QUANTIFICATION OF INTANGIBLES

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A REVIEW OF INTANGIBLE FACTORS FOR TRANSIT NEW ZEALAND'S PROJECT EVALUATION MANUAL

JOHN CHIVERS, Transplan Consulting
SYLVIA ALLAN, Environmental Planning & Assessment
MALCOLM HUNT, Malcolm Hunt Associates

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PO Box 5084, Lambton Quay, Wellington, New Zealand
Telephone (04) 499-6600; Facsimile (04) 499-6666

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AN IMPORTANT NOTE FOR THE READER

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EXECUTIVE SUMMARY

1. This research report considers Appendix A7, Intangible Costs and Benefits, of Transit New Zealand's 1991 edition of Project Evaluation Manual (PEM), used for evaluating roading projects in New Zealand, and makes suggestions on :

   - Additional intangibles which should be included.
   - Modifications to intangibles already recognised in the PEM.
   - Methods by which the intangibles could be measured or quantified.
   - Further research to assist the quantification of the intangibles.

2. The research method involved literature searches, and consultation with users of the PEM and with representatives of transport users, public interest groups and statutory authorities, to ensure that the widest range of possible intangible factors was identified. Several environmental impact assessments for recent roading projects were reviewed to identify additional intangible factors.

3. The report reviews how intangibles are included in the PEM at present, comments on the range of matters covered, and makes some suggestions to improve the evaluation of intangibles already included, such as traffic noise, vibration, community severance and local air pollution.

4. The report identifies and discusses six particular intangible factors which are considered important. Some of these are not at present included in the PEM, and others were found to be expressed or grouped in an unsatisfactory way.

5. The six factors, and a summary of the research findings for each, are as follows:

   Visual Impact - This is an important intangible, and can be considered as a range of impacts, including visual obstruction, visual intrusion, view from the road, and view of the road. There are a number of methods of quantification, but all require further investigation to be useful.

   Special Areas - This is suggested as a new category for evaluating intangible impacts. It involves identifying a range of special sites and areas (from ecological areas, to historic places, to waahi tapu). There are some special areas where quantification is possible but others will remain true intangibles. This category should be incorporated in the PEM, and will involve redefinition or replacement of some existing categories.

   Effects on Water - This intangible category is important as water is a receiving medium for pollution. Research which will assist the quantification of effects is needed, and suggestions for research are made.

Ecology - This intangible is evaluated in terms of the grouping of other factors proposed in this report, and it is suggested that the category should be redefined and simplified to include only habitat loss and interruption of ecological corridors. Other aspects at present included under this heading are proposed to be transferred to categories such as effects on water, air pollution, or special areas. Methods of evaluation such as "shadow projects" (and "shadow pricing") are commented upon.

Psychological Stress - Inclusion of this factor is based on the extent to which it is not included in monetary valuations in other PEM categories. Both non-user and road user stress aspects, not covered in the PEM at present, are identified.

Overshadowing - This is an impact which is small in extent but severe when it does occur. It is a recommended aspect for further research.

6. A number of other factors were identified in the course of the research, and are noted. These include security, urban blight, pedestrian and cyclist intimidation, use of road reserves for other purposes (e.g. for public utilities), and stated policies of international, national and regional organisations. Relatively little is known about these intangibles at present, and quantification methods seem remote. They may, however, prove to be worthy of investigation in the future.

7. The report gives a summary of methods of quantification for each of the above factors and finds that there is limited opportunity for quantification, and that further research would be worthwhile in some areas. At present there are no known satisfactory methods of quantifying many aspects of the intangibles discussed in the report.

8. The need for integration between environmental impact and/or assessment procedures, transport planning objectives and strategies, and the content and use of the PEM, is noted.

ABSTRACT

Appendix A7, Intangible Costs and Benefits, of Transit New Zealand's Project Evaluation Manual (1991 edition) is reviewed. The review makes suggestions on: additional intangibles which should be included; modifications to intangibles already recognised in the PEM; methods by which the intangibles could be measured or quantified; and further research to assist the quantification of the intangibles to be used in Appendix A7.

The study reviewed available information on overseas practices and recent environmental impact studies on roading projects in New Zealand. Consultation with a group of users and non-users of the Project Evaluation Manual was also undertaken.

Recommendations are made on methods of objective quantification of intangible factors for eventual incorporation into the Project Evaluation Manual, as well as about the methodologies that may require further research and refinement.

Intangible factors considered important for inclusion or modification are: visual impact (which includes visual obstruction, visual intrusion, view from the road, view of the road), special areas, effects on water, ecology, psychological stress, overshadowing. Other intangible factors that may have potential for inclusion in Appendix A7 are: exposure to wind, litter, security, urban blight, pedestrian and cyclist intimidation, use of road reserve for public utilities, effects on soil, effects of road alignments, adherence to global, national or regional environmental goals.

1. INTRODUCTION

Transit New Zealand's Project Evaluation Manual (PEM) (Transit New Zealand 1991) uses cost-benefit analysis to evaluate a project's relative worth. Appendix A7, Intangible Costs and Benefits, of the 1991 edition of the manual sets out a list of intangibles that have to be investigated for a project evaluation, and methods for the quantitative and/or qualitative assessment for each intangible factor. The procedures set out in PEM require that all tangible impacts are incorporated in a cost-benefit analysis. A "Planning Balance Sheet" is to be used to separately identify and compare intangible impacts for presentation along with the cost-benefit analysis.

This report evaluates the range of intangible factors listed in the PEM's Appendix A7, and comments on their scope and the adequacy of the assessment methods. It recommends further intangible factors for incorporation in the PEM assessment. Further comment is made on the process of investigation and evaluation of social and environmental factors for proposed roading projects, particularly with respect to the integration of Environmental Impact Assessment (EIA) studies and the assessment procedures contained in the PEM.

1.1 Method

The methods used to research the material for this project involved consultation and information retrieval. Consultation was first undertaken with a group of professionals who represent the users of the PEM, and later with representatives of transport users (Automobile Association and NZ Road Transport Association), statutory authorities (Ministry of Transport), and interest groups (Pacific Institute of Resource Management and Transport 2000). Parties consulted at this stage were asked to comment on the scope and adequacy of the recommended changes to Appendix A7. Section 4.4 discusses the consultation and the findings of the second consultation round are summarised in the Appendix.

Information retrieval was undertaken using a comprehensive literature search conducted by TeLIS Library, Wellington. Information used came from local and overseas sources and the emphasis was on more recently published material relevant to the investigation and to quantification of social and environmental factors associated with traffic and roading developments.

1.2 Background

The need to re-evaluate the range of intangible factors for Appendix A7 arises from the increasing awareness of environmental impacts by the public at large. The Resource Management Act 1991 requires planning authorities to focus on the effects of activities. The central concept in the Resource Management Act is sustainable management. Sustainability can be defined as requiring that future generations be left a stock of environmental wealth no less than that existing at the present time. The exact interpretation of sustainability is problematic, given the difficulty of valuing and adding together various forms of environmental wealth. Nevertheless, it can be taken to mean that pollution must not exceed the assimilative capacity of the natural environment, and the depletion of one resource must be compensated for by building up stocks of another one.

In the case of transport, including roading projects, many of the key issues concerning sustainability arise at the national level, and mainly concern the greenhouse effect and depletion of natural resources (especially oil consumption and destruction of sites of special scientific interest) (Hopkinson *et al.* 1991).

A further reason for investigating intangible factors associated with roading projects comes from the general disparity between the apparent accuracy and objectivity of the cost-benefit analysis of tangible factors versus the value judgement approach used to evaluate intangible factors.

Cost-benefit analysis is normally based on the principle that benefits should be measured in terms of payments, which the "gainers" are willing to make to achieve the outcome, balanced against the costs measured in terms of compensation, which the "losers" are willing to accept for those losses. If the benefits exceed the costs, the scheme should go ahead. In the road project evaluation method used in New Zealand, the "benefits" are savings to the general public of road users and non-users and the "costs" are the monetary values carried by the roading providers.

Given this approach to project evaluation there may be, wittingly or unwittingly, a higher priority given to those factors to which monetary values can be applied. The UK Standing Advisory Committee on Trunk Road Assessment (SACTRA 1991) recommended that *"a responsibility is placed on those carrying out the appraisal to ensure that no bias is introduced between those effects which are valued (in monetary terms) and those which are not"*. It therefore stands to reason that, as project evaluation comes under close scrutiny, the non-monetary valued effects require more robust valuation methodologies to ensure better parity with the monetary values used to quantify tangible costs and benefits.

1.3 Definition of Intangibles

Intangible factors are those effects for which there is no market. Consequently they cannot be given a direct monetary value. Section 2 of this report identifies the typical range of intangible impacts for representative roading projects and BCHF (1992) divides intangible factors into the following groups.

1.3.1 Direct "Proximity" Effects

These are the direct environmental impacts on neighbouring land and the uses of that land. They are described as :

- Traffic noise and vibration.

- Air pollution - from gaseous emissions, including carbon monoxide (CO), nitrogen oxides NOx (nitric oxide NO and nitrogen dioxide NO_2), unburnt hydrocarbons (HCs); and from particulate emissions, e.g. smoke, lead, brake and tyre wear products.

- Visual impact - of vehicles, roadways and appurtenances, glare of lights and loss of privacy.

- Intimidation - of pedestrians and cyclists by vehicles which, in close proximity, give rise to feelings of insecurity and anxiety.

- Community severance - interference with local community pedestrian or vehicle routes by a road or traffic stream.

- Impacts of partial or total acquisition of property which are not wholly captured in either the future productive value of the property or its market value. Such uncompensated effects may include personal, family and community attachments, including historical and cultural values.

1.3.2 Effects on Transport Users

These include : physical comfort of the vehicle; mental stress on the driver; passenger view of the surroundings.

1.3.3 Effects on the Natural Environment

These include : natural physical features, flora and fauna, particular issues associated with rare or endangered species. Although human interests are not directly involved, a community values the fact that the natural environment, its fauna and flora, continue to exist and are protected. This "existence value" may be held even if most of the community have little chance to experience the areas first hand.

While the above categories of intangible factors of roading projects are suitable for descriptive purposes, the list is by no means exhaustive. Section 2 of this report provides an overview of the intangible factors already included in the PEM's Appendix A7.

2. INTANGIBLE FACTORS INCLUDED IN PRESENT APPENDIX A7

Appendix A7 of the PEM describes separately the intangible effects of roads and road traffic that are to be incorporated in *social cost-benefit analysis*. PEM uses a "project balance sheet" approach as a framework to decide on options which should receive Transit New Zealand funding. The intangible factors as described in Appendix A7 are listed here in summary form.

2.1 Traffic Noise

Traffic noise is defined, its effects are summarised, measurement units described, and traffic noise prediction methods discussed in Appendix A7.5. Guideline traffic noise exposure limits are presented for various types of land use. Information is also provided on methods of reducing noise impact, when these should be implemented, how the evaluation of traffic noise impact should be carried out, and how to report noise impacts. Although traffic noise is a technical matter, Appendix A7.5 provides the user with a brief, but comprehensive, review of the various aspects of traffic noise impact.

However the traffic noise section of Appendix A7 appears to have one serious deficiency. There is a basic misunderstanding of the concept of the measurement unit L_{10}(18 hour). The guideline traffic noise information presented in Table A7.1 of Appendix A7 gives indicative levels for both daytime and night-time. Although daytime and night-time hours are not specified, the main problem is that an L_{10}(18 hour) traffic noise level represents a "whole day" exposure level. It is not physically possible to have two 18-hour periods during a 24-hour day. When reviewing Table A7.1, daytime limits can be supplemented with night-time levels for single events (or guideline levels for single or multiple events). However, night-time limits should not be specified in terms of L_{10}(18 hour).

2.2 Vibration

Traffic-induced vibration is covered briefly by Appendix A7.6. Effects of vibration are briefly described and some guidance is given on how to measure and assess traffic-induced vibration. Apart from a general lack of detail on this factor, the most obvious shortcoming is the failure to distinguish between ground-borne vibration and that transmitted through the air. While this may not influence the reaction of individuals, it is known (Martin 1978) that traffic-induced vibrations perceived indoors are related to the presence of ground-propagated vibrations (dependent upon the condition of the road surface and subsoil geology) and to the presence of low-frequency sound-pressure induced vibrations (dependent upon building construction, and the sound-absorbing properties of the building and its contents). The failure to distinguish between these two aspects of traffic-induced vibration will affect the degree to which this impact can be accurately assessed, and the range of suggested options available to mitigate the impact. Appendix A7.6 notes that the reporting of traffic-induced vibrations should be linked to traffic noise reporting. This view is supported. Apart from unusual ground conditions or road surface irregularities, the presence of building vibration

caused by road surface irregularities, and the presence of building vibration caused by road traffic, can be linked to excessive exposure to traffic noise.

2.3 Community Severance

Community severance encompasses a wide range of effects and impacts and is covered in a relatively cursory manner in Appendix A7.7. Although attention is paid to assessment and reporting of physical effects, the psychological impact is not adequately addressed. This matter is addressed in Section 4 of this report. Regarding the physical effects, there is a possibility of double counting the value of travel time savings as they are a readily quantifiable tangible factor.

While large roading proposals would normally require an EIA, by which means community concerns can be gauged through public meetings and community consultation, the concern with the method of assessment outlined in Appendix A7.7 is that there is no requirement to consult with the community (or its representatives) for small and medium sized roading projects. For example no aspect of the assessment procedure appears to address the impacts caused by disruption of the community or the identity of a locality.

2.4 Local Air Pollution

The air pollution section (A7.8) of Appendix A7 deals adequately with all aspects of motor vehicle air pollution. The pollutants are identified, their general implications for human health stated, guideline exposure limits presented and assessment methods detailed.

Perhaps the most significant shortcoming with respect to air pollution is the lack of information on dust impacts. While Section A7.11 (Animal and Plant Ecology) of Appendix A7 does mention dust impacts on vegetation, it is important to recognise that the first impact is on air quality even though it has no measurable effects apart from visual. Further discussion of this approach to categorising intangible effects is given in Section 2.7 of this Report.

2.5 Visual Impact

Visual impact is described in Section A7.9 of Appendix A7. This describes the types of impacts resulting from visual obstruction. A method of measurement for the quantification of visual obstruction is suggested, based on the solid angle subtended at the viewpoint by the obstructing feature. However, limited guidance is given for rating the size of the obstructed angle in terms of quantifying the disbenefit. Visual intrusion is identified as a further factor for assessment. As this intangible is highly subjective, the engagement of appropriate professional expertise will be an advantage for larger works.

The short-comings of the procedures outlined for assessing visual impacts are:

- Quality of the view which may be lost by the proposed roading development is not considered.

- "View from the road", which can be a significant intangible benefit of roading projects in scenic areas, is not mentioned.

2.6 Historic, Preservation and Cultural Values

Although this section (A7.10) of Appendix A7 defines the types of features and locations that may be of special value to individuals or to the community, the examples given represent only a small sample of the types of special areas that require assessment. The Resource Management Act 1991 gives recognition to specific types of special areas that require protection. Suggested modifications for this section are put forward in Section 4.2.2 of this Report.

2.7 Animal and Plant Ecology

Ecological impacts are described in Appendix A7.11 in terms of the nature of ecological effects, measurement of ecological effects, evaluation of impact and reporting or impacts. In Section A7.2 of Appendix A7, ecological impacts of road projects include dust contamination, and run-off and spills into water-ways. While these impacts may be significant, they are often "down stream" effects. A more appropriate method would be to identify where the first impact has effect, and the medium in which this impact takes place. For instance, dust impacts are more appropriately covered by the issue of "Local Air Pollution", as the air quality is affected before any ecological impact occurs. Likewise, with run-off and spills into waterways, the first impact is on water quality, from where it may have possible ecological impacts. Impacts should preferably be assigned to the category into which they naturally fall in the first instance. This gives certainty that impacts will not be overlooked. The existing methods of assigning impacts to intangible categories suggests that, unless the impact has a quantifiable effect, it may not be counted.

2.8 Psychological Stress from Forced Property Purchase

Psychological stress from forced property purchase is identified in Appendix A7.12 as an impact for which special provision should be made. The type and circumstances of the property owner are to be taken into account and, if the price offered to the owner does not compensate for the distress caused, the intangible effects should be "recognised".

While it is acknowledged that psychological stress of forced property purchase is a valid intangible cost factor of roading developments, it is but one of a number of psychological impacts on those affected by the planning and development of new roads, those who live in the vicinity of roads and who are unduly psychologically affected by the project operation, and those who are unduly psychologically affected by the task of driving vehicles.

2.9 Evaluation of Present Appendix A7

The foregoing commentary on the definitions, assessment and reporting procedures indicates a number of inadequacies. These are:

- Lack of quantitative methods.
- Restricted range of impacts which are required to be assessed.
- Unclear outcome of role of reported intangible effects in the *Planning Balance Sheet* process.

While it is not always possible to define quantitative methods for determining the extent of intangible impacts, it is important that, as far as possible, methods are developed to objectively quantify impacts.

However, quantification using arbitrary objective measures will not necessarily solve this problem. There is a basic evaluation problem when one tries to compare alternative schemes, as there are a large number of different impacts that need to be considered. These impacts are difficult to compare because they are measured both in different units and at different scales. Selection of the preferred scheme then becomes a judgement based on skill and experience. The difficulty with the judgement-based approach is that there is a potential for inconsistencies in decision-making (Turner and Hargest 1991).

A second problem is that environmental effects (e.g. air pollution) are often not quantifiable by current methods. They become "soft" values compared to other monetary effects and, because of that, there is a danger that they become downgraded to be of lesser importance. Alternatively, they may become excessively upgraded.

A third concern is the potential for this judgement-based system to lead to a less efficient use of resources. These resources not only include finance, land, or minerals but they also include environmental assets such as areas of ecological or scenic importance. One criticism of the UK roading appraisal system, where a judgement-based system (Manual for Environmental Appraisal) is used alongside cost-benefit analysis (i.e. similar to the Transit New Zealand system), is that it does not explicitly consider the trade-off between lost environmental assets, for example, in response to gains in travel time (Turner and Hargest 1991). If these trade-offs can be established, a more accurate assessment of the benefits and costs of scheme alternatives can be made.

A further shortcoming in recent years has been the lack of clear links between the assessment of intangibles required by PEM, and the Environmental Protection and Enhancement Procedures. In the past, there were clear criteria as to when an environmental impact report (EIR) and an audit was needed. In recent years the need for EIRs, the criteria, and the process to be followed have all become less explicit. EIRs and EIAs are a formal public assessment of positive and negative environmental effects and are frequently audited; PEM evaluations are essentially "in-house" and deal with allocation of investment. When an EIR or EIA has been done, as for many large projects, the information on relevant intangibles has been able to be incorporated in the PEM evaluation. However most medium and smaller scale roading projects (especially those already designated in district plans) have not been subject to such procedures.

In future, requirements and designations for roading projects will need to be shown on district plans or obtain a resource consent. Both procedures require a full assessment of environmental effects (AEE) under the Resource Management Act. Information from the AEE will be available for the PEM process, and evaluation will be able to take place on a more integrated basis.

Section 4.5 of this report discusses, in a preliminary manner, the PEM evaluation process, and Section 5 recommends modifications that would enhance the assessment process for intangible factors in project evaluation.

3. REVIEW OF ENVIRONMENTAL IMPACT STUDIES

To sample the range of intangible impacts of typical medium to large scale roading projects, three projects proposed for the Wellington region were reviewed. Although their size is perhaps larger than most of the projects which are the subject of PEM evaluations, they combine a wide range of impacts and are therefore useful for the purposes of assessing both the range and scope of Appendix A7 of the PEM. Information from a survey of 1032 dwellings located alongside major roads in the Christchurch urban area is also reviewed with respect to subjective responses to the effects of traffic. To complete the review, overseas assessment methods (and the range of impacts assessed) are briefly examined.

3.1 Wellington Urban Motorway Extension EIA

This project involves extending the existing motorway (completed in 1978) from the Terrace Tunnel, across major urban streets, to the Mt Victoria road tunnel. All street crossings would be retained, except for Cuba Street and Tory Street which are bisected by the proposed route. The project "cuts across" many of the existing north-south traffic routes, but is predicted to give significant benefits for east-west, cross-city traffic. The character of the area has been affected over a long period by the motorway land-use designation.

The issues investigated by the consultant team of investigators were reported, and the subsequent group of documents formed the basis of an initial appraisal of the scheme on which public comments were sought. The issues investigated are summarised here.

3.1.1 Pedestrian and Cycle Access

Pedestrian and cycle access was investigated under the headings of safety from traffic accidents, safety from public violence, environmental quality (for pedestrians and cyclists) and time. Recommendations to preserve access using crossings and subways were made at specific locations along the route. Further recommendations for the final motorway design were made to minimise the effects of the traffic stream (e.g. noise and air pollution) on pedestrians and cyclists.

3.1.2 Property Acquisition, Management and Disposal

An important issue raised by the review team was the "urban blight" occurring along the designated route. Urban blight is the general downgrading of environmental quality and lack of investment which has happened over time caused by "a lack of clarity as to the future of the designation". Minimum maintenance has been carried out on many of the properties and rental values have dropped. As a result, many social service and voluntary agencies had moved into the area. The relocation of these important community services was specifically catered for in the property management recommendation. In some cases, however, demolition had already taken place because of the poor state of the buildings. The use of these areas as ad-hoc car parks and the general urban blight that has occurred was recognised as a problem that must be addressed, even if the motorway extension project is deferred or abandoned.

3.1.3 Community Severance

Loss of common identity and of community sharing was expected to be a consequence of severance effects of the motorway extension. The compact nature of many of the inner city suburbs was seen to be susceptible to the divisive effects of a major east-west traffic route. Four communities were identified as being immediately impacted by the extension. Several recommendations were made in the EIA to consult community groups, to keep them informed of developments and to receive feedback on proposed ameliorative measures. Psychological impact was an expected response to one elevated section of the motorway. Recommendations were made to help maintain north-south links for community cohesiveness and also to preserve certain older buildings with historical or cultural value. Special areas were identified to be retained and these included murals, areas of community interest and service. If they could not be retained, it was recommended that they should, as an alternative, be relocated nearby.

3.1.4 Wind Comfort and Safety Impacts

This issue was investigated to ascertain the effects of wind on pedestrian comfort and safety. While wind was not seen as an important impact for motorway users, the east-west alignment was predicted to have important implications at ground level for pedestrians and cyclists, related to the elevated structures and the large vertical surfaces which are exposed to the prevailing northerly winds. This section of the EIA did not specify particular recommendations to mitigate impacts, but suggested a number of sites where wind testing should be carried out to determine whether or not a problem may exist and what remedial steps could be take to reduce the impact of wind.

3.1.5 Visual Impact

The visual impact of the proposed extension was assessed using both objective methods (Vamplan - Visual Assessment Method for Planning) and subjective assessment ("visibleness" and "land form"). The impact of the motorway extension was seen in many areas to "closely follow the boundaries of existing visual components", although both the elevated sections and the area in front of the Museum were expected to create significant negative impacts. Recommendations were made to re-design those sections, and to enhance the visual impact of residual designated areas to improve the appearance of the finished motorway.

3.1.6 Traffic Noise and Vibration

The traffic noise and vibration section of the EIA considered impacts from both the construction and operation of the proposed motorway extension. The traffic noise impact of motorway operation received a full objective assessment by comparing existing noise levels with future predicted noise levels. Thus it was the one intangible factor for which a comprehensive quantitative assessment was undertaken. Vibration impacts were subject to more qualitative assessment. They were identified as being a potential problem only during the construction phase. Apart from some general recommendations covering policy and construction matters, recommendations were made regarding the need to assess traffic noise in detail when the motorway design details are finalised.

3.1.7 Local Air Pollution

This impact was not quantified in detail and the overall assessment was that, because of the topography and meteorology of the area, no significant air quality impacts were likely to appear. However, concern was raised about the increased localised air pollution (especially for cyclists and pedestrians) in the Mount Victoria tunnel.

3.1.8 Summary

The overall impression of this EIA is of an investigation which focused on qualitative assessment. While this explicit, informal method of determining impacts may be appropriate when route options were not central to the purpose of the study, it has little relevance to the "project balance sheet" approach of Appendix A7 (PEM), where quantification (either in specified units or number of properties affected) is advocated. The range of impacts investigated for this roading proposal does, however, provide useful information on intangibles of urban blight, community cohesiveness, wind comfort and safety, which are not presently covered by Appendix A7.

3.2 State Highway 1/Transmission Gully EIA

This is an extensive environmental impact assessment prepared by the Wellington Regional Council (1989) for a proposed upgrading or re-routing of State Highway No. 1 via Transmission Gully between Tawa and Mackay's Crossing north of Wellington. The route length is about of 30 kilometres.

The study was carried out in consultation with several groups of affected parties including the roading authority (Transit New Zealand), the Regional Council, territorial local authorities, providers of emergency services, the tangata whenua, and local community and interest groups.

Most of the environmental and social impacts were addressed by descriptive comparisons, and any quantification of impacts or placing of monetary value on impacts were relatively limited. An extensive social impact assessment was undertaken and the evaluation of the various options was carried out by classifying social impacts as positive impacts and negative impacts. The Parliamentary Commissioner for the Environment found this approach helpful.

The types of impacts that were considered in this study are listed as follows:

- Preservation of the coastline
- Benefits of a fast safe traffic route to Wellington
- Provision of emergency services (including civil defence) in the Region
- Effect on State Corporations
- The Maori perspective
- Quality of life
- Traffic noise
- Air pollution
- Effects on property
- Effects on community life
- Recreation

- Visual impact
- Construction activities
- Public transport upgrading
- Uncertainty about roading decisions
- Fresh water quality, biology and hydrology

The following comments indicate outcomes of the EIA investigation which relate to the present study:

- Concern about the coast included possible damage to the natural environment, depletion of Maori food sources, Maori spiritual values, and land instability.

- Quality of life included changes to lifestyles that a highway would impose, mainly those related to loss of peace and quiet.

- Effects on property included loss of value and, for rural land owners, severance.

- Effects on community life related mainly to severance.

- Recreation facilities, both natural and man-made, were highly valued by the affected community.

- Visual impacts were assessed in depth on the basis of the impact of the road on the landscape. No investigation was carried out of the "view from the road" for drivers and passengers even though the scenic qualities of alternative routes differ greatly.

- Construction impact concerned noise, dust, danger, delays to traffic, effect on fences and stock, and construction vehicles using small local roads. Some of these can be tangible factors, e.g. delay, if they can be accurately estimated.

- Uncertainty referred to the stress to residents concerned by speculation and uncertainty about long-term roading proposals.

- Emergency services related to police, fire, ambulance and civil defence activities. Their concerns were mainly for free and speedy access to an incident, and for flexibility of route choice, should an incident directly affect a major road.

3.3 Kaitoke Route Upgrading EIR

This environmental impact report (Synergy Applied Research Ltd 1989) assesses the engineering, economic, and environmental factors relating to the upgrading of State Highway 2 between Te Marua and Kaitoke, north of Upper Hutt. The upgrading may involve using the existing alignment or a new route passing through Kaitoke Regional Park, which contains a major water supply storage and treatment facility for the Wellington region. The route length is approximately 6 kilometres.

The environmental impacts (which are potentially intangibles) that were evaluated and scored numerically in the appraisal were grouped as follows:

- Impacts on natural environment (ecological values, water and soil values).

- Impacts on cultural environment (community, amenity, property values and development, regional development).

- Impacts on major land uses (water supply complex, Kaitoke Regional Park, MAFTech Research Farm, road users).

- Visual impacts (road users, regional park users, other persons).

The following comments indicate outcomes of the EIR investigations which relate to the present study:

- Ecological values referred specifically to the loss of indigenous forest.

- Water and soil values referred to changes in natural drainage patterns and siltation during or post- construction. Toxic motor vehicle wastes or hazard spills were not referred to.

- Community values related to a reduction in the quality of the living environment as a result of the road and its traffic. This is partly a life-style issue.

- Amenity impacts confined mainly to the short-term impact of road construction.

- The physical and psychological benefits of reducing the length of winding road between Wellington and Wairarapa were referred to as part of regional development, as is the improvement to the "gateway" to Upper Hutt. This latter would have been more appropriately covered under visual impact.

- Construction dust could affect water quality in nearby water supply lakes.

- The highway could form a barrier between the Regional Park and the water supply facilities. This severance might be beneficial.

- Changes to the quality of local access to public and privately owned land were identified.

- The siting of the major arterial within the Park would increase noise and litter, and reduce privacy and pedestrian safety.

- The road construction would generate disruption to research programmes and farm operations on the MAFTech Research Farm. Monetary values for this externality were able to be calculated by an economist and included in the benefit-cost analysis.

- Potential intangibles that would limit the long-term viability of the research farm were identified as disruption to stock operations caused by severance, litter from the highway, and loss of security for farm stock and equipment caused by the increased access to the fence boundaries by highway users.

- Factors affecting residential properties along the highway were listed as temporary disruption to property access, reduction in privacy and visual quality, and an overall degradation of residential amenity.

- Road user impacts were said to include the non-tangible benefits of better driving conditions, improving travellers' comfort, and reducing driver frustration.

- The visual impacts for road users included scarring from road construction (particularly high cuttings), and the benefits of better scenic views of a route through the Park.

- The visual impact of moving vehicles was considered to be adverse for regional park users, as well as of the road structure itself.

- For residents along the road, the adverse impacts of fill embankments across several gullies, restricting their down-valley views, were considered.

3.4 Social Survey Information

To provide a further indicator of the range of impacts of traffic in residential areas, the results of a social survey are summarised below. The survey was conducted in 1988 by Malcolm Hunt (1988) as a post-graduate thesis on the subjective reaction to traffic noise. The survey was conducted by a team of workers who conducted face-to-face interviews. 1032 interviews were successfully completed and various analyses and correlations were conducted using measured traffic noise levels for 32 sites. All households selected for the survey were adjacent to roads carrying significant traffic flows (more than 2500 vehicles per day (vpd)).

Some questions are of considerable interest in the current study. Although all respondents were shown a letter outlining the bona fide nature of the survey, no specific mention was made of the words "traffic noise". Instead, the purpose of survey was stated as "an investigation into the environmental conditions in your area".

The questions of most interest to the present study (and the responses) were as follows:

1. What do you think of this area as a place to live ?

EXCELLENT	27.8%
GOOD	57.1%
FAIR	13.4%
POOR	1.2%
VERY POOR	0.4%

2. Do you have any particular dislikes about the area where you live ?

NONE	39.5%
TRAFFIC NOISE	30.0%
ANY NOISE	4.7%
TRAFFIC (GENERAL)	0.6%
HEAVY TRAFFIC	7.5%
AIR POLLUTION	1.0%
OTHER	16.8%

Fourteen further questions relating to traffic noise, reaction to noise in general, and demographic information, were included in the questionnaire.

For the first question above, 84.9% of respondents thought their area was either an excellent or a good place to live. This is to be expected if there has been no recent increase in traffic effects, as it is predicted that each resident has some control on where they choose to live, and residents experiencing discomfort will generally tend to move out of the area. To this end a degree of self-selection was evident.

A process of self-selection is also predicted to occur at locations exposed to what may be considered "undesirable" traffic effects, as those who are dissatisfied have, over time, an ability to move out. Those who move in to the area are able to trade-off the negative environmental effects of road traffic with reduced house prices.

The question about the dislikes of the areas in which the respondents live was open-ended, and required the respondent to actually mention a particular dislike. Not surprisingly (considering the response from the earlier question) most respondents had no particular dislike about the area in which they lived. However, the next highest category of dislike (30%) was traffic noise. The second highest category of dislike was "other". Responses in this category included safety, community crime, etc. The third highest category was "heavy traffic impacts". This category included vehicular access into their property, pedestrian safety, lack of parking, and general dissatisfaction (non-noise related) with the traffic passing their residence.

It would appear that residents are capable of forming a negative response to road traffic in the urban setting without focusing on any single impact. Obviously, those in the survey who felt unduly unaffected by one (or more) particular feature of the traffic were able to quote the particular effect. Others were content to state they "don't like the traffic."

A further relevant aspect of the survey was the relationship between the respondent's stated response to traffic noise (7 point scale, from "not at all annoyed" to "highly annoyed") and the opinion of the area as a place to live. The responses of two extreme groups of respondents who registered no or low annoyance and those who registered high annoyance (categories 6 and 7), were related to their corresponding opinion of the area as a place to live. The relationship is shown in Figure 1.

Figure 1 shows a distinct relationship between these two levels of responses with those who are highly annoyed by traffic noise also having a low opinion of the area as a place to live. Conversely, those who are not at all annoyed by traffic noise have a correspondingly high opinion of the area as a place to live. Although it is not possible to prove causality (in either direction) between these two responses, it stands to reason that areas of high traffic noise causing high annoyance are not thought of as good places to live.

Another question in the survey asked respondents if they perceived traffic-induced vibrations. If the respondent answered "yes", a subsequent question was asked "is this a cause of concern for you". Although 63.7% of respondents stated they noticed traffic-induced vibration, only 38.8% of these people stated it was a cause for concern. An assessment of the mean traffic noise annoyance score for the two groups of "vibrations were/were not a concern", showed a statistically significant higher annoyance score for the group indicated that vibrations were a concern. There is therefore an obvious link between high traffic noise exposure and concern about vibrations.

In summary, the survey results have shown that intangible factors of annoyance from high traffic noise and concern about vibration are evident in those residents who have a low opinion of the area as a place to live. The study revealed a range of traffic-related impacts to which people take a dislike, and these factors are also related to their opinion of the area as a place to live.

3.5 Relevant Overseas Literature

Methods used in other countries to quantify intangible factors in roading project evaluation have been considered as part of this study. A recent review of overseas practice with respect to intangible factors in transport project appraisal (BCHF 1992) found considerable variation in the project effects that different countries take into account in project evaluation. Some confine the evaluation to costs, time savings, vehicle operating costs, and local environmental impacts (primarily noise and severance, sometimes air pollution, and less frequently intimidation and visual intrusion).

A further review of overseas practice (for France, Denmark, Sweden, Norway, Finland, USA, Japan and Australia) in the appraisal of road and traffic schemes has been recently published by the Transport and Road Research Laboratory (TRRL, UK) (Rendell Planning

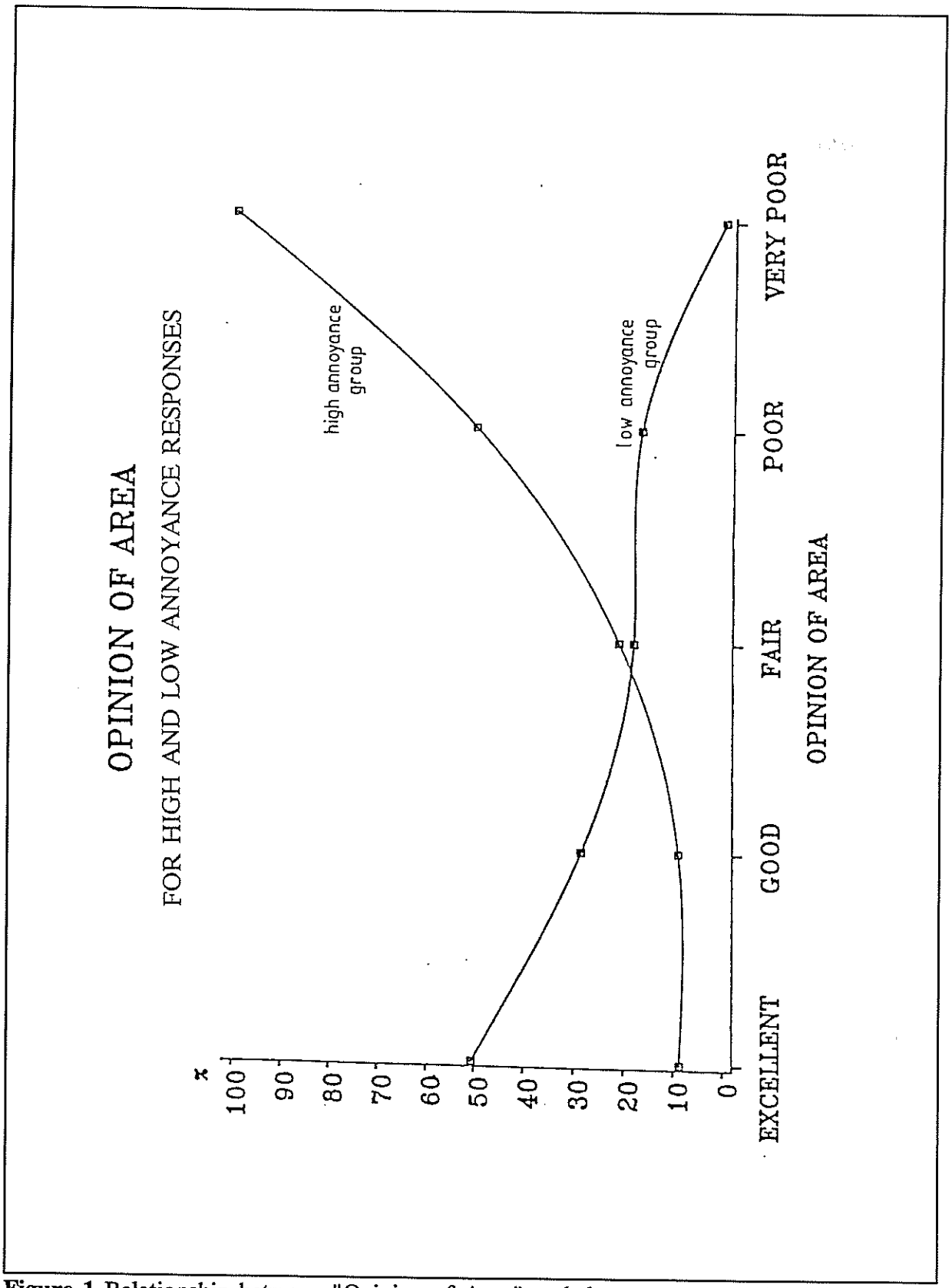

Figure 1 Relationship between "Opinion of Area" and the two groups with high and low annoyance responses to traffic noise (Hunt 1988).

& UEA 1992). The review identified the general requirements for the environmental assessment of road and traffic schemes and whether monetary and non-monetary techniques are used in scheme appraisal. Table 1 summarises their findings.

Table 1. Summary of techniques used overseas for the appraisal of environmental effects of road schemes (Rendell Planning & UEA 1992).

Country	Environmental Assessment Required for Major Road Schemes	Monetary Values Placed on Environmental Impacts	Role of Non-monetary Appraisal Technique
SWEDEN	Yes	Yes for noise, air pollution, barrier effects	Overall assessment of both monetised & non-monetised impacts. No formal non-monetary MCDM* techniques used.
DENMARK	Yes	Yes for noise, air pollution, barrier effects	Overall assessment of both monetised & non-monetised impacts. No formal non-monetary MCDM techniques used.
NORWAY	Yes	Yes for noise	Overall assessment of both monetised & non-monetised impacts. No formal non-monetary MCDM techniques used.
FINLAND	Legislation in preparation	No	Overall assessment of all impacts. No formal non-monetary MCDM techniques used.
JAPAN	Yes	No	Overall assessment of all impacts. Use of environmental standards as threshold values. No formal non-monetary MCDM techniques used.
AUSTRALIA	Yes	No	Overall assessment of all impacts. No formal non-monetary MCDM techniques used.
FRANCE	Yes	No	Overall assessment of all impacts. No formal non-monetary MCDM techniques used but summary tables facilitate comparisons between alternatives and a range of criteria.
USA	Yes for Public Sector projects	No for EIA Yes for Regulatory Impact Analysis	Overall assessment of all impacts. No formal non-monetary MCDM techniques required to be used.

* MCDM MultiCriteria Decision-Making

In Sweden, Denmark and Norway, monetary techniques are used to derive values of certain environmental effects which are included in the CBA analysis of schemes. In both Sweden and Denmark money values for noise, air pollution and community severance effects are estimated and used in the CBA analysis together with the value of construction, accident savings, changes in travel times, and vehicle operating costs. In these countries a monetary value is applied per unit of environmental impact per person or per dwelling affected.

In terms of non-monetary valuation techniques, many countries use the same kind of approach as used in the UK Manual of Environmental Appraisal (the UK MEA) (DoT 1984) in which the type and magnitude of environmental effects are documented and the magnitude of impact reported to allow comparison between alternative schemes. In New Zealand this approach is described in the PEM for the evaluation of intangible effects.

4. ISSUES AND OPTIONS FOR INTANGIBLES IN PRESENT APPENDIX A7

The foregoing information on the assessment of the adequacy of the existing provisions of Appendix A7 (PEM), the information obtained from a review of sample EIA projects, a social survey, and relevant overseas literature, are brought together in this section. The issues and options relating to intangible factors in the assessment of roading options are considered under three headings. The first group of factors were not examined in detail as they were not included in the project brief. However, some comments are made regarding outstanding inconsistencies which, in many cases, are related to issues relevant other intangible impacts.

The second group of factors are those which have been the main focus of this research; these are intangibles which are either not included in Appendix A7, or which are included in a way which could be improved. Other miscellaneous intangible factors, which were identified in the main research and which have not been dealt with in depth in this study for a number of reasons, form a third group.

4.1 Factors in Present Appendix A7

4.1.1 Traffic Noise

Traffic noise is an intangible factor for which a suitable method of quantification can be applied (e.g. measured or predicted noise level, and numbers of properties affected). Although further work can be carried out to provide monetary estimations of impact (as is carried out in Scandinavian countries, OECD 1989), the information contained in the traffic noise section of Appendix A7 (A7.5) should be retained apart from a modification (discussed in Section 2.1) to Table A7.1 to remove reference to L_{10} (18 hour) night-time traffic noise levels. Night-time noise limits can be better expressed in terms of Single Event Levels, or as L_{10} values for six hours or less. This matter is currently the subject of a Transit New Zealand in-house study to determine definitive traffic noise guidelines. Recommendations regarding modifications to the traffic noise aspects of Appendix A7.5 should be based on the findings of this in-house research.

4.1.2 Traffic-Induced Vibration

The definition and effects of traffic-induced vibration in Appendix A7.6 appear to be satisfactory, although two issues arise as a result of the investigations carried out in this study. First, as described by the EIA on the Wellington Motorway Extension, the effects of vibration from road construction could be quite severe compared to vibration arising from the normal operation of a road. Consideration should be given to separately assessing construction vibration (this approach is used in the UK MEA) from traffic-induced vibration. The second issue is the need for evaluation of two separate aspects of traffic-induced vibration. The effects of vibration can be brought about either by low frequency sound waves propagated through the air, or by pressure waves travelling through the soil and subsoil. While the impacts may be similar, there are implications for the accuracy of quantification.

4.1.3 Community Severance

As community severance is a complex issue, Appendix A7.7 needs modifying so it can detail the full range of potential severance impacts that may occur whenever PEM is applied. The review of EIAs shows that severance is an important issue, and is often one on which community concerns will be focused. Severance was specifically excluded for the brief for the present study but the following comments arising from the research are, however, noted.

1. The assessment method used at present with PEM emphasises trip diversion and/or suppression. While these factors may be a central concern for many people affected by roading developments, other issues such as neighbourhood and community linkage patterns, and effects on neighbourhood stability, are equally important and should be included in Appendix A7.7 to broaden the type of investigation required.

2. Quantification of severance effects relies on existing information on land use and movement patterns and the travel demands for walking/cycling, etc. between home and other destinations. This information can only be obtained through observation (pedestrian counts, etc.) and interviews on travel destinations and frequency of trips. Community consultation will provide additional qualitative data requiring value judgements in the decision-making process.

   As a means of quantifying, objectively, the severance effect on pedestrian movements, the delays to pedestrian traffic caused by the proposed road can be considered. Several studies have been completed (e.g. Bowers 1974) whereby relationships have been derived for time delays in crossing roads, as a function of type of crossing and traffic density. Such methods could be refined to give monetary values on pedestrian time costs. As values obtained are comparatively low and useful only as a lower bound of severance costs, it appears there will always be a need to assess, in qualitative terms, other severance impacts. These include:

   - Individuals are required to alter destinations. The replacement destinations may not be as adequate to meet the person's need.

   - Individuals suppress trips because of fear and intimidation.

   - Other impacts - e.g. research has shown that mothers of young children suffer anxiety caused by fear that their young children may have an accident while crossing roads on their own.

   Those most greatly affected by severance are often older people and children, who gain little benefit from an improved road network.

3. Effects on local access for residential properties are identified in Section 3 as being a significant factor. Traffic in close proximity to residential locations can cause perceived access problems for vehicles entering or leaving a property. As effects on vehicles are considered only while the vehicles are in the traffic stream, delays (and the ensuing frustration and fear) for vehicles trying to enter the traffic stream from residential properties are generally not included in travel time costs.

4.1.4 Local Air Pollution

Local air pollution can be quantified by monitoring or modelling of vehicle emissions. Suitable guideline pollutant concentration limits for roadside assessment points are included in Appendix A7.8. Compared to overseas levels (BCHF 1992) these limits lie between those of countries with high environmental standards (e.g. Switzerland) and of countries (e.g. Finland) with lower environmental standards.

Generally, the air pollution information in Appendix A7.8 appears adequate, although the method for assessment set out in the UK MEA has advantages over the PEM procedures. The MEA uses an indicative level of carbon monoxide as an indicator of whether a motor vehicle air pollution problem is likely. Using a simple prediction chart, a level of carbon monoxide is predicted for roadside positions, based on traffic flow. If the indicator level is likely to be exceeded, then a detailed air pollution study is recommended. In this way, impacts of motor vehicle air pollution can be efficiently assessed.

4.2 New or Improved Factors for Amended Appendix A7

4.2.1 Visual Impact

Road projects may have a number of different visual impacts. These can be positive (good) and/or negative (bad). The impacts can be experienced by road users (drivers and passengers, including those in buses) and non-road users (observers of the road in the landscape such as from nearby houses).

In deciding on the weight to give visual impact, it is appropriate to take into account the number of persons to whom the impact will apply. For example, accounting might be based on the number of houses that overlook the new road, or the number of cars expected to use a new scenic route. In addition, the quality of all landscapes may not be the same. For example a road through a national park could be considered to have a higher visual impact even though it is well designed and viewed by relatively few people.

The aesthetic value of a landscape from a road or a road from a landscape is regarded by most analysts as highly subjective and variable between different observers. Because of this, most project evaluation manuals recommend the use of professional guidance (landscape architects or urban designers) in making visual impact evaluations, particularly for larger projects or in visually sensitive locations.

The researchers suggest that the values of local people are important and likely to differ from other assessments (e.g. non-residents, including professionals), particularly if the local residents are of different cultural or educational backgrounds.

The relatively little research that is available on the quantification of visual impacts, appears to be relatively isolated over time, which suggests that such matters have not yet achieved wide acceptance.

4.2.1.1 Categories of visual impacts

- **Visual Obstruction**

Visual obstruction is defined in the UK MEA as *the blocking of a view by a road structure - for example a 10-metre high embankment at the end of a garden.* This is a simple concept which does not require further elaboration.

The magnitude of the visual impact caused by obstruction depends on:

- Size of the obstruction in relation to the viewing point.
- Quality of the view being obstructed.
- Visual quality of the obstruction.
- Numbers of persons or properties affected by the obstruction.

The UK MEA gives limited procedures for dealing with these factors.

The size of the obstruction in relation to a nominated viewing point can be measured by the solid (3 dimensional) angle subtended between the viewing point and the obstruction. The UK MEA details a procedure for this, based on measuring the obstruction in a central viewing *zone of maximum significance* which is defined as the S40 measurement (solid angle of 40 degrees).

The impact of visual obstruction is classified in the MEA according to the following scale (Table 2), which is said to be based on *perceived public reactions.*

Table 2. Classification of visual obstruction.

S40 Range (milli steradians)	Level of Obstruction
over 150	High
50 - 150	Moderate
25 - 50	Slight

To make comparisons between different project alternatives, a number of viewing points must be selected, from which the subtracted angles can be calculated. In some cases this may be fairly simple, such as from a number of isolated houses in a farming landscape. In other situations, including urban locations, it is more complicated, requiring judgement about viewing points and their relative importance. However, having made the choice, a mathematical evaluation can be made.

Another way of describing the impact would be to use contours of degree of obstruction. Again this can be handled on a mathematical basis with adequate data. The researchers are not aware of any examples where the MEA technique has been used in New Zealand.

The quantification of the *quality of the view* being obstructed is more difficult. The method developed by Watkins (1977) for Waitemata Harbour may have some application here. However, the analysis is essentially symbolic and it would appear to be difficult to make comparisons between different options using this method.

The quantification of the *quality of the obstruction* is again subjective. In this impact the quality of the design of the road structure may be able to mitigate the impact of the road, or even enhance the view (e.g. a graceful bridge design). This may be a more individual choice, as different persons affected are likely to have individual preferences for the mitigating treatment.

- **Visual Intrusion**

Visual intrusion is a broader visual concept than visual obstruction. It relates to perceived loss of amenity by persons located close to a road and its traffic, and includes loss of privacy, night-time glare from streetlights and vehicle headlights, and the changed character of the landscape (e.g. from natural to modified).

The researchers are of the opinion that visual intrusion has a significant cultural component. For example, the visual impact of a road could be substantially different for residents of normal suburban density housing, and for those whose residences are isolated on rural-residential blocks (and who have deliberately established that life-style). A study by Brown and Park (1982) in three demographically different residential areas of Vancouver, identified differences in the visual intrusion of traffic (parked and moving vehicles) between different socio-economic groups. This study also showed that parked vehicles on streets have an intrusive impact as well as the vehicles moving along the streets. The visual impact of a mass of vehicles on a road was commented on by one of the public interest groups consulted in this study (see Section 4.4.2) and moving vehicles were identified as visually intrusive in a regional park area in the Kaitoke Route Upgrading EIR (Section 3.3).

The method of Watkins (1977) may also have application to visual intrusion. The impact of a road proposal can be measured against an index of visual management objectives, but this raises the question of what are the right objectives and who should determine them.

Vamplan (Visual Assessment Method for Planning, Bennett 1987) is a method of evaluating visual impacts of a road in a landscape. Vamplan is claimed to be an objective method, originally developed for use in New Zealand rural landscapes and has been modified for use in urban landscapes by eliminating the qualities called "unbuiltness" and "unstructuredness". The validity of this approach may be questionable. The attributes of landscape quality considered in Vamplan in urban locations are "extent of sensitive areas", "coherence", "visibleness", and "distinctiveness".

The evaluation of visual intrusion in MEA and elsewhere is recommended for analysis by trained professionals. This approach should be continued but, because of the cultural differences that may apply, the evaluation should also be designed to include the direct input of local community values. To obtain effective input from local communities, planned public participation is needed, involving the use of presentation techniques (such as photomontages and 3D models).

The evaluation of visual intrusion has been largely descriptive and subjective. A number of procedures which claim to be objective have now been developed although more research and development is required before any particular one could be recommended for inclusion in the PEM. However, as visual intrusion can be a very compelling factor in deciding between alternative projects, research into the methodology of evaluating visual intrusion deserves a high priority.

- **View From the Road**

The view of the landscape as seen by a driver and passengers can have positive or negative impacts for those categories of road users. If the road passes, for example, through a heavily industrialised area or is located in a trench or tunnel, the impact will be negative. If the road opens to views of natural landscape that were not otherwise seen, then the impact will be positive. An example of such a project discussed earlier is the proposed re-routing of State Highway No. 2 between Kaitoke and Te Marua through the Kaitoke Regional Park.

"View from the road" evaluations are not always carried out in road project scheme assessments. For example, this effect was not included in the studies for the Transmission Gully project. In MEA the view from the road is defined as:

> *The extent to which travellers, including drivers, are exposed to the different types of scenery through which a route passes. There are two aspects to be considered:*
>
> *a. the types of scenery;*
>
> *b. the extent to which travellers are enabled to view the scene.*

Four different types of landscape are described in the MEA, namely industrial/commercial, residential, agricultural/rural, and scenic (which implies above average local quality). It notes that the extent to which travellers can perceive the landscape through which they are passing depends on the relative level of the road and its surrounding ground.

A method of quantifying the value of scenic landscape through which a road passes has recently been reported by Smith and Smith (1991). This is carried out by a drive-over technique using a video camera and a laptop computer. The types of view are categorised as panoramas, scenes, or focal points. For each, 13 to 16 items can be recorded to describe factors such as materials, colour, quality of view, quality of presentation, distance of view, and monotony versus variety. At the time the Smith and Smith report was prepared (1991), a technique to develop rating numbers was still being formulated. This work appears to have some potential and should be followed up.

On New Zealand highways, there are often relatively long lengths of road made up of a succession of horizontal curves of very small radius. This is referred to as a "bendy" road alignment. For the driver, there is the inherent conflict between viewing the landscape and concentrating on the visual task of safe driving. In roads that wind over mountain ranges with a succession of left and right hand corners at close intervals, the driver has little opportunity to view the scenery. Even passengers are likely to be drawn to watching the road to brace themselves for lateral forces and because of general anxiety. Where there is high design speed and large radius curves, then a much greater opportunity to enjoy the scenery will exist, as both driver and passenger will be confident enough to divert their eyes from the road pavement ahead, for at least short periods. This might not apply when

following other vehicles in traffic streams. In terms of quantification, it seems possible to measure and aggregate the relative attentiveness required for the driving task based on road geometry and traffic flow. The researchers are not aware of any such work having been done, except that BCHF (1992) reports on work done in Sweden in relation to vehicles in view on the road ahead.

Quantifying aesthetic values of different landscapes is described in a relatively old report by Melhorn and Keller (1973). It is in itself a development of work reported by Leopold in 1969.

Leopold's quantitative approach was confined to comparing the natural qualities of river valleys at on-site locations. His basic philosophy was that any landscape that is "unique", in either a positive or negative way, is more significant to society than a landscape that is commonplace. The evaluation of landscape initially requires an evaluation of its relative uniqueness, which for practical purposes becomes defined as a measure of the relative difference between landscapes. Those shown to be unique must then be analysed to determine why they are unique. This is accomplished by defining what is to be evaluated, and numerically determining what part of the uniqueness is due to characteristics that are antithetical to the definition.

Melhorn and Keller used a model called LAND (landscape aesthetics numerically determined) for river valleys at the time of their report (1973). The factors evaluated are grouped into Leopold's three categories - physical, geologic, human use and interest. The paper goes on to describe how to calculate a uniqueness index and then, as the final comparator, an aesthetic index for each landscape. This approach is suggested by them as being useful for highway corridors. A follow-up literature search did not identify any reports on further development of this LAND model since 1973.

If the method is applicable in project evaluation, it could probably be best used to evaluate view from the road along alternative highway corridors.

- **View of the Road**

Research into the view of the road by the driver and passengers is not evident in the literature.

The three dimensional shape of the road spreading out in front of the vehicle can be regarded as having a visual quality of its own, or a form of sculpture in the landscape. Engineers who design roads have rules about how to integrate the horizontal and vertical curves of the road to produce the most elegant visual effect. Also the design speed of the road can, by choice, be varied so that the curvature and the scale of cuts and fills better matches the natural landscape forms. While good design is apparent to the expert road designer, it is not known whether this is perceptible to the average driver and passenger. Possibly it is not, but there still may be some unconscious benefit for those road users. The scale of such benefit is purely speculative at this stage although it may be able to be explored by contingent valuation techniques (willingness to pay). An overview of contingent valuation techniques is contained in Section 4.4 of OECD (1989). This topic is also related to the opportunities to relieve the driving task and look at the landscape, referred to earlier.

4.2.2 Special Areas

Most transport project appraisal systems include some recognition of historic, cultural, ecological, or habitat values. These are defined and grouped in various ways, a common one being to separate out the "historic-cultural" group from the "ecological-habitat" group. Definition and recognition ranges from some type of statutory protection (such as protected heritage sites in the UK), to vague descriptions of local environmental or ecological value ("neighbourhood" importance). All such intangibles have some of the following in common:

- They are recognised and identified by some (or all) people in a community (at national, regional or local level) as having qualities which give them unquantifiable merit.

- The qualities may be spiritual, historic, scientific, cultural, traditional, aesthetic or technological.

- They have a geographic basis.

- They are "sites and localities" which can be (at least) approximately defined.

The Resource Management Act 1991 gives a lead in the recognition of this type of intangible by recognising in its purposes and principles (Sections 5 to 8), the need for the identification and protection of places to which the community attaches certain qualities and values.

4.2.2.1 Scope of "Special Area" category

It is suggested that future appraisal systems should recognise a single category called "special areas".

The distinction between "historic-cultural" values and "ecological-habitat" values has little merit or benefits. As the qualities people attach to the places and areas are difficult to measure, then it does not matter that the basis for recognition of the quality is different. There is often blurring of distinction in people's definition of a site's value. For example, to a botanist, the habitat of a very rare or endangered plant species can have the same spiritual significance as a church to a devout Christian, or a historic battle site to a military historian. The important attribute in identifying a "special area" is simply that the community has recognised it.

The category as proposed would include the following:

- Sites of cultural, spiritual, historic, aesthetic and amenity values.
- Archaeological sites.
- Waahi tapu, and other sites of special importance to tangata whenua.
- Sites of special ecological, botanical, geological, geomorphological, or other scientific values.
- Important recreational areas.

As a site- or area-based category, this group of intangibles would stand out from most others, and double-counting could therefore be minimised. The only possibility of double-counting would be in the "ecology" category, and it is suggested that the category of "ecological impacts" in Appendix A7.11 should be re-defined to exclude specific sites.

Special areas can be identified from a range of sources. Regional and District Planning Schemes already identify areas with special community values under a number of categories such as "listed buildings", "identified sites", "protected trees", "protected ecological areas" and will increasingly be an easy means of identifying most of the sites and areas to be included in this category as new plans are prepared under the Resource Management Act. Other lists, such as that held by Department of Conservation for archaeological sites, also give basic information. Sites such as churches and maraes can be readily identified from site inspections.

There will always be sites and areas which can only be recognised through local knowledge. Examples are locally important recreational areas. Such sites, and the values people place on them, can generally be readily identified from local informants or a process of consultation.

Waahi tapu are a special group. It may not ever be possible to identify the exact site or locality affected. However, consultation with those who hold mana whenua in the area will advise on the presence of waahi tapu without disclosing the site or the reason for it being tapu.

4.2.2.2 Defining the impact

The impact of a roading project on a special area can be:

- Direct, and completely destroy the site,
- Direct, and partly destroy the site,
- Indirect and detracts from the values for which the site is identified as "special". For example, water pollution arising from construction of a new road could destroy a area of special ecological value; noise from traffic could severely detract from spiritual or recreational values associated with special areas.

Special areas have qualities which make them impossible to quantify in monetary terms because they cannot (by definition) be replaced or substituted. Their values have been built up over many generations, or over thousands, or hundreds of thousands, of years.

Some of the sites are held in such high regard that they are non-negotiable. For that reason they will not be able to be modified or otherwise adversely affected at all. The only acceptable mitigation measure would be re-routing of the road, or cancellation of the project. In this case the quantification of the intangible values outweighs the total of all other costs and benefits. An example of this type of site may be a waahi tapu, where values accord to the site itself and are non-negotiable. Some archaeological sites and ecological and scientific sites are also in this category.

The intangible values attached to other sites may be able to be negotiated by a range of mitigation measures. Examples may be relocation of a historic building, or the development (and therefore partial substitution of site) of new alternative recreational opportunities. In these cases, it is possible to attach a dollar value to the effect by pricing the mitigation or amelioratory action required. However, because of the lack of complete substitutability, this would give only a lower bound of the real value and leaves an additional intangible value to be applied.

The only way of identifying which sites and values are non-negotiable, and which can be mitigated, and to what extent, is through consultation. Some sites should involve broad consultation (e.g. a recreational area). Others may be more appropriately negotiated by dealing with those to whom the value means most (i.e. tangata whenua for waahi tapu, ecological experts for ecological sites).

4.2.2.3 Developing quantification systems

Dealing with special sites involves a site-by-site consideration of values within a community context. As suggested above, it may be possible to develop monetary value quantification for some sites on the basis of a careful exploration of mitigation measures through consultation and negotiation with the appropriate parties for the site.

The opportunities for generic research to identify methods of measuring intangibles relating to special areas are very limited and the means of mitigating or ameliorating adverse impacts on the special areas themselves would be more appropriate to identify. Possibly some generic solutions exist which could be identified and publicised. For example, techniques and costs of moving old buildings; techniques of replacing lost or damaged areas of ecological significance.

4.2.3 Effects on Water

Effects of road proposals on water resources are often not included in transport appraisal systems. However, there is a growing recognition of roads, and the traffic on them, as sources of adverse effects including both point source pollution (e.g. from storm water drains, accidental spills directly into water), and non-point source pollution (e.g. general run-off into water, and matter precipitated from air).

Soil effects are less frequently identified, but a growing body of research is identifying high levels of heavy metals in soils and vegetation adjacent to both urban and rural roads (Fergusson and Simmonds 1983, Fergusson *et al.* 1980).

Adverse effects of roading and traffic on water have been identified in a number of New Zealand studies (Kingett Mitchell & Associates 1992, Fergusson and Simmonds 1983, and Fergusson *et al.* 1980).

Overseas appraisal systems include water- and sometimes soil-related effects, such as "water pollution" and "drainage and sediment phenomena, soil erosion", for example in the Australian evaluation system. In Sweden and France, some recognition is given to water effects such as possible lowering of the ground-water table, catchment pollution from spills and road run-off, and increases in "peak" flows caused by increased paved areas. OECD reports are increasingly mentioning effects of transport system on water resources. Effects

on soil are less commonly mentioned and, when they are, it is in terms of generic "water and soil" effects.

The Resource Management Act states, as a matter of national importance, the need to preserve the natural character of the coastal environment, wetlands, and lakes and rivers and their margins. It also provides for control of point-source pollution by requiring consents to be obtained if contaminants are to be discharged into natural water, or if river, lake or sea beds are to be built on.

While it is recognised that effects on soil do occur as a result of traffic, it is proposed that this category not be pursued at present because it appears that only approximately 10% of heavy metals emitted by vehicles find their way into soils within the first 100m on either side of a road. Most appear to either enter the stormwater and hence the water system, become trapped on vegetation or building surfaces, or add to general air pollution. This is not to say that an intangible effect on soil does not exist, but rather that it can be best identified and assessed in terms of water and air pollution.

4.2.3.1 Scope of "Effects on Water" category

The effects that roads, and the traffic that they carry, have on water are quite diverse. They include :

Construction effects : such as direct modification of beds of rivers and lakes causing interruption or change to natural flows, permanent modification of the channel, and a release of sediment downstream caused by disturbance from engineering works. These are relatively short-term effects.

Permanent changes : such as permanent modification of a river channel or lake or sea bed, caused by engineering works, and modifications in ground-water levels caused by aquifer penetration, changes in permeability, or the shape of the ground surface.

Discharge effects : such as modification of natural flow regimes caused by faster rates of run-off from paved surfaces, and the use of stormwater drains and channels.

Water pollution : including hydrocarbons from leaked fuel, heavy metals from fuel additives and engine wear, and particulates such as asbestos and rubber, all from vehicle operation (particularly heavy vehicles); from accidental spills from loads (of highly variable contents) and crashes; from material from deterioration of the road itself; and from dust which is washed off the road in rain.

The definition of this category is based on the recognition that water bodies are a receiving medium for products of the construction and operation of roads, in the same way that air is. Pollutants that do not remain air-borne are either trapped by vegetation and soil, or are washed into rivers and streams and hence to the marine environment.

Such effects have been, in the past, identified only in a very indirect manner through ecological impacts, and there is some possibility of double-counting given the wide scope of ecological considerations. If an "effect on water" category is to be included in the PEM, the "animal and plant ecology" category will need to be redefined to avoid counting the same effect in both categories (Section 4.2.4).

4.2.3.2 Defining the impact

All water effects are directly measurable through clarity and volume measurements (sediment), chemical analysis (water pollution), flow measurements (change in run-off rates), physical observation (some surface pollutants), or ground-water level measurements. Appropriate measurement techniques are well established, and have been applied to identify transport corridor effects (Kingett Mitchell & Associates 1992).

However, a number of problems arise in measuring water effects relating to a road. These limit the possibility of calculating with any certainty the water effects of any proposed new roading. These problems are;

- Difficulties in identifying accurately how much of a measured effect is related to a particular road project or to operating a stretch of road. Especially in urban areas, there are many sources and contributions to water contamination from roads which are not directly related to the operation of the road itself. For example, "gutter dust" includes industrial and household as well as vehicular pollution.

- Difficulties in identifying accurately the traffic volumes and type of vehicles likely to use a road (although this can be modelled reasonably accurately).

- Difficulties in assessing safety performance, the risk of crashes and load loss, and the likely type and level of pollutants arising from such accidents.

- While "before and after" measurements can identify changes arising from a road project, they cannot be used at project appraisal stage. There is insufficient research information on which to base prediction of effects, at present.

Because of these problems, it is appropriate to consider effects on water as "intangibles" given the current state of knowledge.

However, the identification and measurement of water effects separately from ecological effects, and the attempt to apply them in some quantitative form in roading project appraisal, is much more realistic than attempting to evaluate them as "downstream" effects such as changes to the ecology of rivers and streams.

Studies of effects on water arising from roading development and operation are still at an early stage. Applicable information is beginning to build up both in Europe and New Zealand, where it will come from general environmental monitoring studies as well as from specific project-related studies. There is considerable scope for the application of well-targeted research in the area of relating water effects to roading development and use.

4.2.3.3 Developing quantification systems for Effects on Water

Once more is known about water effects, and once likely effects arising from new proposals are able to be predicted with some accuracy, it may be possible to at least partly express the effect in dollar terms. This could be achieved through estimating the cost of an environmental clean-up. However, it is certain that such an approach would only be able to identify part of the total effect, as effects and pollutants quickly become widespread throughout the food chain, and dispersed and dissolved into the water medium, and in bottom and bank sediments.

Avoidance and mitigation of some effects is possible through a wide variety of measures including :

- Bunding, vacuuming and filtering during construction.

- Safety measures in road design to limit crashes; emergency management such as sealing of drains and collection of clean-up materials.

- Stormwater run-off management using marginal strips and swales along roads that provide for infiltration, rather than engineered stormwater drains feeding into water bodies.

- Vehicle maintenance standard improvement, fuel volume and additive control.

- Traffic management, to limit stop-start actions which produce increased volumes of pollutants.

These "good management" techniques cannot provide full limitation of water effects, but need to be taken into account in project appraisal.

Further research identifying other mitigation possibilities, and relating the costs and benefits of them to the water effects of roading, is desirable for environmental reasons as well as for road project appraisal.

4.2.4 Ecology

4.2.4.1 Definition

Under the proposed revised categories for Appendix A7, the wider interpretation of ecological impacts at present included (i.e. the existence and wellbeing of animals and plants) is to be re-defined. Whereas the previous definition incorporated ecosystem impacts from the on-going operation of a road (e.g. dust and water pollution), these matters are now more appropriately addressed separately under the topics of air or water pollution. The remaining issues with respect to ecology are the loss of habitat, caused by either land acquisitions for road construction, disruption of territorial domains, or interruption of ecological corridors.

4.2.4.2 Impact assessment

The key steps in assessing the impact on ecology relate to the following:

- Predicted extent of physical disturbance to the local environment.

- Relative sensitivity of the local ecosystem. It is recognised that relatively unaltered ecosystems are a scarce resource and that society is placing increasingly high values on "natural" ecosystems. Areas with "Reserve" or "National Park" status automatically attain a higher protection status than do areas without this designation. However, other areas of ecological significance do exist and may be formally identified for the first time during the planning of new or altered roads. Likewise, the natural coastline has a high status. These areas will often be referred to as "special areas", and should be considered under that category (see Section 4.2.2).

The general approach to assessing ecological impact of roading proposals is to conduct an expert assessment of the affected area. Personnel from the Department of Conservation may provide the necessary expertise. A first level "initial" assessment is required to determine the general nature of the area to determine whether the area contains any special features such as endangered species of fauna or flora. Other aspects related to species diversity may also require assessment as well as information on the abundance of identified species. If this appraisal determines that the local ecology has significant features, a further detailed appraisal is recommended which can establish the ecological effects in detail.

In quantifying the impact it will be necessary to report the findings in an objective way, noting (and in some cases, mapping) the affected species, the relative risks to species diversity and abundance, and using qualitative assessment information to derive information for the Project Balance Sheet.

To define a possible method for the assessment of ecological impacts in monetary terms, the most longstanding approach to this aspect of environmental valuation is the calculation of the cost of rectifying the damage or restoring the destroyed resource. An extension of this technique to nature conservation issues is offered by the "shadow project" approach (Klassen and Botterweg 1976). Destruction of a particular habitat is compensated by artificially creating an identical habitat elsewhere. The cost of the "shadow project" must be entered in the CBA and the shadow project must be carried out if the scheme is implemented. However, in some cases (e.g. ancient podocarp forests) it may be doubted whether re-creation is possible within a reasonable time frame. In such cases the ecology impacts should probably act as a binding constraint on a project development at any cost and the scheme adjusted to avoid damage to that particular aspect of the environment (Hopkinson *et al.* 1991).

A recent TRRL report (Rendell Planning & UEA 1992) concludes that certain inter-generational impacts (such as impact on important ecological sites) could be accounted for in scheme appraisal by using shadow projects, in which the cost of the shadow project would be entered in the CBA instead of the cost of the environmental impact it removes. However, the shadow project is not a valuation method for measuring environmental impacts, as the cost of the shadow project does not necessarily have any connection with the value of the impact that it would remove. This means that if the shadow project is not implemented, the impact value and not the shadow project cost must be used in the CBA.

4.2.5 Psychological Stress

This is a group of effects that mentally or emotionally affect users or non-users of the road but are not covered by other tangible or intangible factors. The stress can have both physical and physiological outcomes.

The effects involved include:

- Psychological distress to the owners of property affected by a road proposal.

- Stress to the wider community associated with the uncertainty of whether a roading proposal will or will not go ahead.

- Stress to drivers and passengers caused by discomfort, fear, and frustration when using a given road. This can arise from both the geometry of the road and the other traffic sharing the road.

- Stress to those who have to cross the road (severance-related).

The word "stress" is not regarded as a scientific term that can be defined. Better words include discomfort, anxiety, frustration, fear, and fatigue. Although further research should be channelled into the more definable areas, for this discussion stress will be used as a catch-all term.

An important issue to be considered for the PEM is whether psychological stress is already covered within other factors used in the evaluation, as there appears to be a significant risk of double-counting. For example, the proper calculation of the costs of property purchase and compensation (including that for noise) could include the stress to property owners directly and indirectly affected by the road. For vehicle occupants, it can be argued that the costs of vehicle operation, travel time and accidents together should correctly value all the outcomes of stress associated with driving. A general lay opinion is that this is not the case at the present time. The following discussion is based on the assumption that there is at least an element of psychological stress not included in monetary valuations at present used in PEM. This is divided into the categories of Non-User and Road User Stress.

4.2.5.1 Non-user stress

The stress from forced property purchase is judged to be already adequately covered in Appendix A7.12. One of the difficulties that frequently arise in property purchase for roading purposes is the amount of compensation. At a minimal level this is the value of the property to be bought at its current market price, plus an allowance for the cost of relocation. This in effect allows no compensation for the "stress" of having to relocate.

It is understandable that the roading authority will want to minimise its property purchase cost. Patten (1990) reports on a concept which is called "the polluter pays principle" developed by Pearce *et al.* (1989). For road building this is compensation that would be paid for homes spoilt by noise, visual intrusion, air pollution, etc. This compensation would amount to a golden handshake to the community to reflect the environmental detriment that has occurred. In relation to stress, it could be predicted that knowledge of a commitment by the roading authority to the polluter pays principle would reduce uncertainty and stress

for some persons affected. However there will be some occupiers, particularly residents who have lived in an area for a long time, to whom adequate monetary compensation will never match the discomfort of relocation or environmental degradation if they remain living close to the road.

On a broader scale, there is the stress to the wider community associated with the uncertainty of major road building. This was notable in the State Highway 1/Transmission Gully study in which coastal settlements have been subjected to progressive traffic growth over a long period. The study process activated their concerns about such traffic growth, and whether this would continue or would be reduced by provision of a major new route. Unfortunately as the time involved in obtaining planning consents for a major road can be up to 10 years, the time this process takes and its effect on those wanting to buy or sell property near the proposed road over that period exacerbates this stress for large numbers of people.

4.2.5.2 Road user stress

In the UK MEA, Road User Stress is called Driver Stress. Conceptually this term includes passengers, so we prefer the term Road User. Drivers under stress have a lowered standard of driving, reflected in more aggression and taking more risks. The MEA identifies three main components of driver stress:

Frustration : factors that contribute to frustration are poor forward sight distances (bendy alignment), frequent intersections (mainly in urban situations), a high proportion of heavy vehicles in the traffic flow (which both block forward sight distance and are difficult to overtake), and the density of vehicles in the traffic stream (which is a function of the volume to capacity ratio of the road).

Fear : this is mainly fear of a potential accident. It is promoted by factors such as high traffic speed, poor lighting at night, adverse weather conditions, and difficulties with overtaking.

Uncertainty of route : this stress is related to a deficiency in map and/or sign information.

The MEA suggests that the fear factor may be relevant when a close choice has to be made between building a single or dual carriageway road. A New Zealand example is the Upper Hutt Bypass on State Highway 2. Built as a high speed road with single carriageway and curvilinear alignment, it requires drivers to make overtaking decisions in relatively dense traffic streams. Because of a bad accident record it has subsequently been converted to a 3-lane road with long passing bay sections alternating in each direction. This has reduced the stresses of the driving task significantly.

Drory (1985) identifies another component of driver stress, that of driver fatigue. Driver fatigue is a function of the intensity, length and monotony of the driving task. His study of truck drivers and those of others, (for example King's (1984) study of roadside rest areas), has shown that fatigue is reduced by opportunities for short rests, and occupation with some secondary tasks such as radio communication with their base.

In determining driver stress, both the intensity and, to a lesser extent, the length of journey are contributing factors. In the example of State Highway 2, Te Marua to Kaitoke, frequent users of the road commented that driving along the poor alignment of the existing Kaitoke Hill adds significant stress to the drive over the Rimutaka Range.

The NHCRP Report 122 (Winfery and Zellner 1977) makes several good points about driver strain. It states that driver strain is a personal reaction evaluated by each individual separately, and what the driver is willing to pay for an increase in comfort or convenience is a personal matter. Note that in this context "stress" and "strain" can be assumed to be the same psychological condition. There are plenty of examples of personal preference in society inside and outside the transportation system (e.g. air conditioning of automobiles or private houses). The report goes on to say that the price people are prepared to pay for less driving strain does not contribute to monetary savings such as reductions in the consumption of fuel, oil and tyres. People pay for their preferences by a reduction in spending on other activities; i.e. consumer spending is a transfer payment which should not be included in a national viewpoint economic analysis. Therefore to include comfort and convenience costs in the analysis may be a form of double counting.

This NHCRP report makes one further interesting observation:

A person who travels a comfortable and convenient highway may reach his destination in a good mental and physical condition with more energy than he would have otherwise. Therefore, he may be more productive in his daily occupation than he otherwise would be. In this case there is a direct economic contribution of the reduction of driver strains resulting from improved highways.

Although pedestrians are considered to be road users, stress ascribed to crossing the road is not to be included here, as it is already included in community severance (Section 4.1.3).

Driver and passenger comfort on a journey can conceptually be regarded as part of psychological stress. Jacobson *et al.* (1980) have developed models for calculating the comfort index of a journey based on six variables of linear and angular acceleration. Their equations are based on regression analysis of measurements made from instrumented vehicles. The equations could be used to compare road project alternatives in which routes of different degrees of "bendiness" are being compared.

These researchers also note a temporal effect of comfort which is the amount of discomfort that increases the longer the journey takes. Thus segments at the end of the trip should be more heavily weighted than those at the beginning. Although some aspects of comfort may be accounted for in the PEM by the travel time and vehicle operating cost values, this temporal effect will not be, and therefore it is truly intangible. This temporal effect was also noted in the Kaitoke study, where users felt that the Kaitoke Hill was an added burden after having crossed the Rimutaka Range.

4.2.6 Overshadowing

When a proposed road structure reduces the amount of direct sunlight that falls on an occupied property, in most cases it has an adverse environmental effect. For example an elevated roadway or bridge casts substantial shadows, and a high retaining wall or embankment could also cast shade in the early or late part of the day.

Overshadowing is a recognised intangible effect which is frequently guarded against in town planning ordinances by applying daylight admission controls which restrict the height and location of building development on individual sites. The overshadowing effect is analogous to the overshadowing effects of trees on neighbours, where enjoyment of property and personal health is protected by the provisions of the Property Law Amendment Act (1984), and the District Court can order the obstacle to be removed.

While shading will in most cases be a negative impact, occasionally it could be a positive benefit. For example shelter provided from the weather by an overhead bridge could be beneficial and, in the case of earthworks, an excavation of a hill might increase the amount of sunlight reaching a property.

The changes in shadows cast by a structure is theoretically calculable from azimuth and altitude data for the sun during the year at the site's particular location. This could be expressed in sunshine hours lost per year. An adjustment would be necessary to compensate for the average amount of cloud cover in a year, which will reduce the hours of direct sunlight.

No information about the monetary valuation of overshadowing is known at this time and it is therefore an intangible. However it would appear suitable for non-market valuation based on either contingent valuation or hedonic pricing.

4.3 Miscellaneous Intangible Factors

Other factors for potential consideration as intangibles have been identified in the course of this research and form a miscellaneous group.

4.3.1 Exposure to Wind

This intangible affects pedestrians and cyclists exposed to high wind on or near a proposed roading development. It is likely to occur in wind-prone areas on or near elevated structures or large flat surfaces that are exposed to prevailing winds. Examples are the Wellington Motorway Extension and the Ewen Bridge replacement in Lower Hutt.

4.3.2 Litter

Road users discard litter, which becomes distributed in the general vicinity of the road and, in some cases, on private property. Monetary valuation may be estimated by the costs of clean-up.

4.3.3 Security

Private property may be exposed to vandalism and damage by the proximity to a main road. As well as the actual cost of damage, potential loss of amenity and intimidation may result.

4.3.4 Urban Blight

This is the social and environmental degradation of property and areas in the expectation that the land will be required for a road project. Urban blight has particular impacts in established urban areas, and its severity is related to the length of time between the public becoming aware of the project and when the land is actually used.

4.3.5 Pedestrian and Cyclist Intimidation

This is fear aroused in pedestrians and cyclists because of proximity to fast moving traffic. The presence of heavy vehicles in the traffic stream will greatly influence the intimidation. Note that an actual accident, to which this fear is related, is accounted for in tangible accident costs.

4.3.6 Use of Road Reserve for Public Utilities

Utility authorities can benefit by the availability of a road reserve in which to locate their services e.g. sewerage, power and telecommunication cables. This benefit may be able to be quantified in monetary terms, in which case potential tangible benefits can be included in the CBA.

4.3.7 Global, National and Regional Environmental Goals

A project that helps to achieve established global, national, or regional policies relating to environmental goals could be recognised as another category of intangible in project evaluation. This is further discussed in Section 4.5.

4.4 Consultation with Users and Non-Users of PEM

4.4.1 Consultation with Practitioners

At an early stage of the investigation a meeting was held with practitioners who are currently involved in applying PEM to real situations. The purpose was to obtain feedback on their experience in use of the intangibles listed in the PEM.

The discussion showed that intangibles at present do not play a large part in small- and medium-sized projects. For large projects, an EIA is prepared which is considered in parallel with the project evaluation. The EIA describes impacts in mainly subjective terms, compared to the relatively more objective methods set out in the PEM.

4.4.2 Consultation with Public Interest Groups

Interviews were arranged with the representatives of five public interest groups, namely the New Zealand Road Transport Association, the Pacific Institute of Resource Management, the Ministry of Transport, the Automobile Association of New Zealand, and Transport 2000.

A summary of the results of the interviews is given in the Appendix. Although information obtained on intangibles was rather limited, some useful comments were obtained on urban blight, loss of local access, the extent of the use of urban land for the road and public utilities, pedestrian and cyclist intimidation, and the visual perceptions of the mass of traffic using roads in cities.

4.5 Comments on the Evaluation Process

During the research and consultation conducted during this project a number of issues arose relating to shortcomings with the evaluation process and the way it integrates with other land use planning matters. A particular issue was the conformity with strategic plans.

Information from the review of overseas evaluation procedures revealed that many countries evaluate transport plans according to the effects of the proposed development on national transport plans and economic policies. The importance of a proposal to the development of a nation or region is considered at the time of project appraisal and a positive weighting is given to the specific proposal if it conforms to the aims of national transport plans and economic policies.

Since the time that this research commenced, Parliament has passed the Transit New Zealand Amendment Act 1992. This amendment act requires every regional council to prepare and maintain a land transport strategy for its region. The strategy is to be kept current for at least three years but not more than five years in advance. The strategy must be implemented in regional and district land transport programmes, unless it is impractical to do so. The strategy cannot be inconsistent with the provisions of a regional plan in force under the Resource Management Act 1991.

The Transit New Zealand Amendment Act 1992 will ensure that any road project planned by a regional or local authority will comply with a formalised regional land transport strategy. Therefore there will not be any difference between projects, because they all must comply. The only exception to this is projects of Transit New Zealand (e.g. state highways) which need only "have regard to" the relevant land transport strategy. If Transit New Zealand proposed a project inconsistent with a regional transport strategy then this should be considered as a negative intangible benefit, or perhaps should be included in the economic analysis as an arbitrary but relatively large magnitude reduction of the benefit/cost ratio.

Fuel use, CO_2 emissions, and localised air/water/soil pollution are matters that an environmental policy should address. Current undertakings in this regard by Transit New Zealand will assist towards the acceptability of scheme proposals "external" to the PEM process. It should be noted that, unless Transit New Zealand's PEM process is widened to incorporate global and national environmental issues, it may not be appropriate for these issues to be considered in individual project evaluations.

If compliance with established policies on economic development and environmental protection was to become a requirement of project evaluation, there is a need to develop concise policy statements for general use. At the individual project level, this intangible factor would be a further item to be considered together with other intangible factors in the planning balance sheet. It is suggested that non-compliance should be sufficient to eliminate or downgrade projects which are well outside the policy guidelines. These would be "flagged" as socially, environmentally, or economically incompatible or unsustainable.

5. CONCLUSIONS

The intangible factors of roading development projects, particularly with respect to the range of intangibles currently included in Appendix A7 of the PEM, have been investigated. As a result the degree to which these and other intangible factors, identified as a result of project reviews and consultation, are and can be quantified, has been assessed. The intangible factors of traffic noise, vibration, severance, and air pollution were not considered in detail by this investigation, and only incidental information relating to obvious shortcomings or matters arising out of modifications to these intangibles is given. The emphasis of the study and of this report was placed on a range of other intangibles.

Overall, the intangibles included at present in Appendix A7 were found to be inadequate in terms of:

- Quantitative methods.
- Range of impacts required to be assessed.
- Outcome of role of reported intangible effects in the production of the Planning Balance Sheet.

With respect to future development of the intangibles incorporated in Appendix A7, twelve conclusions were drawn which are set out in this Section. Section 6 then gives a summary of the intangibles that can be quantified, and recommendations for further research.

5.1 Visual Impacts

5.1.1 Visual Obstruction

The quantification of visual obstruction using the method described in the UK MEA has potential for application in the PEM. Although the method does not attempt to quantify the *quality* of the obstruction, it makes use of information which is sufficiently objective for the method to contribute in a meaningful way to the qualitative assessment methods used for visual assessment.

It is recommended that the UK MEA procedure for determining visual obstruction be trialed for a typical roading project in New Zealand with the aim of assessing its potential for incorporation in the PEM.

5.1.2 Visual Intrusion

This intangible factor is important and justifies a substantive research project to further investigate and trial the known objective methods. This should include consideration of appropriate methods to include community opinions as well as those of landscape professionals.

5.1.3 View from the Road

View from the road may represent an important intangible for some roading proposals in New Zealand, particularly with respect to tourist routes. Although potential exists to quantify this factor for road users, insufficient information is available and further research is recommended before it is incorporated in the PEM.

5.1.4 View of the Road

View of the road is linked to the driving task and is a consideration for roading designers in terms of the integration of horizontal and vertical curves. It is not known if road users consciously recognise the positive design aspects of road design. It is suggested that further research on the use of "contingent valuation" to quantify the value of this intangible factor could be productive. However, it is recommended that this not be given high priority at this time.

5.2 Special Areas

It is recommended that a new category, "Special Areas" (i.e. areas identified by the community at national, regional, or local level as having special and important qualities), be added to Appendix A7. This would replace the "Historic, Preservation and Cultural Values" category (Appendix A7.10).

It is suggested that this category should be accepted as one for which quantification is largely impossible. However, in some situations it may be possible to obtain a partial quantification by costing out mitigation measures which have been found to be acceptable to the community through a consultative process.

5.3 Effects on Water

It is recommended that a new category, "Effects on Water", should be included in Appendix A7 of the PEM.

It is suggested that this category is one for which quantification (even in monetary terms) may become possible in the future when more is known about the nature and extent of effects on water, and about the costs and benefits of mitigating those effects.

Further research is needed to identify:

- Actual effects of road construction and operation on water (e.g. before and after case studies, such as that possible now for the Waimea Inlet adjacent to the proposed Nelson-Stoke Bypass, would be of value to ascertain the extent of impacts of typical water impacts, and suitable quantification parameters).

- The range, and the costs and benefits, of appropriate mitigation measures.

Such studies would be beneficial in terms of general environmental management, as well as assisting in road project appraisal.

No recommendation is made on impacts on soil, although information from overseas findings could be periodically reviewed.

5.4 Ecology

It is recommended that the intangible factor of "Animal and Plant Ecology" be renamed "Ecology" and modified to include only "loss of habitat" issues such as direct land acquisition, or interruption of ecological corridors. Other matters currently covered in this category are proposed to be included in the "Special Areas" category.

Although this impact is largely unquantifiable, "shadow project" pricing may provide a useful avenue for future research into the quantification of this factor.

5.5 Non-User Stress

Non-user stress to people affected by displacement and proximity to a roading project is generally accepted as real, but unquantifiable. It must still be regarded as important for the planning balance sheet. A monetary value may be able to be placed on this factor in the future if and when a "polluter pays" principle is adopted by roading authorities.

It is recommended that consultation on projects should be continued, as it is the best means of investigating this impact, particularly for the small- and medium-sized projects for which EIAs are not commonly conducted.

5.6 Road User Stress

An element of road user stress cost apparently can be attributed to a road. This particularly applies to the "do-minimum" case of existing roads with "bendy" alignments. Because of the risk of double counting, it is recommended at this stage that only a low weighting should be given to road user stress as an intangible when carrying out project evaluations.

5.7 Overshadowing

This intangible factor is not commonly encountered, although the impact can be serious. Further research is therefore recommended so that this category can be assessed for incorporation in the PEM procedures.

5.8 Miscellaneous Factors

Wind, litter, security, urban blight, pedestrian/cyclist intimidation, and use of road reserve for public utilities were identified as intangible factors that should be listed in Appendix A7 for possible inclusion in project evaluation where they are relevant to specific projects.

5.9 Conformity with Global, National or Regional Environmental Goals

This is a fundamental issue relating to the inclusion of broadly based environmental policy issues in project evaluation. Projects which are assessed as conforming to these goals should be perceived as having significant benefit. It is recommended that Transit New Zealand develop an approach to enable this factor to be included in the intangible factors of Appendix A7.

6. SUMMARY

6.1 Intangibles That Can Be Quantified

Of the intangibles studied in this investigation, those for which methods of quantification have been identified are summarised as follows:

6.1.1 Visual Impact

6.1.1.1 Visual obstruction

Measurement of solid angles Refer page 34

6.1.1.2 Visual intrusion

Vamplan method of evaluating landscape quality Refer page 35

6.1.1.3 View from the road

Qualification of scenic quality using a drive-over technique Refer page 36

Leopold method for comparing landscape uniqueness Refer page 37

6.1.2 Special Areas

Monetary quantification based on costs of mitigation Refer page 40

6.1.3 Effects on Water

Estimated cost of environmental clean-up Refer page 43

6.1.4 Ecology

Measurement of areas affected, relative risks to species diversity and abundance, and synthesis of shadow projects Refer page 44

6.1.5 Psychological Stress

Driver and passenger comfort index rating Refer page 47

While these methods have been identified, most if not all require further development before inclusion in the PEM

6.2 Research Recommendations

In Section 5 of this report a number of recommendations for further research were made. These are summarised as follows:

6.2.1 Visual Impact

6.2.1.1 Visual obstruction

Trial UK MEA procedure on a typical New Zealand roading project

Refer pages 34, 51

6.2.1.2 Visual intrusion

Further investigate the visual impact techniques that have been identified before choosing a suitable method for the PEM Refer pages 35, 51

6.2.1.3 View from the road

Follow-up on the drive-over technique for quantifying a scenic landscape reported by Smith and Smith (1991) Refer pages 36, 52

6.2.1.4 View of the road

Investigate contingent valuation techniques (willingness to pay) to quantify advantages of good road design Refer pages 37, 52

6.2.2 Special Areas

Identify techniques and costs for moving all buildings and replacing lost or damaged ecological areas and produce guidelines Refer pages 40, 52

6.2.3 Effects on Water

Carry out Before and After studies of the effects of road construction on water quality Refer page 52

Investigate the range, costs and benefits of mitigation measures Refer page 52

6.2.4 Overshadowing

Investigate usefulness of non-market valuation techniques Refer pages 48, 53

6.2.5 Effects of "Bendy" Road Alignments

Investigate if loss of scenic amenity and journey comfort to driver and passengers on bendy roads, and increased travel time and vehicle running costs, are adequately covered in PEM calculations Refer pages 36-37, 47

6.2.6 Global, National or Regional Environmental Goals

Investigate how conformity or otherwise with such goals should be incorporated into project evaluation Refer pages 49, 50

6.2.7 Miscellaneous Intangible Factors

Monitor the possible significance of the intangible factors of wind, litter, security, urban blight, pedestrian/cyclist intimidation, use of road reserve for public utilities, in project evaluations being carried out by Transit New Zealand and other authorities Refer page 54

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APPENDIX. RESULTS OF INTERVIEWS WITH PUBLIC INTEREST GROUPS

INTERVIEWS WITH USERS AND NON-USERS

This Appendix summarises the outcome of discussions with representatives of both user and non-user groups. The purpose of the interviews was to identify any intangibles which may have been overlooked in the study, and to obtain group comments on the intangibles already identified.

The method used was an unstructured interview technique. Each interview lasted one to two hours and the following people were interviewed :

- Mr O'Brian Reeve : NZ Road Transport Association
- Mr George Porter : Pacific Institute of Resource Management
- Mr Tom Steiner : Ministry of Transport
- Messrs G Fairburn and T Burling : New Zealand Automobile Association
- Mr Kerry Wood : Transport 2000.

Comments from the interviews are summarised as follows. Where appropriate, relevant points have been incorporated in the main report.

1. Mr O'Brian Reeve : NZ Road Transport Association

The Association represents commercial road user and carrier interests and, as such, favours the free flow of traffic, maintenance of traffic speeds, and little disruption to the road user. The ideal would be a road system which avoids stop/start traffic, allows separation of users and maintains flows at an economic speed.

Mr Reeve referred to an article, "AMISE - The Motorway Project for the Europe of Tomorrow", which expounded the philosophy of the association and was considered to be a suitable role model for New Zealand. This article was made available to the interviewer, and discusses the role of motorways, seen as desirable from the point of view of efficiency, minimising air emissions and safety. The adverse effects on the environment, including noise, aesthetic and space requests, are recognised but it is postulated that design solutions are available for most problems.

In summary, this interview confirmed expectations that the group, although expressing concern at the effect of their activities upon neighbours, is primarily involved in the movement of goods. No useful identification of intangibles was achieved.

2. Mr George Porter : Pacific Institute of Resource Management

The Institute has a primary interest in global environmental issues and the protection or better use of earth resources. They are opposed to the use of fossil fuels and favour use of alternative energy sources. CO_2 emissions are therefore of major concern.

Matters raised regarding intangibles were :

- achieving better mileage from vehicles (a user pays approach);
- true costs of energy to be borne by the user;
- a need to consider the alternative use and possibly better use of funds now spent on roads and fuels;
- the use of fossil fuels (oils) in the road surfacing materials;
- disturbance to the environment of obtaining materials, e.g. quarrying for road metal, and the transporting of materials;
- our increasing dependence upon overseas countries supplying needed fuels and imports.

In summary, the Institute, while clearly concerned about the environment, did not proffer new information relevant to the study.

3. Mr Tom Steiner : Ministry of Transport

The Ministry has been actively involved in considering externalities and intangibles regarding roading matters and Mr Steiner has commented upon another "externalities" study being carried out for Transit New Zealand concurrently. Matters discussed regarding intangibles as outlined in both studies were :

Air Pollution
Concerns were expressed about such features as smog, CO_2 and lead which are emitted by traffic and have local and regional effects. These are seen as differing from the national or global "greenhouse" emissions of CO_2 and CFCs which have global effects and remain in the earth's atmosphere.

Water Pollution
Derived from tyre wear, oil leaks, carbon from exhausts, etc., the water running off road surfaces and car parking areas is therefore not clean or is of inferior quality.

Other effects on water are changes to the hydrology of the natural landscape, to watercourses, and to other normal flow patterns, including those of estuarine areas.

Construction Effects
Matters for consideration include changes to run-off, loss of vegetation and wildlife areas, or separation of such habitats.

Noise
Preference is to minimise noise at the vehicle or road source by requiring appropriate silencing of vehicles and low noise-factor road-surfacing materials. Other forms of control might be screening the road using vegetation or embankments, etc.; payments to adjoining residents to double-glaze windows (which is not beneficial to users of outside spaces); and changes to building practices.

Urban Blight
This includes the consequences of indecision or delays in road building.

In summary, the Ministry was well aware of the need to consider intangibles and concurred with the matters being examined in this study, and the concurrent study.

4. Messrs G Fairburn & T Burling : Automobile Association of New Zealand

The Automobile Association acts for its members and is interested in all roading matters including the welfare of transport-disadvantaged people. They are aware of problems arising from noise, e.g. chipseal versus asphalt surfaces, heavy vehicles, roads through built-up areas etc. A comment was made to the effect that although people knowingly bought property alongside a highway, further changes resulting in additional disturbances or loss of access should be avoided. They favoured control of non-essential roadside activities, e.g. the stalls at Otaki.

A matter of major interest was the need to improve roads in tourist areas. The prediction is that tourism will grow from the present 1.1 million per annum to 3 million by year 2000. Good quality access along sealed surface roads was important.

Their final concern was that other users of the road reserve (Telecom, Clear, etc.) were not paying for a right to use this space which (it was suggested) has been paid for already by the travelling public.

5. Mr Kerry Wood : Transport 2000

Matters discussed included :

- Loss of rateable land to the road reserve, important for revenue generation in urban areas where land is at a premium.

- Payment of street costs/repairs/improvements, etc. from rates where ratepayers (whether using the street or not) are obliged to pay, often for another person's or organisation's advantage. Some form of user pays system may be preferable, e.g. increase licensing and insurance costs.

- Scarcity value of land, e.g. it may be preferable to eliminate subsidising building at the city edge.

- Ground vibration, including the destructive effect upon buildings and underground services.

- Local pollution (i.e. exclusive of global CO_2/CFC issues) including fumes, noise.

- Health and environmental disturbances, psychological problems (loss of sleep, threatened severance of land, close passage of heavy vehicles, traffic lights outside residences).

- Accident transferral, i.e. reducing accidents at one junction may merely transfer the problem to another, or create further problems.

- Visual factors, i.e. the very mass of cars in the city or on a road of themselves create a visual disturbance.

- Restriction of movement : vehicles may intimidate other road users; cause pedestrians to avoid certain roads or localities where there are too many vehicles which are too close and too fast: threaten cyclists.

In summary, Transport 2000 has a variety of concerns regarding the overall funding and use of roads, and considers that external and intangible factors should be fully identified and included in any project evaluation process. They appeared to agree with the intangibles included in this study and would welcome attention being given to user pays approaches to road funding, evaluations of the needs for new roads, and consideration of alternative transport modes.