



# Bikes not fumes



**The emission and health benefits  
of a modal shift from motor vehicles to cycling**

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A report for the Cyclists' Touring Club by Andy Rowell and Malcolm Fergusson of Earth Resources Research.

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## Southampton City Council

Southampton City Council has long recognised the need to provide and sustain a CLEAN, HEALTHY and SAFE environment.

The City Council in partnership with Hampshire County Council has just embarked upon a major review of transportation strategies for Southampton.

The overall goal of this review is to seek the integration of land-use planning and transportation policies within a single Strategy which will balance restraints on use of the car with the need to sustain the local economy, develop the quality of the environment and improve accessibility for people in the city.

Southampton City Council have supported the commissioning of the CTC report because of its direct relevance to the above study.

## Cyclists' Touring Club

The CTC, established in 1878, is a company limited by guarantee, whose objects are the promotion of bicycles and cycling as a means of transport and travel, and the protection of cyclists' interests. It is Britain's largest national cycling organisation, with some 40,000 individual members, over 200 local groups and a further 200 affiliated clubs.

Information and advice on planning and traffic matters as they affect cyclists are available from the CTC's specialist Rights and Planning Department at Godalming.

**The Cyclists' Touring Club** and Greenscreen share a long-term policy to eradicate the need for anti-pollution masks by tackling the causes of pollution. **Bikes not Fumes** provides illustration and analysis of the reasons for, and actions towards, a sustainable and healthy transport policy.

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# **i** Executive Summary

- This report evaluates the potential environmental and health benefits of a significant modal shift from motor vehicles to bicycles in the United Kingdom.
- Car traffic is one of the major sources of atmospheric and noise pollution, causing adverse effects to the built environment, plants, and human health. In addition, atmospheric emissions from motor vehicles are contributing increasingly to global climate change.
- Car use is especially damaging in the urban environment where air quality is at its worst, since journeys are typically short and in congested conditions.
- Current and planned measures to reduce vehicle emissions will have a limited effect, particularly if car use continues to increase in line with the official forecasts.
- There is enormous potential for an increase in cycling, substituting for the shortest and most environmentally damaging car journeys. Currently 75 per cent of all journeys in Britain are under five miles in length, as are 61 per cent of car journeys.
- Overseas experience suggests that promoting cycle use is possible, as positive policies have already led to dramatically increased levels of cycle use.
- Further evidence for the potential of cycling can also be found within the UK, and suggests that 40 to 50 per cent of all non walking journeys could be undertaken by bicycle without greatly increasing the average length of bike trips.
- This increase could displace up to one sixth of all car mileage, and up to half of all car trips, without a significant increase in average trip length for cyclists.
- An increase in cycling need not be associated with higher cycle accident rates, if suitable measures are taken to control traffic and protect cyclists.
- Suitable policies would in any case need to be implemented to encourage a significant increase in cycling, particularly to improve the safety of cycling through improved traffic calming measures, lower speed limits, and better separation of cyclists from motor vehicles.
- A major increase in cycle use could save up to three quarters of a million tonnes of carbon monoxide, one hundred thousand tonnes of nitrogen oxides, and sixteen million tonnes of carbon dioxide from being emitted into the atmosphere each year.
- As well as the substantial health improvements which could result from better air quality, a major increase in cycle use offers significant direct benefits to public health through more regular exercise.
- The study concludes with detailed policy recommendations to encourage an increase in cycle use in the United Kingdom.

# 1

## Transport and Environment: An overview of the problem

### 1.1

#### Introduction

The Department of Transport (1991b, p45) has stated that 'the Government does not promote any particular mode of transport'. However, in the last 50 years cycling has changed from a mainstream mode of transport to one largely sidelined by policy makers. After years of neglect, cycling now only accounts for four per cent of journeys. On the other hand, there are still more journeys undertaken by bike than on British Rail and London Underground combined (Cyclists' Touring Club, 1991a, p17; Morgan, 1991, B1).

Despite this decline, there is a great potential for a cycling revival coupled with a concomitant reduction in car travel. There is, in addition, an ever increasing urgency for this modal shift in the light of growing environmental problems such as acid rain, photochemical smog and global warming, coupled with increasing evidence that atmospheric pollution from motorised transport is a serious risk to health.

Cycling, as a means of transport, is environmentally friendly, consumes very few finite resources, produces virtually no atmospheric or noise pollution, and does not cause congestion. Road transport, on the other hand, is the fastest growing energy end-use sector and is the predominant source of air and noise pollution in the UK. Increasingly associated with road travel is chronic congestion which costs billions of pounds each year, exacerbating the environmental and social problems caused by motor vehicles.

Motor vehicles are the single largest source of air pollution. This is a matter of serious concern to cyclists, pedestrians and motorists, as air quality is likely to be at its worst in or near built up roads. The World Health Organisation (1990, p16) has recently concluded that

Millions of Europeans live in areas with air pollution severe enough to cause each year thousands of premature deaths and many more chronically ill and disabled.

In the USA, where research on air quality and health has been carried out, 146 million Americans (60.5 per cent of the population) live in areas that do not meet air quality standards, and up to 30,000 premature deaths are estimated to be caused by air pollution from motor vehicles (American Lung Association, 1989, p2; Renner, 1989, p35).

In spite of this growing concern, no comprehensive analysis of the risk to the British population from air pollution has been undertaken. However, a reduction in car travel would not only reduce emissions, but also significantly enhance air quality, and probably result in an improvement in general health. Especially at risk at present are the 50 per cent of the population who are particularly susceptible to adverse air quality: ie children, the elderly, asthmatics, pregnant women and unborn children, and sufferers from cardiovascular or respiratory diseases (Holman, 1991).

The majority of us have become dependent to a large extent on motorised means of private transport, justifying ownership and usage by the need for journeys impossible or impracticable by non motorised modes. However, 75 per cent of all journeys are under five miles in length, half are under two miles, and 32 per cent under a mile (Banister, 1991, p21; reworking Department of Transport, 1988).

Even of those journeys undertaken by car, 61 per cent are under five miles in length (Department of Transport, 1988, p58), and it is therefore possible for most of these journeys to be made by bicycle, whether the journey is for work, recreation, shopping or educational purposes. A government study in Britain has shown that over forty per cent of work journeys could be made by bike in many cities (Waldman, 1977, Table 3.2), and a shift to cycling on this scale has already been achieved on the continent in cities such as Delft and Groningen, and in some British cities.

These aspects of cycle use are discussed in greater detail in Section 3 below.

## 1.2

### Effects of traffic growth on pollution

**Table 1**

Atmospheric Emissions from Road Transport in the UK in 1989

Pollutant	Total Emissions (thousand tonnes)	Percentage of UK Total Emissions
Carbon monoxide	5,793	88
Nitrogen oxides	1,298	48
Volatile organic compounds	762	37
Carbon dioxide	106,810	19

Source: Department of Transport, 1991a, pp154-155

In 1989, road transport was the dominant single source of carbon monoxide, nitrogen oxides, and volatile organic compounds in the UK. The total quantities of atmospheric emissions which resulted are set out in Table 1 below.

New road traffic forecasts were published in 1989, and predicted that between 1988 and 2025 traffic would increase by between 83 per cent and 142 per cent (Department of Transport, 1989, p26). Previous forecasts had consistently underestimated traffic levels, and car usage in 1988 and 1989 exceeded the forecasts. In contrast no predictions of future levels of cycling were made, reinforcing how marginal cycling has become to the Department of Transport.

Fergusson, Holman and Barrett (1989) modelled the future emission levels of the regulated pollutants from the road transport sector, due to this predicted increase in traffic. The major findings were that by 2020:

- Nitrogen oxides (NOx) levels could be higher than they are today, despite the introduction of catalytic converters;
- Hydrocarbon levels are predicted to decline to 56 to 74 per cent of current levels;
- Carbon monoxide (CO) levels are projected to be 50 per cent to 63 per cent of the current levels;
- Carbon dioxide (CO<sub>2</sub>) emissions could more than double due to the increase in traffic, which is the fastest growing source of carbon dioxide in the United Kingdom.

In international negotiations at the European Community the UK Government has committed itself provisionally to stabilising 1990 carbon dioxide levels by the year 2005. However research at Earth Resources Research has shown that, due to the increase in traffic, even stabilisation at 1990 levels for the transport sector would be impossible without either a drastic improvement in fuel efficiency or a reduction in vehicle mileage.

## 1.3

### Technical approaches to emissions control

#### 1.3.1 Catalytic converters

European Community regulations will require catalytic converters to be fitted on all new cars sold in the Community from 1993. While some reduction in emissions of certain pollutants will result, this measure will not by any means solve the problems of traffic pollution.

Urban driving conditions are characterised by short journeys, often with a cold engine, in stop-start conditions where catalysts are at their least effective. Under these conditions it is the number of trips that are made, and not necessarily their length that will be the major determinant of air quality. Research from the US shows that for a five mile urban trip with a catalyst equipped car, 80 per cent of the hydrocarbon emissions are generated by cold starting and evaporation (California Air Resources Board, 1989a, p4). When starting from cold, emissions of nitrogen oxides and hydrocarbons can be five times higher than under a warm start; whereas emissions of carbon monoxide can be ten times higher (National Society for Clean Air, 1990, p11).

Congestion also adds to emissions. For example, a 19 minute delay on a ten mile journey can increase running emissions by 250 per cent (California Air Resources Board, 1989a, pp4-5).

In the longer term, there remains considerable uncertainty as to whether catalytic converters will perform properly over the entire lifetime of a vehicle. Future monitoring arrangements for catalyst cars will be vitally important, as a malfunctioning catalytic converter can be worse than useless at controlling emissions.



### 1.3.2 Exhaust emissions and the MoT test

From November 1991, emissions of hydrocarbons and carbon monoxide from most car exhausts will be tested as part of the annual MoT testing arrangements, and cars will fail the test if they cannot meet the required limits (Department of Transport, 1991d). This is a significant step, which may be useful in removing some of the worst polluters from the roads. However, the test as it stands will have only limited overall effect, for the following reasons:

- The emissions limits imposed are not stringent, and are intended only to weed out those cars which are badly out of tune or malfunctioning;
- No limit on nitrogen oxides emissions has been imposed, and if a car is retuned to meet the new hydrocarbon or carbon monoxide requirements, its nitrogen oxides emissions may well increase;
- The test is carried out with the vehicle stationary and the engine idling, and early indications suggest that this may not be an effective way of picking out the vehicles which are most polluting when driven.

Previous estimates of total pollution emissions (including those of the authors) have never truly taken account of the excessive pollution from the worst vehicles, so the calculations contained in this study will not be affected by the new testing arrangements.

## 1.4 The results of traffic pollution

Every year, in Britain, air quality standards are exceeded in urban areas, and despite the predicted reductions in national emission levels of the regulated pollutants it is extremely unlikely that there will be a corresponding improvement in urban air quality. Research from Warren Spring, a government research laboratory (Munday et al, 1990), has shown that in the year 2000, ground level concentrations of nitrogen dioxide will be only five per cent lower than 1983/84 levels.

In 1989 it was estimated that 29 per cent of the air quality sites recording nitrogen dioxide levels in London exceeded European Community limits. In addition, carbon monoxide levels in London exceeded the World Health Organisation eight hour air quality guidelines for 27 days (London Planning Advisory Committee, 1990). In Bristol, during a four month period over the winter of 1990-91, the same guidelines for carbon monoxide were exceeded 77 times (Bristol City Council, 1991, p22). Similarly, in the first nine months of 1991, nitrogen dioxide levels were classified as poor (under Department of the Environment guidelines) on 24, 14, and eight days respectively at the three London monitoring stations, with the longest episode lasting for 17 hours (Warren Spring Laboratory, 1991).

In rural areas, ozone levels are also regularly exceeded, especially during episodes of hot, sunny weather. Data from Warren Spring Laboratory (Broughton, 1991, p6) shows that in 1989/90 ozone levels exceeded 60 parts per billion (ppb) (the eight hour World Health Organisation limit) at two or more measuring sites for 53 days; and 12 measuring sites experienced levels exceeding the one hour World Health Organisation limit of 100ppb. In Devon and Sussex, where the highest levels were recorded, susceptible groups would have been at risk from elevated air pollution, potentially suffering impaired lung function, for one day in every seven (Greenpeace, 1991).

Cyclists suffer the adverse affects of pollution because of heavier breathing whilst exercising close to the source of exhaust pollution. However, it seems that motorists suffer from even higher pollution levels than cyclists. Research from the Netherlands has shown that nitrogen oxides and benzene levels are higher inside cars than outside, especially in commuter traffic (Prof H C van Hall Instituut, 1988, p31). Other studies in the Netherlands and in Germany have reported higher levels of carbon monoxide inside cars than outside (World Health Organisation, 1987, p211; quoting Den Tonkelaar and Rudolf, 1982). Results from the Transport and Road Research Laboratory in the United Kingdom also show that levels of carbon monoxide are higher for people inside cars than for those riding bicycles (Hickman, 1990, p5). In addition, other surveys have found blood carbon monoxide levels in

commuting motorists at 0.9 per cent, compared to 0.5 per cent for cyclists (Sharp, 1990, p4; quoting Williams, 1989).

Similarly, research undertaken for the US Environmental Protection Agency (Weisel et al, 1991) compared concentrations of volatile organic compounds inside cars to those in the outside air on different journey types. They found that benzene (for which the World Health Organisation (1987, p54) recommends no safe level on account of its carcinogenicity to humans) levels were higher inside cars than outside. Emission levels inside cars were dependent on traffic density and driving speed, and therefore urban commuters, who tend to experience slower average speeds, were exposed to higher levels of benzene.

Weisel et al also comment on other surveys that found benzene levels two to three times higher inside cars compared to ambient concentrations (California Air Resources Board, 1989b). Motorists were also exposed to formaldehyde levels (a probable human carcinogen) nearly double those of the outside air (California Air Resources Board, 1989b), and hydrocarbon levels up to eight times higher than background levels (Chan, 1990; Chan et al, 1989).

Finally, whilst refuelling at petrol stations, motorists could also be exposed to benzene concentrations over ten times normal levels found in residential areas (World Health Organisation, 1987, pp46, 52).

Owing to the likelihood of continuing poor air quality, objectives laid out in the Government's health strategy 'Health of the Nation' on emission levels, air quality, and asthma reduction are unlikely to be met. For example, evidence is growing that air pollution is a significant contributor to the ever increasing problem of asthma (Reed, 1991, p3). There are already two and a half million asthmatics in the UK, but the number of sufferers is increasing at a rate of five per cent each year (National Asthma Campaign, 1991). Asthma caused 5.5 million days of certified sickness absence in 1987/88, costing £350 million in lost productivity, £60 million in sickness benefit and £40 million to the National Health Service (The Health of the Nation, 1991, p99).

## 2

## Environmental impacts of road transport

### 2.1

### Introduction

Transport is one of the most polluting of all human activities. Of the pollutants discussed below, all except carbon dioxide can have direct effects on human health and the environment, and in the majority of cases, motorised road traffic is the single largest source of the pollution.

However, environmental damage from motor transport is not restricted to the effects of vehicle exhaust alone. For example, road traffic is the dominant source of noise nuisance in Britain. Over 6 million people are exposed to unacceptable noise from motor vehicles (TEST, 1991, pp142-144). Similarly, the growing demand for road space has increasingly controversial effects on the landscape, dividing communities and threatening rare wildlife habitats.

Cycling, in contrast, generates almost no noise pollution. Furthermore, surveys have shown that a cyclist can travel 1,600 miles on the equivalent energy of one gallon of petrol (Sharp, 1990, p1), and as a result, emissions of the other pollutants discussed below are also negligible. Bikes also make far less demands on road space.



## 2.2

### Atmospheric emissions from road traffic

In the sections which follow, the impacts of the main atmospheric pollutants arising from motor vehicle use are described in greater detail.

#### 2.2.1 Hydrocarbons

Hydrocarbon compounds (also known as volatile organic compounds) arise from unburnt or partly burnt fuel, emitted from vehicle fuel systems and exhausts. Some hydrocarbons can cause unpleasant effects such as drowsiness, eye irritation and coughing, while others such as benzene are known to be carcinogenic. These compounds are also important because they react with nitrogen oxides to form ozone in the air near ground level.

#### 2.2.2 Carbon monoxide

Cars are the main source of carbon monoxide pollution in the UK, especially in urban centres. Described by the Department of the Environment (1991, p13) as "one of the most directly toxic substances", carbon monoxide affects human health by impairing the oxygen carrying capacity of the blood. This can lead to impaired vision, coordination and judgement, to slower reflexes and to drowsiness. It can also increase the incidence of headaches, and affects the central nervous and cardiovascular systems.

#### 2.2.3 Nitrogen oxides

Nitrogen oxides (NO<sub>x</sub>) is an umbrella term for nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>). These two gases are formed in engines as a result of high combustion temperatures and pressures, when atmospheric oxygen in the engine combines with nitrogen either from the air or in the fuel itself.

Nitrogen dioxide has been shown to have adverse effects both on plants and on human health. It reduces productivity in sensitive crops, while in humans it can irritate the respiratory tract, reduce lung function, and increase susceptibility to viral infections. Nitrogen oxides are thought to contribute up to half of the acidification of rainfall. They are also important precursors of ground level ozone.

#### 2.2.4 Tropospheric ozone

Ozone is one of the principal components of urban smogs. These are also known as photochemical smogs, since they are formed when bright sunlight causes a series of chemical reactions involving mixtures of hydrocarbons and nitrogen oxides. Increased levels of ozone can now be detected in or downwind of every major conurbation around the world in certain weather conditions.

Ozone is an extremely powerful oxidizing agent, and at ground level it can damage human health, trees and other plants, and a wide range of natural and synthetic materials.

Photochemical smog causes irritation to the eyes, nose and throat, headaches, coughing, and impaired lung function. Post mortems of apparently healthy and non-smoking young accident victims in California have shown signs of premature ageing of the lungs, due to ozone. The chance of experiencing adverse health effects increases if heavy exercise is undertaken during periods of elevated ozone concentrations. Ozone is also an extremely powerful greenhouse gas and a major contributor to global warming.

#### 2.2.5 Diesel particulates

Particulates consist primarily of carbon, resulting from incomplete combustion of diesel fuel. Particulates in the air can aggravate respiratory diseases such as bronchitis and asthma. They are also carriers for cancer-causing chemicals, particularly polynuclear aromatic hydrocarbons (PAHs). The International Agency for Research on Cancer (1989) has recently concluded that there is sufficient evidence to classify diesel exhaust as a probable carcinogen.

One of the most obvious effects of air pollution in urban areas is the soiling of buildings. Diesel particulates are black and oily have a greater soiling effect than other types of particulates.

### 2.2.6 Acidic compounds

Both sulphur and nitrogen oxides, the latter predominantly from motor vehicles, are precursors to acid rain or mists, the phenomenon which has received wide publicity owing to the damage it causes to forests, lakes, and buildings. Acid mists are composed of sulphuric acid, ammonium bisulphate and nitric acid, and can be formed by photochemical oxidation or reaction with water vapour (Reed, 1991, p22).

Evidence is now growing that aerial acid episodes are also detrimental to human health (Dockery et al, 1990, p1). Even low levels of acid in the air are associated with worsening asthma and bronchitis in children (Reed, 1991, p3). Despite this evidence, there is currently no monitoring of acid aerosols in the UK, and owing to the lack of data there are no guidelines to limit exposure (Reed, 1991, pp22-23).

### 2.2.7 Carbon dioxide

Carbon dioxide is currently believed to have contributed 55 per cent of the global warming which occurred between 1980 and 1990. Concentrations in the atmosphere are known to be rising by about 0.5 per cent per annum.

It has been calculated that the average European car emits four times its own weight of carbon dioxide each year (Holman, Fergusson and Mitchell, 1991, p11). The amount of carbon dioxide emitted is directly proportional to the quantity of carbon in the fuel burnt, since there is no add-on technology available which can remove the carbon dioxide from exhaust gases. As a result, the only way to cut down emissions is to reduce the amount of fuel used in the vehicle or to switch to a fuel with less carbon.

### 2.2.8 Lead

Lead compounds are added to petrol to improve running and reduce damage to the engine. This is the main source of airborne lead in the urban environment, which impairs children's intelligence even at low levels of exposure.

Ambient levels of lead in London are now 20 per cent of the levels found in the 1970s. This reduction has been achieved primarily through a progressive reduction in the proportion of lead permitted in leaded fuel, but in future the increase in use of unleaded petrol will bring about further reductions.

## 2.3 Other effects of motor transport

As noted above, road traffic gives rise to a wide range of environmental impacts other than atmospheric emissions. These are not considered in any detail in this report; but in this section, two effects which are of particular relevance to cyclists as road users are briefly considered.

### 2.3.1 Traffic congestion

Traffic congestion is now a common feature in our major cities and on many roads. A recent publication from the Department of Transport (1991c, p4) states that

Congestion has long been recognised as an environmental blight. ... It particularly affects towns, where there is least scope for relieving it by road-building. As well as delaying drivers, it causes noise and fumes.

Congestion is widely estimated to cause huge financial losses, is inefficient, and hinders essential services. It also adds to air pollution, and possibly also to the health risk to drivers, as noted above.

Congestion is of importance to cyclists and cycling policy for two main reasons. First, because congestion leads to worse air quality, a poorer environment and increased danger for cyclists. As a result, congestion itself may act as a deterrent to greater use of cycles in inner cities.

Conversely, however, policies which promoted cycling, for example through better lane separation, would in themselves help to relieve congestion because cyclists take up so much less road space than motorists, both when travelling and when parking.

### 2.3.2 Deaths and injuries

In the UK, road travel alone causes approximately five thousand deaths and three hundred thousand injuries per annum. Apart from those directly affected by these casualties, many others may suffer loss of amenity through being discouraged from travelling, particularly as pedestrians or cyclists. This will especially be true for the vulnerable members of society such as children, disabled and elderly people.

It is of course well known that cyclists suffer a higher rate of deaths and injuries on a distance travelled basis than most other categories of road user (Department of Transport, 1991b, p46). There are however a number of factors which tend to exaggerate the apparent danger of an increase in cycling.

First, it has been pointed out that because of the vagaries of accident reporting rates and estimates of distance travelled, especially for cyclists, there is great uncertainty as to the accident risk of cycling (Morgan, 1991, B2).

Second, it has been argued that the high accident rate for cyclists is paradoxical, in that cycling is not a particularly dangerous activity for adults, but it is primarily the behaviour of motorists which makes it so hazardous. This is illustrated by the fact that 95 per cent of cycle casualties result from urban traffic accidents, 85 per cent of cycle accidents involve a car, and 74 per cent of cycle accidents occur at or near road junctions (Cyclists' Touring Club, 1991b; Morgan, 1991, B7).

In addition, it appears that the speed of passing motor vehicles is the critical factor, not the number (Cleary, 1991, p3), and so there is a great potential for cyclist accident reduction if cars are restrained and travelling speed reduced. Studies by the Transport and Road Research Laboratory have shown that urban safety management and traffic calming can reduce cycle accidents by one third (Morgan, 1991, B12 quoting Mackie, Ward and Walker, 1990). The recent £1 million Government campaign "Kill your speed. Not a child" urging motorists to reduce urban speeds to 20mph in order to cut the number of child casualties must be welcomed as a positive step. However, since exhortation alone has often had little effect on driver behaviour, it could be argued that more would be achieved by compelling motorists to drive more slowly through extensive traffic calming, tighter speed restrictions, and better enforcement measures.

Furthermore, Swedish experience illustrates what can be achieved by the latter methods. In this case, cycle schemes and traffic restraint have brought about a cycle accident rate one-tenth of Britain's, on the basis of distance travelled (Potter and Hughes 1990, p11; quoting Tight and Carston, 1989). Finally other evidence from the continent suggests that increasing cycle use does not necessarily mean higher accident rates. In Basle, Switzerland, there has been a doubling in cycling over the last fifteen years, and on average, cycle accidents have decreased (Tschopp, 1991).

The accident statistics include a significant proportion of child cyclist casualties (Department of Transport, 1991b, p46). In spite of a relative improvement in recent years, children aged 10 to 14 years who cycle are still four times as likely to be killed or seriously injured as adult cyclists. However, many of these casualties might more reasonably be attributed to play than to travel, and would not rise in proportion to an increase in cycling for work purposes. Furthermore, the inclusion of children inherently distorts the statistics, as children are not allowed to drive motor vehicles.

A growing proportion of motor travel takes place on motorways, which have lower accident rates than other roads on a per kilometre basis, and therefore reduce the average casualty figures for motor traffic. The UK motorway network is constructed and maintained with the help of massive public expenditure, with improved safety for motorists as a primary objective. An important element in securing this aim is the exclusion of other categories of road users, including cyclists, from motorways.

A mile of urban motorway typically costs tens of millions of pounds to build (as illustrated by the Black Country Spine Road at £56 million per mile (Transport Retort, 1990, p11) and the Limehouse Link at over £200 million per mile (Hansard, 1990, p40)); while a mile of dedicated cycle path costs up to £100,000, and designation of a cycle lane on an existing route much less. It is therefore highly likely that comparable or even greater gains in safety to those resulting from motorway



construction could be achieved by building extensive facilities for cyclists, and at considerably less expense.

**Table 2**

Accident Rates for Road Transport Modes, 1990

Mode	Rate per billion person kilometres		Rate per billion person trips	
	KSI	All	KSI	All
Walking	704	2,429	739	2,552
Cycling	967	5,515	2,933	16,728
Car/Taxi	52	340	396	2,594
Others	298	1,303	2,275	9,929
Ratio cycle:car	18.6	16.2	7.4	6.4

Notes: KSI indicates killed or seriously injured. Relative risk calculated from Department of Transport data (1988 and 1991a)

As a final point, accident rates for cyclists and pedestrians are far lower on a per trip basis than when calculated against distance travelled. As Table 2 illustrates, the ratio of accident risks for cycle against car is nearly 20 when estimated against distance travelled; but only six or seven on a per trip basis.

It can be argued that the latter is at least as good a measure of the effective accident rate as the former, in that most trips are presumably undertaken for some purpose; and the importance of a trip is not necessarily proportional to its length.

## 3

## The potential for a modal shift to cycling

### 3.1

### The effect of company cars

Company assistance to travel is a major cause of distortion in the transport market, influencing modal choice, travel pattern and behaviour. This form of assistance is of particular significance in its effect on travel, because it is supported by what amounts to a huge public subsidy through undertaxation and related effects (TEST, 1984; Fergusson, 1990; Fergusson and Rowell, 1991).

Of all the types of company 'perk', the most prolific is the company car (Inland Revenue, 1990, p43), although free parking and fuel for employees are also common. In 1990, 52 per cent of new cars registered were by companies, and the number of company cars at the time of the 1991 Budget was 3.46 million (Department of Transport, 1991a, p108; Fergusson and Rowell, 1991, p1).

Company cars distort not only the market for new cars, but also travel behaviour. A recent Transport and Road Research Laboratory report (Kompfner et al, 1991, p7) showed that 80 per cent of cars entering London during the rush hour were company assisted, and 50 per cent were company cars.

Earlier research by Earth Resources Research (Fergusson, 1990) highlighted the fact that company car drivers travel an extra 1,700 extra private miles per year on average, and are a significant source of additional pollution. Similarly, a more recent report suggests that company car drivers waste three billion business miles and 10 million days each year on unnecessary trips because of the illogical nature of the current taxation system (Fleet News, 1991, p1; quoting Pykett, 1991).

Clearly, this amounts to a significant incentive to travel by car, especially for commuting purposes; so the removal of this and related incentives could significantly encourage increased use of cycles. Aside from the possibility that many company car owners might opt to cycle if they were not encouraged to travel by car, there would be additional benefits. These would include reduced congestion; less pollution; and the removal from the roads of a group of motorists known to be the worst offenders in terms of excessive speed (Home Office, 1989, ¶25) and apparently also rather accident-prone (General Accident, 1990).

## 3.2

### Overseas experience of high levels of cycle use

On the Continent, where some city authorities and even national governments have actively promoted cycling, the potential for more use of bikes is already being realised.

In Delft and Groningen, for example, cycles are used for 43 and 50 per cent of trips respectively (Bracher, 1989), and in Copenhagen 25 per cent of all journeys are by bike, representing a 50 per cent increase in just five years (Copenhagen City Engineers Department, 1989, p2). Nor are these isolated examples. Throughout the whole of the Netherlands, bicycles are used for 29 per cent of all journeys; and for 18 and 11 per cent of trips in Denmark and the former West Germany respectively (Bracher, 1989, pxii).

Mathew (1991; quoting Herz, 1985) cites German studies which have estimated that cycling could achieve the following percentages of total trips:

■ School journeys	50 per cent
■ Shopping	25 per cent
■ Trips to work	15 per cent

Other studies have concluded that 25 per cent to 35 per cent of all car journeys could be transferred to bikes (Mathew, 1991; quoting Otto, 1985). Similarly, studies from New York show that 49 per cent of commuters would bike to work from a distance of 10 miles or less, if bike lanes, parking and showering facilities were provided (Komanoff, 1991).

Other evidence, again from Germany, has showed that only 27 per cent of motorists questioned in a survey had no choice but to use their car, due to journey length or number of people, load etc. This means that 73 per cent of the motorists questioned could theoretically have cycled instead.

The city of Graz in Austria (population 242,000) has implemented a policy specifically to achieve a modal shift from cars to bikes use. Integrated measures have been introduced, including the development of a cycle path network and cycle parking facilities, coupled with traffic calming measures, and car parking management (Bracher et al, 1991). The following targets appear set to be achieved:

■ Cycle journeys increase from 9 to 28 per cent
■ Car journeys decrease from 44 to 30 per cent
■ Pedestrian journeys decrease from 28 to 25 per cent
■ Public transport journeys decrease from 19 to 16 per cent

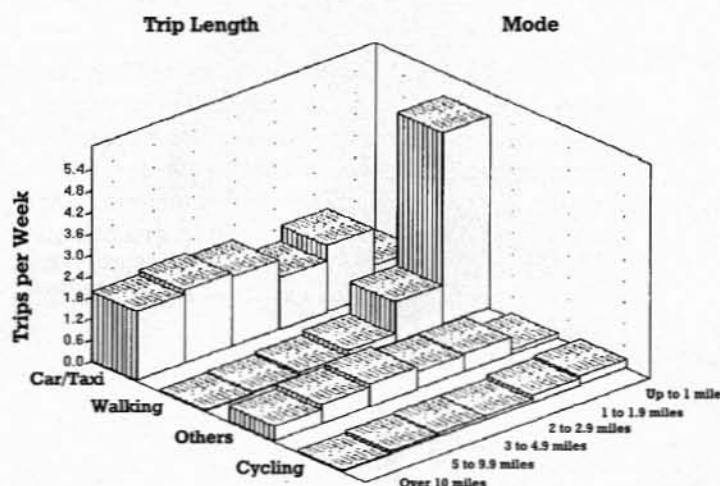
These examples, primarily from Europe, indicate what can be achieved where concerted policies are brought to bear to encourage cycle use. As the next section argues, moreover, there are many reasons to suppose that similar increase in cycle use could be achieved in Britain, if appropriate policies were pursued.

## 3.3

### The potential for cycle use in Britain

During the eighties, cycle sales in Britain increased by 80 per cent, and for most years cycle sales outstripped car sales. In 1989, for example, 2.4 million bikes were sold, compared to 2.3 million cars, which was itself the highest car sales figure ever recorded in the United Kingdom (Cyclists' Touring Club, 1991a, p17; Society of Motor Manufacturers and Traders, 1991).

In the UK, 90 per cent of men and 67 per cent of women can cycle; whereas only 56 per cent of adults over 17 years hold a driving licence, and only 41 per cent of women (Sharp, 1990, p1). There are now 15 million cycle owners in Britain, of whom six million are cycle users. However, only 3.6 million use their bicycles 'regularly', and of these only 1.1 million cycle to work in an average week (Cyclists Touring Club, 1991b; Morgan, 1991, B1). So there is a huge potential to increase bike usage, owing to the high numbers of people who can cycle and who own a bike but who currently do not cycle regularly.

**Figure 1** Average Number of Trips per Week, by Mode and Trip Length

Source: Department of Transport, 1988, unpublished data

Seventy five per cent of all journeys in Britain are under five miles in length; half are under two miles; and thirty two per cent under a mile (Bannister, 1991, p21). Of all journeys undertaken by car, sixty one per cent are under five miles in length; and a similar proportion of all short journeys currently take place in cars (Department of Transport, 1988, p13).

These figures alone indicate the enormous potential for a modal shift to cycling; but in the next section, a more detailed discussion of trips and trip types is presented.

The most detailed report on the capacity for cycling in the UK was published by the Department of Transport (Waldman, 1977) fourteen years ago; and it is still of considerable interest in evaluating the potential for increased cycle use in the UK. The report incorporated data on the levels of cycling in nearly two hundred urban districts in Britain, and used statistical analysis to estimate the effect of a range of variables on cycle use. Of those considered, it concluded that hilliness and risk of accident were the two most important factors in determining cycle use.

Not much can be done about degrees of hilliness, levels of rainfall or the size of towns in the short term, all of which appear to influence cycle use. On the other hand, it should be borne in mind that the recent increase in sales of new bikes has included a high proportion of mountain bikes (1.1 million mountain bikes in 1990 out of a total sales of 2.4 million), and modern technology of this sort definitely renders both hills and distances less daunting than in the past.

In the longer term, however, changes in land use planning could be used to modify the layout of towns in order to maximise the use of walking and cycling. For example, amenities and places of work could be located closer to residential areas, and the trend towards out of town shopping centres reversed. The Department of the Environment has recently commissioned research on this topic, but the results will not be available for several years.

**Table 3**

Estimates of Proportions of Trips to Work by Bicycle

Cyclists' Risk of Accident	Type of Town		
	Mean or 'Average'	Median or 'Typical'	Typical but Flat
'Average'	13.23%	16.65%	30.83%
'Typical'	14.09%	17.71%	32.71%
Safest in Sample	20.57%	25.70%	46.97%

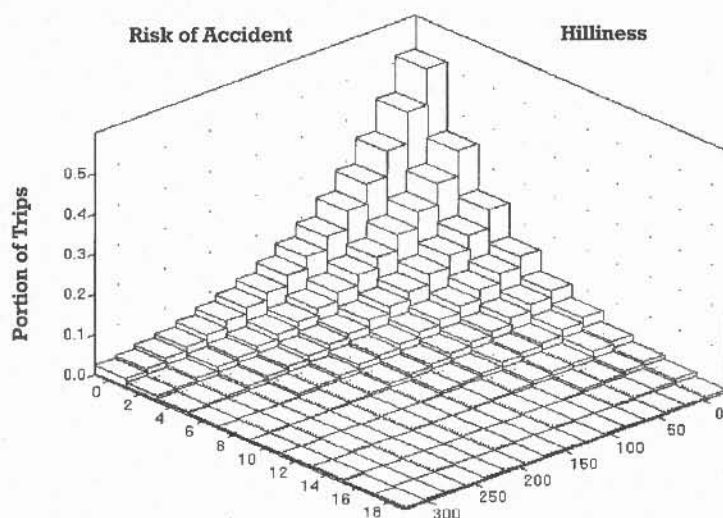
Source: Based on a reworking of Waldman (1977)

This study is now somewhat dated, but given the technical improvements in cycles and growing sales noted above, there is no reason to suppose that the 1977 study exaggerates the potential for cycling. On the contrary, the study consistently understates the potential for cycling by adopting average values for parameters when estimating attainable rates of cycling. This is unrealistic, since a few towns are extremely hilly, for example, but the majority are well below the average value for hilliness. In these circumstances it is more representative to adopt the median rather than the mean to give 'typical' values for potential levels of cycle use.

This has been done in Table 3 above, and illustrates the higher values for cycle use which result. Thus for example, the first column indicates that an 'average' town might have around 13 per cent of work trips by bicycle if the risk of cycling was also around the average, rising to over 20 per cent with a high standard of safety. However, column two suggests that more representative values would be nearly 18 and 26 per cent respectively, and rising to nearly 47 per cent in safe towns with flat terrain. These values are significantly above those originally reported by Waldman (1977, Table 3.2), and provide further evidence of the potential for increased cycle use.

It should be emphasised, moreover, that this study indicates the potential for cycling only within the current social, economic and policy framework. That is, it should not be regarded as an upper limit to the proportion of trips which might be accomplished by cycling, and economic incentives or a radical shift in urban transport provision might achieve even greater increases. For instance, the main



**Figure 2** Proportion of Trips by Bicycle

Source: Waldman, (1977)

**Notes:** Risk of accident is expressed as accidents per 10,000 cyclists per year. A safe town would score less than 50, and a dangerous one up to 200. Hilliness ranges from 0 (flat) to 18 (very hilly), a typical value would be around 3.0

reason given for not cycling is fear, especially of accidents (Hillman, 1990, p6), therefore if cyclists were to be protected from motor traffic, this might release pent up demand for cycle use.

As Waldman's study suggests that up to 47 per cent of all journeys to work might be carried out by bicycle in flat towns, and 26 per cent in typical towns if safety were improved, this report will evaluate the effects of transferring up to 50 per cent of non walking journeys, or 33 per cent of all journeys, to bicycle. We consider that this gives a reasonable reflection of what might be achieved, given the indications from overseas experience and from Waldman's study.

## 3.4 Patterns of journeys in Britain

As noted above, 75 per cent of all journeys in Britain are under five miles in length, and we have argued in the preceding sections that many of these could potentially be undertaken by bicycle. In this section we therefore consider the pattern of short journeys in greater detail, using unpublished data from the latest National Travel Survey (Department of Transport, 1988). The brief summary which follows is presented more fully in the Appendix to this report.

**Table 4**  
Purposes of Short Journeys up to 5 Miles

Journey Purpose	Journeys per Week	% of Total
Travel to Work	2.42	16.4%
In Course of Work	0.27	1.8%
Education	1.28	8.7%
Escorting: Work	0.21	1.4%
Education	0.61	4.1%
Shopping	3.53	23.9%
Other Personal Business	2.03	13.7%
Social & Entertainment	3.30	22.3%
Holidays, Trips, etc	1.13	7.6%
<b>Total</b>	<b>14.78</b>	<b>100.0%</b>

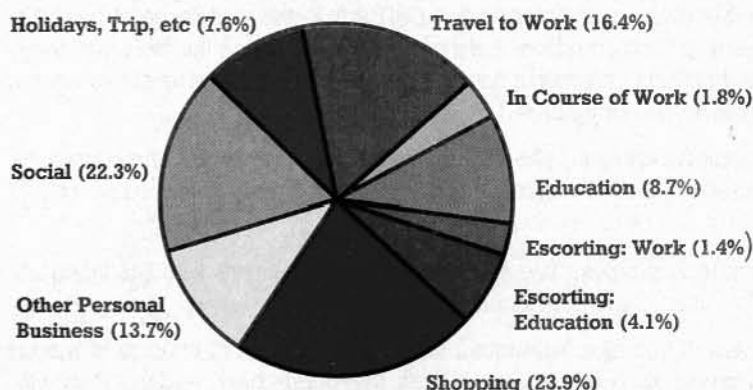
Source: Department of Transport, 1988

As Table 4 illustrates, nearly one quarter of all short journeys are attributable to shopping and social activities. Travelling to and from work is the third most common purpose, accounting for around one trip in six. Education is also an important category, particularly if the journeys of parents or others escorting children are included in the total. These main reasons for travelling are discussed briefly in turn below.

Currently, more than one quarter of short shopping trips are by car, and while walking is still predominant for very short trips, car is the main mode used for shopping trips of over one mile. Most shopping trips are to close destinations, yet bikes are rarely used for shopping. Not all shopping trips are for heavy or bulky items, and the use of good quality panniers, racks or even trailers could render cycles far more effective carriers of goods such as groceries.

Visiting friends is conspicuous for its very high level of car use (42 per cent). Once again cycle use is not common at present (only three per cent of the total), but there would seem to be significant scope for an increase here.

While some commuters travel long distances to work, 64 per cent of journeys to and from work are less than five miles in length; and of the latter, two thirds are below two miles. Walking once more predominates for the very shortest journeys, but private motor travel is the commonest mode for all commuting trips above a mile in length. Cycling is already a moderately common mode of travel to work, but there remains considerable scope for an increase in this area, as car journeys remain eight times as common for commuter trips up to five miles, and four times as common even for journeys under two miles.

**Figure 3** Purposes of Short Journeys under Five Miles

More than one in six journeys to school is by car; and journeys to escort children to school are nearly half as common as trips by pupils. There is thus considerable scope for an increase in cycling by students and school-children, but improved safety would need to play an important element in any attempt to encourage cycling to school, as child cyclists are especially vulnerable. On the other hand, it appears that approximately one third of all casualties occur within 250 metres of school entrances (Thomthwaite, 1991, p22), so better safety measures in these areas and on commonly used routes could improve the situation significantly.

## 3.5

### Predicting the effects of more cycling

Having concluded that an enormous increase in cycling could be attained in most areas, it would however be misleading to assume that a corresponding large decrease in car use would necessarily result. There are three main reasons for this:

- If cycling were to become far more popular (perhaps through better cycling facilities and greater safety) there would almost certainly be an increase in mobility for the cyclists due to the low marginal cost of cycling. This could result in many trips being made which would not previously have been undertaken at all; and while this might be a benefit in itself, it would not contribute to a reduction in car use.
- There is a clear danger that many of those who took to cycling would be switching from public transport rather than cars. This would produce little or no pollution benefit, and might actually contribute to a decline in public transport provision if carried out in isolation from other policies.
- Similarly, some new cyclists might previously have travelled as passengers in cars, in which case the car trip might be carried out anyway. However, the low average load factor for cars, especially for commuting purposes, suggests that these cases would be relatively few; and there would be a reduction in car use when the purpose of a trip was primarily or solely to carry that passenger (for example in taking a child to school).

However, evidence from areas of growing bicycle use in the UK indicates that the modal shift to bikes is as much from cars as from public transport, even where no additional measures are taken to limit car traffic or promote public transport (Department of Transport, 1991b, p50). As a further indication that a modal shift from cars to bikes is possible, it should be emphasised that bicycle ownership is highest in car-owning households (Department of Transport, 1988, p43). These factors have been incorporated into our analysis, as described in Section 4 below.

## 4

### The results of a modal shift to cycling

#### 4.1

#### Calculating the emissions benefits of a shift to cycling

The main purpose of this study is to determine the emissions reductions which would result from a significant modal shift from cars to cycling. We have therefore calculated both higher and lower bound estimates for modal shifts of various magnitudes, ranging from 20 to 50 per cent of all trips other than walking being carried out by bicycle. This approach is intended to give an indication of the range of savings which might be achieved under different circumstances.

#### 4.1.1 The Earth Resources Research transport emissions model

For a number of years the transport group at Earth Resources Research has been estimating atmospheric emissions from road transport. To do this we have developed a sophisticated computer model for predicting emissions levels by sector, vehicle and road type across time.

Our computer analysis is based on detailed research in the UK and elsewhere, and is designed to reflect the influence of the following main determinants of total emissions:

- Vehicle technologies in use, taking into account fuel types, vehicle efficiencies and pollution abatement technologies;
- The mix of vehicles in the total stock, and the rate of change of mix as determined by vehicle operating lives, rate of purchase, and stock growth;
- Road network conditions, including average speeds and degree of traffic congestion;
- Total demand for travel in motor vehicles.

As in the present instance, the model has been applied mainly to emissions of carbon monoxide, nitrogen oxides, volatile organic compounds and carbon dioxide in the United Kingdom, and was originally described in detail in Fergusson, Holman and Barrett (1989).

In the next section the critical assumptions which we have adopted in this analysis are set out, followed by a discussion of the results of the calculations for the principal gaseous pollutants.

#### 4.1.2 Basic assumptions used

In this analysis we have assumed that the average cycling trip length remains unchanged as far as is realistic. For very large shifts to bicycle use, cycling has to replace an increasing proportion of the longer motorised journeys, but since average trip length is very short for all modes, the effect is small. For example, even if half of all non walk journeys currently undertaken were to be taken by bicycle, the average cycle trip length would still be only 2.26 miles (currently it is just under 1.9 miles); and the vast majority of cycling trips would still be less than 3.0 miles.

We have assumed that the shortest motorised journeys could be switched to bike first, as Bannister (1991, pp25-26) assumed would be the case, and smaller proportions of the longer journeys (mainly up to 10 miles) are switched until the target modal shift is attained. It should also be emphasised that this exercise considers only a shift in the modal distribution of motorised trips currently undertaken. That is, no switch from walking to cycling is assumed, as this would have a negligible effect on emissions.

For the higher case emissions reduction estimate, we assume that motorised trips are displaced in proportion to the current split between cars and public transport use (typically four or five car journeys to every public transport journey over short distances). The more pessimistic estimate takes note of the Department of Transport's view that up to half of trips shifted to cycling might come from public rather than private car journeys (Department of Transport, 1991b, p50). However, this assumption cannot hold good for very high levels of modal shift to cycling as there are simply not enough public transport journeys to be shifted. In these cases we have assumed that any additional journeys are displaced from walking journeys, having no effect on pollution reduction. It should be emphasised that this is a highly conservative case, and a far better level of shift from cars might be expected if policies adopted integrated measures.

For car emissions, assumptions must also be made as to the type and load factor of the car journeys which are to be replaced by cycling. Bannister (1991, p21) has pointed out that cycles are currently used predominantly for journeys to work or school; and as argued above these would be amongst the journey types most susceptible to increased cycle use. As a result, the reduction in vehicle use would be greater than the average car load factor of 1.7 reported in the latest transport



statistics (Department of Transport, 1991a, p35) might suggest. Load factors for commuting are typically low, and when driving children to school, the driver is likely to be the only occupant of the car on one leg of the journey. Therefore, reflecting the findings of a recent report on load factors for London commuters (Kompfner et al, 1991, pp2, 7), an average car load factor of 1.35 has been adopted in this study.

For the reasons noted above, it is assumed that the majority of additional bike trips would be for commuting and journeys to school, and for other urban trips. We have therefore used the Earth Resources Research emissions model to estimate the average emissions factors for urban trips only. This is a better reflection of the pollution from the type of car trips which might be displaced, and typically gives higher estimates for the quantities of pollution avoided. However, this is still likely to be a significant underestimate of the full benefits of avoiding very short car journeys in cars with cold engines on congested roads.

No reduction in emissions from public transport vehicles is assumed, even where passenger mileage is assumed to fall. This again is a conservative assumption.

## 4.2 Results of the modelling

**Table 5**

Potential Modal Shift from Car to Bike

		Proportion of non-walk trips by bicycle			
		20%	30%	40%	50%
Car trips switched to bike (percentage of all trips undertaken)					
Upper Estimate		8.7	13.9	19.1	24.1
Lower Estimate		5.3	8.6	11.9	15.2
Car passengers switched to bikes (percentage of total distance travelled)					
Upper Estimate		4.8	8.3	12.0	16.6
Lower Estimate		3.0	5.2	7.6	10.6
Car mileage displaced (billion vehicle kilometres)					
Upper Estimate		17.1	29.4	42.6	59.0
Lower Estimate		10.8	18.6	27.0	37.6

Data from the most recent National Travel Survey suggests that approximately half of all journeys are currently undertaken in a car, and that these account for nearly three quarters of all distance travelled (Banister, 1991, p21). As this table indicates, however, an increase in cycle use could significantly reduce this total. In the case of number of trips, the reduction is calculated to fall between five and 25 per cent (that is, up to half of all car trips). The proportion of distance travelled which could be taken from cars is significantly less, but could still amount to one sixth of all personal travel.

Even on conservative assumptions, a 20 per cent trip share for bikes would displace over ten billion car kilometres per year, while a 50 per cent share could reduce car kilometres by nearly 60 billion out of a total 330 billion.

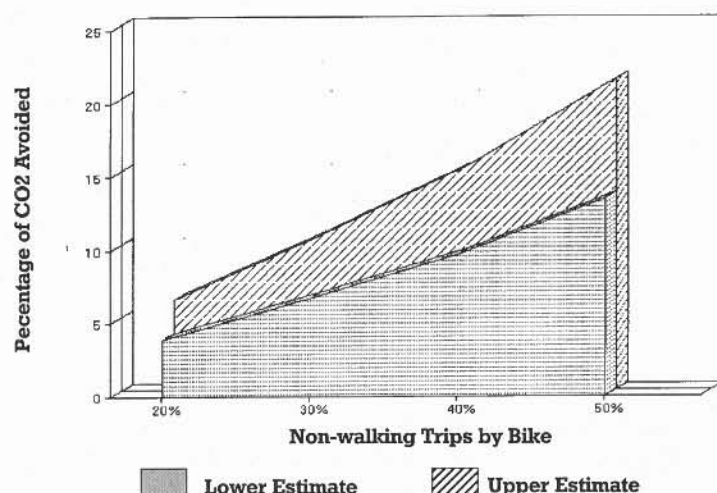
**Table 6**

Potential Pollution Reductions (thousand tonnes)

Pollutant		Proportion of non-walk trips by bicycle			
		20%	30%	40%	50%
Carbon Monoxide	Upper Estimate	215	369	535	741
	Lower Estimate	136	234	339	472
Hydrocarbons	Upper Estimate	24	42	61	84
	Lower Estimate	15	27	39	54
Nitrogen Oxides	Upper Estimate	30	51	74	102
	Lower Estimate	19	32	47	65
Carbon Dioxide	Upper Estimate	4,766	8,195	11,874	16,446
	Lower Estimate	3,010	5,185	7,526	10,481

As Table 6 illustrates, this in turn could have a significant effect on total emissions from road traffic. For example, if 20 per cent of non walking trips were carried out by bicycle the following emission reductions could be achieved:

- thirty thousand tonnes of nitrogen oxides
- two hundred thousand tonnes of carbon monoxide
- four and a half million tonnes of carbon dioxide

**Figure 4** Carbon Dioxide Savings from Increased Cycle Use

If, however, cycles were used for half of all non pedestrian journeys (but still primarily for journeys of less than three miles) the following quantities of atmospheric emissions could be avoided:

- one hundred thousand tonnes of nitrogen oxides
- three quarters of a million tonnes of carbon monoxide
- sixteen million tonnes of carbon dioxide.

**Table 7**

Proportion of Car Emissions Avoided (upper estimates) as percentages

	Proportion of non-walk trips by bicycle			
	20%	30%	40%	50%
Carbon Monoxide	6.3%	10.8%	15.7%	21.7%
Hydrocarbons	6.6%	11.3%	16.4%	22.7%
Nitrogen Oxides	4.2%	7.2%	10.4%	14.4%
Carbon Dioxide	6.1%	10.6%	15.3%	21.2%

As table 7 illustrates the reductions in vehicle emissions of carbon monoxide and carbon dioxide are significant.

## 4.3

### Health improvement from a modal shift to cycling

Britons are not very fit or healthy people, and recent Government guidance suggests that most need to take more exercise. For example, each year 37,000 people under the age of 65 die in Britain from coronary heart disease, strokes and lung cancer. These are preventable deaths, brought on by unhealthy lifestyles (Health of the Nation, 1991, p5).

According to the British Heart Foundation (1991a, p6) fewer than 20 per cent of individuals take enough exercise to benefit their cardiovascular health. This is cause for serious concern, as it is estimated that the relative risk of physical inactivity in relation to coronary heart disease may approach that attributable to smoking 20 cigarettes a day (British Heart Foundation, 1991b).

People are also becoming more overweight. Between 1980 and 1987 the percentage of British adults aged 16 to 64 who were overweight or obese increased from 39 per cent to 45 per cent of men, and from 32 per cent to 36 per cent of women (Health of the Nation, 1991, p13).

In this context, cycling offers numerous benefits to health. Cycling not only improves the quality of life and the individual health of the cyclist, but it also improves the health of others because of reduced atmospheric pollution, noise and other impacts on the surrounding environment (Hillman, 1990, p4).

A leading specialist in heart disease reduction, Professor Jerry Morris has stated that 'Cycling comes nearest to an ideal form of exercise.. among the common physical activities'. It incorporates non-weight bearing aerobic exercise, which does not strain muscles, limbs and joints. Regular cycling improves cardiovascular fitness, endurance and stamina (Morris, 1991, p14), and also reduces the incidence of respiratory disease, improves blood circulation, and helps regulate weight. Regular cyclists typically enjoy a fitness level equivalent to being ten years younger (Sharp, 1990, p3).

Studies have shown that regular cyclists experience a coronary attack rate lower than that of motorists, and less than half that of the population in general (Morris J, 1991, pp15-16; quoting Morris et al, 1990: Public Health Alliance, 1991, p4; quoting Fox and Goldblatt, 1982). It is predicted that heart disease rates would drop by around five per cent to ten per cent if one third of all short car journeys were made by bike, which could account for a third of the proposed reduction targeted in 'Health of the Nation'.

In addition, such an improvement as this could save the NHS around £50m a year (Green Magazine, 1991, p39). Illnesses related to coronary heart disease take up 5,000 hospital beds a year and account for an annual loss of 35 million working days, so clearly the economy as a whole would also benefit from such changes.

## 5 Conclusions

- Car traffic is one of the major sources of atmospheric and noise pollution, causing adverse effects to the built environment, plants, and human health. In addition, atmospheric emissions from motor vehicles are contributing increasingly to global climate change.
- Current and planned measures to reduce vehicle emissions will have a limited effect, particularly if car use continues to increase in line with the official forecasts. Car use is especially damaging in the urban environment where air quality is at its worst, since journeys are typically short and in congested conditions.
- There is enormous potential for an increase in cycling, substituting for the shortest and most environmentally damaging car journeys. This conclusion is supported by evidence both from within the UK, and from overseas experience.
- Given suitable policies there is the potential for at least a tenfold increase in cycling.
- This increase could displace up to one sixth of all car mileage, and up to half of all car trips, without a significant increase in average trip length for cyclists. This need not be associated with an increase in cycle accidents, if suitable measures are taken to protect cyclists.
- Such an increase in cycle use could save up to three quarters of a million tonnes of carbon monoxide, one hundred thousand tonnes of nitrogen oxides, and sixteen million tonnes of carbon dioxide from being emitted into the atmosphere each year.
- As well as substantial health improvements which would result from better air quality, a major increase in cycle use offers significant benefits to public health through more regular exercise.



# 6

## Policy and Campaigning recommendations

### 6.1

#### General approach

In order to achieve the environmental and health benefits set out in this study, a central objective must be to campaign on integrated transport policies that both promote cycling and other non-motorised modes as well as public transport, while at the same time discouraging private motor traffic.

If integration of transport modes is the way forward, then motorised traffic must be restrained, and travelling speeds reduced. Even if there is integration of modes, there can still be separation of vehicle types, with more road space given over to cyclists and pedestrians. This would encourage more cycle use by reducing the fear and danger of road accidents - the single largest deterrent to cycling, and on the other hand would distance cyclists from some of the worst health effects of traffic pollution.

### 6.2

#### The Department of Transport

In general, the Department could obviously help to promote a modal shift to cycling through a radical change in approach towards policy, resources, and administration:

- Policy should be restructured in order to actively promote cycling as a mainstream mode of transport with substantial emission and health benefits.
- Far greater resources should be allocated for cycle routes and cycling promotion, coupled with nationwide urban traffic calming schemes.
- Administration could be improved by setting up a powerful Cycle Unit within the Department to oversee these developments and liaise with the other authorities considered below.

More specifically, the following policies should be actively pursued:

- The Department should update the work of Waldman (1977) on propensity to cycle, and determine whether the effects of distance, safety or hills have indeed changed over time. This research should then be used to set targets for future cycling levels, and these in turn should be adopted as policy objectives at the national level, and measures implemented to ensure that they are met.
- Waldman's methodology should also be used to establish target cycling levels for each local authority area, taking into account local conditions. The Department should incorporate these targets into the national transport policy and programme, encouraging local authorities to adopt them as policy goals. Targets should be raised over time to reflect the improving conditions for cycling, for example in respect of safety.
- The benefits of cycling should be fully taken into account in current and future studies of measures to combat urban congestion.
- The Department should publish better information on cycling, for example through revising the structures of the National Travel Survey and the Traffic Census to remove their systematic biases against cycling. Similarly, better reporting procedures for cycling accidents should be promoted.
- The Department should extend the National Road Traffic Forecasts to include predictions for all modes of travel, including both cycling and walking.
- More help should be given to local authorities to improve safety in accident black-spot areas.

## 6.3

### Department of Health and Social Security

- The Department should support a modal shift to cycling as a step to meeting three of the Government objectives laid out in *The Health of the Nation* (1991, pp99, 102): to reduce NOx levels in urban air by at least 50 per cent; to end exceedances of the World Health Organisation peak ozone guidelines by the year 2000; and to reduce death and ill-health from asthma.
- In addition, the role that cycling can play in health promotion policies should be highlighted. In particular the improvement to general health, and to cardiovascular fitness, and the reduction in population exposure to adverse air quality should be stressed.
- The Department should promote and sponsor further research into the links between air pollution and ill health.

## 6.4

### Department of the Environment

- As argued in a recent paper on transport and environment policy (Fergusson and Holman, in press), the Department of the Environment should pursue a critical loads approach to atmospheric emissions, and insist on transport and other policies which allow stringent emissions targets to be met.
- The Department should require progressive national emission reduction targets from motor vehicles for the regulated pollutants and carbon dioxide. It should liaise with local authorities on regional and local emission reduction targets.
- The Department should construct a comprehensive national air quality monitoring network, and ensure that consistent guidelines and air quality categories are adopted at national and local level.
- The Department should institute a nation wide public information campaign to promote and explain air quality guidelines. Warnings should be issued when air quality is predicted to be poor, rather than waiting for the pollution episode to begin before action is taken.
- The Department should review its current guidelines for ozone, and accept the ozone guidelines proposed in the European Community draft Directive. The United Kingdom Government should carry out more research on the health implications of exposure to ozone over long periods.
- The United Kingdom should adopt the World Health Organisation guidelines for carbon monoxide, as there are currently no official guidelines in operation at national or European Commission level. The Department should also undertake further research on the health risks of exposure to carbon monoxide, and consider establishing a standard more stringent than that advised by the World Health Organization.
- The Department should commission further studies on the impact of land-use planning practices on transport demand, and formulate improved guidance to promote non motorised travel in urban areas.

## 6.5

### Treasury

- The Treasury should follow recent EC guidance (European Commission, 1991) by imposing a carbon tax on motor fuel.
- Fiscal incentives should be introduced to promote the purchase of less polluting and more fuel efficient motor vehicles.
- The taxation and national insurance systems should be restructured to remove financial incentives for private use of company cars.

## 6.6

### Inter-departmental cooperation

- The Government should initiate a cross departmental investigation to confirm the health and emission benefits highlighted in this report, and to promote the financial and social benefits of a modal shift in departmental policy making.

## 6.7

### European Community and other international bodies

- The European Commission and the European Parliament should ensure that provision for cycling and walking are fully integrated into their transport policies, and that financial and administrative provision in all member states fairly reflects the importance of these transport modes.
- The Commission should increase its staff allocation for transport policy, to reflect the potential importance of cycling as a mode of transport, and promote a community-wide policy on cycle safety.
- The Commission should take full account of critical loads criteria and the Intergovernmental Panel on Climate Change estimates of carbon dioxide emissions reduction requirements in the formulation of future transport policies.
- Cycling should form a major plank of European Commission (EC) policy on the urban environment in recognition of its environmental benefits, as advocated in the Pollack report on the EC Green Paper on the urban environment (Pollack, 1991).
- In accordance with the subsidiarity principle, whereby all powers are devolved to the most suitable level of government, the Commission should ensure that its future policies on provision for cycling are appropriately devolved to regional and local governments.
- The findings of this report should be reflected in future policy making in the European Commission, the European Conference of Ministers of Transport, the Organisation for Economic Cooperation and Development, and the World Health Organization, with particular reference to the Healthy Cities Programme.

## 6.8

### Local authorities

Local authorities should set up cycling units to implement policies from central government, and to ensure that proposed targets are met.

- Progressive emission reduction targets for motor vehicles should be set in urban areas; as well as clean air requirements throughout the authority area. Authorities should set specific targets for reducing levels of car use on local roads.
- Authorities should ensure that they have access to a comprehensive air quality monitoring network, and monitor local air quality on a regular basis. Information on air quality should be broadcast to the public via local media, and prior warning should be given of potential pollution episodes.
- Each authority should establish a cycle unit, which in turn should set up a cycle committee incorporating local cycle groups. These should be consulted on Traffic Regulation Orders, and on other policies to promote the interests of the cyclist.
- All authorities, especially those in urban areas, should design and implement a strategic cycle network.
- Cycles should be exempt from street closures and one way systems. Assistance should be provided at junctions and roundabouts, such as phased lights for cyclists.
- Authorities should implement 20mph speed limits in all residential areas, using traffic calming measures where appropriate.
- Authorities should publicise the adverse health effects of traffic pollution and highlight the regional emission benefits of cycling.
- Local planning standards should incorporate requirements for cycle parking, and showering and changing facilities in buildings put forward for planning consent. These should be designed to provide facilities for workers at all business premises, and additionally for customers at retail outlets, administrative offices and other similar sites.



## 6.9 Education Authorities

- Authorities should take advantage of the provisions of the Traffic Act 1991 to improve enforcement of parking regulations, and to ensure that illegal parking does not interfere with the safety or freedom of movement of cyclists.
- Education Authorities should promote the health benefits to children of cycling to school where it is safe to do so. They should press for improved road safety features around school entrances, where a third of road accident injuries to pupils occur.
- They should make adequate and secure cycling storage facilities available at all schools.
- Authorities should encourage cycling proficiency courses in schools.

## 6.10 Health Authorities

- Health Authorities should actively promote cycling as a healthy activity, on the lines of the 'For Health's Sake Swim' campaign.
- Authorities could lobby their local authorities to promote cycle routes for public health reasons, and endorse local authority bike schemes.
- They could encourage the implementation of progressive clean air quality targets by the Environmental Health Departments and set up disease reduction targets at a local level.

## 6.11 Employers

Employers should be encouraged to promote cycling and discourage car use by a range of measures:

- Employers can explicitly encourage modal shift for commuting by offering rail passes and cycles as an alternative to company car provision.
- For example, Greenpeace offers a 100 per cent interest-free loan on bike purchase, to be repaid over a twelve month period, as well as shower and changing facilities to employees. The Body Shop offer discounted bikes for employees, as well as having a pool of company bikes for use.
- Cycling should be preferred and encouraged where possible for travel in the course of work. For example, the London Borough of Sutton and Southampton City Council offer employees who cycle in the course of work the same mileage rates as those given to people who drive. The London Borough of Sutton is also introducing a pool of cycles for people who commute to work by car, to use on work business.
- Employers should provide better facilities for cyclists, including secure parking space and showers. Since many large employers already offer sports facilities to promote the health of their workers, the encouragement of cycling could be incorporated into these programmes.
- Retailers and others should also ensure that adequate cycle parking provision is available for customers and other visitors to premises.
- Companies should be encouraged to adopt progressive company travel assistance policies. For example, in Switzerland Ciba-Geigy gave free bikes to employees who were willing to give up their free car parking spaces, and substituted rail passes for some company cars.

## 6.12 The Cyclists' Touring Club

- The cycling lobby, including the Cyclists' Touring Club, should put its weight behind campaigns against company cars, as the prospects for reducing congestion and making cycling more attractive are limited until subsidies to private car travel are removed.

## 6.13 British Rail and other transport operators

- The Cyclists' Touring Club and others should organise a campaign to highlight the environmental, health, social and financial benefits of cycling to a wider audience than it currently reaches.
- British Rail should be pressed to provide secure cycle parking facilities at each station to encourage bike and ride. British Rail should also do more to make taking bikes on trains easier and safer.
- British Rail should design better cycle carrying facilities on future rolling stock and in station layouts.

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# A

## Appendix: The pattern of short journeys

### A.1 Introduction

As part of this analysis, we have considered the pattern of journey types and purposes in greater detail, using unpublished data from the latest National Travel Survey (Department of Transport, 1988). This analysis focuses on the trip structure of short trips (up to five miles in length), considering both the purpose and the mode of travel used.

**Table A1**

Purposes of Short Journeys

Journey Purpose	Journey Length in Miles		Total	% of Total
	Under 1	1 to 5		
Travel to Work	0.7	1.72	2.42	16.4%
In Course of Work	0.1	0.17	0.27	1.8%
Education	0.7	0.58	1.28	8.7%
Escorting: Work		0.21	0.21	1.4%
Education	0.4	0.21	0.61	4.1%
Shopping	1.7	1.83	3.53	23.9%
Other Personal Business	0.9	1.13	2.03	13.7%
Social & Entertainment	1.2	2.10	3.30	22.3%
Holidays, Trips, etc	0.7	0.4	31.1	37.6%
<b>Total</b>	<b>6.4</b>	<b>8.38</b>	<b>14.78</b>	<b>100.0%</b>

Source: Department of Transport, 1988

As Table A1 illustrates, nearly one quarter of all short journeys are attributable to shopping and social activities. Travelling to and from work is the third most common purpose, accounting for around one trip in six, followed by the more heterogeneous category of 'other personal business'. Education (primarily journeys to school) is also an important category, particularly if the journeys of parents or others escorting children are included in the total. It is noteworthy that nearly half as many journeys are undertaken in escorting children to school as in actually attending, and as discussed below, driving children to school is a particularly important activity from the fuel use and pollution perspective.

In the sections which follow, some of the key categories are analysed in greater detail to consider the potential for increased use of cycling on short trips.

### A.2 Shopping trips

As Table A2 illustrates, 60 per cent of all shopping trips are undertaken on foot, and over half are for walk journeys of less than one mile. However, more than one quarter of short shopping trips are by car, and this is the main mode used for shopping trips of over one mile. This table underlines the point that most shopping

trips are still extremely short, yet cycling is used for very few of these. Currently cycling accounts for less than two per cent of such trips, and even for trips under one mile, car use is four times as common.

**Table A2**

Short Shopping Trips, by Mode and Journey Length

Mode of Travel	Trip Length in Miles				Total
	Under 1	1 to 2	2 to 3	3 to 5	
Walking	52.2%	7.0%	1.2%	0.4%	60.9%
Cycling	0.9%	0.5%	0.2%	0.1%	1.7%
Private Motor	3.5%	8.8%	6.7%	8.6%	27.6%
Public Transport	0.7%	3.4%	2.7%	3.1%	9.9%
<b>TOTAL</b>	<b>57.4%</b>	<b>19.8%</b>	<b>10.8%</b>	<b>12.1%</b>	<b>100.0%</b>

Clearly there are situations in which bicycles cannot be used for shopping as goods bought may be too heavy or bulky, but the higher incidences of walking and public transport use suggest that this is not usually the case. Furthermore, the use of good quality panniers, racks or even trailers can render cycles extremely effective carriers of heavy goods such as groceries.

## A.3

### Visiting friends

Well over half of all social and entertainment trips are less than five miles in length, and of these, visiting friends is one of the main subgroups.

**Table A3**

Short Trips to Visit Friends

	Trip Length in Miles				Total
	Under 1	1 to 2	2 to 3	3 to 5	0 to 5
Walking	38.7%	6.1%	1.1%	0.4%	46.3%
Cycling	1.3%	1.1%	0.3%	0.3%	3.0%
Private Motor	5.0%	11.6%	10.7%	14.8%	42.2%
Public Transport	0.6%	2.4%	2.3%	3.1%	8.5%
<b>TOTAL</b>	<b>45.6%</b>	<b>21.3%</b>	<b>14.6%</b>	<b>18.6%</b>	<b>100.0%</b>

While many of the shortest such journeys are still carried out on foot, this type of visit is conspicuous for its very high level of car use (42 per cent). Once again cycle use is not common at present (only three per cent of the total), but there would seem to be significant scope for an increase. In particular it should be emphasised that social visits such as these seem unlikely to be restricted by the need to carry heavy goods, as in the case of shopping. Furthermore, more than a quarter of the trips in Table A3 are car journeys of less than three miles.

## A.4

### Travelling to work

While some commuters travel long distances to work, 64 per cent of journeys to and from work are less than five miles in length; and of the latter, two thirds are below two miles, as Table A4 illustrates.

**Table A4**

Travel to Work

	Trip Length in Miles				Total
	Under 1	1 to 2	2 to 3	3 to 5	0 to 5
Walking	37.5%	5.8%	0.8%	0.2%	44.3%
Cycling	1.5%	1.8%	1.0%	0.8%	5.1%
Private Motor	3.8%	10.5%	9.6%	15.2%	39.2%
Public Transport	0.8%	3.0%	3.3%	4.3%	11.4%
<b>TOTAL</b>	<b>43.6%</b>	<b>21.0%</b>	<b>14.7%</b>	<b>20.6%</b>	<b>100.0%</b>

Walking once more predominates for the very shortest journeys, but private motor travel is the commonest mode for all commuting trips above a mile in length. Cycling is already a moderately common mode of travel to work, but there remains considerable scope for an increase in this area. Car journeys remain eight times as common for commuter trips up to five miles; and four times as common even for journeys under two miles.

## A.5

### Journeys associated with education

Perhaps surprisingly, cycling is not a common mode of transport for schoolchildren or other students. Two thirds of trips are on foot, of which the vast majority are of less than one mile. However, more than one in six journeys to school is by car - a fact underlined by the high incidence of car journeys by those (typically parents) who escort their children to school. These car journeys are particularly polluting, as many

are extremely short (Hillman et al, 1991, p41) and take place in overcrowded rush hour conditions. Furthermore, an escort trip generally involves a return trip which serves no useful purpose except to get the driver back home, so the per capita emissions for the journey as a whole is extremely high.


There is thus considerable scope for an increase in cycling by students and schoolchildren, in part to reverse a trend towards less unescorted trips by children (Hillman et al, 1991, pp78-9). It should be emphasised, however, that improved safety would need to play an important element in any attempt to encourage cycling to school, as child cyclists currently contribute disproportionately to the total casualties on journeys to and from school (Thornthwaite, 1991, pp21-22). On the other hand, it appears that approximately one third of all casualties occur within 250 metres of school entrances (Thornthwaite, 1991, p22), so better safety measures in these areas and on commonly used routes could improve the situation significantly.

**Table A5**

Journeys Associated with Education

Directly Involved	Trip Length in Miles				Total
	Under 1	1 to 2	2 to 3	3 to 5	0 to 5
Walking	57.1%	9.7%	0.9%	0.1%	67.8%
Cycling	0.7%	1.7%	0.7%	0.2%	3.3%
Private Motor	3.8%	6.3%	3.6%	4.0%	17.7%
Public Transport	0.7%	3.2%	3.3%	4.0%	11.1%
<b>TOTAL</b>	<b>62.3%</b>	<b>20.9%</b>	<b>8.5%</b>	<b>8.3%</b>	<b>100.0%</b>
Escorting Others	Trip Length in Miles				Total
	Under 1	1 to 2	2 to 3	3 to 5	0 to 5
Walking	34.3%	4.9%	0.6%	0.1%	39.8%
Cycling	0.4%	0.1%	0.0%	0.0%	0.5%
Private Motor	10.4%	19.3%	12.4%	14.6%	56.7%
Public Transport	0.3%	1.0%	0.9%	0.7%	2.9%
<b>TOTAL</b>	<b>45.3%</b>	<b>25.3%</b>	<b>13.9%</b>	<b>15.5%</b>	<b>100.0%</b>





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