Development of regional estimates of fuel consumption by the road transport sector – Stage 2

A report produced for DTI

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March 2005.

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Customer	Energy Group, DTI.
Customer reference	
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File reference	ED 48366
Report number	AEAT / ENV / R / 1880
Report status	Unrestricted

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EXECUTIVE SUMMARY

DTI has commissioned Netcen, an operating division of AEA Technology to provide regional estimates of fuel consumption by the road transport sector. This came about as a result of the Energy White Paper, issued in February 2003 which emphasised the importance of local and regional decision making in energy policy. It confirmed the DTI's commitment to "collect and make available data on the pattern of energy use in local areas to enable local authorities and regional bodies to target activity more effectively".

The aim of the project was to compile regional road transport fuel estimates at the NUTS1 (Regional Development Agency) level and NUTS4 (local authority) level for 2002 and 2003.

The project is in two stages. Stage 1 was an assessment of current data and methods available. This stage has now been completed. The relevant data sources and methods available to compile regional road transport fuel consumption estimates have been assessed as outlined in the Stage 1 report. The objective of stage 2 is to deliver the 2002 and 2003 regional road transport fuel consumption data. This is the second and final report of this study which completes stage 2 in which the regional road transport fuel consumption estimates are presented at the NUTS1 and NUTS4 level.

Contents

1. Introduction

DTI has commissioned Netcen to provide regional estimates of fuel consumption by the road transport sector. This came about as a result of the Energy White Paper, issued in February 2003 which emphasised the importance of local and regional decision making in energy policy. It confirmed the DTI's commitment to "collect and make available data on the pattern of energy use in local areas to enable local authorities and regional bodies to target activity more effectively".

The aim of the project was to compile regional road transport fuel consumption estimates at the NUTS1 (Regional Development Agency) level and NUTS4 (local authority) level for 2002 and 2003

The project is in two stages. This report concludes stage 2 of the project. The aim of Stage 1 of the project was to undertake research to try and improve the current NAEI road transport mapping methodology. The outcome of this research, and recommendations as to whether the new data obtained could make a useful improvement to the road transport fuel consumption mapping methodology, was discussed in the Stage 1 Report. The aim of stage 2 of the project was to undertake the mapping work itself and compile road transport fuel consumption estimates at the NUTS1 & NUTS4 level for 2002 and 2003.

The methodology used to compile the road transport fuel estimates is described in Section 2 of this report. The output from the project is road transport fuel estimates at point of consumption and not by the point of sales. In addition, no consideration of trip purpose has been taken into account. However, both these areas were researched to find out whether the information is available if it becomes of interest at a later date. This was discussed in the Stage 1 report.

The NAEI calculates fuel consumption for each vehicle type on the basis of the composition of the vehicle fleet (age profile and fuel mix) from the DVLA's national licensing data and assumes that the fleet mix in these terms is the same everywhere on the UK road network. It assumes that there are no regional variations in either the age of the fleet or the fuel mix. This approach has been used in this study. Whilst DVLA regional licensing data was obtained and showed some interesting trends (see the Stage 1 report), it was concluded that this data could not be used because the areas where cars were licensed did not necessarily reflect where they were used. As an addition to producing the regional road transport fuel consumption maps using the approach outlined above, a sensitivity analysis has been carried out into whether the regional variations in fuel mix of cars could be of significance to regional patterns of road transport fuel consumption. The results of this analysis are shown in Section 4.

2. Methodology used to generate the regional road transport fuel consumption estimates

2.1 FUEL CONSUMPTION FACTORS

For the National Atmospheric Emissions Inventory (NAEI), Netcen uses fuel consumption factors combined with traffic data on 6 major classes of vehicles to estimate national fuel consumption and CO_2 emissions from the road transport sector: passenger cars, light goods vehicles (LGVs), rigid HGVs, articulated HGVs, buses & coaches and mopeds and motorcycles. The vehicle classifications are further sub-divided according to fuel type (petrol or diesel) and the regulatory emission standard the vehicle or engine had to comply with when manufactured or first registered. The vehicle Euro emission standards apply only to the pollutants nitrogen oxides, particulate matter, carbon monoxide and hydrocarbons and not to CO_2 or fuel consumption. Nevertheless, the Euro standards are a convenient way to represent the stages of improvement in vehicle or engine design that have led to improvements in fuel economy and are related to the age and composition profile of the fleet. For example, the proportion of pre-Euro I, Euro I, Euro II and Euro III vehicles in the national car fleet can be associated with the age of the car fleet (year-of-first registration).

Fuel consumption factors are expressed in grams fuel per kilometre driven for each detailed vehicle class and are taken from two distinct data sources.

- Vehicle emission test data provided by the Transport Research Laboratory (TRL) over different drive cycles from measurements on a limited sample of vehicles;
- Car manufacturers' data on CO_2 emissions and surveys with freight haulage companies on fuel efficiency of HGVs.

a) TRL emissions data

This is the primary source of data used for emissions modelling in the NAEI. A select, but representative, sample of in-service vehicles are subjected to rigorous emission testing under controlled laboratory conditions on a chassis dynamometer (rolling road). Tests are carried out over a range of drive cycles characteristic of traffic movement on congested, urban, rural and high speed motorway cycles. Tailpipe emissions are measured, including CO_2 and other carbon-containing material. The sum of all carbon material emitted provides the carbon emission factors at each different drive cycle. These carbon factors are directly related to fuel consumption by the carbon content of the fuel used.

TRL maintain a large database of emissions from test programmes carried out at test facilities in the UK and Europe. Test data from different vehicles are pooled into different vehicle types, engine size or vehicle weight and Euro standard and have been analysed by TRL to generate empirically-based equations relating carbon emissions (and fuel consumption) in g/km to average vehicle speed.

b) Data from car manufacturers and HGV haulier surveys

Car manufacturers provide CO_2 emissions data for each model sold in the UK. Combined with registration data from DfT and the Society of Motor Manufacturers and Traders (SMMT) on the numbers of each model sold in a year, a weighted average CO_2 emission factor can be derived for new cars sold each year. However, these data only refer to CO_2 emissions and fuel consumption for the vehicle over the regulatory test cycle.

DfT, through the Continuous Survey of Road Goods Transport (CSRGT), obtain data each year on the fuel efficiency of HGVs of different weights from surveys among goods hauliers. Again these relate to fuel consumption (e.g. in litre/100km or in miles per gallon) that are averaged over all operational drive cycles.

Data from both the TRL vehicle test database and the car manufacturers and HGV haulage surveys are used to calculate fuel consumption in the NAEI by combination with national fleet composition data (e.g. age profile, proportion of diesel cars on the road) and traffic data (e.g. vehicle kilometres travelled per year). Both datasets are used for this study.

The two principal fuel consumption factor datasets described above are complementary. The TRL-based dataset is limited in coverage as the data are based on only tens to hundreds of vehicles tested (the tests being expensive to undertake on specialist facilities), but it has the advantage of showing how fuel consumption varies with vehicle operational or drive cycle (e.g. whether the vehicle is running on urban, rural or motorway roads). The data therefore complement the traffic flow data available in regions on different types of roads.

The car manufacturers, SMMT and CSRGT haulage surveys are limited in that they only provide data for very distinct or highly-averaged drive cycles, and hence do not allow distinction between consumption on different road classes, but they do have the advantage of being based on the fuel performance of vehicles among a larger vehicle sample.

Overall, the NAEI gives priority to the factors from car manufacturers, SMMT and CSRGT haulage surveys on the basis of their large and more representative sample size for cars and HGVs, but uses the information from the TRL dataset to define the relative changes in fuel consumption with average vehicle speed (i.e. to define the shape of the fuel consumption factor – speed curve). Information is available to reconcile data from these two sources, for example allocating new cars sold in a particular year to a specific Euro class and using the age profile of the rigid and articulated HGV fleet each year to determine the mix of HGVs made to different Euro emission standards.

As there are no data from fuel efficiency surveys covering LGVs, buses and coaches and motorcycles (either new models or those in the fleet), these have to be based solely on data from the TRL dataset.

2.2 MAPPING METHODOLOGY

2.2.1 Base maps

The Ordnance Survey Meridian 2 dataset of roads has been used to map all roads in Great Britain. This provides locations of all roads (motorways, A roads, B roads and Unclassified roads).

A dataset of roads in Northern Ireland was obtained from Department of Environment Northern Ireland. This provides all major roads and most minor roads (not all unclassified roads).

2.2.2 Traffic Flow on Major roads

Traffic flow data is available on a census count point basis for both GB and Northern Ireland. However, the coverage in GB is considerably better than that for NI.

The traffic flow data includes counts of each type of vehicle as an annual average daily flow. These have been aggregated up to annual flows by simply multiplying by 365. There is no seasonal variation assumed. Some Northern Ireland count points only record total vehicles, rather that a split of different vehicle types. An average vehicle split has there fore been applied to these.

Each traffic count point has been allocated to a section of road according to the road name and its proximity to the road – i.e each link has the nearest count point assigned to it.

2.2.3 Traffic Flow on Minor roads

Traffic flow data is not available for minor roads on a link by link basis. Instead regional average flows by vehicle type have been applied to each type of minor roads – B roads and C or unclassified roads. These data were obtained from DfT (ref to spreadsheet 041123Melanie_Hobson-minor_road-vehicle_type00604.xls)

For Northern Ireland vehicle specific flows have been calculated from data in the Traffic and Travel Information 2003 report (Department for Regional Development NI) which provides average flows for all vehicle types by minor roads and also average vehicle splits by the same road types.

2.2.4 Traffic flows in Greater London

Whilst it was suggested in the Stage 1 report that the NAEI road transport fuel consumption estimates would be improved for Greater London as a result of obtaining additional data from GLA, unfortunately this has not been the case. This is because the data was not received in time from GLA for inclusion in this project.

2.2.5 Fuel split by vehicle types

As discussed in the Stage 1 report, it has been assumed that there are no regional variations in either the age of the fleet or the fuel mix. The fuel splits for passenger cars and LGVs in 2002 and 2003 are provided in Table 2.2.5 below. For other vehicles, it has been assumed that 100% of motorcycles are fuelled by petrol and 100% of heavy goods vehicles and buses run on diesel.

Table 2.2.5. UK fuel split by vehicle type.

Year	Vehicle	Fuel type	FuelSplit
2002	Cars	Diesel	15.20%
2002	Cars	Petrol	84.80%
2002	LGVs	Diesel	85.29%
2002	LGVs	Petrol	14.71%
2003	Cars	Diesel	16.80%
2003	Cars	Petrol	83.20%
2003	LGVs	Diesel	88.00%
2003	LGVs	Petrol	12.00%

2.2.6 Allocation of Fuel consumption factors to the mapped road links and flows.

Each road link has been assigned an area type using the DfT definitions of area type below (DfT, 2004), for which a map of the locations of the areas was also available.

Table 2.2.6 DfT's area types.

Area Type	Description	Population
1	Central London	N/A
2	Inner London	N/A
3	Outer London	N/A
4	Inner Connurb	N/A
5	Outer Connurb	N/A
6	Urban Big	> 250,000
7	Urban Large	>100,000
8	Urban Medium	> 25,000
9	Urban Small	> 10,000
10	Rural	N/A

Different vehicle speeds have been assigned to the different road types within each area type.

Calculations of fuel use have been done at the 1km resolution level. Vehicle kilometers of travel (vkm) by each vehicle type were calculated from the traffic flow rates, fuel splits and the lengths of each road type. These vkm numbers were then multiplied up by the fuel consumption factors taking into account the speed on the road of concern. Maps of fuel use by fuel type could then be created. The 2003 map of road transport petrol consumption is shown in Figure 1. Diesel consumption is shown in Figure 2 and a combined petrol and diesel map is provided in Figure 3.

Figure 1.

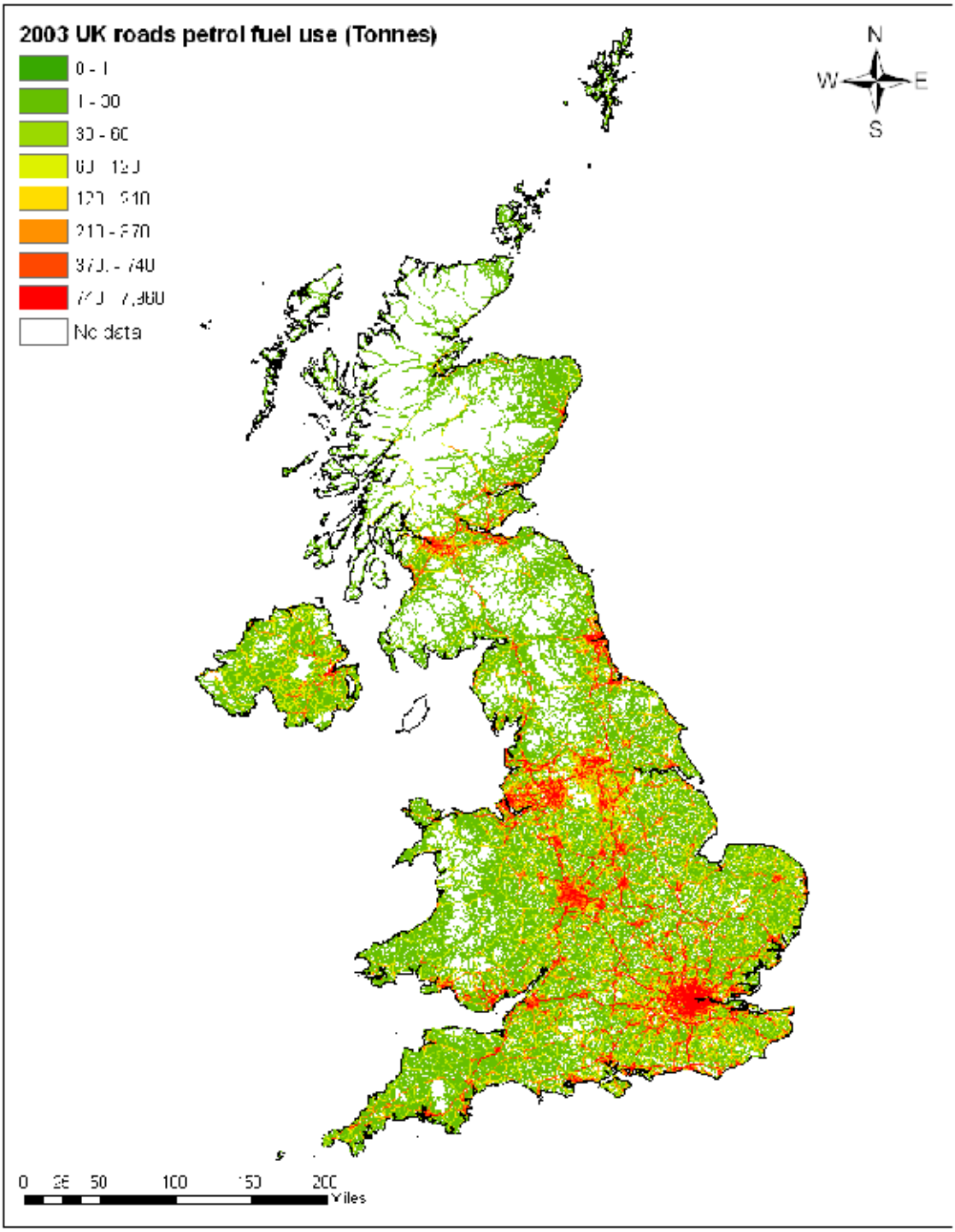

2003 UK roads petrol fuel use (Tonnes)
0 - 1
1 - 30
30 - 60
60 - 120
120 - 210
210 - 370
370 - 740
740 - 7,360
No data
N
W
E
S
0
25
50
100
150
200
Miles

Figure 2.

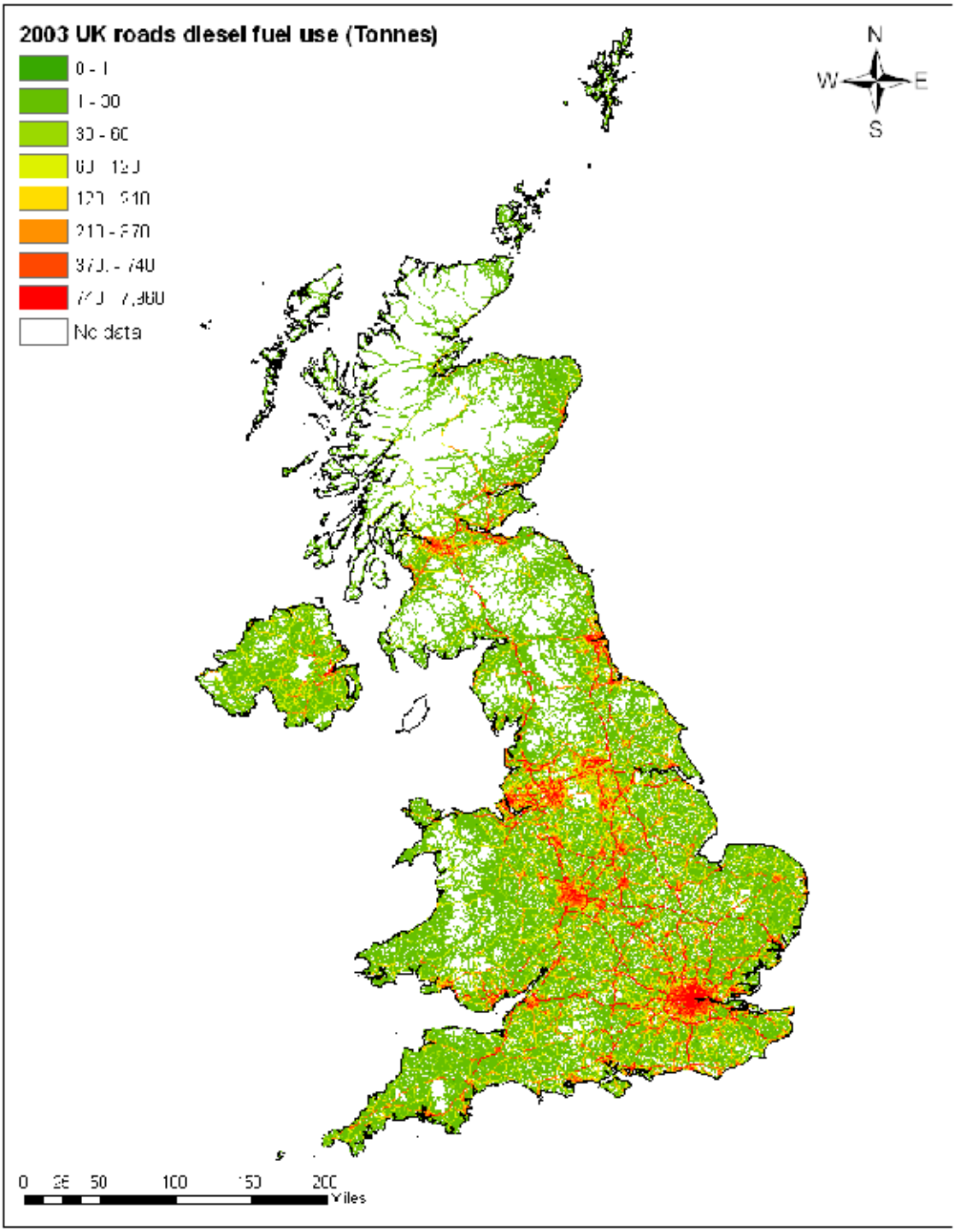
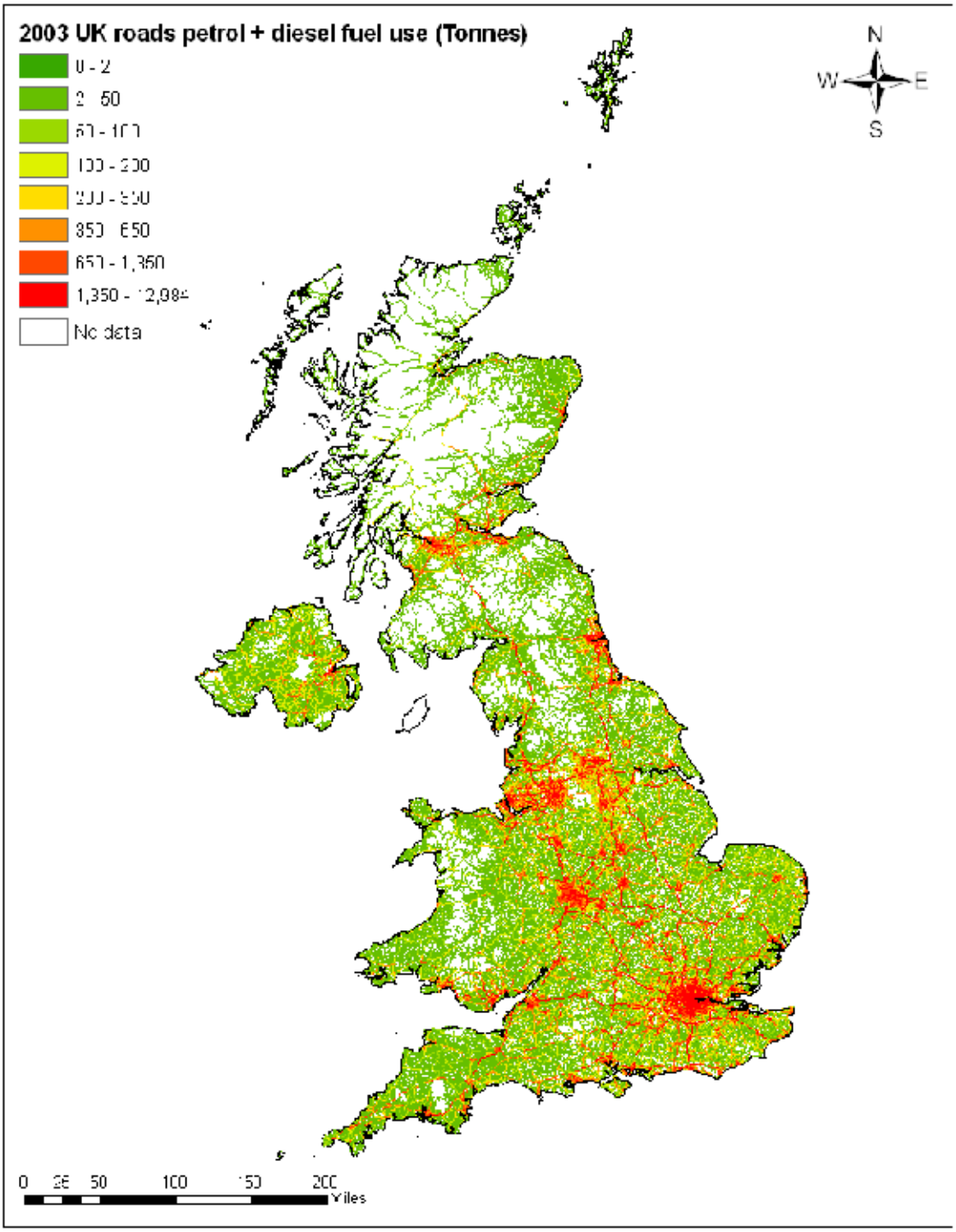

2003 UK roads diesel fuel use (Tonnes)
0 - 1
1 - 30
30 - 60
60 - 120
120 - 210
210 - 370
370 - 740
740 - 7,860
No data
N
W
E
S
0
25
50
100
150
200
Miles

Figure 3.


2003 UK roads petrol + diesel fuel use (Tonnes)
0 - 2
2 - 50
50 - 100
100 - 200
200 - 350
350 - 650
650 - 1,350
1,350 - 12,084
No data
N
W
E
S
0
25
50
100
150
200
Miles

2.2.7 Aggregation to NUTS 1 and NUTS 4 level

From the detailed 1km data, totals for each Local Authority (NUTS4) and Government Office region (NUTS1) were produced. The GOR data are shown in Section 3, Tables 3.1 & 3.2. The Local Authority data are provided in an accompanying spreadsheet due to the size of the dataset.

The results are presented by vehicle and fuel type. From this information, the data can be aggregated to fuel consumption for personal use (passenger cars, buses and motorcycles) and business use (LGVs & HGVs) if required.

2.2.8 DUKES road transport fuel consumption

When the NAEI fuel based emission maps are compiled, they are scaled so that the total UK fuel consumption calculated as outlined above matches DTI's annual UK total road transport fuel consumption estimates as presented in DUKES. This approach is necessary because of International emission reporting requirements for CO_2, but will not however be followed in this study. There will be differences between the two sources of information because of (1) vehicles consuming foreign fuel on UK roads (especially HGVs) and (2) uncertainties in the activity data and fuel consumption factors used to derive the regional estimates.

By way of comparison, in 2002, Netcen's UK petrol consumption figures are 7.7% higher than what DUKES reports and Netcen's diesel figures are 6.8% higher than what DUKES reports. In 2003, the petrol and diesel differences are 9.0% higher and 7.1% higher than DUKES respectively.

3. Regional road transport fuel estimates at the NUTS1 & NUTS4 level

Table 3.1: 2002 Road transport fuel estimates by government office region (thousand tonnes).

GOR	Petrol cars	Diesel cars	Petrol LGVs	Diesel LGVs	HGVs	Buses	M/cycles	TOTAL
East Midlands	1,617	281	61	405	885	81	10	3,340
Eastern	2,166	373	80	525	928	120	16	4,209
Greater London	1,901	322	66	411	340	235	34	3,310
North East	812	140	27	172	226	92	4	1,472
Northern Ireland	808	136	13	84	254	5	-	1,301
Northwest & Merseyside	2,361	411	78	515	936	191	13	4,505
Scotland	1,710	297	63	414	621	157	9	3,272
South East	3,452	597	113	740	1,067	163	25	6,157
South West	1,903	330	66	438	649	110	17	3,513
Wales	1,040	181	39	258	323	62	6	1,909
West Midlands	2,013	351	72	478	936	152	11	4,014
Yorkshire & Humberside	1,729	299	65	426	829	131	12	3,491
TOTAL	**21,513**	**3,717**	**742**	**4,866**	**7,993**	**1,501**	**159**	**40,492**

Please note: there is no motorcycle information available for Northern Ireland.
Note: These figures are not the same as those provided in the DTI's DUKES publication. For the differences and the reasons why please refer to Section 2.2.8.

Table 3.2: 2003 Road transport fuel estimates by government office region (thousand tonnes).

GOR	Petrol cars	Diesel cars	Petrol LGVs	Diesel LGVs	HGVs	Buses	M/cycles	TOTAL
East Midlands	1,589	311	53	430	924	79	11	3,397
Eastern	2,105	408	67	539	955	117	17	4,209
Greater London	1,804	344	57	436	346	240	36	3,263
North East	790	153	23	179	236	90	4	1,474
Northern Ireland	788	149	12	88	304	5	-	1,344
Northwest & Merseyside	2,294	449	67	545	980	183	14	4,532
Scotland	1,679	328	54	439	660	155	10	3,325
South East	3,349	650	96	777	1,099	157	26	6,156
South West	1,867	364	57	463	656	106	18	3,531
Wales	1,021	200	33	273	320	62	7	1,915
West Midlands	1,952	382	62	505	983	146	12	4,042
Yorkshire & Humberside	1,674	325	56	446	867	127	12	3,508
TOTAL	**20,912**	**4,062**	**637**	**5,119**	**8,328**	**1,469**	**168**	**40,694**

Please note: there is no motorcycle information available for Northern Ireland.
Note: These figures are not the same as those provided in the DTI's DUKES publication. For the differences and the reasons why please refer to Section 2.2.8.

For the above information in electronic format and for the local authority dataset (NUTS4) please refer to the accompanying spreadsheet.

4. Sensitivity analysis

4.1 REGIONAL VARIATION IN FLEET COMPOSITION

4.1.1 DVLA data on national car fleet

The NAEI calculates fuel consumption for each vehicle type on the basis of the composition of the vehicle fleet (age profile and fuel mix) from the DVLA's national licensing data and assumes that the fleet mix in these terms is the same everywhere on the UK road network. It assumes that there are no regional variations in either the age of the fleet or the fuel mix.

Detailed licensing data at a regional level is available from the DVLA. Although analysis of the regional licensing data in the Stage 1 report showed some interesting trends, it was concluded that it probably should not be used because the area where cars were licensed did not necessarily reflect where they were used on the road. Company cars in particular may be registered in areas some distance from where they normally reside and are used. However, as part of this study a sensitivity analysis has been conducted to see whether this issue is of importance or not when estimating regional road transport fuel consumption.

4.1.2 Sensitivity analysis

As part of this second stage, a sensitivity analysis has been conducted to ascertain whether regional variations in passenger car fuel mix is of great importance or not when trying to estimate regional road transport fuel consumption.

As discussed in the Stage 1 report the petrol/diesel split will be of more importance than the age of the passenger cars where fuel consumption is concerned. Therefore this sensitivity analysis focuses solely on the split of petrol and diesel cars rather than variations in the age of the fleet.

To give some idea of the impact of variations in passenger car fuel mix, an upper value of 30% and a low value of 4% diesel has been chosen and applied to a predominately rural Local Authority in the south-east (South Oxfordshire), an urban London Local Authority (Haringey), a northern City (Leeds) and a rural area in Wales (Denbighshire). In the 2003 NAEI, 16.8% of cars were diesel (See Table 2.2.5).

At the extreme, it is assumed that all the trips done by these cars are within the Local Authority boundary and that cars from other Local Authorities do not enter; i.e. it is a self contained unit.

The National Traffic Survey (NTS) was researched to see whether any information on the numbers of trips within regions as compared to out of the region was available. However, no such information was found. In this study the extreme scenario as outlined above has been compared to using the UK average fuel mix for passenger cars.

The results are shown in Table 4.1.2 below.

Table 4.1.2 The difference in road transport fuel consumption for Haringey, South Oxfordshire, Leeds and Denbighshire council between the base case and assuming a 30/70 and 4/96 diesel : petrol car split. Fuel consumption is in tonnes.

Scenario	LA	Diesel cars	Petrol cars	Other vehicles	TOTAL
Base case	Haringey	8,335	43,966	27,617	79,918
30/70	Haringey	14,884	36,991	27,617	79,492
% change from base case	Haringey	+79%	-16%	0.0%	-0.5%
4/96	Haringey	1,984	50,730	27,617	80,332
% change from base case	Haringey	-76%	15%	0.0%	0.5%
Base case	S Ox'shire	3,578	18,581	10,008	32,167
30/70	S Ox'shire	6,389	15,633	10,008	32,030
% change from base case	S Ox'shire	79%	-16%	0.0%	-0.4%
4/96	S Ox'shire	852	21,440	3,590	4,451
% change from base case	S Ox'shire	-76%	15%	0.0%	0.4%
Base case	Leeds	49,470	253,868	213,089	516,427
30/70	Leeds	88,340	213,591	213,089	515,019
% change from base case	Leeds	79%	-16%	0.0%	-0.3%
4/96	Leeds	11,779	292,924	213,089	517,792
% change from base case	Leeds	-76%	15%	0.0%	0.3%
Base case	Denbighshire	7,399	38,304	32,391	78,094
30/70	Denbighshire	13,213	32,227	32,391	77,831
% change from base case	Denbighshire	79%	-16%	0.0%	-0.3%
4/96	Denbighshire	1,762	44,197	32,391	78,349
% change from base case	Denbighshire	-76%	15%	0.0%	0.3%

The results show that even with a large increase in the proportion of diesel cars in the four Local Authority areas studied (from 16.8% diesel to 30% diesel), there is very little difference overall in fuel consumption in the regions. The effect is less in Leeds and Debighshire where HGVs consume a greater proportion of the total fuel than in Haringey and South Oxfordshire. Reducing the number of diesel cars has a similar effect – i.e. there is little difference in the fuel consumption occurring in each local authority.

The carbon emission factor for diesel in terms of kilo tonnes per million tonnes of fuel combusted is only 1% higher than for petrol fuel. Therefore even when the figures in the above table are converted into tonnes of carbon there is little impact of the changes in proportion of diesel cars on the roads on total road transport carbon dioxide emissions for each local authority.

As a result of this finding it is not recommended that this approach is worth pursuing.

4.2 RECOMMENDATIONS

It is anticipated that the road transport fuel consumption estimates at NUTS1 & NUTS4 level of detail could be updated annually in the summer each year. This would commence with the 2004 dataset being produced in summer 2006. Discussions need to be had between DTI, Defra and Netcen to initiate the process.

It is also worth highlighting that if there are methodological changes in the future to the mapping methodology then the previous maps would have to be updated so that a comparison could be made between different years.

4.3 REFERENCES

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Transport Statistics Great Britain, Department for Transport, October 2004.
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4.3 ACKNOWLEDGEMENTS

Netcen would like to acknowledge the help of the following people for their contribution to this report:
Eric Crane for providing contacts in DfT.
John Garnsworthy, DfT for providing detailed information on minor roads.
Mouna Kehil, Transport Statistics Roads, DfT for providing information on TrafficMaster and IT IS.

5. Appendix – Stage 1 Report.

Development of regional estimates of fuel consumption by the road transport sector – Stage 1. January 2005

Development of regional road transport estimates – Stage 1 report.
January 2005

EXECUTIVE SUMMARY

DTI has commissioned Netcen, an operating division of AEA Technology to provide regional estimates of fuel consumption by the road transport sector. This came about as a result of the Energy White Paper, issued in February 2003 which emphasised the importance of local and regional decision making in energy policy. It confirmed the DTI's commitment to "collect and make available data on the pattern of energy use in local areas to enable local authorities and regional bodies to target activity more effectively".

The aim of the project is to compile regional road transport fuel estimates at the NUTS1 (Regional Development Agency) level and NUTS4 (local authority) level for 2002 and 2003. This data needs to be presented in a form so that DTI can update the estimates on an annual basis.

The project is in two stages. Stage 1 was an assessment of current data and methods available. This stage has now been completed. The relevant data sources and methods available to compile regional road transport fuel consumption estimates have been assessed as outlined in this report. The objective of stage 2 is to deliver the 2002 and 2003 regional road transport fuel consumption data and documentation to enable compilation of similar estimates on an annual basis by DTI.

This report describes the research that has been carried out as part of Stage 1 and makes recommendations as to what methodology Netcen propose to use for Stage 2.

The research carried out as part of Stage 1 has shown that a few improvements can be made to the current NAEI mapping methodology. This is as a result of new data for London becoming available and more up to date data for minor roads being obtained from DfT.

1B. Introduction

DTI has commissioned Netcen to provide regional estimates of fuel consumption by the road transport sector. This came about as a result of the Energy White Paper, issued in February 2003 which emphasised the importance of local and regional decision making in energy policy. It confirmed the DTI's commitment to "collect and make available data on the pattern of energy use in local areas to enable local authorities and regional bodies to target activity more effectively".

The aim of the project is to compile regional road transport fuel consumption estimates at the NUTS1 (Regional Development Agency) level and NUTS4 (local authority) level for 2002 and 2003. This data needs to be presented in a form so that DTI can update the estimates on an annual basis.

Netcen run the National Atmospheric Emissions Inventory (NAEI) programme for Defra, the Scottish Executive, The National Assembly of Wales and the Department of the Environment, Northern Ireland. As part of this work, emission maps at the 1 x 1 kilometre level are produced annually. Therefore as a starting point it was intended that the NAEI mapping methodology would be used.

The project is in two stages. This report concludes stage 1 of the project.
The aim of Stage 1 of the project was to undertake research to try and improve the current NAEI road transport mapping methodology. The outcome of this research and recommendations as to whether the new data obtained can make a useful improvement to the road transport fuel consumption mapping methodology is contained in Section 3 of this report.

The aim of stage 2 of the project will be to undertake the mapping work itself and compile road transport fuel consumption estimates at the NUTS1 & NUTS4 level for 2002 and 2003 and a methodology for DTI to use in future years.

The output from the project will be road transport fuel estimates at point of consumption and not by the point of sales. In addition, no consideration of trip purpose has been taken into account. However, both these area have been researched to find out whether the information is available if it becomes of interest at a later date. This is discussed in Section 4.

2B. Mapping methodology currently used in the NAEI

Netcen currently compile UK CO_2 emission maps for Defra at the 1 x 1 kilometre level. Emissions of CO_2 for road transport are mapped using DfT's detailed traffic count data for the major road network, estimated traffic on minor roads, ordnance survey data and fuel consumption factors for different vehicle and road classes developed by Netcen from speed emission factor relationships originally provided by TRL.

The fuel consumption factors are based on emission tests (tailpipe CO_2 and other carbon containing pollutants emitted) carried out on in-service vehicles over different drive cycles (urban, rural and motorway) and manufactured to different Euro emission standards.

The data that is currently used is as follows:

- Annual average daily flows of traffic by vehicle type on road links on the GB major road network from DfT's annual traffic census.
- Northern Ireland traffic flow data for major roads
- OS digital road maps are used to apply the traffic counts across all major roads – a GIS procedure has been used to allocate each traffic count sampling point to appropriate adjacent sections of road
- DfT statistics on vehicle kilometres and regional traffic flows on minor roads
- DVLA's Vehicle Licensing Statistics for data on the national (GB) fleet mix (age, fuel type)
- Vehicle Licensing Data for registrations in Northern Ireland
- Netcen's fuel consumption factors for different vehicle classes (in grams of fuel per kilometre) on different road types and average speeds, as used in the NAEI.
- Netcen estimates of average speeds by road type

Fuel consumption on major roads at a grid resolution of 1km are generated by calculating fuel consumption per km for each road link and combining this with data on lengths of each road link within the 1km grid squares.

The fuel consumption on minor roads is mapped using Ordnance Survey data for the minor road network and generic total vehicle flow rates applied at the regional level to various different road types: built up and non-built up B, C and unclassified roads. There are currently no other local variations in minor road traffic flows or vehicle mix. This results in a total fuel consumption for each grid square. This gridded data can then be aggregated up to NUTS 4 and NUTS 1 levels.

When the NAEI fuel based emission maps are compiled, they are scaled so that the total UK fuel consumption calculated as outlined above matches DTI's annual UK total road transport fuel consumption estimates as presented in DUKES. This approach is necessary because of International emission reporting requirements for CO_2, but will not however be followed in this study. There will be differences between the two sources of information because of (1) vehicles consuming foreign fuel on UK roads (especially HGVs) and (2) uncertainties in the activity data and fuel consumption factors used to derive the regional estimates.

2.1B FUEL CONSUMPTION FACTORS

For the National Atmospheric Emissions Inventory (NAEI), Netcen uses fuel consumption factors combined with traffic data on 6 major classes of vehicles to estimate national fuel consumption and CO_2 emissions from the road transport sector: passenger cars, light goods vehicles (LGVs), rigid HGVs, articulated HGVs, buses & coaches and mopeds and motorcycles. The vehicle classifications are further sub-divided according to fuel type (petrol or diesel) and the regulatory emission standard the vehicle or engine had to comply with when manufactured or first registered. The vehicle Euro emission standards apply only to the pollutants nitrogen oxides, particulate matter, carbon monoxide and hydrocarbons and not to CO_2 or fuel consumption. Nevertheless, the Euro standards are a convenient way to represent the stages of improvement in vehicle or engine design that have led to improvements in fuel economy and are related to the age and composition profile of the fleet. For example, the proportion of pre-Euro I, Euro I, Euro II and Euro III vehicles in the national car fleet can be associated with the age of the car fleet (year-of-first registration).

Fuel consumption factors are expressed in grammes fuel per kilometre driven for each detailed vehicle class and are taken from two distinct data sources.

- Vehicle emission test data provided by the Transport Research Laboratory (TRL) over different drive cycles from measurements on a limited sample of vehicles;

- Car manufacturers' data on CO_2 emissions and surveys with freight haulage companies on fuel efficiency of HGVs.

a) TRL emissions data

This is the primary source of data used for emissions modeling in the NAEI. A select, but representative, sample of in-service vehicles are subjected to rigorous emission testing under controlled laboratory conditions on a chassis dynamometer (rolling road). Tests are carried out over a range of drive cycles characteristic of traffic movement on congested, urban, rural and high speed motorway cycles. Tailpipe emissions are measured, including CO_2 and other carbon-containing material. The sum of all carbon material emitted provides the carbon emission factors at each different drive cycle. These carbon factors are directly related to fuel consumption by the carbon content of the fuel used.

TRL maintain a large database of emissions from test programmes carried out at test facilities in the UK and Europe. Test data from different vehicles are pooled into different vehicle types, engine size or vehicle weight and Euro standard and have been analysed by TRL to generate empirically-based equations relating carbon emissions (and fuel consumption) in g/km to average vehicle speed.

b) Data from car manufacturers and HGV haulier surveys

Car manufacturers provide CO_2 emissions data for each model sold in the UK. Combined with registration data from DfT and the Society of Motor Manufacturers and Traders (SMMT) on the numbers of each model sold in a year, a weighted average CO_2 emission factor can be derived for new cars sold each year.

However, these data only refer to CO_2 emissions and fuel consumption for the vehicle over the regulatory test cycle.

DfT, through the Continuous Survey of Road Goods Transport (CSRGT), obtain data each year on the fuel efficiency of HGVs of different weights from surveys among goods hauliers. Again these relate to fuel consumption (e.g. in litre/100km or in miles per gallon) that are averaged over all operational drive cycles.

Data from both the TRL vehicle test database and the car manufacturers and HGV haulage surveys are used to calculate fuel consumption in the NAEI by combination with national fleet composition data (e.g. age profile, proportion of diesel cars on the road) and traffic data (e.g. vehicle kilometres travelled per year). It is recommended that both datasets are used for the Dti's regional fuel consumption estimates.

The two principal fuel consumption factor datasets described above are complementary. The TRL-based dataset is limited in coverage as the data are based on only tens to hundreds of vehicles tested (the tests being expensive to undertake on specialist facilities), but it has the advantage of showing how fuel consumption varies with vehicle operational or drive cycle (e.g. whether the vehicle is running on urban, rural or motorway roads). The data therefore complement the traffic flow data available in regions on different types of roads.

The car manufacturers, SMMT and CSRGT haulage surveys are limited in that they only provide data for very distinct or highly-averaged drive cycles, and hence do not allow distinction between consumption on different road classes, but they do have the advantage of being based on the fuel performance of vehicles among a larger vehicle sample.

Overall, the NAEI gives priority to the factors from car manufacturers, SMMT and CSRGT haulage surveys on the basis of their large and more representative sample size for cars and HGVs, but uses the information from the TRL dataset to define the relative changes in fuel consumption with average vehicle speed (i.e. to define the shape of the fuel consumption factor – speed curve). Information is available to reconcile data from these two sources, for example allocating new cars sold in a particular year to a specific Euro class and using the age profile of the rigid and articulated HGV fleet each year to determine the mix of HGVs made to different Euro emission standards.

As there are no data from fuel efficiency surveys covering LGVs, buses and coaches and motorcycles (either new models or those in the fleet), these have to be based solely on data from the TRL dataset.

3B Areas of research

This section discusses those subject areas which have been researched in detail for this study with the aim of improving the current methodology.

3.1B UPDATING MINOR ROAD TRAFFIC FLOW DATA

DfT was contacted to ascertain whether any new information on traffic flows on minor roads could be obtained. They supplied up to date vehicle kilometres and vehicles per day by government office region for "B" & "C" & "unclassified" roads. For each road type information was split into urban and rural roads and by vehicle type. The addition of vehicle specific flow data is a significant improvement on the existing methodology. This information will therefore be used in Stage 2 of this project to improve the estimates of fuel consumption on minor roads in the UK.

3.2B IMPROVEMENT OF TRAFFIC FLOWS IN SCOTLAND

Traffic count data for Scotland is relatively sparse because of the number of minor roads. Discussions have been had with the Scottish Executive and the Scottish Traffic Bulletins published in August 2004 have been studied to try and establish whether there are any additional traffic flow data to what DfT currently hold for Scotland. A review of the data together with input from Frank Dixon at the Scottish Executive has confirmed that the figures in the Scottish Traffic Bulletin tables are consistent with the data that DfT publish. Therefore it was concluded that no further data is available at the current time to improve the NAEI mapping methodology for traffic in Scotland.

3.3B IMPROVEMENT OF TRAFFIC FLOWS IN NORTHERN IRELAND

The traffic count data in Northern Ireland are rather sparse and therefore the mapping of traffic flow is not as comprehensive as that for GB. Therefore any increase in the number of traffic count points would improve this mapping. The Department for Regional Development in Northern Ireland have provided data for the 2002 & 2003 traffic census and discussions with the department indicate this is the most comprehensive traffic dataset currently available for Northern Ireland.

3.4B IMPROVEMENT OF TRAFFIC FLOWS IN GREATER LONDON

The GLA London Atmospheric Emissions Inventory (LAEI) uses the DfT traffic count point dataset and an additional dataset of 55 automatic traffic counts from TfL. 33 of these sites are located on major roads and therefore enable a comparison with DfT count data. Furthermore these data provide a means of expanding 12-hour flow data to 24 and also to account for day of the week and day of the year influences. (GLA, 2003). This data is used to enhance the DfT dataset in London to produce a more accurate estimate of total vehicle kilometres.

It would be possible to make use of the additional 33 major roads count point data to add to our set of DfT traffic counts. This data for 2002 is in the process of being obtained from the GLA and is expected to be received from them in mid January. When received, we are proposing to calculate an annual average daily flow from the total traffic count.

3.5B REGIONAL VARIATION IN FLEET COMPOSITION

3.5.1 DVLA data on national car fleet

The NAEI calculates fuel consumption for each vehicle type on the basis of the composition of the vehicle fleet (age profile and fuel mix) from the DVLA's national licensing data and assumes that the fleet mix in these terms is the same everywhere on the UK road network. It assumes that there are no regional variations in either the age of the fleet or the fuel mix.

In 1996, Netcen explored the potential use of detailed licensing data at a regional level available from the DVLA. The DVLA were able to provide on request licensing data for cars in each of the 115 post-code areas where the vehicles were registered, split by age (given as the number of cars licensed by year of first registration), fuel type and type of ownership. The data supplied by the DVLA covered the calendar year 1995 – this was in an era when cars fitted with catalytic converters and diesel cars were penetrating the fleet at an increasing rate each year, so any regional differences in age profile or fuel mix could have resulted in significantly different regional impacts on changes in pollutant emissions and local air quality each year as these are strongly affected by these parameters.

Although analysis of the regional licensing data in this initial screening showed some interesting trends, it was concluded that they could not be used in the NAEI because the area where cars were licensed did not necessarily reflect where they were used on the road. Company cars in particular may be registered in areas some distance from where they normally reside and are used.

Nevertheless, this section illustrates the main findings of the screening. Although the data are now old, it is illustrative of the extent of regional variations in licensing data that may still exist. Netcen has not since 1996 acquired further regional licensing data from DVLA nor has enquired about their availability.

Netcen's initial screening of the 1995 DVLA regional licensing database focused on two main statistics;

- The variation in the age profile of the car fleet according to variations in the proportions of cars first registered in different years (see Section 3.6);
- The proportion of diesel cars licensed in each region.

The fuel efficiency of new cars has not changed significantly over the years in spite of improvements brought about to reduce tailpipe emissions. Fuel efficiency is more dependent on whether the car runs on petrol or diesel fuel. Therefore, regional differences in age profile are considered less important to this study than variations in the petrol *vs* diesel car split.

3.5.2 LAEI data on vehicle fleet in London

In the London Atmospheric Emissions Inventory (LAEI) an assessment was made of vehicle excise duty (VED) data in London based on 20 camera locations in a range of locations. This data is only available for 2002 at the current time. The VED counts were co-ordinated by DfT to take an on road sample of number plates. The 20 count points are spread out across London with 4 being places on motorways, 8 on "A" roads and 8 on "minor" roads. The sample is dominated by major roads and therefore it is recommended that care is taken when interpreting the results as the results will be skewed towards these road types.

3.5.3 Regional differences in vehicle fuel mix

(a) DVLA data

Table 2 shows the 25 post code areas with the highest proportion of diesel cars licensed in 1995 and the 25 post code areas with the lowest proportion of diesel cars licensed in that year.

There were no clear trends in the regions with the highest proportions of diesel cars licensed, but it is almost exclusively towns in southern England that dominated the areas with the smallest fraction of diesel cars.

Table 1: Ranking of Post Code Area According to the Percentage of Diesel Cars Licensed in 1995

Top-Ranking Post Codes With Diesel Cars			Bottom-Ranking Post Codes With Diesel Cars		
	% diesel	Ranking		% diesel	Ranking
LONDON WC	30.3%	1	CHELMSFORD	7.1%	91
LONDON EC	16.1%	2	COLCHESTER	7.0%	92
GALASHIELS	16.1%	3	STEVENAGE	6.9%	93
SWINDON	15.2%	4	TWICKENHAM	6.7%	94
CARLISLE	14.9%	5	BLACKPOOL	6.6%	95
DUMFRIES	14.6%	6	GUILDFORD	6.4%	96
SHREWSBURY	13.8%	7	PORTSMOUTH	6.3%	97
INVERNESS	13.8%	8	LONDON W	6.1%	98
WATFORD	13.6%	9	BOURNEMOUTH	5.9%	99
PERTH	13.2%	10	BRIGHTON	5.8%	100
HEREFORD	13.1%	11	ENFIELD	5.8%	101
DARLINGTON	12.5%	12	SOUTHEND-ON-SEA	5.8%	102
LANCASTER	12.5%	13	ROMFORD	5.7%	103
COVENTRY	12.5%	14	SOUTHALL	5.6%	104
MANCHESTER	12.4%	15	DARTFORD	5.3%	105
FALKIRK	12.0%	16	HARROW	5.3%	106
BIRMINGHAM	12.0%	17	SUTTON	5.0%	107
YORK	11.8%	18	ST ALBANS	4.9%	108
DURHAM	11.7%	19	KINGSTON-UPON-THAMES	4.9%	109
MOTHERWELL	11.6%	20	ILFORD	4.3%	110
PETERBOROUGH	11.6%	21	LONDON E	4.3%	111
LINCOLN	11.5%	22	LONDON SE	4.1%	112
SWANSEA	11.1%	23	LONDON NW	4.1%	113
WORCESTER	10.9%	24	BROMLEY	3.8%	114
ABERDEEN	10.9%	25	LONDON N	3.6%	115

(b) LAEI data for London

The proportion of vehicles running on diesel, petrol and alternative fuelled vehicles in London according to the VED counts is shown in Table 2 below together with a comparison of the NAEI dataset which is assumed to apply all areas across the UK.

Table 2. The percentage of vehicles running on different fuel types both in London and in the 2002 NAEI for the UK.

Vehicle type	LAEI Diesel	LAEI Petrol	LAEI Alternative fuel	NAEI Diesel
LGV – car derived van	88.2	11.5	0.2	N/a
LGV - LGV	85.6	14.2	0.1	
LGV – all	86.3	13.6	0.2	85.3
Buses & coaches – minibus	75.3	24.7		100
Buses & coaches – single / double decker	99.4	0.6[1]		
Buses & coaches - all	90.2	9.8		100
HGV – artic	100	0		
HGV – rigid 2 axle	99.4	0.6[1]		
HGV – rigid 3 axle	99.1	0.9[1]		
HGV – all	99.4	0.6[1]		100
Cars	13.8	86	0.2	15.2
Taxis	99.2	0.5[1]	0.3	
Other	91.9	7.7	0.3	

[1] Note: The small percentage of petrol vehicles is likely to be a sampling / database error.
Source: LAEI (2001) and NAEI (2002).
Note: a blank cell indicated that either the data is not available or that it is zero.

In the car category, the proportion of diesel vehicles obtained from the VED study is slightly lower than that used in the UK NAEI to generate national emission estimates. The LAEI use the term LGV – car derived van. In the NAEI, car derived vans are not separated out from the rest of the car / LGV fleet and therefore no comparison can be made for this vehicle type. However, overall the proportion of diesel LGVs is similar between the NAEI data and the VED data.

For HGVs, the NAEI model assumes that 100% of these are diesel. This is in line with the LAEI (see note under table). For buses and coaches, the NAEI assumes that 100% of them run on diesel regardless of size. The NAEI model does not have a separate category for minibuses. These are included under the general category buses. Therefore in the NAEI it is assumed that 100% are diesel powered.

3.5.4 Regional differences in age profile of cars

(a) DVLA data on national car fleet

The proportions of cars 0, 1, 2, 3, 4 ….. etc years old registered in each of the 115 post code areas in 1995 were calculated. The information was used to estimate the percentage of petrol cars fitted with catalytic converters. In general, only cars first licensed after 1992 would be fitted with a catalyst. Table 1 shows the 25 top ranking areas and 25 bottom ranking areas in the list of post code areas with petrol cars fitted with catalytic converters licensed in 1995. This reflects the areas with the ‘newest’ and ‘oldest’ car fleets in that year.

Central London is a clear outlier, but there are a number of large conurbations included in the top 25 list of areas with the newest car fleet licensed. However, there is also a clear trend showing many provincial towns in southern England with the oldest car fleet.

Table 3: Ranking of Post Code Area According to the Percentage of Petrol Cars Fitted with Catalytic Converters Licensed in 1995

Top-Ranking Post Codes With Catalyst			Bottom-Ranking Post Codes With Catalyst		
	% cat	Ranking		% cat	Ranking
LONDON EC	60.1%	1	DARTFORD	17.3%	91
LONDON WC	46.7%	2	SOUTHEND-ON-SEA	17.0%	92
WATFORD	38.4%	3	IPSWICH	16.9%	93
MANCHESTER	36.9%	4	ROMFORD	16.8%	94
LONDON SW	35.8%	5	PORTSMOUTH	16.8%	95
SWINDON	34.2%	6	SOUTHAMPTON	16.8%	96
SLOUGH	33.9%	7	MEDWAY	16.6%	97
SOUTHALL	33.6%	8	BRISTOL	16.4%	98
BIRMINGHAM	31.5%	9	SUTTON	16.4%	99
GLASGOW	30.5%	10	CANTERBURY	16.2%	100
SUNDERLAND	30.3%	11	LLANDUDNO	16.0%	101
FALKIRK	29.3%	12	GLOUCESTER	15.9%	102
EDINBURGH	29.1%	13	COLCHESTER	14.9%	103
CROYDON	28.8%	14	LONDON N	14.7%	104
LEEDS	28.1%	15	LONDON SE	14.7%	105
MOTHERWELL	27.4%	16	BOURNEMOUTH	14.6%	106
COVENTRY	27.2%	17	BATH	14.5%	107
HALIFAX	27.1%	18	HEREFORD	14.1%	108
WORCESTER	26.9%	19	LONDON E	14.1%	109
HUDDERSFIELD	26.6%	20	PLYMOUTH	14.0%	110
BLETCHLEY	26.5%	21	DORCHESTER	13.9%	111
ABERDEEN	26.0%	22	EXETER	13.6%	112
PAISLEY	25.8%	23	TORQUAY	13.5%	113
KILMARNOCK	25.6%	24	TAUNTON	13.0%	114
NEWCASTLE-UPON-TYNE	25.3%	25	TRURO	12.3%	115

(b) LAEI data on car fleet in London

From the VED count data (see Section 3.5.2 above) an estimation of the age profile of the fleet in London can be obtained.

At present the NAEI assumes the same age profile of vehicles for all road types and for all areas of the UK. This is due to no comprehensive data being available as an alternative. The VED count data for London suggests that there is some evidence of vehicle age stock varying by road type (GLA, 2003). The likely reason for this is that newer vehicles tend to travel further using motorways and major A roads and that older vehicles are more limited in their journeys and tend therefore to travel on minor roads and local A roads. For diesel cars, in all cases the motorways had the least number of pre Euro cars (5%) and the greatest number of Euro 3 cars (35%). The minor roads which are not built up had the lowest proportions of Euro 3 cars (25%) and the highest proportion of pre Euro (7%) and Euro 1 cars (32%). The VED data showed though that the trend

between road types was not always clear. For example, Euro 2 vehicles made up a similar proportion of the fleet regardless of road type.

Table 4. Percentage of diesel cars in each Euro class by road type from VED data (Source: LAEI 2001)

Road type	Pre Euro	Euro 1	Euro 2	Euro 3
Motorway	5	24	36	35
A road built up	7	26	38	29
A road not built up	6	32	35	28
Minor road built up	6	31	34	30
Minor road not built up	7	32	36	25

Although this points to evidence that the age of the vehicle fleet does differ by road type, this may also be a result of the location in London, as the dataset is only based on a limited number of count points. In time however, the survey will become more useful as a larger and more representative dataset becomes available and more conclusive information will be able to be drawn.

3.5.5 Recommendations

The trends in the above tables should only be regarded as illustrative of the *potential* regional variations in specific features that characterise the composition of the car fleet. Whilst there may be something to be gained in using regional vehicle licensing data for cars to provide regional specificity to the fleet for Dti's regional fuel consumption estimates, this is less likely to be the case for goods vehicles (HGVs) and other vehicle types operated in fleets, such as buses, which are bound to be in use in many areas besides those where they are registered. The exception may be in Northern Ireland where vehicles licensed in this region are more likely to be in use just there due to separation from the GB mainland. We do not intend to use this data in deriving regional fuel consumption estimates.

Of more significance than regional differences in fuel mix in the car fleet may be differences by road type. For example, there is likely to be a higher proportion of cars running on diesel on motorways than in urban areas, but this level of detail is not currently available in the road link traffic flow data provided by DfT. This data would be available from the London VED study but at the moment this is based on limited data and is not available for the regions. Bringing further regional detail into the make-up of the vehicle fleet may be best achieved through roadside monitoring of vehicle registrations in different regions, for example through use of number plate recognition technology to identify fuel type of the vehicle, as has been carried out in London.

3.6B TRAFFICMASTER

DfT was contacted to find out whether the information collected from Trafficmaster (TM) would be of use in improving the regional road transport fuel consumption estimates.

TM cameras cover most of the Highways Agency (HA) all-purpose trunk road network and a few Local Authority A-roads. The raw data is aggregated into 4-

minute camera-to camera average speeds. TRL have done some work in the past to assess whether TM data could be used to estimate traffic flows. Problems arise on dual carriageways since TM cameras only cover one lane and therefore they undercount on dual carriageways.

Since TM covers HA and A roads, there is little point in using that data for traffic estimation anyway since DfT already provide this data to Netcen for use in their road transport emission estimates.

There is the possibility that the TM data could be used to provide more accurate speed data for the major roads. However this needs to be researched. A large drawback to using this data maybe the cost of obtaining the data.

3.7B IMPROVEMENT OF TRAFFIC SPEED DATA

IT IS data is DfT's main source of traffic speed information on urban roads and non-HA roads. The raw IT IS data consists of individual vehicle GPS reporting positions and information on the speed. Most vehicles typically report every minute but some reporting intervals can be as long as 20 minutes. Vehicles are classified as HGVs, LGVs, cars or buses. However, the classification of the vehicles is done by the fleet owners and may not correspond to the standard DfT classification. The raw data is processed into journey times as follows:

1) the individual GPS positions are map-matched onto a digital road network;
2) each vehicle trajectory is reconstructed;
3) the speed between 2 map-matched positions is calculated using the GPS timestamp and the digital road distance;
4) the individual vehicle speeds are assigned to the road network.

The processed data thus consists of average journey times for 15-minute time periods and links.

The data is used for monitoring average traffic speeds and congestion on HA's and urban networks. However there are a few limiting factors:

- There is no control over the IT IS sample and where vehicles go. Most major roads are covered but even on these, the sample sizes can be very small, so one would expect the coverage to be sparser on minor roads.
- Each individual average speed may itself be based on very few individual vehicle observations.
- The spatial coverage may not be representative of traffic patterns.
- The vehicle mix is not representative of the traffic mix at specific time periods.
- The speeds are not representative of the average traffic speeds e.g. a higher proportion of HGVs will bias the average speeds downwards.

Unfortunately it is likely that the data would be too sparse and not representative enough to assess traffic flows.

It is not suggested that IT IS data is utilised to map regional road transport fuel consumption

4B. Further studies

This section briefly outlines additional information which could be of interest for later studies. They are:

(1) trip purpose for both cars and HGVs.
(2) Point of fuel sales

To see whether the information is available for producing estimates of fuel consumption by the road transport sector by trip purpose the following sources have been researched, (1) The National Traffic Survey, (2) Tempro & (3) CSRGT.

4.1B THE NATIONAL TRAFFIC SURVEY (NTS)

The 2004 Regional transport statistics Report was published in November 2004 and is published annually. This report has been reviewed to see if it contained any information that could enable fuel consumption to be allocated by trip purpose. This report contains NTS derived data on trip purpose for passenger cars by region of residence. For information the table of interest has been extracted and is shown below.

1.3 Trips by purpose by region of residence - GO Region and Country: 2002/2003[1,2]

Trips per person per year

Region	Work	Business	Eco Education	Shopping	Personal Business	Social	Visiting Friends	Sports & entertainment	Holidays & day trips	Other including just walk	All purposes
North East	139	23	60	205	99	132	184	66	31	51	990
North West	147	32	65	210	113	150	174	65	34	36	1,027
Yorkshire & the Humber	153	20	61	191	104	140	167	60	34	37	973
East Midlands	159	36	60	206	108	147	188	72	41	43	1,059
West Midlands	149	37	62	202	106	130	173	64	29	39	990
East	162	34	65	193	109	155	190	72	33	34	1,095
London	143	31	70	172	94	119	139	50	29	29	930
South East	152	37	65	206	112	163	156	70	42	43	1,048
South West	159	41	58	204	115	144	184	65	40	55	1,060
England	159	34	64	198	107	144	185	65	36	40	1,032
Wales	141	29	62	185	98	134	168	57	34	40	948
Scotland	159	28	77	192	104	125	158	70	30	46	991
Great Britain	159	33	65	197	106	142	181	65	35	40	998

1 Combined survey years 2002 and 2003.
2 See Table A1 in Annex for note regarding sample sizes.

Source: National Travel Survey
020 7944 3047

For the data to be of use, information on the average trip length and average occupancy for each type of trip purpose by region would need to be obtained. It is not known whether this information is available. However further investigations could be made if DTI would like to pursue this.

4.2B TEMPRO

Overview

TEMPRO is purely a presentation tool aimed at making modelled data available in a convenient format to those who need it. It was designed to provide projections of traffic growth over time for use in local and regional transport models. The software, which derives the modelled data is operated by ITEA division of the Department for Transport, and is known as the National Trip End Model (NTEM). The model was initially constructed to provided estimates of car trips at local authority district level. More recently it has been developed to provide suitable growth factors for multi-modal models. The growth factors are then used in the forecasting of future years transport mode split and trip rates.

For the base year, the NTEM model estimates trip productions for each trip purpose, zone and traveller type. These estimates are then segmented into time periods and modes, based on a set of factors derived from the NTS data. In addition, NTEM relates trip attractions to employment and other land-use indicators in each zone. The model gives all journeys made by people living in households in Britain, including trips where part of the journey is made by air.

Groups of 1991 Census wards define the NTEM zones. The zones are a level below the district level (local authorities are made up of groups of NTEM zones). In general, authorities are split into named urban zones and rural district remainders. There are approximately 1200 zones covering Great Britain.

There are 8 trip destination purposes incorporated in the model and these include:

- Shopping
- Work
- visit friends and relatives at home
- recreation & leisure
- personal business
- education
- holiday & day trips
- business trips

The model defines six modes of travel and these include:

- Walk (includes NTS “short walk” trips)
- Bicycle
- Car drivers (includes motorbike and van driver)
- Car passengers (including taxi)
- Bus (including coaches)
- Rail (including underground and light rail systems)

The six time periods available to the user are:

- Weekday AM peak period (0700–0959)
- Weekday Inter-peak period (1000-1559)
- Weekday PM peak period (1600-1859)
- Weekday Off peak (1900-0659)
- Saturday
- Sunday

The traveller type desegregation used internally within the model includes:

- age (under 16, 16-64, 65+)
- gender
- employment status (for 16-64 age group)
- household car availability
- household size (number of adults)

Limitations of using the NTEM model for the development of regional estimates of fuel consumption by the road transport sector.

TEMPRO may be useful as it gives trip productions for 6 different modes of transport, 8 trip purposes, 6 time periods and different traveller types in each of the 1200 defined zones. Unfortunately, it fails to differentiate between trips undertaken on major or minor roads or between different vehicle speeds. In addition, trips carried out by motor vehicles are not segregated into vehicle type, size or age and trips by HGV's are not accurately represented.

4.3B CSRGT

The Continuing Survey of Road Goods Transport (CSRGT) samples vehicles on Operators' Licences registered with the Department for Transport. The data is concerned with heavy goods vehicles (over 3.5 tonnes gross vehicle weight in 1997) using public roads and includes information on journeys made, weight of vehicle, types of goods moved and fuel used, together with some related documentation. It covers heavy goods vehicles registered in the United Kingdom (including Northern Ireland from 1998) only; survey data relating to international road haulage and small goods freight are compiled separately.

The majority of data in the annual CSRGT report is given for the United Kingdom as a whole and is therefore, not particularly useful with regard to regional patterns of goods transportation. However, the report does give data relating to total goods transported between government office regions, which could potentially be of use (see table). The suggested approach would be to assume that fuel consumption is proportional to weight of freight moved. However there are a number of weaknesses with this approach. Firstly this approach would ignore the fact that there maybe some large HGVs that would have high fuel consumption carrying only light goods. Secondly there is the uncertainty over the

sizes of the HGVs and whether for example a tonne of goods is carried in one large HGV or several smaller HGVs.

Table 26 Goods moved by origin and destination Government Office Regions[1] of goods: 2003

Million tonne kilometres

	Destination											
Origin	North East	North West	Yorkshire & the Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	All regions[2]
North East	2,103	897	1,150	414	344	714	105	316	169	193	803	6,853
North West	980	7,083	1,80.	1,545	1,627	1,451	383	1,170	948	1,104	2,667	20,754
Yorkshire & the Humber	994	2,795	6,678	2,017	1,448	1,406	423	1,177	718	595	1,785	19,000
East Midlands	580	1,820	1,643	4,605	1,207	1,861	879	1,690	785	521	645	16,251
West Midlands	460	1,545	884	1,070	5,089	1,414	548	1,558	1,008	749	763	15,243
East of England	304	1,593	1,284	1,757	1,601	6,852	1,349	2,277	1,052	528	355	18,964
London	45	382	251	393	465	786	1,155	801	193	168	232	4,919
South East	332	1,106	837	1,329	1,345	1,722	1,214	5,559	1,161	509	365	15,552
South West	136	713	628	503	980	613	444	1,189	5,877	853	251	12,487
Wales	115	516	530	477	863	755	250	639	966	2,783	121	7,888
Scotland	503	1,850	832	441	593	292	186	361	241	122	8,002	13,420
All regions[2]	6,578	20,426	16,340	14,543	15,562	15,868	7,077	17,443	13,125	8,125	15,225	151,771

1 See Appendix D for a map of the Government Office Regions

2 Includes negligible figures for goods moved with Northern Ireland as origin or destination.

Source: The continuous survey of road goods transport (CSRGT), 2003.

4.4B POINT OF FUEL SALES

Information on the point of fuel sales is available from the catalist database. This database lists for each re-fueling station in the UK, the annual throughput of petrol and diesel. It is not recommended however that this data is used as it is thought to be unsuitable for statistical purposes. In addition it is suggested that providing information on a fuel consumption basis by NUTS1 & NUTS4 regions is more useful as this is where the activity is occurring and therefore can be targeted more effectively by Local Authorities and RDA's than having information on point of fuel sales.

4.5B SUMMARY

The review of further literature has shown that the current NAEI mapping methodology for road transport is robust and with the current traffic data available there is little room for improvement.

It is therefore intended that the 2002 NAEI methodology is used to develop regional estimates of road fuel consumption, subject to the following improvements:

- Updating minor road traffic flow data;
- Improvement of traffic flows in Greater London;

There maybe some scope for allocating fuel consumption by passenger transport according to purpose of trip. However there is less scope for allocating fuel consumption by freight transport.

4.6B SUGGESTIONS FOR FURTHER WORK TO IMPROVE FUTURE ESTIMATES.

In order to improve the regional road transport fuel consumption estimates, it is suggested that the following tasks are considered:

- Collecting more traffic count data particularly for Scotland and Northern Ireland where the traffic count points are sparse.
- Roadside monitoring of vehicle registrations in different regions would be advantageous so that the age and fuel type of vehicles could be obtained.

4.7B REFERENCES

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4.8B ACKNOWLEDGEMENTS

Netcen would like to acknowledge the help of the following people for their contribution to this report:
Eric Crane for providing contacts in DfT.
John Garnsworthy, DfT for providing detailed information on minor roads.
Mouna Kehil, Transport Statistics Roads, DfT for providing information on TrafficMaster and IT IS.