is simple to use. It runs under DOS or Windows 3.1 on any 386-based or higher PC. A further program, SPOT, is under development for possible release in 1998.

2.2 No charge is made for these programs. They are issued on the basis that the Department accepts no liability for any loss or damage arising from the use of this software, however caused.

2.3 TEMPRO is available from the Department of Transport's Web site on the Internet, at

http://www.open.gov.uk/dot/heta/hetatemp.htm

Or by sending a blank 3½-inch diskette to

National Trip End Model,
HETA division,
3/06 Great Minster House,
76 Marsham St,
LONDON SW1P 4DR.

Documentation is included on the program disk.

2.4 Substantive queries on NTEM, TEMPRO, or SPOT, or suggestions for future development of this work, should be addressed to HETA division,

Tel: 0171-271-5006.
Fax: 0171-271-5026
e-mail: heta.dot@gtnet.gov.uk

Queries on the application of the forecasts to particular road schemes should be raised in the first instance with the Overseeing Organisation.

2.5 TEMPRO 3 supersedes the previous NTEM projections, which were released in September 1996. The new forecasts should be used forthwith, unless a stage has been reached at which, in the opinion of the Overseeing Organisation, their use would result in an unacceptable delay to progress. Application to particular schemes should be confirmed with the Overseeing Organisation.

2.6 The research and development work underlying NTEM is referenced in the relevant appendices. (The Bibliography in DMRB v13.1.0 ch3 holds more details of some of these). For access to unpublished material, a fee may be payable.

3 Model Structure

3.1 The model has six main stages, which are illustrated in Figure 3.1 The main outputs as presented in TEMPRO are shown in the shaded oval boxes.

3.2 Appendix A sets out the definitions and assumptions of the initial demographic and land-use dataset, compiled largely from published Government sources. This consists of values for four principal variables - population, households, workforce, jobs - for each district.

3.3 Many of these initial projections are trend-based. To ensure that the figures also reflect the outcome of planning policy, an extensive consultation exercise was undertaken in 1995/96. All county councils in England and Wales were invited to supply alternative projections. The procedure for reconciling the views of the English and Welsh bodies involved is set out in Appendix B. Consultation in Scotland was undertaken to a different timescale, and only interim Scottish data has so far been incorporated.

3.4 The resulting demographic and land-use data projections were used as input to a set of Car Ownership models, developed by consultants MVA for the Department in 1995/96. These models (described in Appendix D) work at two levels - an upper-level model is based on Family Expenditure Survey data over time, and relates car ownership to broad area, household income, household structure and trends in licence-holding over time. The lower-level model is based on 1991 Census data, and runs at a much finer geographical level - approximately 1000 zones for Great Britain. The economic and household structure inputs to these models are described in Appendix C.

3.5 Car ownership forecasts in turn feed into trip end models. Household car driver trip rates are taken to vary with income, with household structure, licence-holding, and broad area type. The models are based on National Travel Survey data from the period 1978 to 1991, from work done for the Department by the Transport Research Laboratory, and are fully described in Appendix E.

3.6 The 1997 National Road Traffic Forecasts are fully described in reference F. NRTF97 uses many of the same components as NTEM. A key feature is the “fitting-on” procedure. This takes a database of traffic by road type by time period in the base year, applies the predicted growth in demand for mileage, and reduces this to a level which will fit onto the road network. Elasticities are used to represent changes in time of travel, road type, destination, or trip frequency in response to congestion. This fitting-on exercise ensures that the overall levels of future traffic are plausible.

3.7 The outcome of the NTEM process is a set of constrained growth factors which are consistent with the fitted-on NRTF97 traffic forecasts. Appendix F presents the details of the constraint process. In almost all cases it is these constrained factors which should be used for transport modelling, in preference to the unconstrained trip end figures.

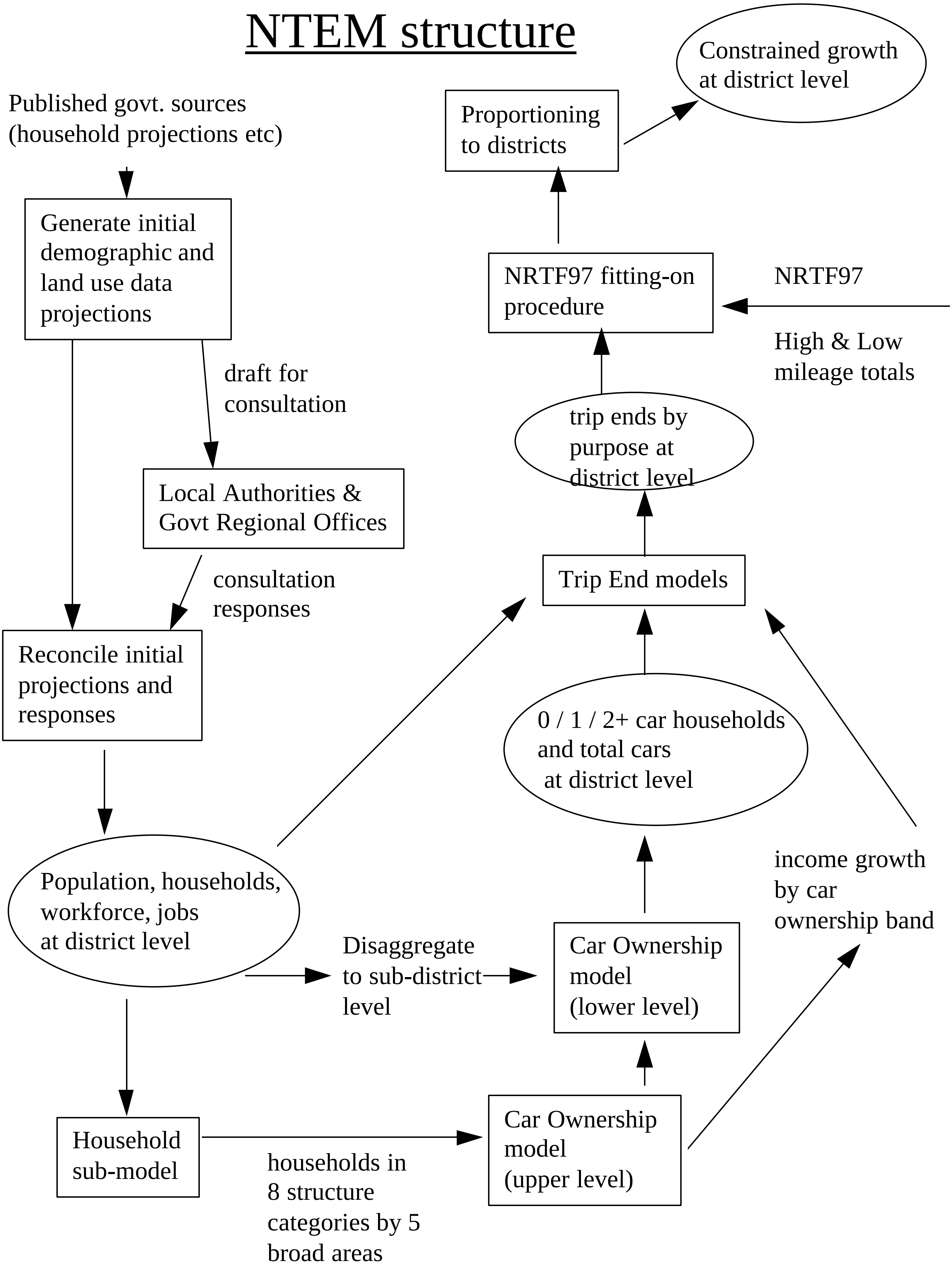


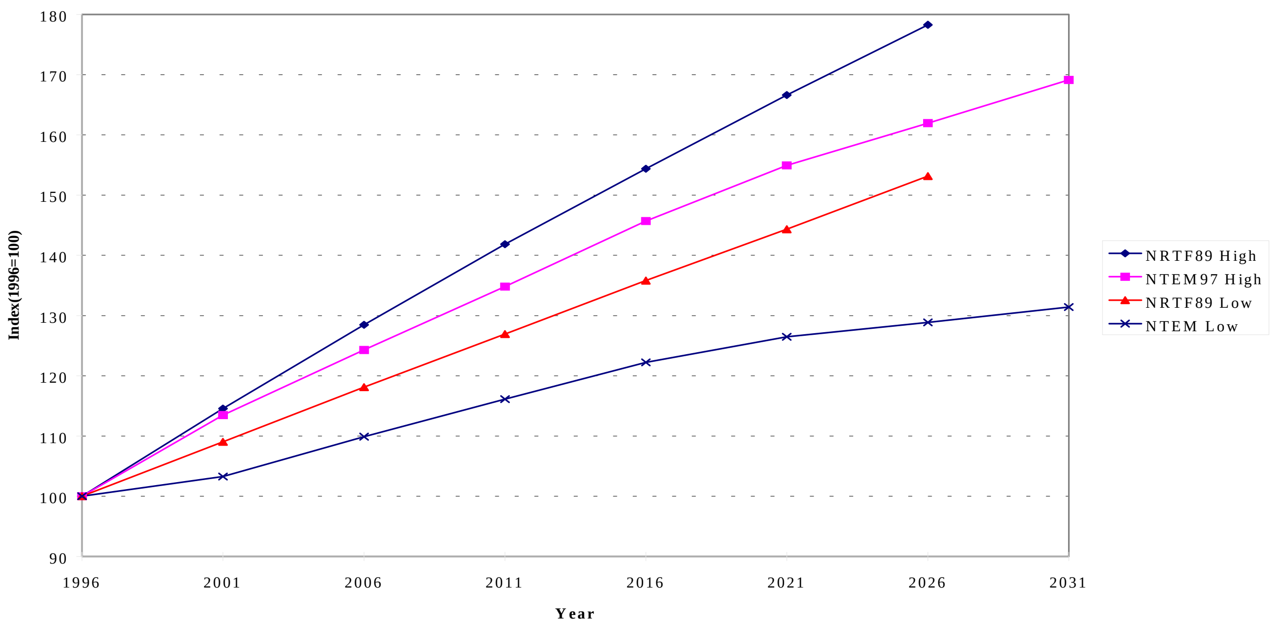
Figure 3.1: NTEM structure (showing for illustration the consultation procedure for England)

4 Patterns of Predicted Growth

4.1 The diagrams in this chapter aim to present the contribution of the different factors underlying car traffic growth, and illustrate which parts of the country are predicted to experience high or low rates of growth.

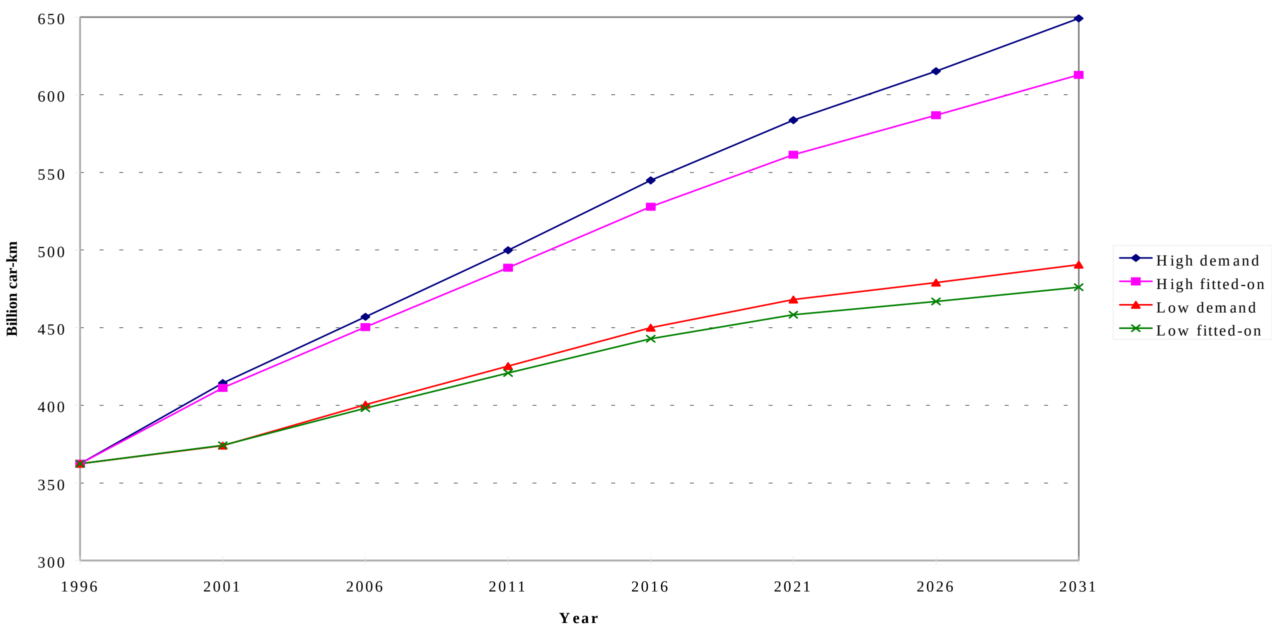
4.2 Figure 4.1 shows the High and Low predicted national car traffic profiles. The predicted growth is less than that forecast by the previous 1989 NRTF and its accompanying NTEM, but the spread between Low and High growth is wider, owing to differing assumptions on uncertainty.

Figure 4.1: Comparison with previous car traffic growth



4.3 As expected, the effect of the "fitting-on" procedure for supply constraint is greater in the High growth case, as figure 4.2 illustrates.

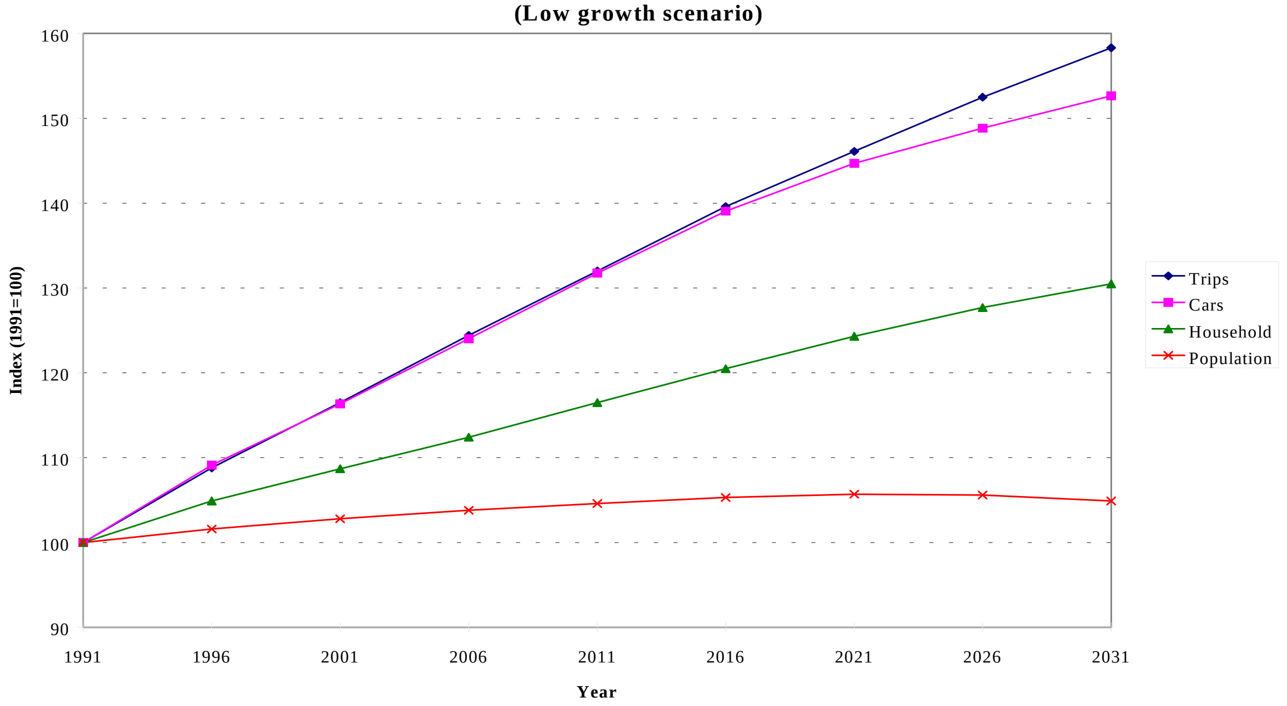
Figure 4.2: Effect of "fitting-on" car traffic



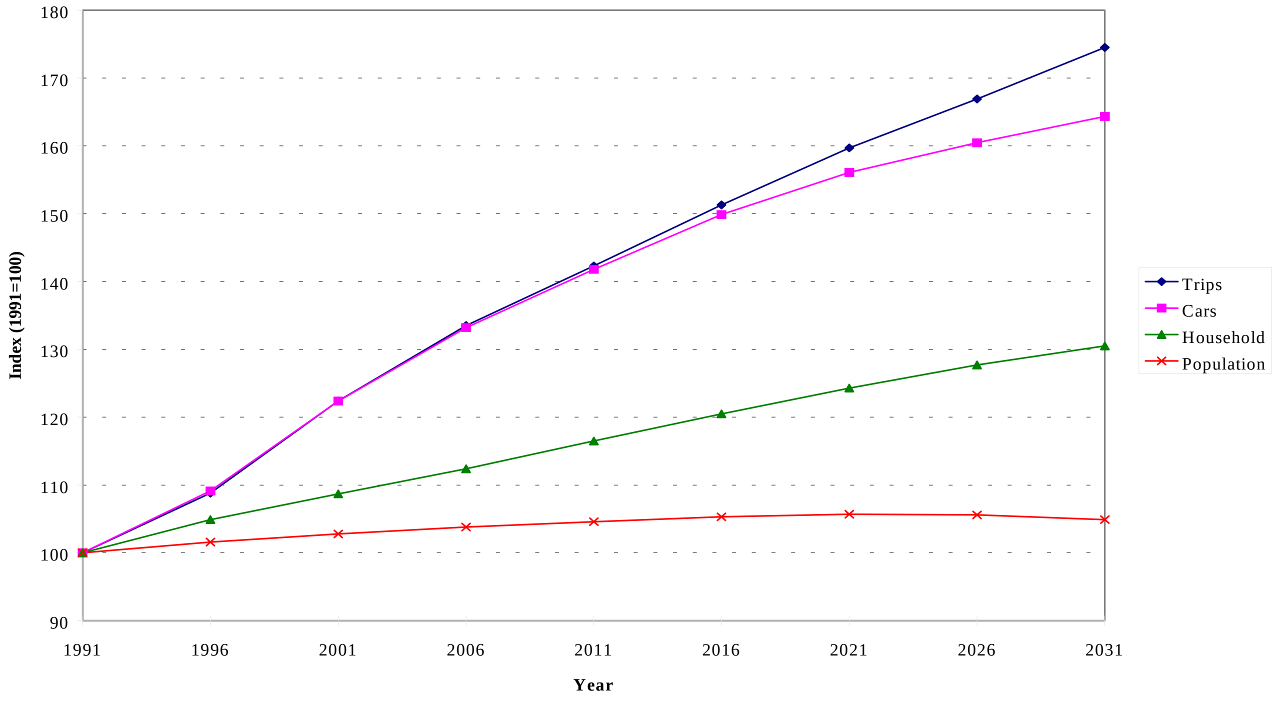
4.4 Figure 4.3 shows how much of the growth in car trips comes form each component of the model - from population increase, from smaller households, from increasing car ownership per household, and from increasing trips per car. (These factors can be combined as required - for example, the increase in cars per person is represented by the gap between the Cars line and the Population line). Car ownership appears to be the single largest effect, but the increase in number of households for a given population (reflecting smaller household size) is also significant.

Figure 4.3: Components of national trip end growth

(Low growth scenario)



(high growth)



4.5 In the previous NTEM, the ratio of traffic growth to trip end growth was interpreted as a trip length effect. In the current version, owing to the way that uncertainty is treated in the 1997 NRTF, there is no correspondingly simple interpretation.

4.6 The predicted growth in average tripends per car is small. Other things being equal, the model predicts that as average incomes rise, existing car owners make more use of their cars, so it might be expected that average tripends per car would grow. There are two reasons why this does not seem to be the case. Firstly, the income of marginal car owners is substantially below that of the average owner, so that the expansion of car ownership depresses the average income growth of car-owning households. Secondly, as household size diminishes and car ownership grows, each car is serving a decreasing number of people, further restraining the growth in use made of the average car.

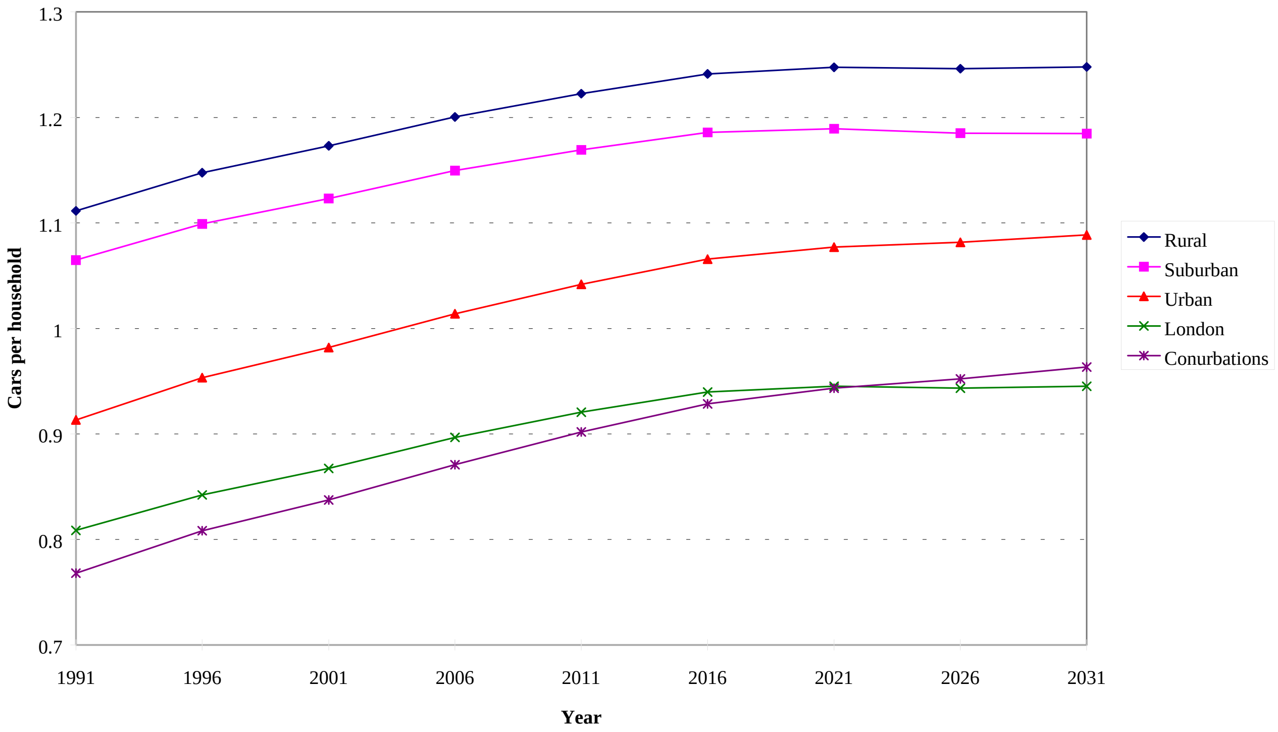
4.7 Given that growth in car ownership is the single largest component of traffic growth, figures 4.4 to 4.6 present this growth in different ways, showing the degree of similarity and difference between different areas of the country and different household types.

4.8 Note that in fig 4.4, after about 2016, cars per household in some area types is roughly constant. This indicates that the rate of acquisition of additional cars is predicted to be close to the rate at which the trend to smaller household size creates additional households.

4.9 This can be seen from figure 4.5 - growth in car ownership for each household type continues, and it is the switch between larger households and smaller households which is producing the levelling-off in cars per household. The forecast continuation of this trend is illustrated in figure 4.7.

Figure 4.4: Cars per household by FES area type

(Low growth scenario)



(High growth scenario)

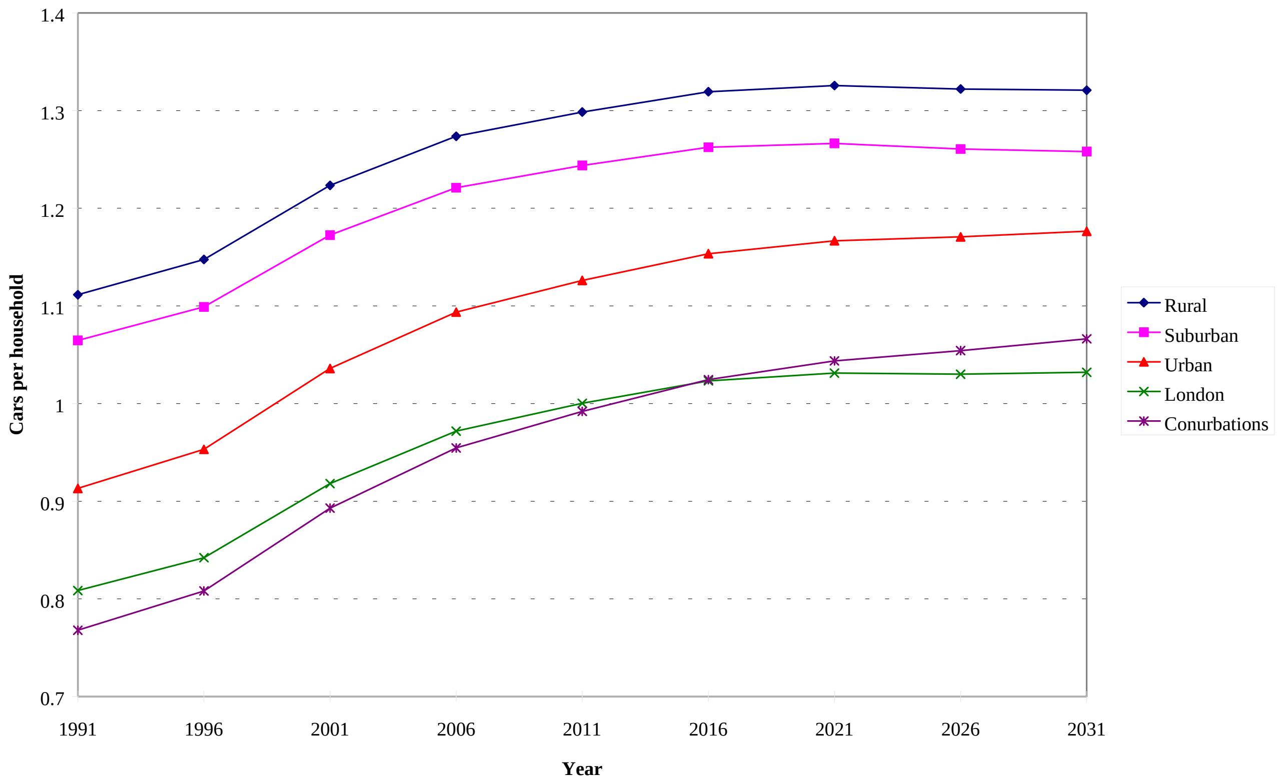
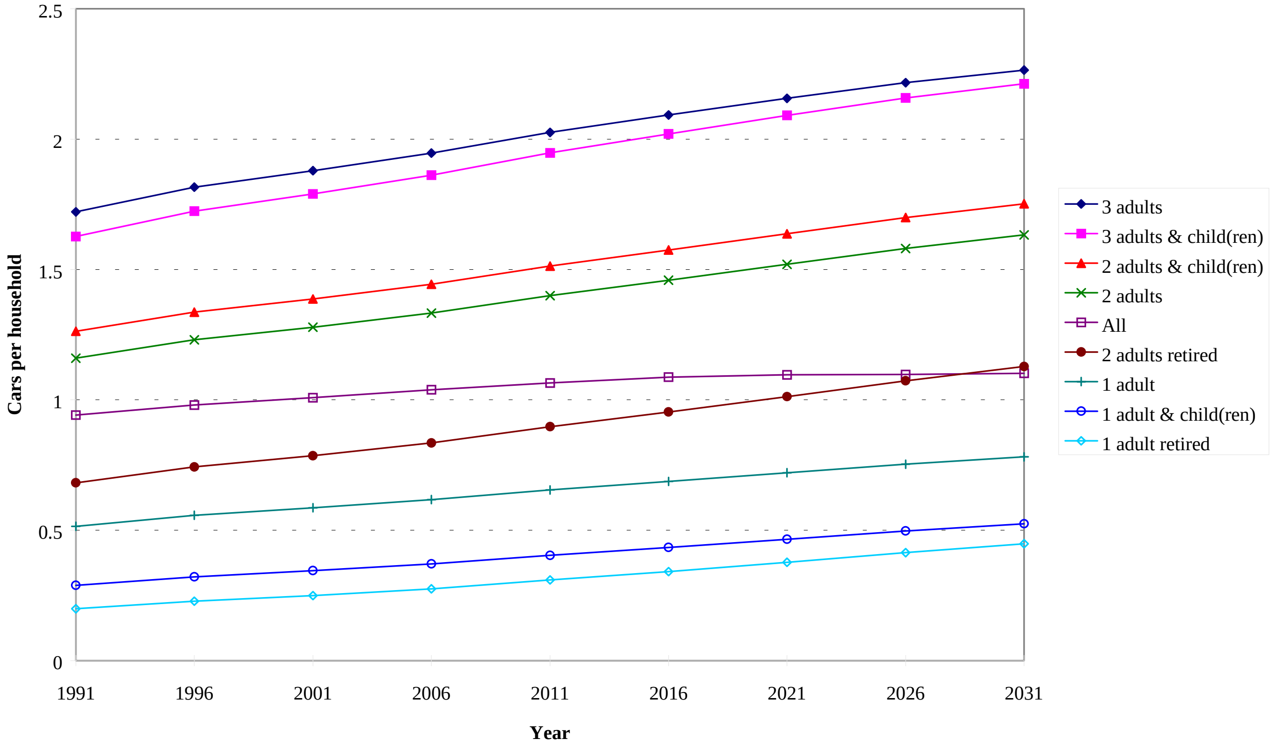


Figure 4.5: Cars per household by household structure

(Low growth scenario)



(High growth scenario)

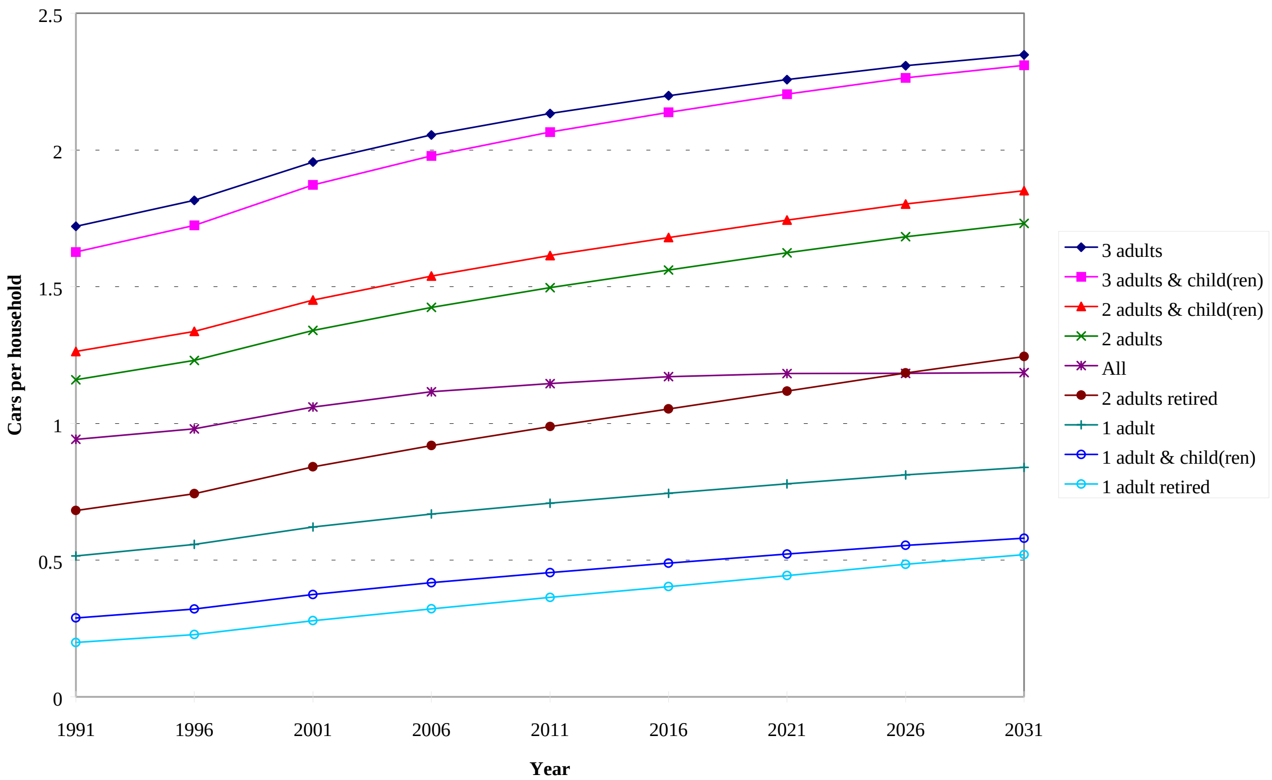
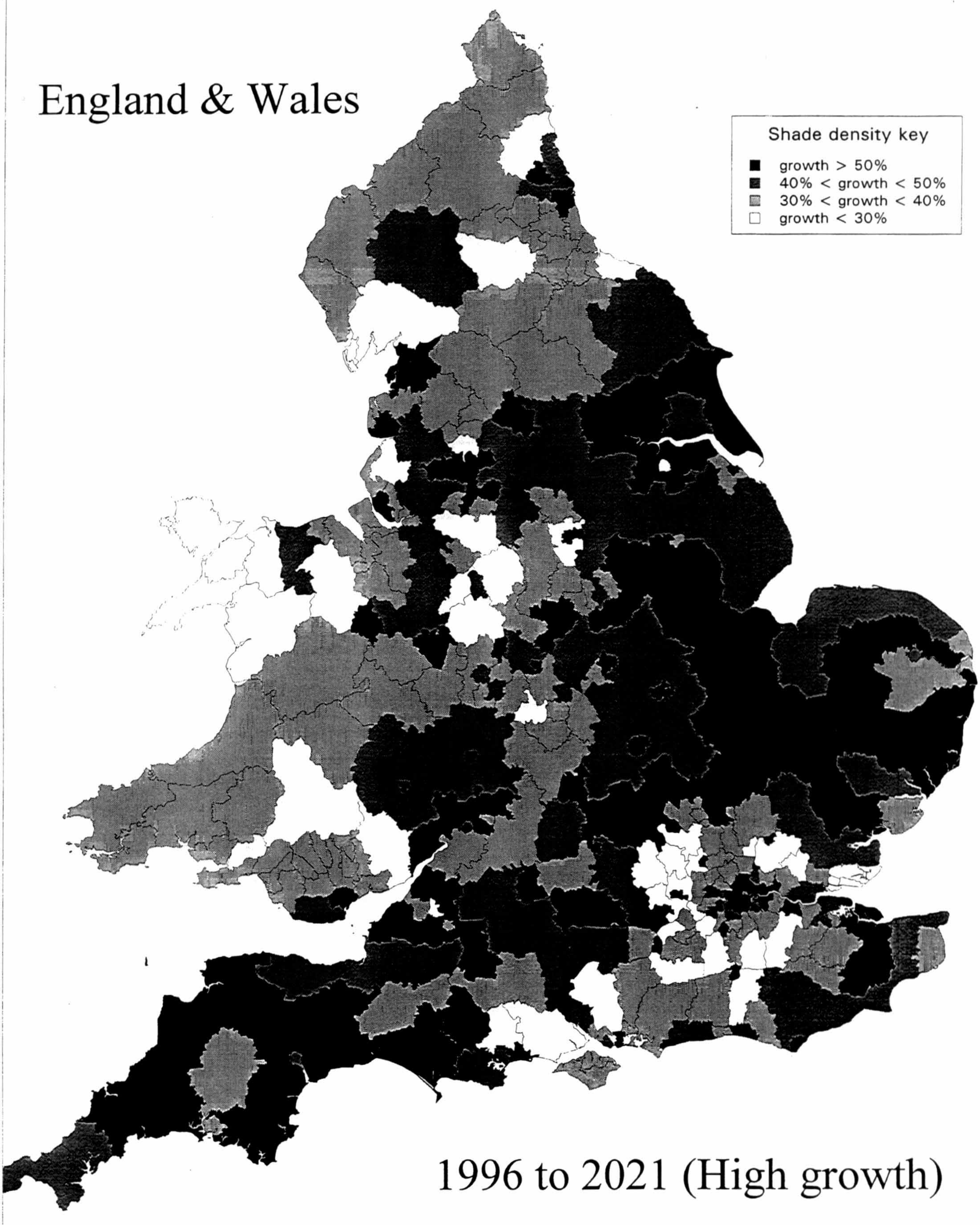
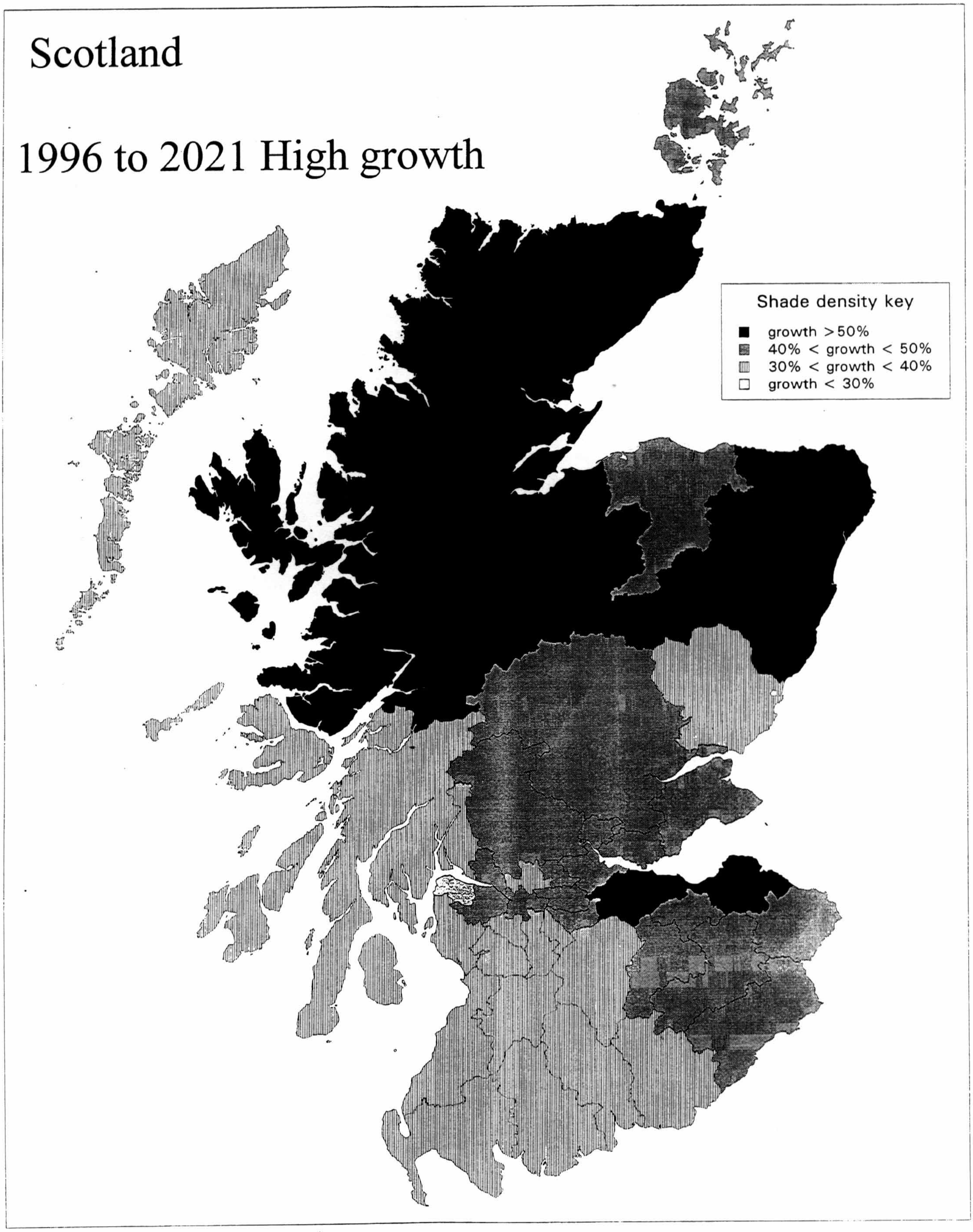


Figure 4.6: % growth in numbers of cars owned




Scotland
1996 to 2021 High growth
Shade density key
growth >50%
40% < growth < 50%
30% < growth < 40%
growth < 30%

5. ENQUIRIES

All technical enquiries or comments on this Advice Note should be sent in writing as appropriate to:

Head of Highways Economics and Traffic Appraisal Division (HETA) Department of Transport Great Minster House 76 Marsham Street London SW1P 4DR	T WORSLEY Head of Highways Economic and Traffic Appraisal Division

The Director of Roads The Scottish Office Development Department National Roads Directorate Victoria Quay Edinburgh EH6 6QQ	N MACKENZIE Director of Roads

The Head of Roads Engineering (Construction) Division Welsh Office Y Swyddfa Gymreig Government Buildings Crown Buildings Cathays Park Cardiff CF1 3NQ	B H HAWKER Head of Roads Engineering (Construction) Division

Technical Director Department of the Environment for Northern Ireland Roads Service Clarence Court 10-18 Adelaide Street Belfast BT2 8GB	V CRAWFORD Technical Director

Appendix A - Planning Data Projections

The planning data projections for England and Wales underlying the NTEM forecasts were compiled in a two-stage process. (The procedure in Scotland was somewhat different). This appendix describes the set of provisional projections. These were prepared largely from published sources, and also draw on responses to the previous round of consultation with local authorities in 1993. These provisional projections were then used as the basis for a new round of consultation, in December 1995. Appendix B describes the process of consultation and resulting revision of the figures. There are four major planning data variables - population, households, workforce and jobs.

A1. POPULATION

A1.1 Base year population figures are OPCS[1] 1991 mid-year estimates at district level. These include the institutional population and students at term-time address.

A1.2 OPCS 1992-based sub-national population projections were available for English counties and metropolitan boroughs. Similar projections from the General Registrars Office (Scotland) and Welsh Office were used for Wales and Scotland. These projections were linearly extrapolated to 2021.

A1.3 Since the OPCS projections are to county level rather than district level over most of England and Wales, one of two methods was used to arrive at district level figures:

- Where County Councils supplied population projections during the 1993 consultation, the Local Authority's own projected district growth rates were applied to the OPCS 1991 base year population. To ensure that the district level projections added up to the OPCS county level projections, the difference between the OPCS county total and the sum of the initial district level projections was allocated between the districts in proportion to their population in the base year.
- Where projections were not supplied, an assumption of uniform percentage growth was used.

A1.4 In February 1996 the Government Actuary's Department issued a new 1994-based national population projection, replacing the previous 1992-based national projection. No new sub-national projections were published. The provisional projections were therefore scaled to sum to the new national projections.

A1.5 The OPCS sub-national population projections for Cornwall included the Isles of Scilly, which are excluded from NTEM. A fixed proportion (derived from the 1991 OPCS mid year estimate) of Cornwall's population projections was subtracted for each projection year to account for this.

A1.6 Those Unitary Authorities which existed at time of publication of the most recent OPCS sub-national population projections were projected as Metropolitan boroughs. Otherwise they were treated as districts within the county from which they were formed. (This also applies to projections of households, workforce and jobs.)

A2. HOUSEHOLDS

A2.1 The number of households in the base year is the 1991 census count, adjusted to ensure that district household counts sum to be consistent at county level with OPCS 1991 population estimate (minus the institutionalised population) divided by DoE estimate of household size.

A2.2 For shire counties, the base year households are projected forward using, for each district:

- projected change in resident (non-institutionalised) population; and

[1] Note: OPCS (the Office of Population Census & Surveys) and CSO (the Central Statistical Office) have since merged to from the Office for National Statistics (ONS). Similarly, the Department of the Environment (DoE) is now part of the Department for the Environment, Transport and the Regions.

- projected change in average household size (from the ratio of the Local Authority's population and household projections, if sent during the previous consultation in 1993; otherwise the DoE projected change in the county's average household size is applied to all districts).

A2.3 In estimating the non-institutionalised population at district level (i.e. people resident in private households) we assume the census distribution of institutionalised population between districts is constant over the projection period.

A2.4 For metropolitan boroughs, provisional projections are equal to the non-institutionalised resident population (OPCS projection minus DoE projected institutionalised population) divided by the DoE projected average household size for the metropolitan borough.

A3. WORKFORCE

A3.1 Base year workforce figures are Census figures of economically active minus unemployed, at district level, scaled up to allow for under-enumeration (difference between Census and OPCS national population).

A3.2 The base year economically active population in each district (census count, adjusted to account for under-enumeration) is projected forward using:

a) projected change in non-institutionalised, working-age population; and
b) an estimate of the projected change in economic activity rate

A3.3 The non-institutional working-age population (a) at district-level is estimated by applying the base year proportion of the district population who are non-institutionalised to the county-level OPCS 1992-based projections of working age population, adjusted to account for the new 1994-based national population projection.

A3.4 The economic activity rate (b) is defined here as the proportion of working-age population who are working or available for work.

- Where the County Council provided both workforce and population projections for each district in the 1993 consultation, economic activity rates for each district were estimated by dividing the Local Authority's workforce projection (corrected by adding a constant allowance for the unemployed) by the Local Authority's district population projection (factored by the OPCS county-level estimate of percentage of population which will be of working age).
- Otherwise the CSO projected change in the region's economic activity rate was applied across all districts in the county.

Note that the change in activity rates over the projection period was used, not the activity rates themselves.

A3.5 To ensure that the district-level workforce projections estimated from Local Authority activity rates are consistent with regional economic activity rate projections published by CSO, they were scaled to sum to a county control total. This is calculated by taking the 1991 economic activity rate (census labour force/working age population), multiplied by the CSO projected growth in the regional economic activity rate, and applying this rate to the projected non-institutionalised working age population calculated above. Economic activity rates are not available beyond 2006, and so are assumed constant at the 2006 level

A4. JOBS

A4.1 Base year figures are district-level jobs, including part-time jobs, from the 1991 Census workplace statistics (10% sample). These were scaled so that jobs are equal to workforce at a national level. The same constraint was applied in future years.

A4.2 County job projections were made by multiplying provisional workforce projections by the base year county “commuting ratio”, and then scaling projections by a national factor so that jobs projections sum nationally to the projected national workforce total. “Commuting ratio” is defined as 1991 census jobs divided by 1991 census workforce (so that a figure greater than one represents net in-commuting to the area).

A4.3 Within each county total, a district estimate of jobs is based on the provisional district workforce projection multiplied by the district commuting ratio, and:

- if the Local Authority replied with both workforce and jobs projections during the previous consultation, then it is adjusted to take into account the Local Authority estimate of growth in commuting ratio in the district between the base year and the projection year.
- otherwise the base year district-level commuting ratio is assumed constant over time.

A4.4 For Metropolitan Authorities, a single county-level commuting ratio is used to project jobs from provisional county-level workforce figures. This jobs projection is then split pro-rata across districts, such that the percentage distribution of jobs between metropolitan districts remains constant, based on the most recent district-level jobs estimate (census).

A5. PUBLISHED DATA SOURCES

Population

◊ 1991 Census Total Population, Census Customer Services, Office for National Statistics (ONS)
◊ OPCS Revised mid-year estimates: district populations for England and Wales (publ. 1992), Population Estimates Unit, ONS.
◊ 1991-Revised mid-year estimate: district populations for Scotland (publ. 1992), Population Statistics Branch, General Register Office for Scotland.
◊ OPCS Series PP3: "1992-Based Sub-National Population Projections for England" (publ. Nov, 1994), Sub-national projections and migration unit, ONS.
◊ "1992-Based Population Projections for Wales" (publ. Dec. 1994), ISBN 0 7504 0740 9, Statistical Directorate, Welsh Office.
◊ "1992-Based population projections for Scotland and its areas by quinary age group and sex; 1992-2006/11" (publ. Dec. 1994), Population Statistics Branch, General Register Office for Scotland.
◊ OPCS Series PP2 no. 19: "1992-Based National Population Projections for the UK" (publ. 1995), ISBN 0-11-691617-6, Government Actuary's Department.
◊ OPCS Monitor PP2 96/1: "1994 Based National Population Projections for England, Wales and Scotland" (publ. Feb. 1996), Government Actuary's Department.

Households

◊ 1991 Census Households Count, Census Customer Services, ONS.
◊ "Projections of Households in England to 2016"; Table 7 - average household size (publ. Mar. 1995), ISBN 0-11-753055-7, Branch HDS4 (Household estimates and projections), Department of Environment.
◊ "1992-Based Household Projections for Wales 1992-2016"; Table 4 - average household size (publ. Mar 1995), ISBN 0 7504 0741 7, Statistical Directorate 7, Welsh Office.
◊ "Statistical Bulletin, Housing Series, 1992-based Household Projections for Scotland 1992-2006" (HSG/1995/3); Table 4(f) - average household size (publ Apr 1995), ISBN 0-7480-2902-8, Housing Statistics Unit, The Scottish Office Environment Department, Edinburgh.
◊ 1991 Census Institutionalised Population Count (Table 3 - Local Base Statistics), Census Customer Services, ONS.
◊ Institutional Population Estimates and Projections for Local Authorities in England and Wales, 1991-2016, Building Research Establishment/ Department of Environment.

Workforce

◊ 1991 Census Civilian Labour Force, Census Customer Services, ONS.
◊ 1991 Census Unemployed Population, Census Customer Services, ONS.
◊ "Table 2.9: Claimant Unemployment Area statistics", Employment Gazette, Sept 1991 and Sept 1995.
◊ "Projected Trends in the Regional Labour Force 1995-2006. Figures for detailed age groups", Employment Gazette (August 1995), Labour Market Statistics Group, C1, ONS.

Jobs

◊ 1991 Census Job Count (10% sample), Census Customer Services, ONS.

REFERENCE

A "Review of National Planning Data: Recommendations for the Future" unpublished internal report, HETA division, Department of the Environment, Transport and the Regions, 1997.

Appendix B - Planning Data Consultation Process

B1. INTRODUCTION

B1.1 This annex sets out the Department's process for consultation with Local Authorities in England and Wales, and regional Government Offices (including the Welsh Office) on the district-level planning data projections. The overall process consisted of five stages:

- Production of Provisional Projections (see Appendix A)
- Consultation with Local Authorities
- Calculation of Revised Projections
- Consultation with Government Offices
- Production of Final Projections

B2. CONSULTATION WITH LOCAL AUTHORITIES

B2.1 On 5 December 1995, the then Department of Transport sent provisional projections to County Councils, various coordinating bodies in metropolitan areas and unitary Authorities, inviting them to comment, and either accept them as a reasonable basis for transport planning or supply alternative projections. The questionnaire asked about the base data and assumptions used to derive any alternative projections supplied.

B2.2 Government offices for the regions were sent copies of the provisional projections for their region. They were invited to discuss the distribution of growth across the region with the relevant Authorities within that region. Government Offices were told that no reply was required from them at this stage, but they would have the opportunity to advise DoT on metropolitan, unitary, county and regional totals after the DoT projections had been revised to take into account Local Authority recommendations.

B3. CALCULATION OF REVISED PROJECTIONS

B3.1 For the purposes of the production of revised projections, each Metropolitan borough/Authority was treated as a separate 'county'. This is because OPCS and DOE projections are available for these areas and in some cases, Metropolitan Councils have replied individually.

B3.2 Revised projections were calculated on three different bases:

- County totals calculated using the provisional projection methodology remain fixed. Any changes recommended by County Councils and Metropolitan co-ordinating Authorities to the distribution of growth between districts within the county are incorporated.
- Totals remain fixed over each Government Office Region[1]. The provisional projections of population, households, workforce and jobs are re-distributed within each region so as to reflect as far as possible the changes requested by consultees.
- Only National totals remain fixed. Population, households, workforce and jobs are re-distributed between all authorities so as to get as close as possible to values suggested by consultees, possibly resulting in changes to the distribution between regions.

B3.3 The re-distribution method used is described below for the case where regional totals remain fixed. The aim of the method was to reconcile Local Authority projections with the provisional projections circulated, in such a way that the revised figures were in some sense intermediate between the Local Authority and provisional projections.

[1] Merseyside was included in the NorthWest region for this purpose. London, SouthEast and Eastern regions were treated as a single large region, in order to accommodate concerns about the distribution of growth between London and its hinterland.

B3.4 For each region, for each planning variable, and for each projection year, the methodology is as follows:

a) Local Authority projections were checked for consistency of definition with DoT projections. If different definitions were specified, adjustments were made to ensure consistency of projections nationally, usually by scaling to the 1991 DoT base figure if a different base had been used. The unemployed (assumed constant unless otherwise specified) were subtracted from Local Authority workforce figures if these had been included in the projection.

b) Where the Local Authority had not supplied an alternative projection, the DoT provisional projection was used in its place in the calculations, unless population projections had been supplied by the Local Authority, in which case an 'implied Local Authority projection' was generated for the missing projections by scaling the DoT provisional projections by the ratio of the Local Authority and DoT population projections.

c) If the regional sum of Local Authority projections was greater than the regional sum of DoT provisional projection, then at county level and for each metropolitan borough, Local Authority projections less than or equal to the DoT provisional projection were accepted, and vice versa.

d) A regional 'control total' was then found by taking the regional sum of DoT provisional projections minus the sum of the 'accepted' projections. The Local Authority projections which had not been accepted were then adjusted to sum to the control total. The adjustment was made by adding to each Local Authority figure a proportion of the difference between the Local Authority figure and the respective DoT provisional projection.

This method results in a set of revised county level projections which are a compromise somewhere between the DoT provisional projections and the Local Authority projections, while remaining consistent at regional level with published projections.

B4. CONSULTATION WITH GOVERNMENT OFFICES

B4.1 In May 1996, the three sets of revised projections at county and metropolitan borough level were sent to Government Offices for the regions, along with copies of replies received from Local Authorities (Note: Where the Local Authority had asked that DoT provisional projections of workforce and jobs be adjusted to take account of their own population projections instead of OPCS figures, the figures sent to Government Offices included 'implied' Local Authority workforce and jobs projections).

B4.2 The Government offices' views were sought on:

- which of the three sets of projections is most appropriate for each variable;
- whether the distribution of growth between counties seemed reasonable;
- suggestions for changes to the calculation method and/or consultation process.

B5. PRODUCTION OF FINAL PROJECTIONS

B5.1 Replies received from Government Offices indicated that the projections controlled to regional totals were generally the most appropriate for all four variables, although there were a few conflicting views. In the absence of complete unanimity, and for greatest consistency between planning variables, the projections controlled to regional totals were used for generating the final projections. The method for generating district-level projections from the county-level revised projections is described below.

B5.2 The constituent district level Local Authority projections were adjusted to sum to the county level revised projections by one of two methods (specified by the Local Authority in their reply to the provisional projections):

- Preserve percentage distributions within the county (default if no method was specified by the Local Authority); or
- Preserve relative differences in growth rates between districts. (This is similar to the controlling method used for the provisional projections)

Appendix C - Inputs to car ownership model

There are four sets of input data which go into the car ownership model - demographic and planning data, base year car ownership, income growth, and increase in licence-holding. Annexes A and B discussed the demographic and planning data; this note describes the other inputs.

C1. INCOME GROWTH ASSUMPTIONS

C1.1 The models are household-based. Average household income growth takes into account the predicted increase in GDP and the predicted increase in number of households, adjusted so that the national average is not distorted by shifts between poorer and richer areas and household categories. The same average income growth factor is applied to each areas and each household category. Within each area and each category, the distribution of household incomes about the average remains unchanged.

C1.2 For the period to 1996 provisional GDP growth figures are used, with no allowance for uncertainty. For years beyond 1996, the rates are taken as a range about current long-range projections. The range reduces over time, to reflect the stability of the underlying long-term trend in GDP. Expressed as percentage growth per annum, the assumed GDP growth is

Period	Central assumption	Low-High Range
1996 to 2001	2.5% pa	1.5% to 3.5% pa
2001 to 2005	2.25% pa	1.65% to 2.85% pa
2005 onwards	2.25% pa	2.08% to 2.42% pa

C1.3 The resulting profile of growth in household income is as follows:

	GDP growth		Household	Index	Growth in GDP/hhold	
	Low	High	growth		Low	High
1991	1	1	22399852	1	1	1
1996	1.109	1.109	23487545	1.049	1.058	1.058
2001	1.195	1.317	24347462	1.087	1.099	1.212
2006	1.297	1.516	25182179	1.124	1.153	1.348
2011	1.437	1.708	26101259	1.165	1.233	1.466
2016	1.593	1.925	26990047	1.205	1.322	1.598
2021	1.766	2.170	27845079	1.243	1.420	1.746
2026	1.957	2.445	28610438	1.277	1.532	1.915
2031	2.169	2.756	29228836	1.305	1.662	2.112

C2. LICENCE-HOLDING

C2.1 One of the inputs to the car ownership model is the proportion of adults (age 17+) holding a valid driving licence. The figures are derived from a simple cohort model. A study of NTS data showed that for people born within any given decade, licence-holding increases from age 17 up to a maximum level (typically at an age between 30 and 50). After age 70 licence-holding declines, and is assume to reach zero at age 95.

C2.2 More recent birth cohorts reach a higher maximum level and reach it at an earlier age (particularly females). The following table shows the assumptions made about the continuation of these trends:

Licence holding by birth cohort: actual to 1950-59 and central assumptions to 2010-19

Birth Cohort	Age of maximum licence holding, by birth cohort: Men	Women	Level of maximum licence holding, by birth cohort: Men	Women
1920-29	-	-	.84	.43
1930-39	45	47	.87	.48
1940-49	42	50	.90	.67
1950-59	41	40	.91	.70
1960-69	38	36	.93	.81
1970-79	35	35	.94	.87
1980-89	35	34	.97	.89
1990-99	34	34	.98	.90
2000-09	33	33	.99	.93
2010-19	31	32	.99	.95

C2.3 This work was undertaken by the MVA consultancy, and is reported in reference D. The above assumptions were varied to generate high and low scenarios, and interpolated for intermediate years using a logistic curve, to give the following profile:

	Licences per adult		
	Low	Central	High
1991	0.640	0.640	0.640
1996	0.674	0.674	0.674
2001	0.700	0.706	0.712
2006	0.726	0.734	0.742
2011	0.748	0.758	0.768
2016	0.766	0.778	0.791
2021	0.780	0.795	0.810
2026	0.792	0.809	0.826
2031	0.801	0.820	0.839

C3. BASE YEAR CAR OWNERSHIP

C3.1 1991 "observed" car ownership is based on Census figures, modified to allow for the conclusions of the Census Validation Survey, and for under-recording of households in the Census. The assumptions made are that

a) households missing from the Census have 75% of the number of cars that would be expected if they were a random sample of households.

b) households with "three or more" cars have an average of 3.2 cars each (based on NTS figures).

This fixes the number of cars in the base year.

C3.2 The model assumes that one-adult households do not own second cars - these households have the choice of either owning a car or not. Two-adult and three-or-more-adult households choose whether to own 0 cars, 1 car, or "two or more" cars. The average number of cars owned by a "two or more" car household is 2.09 for two-adult households and 2.49 for three-adult households. These figures are taken from the National Travel Survey, with the latter figure adjusted to give the right number of cars in the base year. These numbers are assumed to remain constant. This results in the average number of cars in a "two or more" car household falling over time, in line with the falling proportion of households that have three or more adults.

C4. HOUSEHOLD STRUCTURE INPUTS

C4.1 The upper level of the car ownership model distinguishes 8 different types of household, according to the number of adults (=age 18+), whether all the adults are retired, and the presence or absence of children. In the base year the proportion of households in each category, based on Family Expenditure Survey data, are as follows:

Household categories	with children	without children all retired	not all retired
1 adult	4.5%	14.8%	13.0%
2 adults	23.6%	8.5%	23.5%
3 or more adults	4.0%		8.1%

C4.2 The missing categories (households with children in which all adults are retired, households with 3 or more adults all of whom are retired, households with no adults) were judged to represent negligible proportions of the total.

C4.3 The car ownership model requires as an input the number of households in each category. These values are estimated by a three-stage process:

a) The number of children, number of adults and number of retired people are obtained from the predicted population in three age groups (respectively aged 0-15, 16+ and 60+) using conversion factors which are assumed constant over time.

b) For each area type the row and column totals {number of households with 1 adult, with 3 or more adults, with children, and with all adults retired} are estimated from the ratios {adults per household, children per household, retired per household} using linear relationships calibrated over a number of years of FES data.

c) The number of households in each cell is estimated by a three-dimensional proportioning procedure, starting with the base year numbers and repeatedly factoring rows and columns to meet the future year row and column totals.

C4.4. The 1995 Department of the Environment publication (reference **C**) classifies household types differently. There, household category definitions are concerned with whether the adults in the household are living as man and wife, and with whether the children are legally dependent. There is one valid comparison: published figures predict that the proportion of 1-person households in England will increase from 26.6% in 1991 to 36.3% in 2016. The corresponding NTEM figures (for GB) are from 27.8% to 36.5% - a similar level of increase.

REFERENCE

C "Projections of Households in England to 2016", published by HMSO, ISBN 0 11 753055 7

Appendix D - Car ownership models

D1. Two car ownership models are used. The derivation of these is fully described in reference D. The upper level model uses income, licence holding and household structure as explanatory variables. The results from the lower-level model, which operates at a much greater level of geographical disaggregation, are constrained to match totals from the upper level.

UPPER-LEVEL MODEL

D2. The upper level car ownership model is calibrated on FES data from the period 1971 to 1991. It predicts car ownership for each household type for each of five area types (London, other metropolitan districts, urban districts, suburban or mixed-use districts, rural districts), with the last three being distinguished by population density thresholds.

D3. The model is defined by the following equations:

$$P1+ \quad = \quad S_{1h} \;/\; (1 + \exp[-L_1])$$

$$P2+|1+ \quad = \quad S_{2h} \;/\; (1 + \exp[-L_2])$$

where

$$L_i = k_i + k'_i(LPA_t) + (b_i + b_{hi} + b_{ai})\log_e(E_{ai}INC_{hat})$$

where

P1+ is the proportion of households owning 1 or more cars
P2+|1+ is the proportion of car-owning households owning 2 or more cars
S is a saturation level, less than or equal to 1
L is a linear term as defined by the third equation
E is a small adjustment factor that calibrates the model to 1991 observed car ownership (needed because the coefficients are estimated over a series of years and therefore do not give an exact fit to any one year)
LPA is the national value of licences per adult
INC is household income

a is a subscript for area type
h is a subscript for household category
t is a subscript for time
i is a subscript indicating two sets of coefficients (for L_1 and L_2)

b and k terms represent model coefficients, tabulated in Table 1.

D4. Note that this is a household-level model, relating the probabilities of a household owning a first and second car to household income. The model holds a set of FES income distributions, one for each area type and household category. These are enumerated for each run, accumulating probabilities into the overall proportion of households owning 0, 1 or 2-or-more cars in each area type and category. For future years it is assumed that the same national income growth factor applies to each area type and household category, and that the distributions do not change over time.

TABLE D1: upper-level model coefficients

Parameter	P1+ model	P2+|1+ model
k	-19.93054	-20.45269
k'	3.37375	2.74875
b	1.89042	1.82704
ba - modifier for FES area type		
Greater London	0 by defn	0 by defn
Metropolitan counties	0.01557	0.02367
Urban	0.04794	0.04174
Suburban/mixed	0.10698	0.07344
Rural	0.12700	0.07707
bh - modifier for household category	0 by defn	n/a
one adult, non-retired	-0.01238	n/a
one adult, retired	0.03251	n/a
one adult with child(ren)	0.05235	0.12640
2 adults, both retired	0.05690	-0.05448
2 adults, not both retired	0.07761	-0.04078
2 adults with child(ren)	0.01794	0.02674
3+ adults	-0.00558	0 by defn
3+ adults with child(ren)		

D5. Modelled saturation levels S are as follows, these values having given the best fit to base data:

TABLE D2: upper-level model saturation levels

Household category	P1+ saturation level	P2+|1+ saturation level
1 adult non-retired	100%	0
1 adult retired	70%	0
1 adult & children	70%	0
2 adults retired	100%	70%
2 adults non-retired	100%	90%
2 adults & children	100%	100%
3+ adults	100%	100%
3+ adults & children	100%	100%

LOWER-LEVEL MODEL

D6. The lower-level model has been calibrated from 1971, 1981 and 1991 Census data. It is normally applied at the level of sub-district zones, each a set of contiguous 1991 Census wards, so as to pick up the variation between more-urban and less-urban parts of districts. The model is capable of being applied at ward level or district level if required.

D7. It takes the form of an adjusted logistic growth model, applied to zonal data. Car ownership in each zone is assumed to follow a logistic curve to saturation, modified by changes in the demographic composition of the population within the zone. The equation used is

$$\frac{y_t - y_0}{t} = y_0\left(1 - \frac{y_0}{s}\right)\left[a + b_1\frac{EMP_t - EMP_0}{EMP_0} + b_2\frac{OLD_t - OLD_0}{OLD_0} + b_3\frac{HHsiz_t - HHsiz_0}{HHsiz_0}\right]$$

where

t	is number of years after base year
s	is saturation level
a	is an adjustment factor set so that total car ownership over each broad area equals the figure given by the upper-level model
EMP	is the workforce as a proportion of the age 16-59 population
OLD	is the proportion of the population that is aged 60 or over
HHsiz	is the ratio of population to households
b_i	are coefficients

D8. The model is applied twice, once with y as “cars per household” and once with y as “proportion of households owning one or more cars”. Saturation level varies with a density measure (equal to the sum of population and employment per hectare), but this is applied to London and the metropolitan counties only.

D9. Parameter values and saturation levels are given in the following tables. Note that increasing employment and household size tend to increase car ownership; increasing the proportion of the population over 60 tends to reduce it. Saturation levels are fixed for most areas, but vary with density in London and the conurbations. Any ward with a density - calculated as (population + employment) / area - greater than around 10 may reasonably be classified as urban, and any ward with a density greater than around 85 may be considered to represent city centre conditions.

TABLE D3: lower-level model coefficients

Parameter	**y = cars per household**	**y = proportion of households in zone owning one or more cars**
b1	.8189	.5463
b2	-.06078	-.2927
b3	.7913	.4633

TABLE D4: lower-level model saturation levels

Location	**Saturation level for cars per household**	**Saturation level for proportion of households owning one or more cars**
non-Metropolitan areas	1.9 cars per household	100%
density < 35	1.9 cars per household	100%
35 < density < 85	declining linearly with increasing density	95%
85 < density	1.3 cars per household	90%

D10. In order to run the model, it was necessary to make an assumption about the distribution of growth between more-dense and less-dense zones within districts. Uniform growth was assumed. Sensitivity tests showed that assuming instead a continuation of 1981-1991 trends made little difference to the result.

REFERENCE

D "Improved Car Ownership Models", unpublished research report by the MVA consultancy for the Department of Transport, March 1996

Appendix E - Trip end models

THE GENERAL FORM OF THE TRIP END MODELS

E1. The basic function of the models is to estimate for each of several trip purposes the numbers of trips with origins and destinations in each zone. Every (one-way) trip has two trip ends, referred to as generations and attractions for home-based trips or creations and allocations for non-home-based. Separate models are used for generations/creations and attractions/allocations, and they do not necessarily produce identical estimates of total trips for a given purpose. In order to ensure that the totals **do** agree, a balancing procedure is imposed.

Definitions of trip purpose

E2. Where journeys are complex, consisting of more than a simple outward and return trip, attributing purpose to trips is non-trivial. Various systems exist, none of which is fully satisfactory.

E3. The NTEM trip generation/creation models were developed for the Department by the Transport Research Laboratory, based on National Travel Survey data from three separate surveys - 1978/79, 1985/86 and 1989/91. This work checked the time and geographical stability of trip rates, and is reported in references E1 to E3. Purpose definitions follow a "hierarchical" approach:

Home Based Work	trip from home to usual place of work, or vice versa
Employer's Business	all remaining trips where one trip end is either the workplace or a place visited in the course of work
Essential Other	all remaining trips where one trip end is for education, shopping, personal business etc.
Discretionary Other	residual trips (includes purposes such as sport and holiday)

E4. The trip attraction and allocation models are developed from work on RHTM data, and refer to three home-based trip purposes:

i) home based work;
ii) home based employer's business;
iii) home based other.

and two non-home based trip purposes:

i) employer's business;
ii) other.

E5. Thus in order to reconcile the purpose definitions for the generation models and the attraction/allocation models, the essential and discretionary other trip generations are combined, and subsequently split into home-based trips and non-home based trips.

Geographic disaggregation

E6. All of the models take account of zone type. The four types Inner London, Outer London, Other Urban and Rural were adopted. The models are run at local authority district level.

Balancing areas

E7. A set of self-contained "balancing areas" were identified (based on 1991 Census journey-to-work data) and the assumption made that net movement across the boundaries of these areas is zero. For each purpose separately, trip attractions/allocations for the zones in a balancing area are factored so that their total is equal to the total number of trip generations/creations in that balancing area. The trip attraction and allocation models are known to be less reliable than the trip generation/creation models. This is a characteristic of such models, and is probably due to the calibration data being less reliable. The balancing procedure reduces the risk of gross errors, because only the geographical distribution of attractions and allocations is derived from these models; the number of trips is derived from the generation/creation models.

E8. For the non-home based purposes there is an additional step in the process. After balancing, the estimate of creations for each zone is replaced by the corresponding estimate of allocations. This is intended to take account of the fact that, although non-home based trips are created by the households in a zone, they need not start or finish in that zone. Thus, the creations models are used to estimate only the overall numbers of trip ends, the geographical distributions of trip ends being derived from the allocations models. This final step is supported by the observation that, for any given district, the net numbers of interzonal movements of non-home based trips is likely to be small.

TRIP GENERATION MODELS

E9. The models are household-based, picking up from the car ownership models the number of households with 0, 1, 2-or-more cars in each district, and the growth in income for each of these car ownership bands. Growth in trip-making over time is largely driven by income growth and car ownership growth, but household structure effects are also modelled. For example, within one-car households, competition for use of the car is picked up to a certain extent - work trips increase with a decrease in non-employed adults, and Other trips increase with a decrease in employed adults.

E10. The calibration of the five trip generation models began with an analysis of car driver trip rates at the household level to investigate their geographical and temporal stability. Car ownership was found to be the most important variable in explaining locational variation, and therefore separate models of car driver trip rates for one and two-plus car ownership levels were adopted. Mean trip rates for households with no cars were assumed constant. The principal explanatory variables of household car driver trip rates were investigated through a combination of graphical and regression analyses in which many of the household characteristics in the survey data were considered.

E11. The household generation models take the form:

<u>Home-based work</u>
one-car households: $G = B + aE + bN + gI + pL_I + qL_O + rU$
two-plus-car households: $G = B + aE + bN + cK + dC_3 + eL_2 + fI + pL_I + qL_O + rU$

<u>Home-based employers' business</u>
one-car households: $G = B + aE + fI$
two-plus-car households: $G = B + aE + bN + dC_3 + fI + pL_I + qL_O + rU$

<u>Non-home-based employers' business</u>
one-car households: $G = B + aE + bN + fI$
two-plus-car households: $G = B + aE + fI$

<u>Essential other</u>
one-car households: $G = B + aE + bN + cK + eL_2 + fI + pL_I + qL_O + rU$
two-plus-car households: $G = B + aE + bN + cK + dC_3 + eL_2 + fI + pL_I + qL_O + rU$

<u>Discretionary other</u>
one-car households: $G = B + aE + eL_2 + pL_I + qL_O + rU$
two-plus-car households: $G = B + bN + dC_3 + eL_2 + pL_I + qL_O + rU$

where E has the value 1 for households with one or more employees, 0 otherwise

N has the value 1 for households with one or more non-employed adults, 0 otherwise

K has the value 1 for households with one or more children (aged 0-15), 0 otherwise

L_2 has the value 1 for households with two or more driving licence holders, 0 otherwise

C_3 has the value 1 for households with three or more cars, 0 otherwise

L_I has the value 1 for households in inner London, 0 otherwise

L_O has the value 1 for households in outer London, 0 otherwise

U has the value 1 for households in other urban areas, 0 otherwise

and I represents average weekly household income at 1976 prices.

Calibrated coefficients are shown in Table E.1.

TABLE E.1 THE TRIP GENERATION COEFFICIENTS

Purpose and car ownership level	Coefficients									
	B	a	b	c	d	e	f	p	q	r
Home based work:										
one car	0.17	1.05	-0.21	-	-	-	0.001210	-0.54	-0.16	0.09
two plus cars	-0.32	1.45	-0.48	-0.47	0.70	0.86	0.002310	-0.76	-0.14	0.17
Home based employers business:										
one car	0.00	0.05	-	-	-	-	0.000203	-	-	-
two plus cars	0.09	0.11	-0.04	-	0.08	-	0.000215	-0.12	-0.07	-0.06
Non-home-based employers business:										
one car	0.01	0.11	-0.04	-	-	-	0.000747	-	-	-
two plus cars	-0.08	0.35	-	-	-	-	0.001150	-	-	-
Essential Other:										
one car	0.99	-0.55	0.20	0.58	-	0.48	0.000525	-0.33	-0.09	0.01
two plus cars	0.56	-0.85	0.46	1.14	0.30	0.93	0.003190	-0.60	-0.27	0.16
Discretionary Other:										
one car	0.70	-0.05	-	-	-	0.25	-	-0.21	-0.04	0.10
two plus cars	0.52	-	0.19	-	0.59	0.73	-	-0.37	0.03	0.13

E12. In applying the models, zonal base year values for licence-holding are derived from NTS data, as shown in Table E.2. These values are varied for future years in such a way as to maintain consistency with the licence-holding assumptions set out in Appendix C.

TABLE E.2 1991 % OF HOUSEHOLDS WITH TWO OR MORE LICENCES

car ownership level	Inner London	Outer London	Other urban	Rural
one car	0.296	0.367	0.361	0.414
two plus cars	0.878	0.939	0.929	0.936

HOME-BASED TRIP ATTRACTION MODEL

E13. The district level home-based trip attraction model calibration consisted of careful graphical analysis to identify the presence of outliers, which could have a misleading effect on the model calibration. This analysis also served to check that linear models would be suitable and to help identify the most appropriate variables. Having subjected the data to this examination, calibration proceeded by the use of regression analysis. Zone type proved to be an important categorisation. Although a number of outliers were identified, most of them could be explained by the fitted relationships without serious error. The exceptions to this were the Cities of London and Westminster. These were significantly different from the remaining London districts and serious errors would have been generated if the fitted models for London zones had been used for them. Thus separate parameter values were estimated for these districts where necessary.

The home based attraction models take the form:

$ATT_w = f.EMP.CARS/HH$ Work car trip attractions

$ATT_{eb} = g.EMP.CARS/HH$ Employers Business car trip attractions

$ATT_o = h.HH + i.EMP.CARS/HH + j.CARS$ Other car trip attractions

where EMP = total employment in the district

HH = households in the district

CARS = number of cars in the district

f, g, h, i, j are coefficients which are calibrated for each zone type and are given in Table E.3.

TABLE E.3 THE CALIBRATED TRIP ATTRACTION COEFFICIENTS

Purpose:	Work	Employers Business	Other		
Coefficient:	f	g	h	i	j
Zone type:					
RURAL ZONES	0.86	0.13	0.30	0.99	0.00
URBAN ZONES	0.96	0.09	0.00	0.72	0.49
LONDON ZONES	0.84	0.07	0.00	0.00	1.17
CITIES OF LONDON & WESTMINSTER	0.36	0.02*	0.00	0.00	2.45

* City of London only; City of Westminster is included with other LONDON zones for this purpose.

NON-HOME-BASED TRIP ALLOCATIONS

E14. The district level non-home based trip allocation models were developed in the same way as the home based attraction model. They take the form:

$ALL_{eb} = a + b.EMP.CARS/HH$ employers business car trip allocations

$ALL_{o} = c.EMP.CARS/HH + d.CARS$ other car trip allocations

where

HH = households in the district

EMP = total employment places in the district

CARS = number of cars in the district

and a, b, c and d are coefficients calibrated for each zone type and given in Table E.4.

TABLE E.4 CALIBRATED TRIP ALLOCATION MODEL COEFFICIENTS

Purpose:	Employer's business		Other	
Coefficient:	a	b	c	d
Zones type:				
RURAL ZONES	0	.16	0.35	0.00
URBAN ZONES	0	.16	0.32	0.00
LONDON ZONES	1731	0.09	0.00	0.32
CITIES OF LONDON & WESTMINSTER	0*	0.03*	0.00	0.98

* City of London only; City of Westminster is included with other LONDON zones for this purpose.

REFERENCES

E1. Emmerson, P: "Analysis of the Temporal and Spatial Stability of Trip Rates". Unpublished report, September 1992.

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E3. Emmerson, P and Paulley, N J: "Improved Models for Local Road Traffic Forecasts. Final report: Part 2", TRL Unpublished Report PR/TR/029/93, October 1993.

Appendix F - Constrained growth forecasts

F1. The NRTF97 forecast includes a “fitting-on” procedure to represent the interaction between supply and demand for road space. This Annex describes the use of this procedure in the NTEM forecasts.

F2. The growth restraint which this procedure applies is specific to the road types, geographical areas and time periods in which forecast congestion occurs, rather than the origin and destination of the traffic. Conversely, NTEM forecasts the geographical variation in demand for car travel, on the basis of total trip origins and destinations. The problem is how to link the two procedures, given that without a nation-wide traffic model, the origins and destinations of traffic in each cell of the restraint process are unknown.

F3. The assumption made is that within each “sub-region” - which is typically an area of three or four adjacent counties - a reasonably large proportion of the traffic starts or ends its journey within the sub-region. So that the NRTF level of traffic suppression due to lack of capacity within each sub-region can be used as representative of the degree of suppression of mileage for trips starting or ending in the sub-region.

F4. Following this assumption, NTEM tripend growth is used to disaggregate the NRTF background growth that is input to the fitting-on process. The outputs from fitting-on are then aggregated over all road types and times of day, excluding the results for non-car vehicle types and for weekends - NTEM estimates 24-hour average weekday trip rates. This produces car traffic forecasts by trip purpose by sub-region. These forecasts are then allocated to the districts comprising each sub-region, in proportion to the trip-ends for each purpose, and form the basis for NTEM’s constrained growth factors.

F5. The result of this is that NTEM presents two sets of numbers:

Trip end forecasts, which:

a) directly predict the growth in number of trips starting and ending in each district,
b) are of the right dimension to use as row and column growth factors for producing a future year trip matrix,
c) are not constrained to NRTF.

Constrained growth factors, which:

d) are consistent with the NRTF,
e) have the dimension of growth in vehicle-kilometres
f) include elements that represent the impact of fuel price changes, current trends to increasing trip length over time, constraint to the capacity of the road network, and the uncertainty in the NRTF prediction
g) are at district level, but are disaggregated from fitting-on results over a wider geographical area

The latter are recommended for use in all circumstances except where the elements in f) are explicitly modelled.

F6. The remainder of this Annex documents the way that the NRTF fitting-on program FORGE, which models the action of supply constraint in modifying traffic growth, is used to produce NTEM results.

FORGE

F7. The FORGE program itself is documented as part of the NRTF 1997 project. What follows is a summary of the information (on unmodified demand for road travel) that is fed into the NTEM 1997 runs of FORGE. And the way that the FORGE outputs from those runs, representing the outcome of supply constraint, are published in programs TEMPRO and SPOT.

F8. The FORGE program works with a seven-dimensional array. NTEM does not directly address three of these dimensions:

- time of day,
- direction (busy or non-busy), and
- busyness of road (measured as a volume:capacity ratio).

Demand for traffic growth is not varied over these dimensions, and FORGE outputs are aggregated over these factors.

F9. NTEM does work with the remaining four dimensions:

- sub-region (each a set of adjacent counties)
- area type (3 London types, 2 conurbation types, 5 other urban types & 1 rural)
- road type (4 urban and 5 rural types)
- vehicle category (COBA vehicle types, with cars split by journey purpose).

F10. Note that, in accordance with earlier research results, peak/off-peak variation is handled through the mix of journey purposes. To the extent that trips to work are concentrated in the peak hours, peak congestion in FORGE reflects whether the underlying demand for work trips grows slower or faster than other trips. And the resulting predicted growth in work trips is slower or faster according to the degree to which FORGE peak congestion is greater than off-peak congestion. The assumption is that, were it not for the fact that the peak is more congested, work trips in the peak would grow at the same rate as work trips outside the peak.

Demand variation

F11. To make a future year prediction, three input files are used:

A) National predicted background growth by road type by vehicle type, taken directly from the NRTF work and incorporating trip length effects and allowance for uncertainty.
B) The 1996 traffic database prepared by the MVA Consultancy in August/September 1997, which holds base year traffic by road type by area type by sub-region by vehicle type
C) NTEM predicted trip end growth, by district by car trip purpose

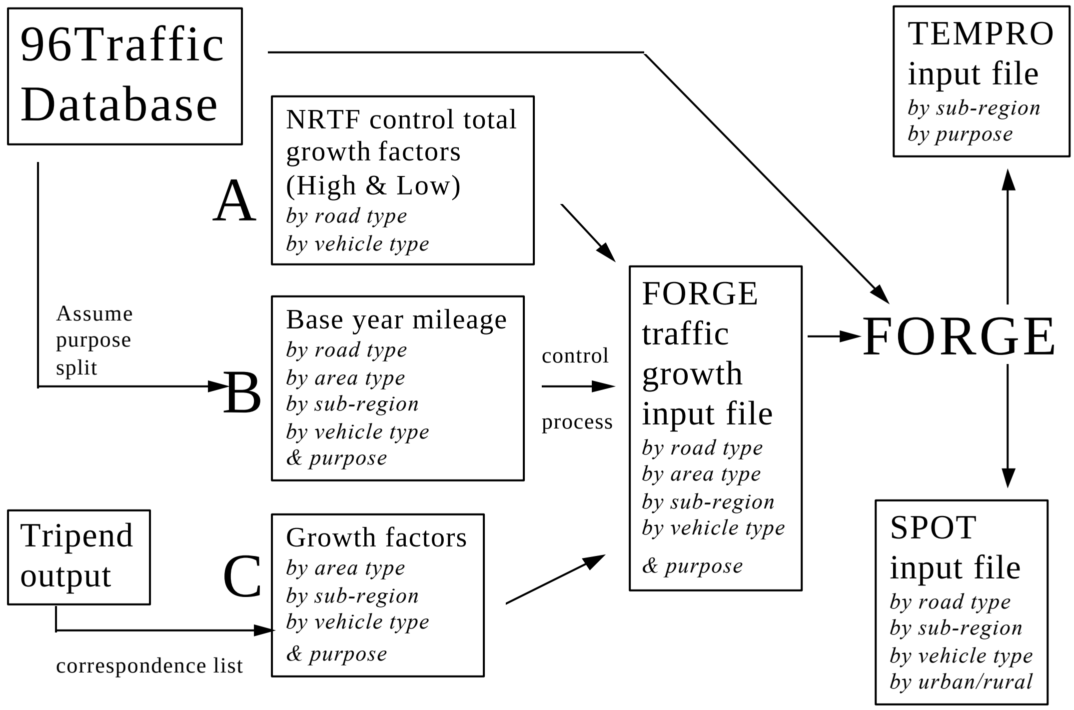
F12. File C) is pre-processed, using a correspondence list to convert tripends by district into tripends by sub-region by area type. Growth in non-car vehicle types is assumed to vary in proportion to growth in total car traffic, analysis of past data having shown that this gives a better result than assuming uniform growth.

F13. A national average purpose split for 1996 is applied to the traffic database, also taken from the NRTF 1997 study:

Home-based work	23.7%
Home-based Employers Business	7.7%
Home-based Essential Other	20.2%
Home-based Discretionary Other	26.7%
Non-home-based Employers Business	8.2%
Non-home-based Other	13.5%

F14. The predicted trip end growth C) is then applied as if it were traffic growth to each cell of the 1996 database B), then a factor applied for each road type and vehicle type to ensure that the national constraints A) are met. This gives a background traffic growth file which is input to FORGE.

F15. FORGE runs for 1991 and 1996 are also undertaken, to ensure consistency between the base and future year figures. For 1996, the 1996 traffic database is used and all growth factors are set to 1.0. For 1991, the same 1996 database is used (for consistency) with growth factors less than 1.0, which are derived from observed 1991-96 growth by road type. The FORGE program is used in such a way as to ensure that no suppression or growth of traffic occurs, so that the FORGE output is consistent with observed data for these years.



Use of Outputs

F16. The TEMPRO program calculates traffic growth factors for use in traffic models. Currently it only covers car traffic, but it is intended to extend this in future to include other vehicle types also.

F17. TEMPRO works at district level, and includes a correspondence list between districts and their groupings into counties, sub-regions and regions. TEMPRO tripends are factored to sum to FORGE output, so as to take account of

- “demand” change in trip length over time,
- the extent to which “demand” traffic levels are suppressed due to lack of road capacity,
- the NRTF approach to uncertainty in forecasting.

TEMPRO uses FORGE results at the sub-regional level, aggregated over area types and road types. For each trip purpose separately, the sub-region level FORGE mileage figure is distributed amongst the constituent districts in proportion to forecast tripends for that purpose.

F18. The SPOT program is intended for use where traffic growth factors are required in the absence of a traffic model. Without a model, traffic growth on a particular road cannot be explained in terms of behavioural factors such as the network function of the road, the degree of congestion on feeder links and competing links, etc., and all that can be done is to pick up trends in growth on particular road types and in the broad area that the road is deemed to serve.

F19. For input to SPOT, the eleven FORGE area types are compressed into two - urban and rural - although London and the conurbations can be identified geographically. Car trips are treated in total, with no split by purpose, but all vehicle categories are included.

F20. To run SPOT, the user specifies

- the set of districts that the road serves,
- the base and future years,
- the type of road (motorway, A-road, minor road)
- whether the location is rural or urban
- the vehicle proportions (although default proportions are supplied).

F21. The program presents the predicted growth rate for each vehicle category, based on the appropriate FORGE sub-regional traffic growth figure, and the extent to which tripends in the specified districts grow more or less quickly than in the sub-region as a whole.

REFERENCE

F “National Road Traffic Forecasts (Great Britain) 1997”, published by the Department of the Environment, Transport and the Regions, November 1997.