Road Transport Forecasts 2008

Results from the Department for Transport's National Transport Model

Executive Summary

This report presents the latest Department for Transport forecasts of road traffic growth, plus the associated congestion, journey times and emissions. The estimates are for England[1] and are provided up to 2025. Results from the Department for Transport's road transport modelling have been published since the 1970s. The frequency of publication has varied over the period, reflecting both changing needs for the forecasts and the development of the modelling capability.

Most recently the model has been used to inform the Active Traffic Management (ATM) feasibility study published earlier this year.[2] Before that a significant piece of modelling work was undertaken for the Eddington Study, with a report published alongside the Study in 2006. Preliminary results of the current work were made available to the Committee on Climate Change for their publication *Building a Low Carbon Economy*. These forecasts will also inform work outlined in the Department's *Delivering a Sustainable Transport System*.

It is clear that transport will need to contribute further towards achieving the Government's ambitious CO_2 targets. The CO_2 forecasts set out in this document should be seen as the current baseline. The Government will outline its policies and proposals to meet carbon budgets in mid 2009. As part of this, we will be developing a strategy for delivering a greater contribution from transport. We will look to incorporate this strategy into our forecasting model and would then expect to see forecast CO_2 emissions reduce further.

This report updates last year's first stand-alone publication of National Transport Model (NTM) forecasts. Many of the modelling assumptions have been updated and we have used the updated freight model GBFM 5. The NTM is a multi-modal model and so allows us to pick up any mode switching impacts that a policy might have. However, the focus of the NTM analysis undertaken for this report is on road transport and on sets of metrics covering traffic, congestion and emissions. The Department's official rail forecasts are produced using the Department's new rail model, the National Modelling Framework (NMF).

Using the NTM, central forecasts of these metrics were produced for England (results for Wales are reported in an annex), based on a 'baseline scenario' that represents a continuation of existing or likely policies up to 2025. Forecasts for two intervening years – 2010 and 2015 – have also been produced.

As with all forecasts, there is uncertainty around the NTM forecasts and the projections should be treated as indicative and illustrative of broad trends.

Chapter 1: Introduction to the National Transport Model

The NTM is a disaggregated multi-modal model of land-based transport in Great Britain (GB)[3]. It comprises six modes - car driver, car passenger, rail, bus, walk and cycle. The NTM combines a wealth of information taken from a range of sources. It uses data of both a time-series nature to reflect differences across time to inform projections, and cross

[1] Forecasts for Wales are included in the annex

[2] See DfT (2008b)

[3] Although, the NTM is a model of land-based transport in Great Britain, forecasts are generally presented at the England level. Domestic air travel is not currently modelled within the NTM.

sectional data to capture the diversity of factors that, at any time, determine travel patterns of people in Great Britain.

The National Transport Model uses a base year of 2003. This means the model is calibrated to 2003 data and this is where we start our forecasting from. However, we reflect the changes since that date in our forecasting assumptions.

The choice of the base year is determined primarily by availability of data and because a year is regarded as 'mid-cycle'. Choosing a year where traffic was unusually high or low risks biasing forecasts as the economy and other drivers of travel return to trend – 2003 was a year with a negligible output gap. The 2003 base year also means we now have nearly five years of traffic data and so can analyse the performance of the model in the light of recent historical trends. Such a comparison shows that the forecasts continue to closely match observed data.

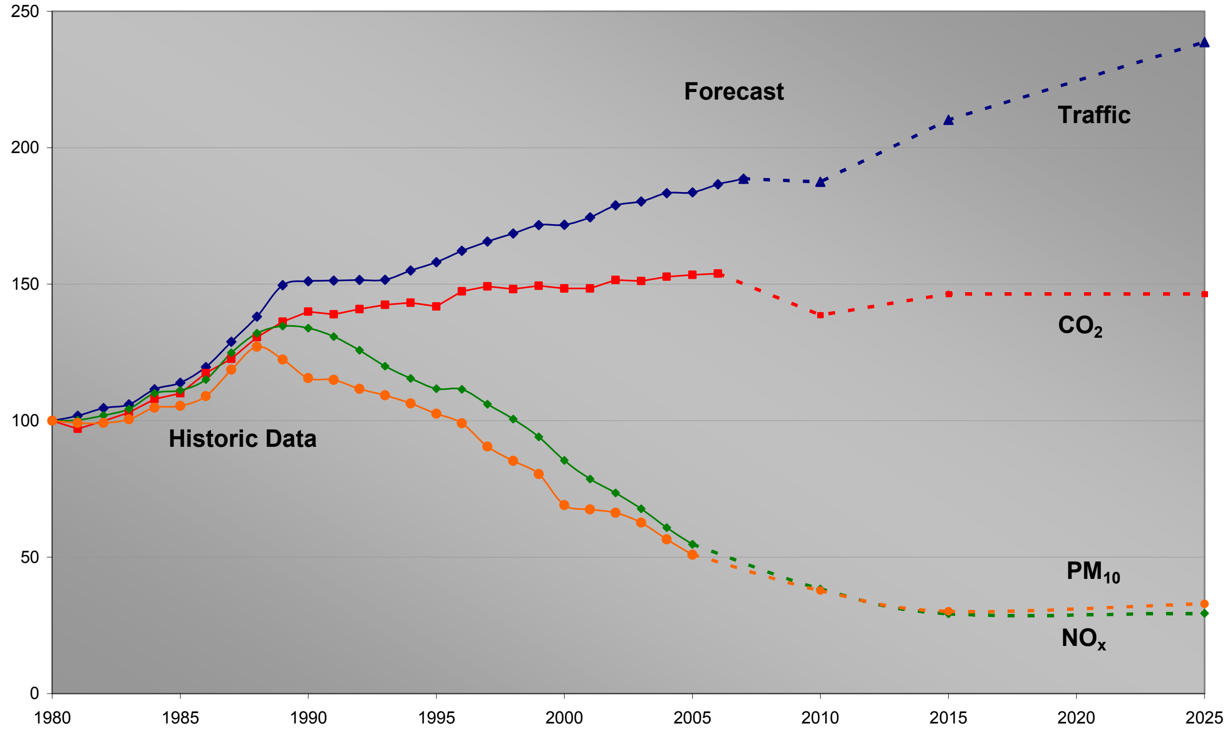
Chapter 2: Road Transport Forecasts

Transport is vital to the economy and the way we live. Taking a long-term view of the likely trends in the key metrics (traffic, congestion and environmental impacts) is important to be able to make the right policy decisions early enough to have an impact. Furthermore, there is uncertainty regarding the development of many of the key drivers of transport demand – such as the development of the economy, and changes in fuel prices – and it is important to consider the range of transport outcomes to which this uncertainty could give rise.

Figure 1 shows the trends in road traffic and emissions since 1980 and the baseline forecasts to 2025. Traffic, CO_2, and air quality pollutants all grew strongly through the 1980s with similar rates of growth. The 1990s saw air quality pollutants going into decline, de-linking from the trend of continued traffic growth. To some extent, the divergence in trends is also observed between traffic and CO_2.

The forecasts to 2025 show: air quality pollutants continuing their decline, although at a slowing rate; CO_2 continuing its recent divergence from traffic growth by slightly falling from current levels; and traffic continuing to grow, though at a slower rate than was seen prior to the 1990s. The stabilising of CO_2 reflects further improvements in vehicle fuel economy which when combined with the adoption of biofuels together roughly offset the CO_2 effects of traffic growth.

Figure 1: Road Traffic and Road Transport Emissions, Past and Forecast



Source: Historic traffic data from DfT (2007); Historic emissions data from DECC (2007); forecasts from the NTM

Table 1 summarises the key central forecasts for years 2010, 2015 and 2025.

Table 1: Summary of Key Forecasts

England, Forecast Change compared to 2003	Year	Traffic (Vehicle km)	Congestion (Lost time/km)	Journey Time (time/km)	Road Traffic Total Emissions		
					CO_2	PM_{10}	NO_x
Central Forecast	2010	4%	1%	0%	-8%	-40%	-43%
	2015	17%	17%	3%	-3%	-52%	-57%
	2025	32%	37%	6%	-3%	-48%	-57%

Source: NTM

The central traffic growth estimate for 2025 is very similar to that published last year, being just one percentage point higher. The forecast rise in congestion, however, is significantly higher than before, by nine percentage points, from 28% to 37%; largely due to the fact that the new demographic and land use planning assumptions forecast the population to be much more concentrated in urban areas where congestion is more prevalent. The forecast change in CO_2 is for a slightly smaller fall in 2025 than was forecast last year, -3% compared to -5%. The changes to the assumptions which caused these changes are discussed in detail in this report.

These forecasts take account of the changes to forecast GDP growth set out in the 2008 Pre-Budget Report (HM Treasury, 2008b)[4]. Recent economic events are affecting traffic, congestion and CO_2 markedly, mimicking the impacts of past high oil price and recessionary periods. Oil prices are forecast to stabilise lower than this year's highs, but low economic growth means the traffic forecasts for 2010 are significantly lower than those published in 2007. For example, traffic is now expected to grow by 4% between 2003 and 2010, which given that it has grown by 4.6% to 2007 means that a small cut in traffic is now forecast in the period to 2010. Estimates for 2015 of traffic and congestion are also slightly lower now compared to the forecasts published in 2007.

Chapter 3: Sensitivity Analysis of Forecasts

Recently, there have been unusual movements in a number of the key drivers for transport demand. Chapter 3 considers the impact of uncertainties associated with the input assumptions included in the model through the use of sensitivity analysis.

Recent global events suggest there is a risk that economic growth will slow down, or even become negative, over the period to 2010. Consequently there has been an increasing interest in what this might mean for traffic. We have, therefore, carried out some sensitivity assumptions analysis for GDP. We have modelled a hypothetical downturn, as a scenario, so that an idea of the potential impacts on traffic can be obtained. This scenario is for GDP to fall in line with the amount it did in the early 1980s recession (-3.5%) over two years. The economy then returns to trend growth rates after 2010.

Following the large variations in oil prices observed recently, we present analysis on the uncertainties around long term projections in this market. The central NTM forecasts are tested for their robustness to a range of oil price scenarios. These oil price[5] assumptions are produced by the Department of Energy and Climate Change (DECC)[6].

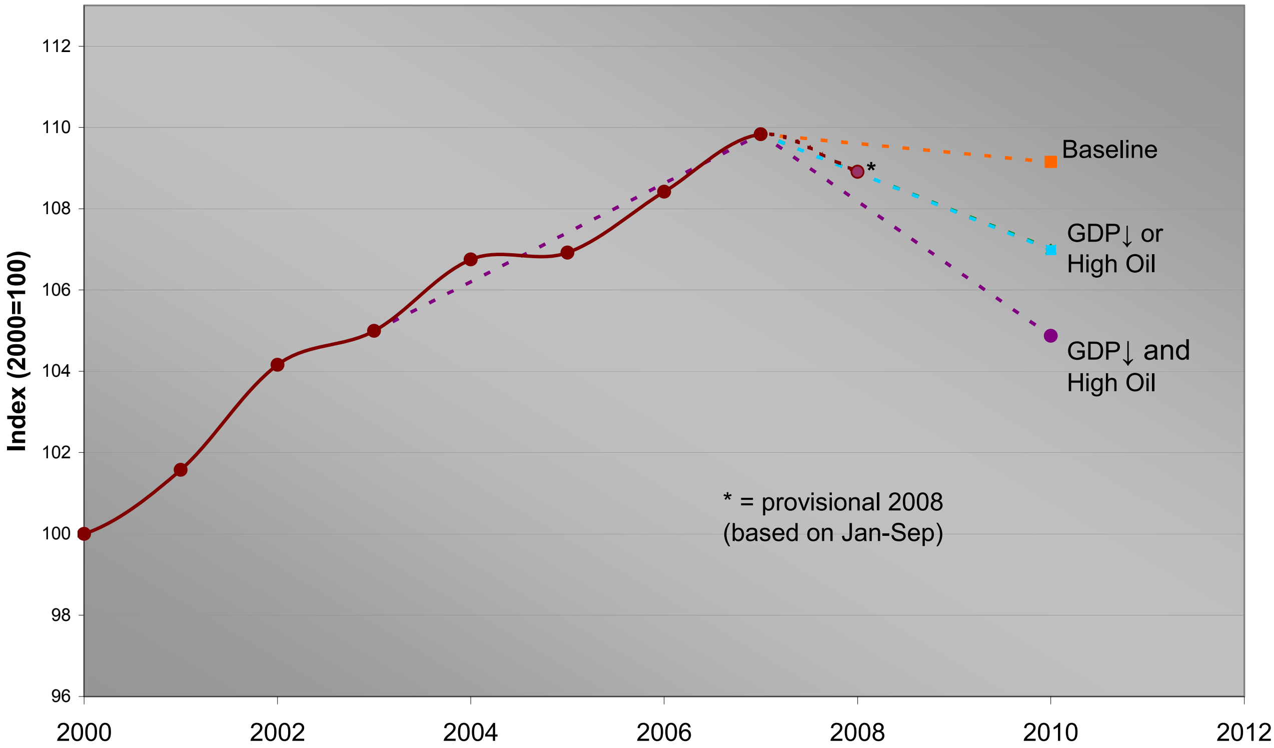
The downturn scenario has then been coupled with the central and high oil price scenarios to produce two potential short-term traffic slowdown scenarios; shown in Figure 2.

[4] The modelling has not been updated to take into account the announcement in November's 2008 Pre Budget Report of road fuel duty changes, including the 2ppl fuel duty increase that took place on 1st of December. The recent changes to the VAT rate end in 2009 and, therefore, do not affect the forecasts because a 2009 forecast has not been made. As demonstrated in the fuel price sensitivity section, the conclusions of this report would not be materially affected by the slightly higher price of fuel.

[5] The NTM uses fuel prices (petrol and diesel price per litre) that are derived from DECC's oil price projections using a fuel price forecasting model.

[6] Until recently, these projections were published by the Department for Business, Enterprise and Regulatory Reform (BERR)

Figure 2: 2010 Economic Downturn Scenarios

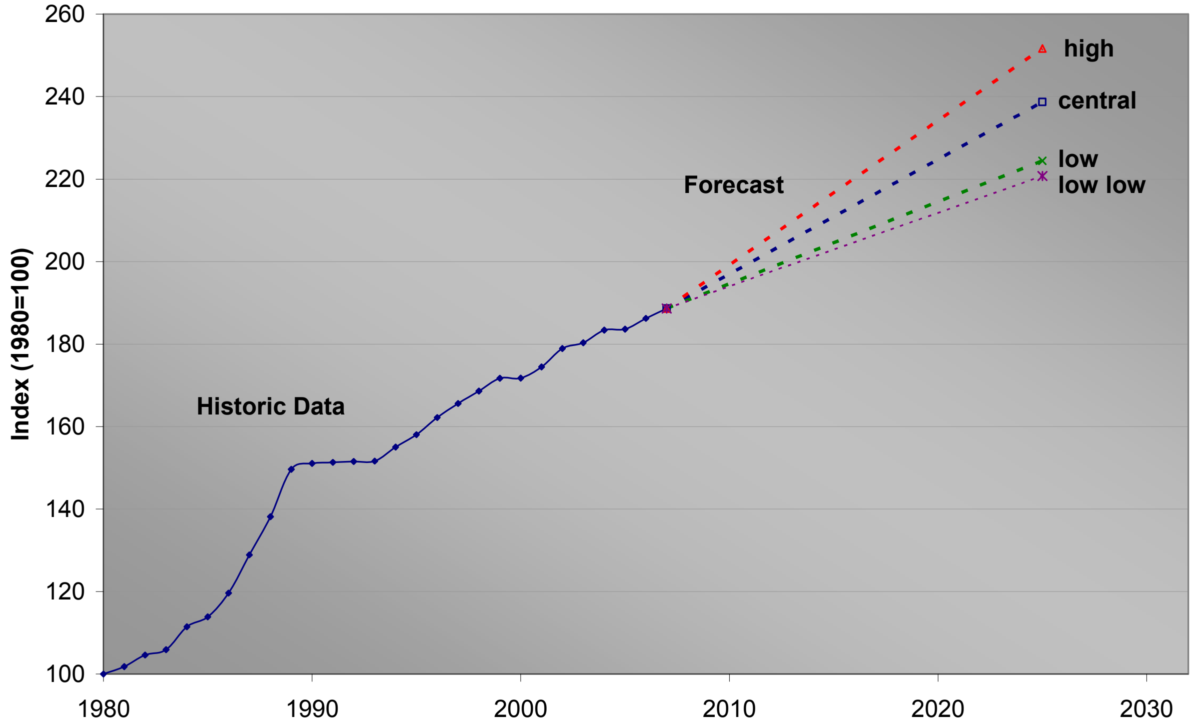


Source: Traffic data from DfT (2007, 2008), forecasts from the NTM

As with last year's analysis, we have also investigated scenarios which combine alternative views on a set of input assumptions. Two scenarios have been produced, resulting in higher and lower overall transport demand compared to the central forecast. As shown in Figure 3, by combining the variations in key assumptions, a forecast range of between 25% and 40% growth in vehicle kilometres is produced for 2025, in comparison with 2003. The central forecast lies in between those at 32%.

We have also combined these sensitivities so as to produce a high and low CO_2 forecast. Thus, high GDP, low fuel economy and low oil prices are combined to produce high CO_2 and low GDP, high fuel economy improvements and high oil prices are combined to produce the low CO_2 scenario. The resulting range for CO_2 emissions in 2025 is to be between 18% lower and 13% higher than in 2003.

Figure 3: Central, Low and High 2025 Traffic Forecasts



Source: Historic traffic data is from DfT (2007); forecasts NTM

Sensitivity testing has also been carried out on the other key driver of road transport demand; population. At the end of 2007 ONS published an updated population projection, which gave a higher population growth rate, especially in the years after 2015. This has been incorporated into the forecasts set out in this report.

The revised ONS population projections suggest the UK is likely to be one of the European countries that expect its population to grow strongly over coming decades. A key driver of this growth is strong net inward migration in the central population projections, continuing recent trends. We have also tested the impact of using the ONS projections where a scenario of lower migration is assumed, to look at the sensitivity of transport forecasts to this driver.

Combining this low migration scenario with the low demand assumptions above provides a 'low low' traffic scenario. Similarly, we recombine the various sensitivities to produce a 'low low' CO_2 forecast.

Chapter 4: Active Traffic Management

This chapter gives an example of how the NTM has been used for policy analysis.

The technologies available today offer a number of ways in which we can better manage traffic flows on our motorways, including opening the hard shoulder to traffic during congested periods, as seen on the M42. Given the encouraging experience of that pilot, the Secretary of State for Transport in October 2007 commissioned a study to examine the potential costs and benefits of extending advanced signalling and traffic management systems more widely across the motorway network.

The Department's National Transport Model (NTM) was used to inform the business case that formed a central part of that feasibility study[7]. Chapter 4 sets out how the use of the hard shoulder as an extra lane during peak periods was modelled in the NTM.

The results showed that both hard shoulder running and widening provide high value for money, but that in the medium term at least, most of the benefits of planned motorway widening could be achieved through hard shoulder running at significantly lower cost.

[7]' DfT (2008b)

CHAPTER 1: INTRODUCTION TO THE NATIONAL TRANSPORT MODEL

Summary

This report presents forecasts from the Department's National Transport Model (NTM) for 2010, 2015 and 2025 for road transport. Forecasts are for England (the appendix provides figures for Wales) and cover the key metrics – traffic, congestion and emissions. Results are presented for area types and regions.

The NTM is a highly disaggregated multi-modal model of land-based transport in Great Britain (GB)[8]. It comprises six modes - car driver, car passenger, rail, bus, walk and cycle. The NTM combines a wealth of information taken from a range of sources. It uses data of both a cross sectional and time-series nature to capture the impact of factors affecting travel patterns and the impact of time on the projections.

This chapter describes the NTM in detail. The results from running the model are presented in the next chapter.

1.1: Strategic Transport Modelling and Appraisal

The NTM is a highly disaggregated multi-modal model of land-based transport in Great Britain (GB). It comprises six modes - car driver, car passenger, rail, bus, walk and cycle – and has two main objectives:

- to *produce forecasts* in a future year of the main transport indicators - traffic, congestion, pollution and public transport patronage;
- to provide *a policy and scenario testing tool* by estimating the impact of a transport policy scenario or a change in forecasting assumption.

The NTM combines a wealth of information taken from a range of sources. These can be described in two ways;

- **Observed data** - This data is usually measured from surveys, the most important of which are the National Travel Survey, the population census and the road traffic and goods vehicle censuses.
- **Forecast Data** – the model requires forecast data or assumptions on future trends, the most important of which are assumptions on population, oil prices and GDP. This data is often provided by other Government Departments such as the Office for National Statistics (ONS), the Treasury (HMT) and the Department of Energy and Climate Change (DECC) and, therefore, the NTM is based on the same planning assumptions as used elsewhere across Government.

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[8] Although, the NTM is a model of land-based transport in Great Britain, forecasts are generally presented at the England level. The forecasts for Wales are provided in the annex. Domestic air travel is not currently modelled.

The NTM uses this time-series data to reflect differences across time, and cross-sectional data to capture the diversity of factors that, at any time, determine the travel patterns of people in Great Britain. The model also has a 'welfare module' which aims to appraise the overall impact, in cost benefit terms, of one modelled scenario against another. Thus, at a relatively high level the NTM could be described as having three distinctive elements:

- **Time series elements** - The model forecasts the change in demand for travel over time in terms of the number of trips. This change in demand for travel depends on changing population and employment patterns, changing levels of income, changing prices, patterns of where people live and work, car ownership and social trends.

- **Cross-sectional elements** - For any point in time, the model projects mode split based on the relative generalised cost[9] of travelling to different destinations by different modes. This includes both the time and money costs of making a journey and hence someone may decide to switch to using their car from taking the bus if the bus journey becomes too slow. The NTM models every trip and every vehicle kilometre and the costs associated with these trips. Furthermore, it projects how generalised costs change with the introduction of various transport interventions, including providing additional road capacity, changing public transport fares and frequencies, or change in motoring costs.

- **Economic elements** – The Welfare module attempts to summarise the main outputs of the NTM to give the overall cost and benefit implications of a policy intervention relative to some base case in a particular future year. The key determinants of overall welfare remain the journey times for trips, which are themselves determined by comparing traffic levels with capacity and identifying (any) congestion. The model also assesses the other welfare effects, such as environmental impacts.

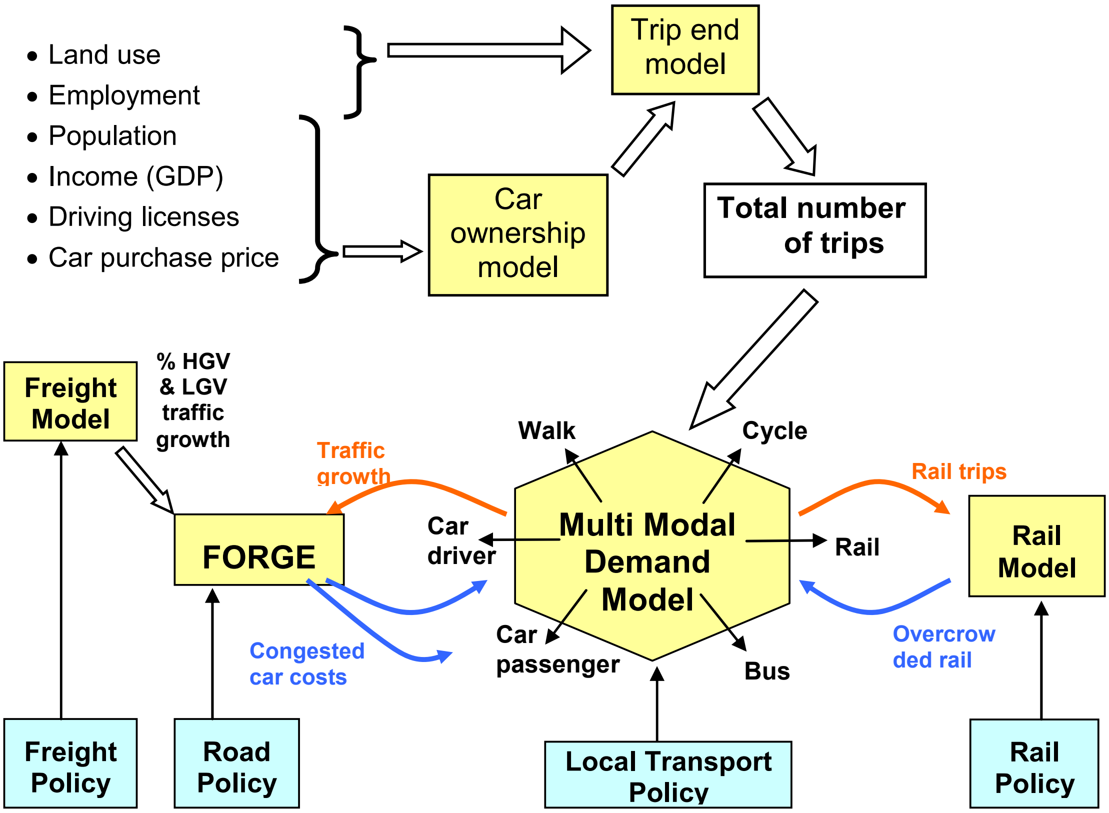
A Technical Overview of the National Transport Model

The National Transport Model[10] uses what is known as a 4 stage behavioural modelling approach to forecast the demand for travel. This approach estimates the demand for travel from the bottom up. Firstly, it estimates the numbers of trips people make; secondly, it allocates those trips to actual journeys made between specific origins and destinations; thirdly, it allocates those journeys to specific modes; and finally, it allocates the journeys being made via a particular mode to specific routes across the transport network. The basic structure of the model through which this is done is illustrated in Figure 4.

[9] The generalised cost of a journey is a combination of time (multiplied by an individual's value of time) plus the monetary costs associated with the trip. The NTM works on a 'Generalised Time' basis - the concept is the same as generalised cost but expressed in units of time rather than money.

[10] More details about the model available at: http://www.dft.gov.uk/pgr/economics/ntm/

Figure 4: Outline Structure of the National Transport Model



At the top of the diagram, the Car Ownership[11] and Trip End Models estimate the number of trips made in each future year as a function of demographic and land use inputs and various economic forecasting assumptions. The Car Ownership Model, National Trip End Model and the demographic and planning input assumptions are collectively known as TEMPRO[12]. TEMPRO calculates the number of trips starting in each zone (trip productions) and the number of trips finishing in each zone (trip attractions) for both the base and future year. Trip productions are primarily generated by the location and structure of households and trip attractions by the location and structure of employment, schools, shops and leisure facilities.

In the centre of the system is the main Demand Model[13] that first determines the geographic distribution of the trips and then the mode by which they are made. The inputs to the demand model are total numbers of trip ends (which are taken to be largely invariant to cost as shown by the National Travel Survey) as calculated by the National Trip End Model and the generalised costs of travelling between each origin and destination for each mode. For any chosen year, the Demand Model then uses these generalised costs to determine how the trip ends are joined together to form trips between specific origins and destinations and the mode they are made by (car driver, car passenger, bus, rail, cycle and walk). The outputs are numbers of trips by each mode segmented by origin, destination, trip length, trip purpose and person type.

The Demand Model is not geographically detailed but it is highly segmented by trip length, trip purpose, and person type. For road and rail, separate and more detailed geographic

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[11] http://www.dft.gov.uk/pgr/economics/ntm/carownership
[12] http://www.tempro.org.uk
[13] http://www.dft.gov.uk/pgr/economics/ntm/demandmodel

models are then used to determine the specific route across the network by which a trip is made. The Demand Model is calibrated to replicate behaviours as observed from the National Travel Survey[14]. It is highly segmented by user class because different user classes are known have different responses to changes in generalised costs.

On the left of the diagram, a specialist highway model FORGE[15] links with the Demand Model to provide a more detailed estimate of highway traffic flows, congestion and pollution. FORGE is not a traditional assignment model; rather it uses observed data on the current level of traffic using each link of the road network and then applies elasticities derived from the Demand Model to forecast future levels of traffic.

To understand how traffic is currently distributed across the road network, FORGE takes data from the national road traffic database which is populated from count censuses of every major road and a sample of minor road sites across Britain. For each of the road types modelled in FORGE a relationship known as a speed flow curve links the average speed on that section of the road to the level of traffic flow. A similar kind of relationship between speed and vehicle emissions is used to determine pollution.

Although the NTM is essentially a passenger transport model, freight road traffic is modelled for the purpose of assessing the impact of freight vehicles on congestion. HGV traffic growth is modelled using the Great Britain Freight Model (GBFM). This takes base year data from 2004 on international and domestic freight movements for 15 different commodities. The model then grows this traffic over time by modelling the effect of changes in macroeconomic variables and also changes in generalised cost. LGV traffic is projected by a separate time series model relating LGV km in a given year to the levels of GDP and fuel price.

On the opposite side of the diagram, the National Rail Model[16] assigns rail passenger trips from the demand model to a detailed geographic network of rail services. The resulting journey time, overcrowding costs, and rail fare outputs are sent back to the demand model so that the interactions between road and rail can be modelled.

The blue boxes at the bottom of the diagram indicate that the NTM can be used to examine the impact of various policy assumptions, which are fed into the different sub-models. In general, changing policy assumptions changes the relative costs and/or time (generalised cost) of travelling by the various modes. However the forecasting assumptions feeding into the car ownership and trip end models can also be altered to represent the impact of different policies and scenarios.

Although the National Transport Model covers the whole of Great Britain (it excludes Northern Ireland) the forecasts set out in this publication are for England. Some results for Wales are provided in the annex.

1.2: Updating the National Transport Model

Peer review and external validation have consistently shown that the National Transport Model (NTM) follows best practice, provides robust results and is fit for purpose.

[14] http://www.dft.gov.uk/pgr/statistics/datatablespublications/personal/
[15] Fitting On of Regional Growth and Elasticities. See http://www.dft.gov.uk/pgr/economics/ntm/nationaltransportmodelntmsummary
[16] http://www.dft.gov.uk/pgr/economics/ntm/railmodellingframeworkfullreport

Nevertheless, the assumptions and methodologies used by the NTM are kept under review. For example, all the main forecasting assumptions, such as GDP, oil prices and population estimates have been updated since the 2007 forecasts were published and the forecasts set out in this paper have made use of these.

Further to this, over the last few years a major research programme to update the underlying methodology of some of the modules making up the NTM has been in progress. During 2009 it is hoped that a new version of the NTM making use of these new techniques will be commissioned.

The broad aims of the Update programme can be summarised as follows:

- To improve the accuracy and capability of the NTM's central Demand Model. The behavioural responses the Demand Model are being recalibrated to more recently available National Travel Survey data, and the geographic and population segmentation of the model improved.

- To improve the modelling of non-car modes. As well including new modes representing metro and taxi, work is underway to replace the National Rail Model by linking the NTM to the Network Modelling Framework (NMF[17]) a strategic rail model used across the rail industry.

- To provide a new detailed assignment model of the GB road network that will work alongside FORGE and allow more detailed analysis of road traffic forecasts.

Next year's forecasts will also, of course, make use of any new updates to the forecasting assumptions that might occur in the intervening period. For example, the Department of Energy and Climate Change (DECC) propose reviewing their oil price projections on a regular basis, at least annually; and we will take on board any updates to these projections.

1.3: The Model Base Year

Choice of Base Year

Since the 2007 forecasts were published, forecasting assumptions such as GDP, oil prices and population estimates have been updated and the forecasts set out in this paper have made use of these. Any available data on the developments of those drivers from 2003 to the present have of course been reflected in the 2003-2010 input growth assumptions.

All forecasting models require a base year on which predictions can be based. The choice of an appropriate base year is driven by a range of criteria - it is not necessarily best practice to pick the most recent year for which data is available.

First of all, required data needs to be final to minimise the risk that future revisions will occur. Given that the NTM requires a wide range of data, for example, on behavioural observations, traffic volumes, economic series, prices and emissions, the scope for having a very recent base year is limited.

[17] http://www.dft.gov.uk/about/strategy/whitepapers/whitepapercm7176/railwhitepapersupportingdocs/

In addition, base year data should be 'uninteresting' in the sense that the likelihood of external shocks influencing the data is minimal. Government budget documents often look at years where the output gap of the economy is small suggesting the economy is operating at capacity (see HMT, 2008c which shows 2003 as having a low output gap). We also need to choose a year where there are no significant shocks. Such shocks would include widespread fuel protests (e.g. in 2000), outbreaks of animal diseases (e.g. foot and mouth in 2001), recessions or large variations in oil prices.

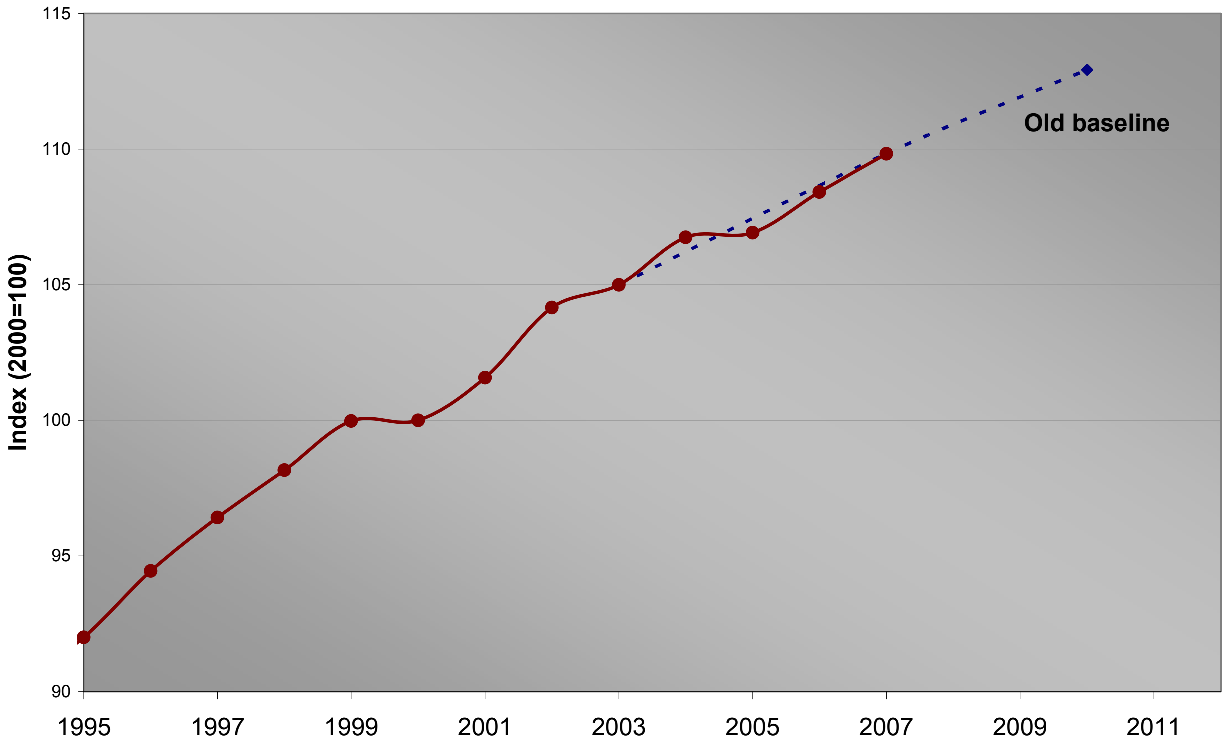
Finally, frequently updating the base year reduces the comparability between subsequent forecasts.

The NTM Base Year

The base year for the NTM has been 2003 for some time. However, the forecasts continue to closely match observed data, adding to our confidence in the model.

Following the comprehensive update of the main exogenous inputs to the model this year we have compared its short term forecasts (2010) to the observed data available. Figure 5, below, shows the observed data as well as the 'baseline' forecast to 2010 that was made prior to the 2008 Pre-Budget Report.

Figure 5: Observed Traffic and Pre-PBR 2010 Forecast



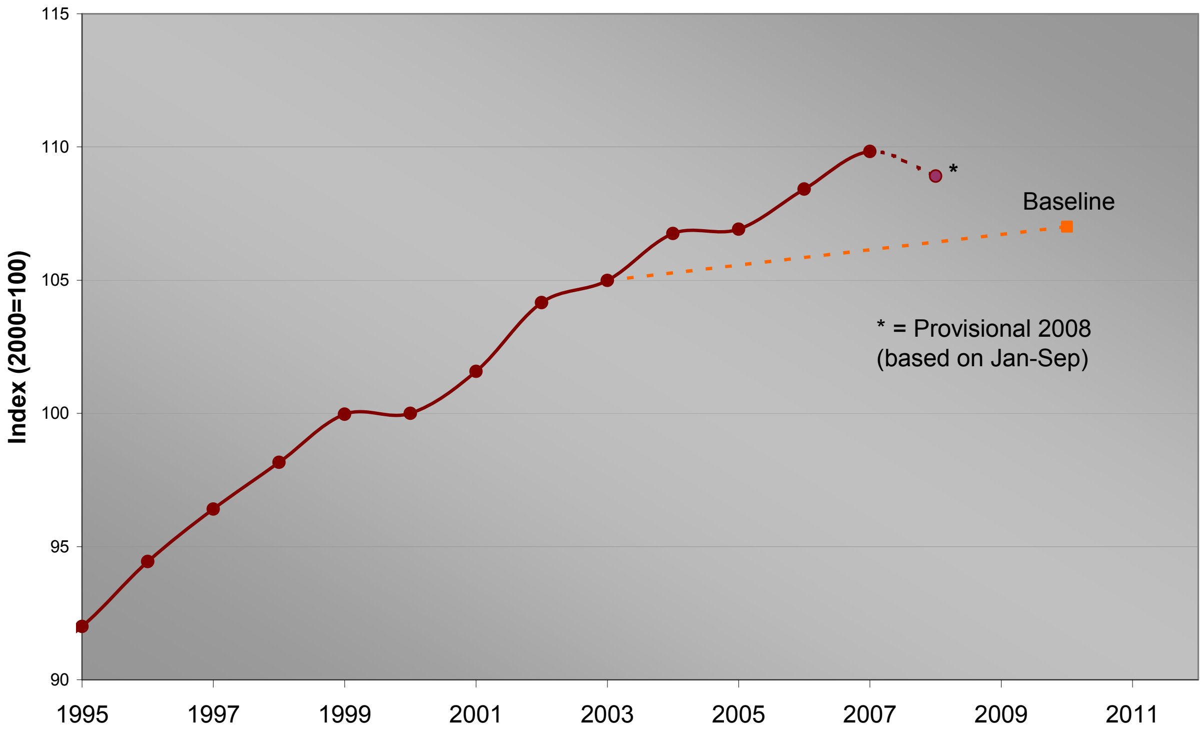
Source: Traffic data from DfT (2007, 2008), forecast from NTM

As can be seen, observed traffic has been almost exactly in line with this forecast. Nevertheless, it is worth pointing out that the NTM is designed to forecast long-term trends (currently to 2010, 2015 and 2025) rather than every individual year. It, therefore, does not provide an insight into the precise path between the base and forecast years.

Following the latest revisions to HM Treasury's short term GDP forecasts at the 2008 Pre-Budget Report (HM Treasury, 2008b), the 2010 forecast has been re-modelled; giving the central 2010 forecast in this report.

Figure 6, below, shows this forecast and also adds an estimated traffic figure for 2008. This is based on provisional data for the first three quarters.

Figure 6: Observed Traffic and Traffic Forecast



Source: Traffic data from DfT (2007, 2008), forecasts from the NTM

The new 2010 forecast suggests a slight reduction in traffic compared to 2007 traffic levels. The early data from 2008 seems to support such an expectation; lower economic growth and volatile oil prices appear to have suppressed travel demand. Final figures for 2008 will be published in 2009. However, if this pattern continues into the fourth quarter, this would represent the first year on year reduction in traffic since the 1970s.

CHAPTER 2: ROAD TRANSPORT FORECASTS

Summary

Transport is vital to the economy and the way we live. Taking a long-term view of the likely trends in the key metrics (traffic, congestion and environmental impacts) is important to be able to make the right policy decisions early enough to have an impact.

Chapter 2 presents the central NTM forecasts of the growth in travel demand and associated emissions over the period to 2025 and discusses any changes to previous forecasts. The 2003 base year used by the modelling allows us to evaluate the performance of the model against actual traffic over the past five years. This chapter looks at this, indicating that the modelled numbers are consistent with recent observed data.

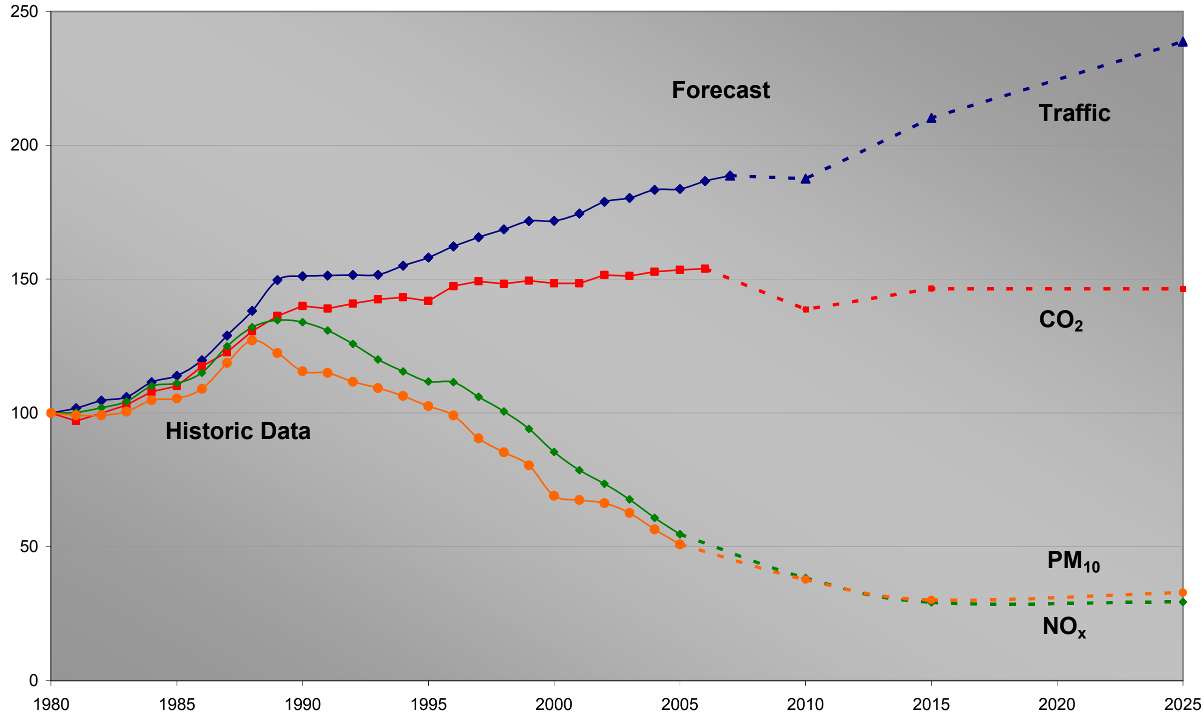
This report updates last year's publication of NTM forecasts. The modelling assumptions have been revised and we have used the improved freight model GBFM 5, which provides a better regional disaggregation. Of particular significance in this update has been the incorporation of new oil price projections, revised population projections and the current predictions about GDP growth.

Inevitably, there is uncertainty regarding the development of many of the key drivers of transport demand – such as the development of the economy, and changes in fuel prices – and it is important to consider the range of transport outcomes to which this uncertainty could give rise. Recent macroeconomic events and gyrations in oil markets, while short-term in nature, have to be factored into the modelling, especially of the near-term forecasts. This is explored in chapter 3.

Figure 7 shows the trends in traffic and emissions since 1980 and the forecasts for the period to 2025. Traffic, CO_2, and emissions of air quality pollutants all grew strongly through the 1980s with similar rates of growth. The 1990s saw air quality pollutants going into decline, de-linking from the trend of continued traffic growth. To some extent, the divergence in trends is also observed between traffic and CO_2.

Traffic is forecast to rise and CO_2 fall over the period to 2025. The fall and then levelling off of CO_2 reflects further improvements in vehicle fuel economy which when combined with the adoption of biofuels together roughly offset the CO_2 effects of traffic growth. Air quality pollutants are forecast to continue their decline, although at a slowing rate.

Figure 7: Traffic and Transport Emissions, Past and Forecast



Source: Historic traffic data is from DfT (2007); Historic emissions data from DEFRA (2007); forecasts from the NTM

Table 2: Summary of Key Forecasts

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Central Forecast	2010	4%	1%	0%	-8%	-40%	-43%
	2015	17%	17%	3%	-3%	-52%	-57%
	2025	32%	37%	6%	-3%	-48%	-57%

Source: NTM

Table 2 summarises the key central forecasts for the years 2010, 2015 and 2025. The NTM forecasts show traffic continuing to grow over the coming decades at similar rates to the recent past, but at a significantly slower pace compared to the period before 1990.

The central traffic growth estimate for 2025 is similar to that published last year. Car traffic represents 81% of all traffic in 2003 and is forecast to grow by 30%. The high growth in LGV traffic in recent years is forecast to continue. HGV traffic is forecast to grow more modestly, by 14%.

However, the forecast rise in congestion is significantly higher than before, largely due to the fact that the new demographic and land use planning assumptions forecast the population to be much more concentrated in urban areas where congestion is more prevalent. Our forecasts suggest that congestion across the English network as a whole will increase by about 37% between 2003 and 2025. This represents an average increase in time spent travelling of 6% (4 seconds for each kilometre travelled). This figure varies from an extra 18% time spent travelling per kilometre in London to a 2% increase in time spent travelling in rural areas.

These forecasts take account of the changes to forecast GDP growth set out in the 2008 Pre-Budget Report (HM Treasury, 2008b)[18]. Recent economic events are affecting traffic, congestion and CO_2 markedly, mimicking the impacts of previous high oil price and recessionary periods. The forecasts for 2010 are consequently significantly lower than those published in 2007. For example, traffic is now expected to grow by 4% between 2003 and 2010, which given that it has grown by 4.6% to 2007 means that a small cut in traffic is now forecast in the period to 2010. Estimates for 2015 of traffic and congestion are also slightly lower now compared to the forecasts published in 2007.

The forecasts also suggest that CO_2 will fall by about 3% over the period as a whole, with emissions of air quality pollutants halving.

Forecast Limitations

As with all forecasts, there is uncertainty around NTM forecasts. These projections should be treated as indicative, illustrating broad trends. Statistical confidence levels cannot easily be calculated in the NTM (a difficulty in most transport models). So the model has been run for a range of scenarios to indicate how sensitive central forecasts are to changes in the main drivers for the model. The results of 'high' and 'low' demand scenarios are summarised in Chapter 3.

Forecasts are for England, unless otherwise stated.

2.1: National Transport Model Results 2008

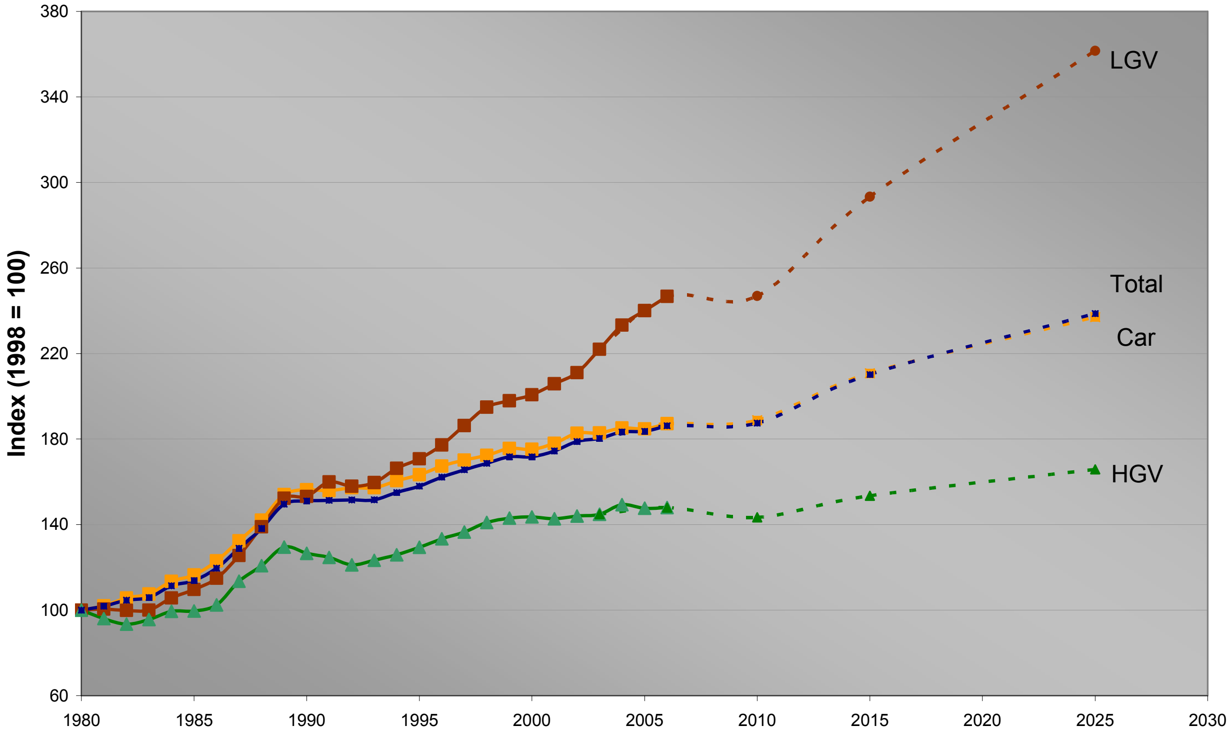
Forecast Traffic

Figure 8 shows forecast traffic by vehicle type. As can be seen total traffic is forecast to grow by 32% over the period to 2025. Car traffic growth follows that of total traffic very closely. This is largely because car traffic accounts for 80% of total traffic in 2025.

In line with recent trends, LGV traffic is forecast to increase most rapidly with expected growth of 63% over the period. Growth in LGV traffic has generally increased in line with GDP in the past and this is projected to continue. Despite this, LGVs are still expected to account for only around 15% of total traffic in 2025 (up from 12% in 2003).

[18] The modelling has not been updated to take into account the announcement in November's 2008 Pre Budget Report of road fuel duty changes, including the 2ppl fuel duty increase that took place on 1st of December. The recent changes to the VAT rate end in 2009 and, therefore, do not affect the forecasts because a 2009 forecast has not been made. As demonstrated in the fuel price sensitivity section, the conclusions of this report would not be materially affected by the slightly higher price of fuel.

Figure 8: Forecast Traffic Growth by Vehicle Type



Source: Historic traffic data is from DfT (2007); forecasts are from the NTM

Over the last twenty years, HGV traffic has grown more slowly than car traffic and the NTM forecasts a continuation of this trend. One of the determinants of HGV traffic forecasts is the trend in the average length of haul, which has flattened off considerably in recent years. HGV traffic growth of 14% is forecast between 2003 and 2025 compared to 32% for traffic overall. It is worth noting, however, that HGV traffic is concentrated on strategic roads.

Table 3: Forecast Traffic by Vehicle and Road Type

Vehicle kms, Change from 2003	Year	London	Large Urban Areas*	Other Urban Areas	Rural Areas	All Areas	Motorway	All HA Trunk Roads
Cars	2010	0%	3%	4%	4%	3%	4%	5%
	2015	12%	14%	14%	17%	15%	19%	19%
	2025	26%	28%	27%	32%	30%	37%	36%
LGV	2010	11%	11%	11%	11%	11%	11%	11%
	2015	31%	32%	32%	32%	32%	32%	32%
	2025	61%	62%	63%	63%	63%	64%	63%
HGV	2010	-1%	-2%	0%	-1%	-1%	-3%	-2%
	2015	4%	4%	5%	7%	6%	7%	7%
	2025	11%	11%	11%	16%	14%	17%	17%
All Traffic	2010	2%	4%	4%	4%	4%	4%	5%
	2015	14%	16%	16%	18%	17%	19%	19%
	2025	30%	30%	30%	35%	32%	37%	37%

* Large urban areas include Metropolitan areas and towns and cities with a population of more than 250,000; Source: NTM

Traffic by Area / Road type

Table 3 shows the forecast traffic growth by area and road types. The highest traffic growth is forecast on motorways and trunk roads with slower growth forecast in already congested urban areas. In the NTM, increased congestion leads to re-routing, travelling at different times, travelling to different places and mode switching (which is usually a small part of the overall response). Congestion has the biggest impact on forecast traffic growth in peak times in those parts of the network that are already most congested.

Due to the already high levels of congestion, the lowest traffic growth is forecast in London, especially in the shorter run. A factor behind revived growth in the longer term is London's relatively young and fast growing population which means that growth is not dampened by the ageing population as much as it is elsewhere in the country. Increases in incomes and falling fuel costs per kilometre are also expected to drive the growth. The largest increases in London traffic are forecast over the weekend and before and after the weekday peaks. This reflects the fact that these times are currently relatively less congested.

The NTM, however, is currently being updated and traffic forecasts for London will be reviewed in the context of this update and in the light of slower than forecast traffic growth in London over the past few years.

The high growth forecast for motorways and trunk roads reflects their relatively uncongested status in the base year as well as rising incomes, which tends to lead people to make longer distance trips.

Detailed regional traffic growth and speeds forecasts from the model are included as an annex.

Box 1: Historical Traffic

Table 4 shows the average annual growth rate for all traffic for each of the last six decades alongside the average annual growth rates for oil prices and GDP. Traffic grew very strongly in the 1950s and 60s. This was fuelled by strong growth in household owning cars for the first time. The 1970s were marked by two oil price shocks which pushed up fuel prices helping trigger a recession. Consequently, traffic growth was significantly below the rates of the previous two decades.

After the steep recession in the early 1980s the economy grew strongly and oil prices fell. Unsurprisingly, therefore, average annual traffic growth was stronger than it had been in the 1970s, but nevertheless it was below the rates of the 1950s and 60s. The period since 1990 has been one of lower and more stable traffic growth. The average rate, since the last recession ended in the early 1990s, has been about 1.6% per annum.

Table 4: Historic Growth in Traffic, GDP and Oil Prices

Decade	Traffic	Oil Prices	GDP	Comments
1950s	8.4%	-0.5%	2.4%	Strong increase in 1st car ownership
1960s	6.3%	-3.7%	3.1%	Strong increase in 1st car ownership
1970s	2.9%	24.4%	2.4%	Oil Crises
1980s	4.7%	-10.3%	2.3%	Strong growth post 1982, falling oil prices
1990s	1.4%	-2.9%	2.1%	Early 90s recession, fuel duty escalator
2000-2007	1.4%	15.4%	2.8%	Steady growth, rocketing oil prices

Source: GDP from ONS, Traffic from DfT, Oil Prices to 1999: Energy Information Administration, US. Post 1999: Brent crude, DECC

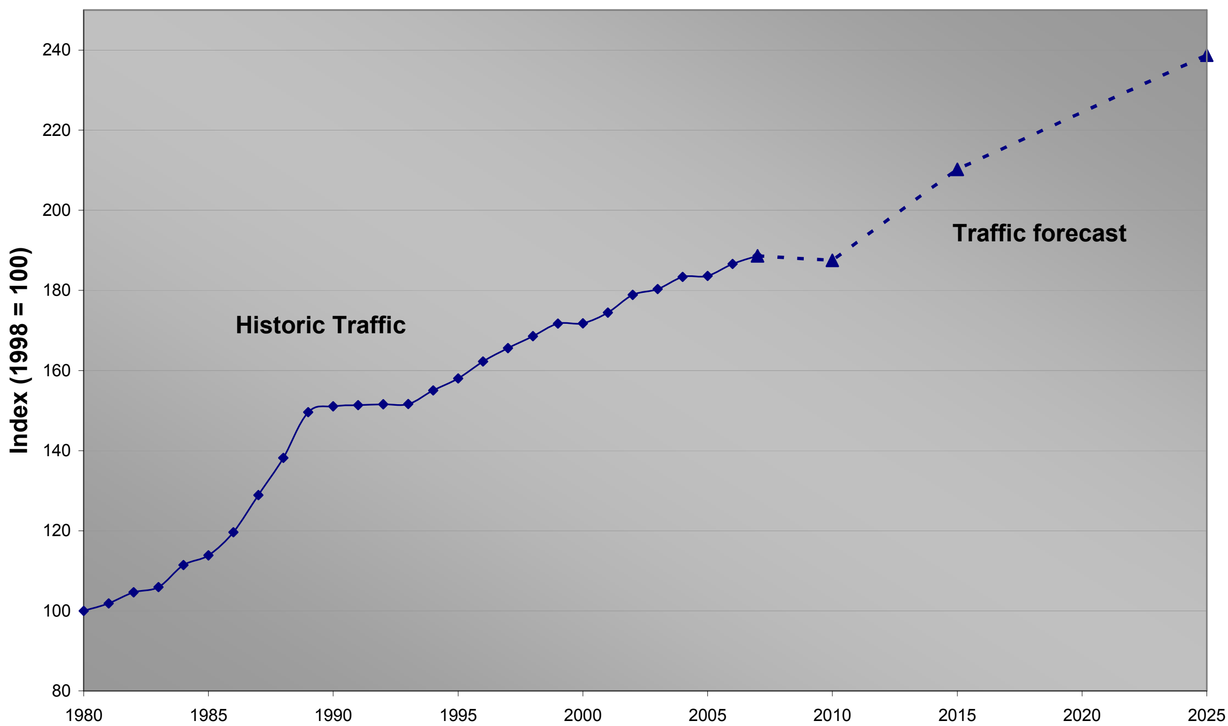
The rate of traffic growth has generally been declining over the last 50 to 60 years. This trend is expected to continue to some extent, with average growth of about 1.2% per annum forecast over the period to 2025. This reflects slowing car ownership growth and an ageing population (pensioners currently make fewer and shorter distance trips than those in work).

The main reason the traffic growth rate does not fall even further is the continued forecast growth in income and the projected strong rise in population. The population of Great Britain is predicted to reach about 67 million by 2025 and GDP is expected to grow by about 71% between 2003 and 2025 (ONS, 2008; HM Treasury, 2008a).

Figure 9 shows trends in traffic over the period 1980 to 2007 along with the NTM forecasts to 2025. As can be seen, traffic has historically grown year on year, with the exception of the early 1990s recession where growth was negligible.

The NTM traffic forecasts for 2010 reflect the revised forecasts for UK GDP growth published in the Pre-Budget Report (HM Treasury, 2008b). Some analysis around falling income is reported in chapter 3. In the longer run, forecasts are for traffic growth to continue at a rate more comparable to the whole of the 1990s but much lower than rates witnessed prior to that.

Figure 9: Trends in Total Traffic



Source: Historic traffic data is from DfT (2008), 2008 data based on first three quarters; forecasts from NTM

Distance Travelled

Table 5 presents the forecast growth of total distance travelled by different modes in 2010, 2015 and 2025 compared to 2003. Total passenger kilometres are forecast to increase by 22% between 2003 and 2025.

Table 5: Forecasts of Total Distance Travelled by Mode

Great Britain, Passenger kms	2003 weekly person km	% change to 2010	% change to 2015	% change to 2025
Car total	513	3%	11%	21%
Driver	*323*	*4%*	*15%*	*30%*
Passenger	*191*	*1%*	*4%*	*6%*
Bus	33	21%	26%	36%
Walk/Cycle	21	9%	11%	19%
Total	567	5%	13%	22%

Source: 2003: National Travel Survey, forecast from NTM

In 2003, car travel accounted for 81% of total movements and it is forecast to reduce its share very slightly to 80% over the next 20 years. This is mainly due to the population growth being concentrated in urban areas where congestion and shorter journeys make slow modes more attractive. Figure 10 shows projections of the change in average trip length over time, as well as variation in trip lengths by journey purpose. Between 2003 and 2025, the average trip length is forecast to increase by around 5% from about 11km to just under 12km.

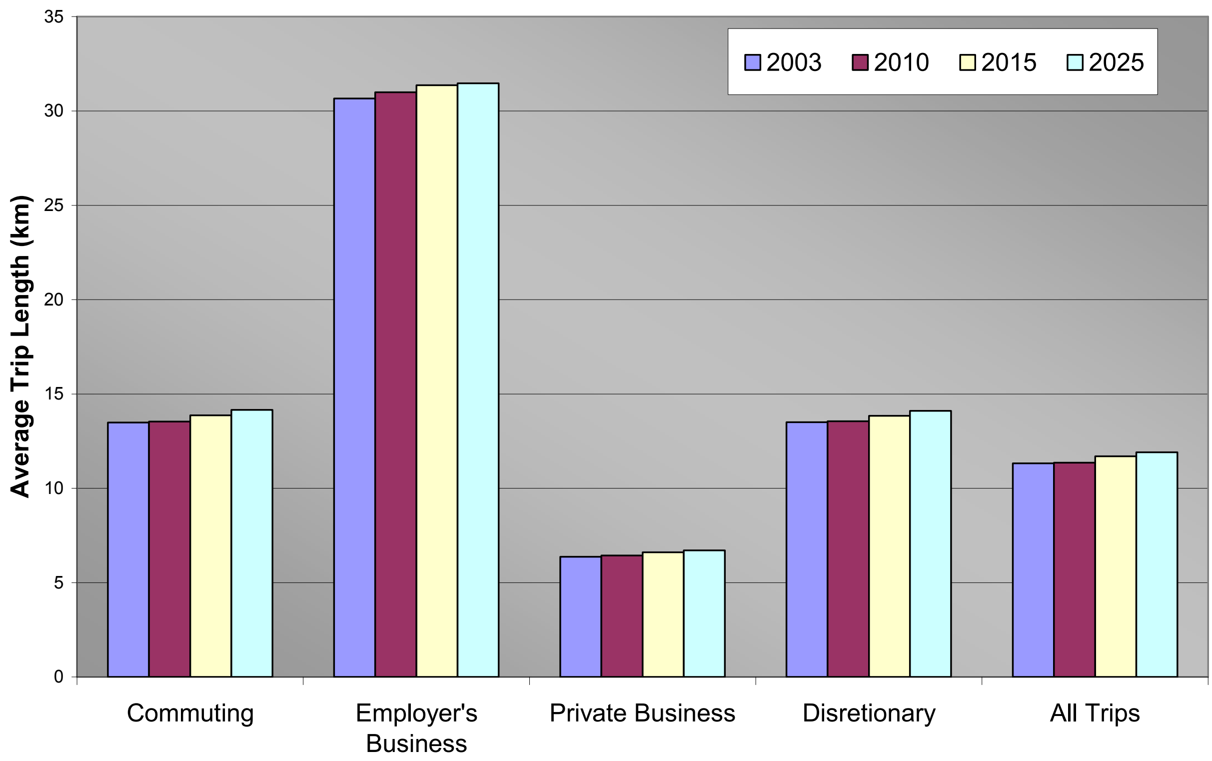
As people become richer, opportunities are taken to travel further away to destinations that were attractive previously but too costly. There is a trade-off with the benefits of the further-off destination, the increased money costs and time costs. This trip lengthening behaviour is driven by the monetary value people place on making any travel time savings increasing as their income rises. Travellers, therefore, become less deterred by the money costs and consequently switch onto modes which are quicker or easier even if they are financially more expensive. As travellers become less concerned about the money costs compared to the time costs they become willing to make longer distance trips, even if they are more money intensive.

For example, if a person wishes to make a shopping trip, they may currently choose to travel to a local shop, rather than pay money to travel to a shop that is further away even though that shop might better meet their needs. However, as their value of time increases, the financial cost becomes less of a factor in choosing which shop to go to relative to how long the journey takes. This may mean that in future, the person decides that it becomes worthwhile to pay more money and travel to the more attractive shop further away.

This behaviour is particularly apparent for longer distance trips because the money costs associated with faster modes such as car, bus and rail tend to increase at a faster rate with respect to trip length than the time costs. Indeed, the forecast increase in the value of time has the single largest impact on the level of congestion on the Highways Agency network.

Annex B of the report for the Eddington Study *Transport Demand to 2025 and the Economic Case for Road Pricing and Investment* provides more detail on these effects; in particular, how the relationship between income and trip lengths is expected to diminish over time.

Figure 10: Average Trip Length



Source: NTM

Congestion

There are various ways of measuring congestion. For example, it can be measured in terms of average lost time, or as changes to journey times. For the purposes of these forecasts, congestion is measured as seconds lost per vehicle km[19] relative to free flow speeds[20]. Alternatively, journey time per kilometre reflects what road users actually experience in totality. As traffic rises, journey time measures will involve smaller percentages than changes to congestion as congestion typically starts at a lower overall level.[21]

The impact of rising traffic on congestion depends on the pattern of traffic growth, how it is spread across the network and across time periods, and the extent to which road capacity is changing.

Our forecasts suggest that congestion across the English network as a whole will increase by about 37% between 2003 and 2025. This represents an average increase in time spent travelling of 6% (4 seconds) for each kilometre travelled. This figure varies from an extra 18% in time spent travelling each kilometre in London to a 2% increase in time spent travelling in rural areas.

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[19] This includes all vehicle kilometres, including those travelling in free flow conditions.

[20] Where 'free flow speeds' are the speeds that vehicles would travel at, subject to speed limits, if there where no other traffic on the road.

[21] If the free flow speed was 70 mph, travelling at 60mph represents about 5 second lost per km (congestion) and 37 sec/km (journey time). A reduction to 50mph increases both measures by 7 s/km. This is a 20% rise in journey time but a 140% increase in congestion.

Table 6 highlights how increased traffic across different area types leads to varying rises in congestion and changes in average speeds. The impact of additional traffic on congestion is markedly higher in places where congestion is already significant. In smaller urban areas, however, increases in traffic impact on congestion by less than one for one, whilst in London the relationship is closer to one to one and a half. It also shows the proportion of traffic on congested roads[22] by area type.

Table 6: Forecast Change in Traffic and Measures of Delay

England	Year	London	Large Urban Areas	Other Urban Areas	Rural Areas	All
Traffic (change in vehicle km from 2003)	2010	2%	4%	4%	4%	4%
	2015	14%	16%	16%	18%	17%
	2025	30%	30%	30%	35%	32%
Congestion (change in lost time/km from 2003)	2010	3%	1%	2%	-1%	1%
	2015	20%	18%	16%	19%	17%
	2025	48%	36%	27%	39%	37%
Vehicle Speed (change from 2003)	2010	-1%	0%	0%	0%	0%
	2015	-7%	-4%	-2%	-1%	-3%
	2025	-15%	-7%	-4%	-2%	-5%
Proportion of all traffic travelling in very congested conditions	2003	24%	14%	9%	2%	8%
	2010	26%	16%	10%	3%	9%
	2015	28%	17%	11%	3%	9%
	2025	35%	19%	13%	4%	11%

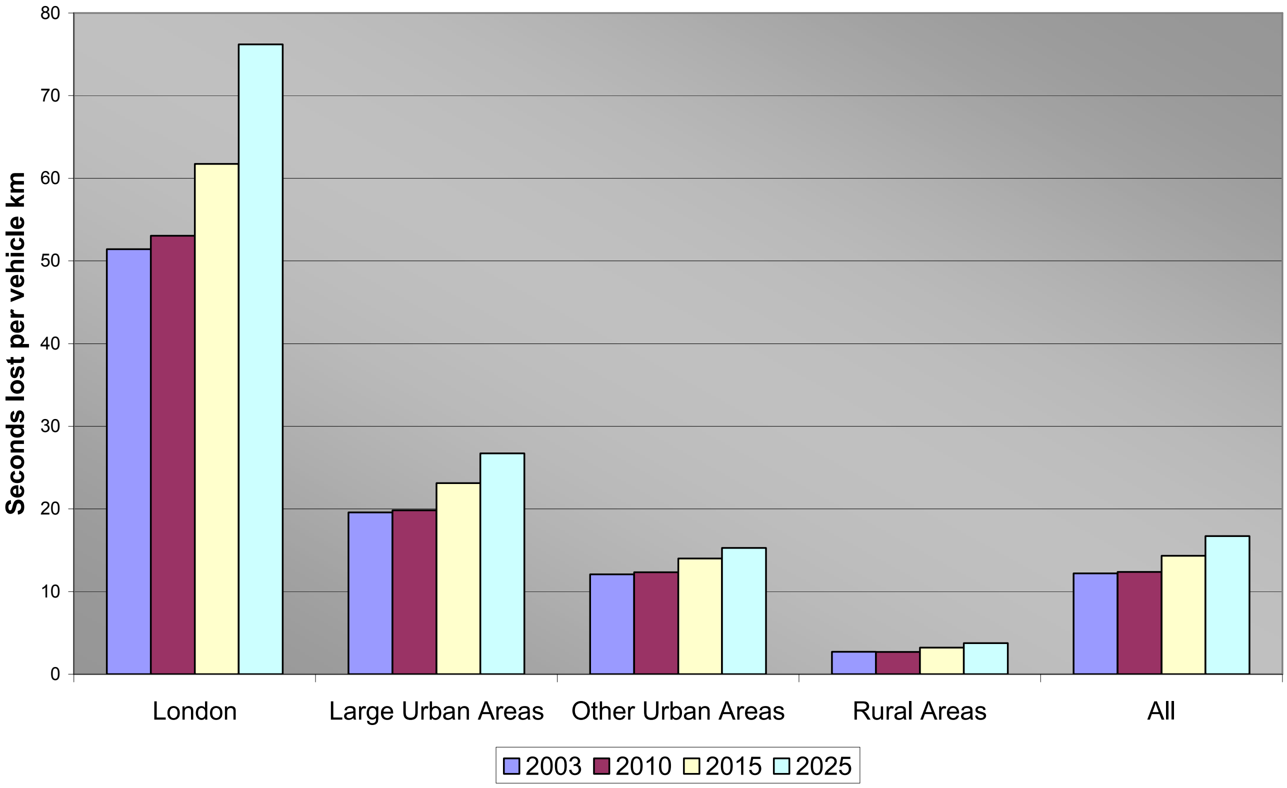
Source: NTM

London has the highest proportion of traffic in congested conditions, with a third of traffic travelling in very congested conditions by 2025. It is important to note, however, that this represents distance and not time and so the proportion of time spent in congested conditions will be higher. For London, for example, the 13 percentage points growth in the ratio of traffic on congested roads leads to an increase in average journey times of 18%.

Figure 11 shows the average seconds lost per kilometre by area type in 2025. For London, the time lost per kilometre travelled by the average vehicle is projected to increase from a level of just over 50 seconds in 2003 to more than 75 seconds in 2025. On rural routes, however, hardly any time is lost to congestion; compared to free-flow conditions, vehicles lost 3 seconds per kilometre in 2003 and would be expected to lose just 4 seconds in 2025.

[22] Defined as conditions where the ratio of the volume of traffic relative to road capacity is above 0.8.

Figure 11: Congestion in 2010, 2015 and 2025 by Area Type



Source: NTM

Figure 12 and Figure 13 show congestion (average delay per kilometre, on an average day) on the major road network for the base year and 2025 forecasts. It identifies road links and clusters of road links where the most severe delays are forecast to be experienced. Much of this chapter considers the national picture, but the map highlights the geographical nature of transport network congestion, illustrating where journey times would be severely affected because of congestion. Further, in these areas, journey time variability is likely to increase, which has consequences for reliability.

Figure 12: Average Delay, 2003

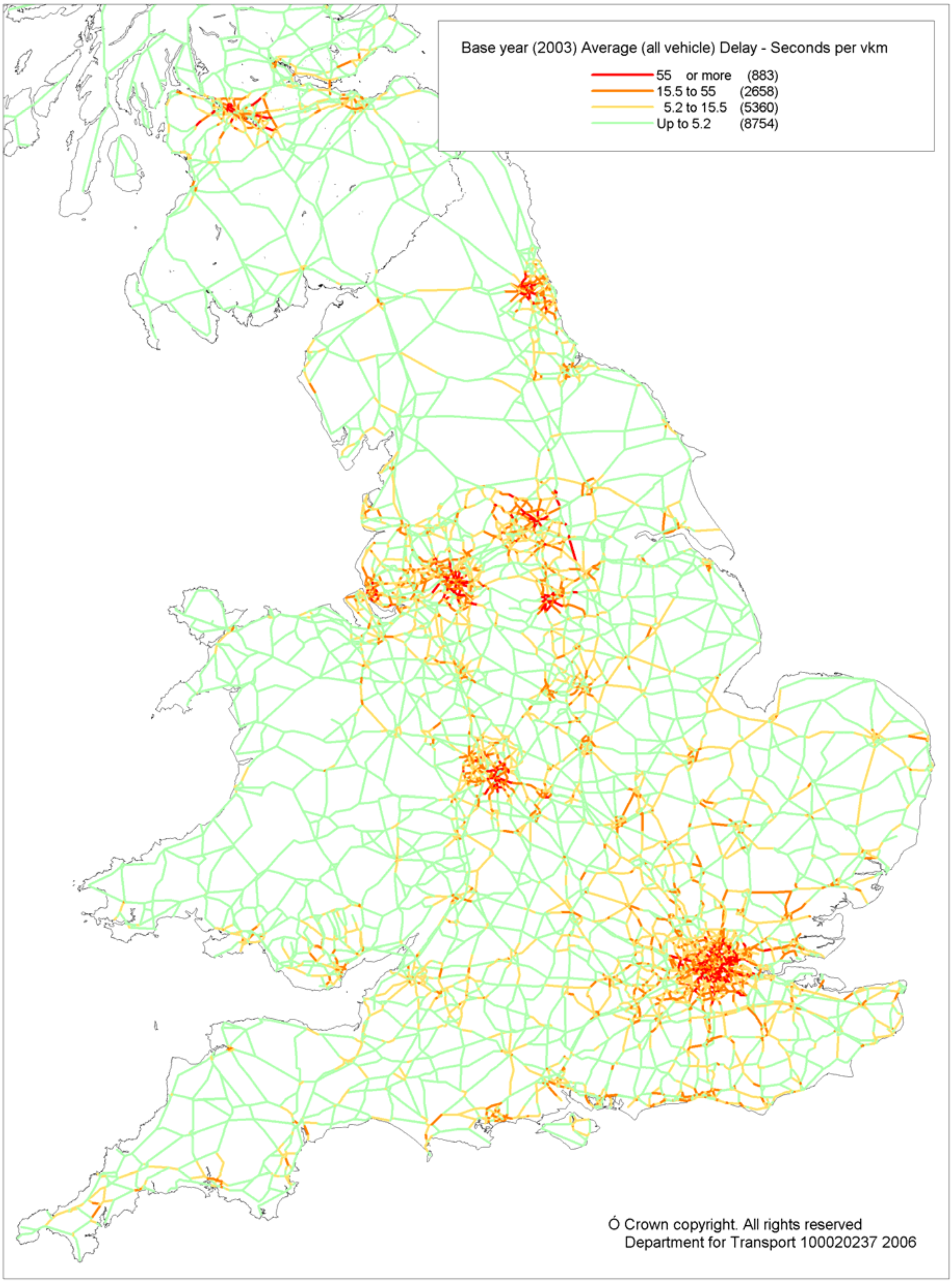


Figure 13: Average Delay with Baseline Policies, 2025

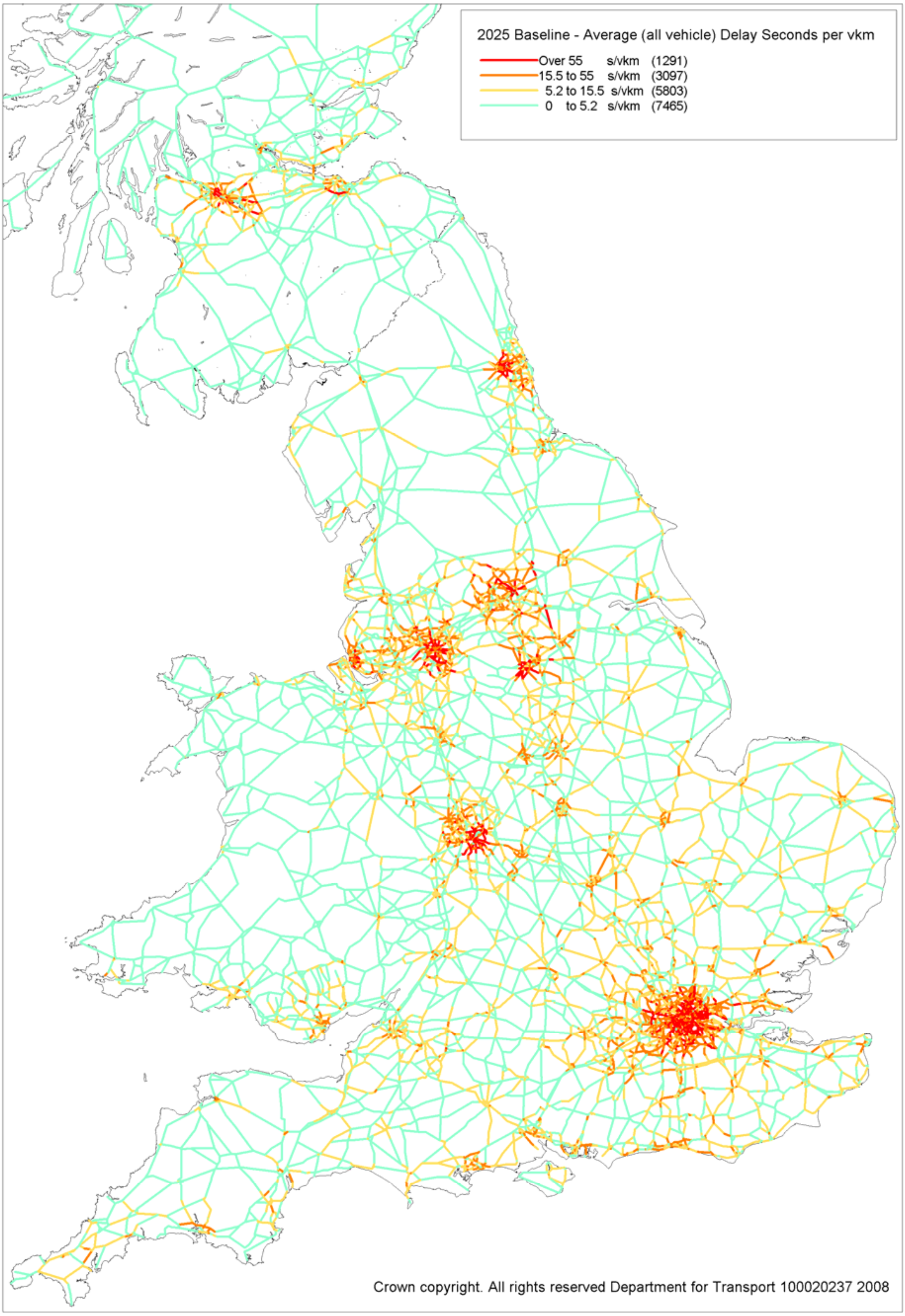
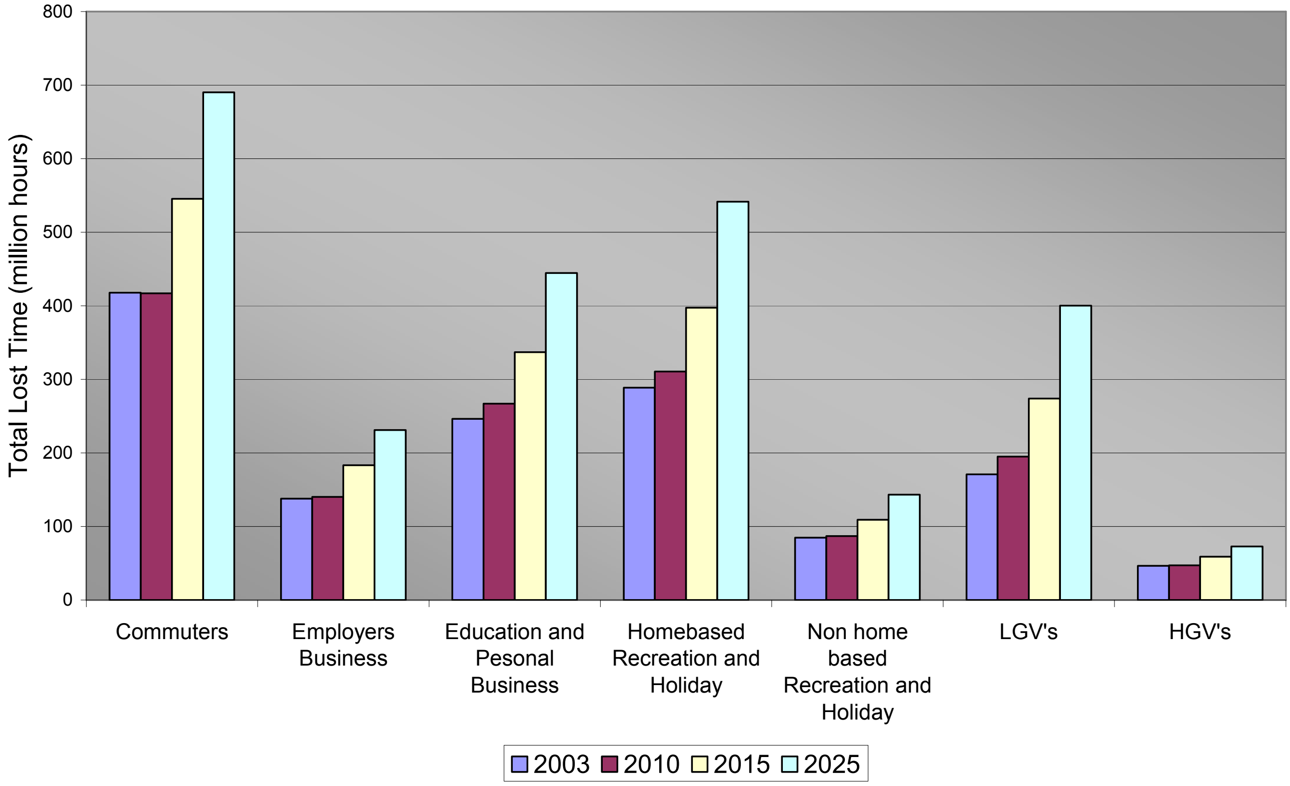


Figure 14 shows total lost time per year from congestion for freight traffic, car traffic by journey purpose and light goods vehicles for the years 2003, 2010, 2015 and 2025. Total lost time for businesses travel[23] in 2025 amounts to 656 million lost hours, an increase of around 95% over 2003 levels. Businesses account for a little more than one quarter of all lost time, with commuting taking a similar share. Other road users suffer a little less than half of the total time lost.

Figure 14: Total Lost Time from Congestion for Freight and Car Traffic



Source: NTM

Emissions

The environmental outputs of the NTM are emissions of the greenhouse gas, CO_2, and the local air pollutants, NO_X and PM_{10}. Figure 15 shows the central forecasts along with the recently observed trends.

As shown in Figure 15, CO_2 emissions have grown over the last decade or so, though at a diminishing rate. The forecasts suggest that emissions will fall a little and then stabilise slightly below current levels. The main causes for the reduction towards 2010 are the introduction of biofuels in line with the Renewable Transport Fuel Obligation (RTFO), the continued improvements in vehicle fuel economy and the economic slow down. This is expected to reduce transport emissions to about 8% below 2003 levels[24]. The somewhat

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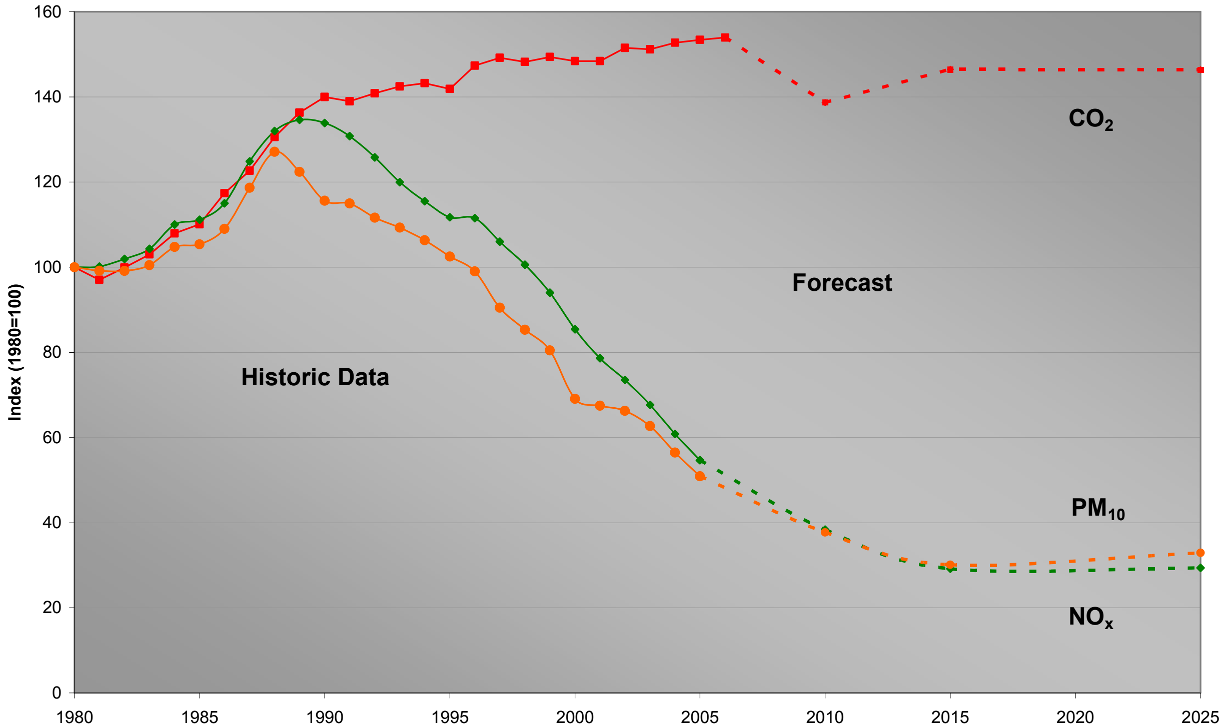
[23] Freight, car trips for employer's business and working LGV (88% of LGV are assumed to be 'in work time' following DfT guidance).

[24] The impact of the RTFO is calculated on an Inter-governmental Panel on Climate Change inventory basis. That is, road transport hydroCO2 fuel sales will fall by 5%. In reality, biofuels grown and

stronger traffic growth forecast beyond 2010 then results in a slight rise in CO_2; with the forecasts for 2015 only 3% below 2003 levels. In the longer run, fuel economy improvements essentially offset traffic growth and consequently, by 2025, CO_2 emissions remain 3% below 2003.

The trend over time of emissions of local air pollutants NO_X and PM_{10} are also shown in Figure 15. This highlights the significant progress that has been made in reducing emissions of pollutants. This is forecast to continue as older vehicles exit the fleet combined with further tightening of the regulatory emission standards. The slight rise in PM_{10} post 2015 is due to the popularity of diesel cars which is assumed to continue.

Figure 15: CO_2, NO_X and PM_{10} Transport Emissions: History and Forecast



Source: Historic emissions data from DEFRA (2007); forecasts from the NTM

Transport Measures Incorporated into Forecasts

There are various measures in place that have and will continue to help mitigate the impact that transport has on the environment – both in terms of air quality and in cutting CO_2 emissions. These include, graduated vehicle excise duty (VED), company car tax (CCT), fuel duty, the Renewable Transport Fuels Obligation (RTFO), the voluntary agreements on new car fuel economy (VAs) and regulatory limits on pollutants (NO_x and PM_{10}).

The bulk of these (VED, CCT, fuel duty and the VAs) all work to reduce road transport CO_2 by encouraging improvements in fuel economy. The other measure aimed at cutting CO_2 emissions is the RTFO, which attempts to reduce the CO_2 content of fuels. Finally, the main

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processed abroad will result in CO_2 emissions there. If these CO_2 emissions are included then road transport emissions will be somewhat higher than this - estimates are available in the Government's Climate Change Programme Review publication.

measure available for tackling air quality pollutants that result from road transport is the regulation of emissions.

It is clear that transport will need to contribute further towards achieving the Government's ambitious CO_2 targets. The CO_2 forecasts set out in this document should be seen as an interim baseline. The Government will outline its policies and proposals to meet carbon budgets in mid 2009. As part of this, we will be developing a strategy for delivering a greater contribution from transport. We will look to incorporate this strategy in our models and can then expect to see these CO_2 forecasts reduce.

The impact on traffic forecasts will depend on the nature and package of measures adopted – measures which operate by improving engine efficiency may be associated with some rebound in traffic levels as costs per km driven fall.

Fuel Economy

Improved fuel economy lowers CO_2 emissions. In recent years, significant improvements to engine technology have been achieved from a combination of the voluntary agreements by car manufacturers and the supportive fiscal measures such as company car tax. This has encouraged the supply and purchase of more fuel economic vehicles. Our forecasts model these improvements, recognising that the full extent of the fuel economy improvements originally envisaged from the voluntary agreements have not been delivered in full. Nevertheless, fuel economy of new cars has improved year upon year for the last decade.

These improvements to new car fuel economy are modelled as gradually filtering through the entire vehicle fleet as old cars are scrapped and replaced with newer cars.

Following the EU negotiations on compulsory targets for new car emissions, we have updated our inputs, assuming average new car CO_2 reaches 130 g/km by 2015. Following from that we assume that improvements in new car fuel economy will continue under a further agreement or regulation on new car fuel economy. We use the average rate of the recent past as a guide for this, about 1.5% per annum.

All the improvements to new cars continue filtering through the entire fleet for some years after their rate of improvement has changed.

In addition to the improvements in engine efficiency, a further expected shift towards more diesel cars[25] contributes towards falling average per kilometre CO_2 emissions.

Biofuels

The RTFO will, from April 2008, place an obligation on fuel suppliers to ensure that a certain percentage of their aggregate sales is made up of biofuels. The effect of this will be to require 5% of all UK fuel sold on UK forecourts to come from a renewable source by 2010.

However, the government is currently consulting on a slowdown of the use of biofuels in road transport. The slowdown will mean that the 5% requirement will not be reached until 2013-14. This proposed slowdown is based on the recommendations from the Gallagher Review published earlier this year.

There are also two European Directives currently being negotiated in Europe. The Renewable Energy Directive will set a target on the amount of surface transport energy that

[25] Despite the higher CO2 content in diesel, lower levels of consumption mean diesel cars emit less CO2 per kilometre driven.

will come from renewable sources by 2020. The Fuel Quality Directive will set a target on GHG reductions from road fuel by 2020. To meet both targets there will need to be an increase in biofuel use above 5% by 2020. The UK government is committed to ensuring the sustainability criteria around the targets address both indirect and direct effects to ensure this increase in use of biofuels can take place sustainably.

Pollutant Technology

The trends over time of emissions of local air pollutants, NO_X and PM_{10}, are also displayed in Figure 15. This highlights the significant progress that has been made in reducing emissions of pollutants. Emissions of NO_x and PM_{10} have been cut by over 50% since the early 1990s. Further tightening of EU standards on permissible emission levels will continue to push emissions of these pollutants down for the foreseeable future – beyond what is shown on this chart.

These forecasts include Euro 4 emissions standards for light duty vehicles, implemented in 2006, and Euro 5 for heavy duty vehicles which comes into practice from 2009, Euro VI from 2012/13. At the end of May 2007 Euro 5 standards for light duty vehicles were agreed by the European Council and European Parliament to become effective from 2011.

Despite these falls at the national level, local air quality problems are expected to remain. However, action is being taken to address these exceedances.

2.2: Key Drivers of Forecast Traffic

The key drivers of traffic growth in the NTM are changes in income, employment, population and travel costs.

Demographic and Land Use Planning Data

As with many transport models, the Department's Trip End Model Presentation Program (TEMPRO) provides demographic and land use planning assumptions for the NTM. This program has recently been updated, with changes including: an upgrade to a higher resolution zoning system; inclusion of the latest planning documents, provided by Regional Planning Bodies; and a revised approach for the allocation of population and households to zones.

Population is assumed to rise by 14.5% (8.5% previously)[26] between 2003 and 2025. Employment patterns and other determinants of growth are likewise expected to rise over the same period. Employed people tend to make more trips and travel further.

Offsetting this growth impetus is the fact that the population is expected to age over time, with the proportion of over-65 year olds set to grow. This has important implications for our forecasts as pensioners currently make fewer and shorter distance trips than other segments of the population. Evidence from the National Travel Survey (NTS) suggests pensioners make on average 50% fewer trips a week than adults of working age. In 2000 the over 65 population was around 20% of the population, but in 2025 this is forecast to grow to over 25%.

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[26] Government Actuary Department (GAD) incorporated into the TEMPRO database (http://www.tempro.org.uk)

GDP Growth and Traffic Growth

Growth in travel is also closely associated with increasing incomes. In a thriving economy, people travel more and businesses move more goods across transport networks. Economic trend growth is assumed to be around 2.5% per annum over the forecast period as a whole, in line with the long term average. GDP per capita grows by 2.1% per annum down from 2.3% p.a. assumed previously due to the population projection changes.

The short-term assumptions on GDP growth have recently been updated in the Pre-Budget Report (HM Treasury, 2008b). The short term GDP growth forecast for 2003-10 used in the National Transport Model has been revised down from 18% to 11.5%.

Rising GDP impacts on traffic growth in two ways.

- Firstly, increasing income is closely associated with increasing levels of car ownership. As might be expected, the impact of having a greater availability of cars is to increase the number and length of car trips, and decrease car vehicle occupancy.

- Secondly, increasing income causes people to change their journey patterns to travel to more attractive destinations which are further away. This trip lengthening phenomenon is explained in more detail later in the section on distance travelled.

Car Ownership Saturation

There is a saturation point in car ownership. This occurs when households with high incomes reach a point where they are unlikely to want to own another car even if their incomes continue to rise. We continue to investigate whether we are reaching saturation levels, but even if some sections of the market are nearing saturation there currently appears to be scope for further growth amongst other sections of the population.

Table 7 shows National Travel Survey data on car ownership rates per household in 2007. As can be seen, for those households in the two highest income quintiles, the average number of cars per household is nearly three times that of those in the lowest income quintile range. Furthermore, 54% of households in the lowest income quintile band do not own a car, whereas only 10% of those households in the highest income quintiles do not.

Table 7: Proportion of Households Owning No, One or More Cars

	No car	One car	Two or more cars	Cars per household
Lowest real income	54%	37%	8%	0.56
Second level	36%	46%	18%	0.85
Third level	17%	49%	34%	1.26
Fourth level	10%	42%	48%	1.51
Highest real income	10%	39%	51%	1.51
All incomes	25%	43%	32%	1.14

Source: National Travel Survey

Revised Assumptions on Motoring Costs

The cost of motoring includes various elements such as the costs of purchasing a car, insurance, fuel costs and servicing costs. Assumptions are unchanged from 2007 on these factors except for the assumptions on fuel costs per kilometre. This is reliant on two assumptions: firstly, fuel prices based on crude oil prices and secondly, the fuel economy of the vehicle – how much fuel a vehicle consumes to drive a kilometre.

Box 2: Historic Oil Prices

Oil prices hit historical highs earlier this year, but have since fallen back markedly. Nevertheless, the average for 2008 is likely to be near $100/ bbl compared to $73 bbl in 2007 and $65 bbl in 2006. It is also worth looking at historical oil prices as these show that even prices of $50 a barrel are significantly above the long term average price.

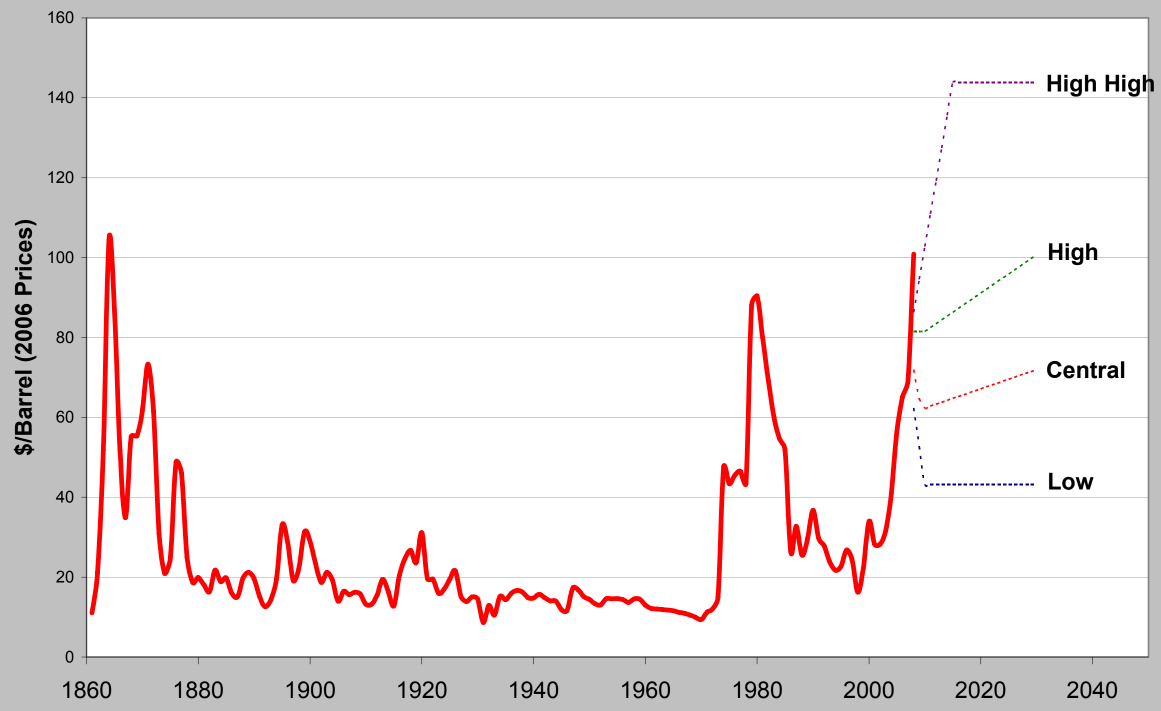
Figure 16 shows oil prices from 1861 to 2008 in constant prices[27] along with the range of DECC oil price projections out to 2025. Data for 2008 is provisional, being an average of prices from January to the end of October. As can be seen, there was an impressive spike in the 1860s that was similar to the price spikes of the 1970s and the one over the last few years.

After peaking in 1864 at over $100, prices gradually trended down until the late 1870s. They then remained in a relatively tight $20 range (between about $10 and $30) for the following 100 years until the first of the 1970s oil price crises of 1974. Prices then remained high for a few years before falling steeply in the early 1980s, returning to the long term range during the period 1986 to 2003.

Prices again broke out of this long term range in 2004 and continued higher until July 2008, reaching the most recent nominal peak of $147. However, they have fallen back substantially since then, falling below $50 in December 2008.

[27] 2006 prices

Figure 16: Oil Prices 1861 to 2008 (annual average)



Data source to 1999: Energy Information Administration, US. Post 1999: Brent crude, DECC

Projected Oil Prices

The fuel price assumptions are based on the latest oil price projections from the Department of Energy and Climate Change, which were last updated in March 2008 (BERR, 2008). The 2008 projections have revised prices significantly; the central projection for 2025 is now $72.5 per barrel in 2007 prices. The projections also include scenarios with a high being $100 and 'low' $45. All these are basically $20 higher than before. The projections also now include a 'high high' price scenario where prices reach $150 by 2015 and then stay at that level.

The DECC oil price assumptions are based on fundamentals (supply and demand) and are used in long-term analysis. They are normally only updated about once a year and are not intended to reflect short-term fluctuations in prices.

Given the impossibility of forecasting the future oil price with real certainty, the range of outcomes covered is intentionally wide, including the "high high" scenario with oil prices at $150/bbl (real) in 2030 (around $200/bbl in nominal terms). Figure 16 indicates the width of those oil price projections.

Fuel Economy

The fuel use per kilometre for petrol cars over the period 2003 to 2025 falls by 1.6% per annum and by 1.1% per annum for diesel. We also assume car owners continue to move towards diesel so that the average car improves by about 1.6% per annum due to the shift.

Assumptions about fuel economy now reflect the 2007 European Commission proposal on the CO_2 emissions of new cars. The draft regulation aims to achieve a Europe-wide reduction in the average CO_2 emissions of new cars by setting mandatory targets for individual car manufacturers.

The NTM assumptions on car fuel economy have been updated based on the expectation that the Commission's target of 130g/km is met at EU level by 2015. Thereafter, we assume annual improvements of 1.5% in new petrol and diesel cars (similar to rate of progress achieved under the EU voluntary agreements). If a longer term target can be agreed, it may well deliver more than this.

We have also revised fuel economy assumptions downward slightly to reflect the fuel penalty associated with the introduction of 5% bio-fuel blends by 2010. Small revisions have also been made to LGV and HGV fuel consumption.

Updated Great Britain Freight Model (GBFM 5)

GBFM5[28] is now used to inform the HGV forecasts. Compared to previous versions, the model now uses a more conventional approach to traffic distribution using a single zoning system throughout. International and domestic stages are now completely separated, the classification of commodities has been simplified and the road network made more consistent with the NTM.

Overall, the results for total HGV traffic are broadly similar to previous forecasts. However, there are more marked differences for the component HGV vehicle types. Also, the GBFM 5 forecasts for rigid and articulated HGV's are now used at a more disaggregate (regional) level within the NTM and this means that the results can now be properly presented by region.

Assumptions on Transport Policy

We have, during this update, reviewed the assumptions made about local transport policy. This had not been undertaken for some years and we have amended policies in the light of developments. In particular, investment levels in public transport have been revised as well as the assumptions on parking levies.

Like previous forecasts the modelling assumes a continuation of current road improvement plans extrapolated to future years. Much of the additional network capacity beyond 2015 is assumed to be provided via the use of Hard Shoulder Running on motorways. This is where the hard shoulder is opened up to traffic during congested periods, as seen on the M42.

2.3 Forecast Revisions Analysis

We have analysed the contribution of each of the changes discussed above individually for 2025. The results are presented in Table 8 where each new assumption is analysed in a cumulative way for both traffic and congestion. For example, the first change is to use the old fuel efficiency settings, the second then assumes last years fuel prices together with those efficiencies.

[28] For more detail see http://www.dft.gov.uk/pgr/economics/rdg/gbfreightmodel/gbfm5report1.pdf .

Table 8: Effect of Revised Assumptions

2025 forecast	Traffic compared to		Congestion compared to	
	2003	Previous line	2003	Previous line
Annual Forecast 2008	32.4%	-	36.6%	-
- Fuel Efficiency	32.0%	-0.3%	36.1%	-0.4%
- Fuel Prices	32.7%	0.5%	37.1%	0.7%
- Engine Split	32.3%	-0.3%	36.5%	-0.4%
- Value of Time	32.6%	0.2%	36.8%	0.2%
- Local Transport	32.4%	-0.1%	35.9%	-0.7%
- Freight Model	32.8%	0.2%	36.2%	0.3%
- Road Improvements	32.7%	-0.1%	36.6%	0.3%
- Demographic&Planning	30.5%	-1.6%	28.2%	-6.0%
Annual Forecast 2007	30.5%	-	28.2%	-

Source: NTM

For example, the previous assumption on fuel economy was slightly less optimistic, making driving in 2025 more expensive. This leads to less traffic (about a quarter percent) and the resulting reduction in congestion. Fuel prices were previously assumed to be lower. Reverting to old prices brings traffic back up by half a percent compared to the case with old fuel economy and new prices.

The breakdown reveals that the major impact on both traffic and congestion comes from revisions to demographic and land use planning data.

The significantly larger effect on congestion highlights that the new demographic and land use planning assumptions forecast the population to be much more concentrated in urban areas where congestion is more prevalent. Using the old inputs reduces congestion forecast for 2025 by 6%. As can be seen in Table 6, congestion is predominantly an urban problem. Adding traffic here therefore adds disproportionally to the problem.

Together these ‘drivers’ explain why this year’s 2025 forecasts are about 1.5% higher for traffic and about 6% higher for congestion than the ones published in autumn 2007.

2.4 Other Government Forecasts of Transport CO_2

Within Government, forecasts of CO_2 emissions from transport are produced both by the DfT and by the Department of Energy and Climate Change (DECC). These forecasts are produced by two separate models, the DfT’s NTM and the DECC’s UK Energy Model.

The DECC’s Energy Model is a time series econometric top-down model that directly forecasts energy use and emissions for all sectors across the United Kingdom including transport. The DECC model provides for consistent whole economy modelling of energy use and associated emissions, of which transport is a part. Such a model is needed for the purposes of cross-Government strategies.

The NTM on the other hand uses a bottom-up approach starting from data on the trips that people make and distinguishing between area, person and household types as well as including a representation of the road network. Emissions are derived taking into account the type of vehicles and the speed they are forecast to be travelling at. The DfT model allows for a greater level of detail in modelling the transport sector specifically and is better suited to the modelling of a range of transport policies.

Nevertheless, there are a number of significant common assumptions between the two models. For example, assumptions on economic growth, fuel prices, vehicle fuel economy, population, cars per household, and the CO_2 impact of biofuels are the same in both models.

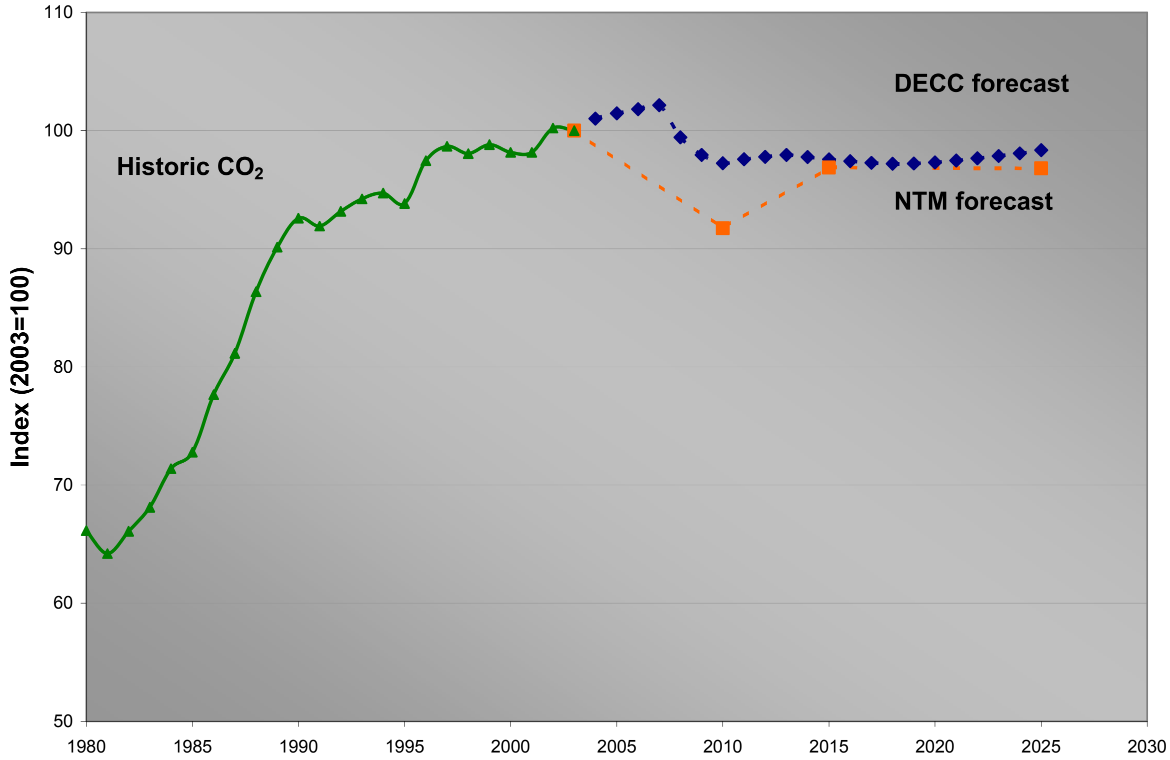
Considered together the two models may provide different insights and a greater understanding of the key influences on the transport sector. But, due to the different nature and purpose of the two models, we would not expect identical forecasts.

Further, NTM forecasts are usually published for England only, whereas DECC forecasts are published on a UK basis. Published forecasts, therefore, cannot usually be directly compared on a levels basis and so Figure 17 compares the trends in growth only.

The latest projections from the DECC model were published in the updated energy and CO_2 emissions projections in November 2008[29]. In order to compare these DECC forecasts relating to the UK with the NTM forecasts relating to England, as presented in this paper, both have been indexed. Figure 17 shows these projections along with the trend in actual road transport CO_2 emissions from 1980 to 2003. It should be noted that while the DECC model computes transport energy demand and emissions on an annual basis, the NTM only models the years 2010, 2015 and 2025 – emissions, therefore, may not follow a straight line between these points.

[29] Available at http://www.berr.gov.uk/files/file48514.pdf

Figure 17: DfT & DECC CO_2 Forecasts



Source: Historical data from DEFRA, DECC forecast from DECC (2008), DfT forecasts from the NTM

Both DECC and the NTM are forecasting a break with the past trend of ever rising emissions in that both are expecting CO_2 emissions to fall towards 2010 and then to stabilise. This reflects policies such as regulation on the CO_2 emission of new cars and the RTFO (biofuels).

The larger difference in 2010 is primarily due to HM Treasury's economic growth revisions at the 2008 Pre-Budget Report. These have been taken account of in the NTM forecasts, but not in DECC's forecasts as they were published before the PBR.

The forecasts themselves are also very similar with any differences occurring within what would be considered normal margins of modelling uncertainty. By 2025, the DECC forecast are around 1.5% higher than the NTM's and, therefore, fall well within the forecast fan produced in the sensitivity analysis reported in the following chapter.

CHAPTER 3: SENSITIVITY ANALYSIS AND SCENARIOS

Summary

Evidence based forecasting involves making assumptions about the key drivers of transport activity. Inevitably there are uncertainties around how these drivers will change in the future. Sensitivity analysis has, therefore, been carried out on key NTM assumptions so as to capture some of this uncertainty. This analysis involved quantifying the impact on the forecasts of uncertainty around the central assumptions that feed into the NTM, including GDP, fuel economy rates, population and oil prices.

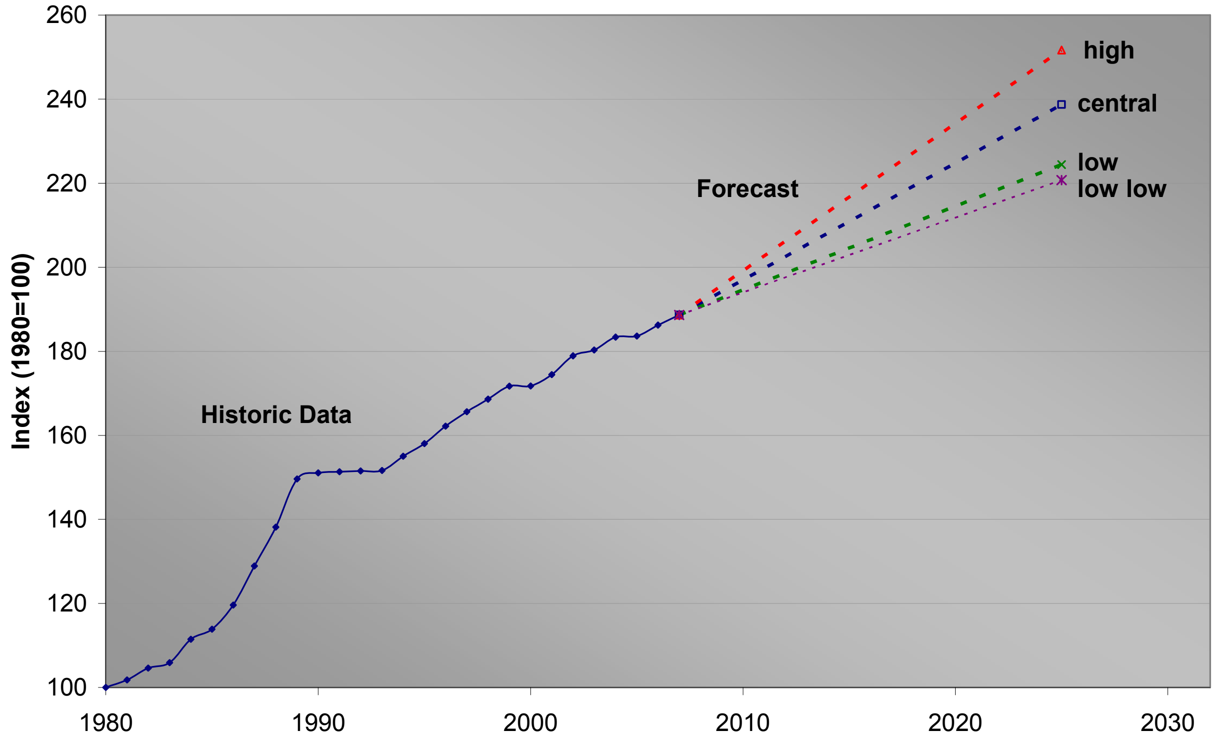
Recent global events suggest there is a risk that economic growth will slow down, or even become negative, over the period to 2010. Consequently there has been an increasing interest in what this might mean for traffic. We have, therefore, carried out some sensitivity assumptions analysis for GDP. We have modelled a hypothetical downturn, as a scenario, so that an idea of the potential impacts on traffic can be obtained. This scenario is for GDP to fall in line with the amount it did in the early 1980s recession (-3.5%) over two years. The economy then returns to trend growth rates after 2010. This downturn scenario has then been coupled with the central and high oil price scenarios to produce two potential short-term traffic slowdown scenarios.

Following the large variations in oil prices observed recently we present analysis on the uncertainties around long term projections in this market. The central NTM forecasts are tested for their robustness to a range of oil price scenarios.

As in last year's publication, the various sensitivity tests were combined into scenarios resulting in higher and lower overall transport demand. This provides a forecast fan around the central forecast. In a similar way, a forecast fan for road transport CO_2 emissions has been generated. Finally both of those low scenarios are also modelled with a lower population projection ('low low').

As shown in Figure 18, combining the variations in key assumptions results in a forecast range of between 22% and 40% growth in vehicle kilometres for 2025 compared to 2003. The central forecast lies in between at 32%.

Figure 18: Central, High, Low and Low Low 2025 Traffic Forecasts



Source: Historic traffic data is from DfT (2007); forecasts are from the NTM

The analysis does not assess the likelihood of the alternative assumptions, but the sensitivities used are based on historical experience of the variability of the key drivers. When forecasting a complex transport system over long time horizons, many assumptions and simplifications have to be made. Some alternative views of the future are intrinsically impossible to model reliably, such as revolutionary technological or societal changes.

3.1: Economic Downturn

Recent global events suggest there may be downside risks to economic growth over the next year or two. Consequently, there has been increased interest in what an economic slowdown might mean for traffic. Following the 2008 Pre Budget Report we re-modelled the 2010 central forecast adjusting for the reduced GDP forecasts up to 2010. GDP is now not expected to grow over the period to 2010. The longer term assumption, however, is for growth to return to trend growth rates of over 2% per annum.

To obtain an idea of the potential impacts of a downturn on traffic growth as well as the subsequent upturn, it is useful to look at what happened during the last recession and subsequent recovery. This is shown in Table 9 below.

Table 9: GDP and Traffic during the 1990's

Economy	Period	2-year GDP Growth	2-year Traffic Growth
Downturn	1991-92	-1.2%	0.3%
Recovery	1993-94	6.7%	2.3%

Source: ONS (2008) for GDP and DfT(2007) for traffic.

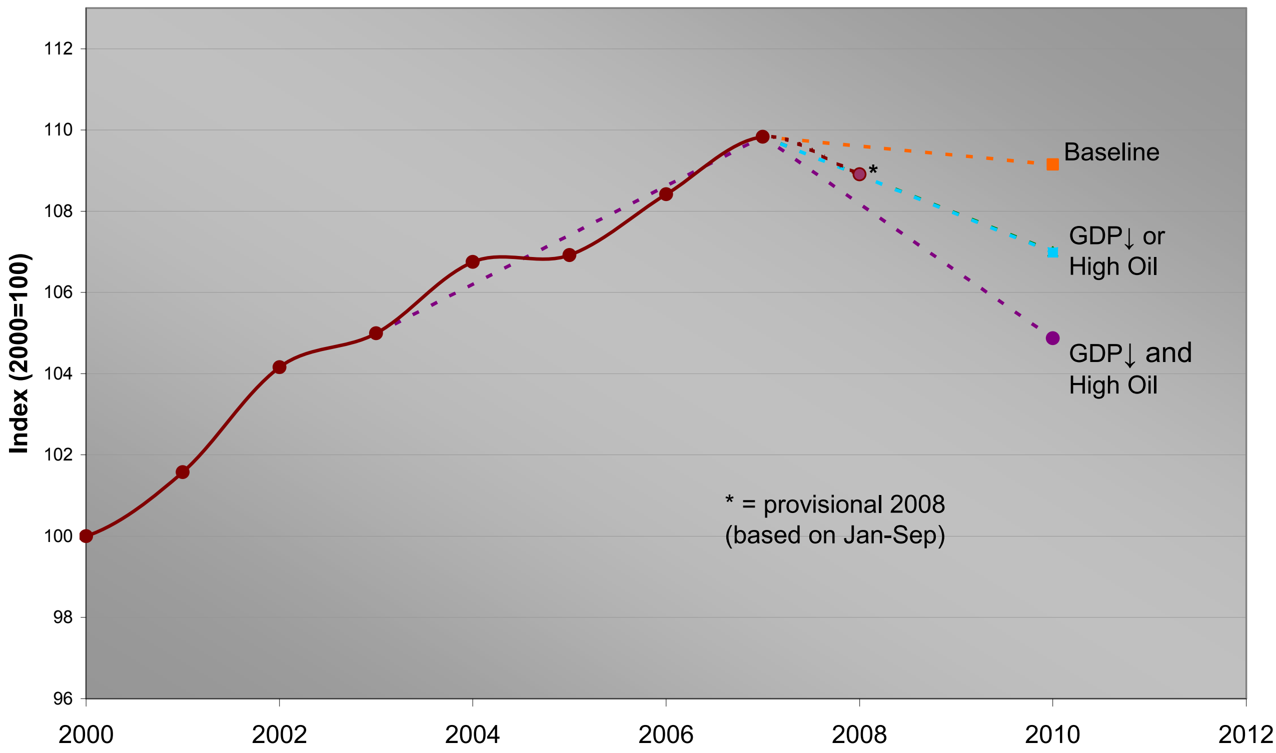
During the early 1990s recession, the economy contracted by about 1.2% over the two year period 1991-92 and traffic grew by just 0.3% over these two years. The economy then recovered strongly with growth of 6.7% for the two years 1993-94 and traffic grew with it, rising by 2.3% over the same period.

Traffic growth rates dropped markedly during the early 1990s recession: traffic had grown at an average rate of nearly 8% per annum from 1987 to 1989, peaking at 8.3% in 1989. Thus, the absolute fall in the rate of traffic growth was in the region of 8 percentage points. This large traffic growth slowdown was mirrored by a similar story on the economy. Prior to the recession, the economy grew by 5% in 1988. In addition, oil prices rose leading up to the early 90s recession, by nearly 50% in real terms, although this was from a low base of just $15 in 1988.

Any direct relationship between GDP growth and traffic growth is complicated by other factors that impact on transport. The NTM allows an assessment of how these interact. We have modelled a hypothetical scenario with GDP falling in line with the amount it did in the early 1980s recession (-3.5%). This scenario is run with central and high oil prices and holding all other drivers unchanged.

In the past, periods of recession have often been followed by higher than average short-term growth in both GDP and traffic, as a result of the output gap being is closed.

Figure 19: 2010 Economic Downturn Scenario



Source: Traffic data from DfT (2008), forecasts are from the NTM

Figure 19 contrasts the NTM forecast for 2010 with observed data. It shows the baseline forecast with central and falling GDP and high oil prices with falling GDP. The central GDP forecast with high oil prices scenario coincides with the one for falling GDP with central oil price, therefore, they show as a single line (light blue).

The central forecast (orange dotted line 'Baseline') suggests traffic is likely to remain largely unchanged over the next two years. A further reduction (the light blue line) would be expected either if oil prices go above the central price projection or if the economy contracts by more than was outlined in the PBR; or if there was a change in another key driver not shown here such as in lower population growth.

If high oil prices and falling GDP coincide then forecast traffic falls back to 2003 levels by 2010.

3.2: Oil Prices

Recent volatility of oil prices has heightened the level of interest in the degree to which transport forecasts are robust to large variations in oil price.

We have remodelled the baseline forecast under a wide range of oil price projections: Table 10 shows the results from running the NTM under the four oil price projections published by DECC. 'Low' price projections is for the price per barrel to fall to $45; the 'central' is for oil to fall to $65 in the short term before gradually rising to $72.50 by 2025; the 'high' is for oil to rise gradually to $100 by 2025; while the 'high high' price series grows to $150 by 2015 and then stays at that level. These are all in 2007 prices and are shown graphically on Figure 16.

Although traffic is affected by oil prices, their impact is less than might be expected. This is because a large percentage of fuel costs is determined by tax (fuel duty, VAT), refinery and other intermediary costs, and profit margins. A doubling in oil prices, therefore, raises pump prices by less than 30%, and this reduces traffic in 2025 by about 4%.

The results suggest that even for such a wide range of prices, the range of traffic growth forecasts to 2025 are quite narrow, varying between 26% and 35%.

Table 10: Summary Baseline Forecasts under Various Oil Prices

England, Forecast Change compared to 2003	Oil Price	Traffic (Vehicle km)	Congestion (Lost time/km)	Journey Time (time/km)	Road Traffic Total Emissions		
					CO_2	PM_{10}	NO_x
2010	low	6%	3%	0%	-7%	-39%	-42%
	Central	4%	1%	0%	-8%	-40%	-43%
	High	2%	-1%	0%	-10%	-41%	-44%
	High High	0%	-3%	-1%	-11%	-42%	-45%
2015	low	19%	20%	3%	-1%	-51%	-56%
	Central	17%	17%	3%	-3%	-52%	-57%
	High	14%	14%	2%	-5%	-53%	-58%
	High High	9%	8%	1%	-9%	-55%	-59%
2025	low	35%	40%	6%	-1%	-46%	-56%
	Central	32%	37%	6%	-3%	-48%	-57%
	High	30%	33%	5%	-5%	-49%	-57%
	High High	26%	27%	4%	-8%	-50%	-59%

Source: NTM

3.3: High/Low Demand

The central assumed level of growth and the variation in the key measures considered were:

- **GDP**: The central estimate is for total income, for the period 2003 to 2025, to grow by 71%, or about 2.5% per annum. In the low scenario, GDP growth is 63% (0.25%-points less p.a. post 2007) and in the high 78% (0.25%-points more p.a. post 2007).
- **Oil Prices**: The central estimate is that oil will cost US$72.5 (2007 prices) in 2025. This is varied to $100 in the high scenario, $45 in the low.
- **Fuel Economy**: The central estimate is that car fuel consumption falls by 1.6% p.a. for petrol cars and 1.1% for diesel. Due to an assumed shift towards more diesel cars, the average car fuel consumption falls by 1.6% annually. HGV's improve by 0.6% per year, 13% to 2025. In the high scenario, all these annual rates are increased by half; in the low scenario it is decreased by 50%.

For the purpose of assessing the maximum variation around the central forecast, we model scenarios based on combination of these sensitivities. The high demand scenario combines high GDP, low oil prices and high fuel economy. Each of these assumptions cause demand for transport to rise. The low demand case assumes low GDP, the high oil price and a low fuel economy setting. Each of these assumptions cause demand for transport to fall. Finally, we have modelled a 'low, low demand' scenario which, in addition to the 'low demand' scenario incorporates the ONS low migration population projections (see below).

The high demand scenario results in 5% higher traffic in 2025, while the low demand leads to a similar 5% reduction. In terms of change from 2003, this represents an increase in traffic within the range of 24 to 40%. This is illustrated in Figure 18 above. In terms of CO_2, the outcomes range from a 3% rise in emissions to a 10% fall. Some more details are summarised in Table 11.

Table 11: Summary Results of High, Low and Low Low Demand

England, Forecast Change compared to 2003	Year	Traffic (Vehicle km)	Congestion (Lost time/km)	Journey Time (time/km)	Road Traffic Total Emissions		
					CO_2	PM_{10}	NO_x
2025 forecasts	High	40%	49%	8%	-10%	-45%	-54%
	Central	32%	37%	6%	-3%	-48%	-57%
	Low	24%	24%	4%	3%	-50%	-59%
	Low Low	22%	21%	3%	2%	-51%	-59%

Source: NTM

The difference between the central and the high/low scenarios confirms the asymmetries in congestion. Adding 5% to traffic increases the average time lost per kilometre by 9% and delays the average journey by 2%. Reducing traffic levels by 5%, however, reduces congestion by 8% and journey times by 1.5%.

The effect on CO_2 is driven by the fuel efficiency settings in high and low demand scenarios. The optimistic fuel economy assumption that leads to low cost and thus high demand reduces emission rates. In the low demand scenario, the reduction in kilometres driven is much less than the increase in emissions per kilometre compared to the central setting. Similarly, even with more than 5% higher traffic in the high demand scenario, CO_2 emissions are almost 7% lower than central.

3.4: High / Low CO_2

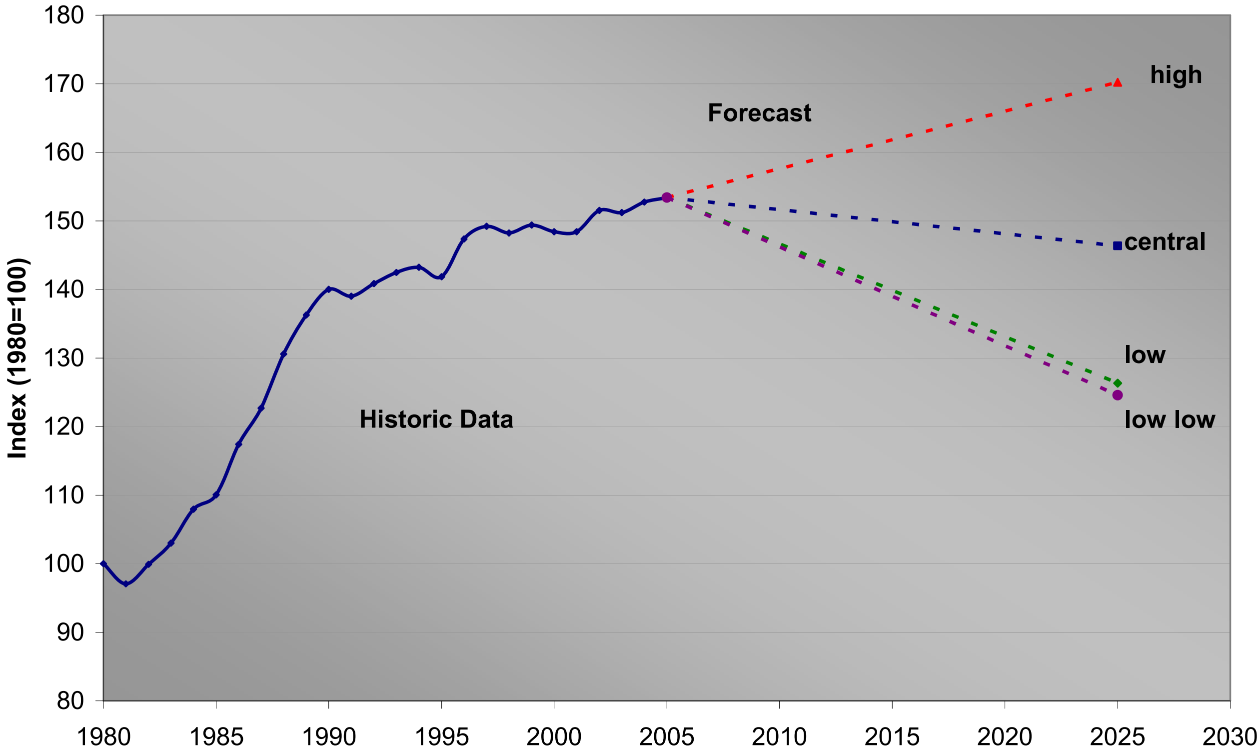
Those assumptions that reduce the amount of CO_2 have been combined, namely all the settings for the 'low low demand' scenario, except for the fuel economy settings, where the high fuel economy setting is used. While high oil prices and low fuel economy make driving both more expensive and, therefore, reduce demand, the lowest CO_2 emissions are achieved when high fuel prices are matched with high fuel economy settings. The reduction in emissions per kilometre more than offsets the higher demand arising from the higher fuel economy improvements. Table 12 shows the summary results from these scenarios.

Table 12: Summary Results of High, Low and Low Low CO_2

England, Forecast Change compared to 2003	Year	Traffic (Vehicle km)	Congestion (Lost time/km)	Journey Time (time/km)	Road Traffic Total Emissions		
					CO_2	PM_{10}	NO_x
2025 forecasts	High	35%	42%	7%	13%	-45%	-55%
	Central	32%	37%	6%	-3%	-48%	-57%
	Low	30%	32%	5%	-16%	-49%	-58%
	Low Low	28%	29%	4%	-18%	-50%	-58%

Figure 20 shows the result against the recent history of road transport CO_2 emissions and the central forecast for 2025. This suggests that with this combination of sensitivities, emissions might fall to 11% below 1990 levels in 2025. The high combination would lead to CO_2 being more than 20% above 1990.

Figure 20: Central, High, Low and Low Low CO_2 Forecasts



Source: Histroic Traffic from DfT (2007), forecast from NTM

3.5: Low Migration

The latest ONS population forecasts incorporated new projections for migration into and out of the UK. ONS also presented alternative estimates recognising that recent migration patterns were higher than observed historically. To test the robustness of the traffic forecasts to these alternatives, we have incorporated the lower growth of the population in line the ‘low migration’ variant from ONS.

Table 13 shows the summary results for this scenario. A lower population assumption reduces traffic by about 2% which reduces congestion by 3%. Emissions fall in line with traffic. The reductions in air quality pollutants in 2025 are insignificant compared to the large fall against 2003 levels that is expected. At the rounded level shown here, the changes to 2003 are the same.

Table 13: Results of Population Sensitivity Test

England, 2025 Forecast Change compared to 2003	Traffic (Vehicle km)	Congestion (Lost time/km)	Journey Time (time/km)	Road Traffic Total Emissions		
				CO_2	PM_{10}	NO_x
Central Forecast	**32%**	**37%**	**6%**	**-3%**	**-48%**	**-57%**
Low Migration	**30%**	**33%**	**5%**	**-5%**	**-48%**	**-57%**

Source: NTM

These relative changes carry through when using the lower population projection together with the other assumptions in the low demand and low CO_2 scenarios.

CHAPTER 4: ACTIVE TRAFFIC MANAGEMENT

Summary

Given the critical importance of getting transport right, Sir Rod Eddington made a number of recommendations to improve the way that Government tackles transport planning, both in the short term and in order to ensure the best long-term outcomes. Chapter 4 of the Department's 'Towards a Sustainable Transport System' states the policy options available for ensuring Transport continues to play its role in a thriving UK economy.

The NTM has been used extensively to inform the debate on some of these options. For some years, the potential impact of pricing options on traffic, congestion and emissions has been demonstrated[30]. More recently another approach to 'better use' has been modelled through the NTM, that of opening up motorway hard shoulders to traffic during peak periods.

The technologies available today offer a number of ways in which we can better manage traffic flows on our motorways, including opening the hard shoulder to traffic during congested periods, as seen on the M42. Given the encouraging experience from that pilot, the Secretary of State for Transport in October 2007 commissioned a study to examine the potential costs and benefits of extending advanced signalling and traffic management systems more widely across the motorway network.

The NTM was used to inform the business case that formed a central part of that feasibility study[31].

The model was slightly modified so that it could predict the impact on traffic, speeds and emissions effects of four scenarios:

- <u>Reference Case</u>: This was largely equivalent to the central scenario from last year's Annual Forecast publication.[32] For strategic roads, the scenario includes the non-motorway elements of the Highways Agency's major schemes programme and the committed elements of the motorway improvements (four sections of the M25, two schemes on the M27, one on the M1 and the recently announced Phase 1 and 2 extensions of the M42 pilot to part of the Birmingham box).
- <u>Planned Motorway Widening</u>: This scenario adds to the reference case a programme of road-building comprising all the motorway elements of the current Highways Agency's major schemes programme, plus widening the M6 between Walsall and Knutsford. This amounts to 435 lane km or an additional lane in each direction along 217km of the motorway network.
- <u>Equivalent hard shoulder running (HSR)</u>: This scenario adds to the reference case the implementation of hard shoulder running in place of planned motorway widening. This scenario, therefore, includes hard shoulder running in both directions on 217km of the motorway network.

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[30] See, for example, DfT (2004b), DfT (2006) or DfT(2007b)

[31]' DfT (2008b)

[32] DfT (2007b)

- Priority HSR: This scenario adds to the reference case the implementation of hard shoulder running on parts of the motorway network identified in chapter 5 of the feasibility study. This amounts to hard-shoulder running in both directions on 397km of the motorway network.

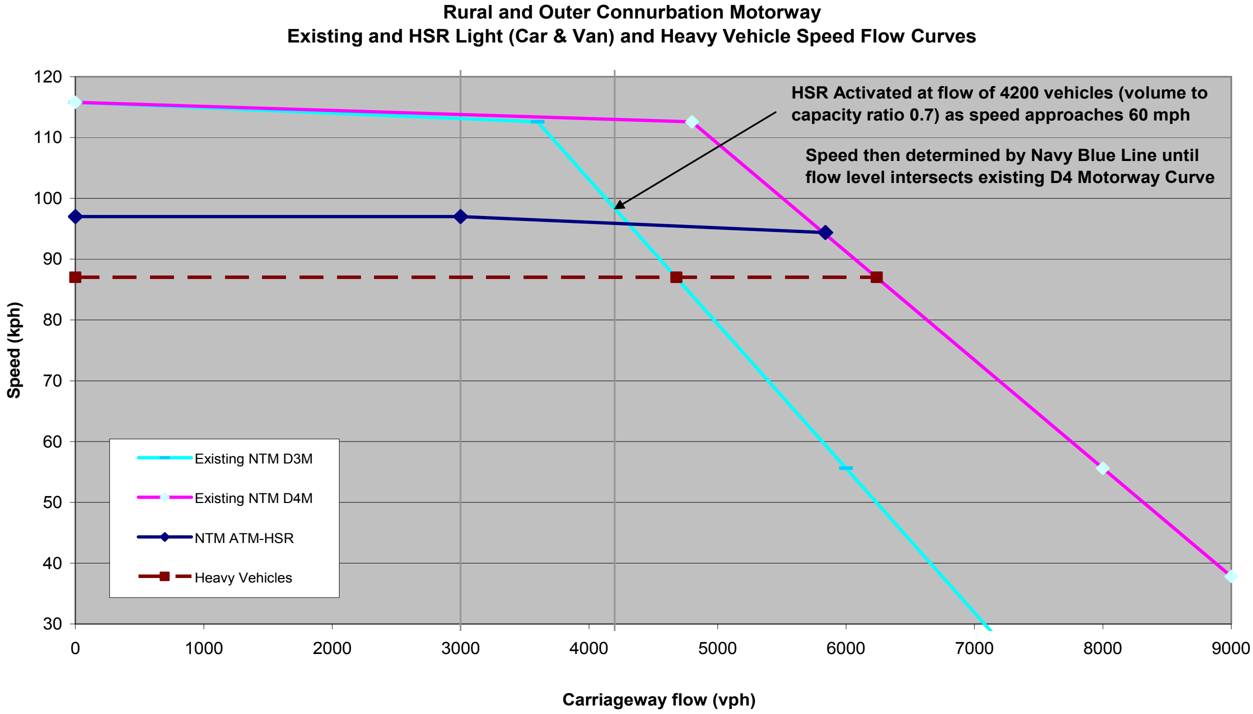
4.1: Modelling Hard Shoulder Running

Modelling road traffic with a road capacity constraint is an advanced area of transport modelling. Transport models can forecast the likely demand for road space and then confront this with the supply, primarily determined by the type and length of available roads. As demand rises, initially the traffic growth is accommodated without too much congestion, with traffic flowing at or near the speed limit. But as capacity is reached, delays become more marked. In strategic transport models, this effect is estimated using curves that map the speed of traffic with flow levels, these being different for different types of roads. Increased capacity reduces congestion for a given flow and this is modelled by changing the speed-flow relationship recognising that the fall off in speed as traffic increases will occur at a higher flow level.

Modelling hard shoulder running does not fundamentally differ from this, but there have been some particular challenges. For an individual road link with an ATM intervention, there may be several speed-flow relationships possible. This will be because the different ATM regimes could involve a different number of lanes in operation, different speed limits and - potentially - quite sophisticated lane-by-lane rules (e.g. HGVs in particular lanes). In this work, the focus has been on the regimes where the hard shoulder is opened for all traffic rather than the most sophisticated uses of ATM.

The motorway speed flow curves used to model hard shoulder running are shown in Figure 21 below. As flows on a link increase the speed declines as shown by the light blue line which is for a dual 3 lane motorway. When the flow reaches a figure of 4200 vehicles, and the speed is approximately 60 mph, the model allows use of the hard shoulder and increases the capacity of the link. In normal circumstances such an increase in capacity would result in speeds increasing to those shown by the pink line (for duel 4 lane motorway - D4M). However, with hard shoulder running, the speed is maintained at approximately 60 mph and then declines gradually as flows increase until it meets the existing dual 4 lane motorway curve at a flow of approximately 5800 vehicles per hour. This is shown by the dark blue line. For flows in excess of this figure the vehicle speeds decline as if the link were a normal 4 lane motorway.

Figure 21: Motorway Speed Flow Curves for Hard Shoulder Running



Source: NTM

The NTM can, therefore, simulate the opening and closing of lanes on particular motorway links. In doing so the model assumes that the hard shoulder is able to provide the same capacity of a normal motorway lane (2000 vehicles per hour). A different rate of traffic growth has been applied in each of the modelled regions. However, when that growth is applied to existing traffic levels and then confronted with the available motorway capacity, congestion on individual links will trigger a switch in regime. In particular, at the most congested times and directions, on the most congested links, hard shoulder running will be simulated to switch on.

Models inevitably have to simplify the likely manner in which hard shoulder running would operate. However, in these NTM modelling runs, many of the most important features of the hard shoulder running option are captured:

- It operates only on links where it is proposed to fit the ATM equipment - different for the different packages being considered
- It operates only for the required time periods on a link-by-link basis where the switching on is determined by traffic flows reaching a defined level (4200 vehicles per hour for a dual 3 lane motorway), in the particular direction of travel
- Once on, speed limits on the link are changed and the added capacity of the additional lane means that flows can be accommodated with less impact on speeds
- Even when on, congestion eventually begins to rise again as flow increases utilise the additional road space.

4.2: Impacts of Packages

Traffic

The traffic impact of the operation of hard shoulder running can be seen in the main traffic and congestion results of the different scenarios which are presented in Table 14. The results here are for England and are presented as percentage changes from the base year of 2003. The Priority HSR scenario is shown to approximately halve the reference case forecast increase in congestion on the motorway network without a significant change in traffic levels.

Table 14: Traffic Impacts of Hard Shoulder Running

Road Type	Time Period	Data Item	Reference Case	Planned Widening	Equivalent HSR	Priority HSR
Motorway	Off-Peak	Congestion s/vkm	79%	57%	71%	57%
		Traffic Bvk	28%	28%	28%	27%
		Speed	-0.2%	0.1%	-0.1%	0.1%
	Peak Hours	Congestion s/vkm	83%	56%	58%	41%
		Traffic Bvk	24%	24%	24%	25%
		Speed	-7.5%	-5.0%	-5.2%	-3.5%
	Inter-Peak and Weekends	Congestion s/vkm	110%	68%	77%	56%
		Traffic Bvk	28%	28%	28%	28%
		Speed	-3.9%	-2.2%	-2.6%	-1.7%
	All Periods	Congestion s/vkm	91%	59%	64%	46%
		Traffic Bvk	27%	27%	27%	27%
		Speed	-4.1%	-2.5%	-2.7%	-1.8%
Major	All Periods	Congestion s/vkm	24%	24%	24%	24%
		Traffic Bvk	20%	20%	20%	20%
		Speed	-4.0%	-4.0%	-4.0%	-4.0%
Minor	All Periods	Congestion s/vkm	19%	19%	19%	19%
		Traffic Bvk	18%	18%	18%	18%
		Speed	-3.3%	-3.3%	-3.3%	-3.3%
All Roads	Congestion s/vkm		22%	21%	21%	21%
All Roads	Traffic Bvk		21%	21%	21%	21%
All Roads	Speed		-2.9%	-2.7%	-2.7%	-2.6%

s/vkm = average delay (seconds per vehicle kilometre); Bvk = billion vehicle kilometres[33]. Source: NTM

[33] Details of the measurement of congestion and the Strategic Network PSA Congestion Target are on the DfT website

http://www.dft.gov.uk/pgr/statistics/datatablespublications/roadstraffic/speedscongestion/congestiononthestrategicroad5359

The results for motorways have been disaggregated by time period to illustrate the impacts of hard shoulder running mentioned above. In off peak periods, when the hard shoulder would not be expected to be in operation, the congestion impacts shown in the Equivalent HSR scenario are similar to those in the reference case. In peak periods, however, when the hard shoulder would be expected to be operational, the Equivalent HSR scenario delivers 93% of the congestion benefits that are attributed to the full widening scenario. During the Monday to Friday Inter-peak period and at weekends, the hard shoulder will be operational at fewer locations and here the Equivalent HSR scenario delivers 78% of the congestion benefits of the full widening scenario.

Overall, the Equivalent HSR scenario delivers 84% of the congestion benefits of the full widening scenario.

Table 15 shows the modelled speeds and traffic flow in the peak period in 2015 for the sections of motorway included in each package compared with the reference case. In the reference case for widening, the average speed in the peak period is predicted to be 48mph. In the widening and hard shoulder running scenarios, peak speeds are predicted to be 57mph, around 20% higher.

In the inter-peak period, the predicted speed improvements are marginally smaller with hard shoulder running than with widening. This is because hard shoulder running would operate only some of the time and cannot improve speeds in excess of 60mph as it is switched off at speeds above this. The provision of the extra permanent lane from widening would provide additional capacity all through the inter-peak period and at all speeds.

As noted above, Table 15 focuses on the sections of the motorway where widening or hard shoulder running are implemented. On these sections, traffic is predicted to increase by about 2% above the reference case level. This is primarily due to traffic diverting from other roads onto the enhanced capacity on the motorways. National traffic as a whole is predicted to increase very little, by approximately 0.1% above the reference case level. Congestion impacts are more perceptible at the national level, with a 1% fall in congestion compared with the reference case. The Priority HSR scenario delivers the greatest overall reduction in congestion, due to the larger scale of the package.

Table 15: Change in Traffic Speeds and Volumes from Packages Compared to the Reference Case[34]

Scenario	*Planned motorway widening*	*Equivalent HSR*	*Priority HSR*
Change in peak period speed	48 → 57mph **20%**	48 → 57mph **18%**	47 → 54mph **16%**
Change in Inter-peak period speed	51 → 60mph **17%**	51 → 59mph **14%**	52 → 59mph **12%**
Change in Traffic volumes on links considered	**2%**	**2%**	**2%**

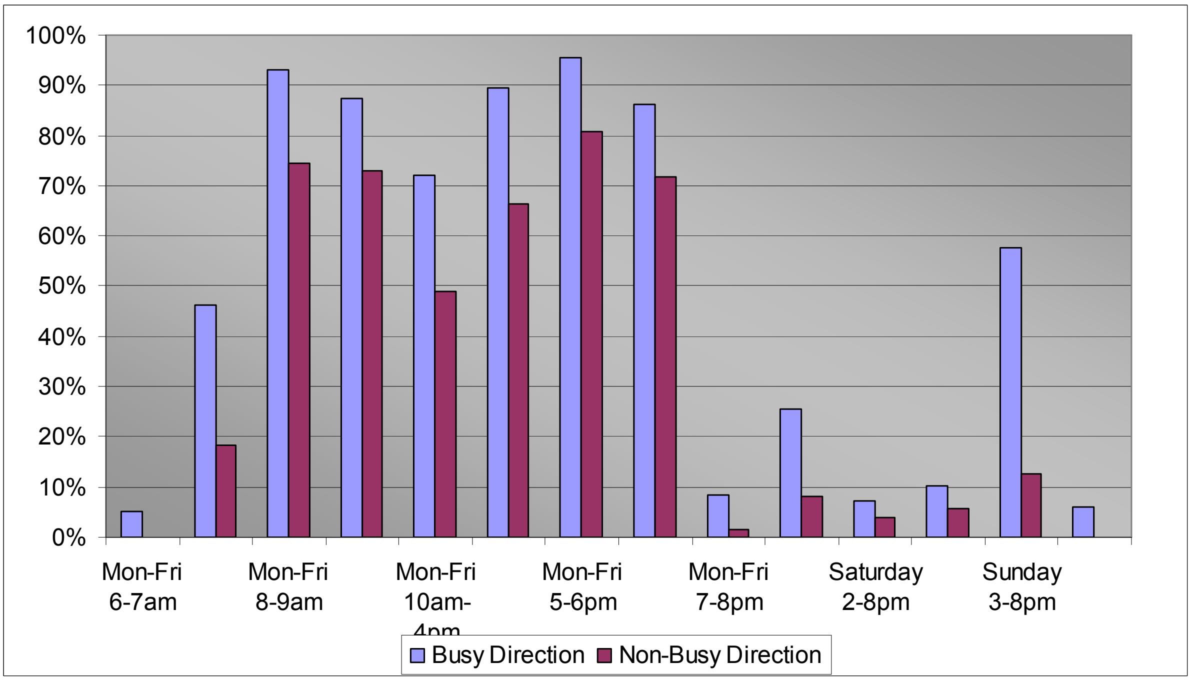
Source: NTM

Operation of the Hard Shoulder

In the NTM, hard shoulder running is 'switched on' according to the level of traffic flow. As explained above, the threshold flow is 4200 vehicles per hour at which point car and other light vehicles speeds approach 60mph. Figure 22 shows the hours when it is predicted that hard shoulder running would be in operation at the most congested times - the morning and evening weekday peaks - for almost all the links where it is being considered. Figure 22 also demonstrates the differing patterns of the hard shoulder's operation during the course of a day and in the different directions of travel. Most hard shoulders would be opened during the weekday daytimes and Sunday evenings.

[34] The Priority HSR scenario covers a different set of links to the widening and Equivalent HSR scenarios. The reference speeds are therefore different. Speeds are rounded to full mph. Percentages are based on non-rounded results.

Figure 22: Operation of Hard Shoulder Running by Time Period



Source: NTM

Emissions

The NTM was used to model the impact on emissions of changes in speeds for each of the scenarios. Additional modelling has also been undertaken to estimate the impact of 'smoother running', as described in Box 3. Smoother running is a feature of the hard shoulder running scenarios, because the imposition of controlled lower speed limits reduces variations in speeds, thereby lowering fuel use.

Box 3: Smoother Running

The effect of smoother traffic flows on vehicle emissions

At times, heavy traffic can cause congestion and a reduced traffic flow, creating a stop/start style of driving on the motorway. However, the intelligent use of speed limits and the temporary addition of capacity with hard-shoulder running can significantly reduce flow breakdown. This improved flow of traffic reduces periods of braking and subsequent acceleration by drivers and thus can reduce the amount of emissions released.

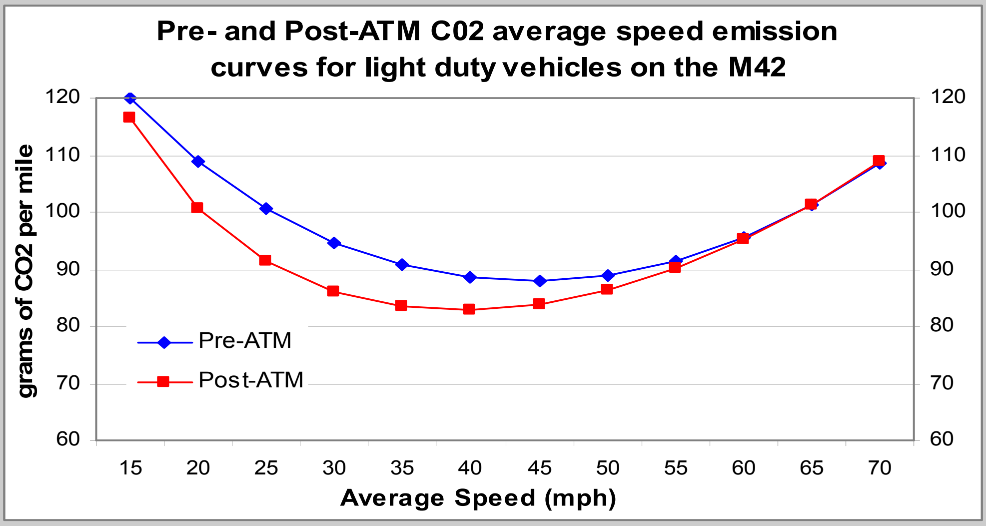
The Transport Research Laboratory (TRL) have analysed the M42 pilot to assess expected changes in driving dynamics associated with the smoother driving, which is encouraged by the use of controlled motorway regimes. TRL used instrumented vehicles (equipped to record vehicle and engine speed from the vehicle's on-board electronics and position from a GPS receiver) during controlled motorway operation on the M42 to assess the impact on emissions. From this, TRL created driving profiles with a range of average speeds for both light duty vehicles (cars and small vans) and heavy duty vehicles (rigid and articulated trucks), which could be used to calculate equivalent emissions using a state-of-the art emissions model. Applying these profiles to National Transport Model outputs allows us to estimate the expected impact of a better flow of traffic on emissions.

An example of these adjusted average speed emission profiles is presented below. Figure 23 illustrates the grams of CO_2 emitted per mile at different average speeds for light duty vehicles, with and without Active Traffic Management. One can see that, in general, regardless of whether ATM is activated, the emissions per mile fall as average speed increases to 40-50mph where the fuel efficiency of the engine is greatest and then rises as the average speed increases towards 70mph and fuel efficiency falls.

The gap between the two lines on the chart illustrates the change in emissions associated with the use of Active Traffic Management on the M42. It can be seen that for the M42 the benefit was greater at lower speeds, where ordinarily, without ATM, the traffic would have been subject to stop-start conditions.

One may expect that in a scenario where ATM was activated at 60mph there may also be benefits from ATM due to improved traffic flow at 60mph. However, we do not currently have enough robust data to make this estimation meaning that at these speeds the curves as illustrated below may be underestimating the emission benefits from ATM activation.

Figure 23: M42 CO_2 Average Speed Emission Curve



Source: NTM

The impacts described above should be viewed as a broad estimate of the benefits of smoothing traffic flows as at this stage they are based on a pilot in one location on the motorway network where hard shoulder running was activated once average speeds reduced to 50mph rather than the 60mph now proposed. We do not currently believe that the activation of the hard shoulder at 60mph compared to 50mph will significantly impact on the average speed emission analysis described above. However, as additional data on the traffic flow impacts of ATM running becomes available, these relationships should be reviewed to take advantage of richer and larger data sets from a wider range of sites.

Table 16 shows the forecast total road vehicle emissions in 2015, as a percentage difference for each scenario compared with the reference case.

Table 16: Emissions Impacts of Packages Compared to the Reference Case

Scenario	*Planned Motorway Widening*	*Equivalent HSR*	*Priority HSR*
Change in CO_2 (Mt CO_2)	0.3	0.2	0.3
% Change in CO_2	0.3%	0.2%	0.3%
% Change in NOx	0.3%	0.2%	0.3%
% Change in PM_{10}	0.7%	0.4%	0.7%

Source: NTM

In all scenarios emissions would be higher than in the reference case. However, the Equivalent HSR scenario compared to planned motorway widening has a lower impact on CO_2 and air pollution emissions than planned motorway widening. This is mostly due to the fact that speeds increase less with hard shoulder running than with widening. Over 10% of the lower impact is due to the smoother running of traffic with hard shoulder running and controlled lower speed limits. Finally, there is a slightly lower level of traffic in the Equivalent HSR scenario in comparison with widening option because widening increases capacity throughout the entire day whereas hard shoulder running does so for only part of the day.

Table 17 focuses on the CO_2 dioxide emissions, showing the impact of increased traffic and speed, and the effect of smoother running. This table shows millions of tonnes of CO_2 dioxide produced in each scenario, as a difference from the reference case. In all three scenarios, there is an increase in CO_2 dioxide due to traffic growth and increased speeds as a result of the enhanced capacity; but hard shoulder running has a smaller effect than the equivalent widening scenario.

In the two scenarios with hard-shoulder running, this increase is partly off-set by the smoother running of traffic. If controlled motorways were installed as part of the motorway widening, as is now usually the case, there would also be some smoothing effect for the widening scenario. However, we have not been able to quantify this.

Table 17: CO_2 Impact – Detailed Analysis

Scenario	*Planned Motorway Widening*	*Equivalent HSR*	*Priority HSR*
Change in CO_2 (Mt CO_2)	0.29	0.19	0.3
Of which due to:			
Increased traffic	0.07	0.06	0.11
Increased speed	0.22	0.16	0.23
Smoother running	-	-0.03	-0.05

Source: NTM

These outputs from the model were then further analysed to provide monetary valuations of impacts such as time savings or changes in emissions, with the single year estimates scaled to lifetime benefits using capitalisation factors. This is an approach that has been used in previous work and means that using scheme cost estimates, the benefit cost ratio can be calculated.

The results showed that both hard shoulder running and widening provide high value for money but that, in the medium term at least, most of the benefits of planned motorway widening could be achieved through hard shoulder running at significantly lower cost.

The full study and the annex providing detail on the NTM modelling and the welfare results can be accessed on

http://www.dft.gov.uk/pgr/roads/network/policy/mtorsigntrafmanagement/

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Annex 1

Forecasts of road traffic growth rates and speed changes, and CO_2 emissions disaggregated by region and vehicle type, are in the attached spreadsheet.

The Department's guidance on Regional Funding Advice[35] has been updated in 2008 and asks that regions estimate the effects of their proposed transport plans on CO_2 emissions.

Annex 2 Summary Results for Wales

Figure 24: Summary Results for Wales

Wales, Forecast Change compared to 2003	Year	Traffic (Vehicle km)	Congestion (Lost time/km)	Journey Time (time/km)	Road Traffic Total Emissions		
					CO_2	PM_{10}	NO_x
Central Forecast	2010	5%	3%	0%	-8%	-38%	-44%
	2015	16%	17%	1%	-4%	-50%	-57%
	2025	29%	35%	2%	-6%	-45%	-58%

Source: NTM

[35] http://www.hm-treasury.gov.uk/consult_regional_funding.htm and http://www.dft.gov.uk/pgr/regional/strategy/rfa/rfaround2/