RAILWAYS AND THE ENVIRONMENT: TOWARDS A STRATEGY FOR 2005 AND BEYOND

Final Report to the

Strategic Rail Authority

from

Institute for European Environmental Policy (IEEP)

together with

Independent Rail Consultancy Group (IRCG) and Open University

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FINAL REPORT

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1. Introduction

1.1 Terms of Reference

Current indications regarding the new Rail Directorate within the Department for Transport (DfT Rail) that will supersede the Strategic Rail authority (SRA) are that the technical section is to increase in size, and that environmental considerations are to be given a higher profile than is currently the case within the context of the SRA's governing statutes and guidance from government. This suggests that there may be a dedicated environmental policy officer within the new structure, or at least significantly greater staff capacity for environmental matters within the technical section.

With this in view, the SRA requested that the Institute for European Environmental Policy and its partners, which were contracted to the SRA to undertake environmental policy work to support their operations, develop an environmental strategy paper to inform this new person or persons in the early stages of their job. The paper was to look at early steps, legislative challenges, strategic priorities, etc to put in place an effective environmental policy for the railways. It was to cover, at least, the following areas:

- Climate change and greenhouse gas emissions;
- Other pollutant emissions;
- Noise;
- Use of materials;
- Waste arisings;
- Contaminated land;
- Land management, amenity and biodiversity.

This paper is the result of that research.

1.2 Methodology and Working Methods

The work began with a brainstorming and planning meeting involving the whole research team, at which the scope of the work, issue areas and the shape of the expected report were set out in detail. This was agreed with the SRA project officer before more detailed new work was undertaken. Once agreement had been reached, the research, including literature reviews and interviews, as necessary, and the writing were shared out amongst the project team as appropriate.

The literature review included the previous work that the team had undertaken for the SRA – on the introduction of low sulphur diesel on the railways and on regenerative braking – and additional material, including:

- An environmental overview by AD Little[1];
- A report for the SRA by AEA Technology[2];
- Miscellaneous other reports known to the research team and the SRA;
- National and EU legislation.

In addition to summarising available research and knowledge, the study team also held a number of informal discussions with informed operators and other experts. The latter included people from within the rail industry, and a number of independent experts, as well as some officials at national and EU levels. The research was undertaken in close cooperation with the SRA's project officer.

1.3 Structure of this Report

The report is set out so as to meet the SRA's requirements in a clear fashion and show the rationale behind our conclusions. Section 2 begins the report with some contextual analysis. This begins by reviewing UK railways' traditional approach to environmental policy and how this has been affected by privatisation. It then gives an overview of the roles and responsibilities of the various actors that make up the UK rail industry in 2005. This is followed by a discussion of the environmental agenda and how this is changing, in order to give an idea of the context within which environmental policies in the new DfT rail Directorate will have to be developed.

Unlike previous reports undertaken for the SRA, this report takes environmental issues, rather than legislative pressures, as its starting point. The environmental issues that it addresses in Section 3 are, in turn:

- Emissions of regulated pollutants;
- Emissions of climate impacting gases;
- Noise and vibration;
- Waste and resource use, including litter, landfill and aggregates extraction;
- Habitats and biodiversity;
- Contaminated land and hazardous substances (PCBs, fuel storage);
- Water pollution;
- Light pollution; and
- Electromagnetic pollution.

For each of these, the relevant sub-section of Section 3 sets out:

  - The details of the environmental issue;
  - The contribution of the rail industry to the problem;
  - Relevant existing and future legislation aimed at addressing the problem and, in particular, rail's contribution;
  - Options for reducing rail's contribution; and
  - Responsibilities for addressing each issue within the UK rail industry, as we understand them to be currently, and potentially within the emerging administrative structure.

[1] ADL (2003) *Sustainable Development: The SRA's role in the UK Rail Industry*
[2] Watkiss and Jones (2001) *SRA's Environmental Agenda* AEA Technology for the SRA

Section 4 addresses some wider strategic issues that need to be taken into account in addressing the environmental dimension of future rail policy. Section 6 includes some observations on policies and ways of working within the new industry structure in pursuit of environmental objectives.

It is important to note at this stage that the research underlying this report was undertaken with a limited budget and so does not claim to be a comprehensive account of all the environmental issues facing the UK's railways. Also, it was desirable to restrict the document to a manageable length. For these reasons we have tried to identify what we feel is important and to complement the existing reports undertaken for the SRA. This is the reason why extensive references are given to earlier reports by ADL and AEA Technology, *inter alia*, with a view to signposting existing material rather than duplicating it.

2. Setting the Context

The aim of this section is to put the report into context. The first section (2.1) gives an overview of the approach taken to the environment by the rail industry in the past and outlines the reasons why this may have changed over time. Section 2.2 gives an overview of the actors currently involved in the railway industry to underline the complexities of addressing environmental issues within the UK rail industry. Section 2.3 then gives an overview of the environmental policy context that is increasingly putting pressure upon the industry and the various actors to respond in new ways.

2.1 The UK Rail Industry's Approach to Environmental Issues

Awareness of environmental issues and active energy management has long standing in the railway industry. As a nationalised industry British Rail needed to be seen to be taking a lead and being a role model on these issues. Also, as a large organisation, the financial incentives for efficient use of energy, for example, were quantifiable and on a significant scale. The organisations that comprise today's railway industry are smaller, and whilst energy efficiency may offer the same proportional benefits the reduction in scale dilutes the incentive (small business saves in £thousands; big business saves in £millions). There may be other issues of scale. For example BR was big enough to fund a Research and Development division, which could claim many environmentally achievements and which sold its expertise around the world. In addition, BR could exert purchasing pressure on suppliers and could justify the, sometimes, high capital outlay required to bring operational improvements.

A preliminary study[3] was undertaken after privatisation of the environmental practices and policies of the new train operating companies (TOCs) and freight companies, and the development of environmental guidance from the Rail Regulator. This study confirmed that the focus of train operators was likely to be on the local environmental issues and immediate legislative requirements identified in Chapter 3. This amounted to compliance with the Environmental Protection Act (Part 1, 1990). Present and anticipated environmental regulation to control vehicle noise and emissions, plus satisfying regulation on effluents, waste and litter, etc from rail operations were the only areas of serious concern. Rail's global environmental impacts were attracting very little attention and the positive role railways could play as part of a more sustainable transport system was of apparently of very little (and vague) concern.

Reflecting this, in July 1994 the then Office of the Rail Regulator (ORR) issued a consultation document[4] on environmental guidance, which included an appendix summarising issues, current best practice and options for improvement. This referred to 'pollution, global warming and the depletion of the ozone layer'. The consultation document included sections on non-renewable resources, energy conservation and ozone-depleting chemicals. In March 1996, this consultative document was followed by environmental guidance that set out the elements that are 'essential in a well-constructed environmental policy'[5]. The guidance was essentially administrative, ie

[3]

[4] ORR (1994) *Railway Operations and the Environment Guidance: A Consultation Document* July 1994; see http://www.rail-reg.gov.uk/upload/pdf/11.pdf

[5] ORR (1996) *Railway operations and the environment: Environmental guidance* March 1996, p.1; see http://www.rail-reg.gov.uk/upload/pdf/29-environment96.pdf

on how to structure an environmental policy. The Regulator's introduction said that it would 'not be appropriate for me to try to summarise current requirements and standards', as he had done in the consultative document. However he did suggest a 'forum' to 'exchange relevant environmental information'.

In March 2003, Network Rail published an Environment Policy statement that set out its vision for the environment and its environmental aims in terms of its commitments, responsibilities and its partners[6]. The Environment Policy is supported by a three-year plan which integrates safety and environment, the first of which was also published in 2003 and covers the period from 2003 to 2006[7]. The plan describes various environment policy related initiatives and processes, for example the Network Rail Annual Environment Conference; Annual Network Rail-sponsored environment awards; an environment management system and a process of monitoring and review. The plan also sets out Network Rail's objectives for improvement against identified environmental impact risks. Each year the plan is reviewed and an update published including progress against objectives in the previous year and actions that will be taken in the coming year[8].

Integrating environment and safety should ensure that environment issues are given consideration. However, it is apparent from reading the plan that the tie-in with safety has resulted in a risk-based approach to environmental issues. This may stifle innovation as developments that do not address a specific risk may be overlooked.

Following recommendations from Lord Cullen's Inquiry into the Ladbroke Grove incident a new Rail Safety and Standards Board (RSSB) was created. RSSB is responsible for Railway Group Standards (RGS). The purpose of RGS is to provide a framework for system safety and safe interworking by providing clear, concise and cost effective standards, which encourage compliance and consistency without hindering innovation[9]. Although RGS are essentially safety related standards there are some incidental connections with environmental issues, eg the use of audible warnings and noise pollution.

Franchising may have introduced a problem of short term-ism, which, along with the focus on achievement of rigid targets, could stifle innovation on environmental issues. A further problem in a fragmented industry is the 'landlord and tenant' problem, wherein one organisation needs to incur costs in order for another to reap the benefit (for example, in installing regenerative braking), and hence an institutional barrier to innovation exists.

With greater direct government control of the rail industry (as envisaged in the Railways Act 2005) there is the opportunity for positive intervention from The Treasury, which will encourage modal shift *and* deliver an even more environmentally sound rail network.

[6] Network Rail (2003a); See http://www.networkrail.co.uk/cache/Network%20Rail%20Env%20Policy.pdf
[7] Network Rail (2003b); See http://www.networkrail.co.uk/cache/SafetyPlan_normal%20res.pdf
[8] Network Rail (2004); See http://www.networkrail.co.uk/Documents/191.pdf
[9] http://www.rssb.co.uk/rgs.asp

2.2 Roles and Responsibilities in the Rail Industry 2005

A key issue in moving forward a strategy for the railways, particularly for a complex cross-cutting issue such as the environment, is the fragmentation of responsibilities and the very different motivations of the various actors within the industry. While the SRA had responsibility in this area, its actual powers to motivate others to act have been limited. The Railways Act of 2005[10] changes this situation in certain important respects. First, it abolishes the SRA and transfers its strategic and financial functions to the DfT, ie the new rail Directorate, and, in some cases, to the devolved administrations. The ORR gains new functions as it takes over the SRA's consumer protection functions and takes over responsibility for railway safety from the Health and Safety Executive/Commission. From reviewing the relevant sections of the legislation and guidance documents, it appears that both ORR and DfT (as well as the Scottish Executive and the Welsh Assembly) have requirements to consider environmental impacts in carrying out their responsibilities. The full implications of the changes cannot be evaluated at this point, as these are clearly still evolving. However, a useful starting point is to set out the broad areas of responsibility of the various actors (see Table 2.1), which also indicates some key activities that are of relevance to the environmental agenda. Some of the possible actions that might be investigated or taken forward within this overall framework are discussed below in Section 6.

[10]see text of the Act at: http://www.opsi.gov.uk/acts/acts2005/20050014.htm

Table 2.1: Environmental Responsibilities of the Actors in the UK Rail Industry

Organisation	*Outline of Roles and Responsibilities*	*Environmental Related Activities*	
		Actual	***Potential***
Network Rail	To provide the fixed railway infrastructure and control operations in a way which enables the safe, efficient and legal operation of franchised and private train services carrying passengers, freight and parcels.	A published commitment to environmental excellence[11], which recognises rail's advantages over other transport modes, the importance of integrated transport and aims to protect heritage features and habitats. An environmental agenda is in place in the form of the Network Rail three year Safety and Environment Plan[12]. Systems for management and measurement are also in place with Board level involvement. There is an Annual Safety and Environment Conference and the Plan is updated each year to report progress and revise objectives. Required by condition of their operating license to have an Environmental Policy, management and measurement processes which are not only legally compliant but also seek to achieve improvements.	With Network Rail's more pivotal role in the rail industry there is an opportunity for them to have a greater overview of environmental developments, coordinate rail-related research into sustainable development and be the depositary for best practice processes, methods and practices. This would underpin claims for government investment in which part of the benefits are of a wider environmental nature. This would not interfere with TOCs, ROSCOs and other private bodies' rights to manage their businesses in their own way but would help to eliminate duplication of research and development.
Train Operating Companies (TOCs)	The efficient, cost-effective delivery of their franchise terms, conditions and obligations.	To be legally compliant in the cost-effective operation of all leased depots, stations, franchised trains services and other leased or owned assets. Required by condition of their operating license to have an Environmental Policy, management and measurement processes which are not only legally compliant but also seek to achieve improvements.	To develop new processes and adopt new technologies which improve TOC bottom-line, have net environmental benefits and present opportunities for new partnerships and positive PR

[11] Network Rail (2003a) *Op cit*
[12] Network Rail (2003b) *Op cit*

Rail Freight Companies	To provide UK-wide, commercial freight transport services.	To be legally compliant in the cost-effective operation of all depots, freight terminals and freight train services whether they are owned or leased. Required by condition of their operating license to have an Environmental Policy, management and measurement processes which are not only legally compliant but also seek to achieve improvements.	Share together in developing low-cost, rail-based logistics solutions which will encourage the transfer of freight from road to rail haulage
Rolling Stock Companies (ROSCOs)	To procure rolling stock for lease to train operators so that investment decisions can be long term rather than limited to the life of the franchise. To ensure that their assets are well maintained and meet legal requirements.	To be fully aware of legal changes which affect the way they manage and maintain their assets. To protect the objectives of their shareholders. Required by condition of their operating license to have an Environmental Policy, management and measurement processes which are not only legally compliant but also seek to achieve improvements.	To research engineering and manufacturing developments which could enhance the environmentally acceptable operation of their trains and find solutions which are acceptable to the hirers of their locomotives and coaches. To purchase environmentally-less damaging technologies and work with TOCs to introduce these.
SRA/DFT Rail	To be the central, government body charged with holding and developing the core strategy for the provision of UK rail services. It has a requirement placed upon it to generate developments which are sustainable and to have a regard to their environmental impact.	In examining proposals for new franchises they should give weight to the wider social and economic benefits, including from road decongestion, and the environmental impact of proposals.	To commission, through an appropriate body, a thorough assessment of the environmental impacts of moving people and freight by the various modes of transport available so that future investment decisions are properly informed.
Office of Rail Regulation (ORR)	To ensure that the rail industry meets all its legal obligations and is properly funded to do so.	Have a full understanding of the effects of environmental developments and requirements and to ensure that there is a proper balance between public and private funding of approved solutions.	Maintain an up-to-date awareness of environmental requirements and be the source for information, which will lead to implementation/enforcement or the justification of derogations.

		Issues guidance and places requirements upon railway license holders with respect to environmental policy[13].	
Environment Agency (EA)	To provide guidance and enforcement of statutory requirements with regard to protecting and enhancing the environment.	See previous column	To create, or procure under contract, a transport division which can have a full understanding of legislation which will affect transport and be leaders in identifying cost-effective solutions.
Rail Passengers Council and Committees (RPC)	To act as a focus for public thinking and public debate on rail-related issues.	The RPC state that in order to achieve their aims they will "encourage cooperation between operators, in order to preserve and enhance the environmental and network benefits of a national railway"[14]	To stimulate public debate on the issues surrounding transport (not just rail) and the environment and canvas support for individual solutions.
Treasury	To oversee public finances and the economy in general; to determine levels of taxation and public expenditure.	Determines the levels of taxation of the rail industry and companies within it. Allocates public funds for development of rail investment, overall levels of subsidy, etc.	To help develop a system of assessment and allocation that rewards and incentivises environmentally-advantageous rail industry initiatives, and sets an appropriate and sustainable balance between rail and other modes.

Note: In some cases the relevant text still refers to the situation prior to the Railways Act 2005 having full effect. These may need to be updated in time to reflect later developments.

[13] ORR (1996) *Op cit*

[14] Rail Passengers Council and Committees: Mission Statement

2.2 *2.3 The New Environment and Sustainable Development Agenda*

The environmental, and the broader sustainable development, agendas will increasingly impact on the rail industry in the years ahead, for three distinct reasons:

- Rail has been neglected, in terms of environmental legislation, when compared to other transport modes;
- The changing nature of environmental policy; and
- The emerging sustainable development agenda.

Compared with, say, road traffic or industrial installations, *the rail industry has been relatively lightly regulated to date* in terms of environmental requirements, but increasingly is being brought within the framework of environmental legislation as other (often bigger or easier) targets are addressed. The recent European legislation on emissions from non-road mobile machinery, which covered railway locomotives for the first time, is a good example of this process. While these requirements will improve certain aspects of the environmental performance of the rail industry, they will do so at a cost, and these costs come at a difficult time in terms of the finances of the rail industry. Hence there is a strong tendency for the rail operators to react negatively and only reactively in response to such requirements.

The 'green' credentials of the rail industry *viz a viz* road transport are often taken for granted, but some recent studies have suggested that road transport is less polluting than rail. In reality this analysis is rather selective, and figures supplied by AEA Technology confirm that rail overall retains an advantage over road[15]. However this is an average; it is far less certain whether diesel passenger rail retains the advantage over road in some respects. Some continental studies have also suggested that road freight can be better than rail in terms of environmental performance.

It is certainly the case that the road sector has improved its performance in terms of pollutant emissions such as nitrogen oxides and particulates over the past two decades, and continues to do so, while rail has yet to make significant progress. It is therefore timely to address some key ways in which the rail industry might improve its environmental performance, and thereby safeguard its green credentials. It will therefore be important for the new DfT Rail to consider not only legislative requirements on environmental matters, but also a more proactive agenda in keeping the rail sector at the cutting edge of 'green transport'.

The ***nature of environment policy is also changing***, with arguably, a 'new' environmental agenda emerging, which will see greater attention paid to certain pressing issues such as climate change and biodiversity. Whereas the 'old' agenda focused on issues that were relatively easy to identify and which often had technical solutions, eg engine emissions, the issues on the new agenda do not offer simple or straightforward solutions, and are not generally subject to 'end of pipe' solutions. Also, because they are diffuse problems they are in their nature difficult for individual institutions to deal with; but at the same time, they will require responses from a much wider range of actors than those subject to most traditional environmental regimes.

[15] ATOC and the Railway Forum (2004) *Rail and the Environment* October 2004

However, issues such as climate change and biodiversity are areas where the rail sector can position itself as a positive actor, and as part of the solution, not part of problem. On climate change, for example, DfT Rail can continue work begun by the SRA (for example in *Everyone's Railway*) to portray and promote rail as a dynamic part of the solution to greenhouse gas emissions, by taking trucks off the roads and diverting passengers from road and air travel, as well as by improving its own performance on greenhouse gas emissions. Similarly, recent successes of the Highways Agency in promoting itself as a major planter of trees suggest that rail could probably do far better at promoting itself as a steward of the countryside than is currently the case.

Finally, the ***emerging sustainable development agenda*** broadens the emphasis of policy from pure environmental issues, to social and economic concerns. This will clearly impact on the future of the rail industry, as rail is a key mode in moves towards a more sustainable transport sector, for example. Numerous definitions of sustainable development exist, most of which are not very precise or operational, and therefore of little use for this purpose. The two key elements identified in the UK's Sustainable Development Strategy[16] are:

- Living within environmental limits, and
- Ensuring a strong, healthy and just society.

A key element within this is also the promotion of a sound economy (conventionally viewed as the third 'pillar' of SD). In an earlier report to the SRA, ADL used a variety of sources to develop a model of rail's contribution to SD under these three pillars. Clearly this report focuses on the first of these three pillars, but it should be noted that all three are closely interconnected at a strategic level. For example, reducing emissions and noise contributes to a healthy society, and reducing traffic congestion brings environmental as well as economic benefits. These considerations are particularly important when considering the 'bigger picture' aspects of rail and environmental policy, and should be reflected in future strategy.

[16] *UK Sustainable Development Strategy* (revised 2005)

3. Environmental Issues of Relevance to the Railways

An earlier report by ADL approached the evaluation of environmental issues from the perspective of need to comply with legislation. This is a pragmatic approach, but arguably insufficient to give a strategic overview that looks well ahead, seeks to be comprehensive, and places environmental requirements within a sustainable development context. In this chapter, therefore, we take an alternative approach of starting from the environmental issues that actually or potentially face the industry, ie:

- Emissions of regulated pollutants;
- Emissions of climate impacting gases;
- Noise and vibration;
- Waste and resource use, including litter, landfill and aggregates extraction;
- Habitats and biodiversity;
- Contaminated land and hazardous substances (PCBs, fuel storage);
- Water pollution;
- Light pollution; and
- Electromagnetic pollution.

These issues are addressed in turn in the sections that follow. For each we give an overview of the issue; an assessment of its relative importance to the rail industry; relevant legislation; possible action; and the actors responsible within the industry and/or government.

3.1 Emissions of regulated pollutants

3.1.1 Issue

As the operation of the railways – with either diesel or electric traction – requires the combustion of fossil fuels, either within the train or elsewhere at a power station, pollution is produced. The principal pollutants emitted are the oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs), particulates and sulphur dioxide (SO_2). Such pollutants can have an adverse effect on human health, vegetation and infrastructure. The main way in which emissions adversely affect human health is by contributing to poor air quality, particularly in urban areas. Emissions of NO_x oxidise to add to ambient concentrations of nitrogen dioxide (NO_2), which adversely affects human health. In certain conditions, such as in the presence of sunlight, NO_x also reacts with VOCs to form ground level ozone, which is the principal component of summer smog, and is also damaging to human health. Additionally, particulates are increasingly recognised as a danger to human health. Poor air quality can also adversely effect vegetation, including crops in rural areas. Additionally, acidic pollutants such as NO_2 and SO_2 can contribute to acid deposition, which can also damage plant life as well as infrastructure[17].

[17] See *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland*, DETR, Scottish Executive, National Assembly for Wales and the Department of the Environment, Northern Ireland (2000) at http://www.defra.gov.uk/environment/airquality/strategy/

3.1.2 Contribution of the Rail Industry

According to the most recent UK transport statistics[18], railways contributes 1% or less to national emissions of NO_x, CO, VOCs and particulates, which is significantly less than the proportion contributed by road transport, which is more than 50% in some cases. A previous AEA report for the SRA highlighted that emissions of SO_2 from railways are higher than those from road transport[19], but the most recent figures for the UK suggest that transport in total contributes no more than 2% to UK SO_2 emissions[20]. The suggestion that rail produces more SO_2 than road transport is due to the fact that the diesel fuel in road transport is of a much higher quality, and therefore contains less sulphur, than that used by trains (see below)[21]. On a passenger kilometre basis, emissions of CO and VOCs from most common rail locomotives/units compare favourably with road based modes, whereas the comparison is not favourable for SO_2, while emissions of NO_x and particulates compare poorly for diesel-powered rail engines, but more favourably for electric units. For freight, the figures for rail compare favourably with those of road transport for all but SO_2[22].

In terms of the impact on human health, it is NO_x and particulates that are of most concern at the moment, as emissions of other pollutants have declined significantly in recent years. In terms of the impact on air quality, if rail is going to have a major impact it will be in major cities, where major rail termini are located. However, a recent report for London, in which numerous rail termini are located, suggested that the contribution of NO_x and particulate emissions from the railways to pollution in London is not significant compared to the other sources in the capital. The report also modelled expected concentrations of these pollutants in 2005 and 2010 and again concluded that emissions from rail would not make a significant contribution, although its contribution would increase[23]. Similarly, the Air Quality Strategy published by the Mayor of London does not seem to have identified rail as a problem in the context of a London AQMA[24]. On the other hand, the City of Westminster has highlighted emissions of NO_x, particulates and SO_2 around Paddington station as issues in its Air Quality Action Plan[25].

[18] Office of National Statistics (2004) *Transport Statistics Great Britain* (TSGB) see http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/page/dft_transstats_032073.pdf
[19] Watkiss and Jones (2001) *Op cit*
[20] National Atmospheric Emissions Inventory (2003) *UK Emission of Air Pollutants 1970-2001* 15th Annual Report. See http://www.airquality.co.uk/archive/reports/cat07/naei_report_1970-2001.pdf
[21] It should be noted that, as rail uses electricity, it indirectly contributes to emissions at power stations. However, as these emissions are effectively those of another sector, ie the energy sector, power station emissions are not addressed in this report.
[22] Watkiss and Jones (2001) *Op cit*
[23] Cambridge Environmental Research Consultants Ltd (2004) *Source Apportionment for London using ADMS-Urban* prepared for DEFRA, National Assembly for Wales, the Scottish Executive and the Department of the Environment, Northern Ireland. See http://www.airquality.co.uk/archive/reports/cat09/0402171101_London_SA_report(28jan04)3_TR-0359.pdf
[24] Mayor of London (2002) *Cleaning London's Air: The Mayor's Air Quality Strategy*, see http://www.london.gov.uk/mayor/strategies/air_quality/air_quality_strategy.jsp
[25] City of Westminster (2004) *Air Quality Action Plan Progress Report*, see http://www.westminster.gov.uk/environment/pollution/airpollution/upload/36391_1.pdf

3.1.3 Relevant Legislation

Legislation aimed at combating the adverse impacts of emissions comes in three forms: air quality legislation; engine emissions legislation; and fuel quality legislation. The former focuses on setting air quality limit values to protect human health and vegetation, and is effectively the driver of the emissions and fuel quality legislation. Emissions legislation sets limit values on the amount of pollutant that can be released from the various sources of the pollution, while fuel quality legislation sets quality parameters for the fuel used in various types of engine, contributing directly or indirectly to a reduction in pollution from the engine. As mentioned above, legislation relating to the railways, specifically, is relatively recent, particularly when compared with the equivalent legislation targeting road transport. The relevant legislation typically has its origin in European law, which is then implemented in the UK (see Table 3.1 for the relevant legislation).

Table 3.1: Relevant European and UK legislation

Air quality legislation *EU legislation:* Directive 96/62 on air quality assessment and management ('the Air Quality Framework Directive') supplemented by 'daughter Directives' 1999/30 (covering SO_2, NO_x and particulates), 2000/69 (CO) and 2002/3 (ozone). In the event of non-compliance with the target values for air quality, local authorities are required to tackle pollution through the implementation of air quality action plans. *UK legislation*: • England: The Air Quality Limit Values Regulations 2003 (SI 2003/2121), as amended by SI 2004/2888 • Wales: The Air Quality Limit Values (Wales) Regulations 2002 (WSI 2002 No 3183 (W299)), as amended by WSI 2005/1157 (W.74) and The Air Quality (Ozone) (Wales) Regulations 2003 (WSI 2003/1848 (W 198)) • Scotland: The Air Quality Limit Values (Scotland) Regulations 2001 (SSI 2001/224), as amended by SSI 2002/556 and SSI 2003/428, SSI 2003/547 • Northern Ireland: The Air Quality Limit Values Regulations (Northern Ireland) 2002 (SR 2002/94) and The Air Quality (Ozone) Regulations (Northern Ireland) (SR 2003/240), as amended by SR 2002/357 and SR 2004/514
Engine emissions legislation *EU legislation:* Directive 2004/26 on the emission of pollutants from engines installed in non-road mobile machinery (amending Directive 97/68) This sets emissions limits for the first time for both diesel multiple units (DMUs) and locomotives. A first stage of limits (Stage IIIA) comes into effect in 2005, and a second (IIIB) from the start of 2011. *UK legislation*:

Not transposed at the time of writing – Directive requires implementation by 20 May 2005.

Fuel quality legislation

EU legislation:

Directive 1999/32/EC on Sulphur Content of Certain Liquid Fuels.

This requires that from 1 January 2008 the sulphur limit of gas oil must not exceed 0.1% by mass. Currently rail diesel has a sulphur content of 0.2%.

UK legislation:

- The Sulphur Content of Liquid Fuels (England and Wales) Regulations 2000 (SI 2000/1460);
- The Sulphur Content of Liquid Fuels (Scotland) Regulations 2000 (SSI 2000/169); and
- The Sulphur Content of Liquid Fuels Regulations (Northern Ireland) 2002 (SR 2002/28).

The key piece of legislation of relevance to the railway industry is Directive 2004/26 on non-road mobile machinery. The Stage IIIA emission standards will mainly have an effect in cutting emissions of NO_x and hydrocarbons, and should be fairly easy to attain as it is comparable to US standards already in force. Stage IIIB in contrast will require almost an order of magnitude reduction in particulates, and hence the use of particulate traps or deNO_x catalysts. Meeting the Stage IIIB emission limit values is likely to need much lower sulphur levels than those currently required for fuel used on the railways – probably in the 10ppm to 50ppm range – although this is equivalent to current standard for motor fuels used in road transport.

3.1.4 Options for reducing emissions

The options for reducing the emission of conventional pollutants from railways (without reducing the amount of railway traffic) could be divided into:

- Cleaner vehicles;
- Cleaner fuel; or
- More efficient use of fuel.

There is a significant overlap between the options for reducing emissions of conventional pollutants and options for reducing emissions of the greenhouse gas, carbon dioxide, which are addressed in the next section. Both currently directly relate to the combustion of fossil fuels, so will be reduced by any measure that results in less fuel use. However, there are other options that will reduce the former considerably without impacting on the latter as much. Options focused primarily on reducing emissions of carbon dioxide are addressed in Section 3.2.4, below.

As discussed above, in relation to ***cleaner vehicles***, emission standards for DMUs and locomotives have been recently set at the European level. This legislation sets

challenging targets, which will result in a significantly less polluting railway sector. Additionally, cleaner vehicles will generally require ***cleaner fuel***. In previous work undertaken by IEEP and its partners for the SRA, it was concluded that the new EU legislation will require the introduction of low sulphur diesel (of at least 50 parts per million (ppm) or even as low as 10ppm) by 2011 at the latest. In addition, many of the perceived obstacles to the introduction of cleaner fuel are surmountable or already solved, but a testing programme is needed to check the performance of low-sulphur fuel in older trains[26].

While the emission standards are a legislative requirement, and the need for cleaner fuel is likely to follow from this, action could be taken to reduce emissions from the railway sector before it becomes a requirement. This would show that the sector is taking its environmental responsibility seriously and would itself bring environmental benefits. In this case, action could be taken to introduce both the cleaner engines and cleaner fuel more quickly than is required by the legislation.

Another approach to reducing emissions from DMUs and locomotives would be to take action to clean ***existing*** vehicles. Options for achieving this include better maintenance and the retrofitting of existing engines with devices to reduce their emissions. ***More efficient fuel use*** could be achieved in a number of ways that would also have an impact on reducing regulated emissions. The rationale behind several of these would be more on reducing carbon dioxide emissions than emissions of conventional pollutants, so they are addressed in Section 3.2.4.

One potential means of reducing railway's contribution to air pollution problems in urban areas – and particularly around major railway stations – would be to reduce the time that engines are spent idling – ie the engine is left running while the train is at a standstill – to a minimum. Additionally, in order to reduce emissions in the more polluted urban areas, the cleanest trains in the fleet could be used for predominantly urban journeys. In the longer-term, there are further options, discussed in Section 3.2.4, below.

Additionally, the various parts of the industry heat, light and operate stations, depots, signal boxes, offices etc. All of these could clearly become part of a programme to introduce cleaner fuel options or more efficient equipment as it becomes life expired.

3.1.5 Responsibilities

The principal responsibility for reducing emissions of conventional pollutants on the railways clearly lies with those who own and operate the locomotives, as these are the principal source of emissions. However, while it is the TOCs that operate the locomotives, and therefore are directly responsible for the emissions of the locomotives, it is the ROSCOs that purchase and own them. Hence, it is the ROSCOs that decide which locomotives are bought and therefore the potential for emissions – or emissions reductions – that result from the operations of the TOCs. So while the TOCs can influence emissions through the way that they operate trains – eg using cleaner trains in more polluted areas and regulating idling – and can presumably also exert some influence on the purchasing behaviour of the ROSCOs, it is ultimately the

[26] IEEP's *Draft Briefing on Low Sulphur Diesel for SRA Board* December 2004

ROSCOs that can ensure that the trains that they purchase are the cleanest available. Finally, clearly, the companies that manufacture the trains have a role to play by designing and manufacturing locomotives and other units with lower emissions. It is therefore important to ensure that the correct incentives and signals are in place to encourage purchase of equipment that is environmentally beneficial, and/or can use more advanced fuels that might be introduced.

Hence, TOCs, ROSCOs and the manufacturers all need to work together if the cleaner engines required by Directive 2004/26 are to be introduced more quickly than required. Clearly the new rail directorate can show leadership by encouraging industry to take the necessary action. The SRA began this process at a Technical Summit it coordinated in 2004[27] – a process that the new Directorate could continue.

The introduction of cleaner fuel would need the cooperation of the oil companies. A similar process of introducing cleaner fuel has already occurred in the road transport sector - again, as a result partly of EU legislation. In the UK, however, the cleaner fuel was introduced more quickly than required by the legislation, as a result of the introduction of a fuel duty differential in favour of the cleaner fuel compared to the standard fuel. Hence, the role of the Treasury is important in this respect, as it needs to introduce the differential that would enable oil companies to produce enough of the relevant fuel. Given that fuel with a sulphur content of no more than 50ppm is already used on the roads and that the even cleaner fuel with 10ppm of sulphur should now also be widely available for road use, then there is no technical barrier to this option. However, the introduction of cleaner fuel may not be an attractive option for operators without a duty reduction (ie increase in rebate) in the region of 2.5p/litre[28]. This issue is discussed further in Section 4.

Measures to reduce emissions in the more polluted urban areas are clearly the responsibility of the TOCs. However, the impetus for such measures would come from the local authority, as it is responsible for ensuring that air quality targets are met in its jurisdiction. Hence, measures, such as restrictions on idling and the use of cleaner versus dirtier trains, would be agreed in negotiations between local authorities and the TOCs.

However, for the TOCs, there is a potential conflict between meeting performance targets and reducing the time that engines spent idling, as trains are often left idling to avoid the risk of delays if a train fails or has difficulty starting-up. TOCs have to balance the risk of financial penalties resulting from not meeting their performance targets against the cost of the additional fuel used when trains a left idling. The performance targets are set out in the franchise agreements, so clearly the railway Directorate will have a role in ensuring that such agreements balance performance and environmental concerns in an appropriate way.

3.2 Emissions of climate impacting gases (GHGs and ODSs)

[27] *Op cit*

[28] The fuel used by the railways is heavily rebated compared to fuel used by road transport. However, a small amount of fuel duty is payable by the TOCS for the fuel used by the railways. In the longer term, these costs are factored into franchise bids, in which case it is the SRA/DfT rail Directorate that effectively pays the fuel duty under current arrangements.

3.2.1 Issue

There is now a broad scientific consensus that greenhouse gas emissions are changing the climate, which will have implications for human health and natural ecosystems. The implication being that there is a need to reduce our greenhouse gas emissions, which, in relation to the most important greenhouse gas carbon dioxide (CO_2), effectively means reducing consumption of fossil fuels. Other greenhouse gases or relevance to the rail industry include methane, sulphur hexafluoride (SF_6) and hydrofluorocarbons (HFCs).

The climate change debate has also become linked with the issue of energy security. In light of recent political events in the Middle East and elsewhere, some western industrialised countries are looking for alternative sources of energy that will not have to rely on oil and gas supplies from volatile political regions. Linked to this is the desire for a more constant, and lower, price for energy, which is regularly effected by political events. Hence, other reasons for reducing fossil fuel use are also gaining in prominence in the wider political agenda.

A further issue relates to the use of ozone depleting substances (ODS), such as halons and chlorofluorocarbons (CFCs) in equipment used by the railways. The use of ODSs contributes to the destruction of the ozone layer that protects the earth from harmful radiation, which can damage human health.

3.2.2 Contribution of the Rail Industry

Rail transport contributes to climate change principally through the combustion of fossil fuels to operate trains – again either directly in a rail engine or indirectly at the power station – that give rise to emissions of CO_2. Rail's contribution to CO_2 emissions in the UK is around 1%, which includes its contribution to emissions at power stations. This is insignificant when compared to the contribution from road transport, which makes up around 26% of UK emissions[29]. Emissions of CO_2 per passenger- and freight-kilometre for a range of DMUs and diesel and electric locomotives compare favourably with CO_2 emissions from all other modes[30].

There are also other sources of greenhouse gas emissions associated with the rail industry:

- CO_2 emissions from road vehicles owned and operated by the industry;
- Methane emissions from landfill sites managed by Network Rail;
- Sulphur hexafluoride (SF_6), which is used as an insulator in electricity switching mechanisms;
- Additional life-cycle emissions associated with the extraction and production of the diesel fuel used by the sector; and
- Additional lifecycle emissions associated with the manufacture, maintenance and disposal of rolling stock[31];
- Hydrofluorocarbons (HFCs) in air conditioning and refrigeration; and

[29] Office of National Statistics *Op cit*
[30] Watkiss and Jones *Op cit*
[31] *Op cit*

- Additional life cycle emissions associated with the construction and maintenance of infrastructure, eg railways, stations, etc.

Additionally, climate change will have an impact on railway industry through, inter alia, a greater risk of flooding on some lines and a greater risk of heat damage in the warmer temperatures[32].

In relation to the issue of ODSs, the railways use equipment containing such substances, eg fire extinguishers, other firefighting systems used in electrical control rooms, refrigeration (in some freight carriages) and air conditioning, . However, in line with legislation on this issue (see below), which required retrofitting of old equipment by the end of 2004, Network Rail has replaced halons in fire extinguishing systems in stations and electrical control rooms. Similarly, train manufacturers are required to modify on train fire extinguishing equipment already in existence and also make sure that future equipment complies with the relevant legislation. An example of this is with Angel Trains who have spent £8m on upgrading equipment, including £3m modifying their HST power cars in the last couple of years[33]. It is unclear at the moment whether there are still any non-compliant systems.

3.2.3 Relevant Legislation

There is, as yet, no legislation directly aimed at reducing the contribution of the railway sector to climate change. Having said that, action is being taken to reduce emissions from the power generation sector and, to a lesser extent, from the road transport sector, which will contribute to reducing railways' indirect contribution. There is also a policy framework at both the European and national levels, within which policies to reduce greenhouse gas emissions are being developed, as a result of international agreements, such as the Kyoto Protocol.

Large landfills – ie those receiving more than 10 tonnes per day or with a total capacity exceeding 25 000 tonnes – are covered by the industrial pollution legislation, as are large plants that manufacture engines and other material used on railways, eg steel[34].

At present, EU legislation on the use of fluorinated gases, such as SF_6 and HFCs, is under development. As it currently stands, it would require the annual inspection, by certified inspectors, of units that use more than 3kg of HFCs a year. In the course of the research for this report, it was not possible to identify whether this would apply to railway coaches with air conditioning or not. Any measures to address existing uses of SF_6 would certainly be of relevance to the railway system.

Recent EU legislation has banned the use of most of ODS, eg fire protection systems and fire extinguishers using halon had to be decommissioned by the end of 2003 and

[32] *Op cit*
[33] ADL (2003) *Op cit*
[34] Directive 96/61 on integrated pollution prevention and control, as implemented in the England and Wales by the Pollution Prevention and Control (PPC) Act 1999 and The Pollution Prevention and Control (England and Wales) Regulations 2000, SI 2000/1973 and amendments, in Scotland by the Pollution Prevention and Control (Scotland) Regulations SSI 2000/323 and in Northern Ireland by The Pollution Prevention and Control Regulations (Northern Ireland) 2003 (SR 2003/46).

the ODS therein contained had to be recovered. However, it is worth noting that the use of halon 1301, the use of which is banned for most purposes, is allowed in the Channel Tunnel and associated installations and rolling stock.

It is also worth noting, at this point, the potential relevance of recent developments in public procurement policy. Recent European court cases and European legislation have underlined that it is justifiable for public bodies to take into account environmental considerations when undertaking public procurement. For example, it is justifiable to award contracts to a more expensive, but 'greener' bid[35].

3.2.4 Options for reducing emissions of greenhouse gases and ODS

As with emissions of conventional pollutants, emissions of CO_2 from the railway sector can be reduced by cleaner vehicles or appliances, cleaner fuels and the more efficient use of fuels. Of the options suggested for reducing emissions, which were discussed in Section 3.1.4, those relating to using less fuel, eg by reducing idling, would directly reduce CO_2 emissions, whereas many of the others focus primarily on reducing conventional pollutants. There are, however, other options for cleaner vehicles and fuels and the more efficient use of fuel, which focus primarily on reducing CO_2 emissions, although many will have the additional benefit of reducing emission of conventional pollutants.

In the short-term, options for ***cleaner fuels*** include the use of alternative fuels, some of which, such as emulsions and biodiesel, are variations on conventional diesel. At the time of writing we are not aware of any serious consideration of using biodiesel on the rail network. This is now under active consideration for road vehicles, probably in a blend of up to 5% in conventional diesel. This offers some CO_2 benefits, and it appears likely that a similar approach would be technically possible for rail engines. However, it appears likely that biofuels will remain too expensive for use in rail engines, and better applications will be found for them on the roads.

Another potential means of reducing rail's indirect CO_2 emissions is for the railway network to source its electricity from renewable sources, such as wind energy and hydroelectric power. For example, in Sweden since 1999, new rail services purchase electricity produced from renewable sources[36]. In this context, further electrification of the network might be beneficial. While public opinion regarding wind power is not yet positive, there may be the potential for requiring that additional electricity be purchased from renewable sources.

In the longer-term, fuel cells offer decisive environmental advantages for displacing diesel rail. The relatively large size of rail engines, especially in locomotives, makes them very suitable applications. They might well be applicable to multiple units, and might also offer a 'halfway house' configuration with a centralised fuel cell stack located in a set that is otherwise composed of units similar to modern-day EMUs. This would provide a far cleaner and more efficient solution when compared to current diesel electric engines. An unresolved issue, however, relates to how they

[35] See relevant webpages of the Office for Government Commerce: http://www.ogc.gov.uk/index.asp?id=1000084

[36] UIC (International Union of Railways) *Railways and the Environment Contributions to Sustainabe Mobility: Examples of Good Practice* September 2001

would be fuelled (and possibly even what will emerge as the preferred fuel cell technology for rail). Hydrogen is currently the preferred option for road-based mobile fuel cells, but a range of options could be possible for rail. These include hydrogen reformed from natural gas and stored at refuelling points; or methanol or even a more conventional hydrocarbon fuel which would be reformed on the train.

These advanced fuelling options are discussed further in Section 5.

In relation to the ***more efficient use of fuel***, it is worth noting at this stage that a potential source of energy loss in trains – the interface between the wheel and the rail – is already friction-efficient and is therefore energy-efficient. However, braking on railways is a significant source of energy loss. Earlier work undertaken by IEEP and its partners for the SRA found that there is the potential to save significant amounts of energy through the application of regenerative braking (RB). This allows a train to recapture and store part of the kinetic energy that would ordinarily be lost when braking by using the motors as generators to slow the train. The energy is then transmitted back along the supply chain, where it can be used by another train operating on the same circuit, or in some cases can be fed back into the grid. The potential savings were found to be significant. RB is widely used on the continent and elsewhere in the world, and as a consequence most new trains in the UK are fitted as standard with RB capability. However, owing to a range of technical factors relating to compatibility with power supply systems, the RB capability has to be switched off in most areas of Britain, and the benefits are lost[37].

Options for reducing other emissions of GHG and ODS from the rail industry include:

- ***CO_2 from road vehicles:*** The CO_2 emissions from the industry's road vehicles can be reduced through the purchase of low emission, or fuel-efficient vehicles. New cars already have a label indicating their CO_2 emissions and fuel efficiency, while such data for vans will be available soon. For heavier vehicles, manufacturer's data on fuel economy is also usually readily available. Procurement rules could ensure that the lowest emission/most fuel efficient vehicles are purchased.
- ***CO_2 emissions from production and manufacturer of purchases:*** Procurement policies could be required to take the environmental record of suppliers, including suppliers of rolling stock, track, fuel and other raw materials, into account, which could include *inter alia* emissions of CO_2.
- ***Methane emissions from landfill:*** All the landfills owned and operated by the industry should be required to utilise good practice in terms of methane capture and disposal.
- ***SF6:*** Better management of existing equipment and the availability of alternatives requires investigation.
- ***HFCs:*** Regular checks should be made on all refrigeration and air conditioning systems to ensure that leakage is minimised. In addition, for end-of-life systems, it should be ensured that all HFCs are recovered and disposed of appropriately.

[37] IEEP's *Briefing on Regenerative Braking for SRA Board* December 2004

The railway industry also needs to prepare for climate change by adopting ***adaptation measures*** to ensure that the industry responds to changes brought about by climate change. A first step might be to identify the tracks, stations and other railway property that might be adversely affected by climate change, eg by identifying the railway infrastructure at risk from flooding using data from the Environment Agency. The EA's flood risk maps could be mapped onto the railways and stations to identify where action might need to be taken to protect infrastructure from flooding. Additionally, the potential impact on railways that run alongside the coast should also be identified. Once the risks to infrastructure have been identified, decisions would need to be taken as to how to respond to the risk. Recent experience also illustrates that excessive heat can have severe detrimental effects on rails and may cause them to buckle. Modified standards or operating procedures are likely to be needed to address this problem.

3.2.5 Responsibilities

The responsibility for reducing emissions of GHG and ODS from the rail industry is shared between a range of actors. Hence, the new rail Directorate will have to work in partnership with different stakeholders depending on the issue to be addressed.

In relation to ***cleaner fuels***, similar issues arise to the possibility of increasing the use of cleaner conventional fuels (see Section 3.1.5). The use of cleaner fuels, such as emulsion or biodiesel, is likely to prove an expensive option, which will not make economic sense as a rebated fuel particularly without substantial additional government support. Currently the government remains sceptical of the cost-benefit ratio of liquid biofuels for the road sector; so it seems very unlikely that it would go even further to encourage their use for rail. Already the duty differential between on-road biofuels and conventional fuels is 20p/litre, and this is claimed to be insufficient to stimulate a major domestic biofuel market. Given the low level of total duty on rail fuel, it therefore seems unlikely that it would be possible or cost-effective to establish sufficient incentive to use biodiesel on the railways.

In relation to the use of cleaner electricity, there are two potential options for increasing the amount of renewable energy used by the rail industry. The first – the railway industry building its own renewable capacity, eg by trackside wind turbines – is likely to be a complicated and expensive option. The new DfT rail directorate would have to work with Network Rail, and suppliers of the technology, to identify suitable locations for the new generation infrastructure. As noted above, wind turbines currently face problems of public acceptability, so are not likely to be a viable option, at least in the short- to medium-term. Alternatively, DfT could work with Network Rail to ensure that the latter increases the amount of renewable electricity it purchases from suppliers. One possible approach might be to follow the example of Sweden and purchase electricity for additional services from renewable sources, which would, at least, mean that there would be no additional contribution of the railways to GHG emissions in the event of an increase in service levels. In the longer-term, however, as the renewable capacity of the UK electricity generation sector increases, it might well be possible to supply all the industry's electricity needs from renewable sources. Another option for the longer-term, might be for the new rail Directorate to work with the industry, notably the TOCs and locomotive suppliers, to introduce other technologies, such as fuel cells. However, the decision to develop fuel cells is part of

a more strategic decision concerning how the railways should be powered in the future (see Section 5.1).

Research undertaken by the Open University suggests that the incentive for ***fuel efficiency*** appears to be considerably diluted under the privatised structure compared to the previously nationalised integrated railway system[38]. Previously, the operating divisions of British Rail reaped all the benefit of investing in more fuel-efficient rolling stock. However, under the privatised structure, such rolling stock would have a premium on its leasing charge and, if electric, the Network Rail charging system can only roughly compensate for the lower fuel demand. Another effect relates to fuel choice and train design. Reviews of literature suggest that diesel rather than electric traction seems likely to be favoured in the privatised railway. There is even talk of de-electrifying some major routes (eg the West Coast Main Line). Privatisation is also leading to somewhat lower-cost, conservative technologies being preferred over innovative, efficient designs. This is because diesel traction reduces the complex interface with Network Rail as:

(a) electric power is purchased from Network Rail;
(b) new electric trains face very rigorous (and controversial) safety procedures to ensure their electrical systems do not cause interference with signalling. This has caused very serious difficulties with rolling stock manufacturers;
(c) any incidents or breakdowns involve penalty payments – with less electrical interface for diesel trains, legal costs are likely to be lower. Also diesel passenger trains are multiple-engined and so a breakdown can be less disruptive.

Overall, legal relationships and litigation risks are pushing companies towards traditional technologies, materials and designs, although the need for flexibility means designs incorporating innovative, flexible internal layouts are being combined with conservative engineering. Clearly, the new rail Directorate will need to work with the TOCs and the ORR to reduce such barriers to ensure that new and cleaner technologies can be introduced were appropriate.

More broadly, the rail Directorate should work with Network Rail to ensure that the latter contributes to improved fuel efficiency through track redesign, eg realignments to reduce braking and enable better acceleration. Network Rail also has a role to play in ensuring that potential users are not put off from utilising the network by introducing working practices, eg in relation to track maintenance, which keep the railway open. It could also work with freight companies to develop quick load/unload methods at lineside platforms adjacent to factories/industrial estates so that boxes can be shifted to/from regular interval freight services. The rail Directorate should also work with Network Rail, the ORR and TOCs, as necessary to ensure that the potential benefits of RB can be utilised.

Network Rail would also be the rail Directorate's principal partner in reducing methane emissions from the former's landfill sites. In addition, the rail Directorate should work with the relevant authorities, eg ORR, to ensure that regular checks are

[38] Potter S, Roy R and Jablonski A (1996) *The Strategic Environmental Implications of Rail Privatisation* Open University

undertaken on all refrigeration and air conditioning systems to ensure that leakage is minimised.

In relation to procurement, clearly the principal responsibility for such decisions lies with the private company undertaking the purchasing. However, the rail Directorate has a role in working with the other parts of the industry to encourage more environmentally-beneficial procurement. Given that Network Rail is likely to be the industry's largest procurer, it would make sense to focus the initial attention in this respect to ensuring that Network Rail's procurement policies take environmental considerations into account.

Such an approach has been taken in Belgium, where the national rail company (SNCB-NMBS) has worked with one of its steel suppliers to improve the environmental performance of freight wagons used to transport steel[39]. There are also examples in other countries, where rail companies, eg Germany's DB or Netherlands' NS, have worked together with national government to improve the energy efficiency of the sector. Examples of action taken include new traction units and locomotives, improvements to air conditioning and amendments to the timetable to allow for more 'coasting', which can save energy[40].

From the perspective of taking action to mitigate the impacts of climate change, clearly Network Rail has a key role to play, but there is no reference to such issues in its Environment and Safety plan update[41]. The DfT's rail Directorate, therefore, needs to take the lead and work with Network Rail and others to ensure that the risks to the country's rail network posed by climate change are assessed and that appropriate action is taken.

3.3 Noise and vibration

3.3.1 Issue and contribution of the rail industry

The 1990 Noise Incidence Survey identified that railways were a source of at least background noise at around 15% of the dwellings that were surveyed. However, no systematic assessment of the impacts of railway noise have yet to be carried out for the UK[42]. The European Environment Agency quotes research based on evidence form France, Germany and the Netherlands, that estimates that 10% of the EU population is exposed to noise levels from railways that are considered to be highly annoying (ie 55 dB LAeq)[43].

[39] UIC (2001) *Op cit*
[40] *Op cit*
[41] Network Rail (2004) *Op cit*
[42] DEFRA (2001) *Towards a National Ambient Noise Strategy: A Consultation Paper* see http://www.defra.gov.uk/environment/consult/noiseambient/pdf/ambientnoise.pdf
[43] EEA (2001) *Traffic Noise: Exposure and Annoyance* Indicator fact sheet accompanying the TERM 2001 report, see http://themes.eea.eu.int/Sectors_and_activities/transport/indicators/consequences/noise_exposure/Noise_TERM_2001.doc.pdf

The main sources of railway noise are[44]:

- the wheel/rail rolling contact;
- wheel impact on rail joints where the rail is not continuously welded;
- sliding contact of wheel flanges resulting in 'wheel squeal' and wheel flats;
- rail corrugations;
- diesel engines.

In general, electric trains are considerably quieter than diesel trains, while new diesels are better than old.

There are also concerns reinforced by WHO reports that long term sleep disturbance from noise sources such as train horns can affect the health of residents in close proximity to railways. Moreover there is also the issue of noise from the announcement of travel information across tannoys. Network Rail receives a number of complaints about both of these sources[45]. There is however a need to balance the provision of travel information to customers, while keeping neighbouring residents happy. As well as the use of the tracks and stations, another source of noise is from railway depots, and these can cause particular annoyance and disturbance when they operate at night.

With the increasing development of new housing in the UK, developers are now frequently building adjacent to railways. At present there is no formal responsibility for railways of any noise impact that their operations may have on new residents. Whilst Planning Policy Guidance Note 24 stipulates that developers must bear some responsibility for any nuisance caused to residents of properties near to railways this is not mandatory, and currently there is no onus of responsibility on the railways. However, if traffic levels increase, along with a subsequent increase in noise levels, it may be that Network Rail will be required to pay costly mitigation measures in the future.

3.3.2 Relevant Legislation

The most significant piece of noise legislation with which the industry will have to deal in the future is the EU Ambient Noise Framework Directive[46]. The Directive requires that strategic noise maps be developed by no later than 30 June 2007 for *inter alia* railways which have more than 60,000 train movements per year[47], which equates to approximately 13% of the UK network[48]. By July 2008, the relevant competent authorities,[49] will have to draw up action plans to reduce noise exposure in the

[44] DEFRA (2001) *Op cit*
[45] ADL (2003) *Op cit*
[46] Directive 2002/49 on the management and assessment of environmental noise; see IEEP's *Manual of Environment Policy: The EU and Britain* Maney (2005).
[47] Noise maps and action plans also have to be prepared for all agglomerations of more than 250,000 people, major roads that carry more than six million vehicles a year and airports with more than 50,000 annual aircraft movements.
[48] ADL (2003) *Op cit*
[49] The legislation has not yet been finalised in the UK, but it is likely that the competent authority will be the respective local authority. The action plans required to reduce noise are analogous to the action plans required to reduce air pollution (see Section 3.1.3).

appropriate locations. By 2012, and every five years thereafter, strategic noise maps for railways that have 30,000 train movements per year[50], which equates to approximately 35% of the network, will be required to produce strategic noise maps. Similarly, action plans will have to be drawn up to reduce exposure where relevant. Network Rail has estimated that the implementation of the Directive may cost up to £1.2billion[51]. DEFRA is currently in the process of developing the necessary UK legislation[52].

At the European level, further work is being undertaken to identify and assess sources of noise pollution and further legislation, possibly relating to noise from particular sources, could follow. It should be stressed that the legislation outlined above applies equally – or in effect more so – to road infrastructure. Thus while the results of noise mapping may highlight the issue of rail noise, they will probably also underline the much greater and more widespread problem of road noise.

In the UK, the most relevant existing legislation is[53]:

- **Environmental Protection Act 1990 (Part III as amended by Noise and Statutory Nuisance Act) 1993.** Of relevance here is that local authorities are required to investigate any complaints of noise made by the public, if certain conditions are met. If a complaint is upheld, notice is served on the person responsible for the nuisance. This could take the form of either an abatement of the nuisance or works to abate the nuisance; conversely prohibition or restriction of the activity may be required. Although noise and vibration caused by the railways is not specifically exempt from statutory nuisance regulations there are very few cases that have been bought to court at the time of writing.
- **Noise Insulation (Railways and other Guided Transport Systems) Regulations 1996.** These regulations apply to any authorised new, additional or altered railway lines and those responsible for managing any such works are required to provide residential properties within 300m of the track with insulation against noise or to pay a grant for the work to be carried out in line with a number of criteria regarding predicted railway day and night time noise levels at the property.

In the short- to medium-term, the impact of the recent EU legislation, and particularly the way in which DEFRA decides to implement it, could have significant implications for the rail industry in terms of the action that it must take to reduce noise.

3.3.3 Options for reducing noise from the railways

There are a number of technical and operational options for reducing noise from the rail industry. Watkiss and Jones list a range of technical measures that would reduce the noise generated by train movement, eg adaptation to wheels, brakes and rails, as well as mitigation measures, such as erecting trackside barriers and redesigning bridges. They are also list more strategic measures, eg not building new lines near

[50] By this stage, strategic noise maps and action plans have to completed for all agglomerations of over 100,000 people and roads carrying more than three million vehicles a year.
[51] ADL (2003) *Op cit*
[52] http://www.defra.gov.uk/environment/consult/noiseambient/pdf/ambientnoise.pdf
[53] Watkiss and Jones (2001) *Op cit*

properties and operational methods, eg lower train speeds and less traffic. Similarly, there are a number of measures for reducing vibration[54]. Action, such as noise barriers, could also be taken to reduce the noise from depots, eg Hinksey depot required a noise barrier.

Some of these measures are already in operation in some instances or are under consideration.

3.3.4 Responsibilities

The responsibility for reducing noise from the railways is divided between several different actors. For the noise generated directly from the operation of the trains, the responsibility lies with the TOCs and the ROSCOs. The latter could purchase quieter trains, while the former could work with the ROSCOs to ensure that it can lease quieter trains. Once a train has been leased it is clearly the responsibility of the TOC to make sure that the train is maintained properly to ensure acceptable noise levels in the course of its operation. Additionally, the manufacturers of the trains have a role to play. Responsibility for ensuring that the infrastructure makes its contribution to reducing noise lies with Network Rail.

At the moment, however, there is no strategic legislative framework to stimulate action on noise from the railways – rather action is taken in response to the existing legislation, eg complaints from those living near tracks, stations or depots. This is likely to change as a result of the legislation to implement the noise framework Directive. The Directive will require action to be taken to reduce noise and it is likely that local authorities will have to engage with the rail industry in certain locations to achieve this. It is likely, as with the equivalent air quality legislation, that specific action will be taken forward on a bi-lateral basis between local authorities and the TOC and/or Network Rail. While overall responsibility for the implementation of the legislation will lie with DEFRA, the DfT rail Directorate clearly has a role in ensuring that the industry is aware of the potential need for action and to facilitate this process, as appropriate.

3.4 Waste and resource use, including litter, landfill and aggregates extraction

3.4.1 Issue

The EU generates approximately 1300 million tonnes of waste per year[55]. Construction and demolition make up more than half of this total, with municipal, mining and waste from other sources contributing about one sixth of the total each. It was estimated that in 1995 waste generation amounted to 3.5 tonnes of solid waste (excluding agricultural waste) per capita, and it was expected that this figure would increase, as it had increased by 10% between 1990 and 1995[56]. Most waste streams are expected to increase with the amount of waste paper and cardboard, glass and plastic increasing by between 40% to 60 by 2010, and significant increases also expected in sewage sludge, electrical and electronic waste and end of life vehicles.

[54] *Op cit*
[55] EEA (2001) *Environmental Signals* European Environment Agency, Copenhagen.
[56] EEA (1999) *Environment on the EU at the turn of the century* European Environment Agency, Copenhagen.

The hazardous content of waste is also a problem as products become more sophisticated and technologically intensive. It is estimated that EEA member countries generate around 36 million tonnes of hazardous waste per year[57].

Options for disposing of all this waste include landfill, composting for organic waste and incineration. Further, waste can be either re-used or recycled, which at least delays the final date of disposal and potentially means that virgin resources do not have to be used. The environmental consequences of waste depend on how it is disposed of. If material is re-used or recycled, then less natural resources and energy could be used compared to if virgin resources had to be extracted and processed, for example. The landfill of waste leads to emissions of methane, CO_2 and odours and the potential pollution of soil and water with hazardous and other pollutants. Incineration, on the other hand, also potentially leads to emissions to the air of a range of pollutants, and the pollution of water and soil. In addition, the ashes from incineration are usually landfilled[58]. However, the amount of suitable landfill sites is running out and incineration – in spite of being subject to strict emission standards – is always a source of concern for those living near such plants. Hence, there is pressure to reduce waste generation at source, and this is likely to intensify in the future.

3.4.2 Contribution of the Rail Industry

There are a number of potential sources of waste in the railway sector:

- Waste generated from the disposal of locomotives and carriages;
- Waste generated in the refurbishment of locomotives and carriages;
- Sleepers and ballast;
- Construction waste;
- Rubbish generated at stations and on board trains;
- Toilet waste from trains; and
- Waste oils.

Waste from railways, therefore, can be associated with the vehicles themselves, the infrastructure, or the operation of the trains or other facilities, such as stations. In relation to the vehicles, railway locomotives, DMUs and carriages typically last longer than on-road vehicles, as they are regularly refurbished, which extends their lifespan to around 30 years. However, both refurbishment and final disposal leads to waste that has to be disposed of.

Network Rail uses 2.5 million tonnes of new ballast each year and lifts 1.5 million tonnes. The lifted old ballast is returned to Local Distribution Centres where it becomes the responsibility of the ballast supplier to dispose of, although much of it is recycled[59]. Paved track is up to 1.3 times more expensive to install but significantly reduced maintenance results in pay-back in 9 years, while removing the ballast disposal problem. Furthermore, because of the greater rigidity of paved track the kinetic envelope can be reduced – when building new tunnels this can lead a cost

[57] EEA (1999) *Op cit*
[58] Monkhouse and Farmer (2003)*Applying Integrated Environmental Assessment to EU Waste Policy: A Scoping Paper for the European Forum on Integrated Environmental Assessment (EFIEA)* IEEP; see http://www.ieep.org.uk/PDFfiles/PUBLICATIONS/EFIEA%20Waste-%20final%20report.pdf
[59] Watkiss and Jones (2001) estimated that, for example, in 1999, 95% of lifted ballast was recycled.

reduction of up to 30%. In addition, any construction of new infrastructure, eg track, stations, etc, will result in construction waste.

The operation of the trains produces waste in the form of litter from the on-board buffets, etc, toilet waste from the trains and waste oils. The on-board buffets generally utilise disposable cups and other packaging, which needs to be disposed of.

In relation to toilet waste, new trains tend to have retention tanks built into their design to store toilet waste, while some of the older 'slam-door' rolling stock and some high-speed diesel trains still deposit waste on the tracks. The problem is further exacerbated in areas where trains are spending more time in stations. Two main issues of concern arise from this. The first relates to the health implications for workers on the tracks who are in close proximity to the waste. The second issue relates to complaints from passengers who have sighted toilet waste on the tracks at they wait for trains at the platform. A recent number of complaints and notices served under the Public Health Act (1936) as a result of toilet waste on the tracks has led to an increase in requests for abatement measures[60].

In relation to waste oils, many depots already have arrangements with sub-contractors who collect waste oil for recycling. Most major stations in the UK have waste compactors, but there appears to be little or no recycling.

3.4.3 Relevant Legislation

The most significant legislation for the railways, as with other sectors, in relation to waste is that relating to landfill. The EU Directive on the landfill of waste and its implementing Regulations in the UK have implications for the operation and management of landfill sites, and, in the longer-term, implications on the amount of waste going to landfill[61]. In addition the UK has introduced a landfill tax in an attempt to reduce the amount of waste that is going to landfill with the aim of encouraging, either other forms of disposal or more re-use and recycling. The rate at which the tax is levied increases each year – Network Rail has estimated that in 2003, £650,000 will be needed for disposing of the 50,000 tonnes of landfill waste produced by Network Rail contractors each year[62].

Other relevant legislation includes[63]:

- **Public Health Act (1936)** with regard to toilet waste. This legislation allowed local authorities to require removal of 'any accumulation of noxious matter' and gives them the power to serve abatement notices and to prosecute offenders.
- **Environmental Protection Act (1990).** Section 33 of the Act prohibits the deposit, treatment, keeping or disposing of controlled waste except under and in accordance with a waste management licence, and in a manner which is not likely to cause pollution or harm to human health. A duty of care is imposed on any

[60] ADL (2003) *Op cit*
[61] Directive 1999/31/EC on the landfill of waste, implemented in England and Wales by the Landfill (England and Wales) Regulations (2002).
[62] ADL (2003) *Op cit*
[63] *Op cit*

person who holds a licence; this has implications for Network Rail who must ensure its contractors manage their waste correctly.

- **Waste Managing Licensing Regulations (1994)** with regard to litter and flytipping. This Regulation places a duty on planning authorities to include policies for suitable waste disposal sites and installations in their development plans.
- **Aggregate Levy Regulations (2002, 2003)** which apply a levy to the commercial exploitation of aggregates extracted in the UK. For the railways, this applies to ballast and aggregates used in concrete sleepers.

Network Rail's Environment and Safety Plan[64] commits the organisation to identifying and quantifying waste streams for maintenance waste, construction waste and hazardous waste, and to setting targets to reduce these, where appropriate.

3.4.4 Options for reducing waste

In order to reduce rail's production of waste, there is a need for the DfT rail Directorate to work with a range of actors. Clearly, an important actor is Network Rail, which has already committed itself to identifying, and, if appropriate reducing its waste streams. Network Rail's contribution to the industry's waste streams will principally be in relation to the maintenance and construction of the infrastructure. Consideration could be given to more creative uses for old ballast and sleepers, bearing in mind that the potential uses are limited, eg old wooden sleepers can no longer be used in any horticultural applications.

In other European countries, eg Norway and Germany, there are recycling bins on both trains and stations, which can increase the amount of recycled waste generated by passengers. However, in the UK, the national culture towards recycling is a lot less well developed than in these countries, so it is unlikely that the introduction of separate recycling bins in trains and on stations would be that much of a success in the short-term. However, with the increase in domestic recycling, the provision of such bins on trains and at major stations might be a way of testing the ground to see whether train passengers can change their behaviour in this way. Additionally, a future government must take positive action to increase recycling in the UK, so a positive lead from the railways could be complemented with broader initiatives. One way of reducing the environmental impact of litter on trains and stations would be to require buffet cars and food outlets on stations only to use recyclable, recycled and biodegradable packaging. This would have the advantage of reducing the resources needed in the production of packaging material, allow it to be recycled and enable it to decompose in the event of its being landfilled.

3.4.5 Responsibilities

Network Rail has established local distribution centres (licensed as waste transfer stations) to manage large waste streams from engineering sites for sleepers, rail and ballast. As holders of waste management licences the implications for Network Rail of the upgrading of waste management licenses at landfill sites, under the Landfill Regulations 2002 means that Network Rail are surrendering licenses at landfill sites

[64] Network Rail (2004) *Op cit*

which will require a number of measures to ensure their safe closure[65]. Given that Network Rail has committed itself to reducing its waste, the DfT rail Directorate could work with Network Rail to ensure that any targets that its sets itself are challenging and to help it meet these targets.

In relation to toilet waste, the TOCs, ROSCOs and train manufacturers are clearly key players. As with other issues, there is the potential to add clauses to franchise agreements (between the DfT and the TOCs, for example) to ensure that all trains that are used retain their toilet waste and to ensure that this is disposed of properly. Alternatively, for existing franchises, the DfT rail Directorate could work with TOCs and ROSCOs to ensure that the new trains coming onto the market in the UK retain their toilet waste. Clearly, the most difficult problem in relation to toilet waste is addressing existing trains that cannot retain toilet waste, and there is very little space available to retrofit such equipment. Work will have to be undertaken with the TOCs to identify innovative solutions.

Network Rail would also be a key partner in introducing recycling bins on major stations and requiring food outlets on these stations to use recycled, recyclable and biodegradable packaging. The latter could be introduced into the leasing agreements with the operators of food outlets. On other stations, the TOCs are responsible for such issues, so would need to be brought on board.

3.5 Habitats and biodiversity

3.5.1 Issue

The majority of railway infrastructure in the UK is constructed in agricultural areas. There are numerous beneficial impacts of railway infrastructure in relation to habitats and biodiversity, through their provision of wildlife corridors, particularly in urban areas. However, conversely where railways pass through areas of natural habitat such as conservation areas they can have negative impacts such as fragmentation of the habitat. Nonetheless it is likely that the severance effect is less severe than with roads because level of traffic is much lower, and the active area covered in aggregate is much narrower, so animals have more opportunity to cross tracks. However, rail infrastructure does impact on a number of wetland sites covered under the Ramsar Convention. According to the TERM report approximately 52% of UK wetland sites have rail infrastructure within 5km of their centre, which is the highest percentage in the EU. Moreover approximately 330 Sites of Special Scientific Interest (SSSI) are intersected by the rail network in the UK. The report also concluded that 44% of special bird areas have major rail infrastructure within 5km of their centre[66].

3.5.2 Contribution of the Rail Industry

Broadly, land used for the railways is either covered in ballast or is managed vegetation. In addition, there is land used for buildings, such as stations, depots, signal boxes, etc. Whilst the total land take from the railways is considerably lower than that for roads, issues may arise from proposed capacity upgrades that may occur in the

[65] ADL (2003) *Op cit*
[66] EEA (2000) Are we moving in the right direction? Indicators on Transport and environment integration in the EU , see http://reports.eea.eu.int/ENVISSUENo12/en/term2000.pdf

future. For instance, the 10 year plan which highlights the need for additional land take in which to upgrade the East Coast Main Line and Great Western Main Line and Thameslink[67]. However, any significant projects will be subject to EIA and addressed on a site by site basis. Note that the requirements of the SEA Directive may also be relevant to plans such as these (see Section 4.2).

3.5.3 Relevant Legislation

Relevant UK legislation includes[68]:

- **Wildlife & Countryside Act (1981)**. This is the principal mechanism for the legislative protection of wildlife in Great Britain. It is organised n three main parts; Part I gives protection to listed flora and fauna; Part II deals with the protection of Sites of Special Scientific Interest (SSSI) and Part III deals with Public Rights of Way.
- **Countryside and Rights of Way Act (2000)** – this creates a new statutory right of access to open country and registered common land, provides greater protection to Sites of Special Scientific Interest (SSSIs), and better management arrangements for Areas of Outstanding Natural Beauty (AONBs), it also strengthens wildlife enforcement legislation.

3.5.4 Options and responsibilities for protecting habitats and biodiversity

Network Rail has agreed in partnership with English Nature to develop Site Management Statements for all SSSIs on Network Rail land, at a cost of approximately £2k per site, or £660k in total[69].

More generally, the practice of cutting down trees next to railway lines (in an attempt to avoid leaves on the line) has led to image problems for the railways, if not actual adverse impacts on biodiversity. It is recognised that the Highways Agency, which is responsible for national roads, manages its verges well and has a substantial tree-planting programme along road verges. In comparison the management of habitat alongside railways has suffered as a result of the focus on short-term financial performance. The railways could learn from the Highways Agency and need to experiment with habitat and biodiversity management more.

3.6 Contaminated land and hazardous substances (PCBs, fuel storage)

3.6.1 Issue

Contaminated land has become a major issue in the UK over the past few decades. However, currently a comprehensive list of sites of contaminated land does not exist. A government report in 1993 estimated that of approximately 39,600 hectares of derelict land in the UK, 80% could possibly be contaminated. The railway's role in contributing to the issue of contaminated land has been highlighted as a particular problem. Indeed Railtrack estimated that approximately 600 sites which have been

[67] Watkiss and Jones (2001) *Op cit*
[68] ADL (2003) *Op cit*
[69] ADL (2003) *Op cit*

used for railway operations could be contaminated. The majority of these have arisen from the storage of diesel used in maintaining and refuelling locomotives[70].

3.6.2 Contribution of the Rail Industry

Railway operations can result in a number of incidences of hazardous substances being released into the environment leading to contaminated land[71]:

- Fuel spills: ground soil can be contaminated during the re-fuelling of diesel engines.
- De-icing: Railtrack's spraying of de-icing fluid on the tracks is also responsible for some contamination of land.
- Pollution from lubricants such as coolants and hydraulic oils used in locomotives and cleaning chemicals.
- Contamination from ballast: end of life ballast and construction waste from Railtrack activities can become contaminated.

3.6.3 Relevant Legislation

Relevant legislation includes[72]:

- **Environmental Protection Act: Part IIA (1990) –** This provides an improved system of identifying and remediating contaminated land. Within this Act contains a specific means to require the remediation of historically contaminated land where this is not already taking place voluntarily.
- **The Environment Act of 1995** - this introduced a regulatory system for the identification and remediation of contaminated land, based on the 'suitable for use' approach. Local authorities have a duty to inspect areas to identify contaminated sites.
- **Environmental Protection (PCB and other dangerous substances) Regulations (2000**)– companies are required to register residual stocks of PCBs contained in a receptacle and items of equipment containing PCBs where there total PCB content exceeds five litres. Requirements for labelling and disposal are also specified.

3.6.4 Options for reducing rail's contribution to land contamination

The main problems arise from routine operations such as fuel spills, de-icing chemicals and releases that occur as a result of operations at stations and depots such as waste generation and disposal. The majority of these occur rarely and could be largely controlled through good site practice and routine environmental management systems.

On the other hand there is a larger problem with contaminated railway land across the rail network, in view of the fact that disused railway land is automatically assumed to

[70] Watkiss and Jones (2001) *Op cit*
[71] Watkiss and Jones (2001) *Op cit*
[72] Watkiss and Jones (2001) *Op cit*

be contaminated. In this respect it might be more economic to keep a corridor as a railway than to decontaminate it.

3.6.5 Responsibilities

Each respective TOCs' Railway Safety Case requires the presence of an environmental policy, which could be made to include a good practice guide on contaminated land. In cases where land causes unacceptable risks to human health or the environment remedial action should be taken. However, at present little information has been collated on details of railway land contamination. The identification of location of sites and the size and extent of contamination should be a priority for future action.

There is an issue of historical pollution from the railways for instance the legacy of contaminated railway land across the rail network. The DfT rail Directorate will inherit responsibility for some of these sites from the SRA, while Network Rail retains responsibility for others[73].

3.7 Water pollution

3.7.1 Issue

Water contamination can result from a number of sources with pollutants entering the surface or groundwater directly, in turn such pollutants may emerge eventually in surface water and then may run off the land. Pollution may arise as point sources, such as discharges through pipes, or may be more dispersed and diffuse. Both point source and diffuse water pollution may be exacerbated by adverse weather conditions.

Contaminants known to be associated with transport and transport related activities include[74]:

- Particulates (eg carbon, organic solids, rubber, plastics, grit, asbestos etc);
- Metals (eg Ni, Zn, Mg, Mn, Fe, Pb, Cu, Ca, B, Cr etc);
- Hydrocarbons (eg Aliphatic HC, PAH, phenols, bitumen, PCB's, herbicides, asphalt, solvents etc);
- Salts and nutrients (eg nitrates, sulphides, chlorides, phosphates, urea, bromide, cyanide etc); and
- Others (eg Microbial, nitrogen oxides etc).

[73] Watkiss and Jones (2001) *Op cit*
[74] source?

3.7.2 Contribution of the Rail Industry

As with land contamination, railway operations can result in a number of incidences of hazardous substances being released into the environment leading to contaminated surface and groundwater, eg[75]:

- Fuel spills: ground water can be contaminated during the re-fuelling of diesel engines.
- De-icing: Railtrack's spraying of de-icing fluid on the tracks is also responsible for some contamination of ground water.
- Pollution from lubricants such as coolants and hydraulic oils used in locomotives and cleaning chemicals.

3.7.3 Relevant Legislation

Relevant legislation includes:

- **Water Resources Act (1991).** This regulates discharges to water, and includes track drainage issues.
- **Groundwater Regulations (1998).** This prevents the discharge of List I toxic substances into the groundwater. List I includes substances such as oil.
- **EU Water Framework Directive.** The framework will cover more diffuse sources of water pollution such as those affecting the track and which may affect particular water catchment areas.

3.7.4 Options and Responsibilities for reducing rail's contribution to water pollution

As with land contamination the main problems in relation to water pollution arise from routine operations such as fuel spills, de-icing chemicals and releases that occur as a result of operations at stations and depots such as waste generation and disposal. Similarly, these could be largely controlled through good site practice and routine environmental management systems.

One option that has recently been used on South East section of the channel tunnel is called Tricky Track. This involves an absorbent fabric placed on the track that retains oils. The tiered construction of the trays allows rainwater to bleed off at regular intervals through RP18 filter packs[76].

As before with land contamination, the encouragement/enforcement of the introduction of Environmental Management Systems for manufacturers, and train and freight operating companies. In relation to this each TOC is required to write a Railway Safety Case which should include an environmental policy. This could be made to include a good practice guide on contaminated water.

[75] Watkiss and Jones (2001) *Op cit*
[76] see http://www.opec.co.uk/casestudies_opsr02.html

3.8 Light pollution

3.8.1 Issue

Light pollution occurs as a result of the use of artificial lights such as street lightening, advertising and display lighting and floodlights. This results in a brightening of the night sky caused by artificial light being scattered by small particles in the air such as water droplets and dust.

3.8.2 Contribution of the Rail Industry

On the whole railways are less light polluting than roads, as the majority of railway tracks are not lit as compared with highways. This could explain why Network Rail receives few complaints on issues relating to light pollution. Rather the majority of light pollution issues arise from the use of lights at depots and stations.

3.8.3 Relevant Legislation

Light pollution may be regarded as a 'nuisance' under common law, but it is not listed as a statutory nuisance in the Environmental Protection Act (1990) and to date only a few local authorities have taken action against it. New legislation is however being debated concerning light pollution. This includes extending the scope of the Environmental Pollution Act (1990) to include nuisance from floodlights and security lights. Lobbyists are calling for the Government to take stronger measures and introduce targets to reduce light pollution[77].

3.8.4 Options and Responsibilities for reducing light pollution from rail

There is the possibility of introducing down-lighters at stations and depots, although this would be a relatively selective requirement, eg where night time freight or maintenance operations cause light nuisance. This would need to be investigated with Network Rail and the TOCs, which would have joint responsibility for the light produced by depots and stations.

The Highways Agency has begun investigating ways in which to reduce light pollution from road lighting. This is something that the railway industry could consider doing also, and could benefit from many of the conclusions for road which might be equally applicable. A good practice guidance could be produced as a result of the findings.

3.9 Electromagnetic pollution

3.9.1 Issue

Every product which has electronic components has the potential to emit electromagnetic signals. In particular exposure to non-ionising electromagnetic fields such as those associated with radar, broadcast transmitters, mobile phones, power lines and domestic equipment are seen as causing particular problems. Impacts such

[77] Watkiss and Jones (2001) *Op cit*

as interference with other electrical equipment, and health related issues, are both causes of concern.

3.9.2 Contribution of the Rail Industry

The effects of electromagnetic radiation from high voltage overhead lines is a particular issue for the railways. Moreover the installation of GSM-R mobile units and other supporting equipment that facilitates mobile communications between rail industry employees could also have problems with not only electromagnetic emissions, but also visual impact and land take. A lesser issue relates to electromagnetic pollution caused by on-board electrical equipment on trains.

3.9.3 Relevant Legislation

Relevant legislation includes:

- **EC/519/1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)** -This Recommendation sets a framework that deals with limiting public exposure, providing public information and undertaking research on the effects of electromagnetic pollution.

3.9.4 Options and responsibilities for reducing electromagnetic pollution from railways

Guidance should be issued to the industry on the use of electromagnetic fields and the location of base stations using GSM-R, this could include requirements in leasing arrangements for commercial operators.

3.10 Summary of Actions that might improve Rail's Environmental Performance

In summary, therefore, there are a number of actions that the DfT rail Directorate might take to improve railway's environmental performance, some of which are in response to legislative requirements, while others could be initiated by the Directorate to reduce the environmental impact of the sector. These are addressed in turn, in the sub-sections that follow. It should be noted that the discussion of this section does not claim to be a comprehensive assessment of the legislative requirements faced by the rail industry in relation to the environment. For example, in its review of legislation governing the environmental performance of the rail industry, ADL identified key legislation to which the industry should respond, as follows:

- Compliance with the EU ambient noise Directive (see Section 3.3.2);
- Compliance with the emissions from non-road mobile machinery Directive (see Section 3.1.3);
- Compliance with the Oil Storage Regulations 2001;
- Compliance with the Public Health Act 1936/EPA 1990 (with regard to toilet waste) (see Section 3.4.3);
- Compliance with the landfill tax Regulations 1996 (see Section 3.4.3);
- Compliance with the EU environmental liability Directive;

- Compliance with Regulations concerning the pollution of surface water and groundwater (see Section 3.7.3).

Most of this legislation is referred to in the relevant sub-section, above. However, some – notably the Oil Storage Regulations and the environmental liability Directive – are not, as they where considered to be outside the scope of this report, as they do not follow from a particular environmental issue, as both are preventative measures.

3.10.1 Actions that might be taken in response to Legislative Requirements

This section presents a summary of action that the DfT rail Directorate might take, or at least initiate or support, in relation to upcoming legislative requirements. Such measures might be seen as supporting legislative measures, encouraging early preparation, or going beyond what are current or anticipated legal requirements.

In relation to meeting the requirements of ***the non-road mobile machinery Directive*** (see Section 3.1.3), a number of actions may taken. As the Directive effectively applies to manufacturers of locomotives and DMUs, the least proactive approach for the rail Directorate to take would be to simply let the Directive come into force in 2011 and take no action to speed up or facilitate its impact. However, such an approach may not necessarily ensure that the necessary cleaner fuel is available, as there is currently no legislation to ensure that this is the case. A more proactive approach would be to seek the earlier introduction of the cleaner engines, as well as the cleaner fuel. To some extent, this process has already begun. Partly as a result of SRA's interventions, a programme of testing to ensure that the cleaner fuel is compatible with older trains has been agreed. In addition, a Technical Summit held by the SRA in 2004 strongly suggested that there were no major obstacles to introducing the cleaner fuel, even at an earlier date. This would offer environmental benefits, and could smooth the transition to the new fuel[78]. For this to happen, the rail Directorate would have to work with the Treasury and oil companies to make sure that the necessary incentive is put in place and that the oil companies can supply the necessary graded fuel. In addition, the TOCs and ROSCOs would be key partners in ensuring that cleaner engines are brought into service as soon as possible. In the longer-term, a decision needs to be made in relation to how best to further reduce emissions, both of conventional pollutants and of GHGs, from the railways (see Section 4.1).

As discussed in Section 3.3.2, the ***environmental noise Directive*** is likely to have implications for the rail industry. Again, the industry could sit back and wait until mid-2008 to see what the implications for its operations are. However, a more proactive response would be to identify which sections of the rail network will be affected by the first, and later, sets of noise maps, and then, when the UK legislation has been finalised, attempt to gain a better understanding of what the implications for the industry might be. This might reveal the possibility for targeted solutions, eg to certain train services or track sections, that the industry could introduce at its own pace, rather than having the requirements imposed at a later date.

Action that could be taken in response to other legislative requirements include:

[78] see IEEP's *Draft Briefing on Low Sulphur Diesel for SRA Board* December 2004

- Working with the TOCs to ensure that rail's contribution to local air pollution hotspots (to help local authorities comply with air quality legislation), eg around major stations, are minimised through the use of cleaner trains, the retrofitting of trains or restrictions on idling (see Section 3.1.4).
- Ensure that all relevant rail installations are in compliance with the ban on ozone depleting substances (see Sections 3.2.3 and 3.2.4).

3.10.2 Actions that might be taken that have no Legislative Origin.

The discussion of Sections 3.1 to 3.9 also highlighted a number of actions that could be taken to improve the environmental performance of the railways that do not have their origins in a particular piece of legislation. The DfT rail Directorate could:

- Work with TOCs/ROSCOs and manufacturers to ***ensure that new trains are cleaner, quieter and retain toilet waste***. One means of taking this forward might be to include such conditions in the franchise agreements that the Directorate negotiates with TOCS (see Section 6).
- Work with the various actors in the industry, particularly the largest procurer Network Rail, to ***green their procurement processes*** by ensuring that their contractors take more account of environmental considerations in their operations, eg in relation to emissions of conventional pollutants and GHS, the protection of water and soil from pollution, as well as minimising the generation of waste. This could be achieved by, for example, requiring all contractors to have their own accredited environmental management systems in place (see Section 6).
- Work with Network Rail to ***increase the amount of electricity used by the industry that has been generated from renewable sources***. At the basic level, this could simply be a case of requiring any increase in electricity demand from rail services to be by electricity generated from renewable sources. As this could have cost implications, it would also be important to have the relevant TOCs on side. In the longer-term, the industry could look to increase the proportion of the electricity that it uses that is generated from renewable sources by utilising the expanding renewable electricity supply or by developing its own renewable capacity (see Section 5.1).
- Work with the work with Network Rail, the ORR and TOCs, as necessary, to explore and exploit the potential for ***regenerative braking*** on the UK rail network.
- Work with Network Rail to ***reduce the amount of its waste that goes to landfill*** and to ensure that the latter's landfill sites are managed according to good practice, particularly in relation to reducing methane emissions.
- Work with the ORR to ensure that regular ***checks on refrigeration and air conditioning systems*** on board trains and carriages are undertaken.
- Work with Network Rail and the Environment Agency/SEPA[79] to undertake a review of the railway network and associated infrastructure to identify that which is most ***at risk from climate change***, eg that which is most prone to flooding, and decide on the best course of adaptive action to take.

[79] Scottish Environmental Protection Agency (the Environment Agency's equivalent in Scotland).

- Work with Network Rail and TOCs that operate stations and depots to ensure that ***noise***, eg from tannoy announcements, ***and light***, eg from floodlights, ***balance the needs*** of rail users with consideration for the neighbours.
- Work with Network Rail and the TOCs to ***reduce the amount of waste generated by the food supply operations*** at stations and on-board trains. This could be undertaken by requiring franchised food outlets, as a result of conditions in their lease, to utilise packaging that is recycled, recyclable and biodegradable. Additionally, recycling bins could be provided on stations and trains to encourage train users to recycle.
- Learn from the experience of the Highways Agency in ***managing roadside verges*** and identify the lessons that could be taken on board for the railways.

4 Wider Policy Issues

This section outlines wider policy issues that are likely to contribute to rail's environmental performance.

4.1 Financing the Railways

Under current arrangements, it is the Treasury that primarily determines the financial envelope for rail and the allocation of non-fare-box funds. This will to a large extent determine the extent and nature of rail operations (as discussed in Section 5), and how much can be invested in their environmental performance. Funding levels will also to a large extent inform the approach taken to more specific environment-related initiatives as outlined in Section 3, as these will in most cases have costs attached, and in some cases these may be large. Where future measures are mandatory then this may affect the level of funding required, or cost constraints may affect the way in which mandatory requirements are implemented. For other measures, cost considerations are an essential element of deciding the priority that can be given to them.

Some specific aspects of the environment-related elements of funding are addressed in the sections that follow.

4.1.1 Funding for Integrated Transport

The return of strategic control of the rail sector to within DfT arguably reinforces the opportunities for adopting a more truly intermodal approach to transport policy. If this is to extend to the funding aspects, then clearly the Treasury will need to be actively involved in multi-modal cost, benefit and environmental impact analyses of possible solutions to identified transport needs. Furthermore, these should be addressed on a strategic corridor basis, rather than as isolated schemes.

The multi-modal corridor assessments were an attempt to address this, and did indeed recommend packages with a substantial share of rail and other public transport. All the consultants who drew up the reports also insisted that their results must be viewed as an integrated and indivisible package of measures, rather than a list of individual measures that could be taken up or not in a piecemeal way. In reality, however, there has been a strong tendency to cherry-pick measures from each package, and rail improvements have frequently been sidelined. The fact that this can occur even after an integrated assessment has been undertaken suggests that differences in funding arrangements, or cost-benefit approaches to different schemes, and/or other institutional factors, undermine an integrated approach.

Thus the new reintegration of control within the DfT offers a renewed opportunity for a truly integrated approach to funding rail alongside road infrastructure, and DfT Rail might address the lessons from the fate of the corridor assessments, and to consider the practical implications of this.

4.1.2 Funding for Specific Initiatives

Another way in which the Treasury could make a positive intervention would be to support the imposition of specific passenger fare and freight tariff increases to contribute to the funding for rail route developments and environmental improvements. This solution should be seen in the context of the precedent of the M6 toll road and other possible toll projects, which has proved that appropriate levels of charging are acceptable to the consumer even in a sector where this is usually free at the point of use.

In a rail context, for example, if an additional pair of tracks between Finsbury Park and London Kings Cross was needed to enhance capacity and hence improve service quality, then a modest addition to fares on this particular infrastructure might contribute significantly to the funding required. If this were to be done, a guaranteed and ring-fenced income stream would be available to finance the cost of the new development or initiative over time.

4.1.3 Taxation of the Railways

The most direct and obvious way in which the rail industry pays tax on fuel is for rail diesel. Other relevant areas touched on it Section 3 include the climate change levy.

The SRA has commissioned more detailed research on the issue of diesel duties[80]. Historically the rail industry, along with some others, enjoys a much lower level of duty than that paid by private road transport operators for comparable fuels. As a result, they have not been subject to the same fiscal pressures to improve fuel economy and reduce CO_2 emissions as the private road sector. Nonetheless, in the last three consecutive years, the duty on rebated fuels has been raised substantially in percentage terms. Ostensibly this has been in order to reduce fraud by narrowing the duty differential between road diesel and other fuels rather than to encourage fuel economy. If so, this suggests that there may be many such increases to come, as the gap in duty rates remains very large.

These measures do not appear to have been aimed primarily at the rail industry; indeed they do not seem to have considered the impact on the railways in any great detail. In effect the TOCs must pay the additional cost in the first instance, but in time the cost is factored into franchise agreements, so in the end DfT Rail is likely to have to underwrite any further additional annual tax bill for the industry. DfT Rail might wish to consider how the changed institutional arrangements might impact upon any further increases in future years.

As against this the Treasury has begun to consider how fiscal incentives could be used to encourage early entry into the market of cleaner fuels, and hence to smooth the transition to their general use by the time they become mandatory (see Section 3). This is similar to the approach which has been used very successfully to encourage unleaded petrol and low sulphur petrol and diesel onto the roads, and will soon be applied for ‘sulphur free’ fuels containing less than 10ppm of sulphur.

[80] *Railways and Atmospheric Emissions: Fuel Duty and Related issues*, IEEP, February 2004; *Briefing on Low Sulphur Diesel for SRA Board*, SRA, 2004

The 2003 PBR announced that a 'modest duty differential' in favour of red diesel with a sulphur content of less than 0.005 per cent (50ppm) would be introduced, and a Consultation on rebated gas oils was held in the same year[81]. In fact the duty differential has not yet occurred, although the 2004 PBR did state (in paragraph 7.34) that:

> 'The Government believes that there are measurable environmental benefits to be gained from the introduction of low-sulphur rebated oils and will continue to keep under review the option of introducing a duty differential …'

As mentioned in Section 3, the 2005 budget took the issue no further. It is understood that the delay has occurred because serious concerns have been raised over the possibilities of fraud that could result. That is, if the incentives were successful, they would make available what is essentially a road-quality fuel, but at a greatly discounted price. Also many of the sites where these fuels must be stored (eg building sites and farms) are not secure, so there is a strong danger of theft and other types of fraud.

These constraints do not generally apply to rail depots, however, in that these are generally secure and well managed, and already participate actively in the government programme to counter red diesel fraud. Thus the rail industry might arguably be a good place to start from the Treasury's perspective, and the door appears clearly to be open for DfT Rail to continue work begun by SRA to play a leadership role in making representations to the Treasury on this issue.

A differential of 1.5 to 2p would be needed to give a full incentive to switch fuels, and if this were to be offered, it is likely that the change would happen quite quickly. On past performance, the Treasury might initially offer only 1p per litre of differential. If this were to occur there would probably not be much initial takeup of ULSD, but it would at least be a signal of intent which might help to spur preparatory actions, especially by the TOCs.

Under the new arrangements, it is possible that DfT Rail may have additional opportunities to work more closely with the Treasury to maximise the environmental opportunities and minimise adverse impacts from rail taxation.

4.2 The Implications of Strategic Environmental Assessment

EU Directive 2001/42/EC requires responsible authorities in the Member States to undertake an environmental assessment of certain plans and programmes that are likely to give rise to significant effects on the environment. The process of assessing plans and programmes is generally referred to as 'strategic environmental assessment' (SEA), and hence the Directive is commonly referred to as the 'SEA Directive' although nowhere is this term used in the text. It sets out standard procedures for undertaking an environmental assessment, and complements Directive 85/337 on the

[81] *Hydrocarbon Oil Duty: Consultation on Duty Differentials for more Environmentally Friendly Rebated Oils*, HM Customs and Excise , 2003

assessment of projects ('the EIA Directive') by requiring assessments at an earlier stage and a higher level in the planning process. The Directive came into force in July 2004.

The relevant Article of the SEA Directive defines plans and programmes as those 'which are subject to preparation and/or adoption by an authority at national and, regional or local level or which are prepared by an authority for adoption, through a legislative procedure by parliament or Government' and 'which are required by legislative, regulatory or administrative provisions'. This has been transposed into the UK Regulations word by word, so, as a result, it is not yet entirely clear what will be covered by the requirements.

An SEA is always required for plans and programmes in certain sectors (and Article 2 specifically includes transport), which sets the future development consent of projects requiring either an EIA or an assessment under the Habitats Directive. The first of these in itself appears likely to cover most rail plans and programmes. An SEA *might* also be required for the above plans and programmes if they cover 'small areas at local level' or 'minor modifications', which are likely to have significant environmental effects. This evaluation, ie of whether an SEA is needed or not, is based on criteria set out in the Directive and the Regulations.

A further complication is that environmental assessment is a devolved matter in the UK, and so separate legal and administrative arrangements can be expected for England, Scotland, Wales and Northern Ireland. Already Scotland has gone further in its new Bill, which also includes strategies and voluntary plans and programmes. This might cause some interesting problems, especially for the rail industry, when setting new 'rail strategies/policies' or new corridor plans covering both England and Scotland. In these circumstances we might have a situation where an SEA is required for the Scottish side but not for the English side.

Aside from making itself aware of the implications of the Directive for the rail industry and its plans, however, the new DfT Rail will need to consider broader implications. That is, the Directive will apply for example to all local plans including LTPs that may well include a rail element. In conducting an SEA, authorities are required to assess a range of impacts (slightly broader than those addressed in Section 3 of this Report) and should include 'secondary, cumulative, synergistic, short, medium and long-term, permanent and temporary, positive and negative effects'. Given the complexity of transport systems and their patterns of use, and the high degree of interconnectivity within and between modes, this is a demanding requirement.

The assessment is also required *inter alia* to address measures proposed to offset any significant adverse effects on the environment; and reasons for selecting the options chosen, rather than reasonable alternatives (which must be described and evaluated). Thus, in principle at least, authorities should evaluate a wide range of secondary environmental impacts of choosing a particular mix of transport modes for their area, and should explicitly address the implications of a significantly different mix (ie with more or less rail travel). Offsetting requirements might also encompass consideration of some of the measures set out in Section 3.

Beyond this, it appears that in the UK, the intention is to roll out these and other SEA requirements within the framework of a broader 'sustainability assessment' that will also address the economic and social implications of plans and programmes. This too will have implications for rail, but whatever the detailed arrangements, they will have at a minimum to meet the basic requirements of the SEA Directive if the UK is to be in compliance with it.

The exact nature of future practice under the SEA Directive is still developing, but our current understanding is that it will be very relevant to the rail industry and could have far reaching consequences. On the one hand there will be costs and new requirements in meeting the terms of the legislation; but on the other, there appears on the face of it to be significant scope for injecting a stronger element of evaluation of modal choices and alternatives into planning and programming at a range of levels and geographical scales. It will therefore be important for the new DfT Rail to keep abreast of developments, and to seek to influence the appraisal methods adopted in order to improve the opportunities for the rail sector. This is probably a good example of an area in which DfT Rail, being within the departmental structure, will be in a better position than the SRA to influence policy development and implementation in a way that is favourable to rail.

4.3 The Rail Industry and Road User Charging

It is not only upcoming environmental policies that will have an impact upon the railway's environmental performance. In the crucial area of rail freight it has been noted that freight carriage by rail has significantly lower environmental impacts than road freight. Thus modal shift to rail freight is particularly environmentally beneficial.

An upcoming policy that would very much stimulate modal shift to rail is that, from 2008, Vehicle Excise Duty on Heavy Goods Vehicles is to be replaced by a new tax that will vary by the weight of the lorry and the distance driven. This will involve lorries to be fitted with on-board GPS electronics, permitting charges to be higher for driving on more congested roads and at peak times. Professor Phil Goodwin has noted that this policy change is likely to result in substantial increase in the demand for rail freight. It is a matter of urgency that the railways undertake market research to estimate the potential magnitude of the demand and its distribution.

In the longer term it is government policy for a National Road User Charge to be introduced for all road vehicles, again with high charges for road use in congested times and places. This change in road pricing structures would generate a large increase in demand for rail travel. What is more, as shown by studies undertaken by Professors Phil Goodwin and Stephen Glaister, because any road charge would be highest in peak periods on busy road corridors, any transfer across to rail is likely to be concentrated upon the busiest rail lines in peak periods. This is theoretically an opportunity in that these are areas where rail plays to its strengths; but a problem in that the recent Rail White Paper has pulled back from increases in rail capacity.

5 Strategic Approaches to Improve the Environmental Performance of the Transport Sector

Having addressed individual environmental issues in previous sections, this section seeks to give a broader perspective on some of the bigger issues surrounding the rail industry and future environmental policy. It also seeks where possible to relate the earlier discussion with these broader issues, and to locate rail policy within the broader context of transport policy as a whole.

5.1 Strategic Considerations in Improving the Environmental Performance of Rail

As noted in Section 3, there is a wide range of technological options available to improve the emissions performance of rail. These include mandatory changes such as improved diesel engine performance, and other options such as increased use of regenerative braking and other operational measures to improve operating efficiency. These are complex technical issues on which SRA has already commissioned more detailed research.

5.1.1 Power Supply and Traction

In relation to the future power supply and traction for the railways, there are some strategic decisions that have to be made, which are discussed in this section.

Electrification

One strategic option would be to switch the whole of the UK network over to electric traction, which is generally cleaner and more efficient than diesel. In the UK, however, only 40% of the network is already electrified and it takes 2% of the national electricity used. This is well below the average in Europe. There was a rolling programme, developed in the mid-1970s, to electrify most of the network over ten years, but this was abandoned when oil prices fell again after the oil price shocks, as the change in economic circumstances were seen to undermine the justification for electrification. Given the growing possibility of continuing high oil prices, and the prospect of declining UK self-sufficiency in oil, it might be timely to reconsider this option.

Certainly electrification offers quieter and more efficient operations, but it is less flexible than diesel under current arrangements (ie electric trains can only be used in areas which have compatible electrical systems, whereas diesels can operate anywhere on the network). It also requires a large amount of costly and visually intrusive transmission gear. As against this, choice of primary fuels in this scenario becomes driven by the generators' and wider government policy rather than that of railway operators, and for this reason should remain compatible with broader policy objectives.

Renewable Electricity

Either within the electrification option or while remaining at current levels of electrification, the railways might consider a move towards 'green' tariff electricity as a means of further improving environmental performance.

Currently the rail system uses around 2% of generated electricity in the UK; electrifying the additional 60% of rail operations might push this to say 5%. With the official aspiration of 10% or perhaps 20% of UK electricity to be generated from renewables over the next decade or two, it would thus be technically feasible for the entire system to be powered from clean and carbon-free sources. There would be cost implications to this that would need to be carefully evaluated, and a suitable mechanism to incentivise or oblige either operators or Network Rail to take green electricity would need to be devised.

At the same time, a shift in demand towards renewable electricity by such a major user of electricity would not only be a powerful signal of the railways' environmental commitment, but would also be a strong market signal to the renewable power industry and could help to stimulate the market to help reach government targets.

Further, recognising that railways will always need an electrical supply under all plausible scenarios, and that the railways own or control a very considerable area of land and buildings, the industry might consider how to increase its own generation of renewable electricity. Currently this appears to be very limited use of small aerogenerators and photovoltaic units to power isolated lineside equipment, but there is significant technical potential to expand the use of these and other technologies to power the rail system itself. This might in the long term help to control costs as well as reinforcing a strong 'green' image for rail, but costs and technical options would need to be carefully evaluated.

A further option that would complement all of the above would be to improve the energy-efficiency of rail rolling stock and operations generally. A particular opportunity would be to maximise the use of regenerative braking, which is currently often not used, and enjoys rather inadequate incentives even where the technical potential is available. A recent report commissioned by the SRA addresses this issue in greater detail[82].

The Fuel Cell Route

An alternative route to conventional electricity may well exist at some point in the future, however. Fuel cells offer decisive environmental advantages for displacing diesel rail. The relatively large size of rail engines, especially in locomotives, also makes them very suitable applications for this technology. They might well be applicable to multiple units, and might also offer a 'halfway house' configuration with a centralised fuel cell stack located in a set which is otherwise composed of units similar to modern-day EMUs. This would provide a far cleaner and more efficient solution when compared to current diesel electric engines.

[82] IEEP's *Briefing on Regenerative Braking for SRA Board* December 2004

As yet, only a few prototype mobile fuel cells are yet in operation, and fewer still for rail. Therefore they are as yet far from tried and tested for mainstream rail industry use, and costs would be very high. Issues about fuel choice and fuelling options will also need to be resolved before they can be widely developed or deployed. In particular there are many and complex questions about how hydrogen would be generated and distributed within a low carbon hydrogen economy, but the depot-based refuelling arrangements of the railways should lend themselves relatively well to refuelling trains with hydrogen.

While fuel cells are clearly a high-cost and long-term option, the costs might in the future look much more favourable if seen as an alternative to electrification, in that much of the additional infrastructure cost could be avoided by this means. Even if no major new electrification is planned, fuel cells might be an attractive alternative to replacement or reinforcement of existing electrified networks, as exemplified by the ECML and Southern Region third rail systems respectively. In cases such as this, even selective use of fuel cells might in theory avoid the need to upgrade, which itself is expensive. It is therefore possible that the initial use of fuel cell trains will be where they provide savings in other parts of a rail investment package, and should therefore be actively considered in such contexts once appropriate technology becomes available.

This would have a number of additional advantages in that it would allow the flexibility of diesel combined with the environmental benefits of electricity (although life cycle benefits would depend on the source of hydrogen used), and could be phased in over time in that fuel cell engines could run on the same systems as conventional electric (or indeed diesel) trains, and gradually supersede them.

5.1.2 Other 'Green' Choices

Irrespective of the above, it is certain that diesel trains will be likely to remain in use for many years to come, and that new diesels will continue to be purchased. As noted in Section 3, there are options to go beyond the requirements of the Non-Road Mobile Machinery Directive and to accelerate a switch to clean diesel across the fleet. Similarly, a number of other areas of railway operation have been noted in Section 3 where best practice might go beyond bare legislative requirements to both improve environmental performance and reinforce the 'green' credentials of the railways.

These sort of 'soft' best practice type issues might offer significant and/or highly visible benefits at relatively limited cost, and might merit further consideration. The extent to which this is pursued is however a strategic one; that is, as to whether funds, time and other resources are available to pursue such options, and whether they offer sufficient benefits to receive priority.

5.2 The Role of the Railways in an Integrated, Sustainable Transport System

To a first approximation, rail remains environmentally more benign than either road or air transport, and the SRA has effectively defended this and other benefits of the railways[83]. This holds good for many if not most of the environmental issues listed in

[83] *Everyone's Railway: The Wider Case for Rail,* SRA, September 2003

Section 3. That is, rail is or can be much cleaner and more fuel efficient than road or air; land take per passenger-kilometre and impacts on habitats are less; noise is an issue but a much more localised one than for road or air; resource consumption is less; and so on.

There are some caveats to this, such as that old or poorly maintained diesels in particular can be very polluting in terms of particulates and nitrogen oxides; and that empty trains cause pollution while delivering little or no benefit in social or economic terms. There is no room for complacency, but in most cases and by most environmental criteria, rail remains environmentally beneficial relative to road and air.

There is therefore a clear strategic benefit in improving the share of journeys undertaken by rail relative to other modes. This is a major strategic goal, which encompasses many aspects of the management and operation of the railways and ways in which it can be made attractive to more people. It is however entirely beyond the scope of this report to offer DfT rail or other rail interests advice on 'how to run a better railway', although running a better railways is of course entirely germane to gaining environmental improvements.

In the sections that follow, however, we explore some aspects of rail demand that have direct consequences for the scale and nature of the environmental benefits that might be gained. The first of these emphasises the environmental importance of delivering modal shift and changed travel behaviour (as opposed to just attracting more travellers to rail), while the second looks at the environmental dimension of expanding rail capacity.

5.2.1 Issues of Modal Shift to Rail

As noted above, it is not merely increasing rail patronage that brings an environmental benefit; it is shifting travellers away from road or air that counts. This is not straightforward, and to achieve this will be dependent on a wide range of driving forces and government policies in areas not under the direct control of DfT Rail. Particularly important will be 'push' factors in other modes, such as road charging as discussed in Section 4, and more generally on the cost and attractiveness of the different modes. With the main onus for strategic overview of rail now returning to the Department for Transport, however, there should be greater opportunities for addressing a balanced approach to maintaining a good modal share for rail.

5.2.2 Shifting Demand in Time and Place

Changing modal balance is not straightforward, however. Rail use has been growing since the mid 1980s and there is often an assumption that any growth in rail use must be environmentally beneficial, in that the trips would otherwise be undertaken by people in cars. This is not necessarily the case. *How* expansion occurs is crucial to the net environmental impacts. If rail does replace car use and is developed so that it supports less car-dependant settlements, then rail's environmental impact will be beneficial. However, if rail is developed such that it generates additional travel and urban decentralisation, then its environmental effects will be predominantly negative.

In practice, there has been no coherent strategy for rail to develop in a strategically environmentally-benign way in recent decades, and as such the structural environmental impact of rail has been random. Most recently, indeed, the trends have tended to be negative rather than positive. This is directly attributable to the post-privatisation rail structure resulting in it generally being more profitable for operators to expand long distance leisure and business markets rather than short distance urban services. Short distance urban commuting is an expensive and loss-making market, but it may well be a priority for urban and environmental policy in that it avoids more car traffic on congested urban roads, while allowing large numbers of workers to reach urban centres quickly and efficiently.

Long distance, high-speed, rail commuting is now viewed as environmentally damaging by the European Commission, for example. Long distance high-speed rail reinforces, if not stimulates, metropolitan decentralisation. People relocate from cities and suburbs, where their trips are relatively short and walking and public transport viable, to dispersed, city fringe and rural settlements, which are highly travel-intensive and where most of that travel has to be by car. Commuting constitutes fewer than 20% of all trips. A fast rail service may result in the work journey being by public transport, but if it is doubled in length, emissions and fuel use will be high. When increased car travel and longer trips for the 80% of all other travel that takes place is added into the equation, then long distance, fast rail services can only be seen as worsening energy consumption and emissions from transport overall.

With today's more flexible work patterns, this pattern is extending as people part commute over long distances and part telecommute the rest of the time (hence the new Friday and Sunday afternoon rail peaks). Here the benefits/disbenefits are equivocal, in that the reduced number of journeys will offset the other impacts to one extent or another. The balance will in practice vary considerably from case to case, but merits further attention in future policy development.

A prime example of an outworking of the environmental impacts of rail market development is the West Coast Main Line upgrade, prioritising Virgin's 125mph long distance trains over short distance passenger services and freight. The result is an upgrading of environmentally degrading rail services (where market research shows expansion will mainly be trip lengthening and newly generated trips and not transfer from car/air) to the disadvantage of shorter distance services that support more environmentally-benign travel behaviour and trip patterns.

There has been some ad hoc recognition of this problem. For example, over its long history, London's CrossRail shifted from a scheme that would tightly serve the transport policy needs of London through to one that could tap more lucrative long distance trips and then back (once strategic planning in London was restored) to one that again addresses London's needs. For financial reasons, Thameslink seems to have been permanently transmuted into a scheme that will largely serve environmentally-degrading longer distance markets, however.

Overall, the strategic role that the railways play in transport is a central environmental policy issue, and is one where the structure of the rail industry is tending to steer rail more towards being part of the environmental problem rather than its solution. The real danger is that the environmental impact of the rail industry structure is little more

than vaguely recognised and only partly understood. The closest to a policy context that exists has arisen from the financial stringency faced by the railways. This has led to the SRA's policy that not all demands for new rail services can be met and need to be prioritised. This has led to the withdrawal of some new developments in order to consolidate core existing services, such as the withdrawal of the Oxford-Bristol service and the proposed withdrawal of the cross-London service from Brighton to Watford Junction. The latter is disturbing as it is just the sort of environmentally-beneficial service that actually needs prioritising.

The operational environmental impacts of the railways clearly need to be addressed and programmes developed to ensure that positive practice is adopted. However, the structural impacts of the railways are a more important environmental influence. A method to evaluate these environmental impacts and incorporate this evaluation into rail service development planning is urgently needed. This point also relates to the discussion of strategic assessment in Section 4 above.

On a more positive note, the new Community Rail Strategy, which has been developed by the SRA and adopted by the DfT, should lead to enhanced services on little used routes. This will have less environmental impact than upgrading the parallel highway. Re-opening a closed route might also be the most environmentally friendly way to enhancing a transport corridor.

5.2.3 Making Rail a more Attractive Choice

Structural environmental impacts extend beyond this to a more fundamental level regarding the sort of markets rail operators seek to develop and the general mix of price, quality, coverage, reliability, integration with other transport systems, etc. that affect modal choice and demand for rail services as opposed to more environmentally-damaging forms of transport such as car, truck or air.

This is a large subject and one that cannot be tackled here. However, in our research and discussions one issue that emerged was current engineering practice that requires major possessions of track during weekdays or at weekends for maintenance or upgrading purposes. This may be efficient in operational terms, but it is questionable whether such practices uphold the long-term interests of the railways and reinforce their status as a major transport mode. That is, if these practices undermine customer loyalty then they may in the long run undermine both the economic, social and environmental case for rail.

Ideally, planning for both scheduled and emergency engineering works should consider a wider range of options that prioritise maintaining customer loyalty and reinforce the strategic position of rail.

5.3 Creating more Capacity on the Railways

Quite aside from the discussion in the previous section, it is likely that additional rail capacity will be requires as and if patronage continues to grow. This is strongly compatible with creating a sustainable transport sector as a whole. Comments follow on some specifically environmental aspects of several ways in which this might be achieved.

5.3.1 New Lines

In the longer term, further capacity may need to be added to the rail network to deal with extra demand, especially demand for long range travel, some of which may be to and from continental Europe through the Channel tunnel. Such links could also help to deal with additional freight demands in a relatively sustainable way.

SRA has already considered the option of a new north-south strategic route, and beyond this other new high speed/high capacity rail corridors, perhaps aligned with the motorway network, might be considered. It is not feasible in this document to address specific proposals in any detail, but one particular point is included to emphasise the potential importance of developing greater compatibility with mainland Europe. While new lines are already likely to be built to Berne convention gauge for maximum capacity – as was the case with the Channel Tunnel Rail Link – it is increasingly important to ensure that all new build and routes which receive major modernisation should be to Berne Convention. Taking the example of the ECML out of London – it would be quite easy to make it Berne-compatible for much of the route but on, say, the 'tight' corridor between south of Grantham and north of Newark where the line is very close to the A1 the new railway alignment would need to straddle the road.

This will imply a more ambitious and potentially costly approach in cases such as this, but such options should nonetheless be actively considered in order to seek ways of achieving full integration with Europe on main corridors. This could offer strategic long-term benefits to pan-Europe freight haulage in particular.

5.3.2 Improving Existing Capacity

Notwithstanding the above, building a new high speed rail line from London to the north may not be the most environmentally-effective means of increasing capacity. That is, high speed lines are much more demanding in terms of energy per kilometre travelled, and because they have more demanding engineering standards, are less flexible and routing and therefore likely to have detrimental impacts on human settlements and natural habitats.

An alternative would be to widen or otherwise enhance the existing routes where possible. This is likely to have much less impact in terms of new land take requirements, and a wide range of interchange facilities generally exist on the existing routes, whereas a new route requires huge amounts of supporting infrastructure including new interchanges.

In terms of physical works, rationalisation of infrastructure in past years has reduced capacity but the space remains in many places within the railway boundaries to increase this once more where needed. A combination of reinstatement and modernisation can enhance capacity considerably at a cost which is considerably lower than completely new works. If this approach is applied at the time when life cycle infrastructure renewals are due the extra cost can become marginal. The immediate approach to Kings Cross is a case in point, and there are numerous points

on the network where two tracks could be increased to three or four tracks with relatively low cost and environmental impact.

Beyond this, introducing carefully-targeted new-build infrastructure is another way of increasing capacity and increasing rail's ability to satisfy the publics' need for transport. In Manchester, for example, trains can serve Piccadilly, Piccadilly and Oxford Road *or* Victoria. In the 1960s and 1970s there was an aspiration to link Piccadilly and Victoria by an underground route for mainline trains (the Picc-Vic Link). This was ruled out on grounds of cost and physical practicality, but the benefits remain. There is also an alternative protected route for this link – the Castlefield curve. In this case the cost would be modest, in terms of in-city transport infrastructure developments. The benefits would include taking more people direct to the part of Manchester they require to be in, improved operations south of Piccadilly and the opportunity to open up more parts of the north of England to direct services to Manchester Airport (the UK's third busiest airport). It is true that the two track corridor between Piccadilly and Oxford Road would need careful operational management but this is achievable.

These possibilities suggest the desirability of taking a strategic view of all the options available for capacity expansion and changing modal shares. For example, proposed engineering works to increase the capacity of the East Coast route have been abandoned, probably because of cost fears, but this may be at the expense of increased use of cars, trucks and aeroplanes instead. This reflects the renewed opportunity for the DfT to look at the totality of transport in assessment of future developments, which has to happen above the level of Railway and Highways Directorates.

5.3.3 Better Traffic Management

On all busy routes signal spacing and line speeds could be reviewed to ensure that capacity is maximised. In certain instances close to terminal stations this may actually mean a reduction in line speed so that all trains can travel at the same speed. This increases capacity in just the same way that reducing motorway speeds from 70 mph to 55 mph increases road capacity (and also reduces fuel consumption and other environmental impacts).

Other low or no-cost initiatives revolve around improved traffic management. Even interval timetables are a fundamental tool as is flighting sequences of trains so that the fastest go first and then priority is determined by the point to point speed of a train. Interestingly, this can in some cases put freight in front of 'stopping' passenger trains. To achieve this conventional conceptions of what train should takes precedence might need to be radically revisited. For example, the new West Coast Main Line services is designed around the need for speed on the inter-city Pendolino services, whereas it could be argued to be more important to maintain the Silverlink County frequencies, as argued above, because of their impact on large flows between the Home Counties and central London.

6 Ways of Working in a Multi-Actor Industry

6.1 Background

This report was commissioned by the Strategic Rail Authority, but by the time of writing it, the Railways Act 2005 had come into force and the SRA was in the process of being wound up.

At the same time, the practical implication of the new Act have yet to be worked out in detail, and the new DfT Rail which is to replace most of the functions of the SRA is yet to become fully operational, or to issue any guidance on how new arrangements will work in practice. It appears at this point that the new structure will have a greater capacity to work on environmental matters than the existing SRA, but it is not yet clear what the implications of this may be.

As noted above in Section 2, the post-privatisation rail industry in the UK is an extremely complex web of separate institutions with diverse functions and interests that are difficult to grasp in totality. Currently this is compounded by additional uncertainty in the current state of flux. It is thus extremely difficult to make a coherent institutional analysis about how the various initiatives and environmental requirements listed in earlier sections might be put into effect, and this is not therefore attempted here.

Instead, this section brings together some lessons learned from past experience, and some suggestions that have arisen as to how the various environmental measures and agendas set out in earlier sections might be taken forward. There is however no attempt to anticipate or prescribe how DfT Rail might interact with other actors in the sector, or to pre-empt its priorities.

6.2 Engaging the Relevant Actors

6.2.1 Railway Culture and Environment

As noted above, the railway industry has historically had relatively few and limited specific environmental requirements placed upon it, but these are likely to expand over time. At the same time, the fragmentation of the rail industry appears also to have led to some dissipation of a sense of responsibility for specific environmental norms and activities, and relevant expertise is now quite fragmented.

As a result, it appears that the environment is not embedded in the culture of the rail industry, and understandably other concerns command a higher priority, especially amongst the commercial operators.

6.2.2 Communication and Training

As noted above, expertise on environmental issues is very patchy across the range of organisations involved in the rail industry, and good environmental practice appears far from universal. This report will hopefully contribute to educating that culture as to current and upcoming environmental requirements, but beyond this, there appears to

be an important job to be done to maintain and enhance communication on environmental requirements, best practice, etc.

Training is also an essential element in developing an environment-oriented culture, so any rail strategy should emphasise the need for training at all levels – for example in induction for new entrants; formal training for those who have direct responsibility for environmental matters; incorporation of environmental components into all graduate trainee courses so that environment is known to be part of their future responsibilities and not an add-on; and general awareness-raising for all staff in relevant organisations.

6.2.3 Environmental Management Systems

All organisations involved in railway operations would benefit from committing to a recognised environmental management system such as the EU's EMAS system. An audit of the current state of engagement in such systems would be a useful first step.

From past experience, a key element of effective environmental management should be for it to have its own specific reporting line to the top (ie the Board) and not be subsumed within the all-important but fundamentally different safety aspect of operations – the latter, from experience, dilutes both and helps neither. This is particularly important in relation to the broader environmental agenda discussed in this report, in which rail should position itself as part of the solution, not part of the problem. Without this, a more defensive attitude is likely to prevail.

6.2.4 Environmental Guidance and Benchmarking

Various actors within the industry have within the legislation or within existing guidance a general requirement to take account of environmental considerations in undertaking their activities, but this is in most cases very general and lacking in operational detail. Although some guidance exists, there appears to be a need to update this to reflect current and upcoming requirements, and to include more operational detail.

It also appears that some benchmarks are needed for key aspects of environmental performance to communicate to various elements within the rail system what is expected – and possibly to act as targets for contractual compliance or achievement. Such an approach might also improve the DfT's opportunity to promote sensible and informed comparison with other transport modes across a range of issue areas. This would also assist in demonstrating rail's contribution to national and international agreements and targets.

6.3 Policies and Policy Approaches

6.3.1 The Intermodal Approach

In Section 4 in particular it was noted that assessment methods, funding arrangements and other institutional barriers have not always allowed for balanced funding of different transport modes, or to outcomes that promote an integrated and intermodal transport system. There appear to be opportunities through the reinsertion of strategic

responsibilities for rail and the environment within DfT to address some possible shortcomings in this area and achieve a balanced approach.

6.3.2 Integration of Environmental Criteria into Franchise Agreements

In many areas such as those outlined in Section 3, it appears to have been the case that where SRA sought to orchestrate common action for environmental improvements, it lacked the necessary 'levers' to encourage any action beyond or in advance of environmental requirements. One apparently important possibility for introducing environmental requirements beyond or in advance of legislative requirements might be to incorporate such conditions within franchising agreements as they come up for renewal.

Upcoming possibilities would include Great Western and the merged Chiltern/WAGN franchises, and these could act as test cases for specific requirements such as those outlined in Section 3. A timetable of the other franchises could be developed subsequently, and a programme developed to incorporate upcoming environmental priorities over time.

Network Rail could also introduce requirements for new rolling stock, specific to other local priorities. For example, trains that enter London could be required to use low sulphur diesel or have low CO_2 emissions. Agreements might also specify other requirements, such as on-board metering for electric trains, that in turn could enable other environmental measures (in this case effective charging for electricity used) in the future.

Renewal bidders are generally expected to produce a market development plan or marketing plan. In the future, bidders' proposals could be scored explicitly on achievement of environmental targets and more generally for their contribution towards sustainable transport policy (eg modal shift attracting high environmental impact travel from other modes), and this could count towards the franchise award. The proposals of the successful bidder would then become part of the franchise agreement and achievement could be monitored.

6.3.3 Research and Research Agenda

In some aspects of pursuing its environmental responsibilities, it appears that SRA has been hampered by lack of information or genuine confusion over the state of play and the best options available. Further, owing to its relatively limited resources to commission research, it has often been reliant on activities by other actors, such as the TOCs, to investigate the state of play.

Arguably if the new DfT Rail were to have a larger research budget of its own, directed towards its own environmental priorities by analogy to that set out for the road sector, it would be in a stronger position to develop consensus and advance policymaking more quickly towards desired environmental outcomes.

6.3.4 Working Groups on Specific Issues Arising

In our experience of undertaking research on behalf of SRA on environmental matters, genuine experience or expertise on a given issue can be hard to find, and at best is not widely distributed. Contradictory views and opinions are also common, but hard facts to back them up can be scarce. This appears in large part to be function of the highly disaggregated nature of the industry, and the lack of adequate fora for exchange of information and best practice.

This is an obstacle to serious progress on environmental (and possibly other) issues, and to the exchange and propagation of important knowledge. To tackle this, SRA undertook some useful initiatives to establish expert working groups on specific environmental issues in order to capture the available expertise and promote consensus. This practice was beneficial, and could usefully be continued or extended.

6.3.5 Systemic Impacts of Rail Structures and Arrangements

This report focuses mainly on direct and local operational impacts of rail, and possible solutions. However, the *structural* environmental impacts of the rail industry arguably exert a more substantial and long-term environmental and SD influence, as set out in Section 5.

These structural impacts can be very complex, and relate to factors such as the way in which the design of rail services, ticketing products and general markets that rail operators prioritise affects environmental outcomes, and also social and economic ones. At a detailed level it can sometimes be readily seen that the way in which the rail industry is structured can have adverse environmental impacts. For example, if the access charge regime for electrified track does not take into account actual fuel use or even a proxy such as the fuel efficiency of the rolling stock used, then there is no incentive for operators or ROSCOs to procure or TOCs to use fuel efficient designs - or indeed for manufacturers to develop them.

This point is touched upon in Section 3 and in earlier work for the SRA[84], but many other such systematic effects are likely to exist but may not yet have been analysed in such detail. Further work to identify and address such effects could make an important contribution to the future of rail operations and their environmental impacts.

[84] N*ote on Regenerative Braking*, IEEP and IRCG, 2004