Sustainable Development Evaluation of Road Infrastructure Programmes and Projects

Section 2

Evaluation of handling of Air and Climate issues at the policy/programme level of road infrastructure investment.

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The Foundation for the Economics of Sustainability

Cad a dhéanfaimid feasta gan adhmad? Tá deireadh na gcoillte ar lár
'What will we do in the future without wood? The end of the forests has come'

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DISCLAIMER

SOCIO ECONOMICS

The Socio Economics Section of the Environmental RTDI Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in this area. The reports in this series are intended as contributions to the necessary debate on Socio Economics and the environment.

Structure of this report

First the report sets out the key environmental policy issues or key changes for sustainability, including relevant international legal obligations, in the air and climate field. These are climate change, long-range acidification and ambient air quality.

Secondly the report describes and discusses the formal environmental policy responses to these three key issues/changes and the associated legal obligations.

Finally, the report addresses the core issues of the relationship between these key issues/changes and the policies developed in relation to them and the policy and programme of road investment as it affects these key issues/changes. The role of these issues in the process of policy/programme development is described and discussed as are the various processes intended to achieve evaluation of environmental impacts and integration of environmental policies, again as they relate to these three key issues and associated legal obligations.

To a significant extent the report quotes from the various documents reviewed and analysed. The length of some of the quotations results from a concern that the handling of the issues in the documents be fairly represented and also that the necessary subtleties be brought to light. (Underlining has been inserted for emphasis in some of the longer quotations to draw the reader's attention to salient aspects which are discussed in this report.)

The environmental policy issues / key changes for sustainability

The policy issues in this area are well documented in international agreements and in National and EU policy and law. The facts with regards to these policy areas and the degree of progress towards the policy objectives and targets are summarised clearly in Ireland's Environment and Ireland's Environment 2004.

1. Climate Change - Emissions of greenhouse gases

The United Nations Framework Convention on Climate Change sets out it's objective as follows:

> The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow

> ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

In pursuance of that objective, most of the Parties to the Convention adopted the Kyoto Protocol in December 1997. It came into force in February 2005 and sets greenhouse gas emission limits for Annex 1 countries including Ireland for the period 2008-2012. By virtue of Article 6, parties to the Protocol can meet some of their obligations by the various forms of trade in emissions rights, but that option is limited by Article 6(d) to a supplemental role:

> d) The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments under Article 3

Ireland's emissions ceiling for the 2008-2012 commitment period as part of the EU "bubble" is an increase of 13% on it's 1990 emissions. The EU total emissions ceiling is a decrease of 8%; the allocation to Ireland of a greater allocation was a decision made at EU level.

If the Framework Convention is to meet it's objective, it can be anticipated that future commitment periods will involve significant decreases in Ireland's emission allocations.

The latest figures in relation to GHG emissions (EPA, 2006) indicate that Ireland's emissions in 2004 were 23.5% above than the 1990 baseline. Transport related emissions were and are the fastest growing sector of greenhouse gas emissions, growing by 143% between 1990 and 2004. In 1990 transport emissions were 9.3% of the total; this had grown to 18.3% by 2004.

The EPA, in *Ireland's Environment 2004,* comments as follows in relation to both CO2 and NOx which is considered next:

> The need to curb the massive growth in energy consumption and associated emissions of CO2 and NOX from road traffic is a daunting challenge at the present time. The problem is exacerbated by the incompatibility between public transport services and the scale of housing development throughout the country. This challenge can only be met by breaking the link between the growth in road transport and growth in the economy, which requires a radical shift to bus, rail and cycle use. The State cannot expect to comply with its emissions ceilings for NOX and GHGs if their contributions from road traffic are not soon brought under control.

2. Acidification and Eutrophication - Emissions of long-range transboundary pollutants

a. Gothenburg Protocol
b. National Emissions Ceilings Directive
c. Strategy to Reduce Emissions of Transboundary Air Pollution by 2010

Emissions of long-range transboundary pollutants

Many of the emissions considered under the heading of long-range transboundary pollutants are also considered under the heading of ambient air quality. (Additionally, a significant percentage of the ambient air pollutant load, even in the vicinity of roads, derives from long-distance transport of primary pollutants and their secondary products.) These pollutants are responsible for both this contribution to ambient air pollution, and also to problems of acidification and eutrophication. (They also contribute to haze although this is an aspect which for some reason receives more attention in North America than in Europe.)

In order to address long-range transboundary pollution, a number of contributory pollutants are regulated by international agreement (Gothenburg Protocol) and EU law (National Emissions Ceilings Directive).

National Emissions Ceilings Directive.

The National Emissions Ceilings Directive (NEC) sets emissions ceilings to be reached by 2020 for a range of emissions which cause In relation to emissions from roads, the main concern is emissions of nitrogen oxides (NO_x). A Strategy to Reduce Emissions of Transboundary Air Pollution by 2010 was adopted in 2005. All the projections in the Strategy envisage a substantial exceedence of the emissions ceiling for NO_x. Emission levels of NO_x in 2010 are predicted at between 94 kt and 82.2 kt depending on which of the identified measures are implemented. Both of these are substantially above the ceiling of 65 kt. Road transport contributes 31.5 kt to both of these estimates. In essence, as the EPA indicates in the quotation above, it will be impossible to meet the ceiling without substantial additional reductions in predicted emissions from transport.

3. Ambient Air Pollution

Ambient air quality

Ambient air quality is the main air pollution/emissions issue considered in EIA of road schemes. This is because of the serious human health impacts of air pollution originating from fossil fuel combustion, especially in motor vehicles.

The WHO Regional Office for Europe, published a study in 1999 entitled "*Health costs due to road traffic–related air pollution"*. The following is an extract from the press release for the study:

> *A new report prepared for the Third Ministerial Conference on Environment and Health and available from WHO reveals that car-related pollution is killing more people than car accidents in the three European countries studied...*
>
> *The report, Health costs due to road traffic–related air pollution, is the result of a health impact assessment project carried out in Austria, France and Switzerland. This project measured the health costs of road traffic–related air pollution in the three countries using*

a common method. It pooled data from transboundary and local hot spots, air pollution from transport emissions and other sources and applied the latest dose–effect models to the data. The study focused on exposure to fine particles – particulate matter that is smaller than 10 microns (PM_{10}) and is easily breathed into the lungs.

The main findings of the report are as follows.

- *One third of PM_{10} air pollution is caused by road transport. In cities this percentage is higher – up to 50%.*
- *Long-term exposure to air pollution from cars to adults over 30 years of age in the three countries studied causes an extra 21 000 premature deaths per year from respiratory or heart disease.*
- *This is more than the total annual deaths from road traffic accidents in the countries studied (1031 in Austria, 8300 in France and 616 for Switzerland: total 9947).*
- *Each year air pollution from cars in the three countries causes 300 000 extra cases of bronchitis in children plus 15 000 hospital admissions for heart disease, 395 000 asthma attacks in adults and 162 000 asthma attacks in children.*
- *This air pollution causes about 16 million person-days of restricted activities for adults over 20 years old because of respiratory disease (days off work or inability to carry out usual activities of daily living).*
- *The total cost of this health impact in the three countries is EUR 27 billion per year, including the intangible costs for pain, grief, suffering and loss of quality of life from illness or premature mortality, as well as the monetary costs of medical treatment and loss of production.*
- *This is 1.7% of the combined gross national product of the three countries in the study: EUR 360 per person per year.*

The EPA (2004) identifies PM_{10}, and NO_x as the pollutants of greatest concern:

Emissions from road traffic are now the primary threat to the quality of air in Ireland. The pollutants of most concern in this regard are nitrogen dioxide (NO2) and fine particulate matter, expressed as PM10. Results of monitoring indicate that compliance with the stringent new PM10 and NO2 standards may present problems in some urban areas subject to heavy traffic. The EPA will advise local authorities on measures needed to ensure compliance with the standards. The introduction of such measures, in the form of air quality management plans or shortterm traffic restrictions, would be a major new challenge for local authorities.

Further background details are contained in the Section 1 report.

1. Policy in relation to climate change

In pursuance of its existing and anticipated obligations, the government published a National Climate Change Strategy in 2000. The Strategy sought to address both the 2008-2012 Kyoto Protocol commitment and the longer-term commitments implicit in the UNFCCC.

In relation to transport, this strategy predicted that business as usual predictions of a 180% increase over 1990 levels by 2010. It included indicative targets for 2010 for transport of 2.67 Mt CO_2 below business as usual emissions, to be achieved by a range of measures as set out below.

Vehicle Efficiency Improvements	0.77 Mt CO2
Fuel Measures (displace bunkering)	0.9 Mt CO2
VRT,Taxes	0.5 Mt CO2
Labelling	0.1 Mt CO2
Public Transport Measures	0.15 Mt CO2
Traffic Management	0.2 Mt CO2
Freight	0.05 Mt CO2
Total	**2.67 Mt CO2 per annum**

(source: National Climate Change Strategy, 2000)

These measures have variously not been implemented or not been successful.

In 2002, the Progress Report on the National Climate Change Strategy claimed that the implementation of the DTO's Platform for Change would lead to a 1 Mt CO_2 compared to business as usual:

> Implementation of this Strategy will reduce emissions by over 1 Mt of CO2 per annum by 2016, a 41% reduction on projected emissions.

There report contains no further explanation of this figure. The assumptions behind such a calculation relate to inelasticity of demand and the issues of induced and suppressed demand, which are discussed below.

Work by Sustainable Energy Ireland (2003) has quantified potential emissions reductions from a) a shift in car purchasing to more efficient cars and b) from reduced milage. It's conclusion is that substantial reductions can only be achieved by reduced milage.

Subsequently SEI (2004) examined grrenhouse gases from transport and concluded:

> This chapter has presented the current and potential Irish response to greenhouse gas emissions from transport. The transport policy measures currently in place such as vehicle and fuel taxes, public transport measures and road charges have not been designed with the reduction of greenhouse gas emissions as their primary function. Many of the measures described in the National Climate Change Strategy to reduce greenhouse gas emissions from transport have yet to be implemented and the latest projections of CO2 emissions per year from transport in 2010 are at 14.2 Mt per year. This is significantly higher than the target set in the National Climate Change strategy at 11.4 Mt CO2 emissions per year from transport.

The DTO claimed that Platform for Change would lead to a 250,000 tonne reduction in CO_2 emissions would result from implementation of its measures. *There are methodological questions about this.(discuss with Kevin F re induced traffic.)*

The National Climate Change Strategy says in relation to road-building:

Roads Investment

As indicated, roads are the primary mode of internal transport in Ireland, and are vital for future economic and social development at both national and local level. Notwithstanding the high level of dependency on roads, the quality of the road infrastructure in Ireland is poor by EU standards; about 0.1% of the total road network is of motorway standard compared to an average of 1.3% in the EU. *The National Road Needs Study* (NRA, July 1998) pointed to the fact that by the end of 1999, 24% of the national primary network and 14% of the national secondary roads would fall below the required standard and that the position would worsen significantly by 2019 without additional significant investment.

The NDP aims to bring the road network up to an acceptable standard in the period to 2006 and to do so as part of an integrated transport investment programme. Pursuant to this approach, a total of £4.7bn is planned in investment in National Roads in the NDP. On the National Primary network, a number of major interurban routes will be upgraded to motorway/high quality dual carriageway standard, with further major improvements on other national primary routes. On the National Secondary Network, the investment strategy will concentrate on routes which are of particular importance to economic and regional development. Within the primary road transport objectives is the objective to contribute to sustainable transport policies, facilitating continued economic growth and regional development while ensuring a high level of environmental protection. In the delivery of the investment programme, the assessment of environmental protection will include the assessment of the impact of individual projects on greenhouse gas emissions. The growth in these emissions will be managed through maximising the efficient use of road transport, removing delays in inter-urban journeys, (which, inter alia, will have the effect of increasing efficiencies in fuel use due to improved journey times and reduced congestion), road pricing, an integrated approach to land use planning and transport, including through the achievement of balanced regional development and the proposed National Spatial Strategy.

It is striking that the role of road-building in facilitating and stimulating road use is not referred to even in the National Climate Change Strategy itself.

2. Policy in relation to emissions of long-range transboundary air pollutants

The Directive is implemented into Irish law by the European Communities (National Emissions Ceilings) Regulations 2004, S.I. No. 010 of 2004, which includes the following provisions:

Objective

3 These Regulations have as their aim the limitation of emissions of acidifying and eutrophying pollutants and ozone precursors in order to improve protection in the Community of the environment and human health against risks of adverse effects from acidification, soil eutrophication and ground-level ozone, and to move towards the long-term objectives of not exceeding critical levels and loads and of effective protection of all people against recognised health risks from air pollution.

Scope

4 The Regulations cover emissions from all sources of the pollutants sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia, hereinafter referred to as “relevant pollutants”, which arise as a result of human activities with the exception

of emissions from international maritime traffic and aircraft emissions beyond the landing and take-off cycle.

National Emission Ceilings

6 (1) Annual national emissions of the relevant pollutants shall, by 2010 at the latest, be limited to amounts not greater than the relevant emission ceilings in the Schedule.

(2) In any year after 2010 annual national emissions of the relevant pollutants shall not exceed the relevant emission ceilings in the Schedule.

(3) Relevant public authorities and statutory undertakers shall have regard to the national emission ceilings in the Schedule and the strategy provided for in article 7, and, when exercising any function in relation to activities and matters which could affect significantly, or are capable of so affecting, the level of emissions of relevant pollutants, shall do so so as to limit any such emissions in accordance with the requirements of sub-articles (1) and (2).

National Strategy

7 (1) The Minister shall draw up, or cause to be drawn up, a strategy, hereinafter referred to as "the strategy", for the progressive reduction of emissions of the relevant pollutants, with the aim of complying with article 6.

(2) The strategy shall include information on adopted and envisaged policies and measures and quantified estimates of the effect of these policies and measures on emissions of the relevant pollutants in 2010 and shall indicate anticipated significant changes in the geographical distribution of national emissions.

(3) The strategy shall be clear, comprehensible and easily accessible and shall be made available to the public, relevant public authorities and statutory undertakers and appropriate organisations such as environmental organisations, and, where so requested, any organisation or any person.

(4) The Minister shall update and revise the strategy as necessary no later than 1 October 2006.

(5) The Minister shall inform the Commission of the strategy when drawn up, and shall inform the Commission of any necessary updating and revision of the strategy no later than 31 December 2006.

…

Offences

8 (1) For the purposes of these Regulations it shall be an offence to contravene article 6(3).

(2) A person or body convicted of an offence under these Regulations shall be liable on summary conviction to a fine not exceeding €1,269, or to imprisonment for any term not exceeding six months, or, at the discretion of the court, to both such fine and such imprisonment.

(3) A prosecution of an offence under these Regulations may be taken by the Minister, the Agency, or by a local authority in whose functional areas the offence is committed, as appropriate.

As the EPA points out above,

> The State cannot expect to comply with its emissions ceilings for NOX and GHGs if their contributions from road traffic are not soon brought under control.

Unlike the Kyoto allocations, there is no provision or allowance in the NEC Directive for trading of emission rights. A breach of the emissions ceilings is a breach of the Directive. This puts the NEC Directive in unavoidable conflict with national transport policy which is facilitating ongoing increases in NOx emissions and certainly not providing for sharp cuts in such emissions.

The "National Programme for Ireland under Article 6 of Directive 2001/81/EC for the progressive reduction of national emissions of transboundary pollutants by 2010" which the Department of the Environment, released in April 2005, deals with this conflict as follows.

> The legislative proposal to revise the national emission ceilings and other aspects of the directive by mid-2006 will, as before, be based on integrated assessment modelling and consultations to update the model are due to commence with Member States in April 2005. It seems clear, based on available updated data sets, that the current ceilings for Ireland do not represent the most cost effective route for Ireland to make its contribution to meeting the directive's interim environmental objectives. It is anticipated that this will become evident during the analytical preparations for the new legislative proposal.
>
> This National Programme will be updated and revised as necessary in 2006 to take account fully of all relevant policy and legislative developments particularly the proposal to revise the national emission ceilings and other aspects of the directive.

Demand reduction whether by congestion charging or other means does not appear to have been considered as a policy measure in this regard nor assessed for cost-effectiveness.

3. Policy in relation to ambient air quality

No specific national policy in relation to ambient air quality has been articulated as such. However, EU policy which Ireland is legally bound by is clear, with a Framework Directive on Ambient Air Quality (Directive 96/62/EC) and a series of Daughter Directives in place. These Directives set legal limits, action thresholds and require actions to reduce ambient concentrations below specified levels.

4. The policy development / programme development process for road infrastructure

We have identified the following documents as belonging to this process.

National Roads Needs Study 1998

The National Roads Needs Study includes two relevant sections. One is entitled "Sustainable Development". This refers to the National Sustainable Development Strategy and says:

> "The goal of sustainable development implies setting limits on the external effects of the transport system, therefore, in relation to air pollution, energy consumption, noise nuisance, the numbers of accidents, the impact on wildlife and the countryside, the erosion of the quality of urban life and the consumption of space at levels acceptable for present and future generations."

This is a clear statement of what is best described as the limits aspect of Sustainable Development. Unfortunately, these limits are not discussed or developed in the study itself. This conceptualisation is not referred to again in the study.

The following section in the Study is entitled "Overview of Environmental Considerations" the first subdivision of which is "Air Pollution." This refers to vehicle emissions and summarises their impacts including impacts on climate, acidification, and human health. The summary of impacts is relevant

The text then reads:

> "The current period of rapid economic growth is resulting in higher levels of ownership and use of private transport. Improved vehicle efficiencies are at least partly offset by the purchase of larger and less efficient classes of vehicles.
>
> "The greatest impact of air emissions is in urban areas and this can be alleviated by the development of the National Road Network to relieve such congestion and diver heavy traffic away from communities. Air pollution from transport is most effectively addressed by measures to reduce emissions from vehicles at EU and National level. A range of options may also have to be considered, as detailed in the Environmental Resources Management (ERM) Report, to ensure improved efficiency for new vehicles including the use of alternative fuels, improved maintenance of vehicles, etc."

The concept of limits referred to above is not relied on. Improved vehicle efficiencies are stated to be the most effective means to reduce emissions. No evidence is adduced to support this statement.

In fact, it is clear that improved vehicle efficiencies will not be sufficient to reduce emissions in a situation of high growth in traffic such as in Ireland. Work by SEI shows definitively they will not meet greenhouse gas targets and research on ambient air quality shows increased total traffic levels can easily make up for

reduced emission levels from individual vehicles. (SACTRA, New Scientist, Newman and Kenworthy-SEI)

The entire thrust of the EU Ambient Air Quality legislation made up of the Framework Directive and Daughter Directives is based on a recognition that action in relation to the emission rates of individual vehicles is not sufficient to achieve the targets in the Directives and that therefore Member States need to carry out local air quality management.

Having apparently decided what the most effective means of reducing emissions is, the study does not refer again to emissions. Nor does it refer to the limits which it had identified as being implicit in the goal of sustainable development. Instead the study uses a predict and provide approach to roads, with varying levels of service determined as appropriate for different categories of roads and no calculations or estimation of the impact of the various recommendations on emissions or ambient concentrations.

It is striking that the conceptual framework was set out for integrating the relevant environmental policy objectives were identified and objectives into the study, but nonetheless, there was no attempt to carry out this integration or rely on the environmental policy objectives in carrying out the study or making recommendations as to investment priorities and quantities.

Review of Transport Infrastructure Investment Needs DKM Economic Consultants, 1999

In response to the National Roads Needs Study, DKM Economic Consultants carried out a detailed critical review of the Study. The review is concise and incisive, recommending a reduction in the proposed expenditure on the grounds that what was proposed would constitute overprovision. There is a subsection entitled "Environmental Aspects". However it contains just a few general comments. The analysis carried out did not rely in any way on the environmental aspects mentioned or any environmental policy objectives.

National Development Plan (NDP) 1999

The policy framework is stated as follows:

> Environmental Impact (Sustainable Development)
> 13.21 Under the Treaty of Amsterdam, the Union's financial instruments are required to work, simultaneously and in the long term interest, towards economic growth, social cohesion and the protection of the environment; in other words, sustainable development. The European Council at Vienna confirmed the political priority of integrating the environment in structural and agricultural policies in the context of Agenda 2000. As indicated in the Commission's guidelines, this means that environmental considerations, and in particular, compliance with Community environmental and nature protection

legislation must be incorporated into the definition and implementation of measures supported by the Structural Funds and the Cohesion Fund. This will help the Union to comply with its international commitments such as those concerning climate change at Kyoto. At the 1997 Kyoto conference, it was agreed that the EU Member States would reduce their collective emissions of greenhouse gases to 92% of their 1990 levels by 2010.

Ireland's target has been set at an increase of not more than 13% over the reference period.

Achieving this target will prove extremely difficult in the context of rapid economic growth.

13.22 The establishment of a system of eco-audit of policies is a key environmental priority in the Government's ''An Action Programme for the Millenium''. In addition, ''Sustainable Development: A Strategy for Ireland'' undertook to develop within three years, a Strategic Environmental Assessment (SEA) system for major sectoral plans and programmes. In June 1999, the Government approved:

• the introduction on a pilot basis of a procedure for the eco-auditing of policies in specific sectoral areas of Government Departments and in respect of national development plans; and

• the evaluation of the results of pilot exercises by the Departments concerned and the Green Network of Government Departments with a view to wider use of eco-audit after one year.

13.23 Eco-auditing (also known as environmental appraisal) involves the establishment of a formal procedure for identifying the environmental impacts of sectoral policies and programmes 220 and for mitigating/eliminating their adverse impacts. This enables the environmental dimensions of policy to be considered in an integrated way, at the same time as the broad social, economic and other dimensions. Eco-audit will not apply to the carrying out of physical projects as these are already governed by Environmental Impact Assessment (EIA) legislation.

Government Departments have been instructed to arrange for the introduction of eco-auditing of policies in accordance with the Government decision and on the basis of specific agreed guidelines. Pilot projects should be completed by the end of April 2000 and will then be evaluated by the Departments concerned and by the Green Network of Government Departments.

13.24 The National Development Plan 2000-2006 has been eco-audited on a pilot scale and the results are set out at Appendix 4.

13.25 Economic and social development should not be to the detriment of environmental quality. The Plan has been framed taking into account the need for balance between environment and development, embodied in the concept of sustainable development, so that economic and social activity will not undermine the long-term productivity of supporting ecosystems. Integration of environmental considerations into other policies is a key means of securing this balance, and environmental considerations associated with development proposals are addressed in the relevant chapters of the Plan. A National Spatial Strategy will be prepared to secure sustainable spatial development over the longer term. A new State of the Environment Report will be published by the Environmental Protection Agency in 2000.

There are obvious difficulties with the redefinition of sustainable development here and with the return to the concept of balance, which sustainable development was supposed to displace. Nonetheless, the above section makes two signficant commitments:

a) it sets out an eco-audit process to be followed and emphasises the importance of integration of environmental policies, and

b) states that "environmental considerations associated with development proposals are addressed in the relevant chapters of the Plan".

The NDP refers to the key changes identified above as follows: (13.28)

"• Although there has been some decoupling of growth in greenhouse gas emissions from growth in the economy, CO2 emissions had increased by almost 20% over 1990 levels by end 1997. Ireland's Kyoto commitment is to limit the growth of a basket of 6 greenhouse gases to 13% above 1990 levels in the period 2008-12; on a business as usual basis net annual

"• Sulphur dioxide (SO2), nitrogen oxides (NOx) and ammonia (NH3) contribute to local and transboundary air pollution problems (acidification, eutrophication and ground-level ozone). Irish compliance with existing international obligations, particularly in the case of NOx, is under threat from rising emissions from transport. Future obligations, to apply from 2010, will require considerable reductions in emissions (76% reduction from 1990 levels in the case of SO2, 42% reduction for NOx and 8% for NH3). Meeting these targets will require significant action in the energy, industry, transport and agriculture sectors;

"• Traffic growth has impacted in urban areas, especially in the cities, in terms of congestion, air pollution and noise; without more intensive traffic management, Ireland will face difficulty in meeting EU air quality standards for 2005 particularly in heavily trafficked urban areas;"

It is striking that this is an excellent summary of the key changes required.

Unfortunately, in the sections of the NDP where the detail in relation to the Roads programme and it's environmental impact would be expected, analysis set out above is not worked out in a manner to inform or influence the plan itself.

In the Roads section, all reference to both the environmental policy objectives and the framework described in 13.21 for integrating them into the plan is dropped in favour of a discursive and vague approach:

Environmental Impact of Economic and Social Infrastruture Programme

Roads

4.118 Roads and road transportation can have adverse environmental effects in terms of emissions, noise, visual intrusion, road accidents, property severance and impacts on residential and shopping/business districts and sensitive areas. Well-designed road improvements do however help reduce emissions, whilst by-passes and relief roads remove traffic from unsuitable areas, and road improvements contribute to improved safety. Many towns situated on national roads have substantial traffic problems, with congestion, traffic encroachment into the main shopping streets and even residential areas, pedestrian/vehicular conflict, and increased road accidents, noise and emissions. The provision of by-passes and relief roads alleviates these problems and make the towns safer, quieter, cleaner and more attractive places in which to live, work and visit.

4.119 The national roads programme will result in the removal of through-traffic from many towns and villages with a consequent improvement in environmental conditions and the quality of life generally in these areas. The elimination of congestion due to through-traffic, and improvement of journey times and traffic conditions, will also have beneficial effects on vehicle emissions. Particular care will be taken in the route selection and design of road projects to minimise the impact on local communities (by, for example, avoiding demolition of houses and preventing severance), to by-pass sensitive areas, and to minimise the impact on flora and fauna and visual intrusion. Effective and early public consultation and careful planning are important in ensuring environmental compatibility. All road projects in the NDP likely to have significant effects on the environment will be subject to a comprehensive Environmental Impact Assessment (EIA) process. It is proposed under the Planning Bill to transfer the role of competent authority in the EIA process in relation to road and other infrastructure projects from the Minister for the Environment and Local Government to An Bord Pleana´la.

Public Transport

4.120 The large investment in public transport will have substantial environmental benefits particularly in the Greater Dublin Area. It will encourage a switch to public and non-motorised transport leading to reduced congestion, emissions, noise levels and accidents. There will also be environmental improvements associated with the development of environmental traffic cells, traffic calming and street/suburban village improvement schemes. In addition it is envisaged that transport demand management policy will be increasingly important in ensuring effective, efficient and sustainable use of our transport infrastructure, particularly in the major urban areas. A comprehensive demand management strategy for the Dublin area will be developed for implementation over the time scale of this investment programme.

The elimination of congestion due to through-traffic, and improvement of journey times and traffic conditions, will also have beneficial effects on vehicle emissions."

Even more surprisingly, the Pilot Eco-audit of the plan also fails to refer specifically to the key changes identified in Chapter 13. The entire text of the Eco-Audit is reproduced below.

Appendix 4 National Development Plan
2000-2006 Pilot Eco-Audit

4.1 The National Development Plan has been prepared within the overall framework of national environmental, as well as economic and social development, policy.

4.2 The overall aim of Sustainable Development: A Strategy for Ireland, as approved by Government, is to ensure that the economy and society can develop to their full potential within a well protected environment without compromising the quality of that environment, and with responsibility towards present and future generations and the wider international community.

4.3 Consistent with this strategic aim, the Government is committed to ensuring that concern for the environment is central to all policy decisions. In June 1999, the Government approved the introduction, on a pilot basis, of a procedure for the eco-auditing of policies in specific sectoral areas and of national development plans. This pilot eco-audit of the National Development Plan
2000-2006 takes into account guidelines on eco-auditing which have been developed to assist in giving effect to the Government decision.

4.4 The National Development Plan 2000-2006 envisages continued growth in the Irish economy over the medium term. The Plan is based on average annual growth in GNP of about 5% over the period and contains measures to secure and maintain that level of growth in the years ahead.

4.5 The Plan provides for expenditure of over £40 billion on the following priority areas:

- Economic and Social Infrastructure;
- Employment and Human Resources;
- Productive Sector;
- Rural Development;
- Social Inclusion;
- Social Capital (housing and health).

4.6 These priorities have been identified as areas for investment in order to support and maintain economic and employment growth. The Plan also addresses wider social issues by means of a commitment to a sharing of the fruits of economic activity, both across different sectors of society and in terms of spatial planning (through the designation of two regions at NUTS II level and the proposed National Spatial Strategy).

4.7 A broad overview of current trends in environmental quality, and of economic and social driving forces now exerting pressure on the environment, is contained in Environment in Focus, a discussion document produced by the Environmental Protection Agency (EPA) in 1999; this has informed preparation of the Plan. A new State of the

Environment Report, being prepared by the EPA, will be available in 2000. Pending this comprehensive assessment, the EPA analysis indicates that the main threats to the environment arise in the areas of climate change, eutrophication, the urban environment (including transport) and waste.

4.8 Economic and social development, together with investment of the order contained in the Plan, has unavoidable implications for the environment. Without appropriate integration measures, there would be impacts, ranging from the insignificant to the significant, on among other things, water and air quality, biodiversity, patterns of land use, energy consumption and waste production.

The Plan recognises this and aims to achieve a balance between environment and development.

4.9 The impact of the totality of proposed development on the environment as a whole places a premium on the pursuit of policies which promote economic efficiency, with less intensive resource use and less environmental stress.

4.10 For example, in the energy sector emphasis is placed on least cost approaches to achieving more sustainable energy systems. In the transport area, high importance is attached to increased efficiency which will reduce journey times, congestion and emissions and to the implementation of the integrated transport strategy for the Greater Dublin Area. Support for manufacturing industry will be linked to explicit commitments by firms to environmentally friendly production and appropriate waste management practices. Finally, in the tourism sector it is recognised that the future development of the industry is critically dependent on managing growth on an environmentally sustainable basis.

4.11 The Plan is a broad strategic document covering an extensive range of activities across most sectors of society. In a Plan of this nature, it is inevitable that detailed programmes remain to be worked out and that, at this stage, there is limited information on overall impact. It will be important that individual operational programmes are subject to eco-audit; these eco-audits will need to be built upon in the Plan and operational programme implementation, including by the use of appropriate indicators to measure the contribution to sustainable development. (Two reports, Environmental Evaluation of the Irish Community Support Framework 1994-99 and Environmental Indicators and Structural Funds Programmes in Ireland: A Guidance Document prepared by ERM Consultants for the Community Support Framework Environment Co-ordinating Committee, should be of assistance in these tasks).

4.12 The Plan incorporates a range of measures to address the environmental and social aspects of sustainable development. The environmental dimension is addressed, through measures to:

- Develop a National Spatial Strategy and promote balanced regional development (including through programmes for urban and village renewal);
- Secure better integration of land use and transport planning through, for example, adherence to the Strategic Planning Guidelines for the Greater Dublin Area;
- Enhance the eco-efficiency of transport through a more efficient road network, substantial investment in public transport, and other sustainable modes, and development of demand management measures;
- Support the meeting of climate change policy objectives, as a major test of sustainable development, through action across the Plan and in specific sectors, for example, in the energy and forestry areas (further measures in relation to climate change will be set out in the planned National Greenhouse Gas Abatement Strategy);
- Assist towards the achievement of sustainable agriculture through the Rural Environment Protection and Control of Farmyard Pollution Schemes;
- Improve water supply and waste water treatment facilities in accordance with the Drinking Water and Urban Waste Water Directives and national legislation;
- Implement integrated waste management strategies;
- Support a dedicated programme of environmental research.

4.13 The possibility of the emergence of some unsustainable patterns of development within the framework of the Plan cannot be excluded. This could arise from a number of

factors, including the pace of current economic development, unforeseen interactions between measures, or unanticipated consequences of particular measures.

4.14 It will, therefore, be of critical importance to ensure that the environmental dimension is fully integrated into the further stages of programme planning and into implementation. This should be achieved through:

• Integration of environmental considerations into the preparation of Operational Programmes and specific policies and measures, with a view to maximising eco-efficiency and minimising adverse impacts;

• The use of environmental criteria in Operational Programme project selection;

• The inclusion of environmental representation on Operational Programme Monitoring Committees;

• The inclusion of the environmental dimension in all evaluations to be carried out under the Plan;

• The establishment of an Environment Co-ordinating Committee for the 2000-2006 Period.

4.15 Development and implementation of indicators of environmental performance at Operational Programme and measure levels will be key to demonstrating the proper integration of environmental considerations into Plan implementation.

4.16 Finally, projects implemented under the Plan will be required to comply with relevant planning and environmental legislation; all projects should aim to minimise their negative environmental impact and secure positive environmental gain.

The "Pilot Eco-audit" lacks any detail in relation to the likely impact of the plan or how it measures up against existing environmental policy objectives. The only area where it goes into any level of useful detail is in relation to the mechanisms for ensuring integration of environment/sustainable development policy in the relevant sections of the NDP.

In summary, the "pilot eco-audit" reveals that it consists of the following

- Paras 4.1 to 4.6 Mostly description of the NDP (unnecessary given that this is an appendix to the NDP
- Paras 4.7 to 4.11 Highly generalised discussion of environmental issues of relevance to NDP
- Paras 4.12 List of NDP measures which "address the environmental dimension"
- Para 4.13 to 4.16 List of mechanisms to ensure integration of environmental policy into programme planning and implementation, including indicators and compliance with legislation.

The question of why the Pilot Eco-Audit contains no auditing or evaluation of any significance is one which it will be interesting to explore.

The process of integration set out in the Eco-audit appears not to have happened.

Economic and Social Infrastructure Operational Programme

3.3 National Roads Priority (2000-2006)

3.3.1Objectives

The objectives of the National Roads Priority are

• to improve the reliability of the road transport system by upgrading major interurban routes to motorway/high quality dual carriageway standard, removing bottlenecks,

remedying capacity deficiencies and reducing absolute journey times and journey time variance
• to improve internal road transport infrastructure between regions and within regions, contribute to the competitiveness of the productive sector and foster balanced regional development
• to facilitate better access to and from the main ports and airports with the main objective of offsetting the negative effects of peripherality
• to contribute to sustainable transport policies, facilitating continued economic growth and regional development while ensuring a high level of environmental protection
• to help achieve the objectives of the Government Strategy for Road Safety in relation to the reduction in fatalities and serious injuries caused by road accidents.

(p.7)
Emissions to air
Ireland has a greenhouse gas emissions growth limitation target of 13% over 1990 levels for the period 2008 to 2012. In a business-as-usual scenario, it is predicted that Ireland's emissions would grow by 35% in the commitment period. It is clear, therefore, that significant reductions from all sectors must be achieved if the Kyoto limit is to be achieved. The major greenhouse gas in Ireland, CO2, is derived from energy use principally in the energy, residential, transport, industrial and commercial sectors while Methane (CH4) and Nitrous Oxide (N2O), the next largest greenhouse gases, are derived mainly from the agricultural sector.
On a positive note, smoke concentrations in Dublin have decreased following the implementation of smoke control legislation in 1990. Concentrations in several other centres are set to decrease as the application of this legislation is extended. In addition, the levels of lead have fallen in line with the fall in the use of leaded petrol throughout the 1990s. However, it is expected that major urban centres such as Dublin will have difficulty in meeting proposed new EU limits on PM10 and nitrogen dioxide (NO2).

p.26
3.2.5 Transport and the environment
As is clear from the evaluation of the environmental situation in the NDP and CSF, the environmental impact of transport is extensive and significant, particularly in relation to air emissions (including greenhouse gas emissions), habitats and landscapes.
Transport is the largest source of NOx and CO and the third largest source of CO2 emissions. In addition congestion is a growing problem, particularly in the larger urban areas.
In response to these challenges, there have been a number of developments which are assisting in mitigating the impacts of transport on the environment.
• Technology has greatly reduced the emissions intensity of transport through improvements in vehicle emission-control systems and fuel efficiencies.
Since
1970, emissions from new cars on the EU market have reduced by over 90%.
Further major reductions will be achieved over the next five years.
Technology in
the form of telematics and intelligent traffic management and signalling systems is also being harnessed to provide better use and logistical management of transport infrastructure, both road and rail.
• Cleaner fuels are being marketed which significantly reduce, and in some cases eliminate, certain pollutants in the composition of the fuels. However, some of these gains are being eroded by increased travel, and CO2, the principal greenhouse gas, is not amenable to "end of pipe" solutions.
Increased emphasis has been maintained on the importance of public transport and urban traffic management initiatives. For example, the proportion of capital investment directed at public transport infrastructure under OPTRANS (1994-1999) was approximately 24% compared to 9% under the 1989-1993 programme.

Inefficiencies and bottlenecks in the national road network are being systematically targeted, and a comprehensive National Roads Needs Study has been carried out to bring greater method and objectivity to this process.
Implementation of the Dublin Transportation Initiative is being intensified through a DTO Short Term Action Plan initiated in Autumn 1998 which provides for an expanded programme of quality bus corridors and cycle lanes and improved bus, DART and suburban rail services.
Marketing of leaded petrol has been prohibited and mandatory car testing introduced.
The operation of the EIA system since 1989 has clearly been beneficial in helping to minimise the adverse, and maximise the positive effects of individual transport infrastructure projects. That the system has teeth is shown in several significant modifications of major projects, and in the rejection of projects in a number of cases.
The Strategic Planning Guidelines for the Greater Dublin Area, the update of the DTI Strategy, the planning guidelines on residential density, and the Retail Planning guidelines (both of which have national application) provide the basis for better co-ordination and investment in planning and transport issues.
Development of demand management policies, e.g. enhanced public transport priority, economic instruments, and better co-ordination of land use/transportation policies etc., which have an important role in sustainable transport.

3.7 Expected impact of the National Roads and Public Transport Priorities

3.7.2 Impact on the environment

The following, as a pilot eco-audit of the National Roads and Public Transport Priorities, outlines the expected environmental impact of the Priority by reference to a number of themes of particular relevance, namely

- nature conservation
- community and land severance
- transport sector emissions/air quality
- urban environment and traffic congestion.

Pilot eco-audit check lists for the National Roads and Public Transport Priorities are included in Annex III. The check list is qualitative in nature having regard to the information available.

...

Transport Sector Emissions/Air Quality

Transport is acknowledged in all developed countries as one of the most difficult challenges to achieving more sustainable development. Society's requirement for mobility of people and goods has been growing and this trend has been accelerated by the increasing integration of EU and global markets.
Air quality in Ireland is generally good and we meet all current mandatory ambient air quality standards. However, transport is a significant source of some pollutants, particularly in heavily trafficked urban areas. The trends for emissions from individual vehicles for most pollutants are downwards as fuel technology and technology for removing pollutants from exhaust emissions continue to improve.
However, the increasing numbers of vehicles on the road and increasing vehicle miles travelled are negating the technological improvements in some respects.
New standards for ambient air quality relating to a range of pollutants, including NOx and PM10, are due to come into operation at EU level over the coming years.
Proposals for standards are also expected in respect of CO, benzene, lead and polyaromatic hydrocarbons, which are transport related emissions. Where existing
Economic and Social Infrastructure Operational Programme standards are being revised, the new standards will be significantly more onerous than at present.
The major growth in the transport sector, particularly the passenger car sector, has counteracted reductions in NOx emissions from the power generation and industrial sectors which were achieved during the last decade. Emissions from transport now

account for 44% of total emissions. However, all ambient air level standards are currently within mandatory EU and national limits. Emissions from individual vehicles are set to fall with an increasing use of catalytic convertor technology and the introduction of new vehicle standards between 2000 and 2005. No standard currently exists for PM10, the primary traffic source of which is diesel-engined vehicles. While reductions in emissions from individual vehicles are expected with changes in fuels and engine technologies between 2000 and 2005, baseline studies carried out by the EPA and Dublin Corporation in Dublin indicate that the proposed new EU standards will be difficult to achieve in heavily trafficked urban areas.

In relation to climate change, Ireland has a legally binding target under the Kyoto Protocol to limit the growth in a basket of six greenhouse gases to 13% above 1990 levels by the commitment period 2008-2012. Irish emissions of greenhouse gases in 1990 were equivalent to 53.752 million tonnes (Mt) of (CO2), and our target is to limit emissions to 60.74Mt by 2012. Without action, it is projected that net annual emissions would increase by up to 34.9% to 72.504 Mt by 2010. This essentially means that Ireland's target is to reduce emissions by up to 11.764 Mt CO2 equivalent per annum for the commitment period 2008-2012.

Of all sectors, the transport sector is expected to show the greatest increase in emissions over the next decade, predominately emissions of CO2. Current projections of CO2 emissions for 2000 show an increase of 31.9%, or 28.9% when counted on a net basis. In 1990, the transport sector contributed approximately 15.7% of Ireland's CO2 emissions and 9.5% of emissions in the basket of six greenhouse gases.

Within the transport sector, there has been a dramatic increase in private transport ownership and usage, resulting in a substantial growth in traffic over the past number of years. While fuel and emissions efficiencies within each class of car are increasing, there have been trends towards purchase of larger vehicles, reducing the overall fuel efficiency of the fleet. As a result, transport sector greenhouse gases are set to grow further both in absolute terms and as a proportion of total greenhouse gas emissions.

In absolute terms, they are forecast to increase by over 200% in the period from 1990 to 2010. Transport sector emission increases are forecast to account for an estimated 59.1% of the total emissions increase to 2010. The proportion of the total basket of greenhouse gas emissions attributable to the sector in 2010 is estimated at 18.9%, double the proportion in 1990.

In common with other countries, Ireland faces a difficult challenge in attaining sustainable transport and, in particular, limiting the growth in greenhouse gas emissions. Abroadly based package of integrated and mutually reinforcing measures will be required to tackle greenhouse gas emissions in the transport sector.

National Roads and Public Transport

In broad terms, the challenge for all pollutants from the transport sector will have to be met through a combination of the following:

• the active encouragement of more efficient road vehicles, having regard to EU voluntary agreements with vehicle manufacturers on CO2 emissions, standards for other vehicle emissions, and standards for fuel quality under the EU Auto Oil Programme

• the promotion of beneficial modal shifts to public transport to reduce the dependence on the private car, particularly in urban areas

• integrated demand management, i.e. through policies such as economic instruments and land use planning to reduce or moderate the demand for mobility or to cater for it more rationally.

Urban Environment and Traffic Congestion

Many towns situated on national roads have substantial traffic problems such as congestion, traffic encroachment into the main shopping streets and even residential areas, pedestrian/vehicular conflict and increased road accidents, noise and air pollution. Traffic has reduced the attractiveness of these towns for residents, shoppers and tourists. The provision of by-passes and relief roads alleviates these problems and makes the towns safer, quieter, cleaner and more attractive places in which to live and work and to visit. By-passes also remove from residential areas vehicles carrying dangerous goods.

> Apart from measures in Dublin, integrated traffic management strategies have been or are being developed for the major cities to respond to the transport issues arising there. These strategies place significant emphasis on public transport, cycling and walking – as well as appropriate road development – to meet mobility needs.
> Of the total planned Operational Programme investment in roads and public transport, 31% will be spent on public transport measures, mainly in urban areas.
> This compares to 9% and 24% of the roads and public transport total on the 1989-1993 and 1994-1999 programmes respectively. This substantial increase in investment will facilitate major improvements in public transport infrastructure and rolling stock.
> These improvements will be complemented by traffic management measures designed to promote a beneficial modal shift particularly in urban areas.
> Conclusion
> The overall environmental impact of the National Roads and Public Transport Priorities is expected to be positive. The programme is consistent with the objectives and strategy outlined in the Sustainable Development Strategy. The infrastructure investment programme proposed will result in a more efficient inter-urban road network which will remove traffic from many towns and villages that are currently experiencing heavy through traffic with associated adverse impacts on the environment and quality of life generally - major improvements to urban and regional public transport services as an alternative to car based transport.
> Road development projects will be subject to comprehensive EIA to minimise the adverse impacts and maximise their beneficial impacts. The investment programme also recognises that infrastructure development requires to be complemented by supporting measures in the areas of transport demand management and telematics.
> Finally, to assist in future policy development, a study on the environmental impacts of current and prospective future levels of traffic and the scope for action to be taken by Government has been completed.

It is noteworthy that no air or climate related objective is stated as an objective of the "national roads priority". The closest that the objectives get is the fifth listed objective:

> • to contribute to sustainable transport policies, facilitating continued economic growth and regional development while ensuring a high level of environmental protection

Congestion is listed as an environmental problem, which is a not infrequent conceptual confusion.

Nowhere in the text is the question of the impact of the "roads priority" on levels of emissions addressed. This appears only in the Eco-audit check lists in Annex III to the report (copy attached to this report) where significant negative impacts are indicated for polluting discharges to atmosphere and for emissions of greenhouse gases.

This is marked with a footnote that reads:

> * The extent to which improved road infrastructure contributes to additional polluting discharges and greenhouse gas emissions remains to be clarified.

As we will see, despite being flagged at this stage, this quantification appears not to have been done.

ESIOP Programme Complement 2000

This Programme Complement which accompanied the Operational Programme contained the following (p.10)

> In addition, the following data will be included in periodic reports to the Monitoring Committee
> • traffic on each transport mode, including traffic volumes, on National Primary Routes
> • associated emissions by mode (subject to availability of data)
> • land-take and implications, if any, for SACs, along with details of population centres benefiting from the removal of through traffic associated with the national roads development programme.

The reports to the Monitoring Committee did not contain any emissions data.

Evaluation of Investment in the Road Network 2002

This document, by Fitzgerald Associates, contains no evaluation of the environmental impact of the investment. It quotes the ESIOP (p.23):

> "With careful planning and adequate prior public consultation, these projects will have little or no adverse environmental effects and will deliver positive impacts in terms of reduced road accidents and vehicle emissions" (ESIOP, 2000-06). "

It makes no reference to the the eco-audit as discussed above.

The rest of this section is a discussion of the EIA process. While this is relevant, it does not address the programme-level impacts of the development. It is an evaluation of the EIA process and not an evaluation of the environmental impact of the road infrastructure either in construction or operation.

The issue of quantification of the impact of the road investment on emissions was flagged to the consultants before the report was produced, when they consulted with Comhar.

Mid-Term Evaluation of the Economic and Social Infrastructure Operational Programme Indecon Consultants 2003

Although there is significant introductory discussion in the report of climate change and the relevant sections of the National Climate Change strategy, the issue of the impact on emissions of road infrastructure investment is not addressed.

Mid-Term Evaluation of the National Development Programme ESRI 2003

Here again, the discussion never moves beyond the general and the issue identified in the ESIOP is not addressed.

ESIOP monitoring committee documents

The issue of failure of the monitoring system to follow up on the impact of increased road infrastructure on emissions has been raised by Comhar at the meetings of the ESIOP Monitoring Committee. Nonetheless, as far as October 2006, there has been no quantification of the impact of the road infrastructure investments in the National Development Plan on emissions of greenhouse gases or other pollutants.

Discussion

The question of how the roads programme included in the NDP was developed is addressed in the reports by Richard Douthwaite and Brian Guckian as part of this research project. It is clear, however, that there was no integration of policies in relation to ambient air quality, greenhouse gases or long-range transboundary air pollution into the process for determining transport policies in the NDP or the process for selecting schemes for inclusion in the NDP roads priority or public transport priority.

There is an implicit assumption in the documentation that traffic demand is independent of supply of road capacity. The only location where this issue is openly raises is in a footnote to the pilot eco-audit of the ESIOP, which says that

> "* The extent to which improved road infrastructure contributes to additional polluting discharges and greenhouse gas emissions remains to be clarified."

This matter was never clarified, despite being raised at ESIOP Monitoring Committee Meetings between 2002 and 2006. It appears that no research was done to investigate or quantify what had been identified as a significant potential impact.

None of the evaluation or review reports addressed the issue. This is even the case for the 2002 *Evaluation of Investment in the Road Network*, whose authors consulted Comhar who responded by flagging the issue to them.

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Annex III Eco-Audit Check Lists

Para. 3.7.2

National Roads Priority

IMPACTS

	Significant	Of some significance	Insignificant	None
Water Quality and Quantity				
Water quality				✓
Polluting discharges to surface ground or marine waters			-	
Water quantity				✓
Air Quality				
Air quality (Local)	+			
Air quality (Transboundary)		0		
*Polluting discharges to atmosphere	-			
*Emissions of greenhouse gases	-			
Biodiversity				
Quality of area of habitats		0		
Populations or range of species				✓
Protected areas		0		
Threatened or protected species				✓
Land Use				
Land use patterns	+			
Landscape		-		
Resource Conservation				
Energy use		0		
Waste recovery		0		
Natural resource/material use		-		
Extraction or use of non-renewable resources		-		
Waste				
Waste production		0		
Disposal		-		
Architectural and Archaeological Heritage				
Buildings and structures of architectural or historic importance			0	
Archaeological sites, monuments and artefacts		0		
Health and Welfare of Population				
Noise levels		0		
Security and safety of the public	+			
Dangerous Substances				
Use of dangerous substances				✓
Risk of accidents during the transport, use and manufacture of dangerous substances				✓

+ = Positive - = Negative 0 = Neutral

* *The extent to which improved road infrastructure contributes to additional polluting discharges and greenhouse gas emissions remains to be clarified.*