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THE DEVELOPMENT OF A COMMON INVESTMENT APPRAISAL FOR URBAN TRANSPORT PROJECTS

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AND
THE MVA CONSULTANCY

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THE DEVELOPMENT OF A COMMON INVESTMENT APPRAISAL FOR URBAN TRANSPORT PROJECTS

A REPORT TO BIRMINGHAM CITY COUNCIL AND CENTRO

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1 INTRODUCTION

1.1 Background

In December 1990 we were invited by Birmingham City Council and Centro to submit a proposal for an introductory study of the development of a common investment appraisal for urban transport projects. Many of the issues had arisen during the Birmingham Integrated Transport Study (BITS) in which we were involved, and in the subsequent assessment of light rail schemes of which we have considerable experience.

In subsequent discussion, the objectives were identified as being:-

(i) to identify, briefly, the weaknesses with existing appraisal techniques;
(ii) to develop proposals for common methods for the social cost-benefit appraisal of both urban road and rail schemes which overcome these weaknesses;
(iii) to develop complementary and consistent proposals for common methods of financial appraisal of such projects;
(iv) to develop proposals for variants of the methods in (ii) and (iii) which are appropriate to schemes of differing complexity and cost;
(v) to consider briefly methods of treating externalities, and performance against other public sector goals, which are consistent with those developed under (ii) to (iv) above;
(vi) to recommend work to be done in the second phase of the study (beyond March 1991) on the provision of input to such evaluation methods from strategic and mode-specific models, and on the testing of the proposed evaluation methods.

Such issues are particularly topical at present, and we have been able to draw, in our study, on experience of:-

(i) evaluation methods developed for BITS and subsequent integrated transport studies (MVA)
(ii) evaluation of individual light rail and heavy rail investment projects (ITS,MVA);
(iii) the recommendations of AMA in "Changing Gear"
(iv) advice to IPPR on appraisal methodology (ITS);
(v) submissions to the House of Commons enquiry into "Roads for the Future" (ITS);
(vi) advice to the National Audit Office (ITS)
(vii) involvement in the SACTRA study of urban road appraisal (MVA, ITS)

1.2 Method

The method adopted followed closely the sequence suggested in the objectives, and was designed to draw as widely as possible on expertise within ITS and MVA.

Given the considerable experience already available, the resources in the study have been used:-

(a) to achieve a consensus on the issues to be resolved and the most appropriate methods for doing so;
(b) to develop the specification of the methods outlined in (a).

The study was conducted in six stages, as outlined below.

Stage 1: Initial Review In this stage, senior staff in ITS and MVA provided initial discussion notes outlining, based on their experience, the weaknesses which they perceive with existing appraisal techniques, and possible solutions to those weaknesses.

Stage 2: Outline Proposals Research staff in both ITS and MVA used the outcome of Stage 1 and the brief provided by the clients (Appendix A) to produce a summary report on the perceived weaknesses, and outlined proposals for:-

(a) common cost-benefit methods;
(b) common financial appraisal methods;
(c) variations in method to reflect complexity;
(d) treatment of externalities.

Stage 3: Seminar One The proposals from Stage 2 were presented at a seminar attended by all contributors to Stages 1 and 2 and representatives of the clients which reached a consensus on the basis for developing the methods outlined.

Stage 4: Development of Methods

In this stage, the work was split between MVA and ITS, with the former being responsible for issues (a) and (b) from Stage 2 and the latter for issues (c) and (d). Each developed a draft specification together with indications of the ways in which they would overcome the weaknesses identified. Particular emphasis was placed on application of the principles of social cost benefit analysis, comprehensive coverage of resources and public and private sector costs, use of standard values to ensure consistency with DTp procedures and treatment of uncertainty. The topics identified in item 5 of the brief (see Appendix A) were discussed under the relevant issue headings and in terms of the ability of strategic and detailed models to reflect them. Recommendations for each issue were presented in the form of a draft final report.

Stage 5: Seminar Two The recommendations from stage 4 were presented at a second seminar, attended by all staff involved and by representatives of the clients.

Stage 6: Final Report The final report was based on the review of weaknesses and the recommendations from stage 4, revised in the light of

comments made in the two seminars. It includes recommendations for work in phase two of the study.

1.3 Outline of the Report

Chapter 2 examines the weaknesses of existing appraisal methods across transport modes. The requirements for Cost Benefit Analysis and Financial Appraisal are discussed in chapter 3. Chapter 4 addresses the issue of externalities and ways in which they may be integrated into the appraisal of urban transport projects. The presentation of externalities is discussed in chapter 5. Issues of modelling are discussed as they arise and summarised in chapter 6. A chapter on conclusions and recommendations follows.

2 PERCEIVED WEAKNESSES OF CURRENT APPRAISAL TECHNIQUES

2.1 Introduction

This chapter presents a summary of the weaknesses in current appraisal techniques based on the discussion papers produced for stages 1 and 2 and the subsequent stage 3 seminar. In overview the method of social cost benefit analysis received broad acceptance as the appropriate tool for use in transport appraisal. However, its current application raised several criticisms which are detailed below. Section 2.2 discusses the importance of objectives in the context of appraisal. Section 2.3 presents the historical background to the present appraisal practice. In section 2.4 the general criticism of the current appraisal methodology is presented whilst sections 2.5 and 2.6 detail weaknesses specific to highway and public transport appraisal respectively. Lastly section 2.7 summarises the chapter.

2.2 Transport Objectives

The Government sets overall objectives in the transport field with a ten year horizon. Currently these focus on the promotion of economic growth, the reduction in accidents, and the care of the environment. However the relation of the Government's overall objectives and the actual selection of schemes to achieve them is unclear. In the case of highways the proposal of a potential scheme is usually the response to an identifiable problem such as traffic congestion. Indeed highway schemes have an implicit local objective of accommodating the volume of traffic forecast on them. The sustainability of such traffic growth is not considered in the light of environmental and other factors. So Cost Benefit Analysis may be the right appraisal tool but its use in the context of vague strategic and implicit local objectives is a weakness.

In the urban context other transportation objectives are of importance in addition to safety, the environment and economic growth. For instance, the following objectives were identified in BITS: environment including townscape and safety, efficiency, accessibility, economic regeneration and practicability including financial feasibility.

The identification and development of appropriate objectives is the essential starting point for future transport plans. Explicit, clearly defined objectives facilitate the identification of problems, the development and design of appropriate solutions, and the appraisal of individual solutions against the range of objectives (for a range of impact groups).

2.3 Historical Background

The notion of comparability between the assessment processes for different modes of transport has been discussed many times in the last 20 years. The general Department of Transport line is that while the methods should be as comparable as possible, there are inherent differences which mean that roads are different. It would be wrong to think that this is merely the thinking of Conservative administrations: it has been deeply embedded in DTp thinking.

The line has been that roads must be different because road users do not pay at the point of travel, so that payments cannot be targeted to specific road improvements. This is despite the possibility of tolled sections (politically impossible, except for estuary crossings) and the fact that many public transport changes are similarly untargeted as far as the fare structure is concerned. Cost-Benefit Analysis has therefore been allowed in in the specific case of highway investment, because there is a need to assess schemes in terms of value for money, given that the market does not operate: but it would be unwise to allow CBA to be applied to overall transport policy. The final argument adduced to quell the debate about comparability is that road users pay fuel tax which is in total greater than the expenditure on roads (this argument persists despite the general principle of non-hypothecation).

The general lines of CBA were set down in the early large-scale urban transportation studies (LTS etc.) where the consumer surplus Rule-of-a-half was naturally applied to all modes. In MAU Note 179 (1970), questions of taxation and the possibility of using DTp-imposed values of time etc. were sorted out. There is nothing in any of this that differentiates between modes. However, when COBA was introduced in the early seventies, while paying lip-service to the general notions of consumer surplus, it used a simplified formula (based on work by RFF Dawson at TRRL 1967) which did not allow for changes in demand (the fixed matrix assumption). A justification for this was, among others, that since it was only being used in inter-urban appraisal, the possibility of modal switching was very small. The fixed matrix assumption is inherently unsuitable for urban transport appraisal.

The position of the last Labour government is set out in the Transport Policy Consultation Document (DTp 1976) prepared under the direction of Anthony Crosland. In Volume 2 there is a discussion of appraisal methods and comparability, discussing CBA, and Financial Appraisal (FA). Page 98 states

"§5.12 Cost benefit appraisals CBA is used to evaluate:

(i) inter-urban road schemes because there is no satisfactory financial way of evaluation;

(ii) urban transport schemes, of all modes, because it is the only common basis on which policies for these different modes can be compared.

This is because:

a) in the urban context, any policy towards one mode inevitably affects the others;

b) there may be positive externalities associated with urban public transport schemes. For instance, local conditions may be such that the scheme relieves some road congestion;

c) PT is inherently less environmentally damaging than private motor transport, though this is also questionable in some circumstances (eg Channel Tunnel rail link, bullet trains in Japan) "

Thus, at that stage it was the position that the only major outsider to CBA was BR inter-urban services, although the DTp did not take much direct interest in urban transport. Arguments about comparability (which were advanced again the following year in the Leitch Report) related largely to BR, for that reason: "Current methods of appraising trunk roads based on cost-benefit analysis do not provide a basis for comparison with the results of appraisals used for alternative modes of transport which are based on financial analysis". The Department was slow to act on the Leitch recommendations for a study on comparability, and this was carried out much later (commissioned from Colin Buchanan & Partners in December 1982 and reported in July 1984: Economic Evaluation Comparability Study). This concluded that "it is possible to adapt and extend the principles of cost-benefit analysis as embodied in the COBA program for roads for application to inter-city rail improvement schemes". No action has been taken on this recommendation, despite the approval of SACTRA.

At the same time, the Government was trying to get local authority spending under control, in particular that of the (erstwhile) Metropolitan Counties. A White Paper ("Public Transport Subsidy in Cities - Cmnd 8735 November 1982") was issued, in the wake of legal uncertainty over the Greater London Council (GLC) Fares Fair experiment. Some crucial quotations:

"§7 Subsidy needs to provide demonstrable benefits in addition to the straight financial gain to the users of public transport...Subsidy should be paid only if its benefits are manifestly greater than the disadvantages of the extra taxes and rates needed to finance it.

§21 ....In assessing value for money, account will be taken of the benefits to users of public transport and to other road users in terms of reduced congestion and accidents....

§31 ...A major consideration is the need to ensure that public transport is given a firm and assured future, and that the institutional arrangements provide for this..."

The initial method devised for the appraisal of subsidy was the Glaister Model, espoused by the DTp and published in two volumes in December 1982 [Urban Public Transport Subsidies - An Economic Assessment of Value for Money]. This firmly stated the principles of CBA and implemented some simple aggregate

demand modelling, with appropriate regard to cross-elasticities etc., for assessing the level of subsidy. This was, to all intents and purposes, a codification of the general principles of comparability, plus a tool for investigating the effects of different levels of fares and services.

This procedure was withdrawn, as soon as it became clear that comparability in urban transport assessment was likely to justify substantial levels of subsidy. At the same time, the abolition of the GLC and the Metropolitan Counties, and the removal of public transport from Transport Supplementary Grant totally changed the situation. There remained nonetheless a need to assist certain kinds of public transport project from time to time. For this purpose, Section 56 of the 1968 Transport Act was reactivated, and the Secretary of State made it known that he was "prepared to give grants [under this Section] for certain large, new public transport infrastructure projects where there are good reasons for using specific grants to spread the costs beyond local users and ratepayers." A warning was issued that funds would be very limited - "only projects of exceptional merit are likely to qualify".

The circular from DTp (2/85 - 23 October) was vague. "..a detailed analysis will need to be provided comparing the quantified benefits of the scheme with its costs at a real discount rate of 7%, together with a broader appraisal of the non-quantifiable considerations. A financial appraisal will also be required setting out estimates of any revenue income associated with the project against its revenue costs, and analysing the effect of the scheme on revenue costs and income of any associated services".

The first signs of clarification appeared during 1988 in the form of a letter written to P Evans of WMPTE. This was the first inkling that a crucial policy statement had been made in a particularly obscure way - the Government's response to the Third Report of the Select Committee on Transport, Session 1986-87 (Financing of Rail Services). Applicants for Section 56 grant were advised that the 1985 Circular should now be read in the light of the Government's response, where the crucial paragraphs were:

"§10 In the Government's view, any subsidy needs to be justified primarily in terms of benefits to non-users, such as relieving road traffic congestion, on the grounds that these benefits cannot be directly met from revenue"

"§12 ...The Government will therefore approve investments of this kind whose cost is justified by the revenues from passengers plus the benefits they will secure for non-users in, for example, reduced road congestion and which are more cost-effective than available alternatives"

Attached to the letter were some supplementary notes prepared by DTp economists which were subsequently substantially modified into the Draft Guidance note dated October 21 1988. This was also circulated on a limited basis, the intention being to receive comments by mid-January and then proceed to a final version early in 1989. However, the final version was not in fact issued until

November 3 1989. Although there were some modifications to the argument, the new distinction between "users" and "non-users" has been adhered to doggedly, presumably because of the clear policy lead given in the "Government's response".

The most obvious way of reacting to these developments was to attempt to convince the DTp of the lack of economic justification for their proposals, and the likely ill-effects. This was the initial reaction of the AMA in conjunction with the PTEG (Passenger Transport Executive Group). At the same time, MVA requested a meeting and put their case along similar lines, and the problems were later analysed in an illustrated example in the paper by Bates & Lowe at PTRC 1989.

Subsequently, taking the view that the DTp were not going to be easily shifted, the PTEG set out to try and develop a methodology which would satisfy the DTp guidelines. This resulted in Halcrow Fox being commissioned to review the appraisal techniques, but this report appeared too late to be incorporated in this study.

2.4 General Criticisms

The key criticism of current urban transport appraisal is its failure to provide a consistent framework in which all possible transport responses to urban policy objectives may be judged. Social CBA is considered to be acceptable as a methodology for this purpose but must be applied to all transport improvements consistently with amendments as suggested by the weaknesses in this chapter. In short the appraisal method should present all the relevant costs and benefits clearly and concisely. It should also enable testing of alternative transport policies involving parking control, public transport subsidy, and company car measures. The end aim is to allow policy makers to take informed decisions and for those affected to see the rationale behind and consequences of these choices. Sections 2.5 and 2.6 detail the shortcomings in highway and public transport appraisal and further demonstrate the inconsistency in appraisal methods.

2.5 Specific Highway Criticisms

2.5.1 Road Funding Distortions

For public funding purposes roads may be divided into three groups: trunk roads which are the responsibility of the DTp and centrally funded, non-trunk roads which are eligible for the centrally funded Transport Supplementary Grant (TSG), and those roads which are wholly financed from local funds. There are identifiable biases in the present system of grant allocation which favour larger scale, capital intensive highway schemes which are eligible for central funds regardless of the benefit to cost ratios. The allocation of the transport supplementary grant for local road building concentrates on projects with a high total Net Present Value rather than those with high benefit/cost ratios. In addition local government might be persuaded to undertake TSG funded road building rather than smaller schemes involving road building or, for example, traffic calming which are funded from local budgets. These observations imply that the present methodology does

not apply a consistent and common appraisal technique to the different highway based measures which may be used to address a transport problem.

A recent development allows for roads to be privately funded, with costs recouped through the imposition of tolls. It is not clear how this will impact upon road building decisions, but it is likely that private money will only be attracted to large scale, free standing schemes with scope for profits.

2.5.2 Treatment of Externalities

The appraisal of trunk highway investment normally has two components: the running of the COBA program and an environmental assessment using the Manual of Environmental Appraisal (MEA). The COBA program estimates the scheme benefits in the form of accident reductions and the time and operating costs savings to all road users. It discounts these benefits and costs to give a measure in current monetary terms of the project's value (NPV). The MEA is a non-monetary assessment of the environmental effects of the highway scheme.

It is often argued that the externalities resulting from highway schemes are either underweighted, as with the environmental effects, or simply not measured, as with the effects on the economic development of an area.

As regards the environmental effects, it appears that these are mainly taken into account at the stage of selecting which option to pursue for a particular scheme. More strategic decisions are based almost entirely on the relative NPV's of different schemes, and these of course take no account of environmental factors (Nash et al, 1991).

The treatment of development effects has been a matter of much controversy. To the extent which they can be predicted, it is correct, of course, to base the traffic forecasts on such predictions, and therefore some attempt needs to be made to consider the impact of new infrastructure on the development of the immediate and wider areas. Annex B submissions for TSG may "if appropriate" include information on "new industrial and commercial development or redevelopments which is associated directly with the scheme" (Dept of Transport 1991a). However, there is no indication of the weight to be placed on such information in the assessments process. Whether there are further development benefits which then accrue is discussed in chapter 4.

2.5.3 Pedestrian and Cyclist Impacts

The effects of highway schemes on the journey times of these groups are not currently estimated. In the urban context the value of these costs and benefits may be significant to the extent of altering the acceptability of a scheme if they were incorporated.

2.5.4 Distribution Effects

These are largely ignored under the present system of appraisal. Cost Benefit Analysis assumes that £1 of cost or benefit is worth the same whoever gains or loses it, just like a commercial appraisal. The marginal utility of money is assumed to be equal and constant between individuals. This introduces a bias in favour of the wealthier members of a society who have a lower marginal utility of money and can afford to pay more for a given level of benefit. A scheme which gave £5 of benefit to a rich man and extracted a cost of £4 from a poor person would yield a positive net benefit under CBA. This is not to say that CBA is an inappropriate appraisal technique, merely, that to be used to best advantage the underlying assumptions must be made clear.

COBA contains a standard value of leisure time, regardless of the incomes of those affected. A value based on willingness to pay would bias investment in favour of wealthier areas. However, there is also a problem with the equity value which gives a greater value to poorer individuals than they actually possess, relative to, say, money savings. The danger is this could result in investments taking place justified on these figures which the true value is negative to those affected by it. Values of time are available disaggregated by income, mode and person type from the MVA\ITS value of time study (1987). These could be incorporated into CBA of it were thought to be appropriate. They are behavioural values of time and it would be necessary to check their validity in a particular application by examining behavioural response.

2.5.5 Scope of the Appraisal

The definition of a study area to capture the full effects of a highway investment is an important step in the appraisal process. The Traffic Appraisal Manual for trunk road assessment section 3.3.1 defines the study area as being the area "within which the construction of the scheme or route improvement would significantly affect the traffic flows" (TAM, 1981). In the appraisal of local highway schemes for TSG grants the criteria for defining the study area are not as apparent. The provision of new highway infrastructure may have consequences for the road network beyond the immediate confines of the planned improvement. To the extent that this happens a scheme cannot be viewed in isolation and the wider impacts of the scheme need to be appraised.

The same argument may be advanced for the environmental and development effects described above. It is likely that the scheme will have impact beyond the immediate area and may indeed have city wide implications.

2.5.6 Fixed Trip Matrix Assumption

The COBA program was originally developed to appraise inter-urban highway investments. It is argued that in this context highway investments do not give rise to changes in trip distribution, modal split, and generation. Therefore the

program operates under the assumption of a fixed trip matrix which simplifies the calculation of benefits. This assumption becomes more questionable when COBA is used in the appraisal of urban highway investments. Consider the situation typical of urban areas where the before investment and after investment highway conditions are congested. Under a fixed matrix assumption the investment secures time savings for present road users and reduced congestion. However when the assumption is relaxed trips will be attracted to highway mode raising congestion levels, link times, and eroding the benefits to existing users calculated using a fixed matrix. Under such circumstances the fixed matrix assumption causes an overestimate of the time savings from the investment.

The previous paragraph covered three facets of the fixed trip matrix assumption - distribution, modal split and the generation of new trips. A fourth facet concerns the effect of a scheme on peak spreading. A change in the cost of highway travel in one time period will cause some movement of trips between time periods. For example the reduction of congestion in the peak will persuade some highway travellers in the off-peak to change their travel time. The fixed matrix assumption in a situation of highway congestion will, as explained above, lead to the over-estimation of benefits.

While there is provision within COBA for departure from the fixed matrix where a scheme impacts on a heavily congested urban area, this provision is rarely used in practice. The vast majority of COBA assessments are run on the fixed matrix assumption.

2.5.7 Monitoring Projected Benefits

The DTp has recently invested resources in comparing the forecast and actual benefits of highway schemes attempting to judge the accuracy of highway appraisals. This is a welcome development because of the existing emphasis placed on the provision of convincing forecasts rather than assessing the achievement of specific results. For most highway schemes there is no systematic monitoring of the project performance and this is seen as a weakness.

2.5.8 The Presentation of Costs and Benefits

Before the final values are presented various adjustments for transfer payments, the effects of taxation, and the use of resource rather than behavioural values are made. At present the changes made are not clearly visible in the method of presentation, so that the breakdown of costs and benefits by incidence group is not readily apparent.

2.5.9 The Treatment of Risk and Uncertainty

Benefits based on forecast traffic volumes, costs and benefits over a 30 year timescale are subject to uncertainty and risk. Current DTp practice is to take high and low growth assumptions and weight the outcomes in order to allow for uncertainty. Doubts were raised as to the adequacy of this procedure.

2.5.10 Further Weaknesses Raised in Stage 3

Highway appraisal does not consider the energy implications of a scheme. Although energy conservation awareness varies with oil prices there is a greater concern over the use of non-renewable resources which has its expression in the desire for more energy efficient transportation. This should be a component of the appraisal.

Concern was also voiced over the current treatment of freight movements, the effects on public transport, and the influence of different pricing and subsidy regimes. Highway appraisal gives insufficient attention to the effects of a scheme on the costs and environmental effects of freight movement. Highway schemes will possibly change public transport trip levels and costs (bus). The existence and magnitude of such consequences needs to be measured. Finally the appraisal does not adequately deal with pricing and subsidy issues such as company car and parking subsidies.

2.5.11 Annex B and Highway Appraisal

In the assesssment of local roads for TSG support under the Annex B guidelines (Dept of Transport 1991a) a COBA assessment of the economic benefits may be supplemented by evidence on road safety, the environment, the local community and local industry and commerce. The latest guidelines have been revised in the light of a report by TPA for the Department of Transport on local scheme appraisal (Transport Planning Associates, 1991). The type of information required in these areas is clarified, for example the Manual of Environmental Appraisal should be used to examine impacts on the environment and on the community, while road safety benefits may be expressed in terms of reduced accident rates and changes in the number of expected personal injury accidents per year. However, coverage of these issues remains largely descriptive with no clear indication of how such impacts should be weighted against those with a monetary value.

2.6 Specific Public Transport Criticisms

2.6.1 Current Public Transport Appraisal Methods

Section 56 grants may be given for certain public transport projects of regional import and of significant cost; generally only projects with a cost in excess of £5 million are considered. Potential benefits come in the form of increased revenue or reduced operating costs. It is easier to justify investment on the basis of the latter because revenue is more difficult to forecast.

Section 56 grants may be given for certain public transport projects of regional significance such as the Manchester LRT system. The history of the criterion for obtaining this grant has been discussed in section 2.3. An authority must conduct a form of CBA and also appraise the environmental effects of a scheme. However section 56 rules prevent the inclusion of benefits accruing to the users (new and existing) of the affected mode when doing the CBA. In effect the application for

grant must be justified on the basis of its external benefits in the form of road de-congestion and development impetus. The DTp assumes that any user benefits will contribute to the cost of the scheme through increased fares. In addition where there is a possibility of gain to commercial organisations - eg developers - they should be made to contribute as far as is practicable. Added complexity is given to the appraisal by the need to study in detail the prospects for private funding.

Investment by bus operators is solely based on commercial criteria with a consequent failure to consider externalities or consumer surplus except where it may be converted into revenue by fares increases. Public funding may be obtained through the tendering process for uncommercial routes. It has been argued that investment in bus services has been depressed by the uncertainties created by this procedure. At the same time, the inability to fund improvements in services or reductions in fares on commercially viable routes is a major constraint on transport policy.

2.6.2 Implications of Public Transport Appraisal Methods

Several of the criticisms detailed under highway appraisal are applicable also to public transport. External effects are not usually considered in BR appraisals at all, although the recent Central London Rail Study (DTp, 1990) includes both benefits to passengers and congestion relief on the roads in the CBA. An environmental impact study was also carried out, and there is some discussion of wider impacts such as regeneration.

Under section 56 external effects are assessed and there is an emphasis on estimating any benefit to developers. However, there is no established procedure for valuing either environmental effects or development benefits in money terms, which makes assessment of value for money from section 56 grants difficult.

Similar criticisms about the scope of the appraisal in assessing all the effects of the scheme, and the effects of rail congestion on peak spreading also apply. These represent minor problems in comparison with the basic methodological inconsistency between appraisal techniques.

In the case of bus companies, it is argued that effects other than any change in the cost of tendered services should be ignored, as these form part of the commercial sector of the industry. However, changes in bus service profitability lead to changes in fares and service levels, with consequent costs or benefits for their users. In a full cost-benefit analysis these user costs or benefits should be assessed together with any second-round effects on third parties such as other road users.

The treatment of accidents under section 56 is very curious and not completely clear, indeed grant applicants are not required to consider accidents at all. If accidents are assessed:-

"Average net output loss plus medical cost should be assumed at 7.5% of the

overall value given there (HEN1) for a fatal accident. The results may then be applied to fatalities avoided by those projected to switch to the new mode" (Department of Transport 1991b)

Accident avoidance by those switching to the new mode is seen predominantly as a user benefit and therefore counted only at a fraction of the normal value. However:

> "The full external benefit attributable to pedestrians and cyclist involvement in accidents avoided by car users projected to switch modes may be scored as an externality" (ibid).

Therefore, if a dual fatality of cyclist and car driver is avoided by the car driver switching to the new mode, the car drivers life is value at 7.5% the valued attributed to the cyclists life. No such distinction is made in highway appraisal.

The section 56 guidelines require that new public transport investments should be funded as far as possible through user contributions, fares. Revenue maximisation will have adverse implications for distribution. No public transport operator can price discriminate perfectly; therefore there will be a loss of scheme benefits as some potential users are priced off. Those priced off will be those who value their trips least in money terms. Low income users are likely to be those most affected as they are least able to pay. These low income users are also unlikely to have access to private transport. Thus, a perverse result emerges whereby an improvement to public transport results in a loss of mobility for low income users.

2.6.3 A Misallocation of Resources in Favour of Highway Solutions

In cases where given objectives may be achieved through alternative combinations of private and public transport this inconsistency in methods of appraisal and funding is likely to lead to a misallocation of resources in favour of highway schemes. For BR the use of financial criteria tends to give a lower benefit to cost ratio than would have resulted using CBA. Benefits resulting from external effects such as road decongestion are omitted and benefits to users are only included to the extent to which they may be reclaimed by fare increases.

For the Section 56 grant the most measurable form of societal gain (user benefit) is disallowed and instead benefits to road users and developers must be estimated. These effects are much more difficult and expensive to measure resulting in very long and expensive applications. Bates and Lowe demonstrate how the different criteria of highway and public transport appraisal undermine the net returns of public transport schemes. In an example they show how the external decongestion benefits of a rail scheme are eroded when fare increases are used to capture all user benefits (Bates and Lowe, 1989). Indeed the ability of most fare systems to do this is questionable given their coarse nature. In short the inconsistencies in evaluation techniques between modes is the major weakness in current appraisal methodology leading as it does to resource misallocation in the light of all the

relevant costs and benefits.

2.7 Summary

This chapter has examined the weaknesses of current appraisal methodology; here we summarise the major points.

2.7.1 Highway Appraisal

(i) Over reliance on NPV as a benefits measure, combined with grant eligibility rules, leads to bias in favour of large scale, capital intensive schemes.

(ii) External impacts such as those on the environment are treated descriptively, if at all, with no clear weight placed on these impacts. There is thus a danger that they will be undervalued relative to those factors included in the NPV.

(iii) Factors excluded from appraisal include impacts of energy consumption, public transport trip levels and costs (bus).

(iv) Factors inadequately treated in appraisal include pricing and subsidy issues relating to public transport, company cars and parking.

(v) Reliance on a fixed matrix for traffic forecasts may lead to distortions particularly in congested networks.

(vi) Results are presented in aggregate form, making distributional impacts difficult to assess.

2.7.2 British Rail

(i) The emphasis is on financial rate of return, with no attempt to assess social costs and benefits.

2.7.3 Bus services

(i) Bus operators assess services on commercial criteria, omiting to any consideration of consumer surplus or externalities except where they may be converted to revenue

(ii) The evaluation of tendered services varies from authority to authority.

2.7.4 Section 56

(i) Revenue extraction of user benefits will reduce total benefits by limiting patronage. Also those priced off are likely to be low income users, who are least likely to have access to private transport. There may be a loss of mobility for low income users.

(ii) Accidents avoided by users are valued at a fraction of the normal values applied in COBA.

(iii) The appraisal omits any valuation of benefits to users aside from that extracted in fares revenue.

2.7.5 Overall

The lack of a consistent appraisal and funding method across all modes was seen as the major weakness of the current appraisal approach in evaluating transport schemes in urban areas. As a result, a systematic bias towards highways investment is likely.

3 COST BENEFIT ANALYSIS AND FINANCIAL APPRAISAL

3.1 Introduction

The aim of this chapter is to define forms of financial and economic evaluation which address the weaknesses discussed in chapter 2. There are several preliminary points on the scope of this chapter which need to be stated.

The study focus is on the development of an appraisal framework rather than the modelling methods required to obtain the necessary input data. However the modelling issues are of great importance in coming to a viable and practical appraisal methodology and as such are highlighted here with a view to being addressed in a subsequent phase of the study.

It is useful to define the areas of cost and benefit which are not the subject of the current chapter. These may be defined as the external effects of the scheme and include environmental, development, land use, and general accessibility effects to which it is currently difficult to attach monetary valuations.

In terms of structure, section 3.2 defines the requirements of an economic appraisal based on CBA, and section 3.3 outlines the CBA methodology. The next two sections parallel the previous two defining firstly, in section 3.4, what questions a financial appraisal should be addressing, and secondly in section 3.5, what shape the financial appraisal should take. Finally section 3.6 summarises the findings of the chapter.

3.2 Economic Appraisal Requirements

Ideally, any comprehensive technique should be capable of assessing strategic options involving a variety of modes and policies, while also being able to compare the merits of small scale schemes. In the development of an appropriate appraisal technique the emphasis is on the evaluation of strategies involving a range of projects or major individual projects. Once a technique is available for consideration of large scale schemes, consideration can be given to its suitability in investigating smaller projects.

The same set of questions should be asked of any scheme. The detail with which they are answered will depend on the anticipated level of impact. The range would include:

Infrastructure	-	Road
		Bus
		Rail
Management	-	Traffic
		Environment
		Rolling stock
		Public transport
		Parking
Pricing	-	Road
		Parking
		Fares

This range of classifications introduces variation in scheme size and the nature of the funding. One approach to dealing with schemes of differing import is that developed by Mackie et al (1988) to assess priorities for local authority highway schemes. The priority assessment technique used is hierarchical; thus minor schemes are assessed on 4 variables, intermediate schemes on 11 and major schemes on 32. The suggested criterion for the initial classification of schemes into one of these categories is capital cost. When concentrating on highway schemes, cost is indeed a good indicator of the scale and range of impacts. However, when looking at the wide range of scheme types to be appraised here, cost alone is an insufficient indicator.

A comprehensive framework approach will be suited to projects with wide ranging impacts. A sifting process to decide which projects are to be fully appraised should be based on the range and extent of anticipated impacts rather than solely on the cost of the project. The implementation of a widespread network of bus lanes, traffic calming and parking restraint may be relatively cheap in financial terms, however, the impacts are likely to be wide ranging and significant. The appraiser should be able to adapt the technique to suit schemes with a small range of impacts, through the reasoned exclusion of irrelevant impacts. For example, when considering subsidies to bus or rail operations many of the financial cost categories are subsumed into an annual subsidy figure. Public transport subsidy needs to be considered in the same way as other schemes particularly at the strategic level.

Clarity and detail in presentation are essential if the distributional issues in particular are to be made clear. The definition of impact groups by which and within which effects can be disaggregated in a realistic and helpful manner is the first step.

The following sections identify requirements which may be used in section 3.3 to measure the potential of the framework.

3.2.1 A Consistent and Comprehensive Multi-modal Framework

The first requirement of the appraisal is the facility to compare transport schemes involving various measures across all modelled transport modes. Inconsistency in the methods used to appraise public transport and highway schemes was seen as the single most important deficiency of the current approach. Furthermore the method should deal with different types of highway solution in the same way. Therefore it should be possible to compare the relative merits of a road building solution with one involving other highway measures such as traffic calming and road pricing.

In terms of comprehensiveness, firstly the effects of a scheme on all modelled modes should be apparent. A weakness of highway appraisal in not estimating the effects on public transport was identified. Where there are commercial operators their reactions to publicly financed investment needs to be estimated and appraised. It should be noted however that the modelling of operators' reactions poses considerable difficulty. Secondly, the appraisal needs to present the wider area effects of a scheme in a geographic sense. This is a modelling issue in that the model should encompass that area which is significantly affected by a scheme or package.

In the context of urban transportation the effects of changed trip generation, redistribution, modal split, and time of travel should be incorporated in the appraisal. Clearly the use of a fixed trip matrix precludes this and techniques are available to incorporate a variable trip matrix (for example the recent integrated transport studies).

3.2.2 A Clear Relationship to Strategic Objectives

In the Birmingham Integrated Transport Study (BITS) transport strategies were constructed and evaluated on the basis of a number of strategic objectives. These concerned economic efficiency, the environment, practicability, and accessibility. (Jones et al, 1990). The appraisal method and its presentation must effectively contribute to an understanding of the attainment of these objectives. Clearly the economic appraisal should shed light on the attainment of the efficiency objective. A definite objective of the appraisal is the clear presentation of data to those either making a decision or offering counsel to those who do. The objectives may vary in importance; this will depend on the priorities of the decision makers and the nature of the scheme under review.

3.2.3 The Ability to Evaluate Relevant Policy Issues

The facility to evaluate policy issues is an important requirement. Once a consistent multi-modal appraisal framework has been adopted then the evaluation of policy issues such as parking restrictions and subsidies, and public transport and company car subsidies is possible. In this context the real problems concern the significant modelling difficulties that exist in several of these areas.

3.2.4 The Incorporation of Pedestrian and Cyclist Effects

The failure to take account of the consequences of a scheme for pedestrian and cyclist journey times was seen as a major weakness. In the appraisal these should be presented by impact group, although again there may be modelling problems.

3.2.5 The Incorporation of Freight Effects

The impacts of a scheme on freight have great importance for commercial operators, and are relevant to local industry. There are of course important environmental effects of goods vehicle traffic which are more properly dealt with in the externality chapter. The effects on freight traffic should be fully incorporated in the appraisal, including any indirect effects on distribution systems.

3.2.6 Other Non-monetary Effects

For both public transport and highway users reliability is an important issue. This concerns the predictability of journey times which for highway travel depend on congestion and for public transport on waiting and in-vehicle times. An appraisal framework should be able to accomodate this source of costs and benefits.

It is usual to divide the effects of a scheme on highway travellers between monetary (operating cost) and time sources. On public transport the range and variety of non-monetary costs and benefits is much wider. For example rail passengers may benefit from changed aspects of the mode's quality such as increased comfort and cleanliness. The appraisal should allow the incorporation of these cost/benefit sources as they are modelled.

3.2.7 Appraisal Requirements Summary

This paragraph contains a summary of the criteria the suggested form of economic appraisal should fulfil.

* A consistent and comprehensive multi-modal framework
* Common appraisal across all modes
* Common appraisal of all types of highway solution
* Presentation of inter-modal effects
* Presentation of wider area effects
* Clear relationship to strategic objectives
* The facility to evaluate policies and more major schemes

3.3 Economic Appraisal Method

3.3.1 Introduction

The CBA methodology proposed is based on the approach used for the MVA work for Lothian Regional Council (May et al, 1991 and Bates et al, 1991) The aims of this section are firstly to describe the approach and then assess its performance against the requirements of section 3.2.

The aim of the Economic Evaluation is to provide a succinct summary of the costs and benefits of each Strategy with respect to the base (Do-Minimum) in a framework consistent with the Department of Transport's cost-benefit analysis for highways but with sufficient detail to allow a number of other items to be recovered: specifically, the information required for a financial appraisal is included. For this purpose, a standard table has been designed, as illustrated in Table 3.1. In the next section we discuss the theoretical basis of this Table; a more detailed discussion of the example to which it relates is postponed until 3.3.6.

3.3.2 The Economic Evaluation

It should be said at the outset that, given the complexity of the information presented, it is not feasible to provide it in such a form that its interpretation is immediately clear. The form proposed is a compromise between a useful level of detail, and succinctness of presentation - specifically, the advantage of having the material on a single page. It thus requires a certain amount of experience in reading it: this should not take long to acquire, and once acquired the form of the output allows alternative strategies to be readily assessed and compared.

The overall output provides the standard evaluation of the change in consumer surplus minus the change in costs as a measure of benefit: the treatment of fuel costs and taxation is generally in line with standard DTp practice for highway assessment. The table contains spaces for those items (such as changes in public transport operating costs, accident savings, or capital costs) which are not available from the model output, but which need to be incorporated in the overall calculus.

The novel nature of the Table consists in the disaggregations made, which are done with a number of purposes in mind. The first distinction, which is more or less conventional, divides the Table vertically, and is that between "users" and "non-users" of the transport system (or rather, given the unfortunate interpretation given to these terms in the recent Section 56 rules, "travellers" and "non-travellers") corresponding to the movement of people and goods, on the one hand, and those parties who are involved in the supply, regulation and financing of the system on the other. According to the principles of CBA, only those parties that are not considered to be operating on a competitive market basis need be included among the "non-travellers": there is thus scope for changes in definition here, but we have assumed that it is necessary to recognize the transport operators, the parking (and possibly a toll) authority, and Government (in the widest sense) in its potential role as provider of highways, health services, and

Table 3.1	Trend Do Minimum V's Trend LRT Test Economic Evaluation								
	travellers				non travellers				Total
source of benefit	non working	working	freight	all	PT operator	Misc. Auth.	Government	all	
time savings (not LRT)	9.550	19.452	0.139	29.141					29.141
highways	4.296	18.535	0.139	22.970					22.970
resources	21.222	20.498	0.139	41.858					41.858
worth	-16.926	-1.963		-18.889					-18.889
bus	3.252	0.600		3.852					3.852
resources	40.120	10.129		50.249					50.249
worth	-36.867	-9.530		-46.397					-46.397
train	2.001	0.318		2.319					2.319
resources	1.056	1.773		2.829					2.829
worth	0.945	-1.455		-0.510					-0.510
money savings (not LRT)	-12.015	-12.424	0.034	-24.405	-10.703	33.056	-8.628	13.725	-10.680
highways	-12.015	-12.424	0.034	-24.405		33.056	-9.933	23.124	-1.281
tolls/parking	-18.503	-11.778		-30.281		33.056	-2.775	30.281	0.000
fuel	7.761	0.387	0.019	8.187			-4.841	-4.841	3.346
operating cost	13.787	0.610	0.014	14.412			-2.316	-2.316	12.096
worth	-15.060	-1.843		-16.704					-16.704
bus	0.000	0.000		0.000	-11.308		1.397	-9.911	-9.911
fares	9.315	0.596		9.911	-11.308		1.397	-9.911	0.000
worth	-9.315	-0.596		-9.911					-9.991
train	0.000	0.000		0.000	0.605		-0.092	0.512	0.512
fares	-0.616	0.103		-0.512	0.605		-0.092	0.512	0.000
worth	0.616	-0.103		0.512					0.512
LRT	26.952	3.941		30.893	16.931		-2.462	14.469	45.362
Total of time and money	24.488	10.969	0.172	35.628	6.228	33.056	-11.090	28.194	63.822
PT operating costs					-p			-p	-p
turnpike costs						-t		-t	-t
accidents	+a	+a	+a	+a			+a	+a	+a
capital costs					-c	-c		-c	-c

(units: £m per annum, 1991 prices)

subsidy. In many contexts it may be desirable to identify central and local government separately.

The general convention is adopted whereby positive benefits and negative costs are given positive signs, whether they accrue to travellers or other interested parties, and negative benefits and positive costs are given negative signs. Thus, to take the example of a fares reduction, this would result in a benefit to travellers (lower fares) - positive, and a cost to transport operators (reduced revenue) - negative.

Among the travellers, we distinguish between freight and passenger transport, and within passenger transport, between journeys carried out in the course of work, and for all other purposes. This again is more or less standard practice, and relates principally to the different assumptions about vehicle operating costs and values of time applicable to these three categories. We will discuss possible further disaggregations below.

The next disaggregation, which divides the Table horizontally, is that between benefits due to savings in money, and those due to savings in time (inasfar as these can be estimated within the model: other elements not available from the model are treated at the bottom of the Table). Note that standard weights for walking and waiting times are applied within the model and are not explicitly distinguished within the evaluation output. Although all benefits are estimated in money terms, the point of making this distinction is to allow a direct evaluation of the flow of money, between travellers and non-travellers. In particular, so-called transfer payments are recognised explicitly: thus a reduction in fares is shown simultaneously as a benefit to travellers and a disbenefit to non-travellers.

Perhaps the most novel element in the Table is the disaggregation of the consumer surplus term into a component related to the change in consumption, and a component related to worth. This is discussed further in Appendix B. Here we merely note a small number of interpretational points.

The standard single mode analysis of transport benefits implies that any benefits arising from an improvement accrue either to existing travellers or to new ("generated") travellers. Unfortunately, once we are dealing with a multi-mode analysis, the situation becomes much more complicated, and it becomes possible for benefits to accrue on parts of the network even when demand falls. In other words, the presence of positive benefits no longer implies increasing (or even constant) demand. For interpretation purposes, it becomes useful to know whether demand has in fact increased or decreased. This is indicated by the sign of the "worth" component: a positive sign means that demand has increased, and conversely for a negative sign. (Although this is not an absolute rule, and it is possible to invent circumstances where the sign gives the wrong indication, in the vast majority of cases it is an acceptable and useful guide).

The other component of overall benefit is the change in consumption: a fall in total consumption is represented as a positive benefit, and conversely. For a change in consumer surplus to occur, there must be a change in generalised cost (or rather, given the proposed disaggregation between time benefits and money benefits, a change in the money or time components of generalised cost). However,

even if there is no such change, there may be a change in demand as a result of changes elsewhere in the system: in such a case, the change in consumption will be exactly cancelled out by the change in worth. In other words the change in resources consumed is exactly equal to the value which travellers place upon it.

The calculation of worth applies only to "travellers": non-travellers are only interested in the change in consumption, and, moreover, this is confined to money items. The entries for non-travellers under the consumption items are a direct indicator of the financial implications: this enables, for example, the change in public transport operators' revenue to be identified from the Table.

The final disaggregation in the Table is by the source of benefits: this is <u>not</u> to be taken as a measure of final incidence. For reasons described in Appendix B, it is dangerous to attempt to attribute benefits to travellers of different modes etc. However, without attribution of such benefits, it <u>is</u> possible to identify what benefits have arisen as a result of, say, an increase in highway speeds, or a reduction in public transport fares. Both components of surplus (worth and consumption) are disaggregated according to the mode on which the change in generalised cost arises - this is done for the three modes car, bus and rail. (See section 3.3.5 for an explanation of the LRT "new mode" presentation).

3.3.3 Forecasting Benefits Over the Scheme's Life

In order to derive the Present Values (PV) of relevant items using Discounted Cash Flow (DCF) techniques several issues must be addressed. Firstly values need to be specified for the discount rate and the time horizon over which the projects effects will be measured. The second issue occurs because project benefits and costs may continue beyond the assumed project lifetime. A method is required to incorporate these residual values into the PV estimates. Finally the project's net benefits must be estimated annually so that DCF techniques may be used and a methodology is required which will allow this. Tentative recommendations regarding these issues are outlined in the following paragraphs in the light of a multi-modal appraisal methodology.

The discount rate represents the relative valuation of benefits and costs in different time periods from the viewpoint of society. It is proposed that the treasury recommended discount rate of 8% be used for the estimation of the net PV. Currently a project life of 30 years is used for highway appraisal whereas for public transport projects 25 years is more common. A standard time period for all investments is needed which most nearly follows the useful life of transport capital assets. It is recommended that a common 30 year period be adopted for the appraisal.

The time period chosen may not capture all the costs and benefits from a transport investment. For example new roads and railways may have a useful life for many years beyond the appraisal period. Where assets have a resale value, it is recommended that they be valued at their market rate at the end of the 30 years. Otherwise, a residual value would need to be estimated based on the remaining net benefits of the asset. The use of a discount rate over a time period in excess of 30 years would, in most cases, make the influence of residual values very small.

We therefore recommend that residual values be ignored unless there are special reasons for believing them to be significant.

A transport model will normally provide estimates of the net benefits for a single forecast year (say in 30 years time). Traffic flows and costs will be estimated for the morning peak and possibly the evening peak and daytime off-peak periods. These results may be raised to an annual level using conversion factors. There are several changes over the project's lifetime which influence the time profile of benefits from the project which are input to the PV calculations. Factors influencing the profile are the change in total levels of traffic (due to demographic factors), changes in the value of time and operating costs, and changes in car ownership which affects the modal split. For more complex schemes, predictions may be made for intermediate years to increase the accuracy of traffic flow and modal split forecasts.

When evaluating highway investment using COBA sets of standard growth factors are provided to enable the annual estimation of benefits. The value of time is assumed to grow with income whilst estimated growth rates for fuel and other operating costs are given. Estimates of future traffic levels are taken from the National Road Traffic Forecasts (NRTF) and embody general traffic growth and changed car ownership. The actual process of estimation is then straightforward relying on the model outputs for a single forecast year and sets of nationally derived growth factors.

In considering public transport appraisal the time and operating cost elements of benefit may be dealt with in a similar way to the highway estimates. However estimation of changed traffic levels and car ownership effects are more difficult. The provision of new public transport investment will, with all other things remaining constant, increase ridership. However there is an identifiable trend towards increased car ownership over time independent of any transport investment. This will shift the modal split towards highway travel and detract from the ridership increase resulting from public transport investment. Thus two conflicting factors have influence over the time profile of public transport benefits which renders the use of a simple growth factor inappropriate.

A possible method of treating public transport relies on at least one additional "model derived" annual estimate of the project benefits. Using this (these) additional point(s) annual benefits for other years may be estimated by interpolating or extrapolating. For these additional forecasts benefits are estimated assuming that all the elements of the project are operational. The limit on the number of additional forecasts is the availability of estimated planning data and model parameters for that year and the amount of computer resources available to do more model runs. The method can operate on one added forecast but estimates will be improved with further forecast runs for intervening years. Before applying the discount rate the stream of benefits would be altered to ensure that benefits were only realised after a certain strategy element came on line. This would be a complex procedure and there could be difficulties forecasting for public transport.

This approach would, however, ignore the disbenefits of doing nothing before a strategy element came on line. For example if the provision of a highway improvement was delayed prevailing traffic growth would increase congestion and lead to negative benefits as a result of the delay. This effect might be crudely modelled by comparing the do minimum and the future base for the final project year and interpolating between this and the net benefit of doing nothing in the current year (which will be zero).

3.3.4 Further Disaggregation

There is scope for further disaggregating the results table to display more detailed information on specific impact groups. In fact this is crucial in meeting some of the requirements stated in section 3.2. For example the table may be disaggregated by time period, the car availability characteristics of households, or by pedestrians as an impact group. In the last case a further vertical disaggregation would add pedestrians as an affected group to the highway and public transport modes. This presumes of course that these effects can be modelled. Table 3.1 shows the source (mode) of costs and benefits allowing no distinction between "new" and "existing" users. There are problems in attributing benefits unambiguously to users of specific modes except in very simple examples (Bates and Lowe, 1989). Gains from further disaggregation should be balanced against the ability to forecast at this level.

3.3.5 New Modes

The rule of a half provides a useful and reliable approximation of benefits when the changes in cost are marginal. When this assumption does not hold the rule breaks down and an alternative estimation method must be used. Examples which illustrate a non-marginal cost change might be the use of a traffic ban in the central area of a city or the introduction of a new mode such as LRT. In the former example travellers are faced with infinitely high costs along sections of some established highway routes whilst the introduction of a new mode gives rise to non-marginal cost changes between some origins and destinations.

The true integral formula for total benefit may be employed if the demand function can be specified and this is true of the hierarchical model often used in integrated transport studies. Thus the net benefit accruing, for example, to a new mode is this total change in benefit minus the net benefits of existing modes estimated by the rule of a half. Unfortunately when the integral formula is used no further disaggregation between time and money or worth and consumption is possible. Hence in Table 3.1 "LRT", the new mode, only has a single entry giving figures for total benefit and total revenues by affected group.

3.3.6 Performance in Relation to Section 3.2 Requirements

In this section the approach outlined is related to the requirements set above. In addition some comment is made about the modelling issues which need consideration.

(a) **A Consistent and Comprehensive Multi-modal Framework**
In essence this approach takes the methodology used for road appraisal and applies it consistently across all modes of transport. Thus the changes in consumer surplus of all modes are calculated in a consistent way.

A further point of relevance concerns the common appraisal of different highway measures. Thus the Table can be produced to show the economic effects of capital intensive road building as well as non capital intensive traffic calming.

Table 3.1 illustrates the value of the approach in highlighting inter-modal effects. The strategy which is being evaluated against the base in this example involves two major components - the introduction of a new LRT system, and a road pricing system. Inspecting the signs and magnitudes of the changes in worth, resources, and fares gives insight into the modal results (from the discussion in 3.3.5 it is not possible to further disaggreagte the new mode results). Clearly substantial benefits to users are generated by LRT (£30.893 million). The negative signs on the worth elements of bus and highway (for both time and money) indicate that demand for these modes has fallen as LRT has attracted patronage and road pricing has taken effect. Reduced bus patronage lowers total fare and time expenditure on that mode. Similarly the time resources used on the highway also fall with decreased demand. However not all highway money costs fall (+ve sign). Indeed an extra £30.281 million is spent on tolls/parking as a result of road pricing. Train patronage has risen as a response to road pricing. Although instruction and practice are needed interpreting the table a great amount of information on inter-modal effects is succinctly displayed.

Finally, incorporating the wider area consequences of a scheme is dependent on the modelling. If scheme costs and benefits were limited in their geographical incidence then only zones in the affected area should be included. Indeed it is possible to use identifiable sub-areas as sources of benefit in the evaluation table.

(b) **A Clear Relationship to Strategic Objectives**
The CBA represents one facet of the overall evaluation. The clear and powerful presentation helps in judging the attainment of certain strategic objectives. Specifically, it contributes in this way to efficiency and practicability objectives. It provides scant information on accessibility and none directly on the environment. Other modelled outputs are likely to provide data on these objectives. Transport models may be used to estimate impacts on accessibility and the environment, but it is necessary to know whether local or wider indicators are needed.

(c) **The Ability to Evaluate Relevant Policy Issues**
In principle the evaluation framework can accommodate the policy issues stated. The constraint is on the model's ability to incorporate such policy magnitudes. For example to test the effects of increased parking charges the do-minimum and do-something situations correspond to two model runs with and without the policy. The resultant evaluation table would show the change in consumer surplus that results whilst displaying the disaggregated effects on highway and public transport benefits, and the financial effects on the parking authority. The framework may be applied similarly for other modelled policy variables.

(d) **The Incorporation of Pedestrian and Cyclist Effects**
Pedestrian and cyclist benefit may be included through the introduction of new "sources of benefit". They would be considered as separate modes on the vertical axis of the table. Whilst there is no theoretical evaluation problem in doing this the modelling practicalities must be mentioned. It is unlikely that a large model would include these as "modes" in a way which allowed changes in pedestrian delay resulting from a scheme to be deduced. Therefore the consequences for these groups will probably be deduced using other model outputs and localised studies. It would still be possible to include the net time saving benefits as a line appended to the current table.

(e) **The Incorporation of Freight Effects**
The net monetary and time benefits to freight are incorporated in Table 3.1. In this example there are time and money savings due to lower highway use and less congestion.

(f) **The Incorporation of Other Non-monetary Effects**
A number of studies have been done on behalf of BR to place money values on changes in reliability, comfort and crowding (Fowkes and Wardman, 1987). If such attributes as the change in reliability resulting from a strategy were measured and valued financially they could readily be included in the evaluation table. In the case of reliability a further horizontal disaggregation would be introduced to parallel those of time and money.

3.3.7 Summary - Attainment of Requirements

The above narrative has demonstrated the potential of this appraisal methodology to incorporate the requirements listed. However there is a need for training in its interpretation and use. There are a number of pertinent questions which have arisen regarding modelling issues: firstly, how feasible is the incorporation of relevant policy issues such as parking policy, bus subsidy, and company car subsidies? Secondly, given the potential importance of cyclists and pedestrians for urban schemes how will their net benefits be measured? Thirdly, how possible is it to measure the reliability changes associated with a given package? Finally, how might changes in public transport non-monetary benefits like comfort and cleanliness be measured?

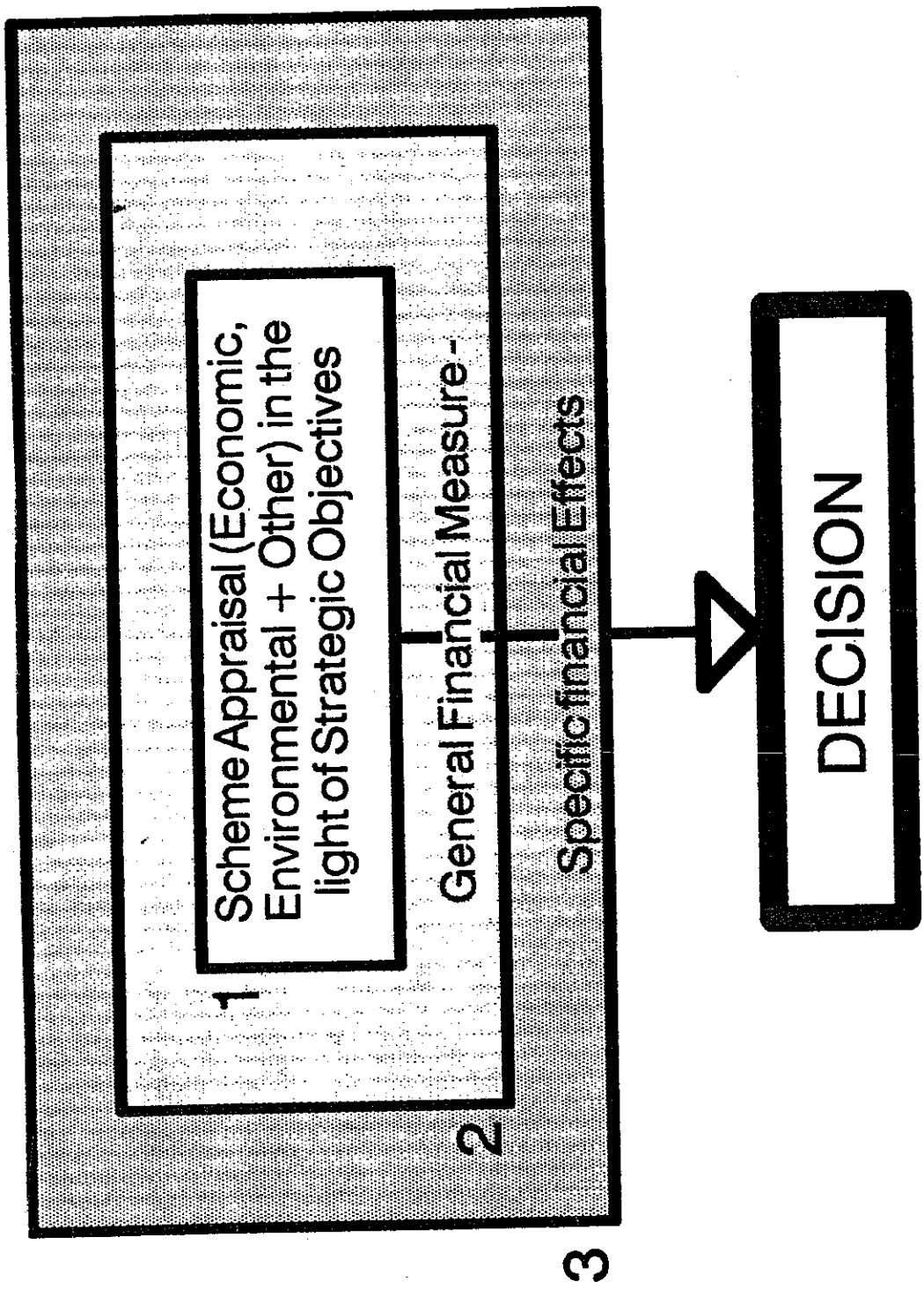
This section has suggested the possibility of several more disaggregations within the suggested presentational format. A perceived strength of the presentation is the summary one page format and it is thought that this is worth retaining. Further disaggregation might more effectively take place in subsidiary tables.

3.4 Financial Appraisal Requirements

3.4.1 The Purpose of Financial Appraisal

In order to specify what is required from a financial appraisal its place in the whole evaluation process needs consideration. In particular how does the financial appraisal relate to the other forms of appraisal? Figure 3.1 presents a simple view of the relations. The figure does not present a full picture of the whole decision

FIGURE 3.1 THE DECISION PROCESS AND FINANCIAL APPRAISAL



process but rather gives a simplistic view to illustrate the role of financial appraisal.

The central and prime consideration behind a decision is the economic, environmental, and accessibility appraisal which gives the societal valuation of a scheme or strategy. Our proposal is that the overall judgement about the value of the strategy/scheme to society will be made on this basis. However, a final decision between alternatives will be constrained by the availability of finance both in terms of the absolute amount needed to fund a project and the flow of funds required in different time periods. Therefore analyses of general financial measures and the specific financial effects are required.

3.4.2 General Financial Measures

At this stage an authority might use the analysis to determine the scheme which performs best in terms of social benefit within a given financial constraint. The aim of the analysis is the provision of financial information to assess a strategy with respect to the institutional constraints of the organisation concerned. These institutional constraints will vary between organisations and in the first instance the present value of the combined financial revenues and costs over the life of the scheme would be a useful indicator. Important factors in the calculation of this present value are the choice of a discount rate, the project lifetime, and the method of dealing with financial returns and costs occurring beyond the chosen appraisal time period (residual values).

3.4.3 Specific Financial Effects

This stage of the financial appraisal has a key objective. It gives information on the predicted implications of the scheme to all those groups affected over the lifetime of the project. The groups which figure in this analysis will be central government, the relevant local authorities, and those other bodies responsible for operating parts of the transport system. Each group has valuable information to gain from this analysis.

The local authority will seek answers to a number of questions. For example what will the financial liabilities of the project be in each year of the project's life? How will this pattern affect local authority capital and current spending budgets? More generally what are the demands on various sources of funds at each stage of the project?

The central government will be concerned with the timing of grant payments so these can be scheduled in the light of other demands on the grant funds. Questions on the financial effects on transport operators would also constitute relevant information.

Finally bus and LRT operators, British Rail, parking and toll authorities, and any sources of private sector investment would have a keen interest in the scheme's effects on their costs and revenues over time.

In summary the basis for judging the merit of a scheme is a full CBA. The financial appraisal identifies constraints on this choice due to limited finance. It should also highlight the future financial implications of the scheme for those groups directly affected.

3.5 Financial Appraisal Methodology

The recommendations in this section are again based on the Edinburgh approach devised by MVA. Under the broad headings defined above this work is applied in the present context. The sign convention used is consistent with the economic evaluation (see Table 3.1) where financial costs have a negative sign and gains a positive sign.

3.5.1 General Financial Measures

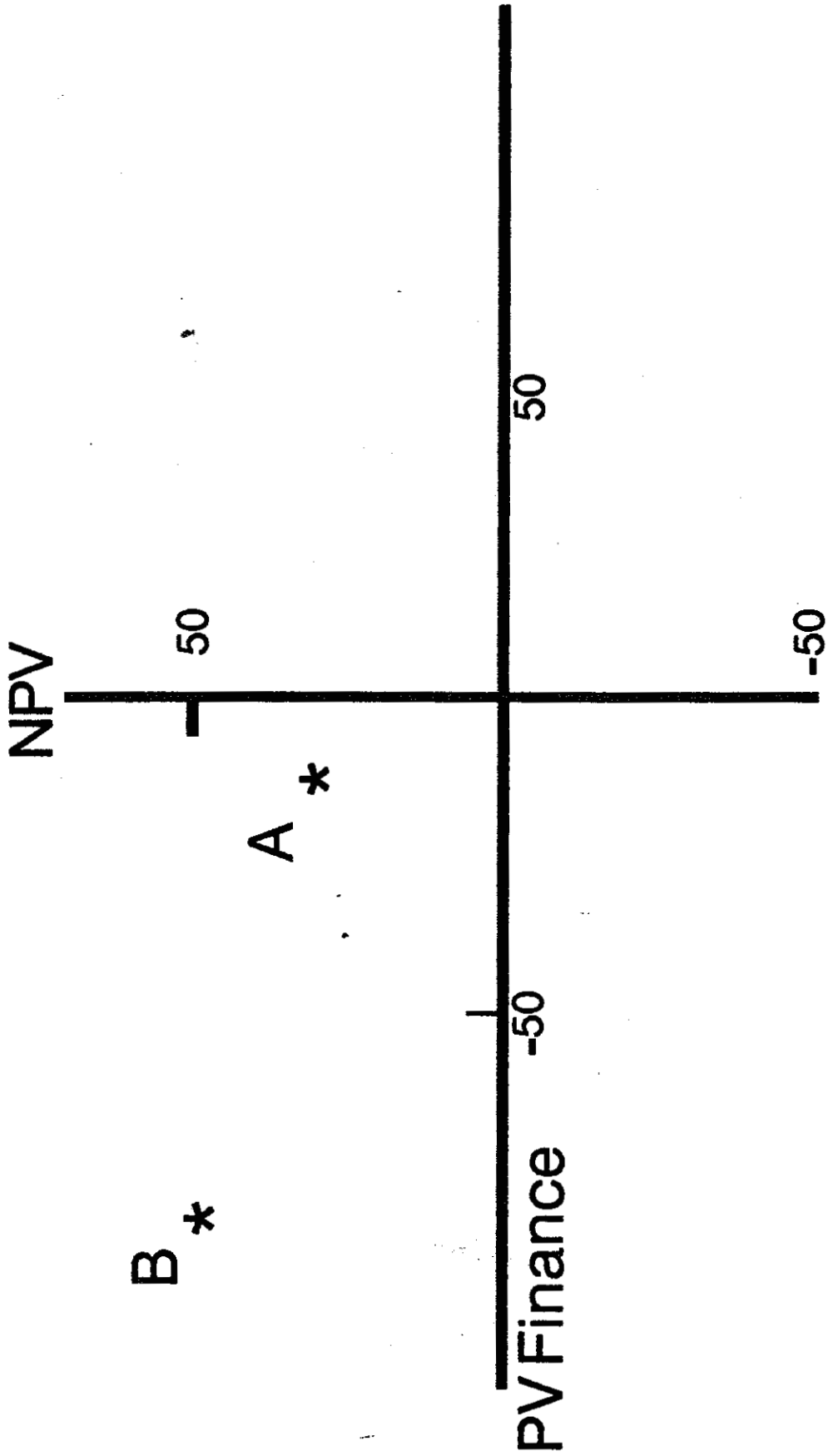
Two general measures are described which may be used to choose between alternative schemes according to overall financial constraints. These are the Present Value of Finance (PVF) and the ratio of NPV to PVF which indicates the return per unit of finance.

The PVF may be defined as the net discounted value of all the financial costs and revenues incurred by the funding agency whose funds are rationed over the life of the project. It is a present value measure of the financial outlay required in attaining the project benefits. Thus if a sponsoring authority could only commit £100 million to an overall transport strategy this stage would be used to identify projects coming within that constraint. In calculating this present value the choice of a discount rate, the choice of the appraisal timescale, and the treatment of residual values need some consideration.

As mentioned earlier the NPV evaluates the project from the societal viewpoint whereas the PVF is a financial indicator for the benefit of the sponsoring authority. It should be remembered that the NPV only reflects some of the benefits of a project; there will always be some impacts, mainly externalities that are not given a financial value. For the NPV the discount rate should be used as an expression of the relative valuation, by society, of net benefits in different time periods. If the sponsoring authority borrows capital for a project then financial cost of the project becomes the stream of interest payments and repayment of capital implied rather than the actual capital outlay, (although where borrowing powers are restricted, the total cost is of relevance) the latter needs consideration as well. Borrowing terms might well go beyond the timescale set for the NPV valuation. It is recommended that the same 30 year timescale be retained for the financial appraisal with residual values being discounted to the base year.

In the Edinburgh study a graphical representation of the NPV and PVF comparison was devised. This is illustrated in a simplified form by Figure 3.2 Here two projects are shown. Project A has a positive NPV (approximately 30) and a PVF of -10 whilst project B has a higher NPV of 50 and a substantially higher PVF of -80. Note that a project returning a zero NPV would be positioned on the x axis and one with no net discounted financial outlay would lie on the y axis. In CBA terms project B should be chosen. However, were funds to be constrained to

FIGURE 3.2 BENEFITS AND FINANCIAL ANALYSIS METHODOLOGY



a discounted value of 50 units then project A would be preferred. It should be remembered that the NPV only reflects some of the benefits of a project; there will always be some impacts, mainly externalities that are not given a financial value.

The ratios of NPV to PVF indicate the return, in terms of economic benefit, per unit of finance. Project A has a ratio of 3 (30/10) and the B ratio equals 0.625 (50/80). A situation may occur where this measure might help to judge between one very large scheme and an alternative of several smaller schemes. The aim would be to maximise the benefits attained from a given financial outlay. This measure could also be used to assess incremental changes resulting from the adding or subtracting an element to or from a strategy, for example to examine whether the increase in NPV resulting from an additional element justified the extra finance required. The authority might set required rates of benefit increase per unit of finance spent. Additional strategy elements would be assessed in relation to their marginal return on finance.

Table 3.2 shows a summary financial analysis from the Edinburgh project. It gives summary totals, discounted and undiscounted, for the components of the PVF measure. Notice that Government tax revenues were not included in this calculation as requested by the department concerned. In addition the table contains limited information to enable the NPV to PVF ratio to be calculated.

These analyses have not incorporated other mostly non-monetary aspects of the evaluation such as environmental effects.

In principle, environmental impacts that can be given a money value and predicted with some accuracy through the scheme life, should be included in the NPV calculations. Where such impacts cannot be valued in monetary terms their presence might lead to a project being preferred even if its NPV per pound of finance were lower that that of an alternative.

TABLE 3.2

SUMMARY OF FINANCIAL ANALYSIS

	£ millions at 1990 prices	
	DISCOUNTED	**UNDISCOUNTED**
CAPITAL COSTS		
metro	-163.467	-280.000
highway	-32.113	- 49.000
rail	0.000	0.000
total	-195.580	-329.000
OPERATING COSTS		
metro	- 25.788	-117.855
highway	0.000	0.000
rail	0.000	0.000
bus	7.899	38.396
total	- 17.889	- 79.459
FARES REVENUES		
metro	99.774	499.580
rail	3.565	17.852
bus	- 66.637	-333.663
total	36.701	183.769
parking	- 11.454	- 54.014
road pricing	210.723	993.752
total	199.270	939.737
GRAND TOTAL	22.502	715.047
Government revenue	- 66.853	-315.274
FINANCIAL INDICATORS		
traveller + non-traveller benefits in 2010 (excluding accidents)		63.8
Net Present Value		176.8
Present Value Finance		22.5
NPV/PVF		7.9

3.5.2 Specific Financial Effects

The aim of this section in analysing specific financial effects across time involves considerable detail. For example each operator of transport services and infrastructure will require information on capital and operating costs across the (30 year?) life of the project. In this part an example of the detailed tabulation used in the Edinburgh work is presented and further analyses suggested.

Table 3.3 gives the undiscounted capital costs for an Edinburgh strategy. Notice the annual information disaggregated by each of the component parts of the strategy. the table shows the capital costs of a metro scheme with some highway infrastructure work. The list of similar tables produced for this analysis are given below.

* Undiscounted and discounted capital costs (two tables)

* Undiscounted and discounted operating costs (two tables)

* Undiscounted and discounted benefits to non-travellers (two tables) (the sum of net capital and operating costs, but also including the effects on central government).

These tabulations give important information to transport operators about the future financial effects of a scheme. They provide the local authority with information about the capital and operating costs of the facilities for which they are responsible. Finally the non-traveller benefits table specifies the taxation effects for government. In the Edinburgh work this information was provided although the government counsel was that changes in tax revenue should be ignored. As stated elsewhere (chapter 2) it is thought that these effects should be represented even if they are pure transfers between different groups.

It is possible to produce tables utilising a range of discount rates, where it is desirable to compare outcomes.

There is considerable scope for discussing the presentational format of these results. Here a number of points are raised. Firstly it is argued that the value of undiscounted costs and revenues is in planning budgets using absolute monetary amounts. Thus the provision of this information for single years seems helpful but the totalling of undiscounted sums over the life of the strategy is less defensible and probably misleading. Secondly, discounted sums are the correct measure of financial effects across time. There is an argument for a disaggregation by single year to see how the discounted total is constructed. However discounted single year sums are not useful for financial planning. These points have implications for the final presentational format chosen.

One dimension requiring further consideration is the expected source of funds over time. An additional summary table is proposed giving the total finance needed each year disaggregated by the source of finance. The dimensions of this table would be the source of finance horizontally and the project life by single year vertically. The relevant sources of finance are likely to be Section 56 grant, TSG,

local authority capital and current budgets, private sector finance, EEC grants, surpluses from public Public Transport operators, and from highway related operations such as road pricing. These sources may be further disaggregated by the destination of the source funds by project year. The taxation effects of a strategy would be included in this disaggregation. Such presentations would aid the government in allocating grants over time. It would allow local authorities to plan expenditure from capital and current budgets. The financial impacts of incorrect revenue and cost predictions for the projects expenditure would also be apparent and this would facilitate sensitivity testing in respect of these crucial items.

3.6 Summary

In this chapter methods of economic and financial appraisal and their accompanying presentational forms have been presented. It was shown how the requirements outlined might be accommodated using these methodologies. The economic appraisal presented is a powerful analytical tool which requires some practice in its interpretation. The financial analysis gives a way of discerning choice in the light of financial constraints whilst giving detailed information on the financial implications of a scheme.

TABLE 3.3 - UNDISCOUNTED CAPITAL COSTS (£ million 1990)

	capital costs metro	capital costs bus	capital costs high-ways	capital costs calming	capital costs parking	capital costs pricing	capital costs rail	capital costs total
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.000
1992	-2.000	0.000	0.000	0.000	0.000	0.000	0.000	-2.000
1993	-2.000	0.000	0.000	0.000	0.000	0.000	0.000	-2.000
1994	-4.000	0.000	0.000	0.000	0.000	0.000	0.000	-4.000
1995	-31.000	0.000	-24.500	0.000	0.000	0.000	0.000	-55.000
1996	-56.000	0.000	-24.500	0.000	0.000	0.000	0.000	-80.500
1997	-74.000	0.000	0.000	0.000	0.000	0.000	0.000	-74.000
1998	-60.000	0.000	0.000	0.000	0.000	0.000	0.000	-60.000
1999	-34.000	0.000	0.000	0.000	0.000	0.000	0.000	-34.000
2000	-13.000	0.000	0.000	0.000	0.000	0.000	0.000	-13.000
2001	-3.000	0.000	0.000	0.000	0.000	0.000	0.000	-3.000
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
total	-280.000	0.000	-49.000	0.000	0.000	0.000	0.000	-329.000

4. TREATMENT OF EXTERNALITIES

4.1 Introduction

As seen in chapter 2, current appraisal techniques have a number of drawbacks; one of significance is the treatment of externalities. In this context one would define externalities to be incidental impacts, unrelated to transport objectives. Where schemes are considered solely on financial grounds, they are obviously excluded from the decision-making process. Where cost-benefit analysis is used, they are usually considered, but there is suspicion that they are often not given due weight in the real decision making process, where Net Present Value (NPV) is often of overwhelming significance. The challenge is to ensure that these impacts are given the correct weight.

The commissioning authority may have overall environmental objectives for the area; these may be the achievement of current standards, eg on air pollution or concerned with enhancing the visible environment or making the area a pleasant one in which to live and work. The use of such standards or constraints would provide a framework in which to operate.

The main requirement is for a consistent, comprehensive approach, with clear presentation of output. In this section we discuss issues in valuation, the treatment of individual aspects, presentation and the availability of data and models.

4.2 Issues in Valuation

While it is at present impossible to place reliable money values on the majority of external effects, considerable effort is being devoted to this area by researchers. In the future such valuation may well be available. It is therefore relevant to include a brief discussion of the methods of valuation being employed and which provides the most promising way forward. This discussion is followed by an assessment of externalities that are already valued in some way and the techniques used.

4.2.1 Revealed Preference Methods

Revealed preference methods look at people's actual behaviour and indirectly identify an implied value for the unmarketed good in question.

(a) Hedonic Pricing

Hedonic pricing involves decomposing the value of a good into those of its characteristics. This technique has been applied to the valuation of environmental and public goods, usually using the housing market. Studies in the USA have looked at the influence of air pollution and noise on house prices (see Pearce & Turner 1990 for a review). A recent British study addressed the issue of airport noise (Pennington et al, 1990).

There are a number of problems with this approach, the most obvious being the identification of a suitable sample population. The technique requires two areas with significant environmental differences; any other differences should be quantifiable. The specification of the predictive equation is also problematic as many of the explanatory variables are likely to be correlated.

(b) Travel Cost Method

This technique has generally been used to value recreational areas. The generalised cost of travel to the site, plus any access fee is assumed to represent the price of that visit. A demand curve can then be estimated relating frequency of visit to price. Consumer surplus can then be calculated as the value of the site.

Again there are problems with the technique. Firstly, any value derived will only represent a use value. Those who use the site may also have existence or bequest values, while non-users may also value the site. Moreover, the time spent driving to a leisure site may not be perceived as a cost but part of the outing. In any case standard values of time may not be appropriate. The journey purpose will also be significant; where visiting this site is the sole purpose then the travel costs may be attributed to the site; with multipurpose trips the issue is less clear cut.

4.2.2 Alternative Cost Methods

The alternative cost method involves asking how much it would cost to offset the damage done by the externality, eg, repairing buildings damaged by air pollution; insulating against noise. The question arises, however, as to whether this expenditure fully offsets the cost of the externality.

More recently the concept has been applied to sites of ecological significance or natural beauty where a road scheme threatens destruction. The idea is that a shadow project be planned and costed that would replace or relocate the threatened facility. The costs of rerouting to avoid the site should also be costed; the cheapest option selected and entered into the Cost Benefit Analysis.

4.2.3 Hypothetical Questioning Techniques

These survey methods are designed to elicit directly from the respondent the value placed on a specified environmental or public good or impact. The methods fall into two main categories:

(a) Contingent Valuation Methods

This approach asks the respondent to express a willingness to pay (WTP) to secure a good or to avoid a disbenefit. The question can also be couched in terms of willingness to accept (WTA) compensation to forgo a benefit or accept a disbenefit. Theoretically the answers should be equivalent; in reality the WTA > WTP in the majority of cases. This suggests that the WTP can be viewed as a lower bound on the true value and the WTA as an upper bound.

(b) Stated Preference Methods
Respondents are presented with a series of hypothetical alternatives, and asked to select which of each set they would prefer. In order to select an option the respondent is required to trade-off money against the good/bad to be valued.

The main requirements for hypothetical questioning techniques are plausible scenarios, preferably of goods familiar to the respondent, and an acceptable payment vehicle.

4.2.4 Valuation of Unmarketed Goods in Existing Appraisals

A number of effects for which there are no markets are already valued - at least in part - in existing appraisals, mainly in trunk road assessment. It is worth reviewing these to illustrate the approaches that have proved acceptable in the past.

(a) Time
The value of working time in COBA is the gross wage cost to the employer; the opportunity cost of the worker. The leisure value of time as used in COBA, has recently been revised, in accordance with values obtained from stated preference surveys.

(b) Accidents
The value placed on accidents has three distinct elements

(i) the direct financial cost eg damage to vehicles. This could be said to be a mitigating cost
(ii) Lost output of those injured or killed, an opportunity cost
(iii) Pain, grief and suffering

The value placed on a fatality in COBA has been revised upwards, in response to stated preference surveys on risk; work applying the same approach to nonfatal injuries is proceeding.

(c) Overall Environmental Impact
In a number of cases the Department of Transport has selected road schemes on a basis other than maximum Net Present Value (NPV). Indeed, between 1980 and 1987, 34 schemes with a negative NPV were approved (National Audit Office, 1988) on environmental grounds. There is then an implied value for environmental effects in these decisions. However the value implied may not be attributable solely (or sometimes at all) to environmental concerns; the objective may be one of development or political.

(d) Noise
Where noise insulation is required to protect properties affected by a trunk road proposal, the cost of this compensation will enter the CBA. Generally, double glazing, vents and venetian blinds may be provided under contract. These costs will undoubtedly reflect some of the value of the noise disturbance. However, they

are unlikely to return noise levels to their original level, neither will they be effective when the windows are open or the occupants outside. On the other hand, some of those who have noise insulation provided, might not have purchased it themselves, either because they could not afford it or because the cost of the noise is less than the cost of the insulation to them. Moreover, the disbenefits to occupiers of properties with less severe noise impacts not qualifying for assistance will not be counted.

The measure included in COBA is unlikely to be a true reflection of the costs of noise nuisance. However, it does at least ensure that a cost is entered for those properties most severely affected.

(e) Land purchase

The market cost of land purchased for road schemes will be paid to the owners in compensation. It is also possible for commercial undertakings to be compensated for a loss of productive capacity over and above the market value of the land, for example, where land take from a farm reduces its economic viability, or pollution reduces the productivity of remaining land.

Where occupiers are forced to move elsewhere, there may be compensation for the disturbance caused, over and above the property value under the Land Compensation Act 1973. The market costs of land may not reflect its amenity value.

(f) Planning Blight

Owners of properties suffering a reduced value due to planning blight may also qualify for compensation.

(g) Unmarketed land use purposes

The University of East Anglia and Rendell Planning (1990) traced the concept of shadow projects back to the 1961 Land Compensation Act. Where land is used for a purpose for which there is no market, for example, a church, school or listed building, the value is the reasonable cost of equivalent reinstatement.

Where an environmental good is valued in the ways described above, the impact is likely to be undervalued in terms of the total impact. Compensation is generally targeted at specific problems and goes only to those with property rights.

4.2.5 The Way Forward for Valuation

There are then a variety of techniques that have already been adopted by government departments to establish values for unmarketed goods. These include hypothetical questioning and alternative cost techniques; the very areas where progress is most likely in valuation. The next step may be the Contingent Valuation Method which is very flexible and produces a monetary value. Although there are still some questions to be answered about the validity of the method it is becoming popular amongst environmental economists.

Stated preference techniques may be more immediately acceptable and perhaps more appropriate in examining scheme options, where trade-offs have to be made (Hopkinson Nash & Wardman, 1990). Where schemes are being compared it also becomes feasible to trade-off benefits against costs. Motorists, for example, could be asked to trade a variety of time savings against levels of environmental degradation. Indeed, Hopkinson et al have found evidence, when examining options for a bypass, that motorists will sacrifice time savings to ensure a more environmentally acceptable route.

However, it is not the case that acceptable values exist now for immediate use. Such a development must await further research.

4.3 Treatment of Specific Items

There are a large number of externalities to consider: in this section they will each be discussed in turn, their treatment in existing appraisal techniques examined and recommendations made for the future. The main source of guidance for the assessment of environmental issues is the Manual of Environmental Appraisal (MEA) (1983) produced by the Department of Transport. This provides "information and advice" rather than specific rules to be followed.

4.3.1 Planning Blight

This category of disbenefit though not considered in the MEA has long been associated with road scheme proposals. It may be just as significant where light rapid transit is proposed, especially under the current lengthy grant application procedures. There is some provision for compensation in existing legislation where property values are adversely affected. Where businesses fail, it is generally assumed that their customers go elsewhere, and the economic activity is transferred rather than lost.

However, as an area loses its facilities and shops and becomes run down the residents will experience a disbenefit. They may have additional travel costs in order to reach facilities previously provided locally. They may suffer from a decrease in maintenance expenditure on roads and buildings, which could be viewed as a benefit to those who would have incurred the expenditure. If the area becomes run down and depopulated, crime levels may rise, and fear and intimidation ensue.

While compensation measures capture a part of the value, there are undoubtedly further disbenefits that may be hard to predict in advance. Additional travel costs to shops will only be incurred if and when local shops close. Surveys of blighted areas over time would aid in prediction of the impacts. However, it may be possible to include estimates of the extra time and journey costs incurred by residents. The maintenance costs avoided may also be identified and the cost included in the analysis. For areas already blighted, the cost of restoration should be used.

At present, compensation and avoided maintenance costs may be identified and included as a monetary measure of the problem, in some cases. Further survey work will be needed to establish the full costs of planning blight.

4.3.2 Land take/demolition

Existing properties for demolition will be included in the financial costs of the project. Open spaces need to be considered in context, and they may be very valuable in urban areas. The MEA recommends that important sites/properties and the impact on them be listed in the framework. This is an area where valuation is probably not far away. Open spaces could be valued via contingent valuation techniques, asking people in the city how much they would be willing to pay in order to avoid the loss of the facility.

An equally viable alternative, where it is considered that replacement facilities are needed, is to consider the costs of replacing or relocating the facility. This cost can then be compared with those of rerouting the scheme away from the site. For facilities of local significance, it may underestimate the value to the local population.

At this stage, where an open space or other facility is considered to be significant to the area, the costs of replacement, relocation or rerouting need to be included in the evaluation.

4.3.3 Disruption during construction

These impacts should be included in the initial CBA of the project. The disruption to traffic may be assessed using QUADRO, and delay costs entered into the equation for the relevant number of construction years. These costs may be significant due to the small number of years over which they are discounted relative to the scheme benefits. Other impacts arising from construction should be appraised in line with the suggestions above and included in the evaluation.

Mitigation of impacts may take place through compensation, in the form of temporary rehousing or noise insulation: these will be included in the financial costs of the scheme. Limits may also be placed on nighttime working or continuous piling: these are likely to increase the costs of the contract directly. Alternatively, contracts can be designed to speed up the work by, for example, charging the contractor for road occupancy. However, the trade-off might be intensified environmental costs, albeit over a shorter time period.

The costs of delays and diversions to traffic and pedestrians, together with any compensation payments, can be measured in money units and included in the framework. The inclusion of these costs is recommended by the MEA. We would further suggest that they be disaggregated within the total capital costs and clearly identified. Environmental impacts should be treated in the same way as scheme effects, discussed below.

4.3.4 Accidents

Accidents are one of the few external effects that are valued in current appraisal techniques. The value (1988 update) of a fatal casualty in COBA is £249,370, at 1979 prices, with serious casualties valued at £7,030 and slight casualties at £140. Accident rates and costs vary according to the type of road, with no change expected on an unimproved road. Thus, benefits arise through switching traffic onto roads with a lower accident risk and/or cost.

Once a variable trip matrix is admitted into the appraisal and consideration is given to changes in public transport as well as roads, it is necessary to widen the basis on which accidents are assessed to include the effects of mode switching. Improvements to public transport may divert people from cycles and motorbikes, both high risk modes, on to safer public transport modes. The accident rate per passenger kilometre is approximately 30 times higher for motorbikes than for buses (Department of Transport, 1987).

A study by Allsop (1983) assessed data from a five year period (1978-83) in order to identify the impact of a substantial fare increase on London Transport Underground and bus services in March 1982, on casualty accident rates. He found an excess casualty rate of 7.5 to 11% (4000 - 6000 casualties) over and above that which would have been expected had the lower fare level prevailed. The highest increases occurred amongst cyclists, car and taxi users.

When considering strategic policies it will then be important to consider the impacts of mode switching on accident rates. This would require knowledge of local accident rates by mode. The rate of diversion to/from walk, cycle and motorbike would be of particular import as these are the most perilous modes. These accidents can then be included in the appraisal, valued at the appropriate Department of Transport rate. The actual number of accidents prevented or caused should also be listed.

4.3.5 Noise and Vibration

The Manual of Environmental Appraisal (1983) contains specific guidelines on the treatment of a number of environmental impacts including noise. The noise measure to be used is the L10 (18 hour) dB(A), which identifies the noise levels exceeded for 10% of the time in each of the 18 hours between 6am and midnight. This measure has been found to correlate well with perceived levels of traffic noise. The threshold level for a perceived change in traffic noise in social surveys is 3 dB(A); while a change of 10 dB(A) is perceived as a doubling or halving of the noise level. Noise levels should be illustrated by constructing bands of 3 dB(A) change and indicating the numbers of buildings affected. The manual also recommends that the sensitivity of affected buildings be taken into account.

The manual's guidance is perhaps not entirely appropriate to urban areas, as recognised in the SACTRA report on urban road appraisal (1986) where nighttime noise was seen to be inadequately treated. The MEA suggests that excessive

nighttime noise should be recorded in the comments column. Also the L10 measure is seen to be less effective in reflecting perceived dissatisfaction with traffic noise in urban areas and congested conditions generally. The combination of L10 with the number of heavy vehicles provides an improved measure. The problem of intermittent noise, loud, but occurring less than 10% of the time may also be an issue: perhaps where heavy vehicles or motorbikes form a small but disproportionately noisy element of the traffic.

Another issue is that of vibration, which tends to be considered only where there is a risk of structural damage and hence compensation claims. However, vibration can be disturbing to a building's occupants and can be examined at various levels. The severity of the vibration can be measured objectively from roadside measures and subjectively from social surveys. The subjective measures can include the level of disturbance caused and how the vibration is felt - rattling windows, bouncing ornaments, house shaking, etc. Another related issue is the incidence of very low frequency sound - infrasound - which cannot be heard by the human ear but may be perceived in similar ways to vibration. Neither vibration nor infrasound can be predicted accurately, but heavy vehicle flow is a good proxy.

Social surveys can investigate the degree of disturbance to normal activities caused by noise, and the perceived nuisance. An alternative cost approach has also been suggested, such as the cost of providing double glazing to affected households as a noise abatement measure. However, the use of double glazing as representing a market for noise abatement is fraught with danger, as pointed out by Nash & Bowers (1988). People may not be willing to pay for double glazing - in which case its use as a proxy may overstate the costs imposed by noise. Where people do pay for double glazing, again this may overstate the costs of the noise as double glazing also plays a role in heat insulation. On the other hand as double glazing is only effective when the windows are closed, its cost may understate the noise costs imposed.

Evaluation should include the L10 (18 hour) dB(A), a similar measure for nighttime noise, and a measure of the proportion of heavy vehicles in the traffic. The changes in noise levels may be expressed as contours, with an indication of the properties affected, in a similar way to the MEA.

4.3.6 Threat and Intimidation

A transport project may lead to changes in perceptions of risk and intimidation that can be examined separately from objective measures of accident rates. The most obvious example is that of a road scheme which increases general traffic levels and the number of heavy vehicles within that flow. This is likely to increase feelings of intimidation and danger amongst pedestrians and cyclists. Where pedestrians now have to use subways or bridges to cross roads, they may feel more vulnerable to physical violence. On the other hand, the introduction of traffic free areas can be beneficial in this regard.

Questions of security on public transport are equally important. Where cost

savings can be achieved through unmanned stations or driver only vehicles, these should be balanced against the fears of existing and potential passengers. If passengers feel unsafe they may not remain passengers for very long and potential passengers will be deterred by a perceived lack of security. This problem has implications for the mobility of those affected and also the revenue of the operator.

Any change in traffic levels, composition, or separation from pedestrians should be considered with regard to the potential threat, as should subways and bridges. In a study of pedestrian amenity May et al (1985) suggest traffic flow thresholds that could be applied: 400 veh/h where many young children cross; 700 veh/h generally for danger and 1300 veh/L for significant danger. While the numbers of persons affected may be listed, the perceived costs to individuals can be assessed only through surveys for which future research is required.

4.3.7 Community severance

The MEA contains guidance on the classification of new severance into four categories: none, slight, moderate and severe. Similar guidance is given towards classifying the extent of any relief from severance as slight, moderate or substantial.

Local residents may find severance a very important aspect of some road/rail schemes. While the costs will be measured to a certain extent through changes in pedestrian journey times, this will not capture all the disbenefit. It will be necessary to examine patterns of use of facilities, catchment areas of schools and day centres, in order to establish whether vulnerable members of the community will be affected. These effects might be best presented on a map, showing the relevant flows.

Some of the required data may be centrally available, such as school rolls, day centre client lists or even doctors' patient lists, allowing facilities to be linked to their users. However, it may not be possible to access such data. To estimate changes in journey time to pedestrians it will be necessary to survey existing flows. The MEA classifications should also be presented.

4.3.8 Energy savings

Impacts on energy consumption are relevant in two contexts. Firstly, where a scheme leads to a fall in congestion, existing vehicles should experience energy savings due to more efficient operation. However, if the scheme also generates extra traffic total energy consumption may rise. Secondly, if energy savings and efficiency is an overall policy objective, it will be necessary to compare modes on the basis of energy efficiency.

Nash et al (forthcoming) give figures for energy consumption per passenger, based on average loadings for a number of modes. Rail is marginally superior to bus, and both consume under a third of the energy consumed by a car. Figures such as this can allow the energy consumption implications of alternative strategies or

projects to be investigated, and - if appropriate - a shadow price of fuel to be used to uprate the value attached to fuel costs in the Social Cost Benefit Analysis.

There is a risk of double counting when considering energy effects as externalities, changes in consumption will be included in the operating cost figures in the CBA. However, some assessment of the energy consumption implications of various schemes needs to be undertaken separately from the actual money cost if energy savings are an overall objective. The shadow price approach acknowledges that while market prices are indeed reflected in operating cost savings/increases, the long run costs of energy consumption may be higher. Such an approach avoids the risk of double counting.

4.3.9 Air pollution

Air pollution is not normally considered in an appraisal unless it gives:

"substantial relief to a heavily polluted area or is likely to be a specific problem due to a localised condition such as a tunnel portal" MEA (1983)

in which case an Air Quality Report would be required.

The level of carbon monoxide produced is taken as a reasonable proxy for other emissions. The concentration of pollutants in the atmosphere will be reliant on factors such as traffic volume, and composition, road layout and climatic conditions. It is likely that the effects of a similar traffic flow will be worse in a congested urban area, particularly where buildings crowd around and limit dispersal. In urban areas effects are likely to be localised, but may be significant.

The MEA is mainly concerned with emissions that may pose a threat to health, in the short term eg carbon monoxide or over the long term eg lead. Thus, one of the main gas emissions, namely, carbon dioxide is neglected. Concern with the level of CO_2 emissions has risen in recent years as it is one of the major contributors to the "greenhouse effect". The transport sector accounted for 21.4% of CO_2 emissions in the UK in 1988, this figure does not include emissions arising from the production of energy for the sector. (Thulow, 1990). It is important that changes in CO_2 levels are catalogued in the framework.

It may be worth considering the extent to which a scheme proposal will change the proportion of diesel vehicles in the traffic flow, perhaps of importance where bus schemes are being considered. Diesel vehicles produce no lead, and other emissions, carbon monoxide, hydrocarbons and oxides of nitrogen are lower. However, particulate emissions may be 10 times higher than petrol engines (MEA, 1983).

One method of inferring a value to air pollution is in examining the effects it has and costing them, for example, ill health, corrosion of buildings, more frequent cleaning of buildings and streets. However, it is very difficult to quantify these factors. A considerable amount of research has been carried out in the UK on the

impacts of pollution on the built environment. However, a recent report (DoE 1989) concluded that clear relationships were difficult to establish due to synergy between pollutants.

4.3.10 Visual intrusion

Visual impairment is classified in two ways in the MEA, as obstruction or intrusion. The degree of any obstruction can be measured using the angle of elevation and the distance of the property from the obstruction. The obstruction would then be classified as slight, moderate or severe, and the number of properties so affected would be listed. The mitigating effect of any landscaping would be taken into account in this assessment.

A related strategic issue is that of the townscape; how do people want the city to look ? The objectives for an area should be considered. Adverse changes should be noted in an assessment.

Visual intrusion is a more subjective phenomenon. For example, in the case of the effect of a doubling in traffic flow on a nearby road, how should the visual impact be assessed, and can it really be separated from noise impacts? Stated preference or Contingent Valuation methods may be used to investigate the views of those affected and their valuation of the visual impact. These surveys would cover a range of affects, and also identify the relative weight placed on each by those affected.

4.3.11 Accessibility

Any changes in spatial accessibility may be assessed in terms of journey times between specific origins and destinations by public and private transport. These can be expressed as contours on a map, for example, a 30 minute public transport contour around the city centre, would mean that all residents within it may access the city centre within 30 minutes.

Access to specific facilities, especially employment opportunities is also important. It would be desirable to assess the extent to which any scheme widens access to jobs. Any such analysis would depend on the availability of data relating to the location of job opportunities.

Accessibility for different groups of people will be more difficult to assess. Car users and bus users in general are covered above; however, variations in income between and within groups are not. Any scheme involving a number of fare or charging options will have implications for the distribution of access. An individual may not be able to take advantage of a fast public transport link if the fare is not affordable. Accessibility contours based on the money cost of the trip would prove useful here.

4.3.12 Economic impacts of schemes

The impacts that follow are secondary effects rather than the physical externalities discussed earlier. Their inclusion in any appraisal must be carefully considered for two main reasons. Firstly, they may represent a redistribution of impacts already counted in the CBA. For example, time savings to travellers may be capitalised in land values and redevelopment, in which case their inclusion elsewhere in the appraisal will constitute double counting. Secondly, the impact measured may be a transfer from another area; for example jobs created in one area may have transferred from elsewhere.

While the above suggests that care is needed in the assessment of economic impacts, their inclusion may be justified in a variety of circumstances.

4.3.13 Impact on existing businesses

Where a scheme causes major disruption during construction or has a significant impact on accessibility to certain streets or properties, damage may be done to existing businesses. The introduction of draconian parking restrictions along the "red routes" in London has led to protests from businesses along the roads concerned whose customers and suppliers face severe access difficulties. The potential upgrading of the A1 to motorway standard may have severe impacts on the businesses it supports, many of which are heavily dependent for customers on users of the A1. At present it is easy to access and egress the road, whereas a motorway would destroy casual passing trade. The loss of these locally based, individual enterprises would have to be balanced against the motorway service stations that would replace them. This is not, perhaps, a "real" externality in that there may be no net economic loss, merely transfers. However, the character of the area and the local employment content may be significant issues.

Scheme implications for access and egress should be examined and their implications for turnover considered. Where sewerage rehabilitation schemes are undertaken there is an obligation to compensate businesses for loss of turnover resulting from the disruption. Guidelines have been developed to indicate which types of business lose most, as the compensation has to be built into the initial scheme costs.

The impact on local businesses of increasing land values impacting as increased rents should also be assessed. The difficulties of predicting the response to change, except perhaps in the most severe cases, makes further evaluation doubtful.

4.3.14 Development/regeneration effects

Job creation is dealt with explicitly below, leaving the physical development of an area the issue here. Any impact on land prices must be considered in the light of objectives for the area. Any benefits arising from regeneration will be visible in terms of an improved environment.

4.3.15 Job creation

The long term impact on job creation of transport schemes is difficult to predict; moreover there are theoretical doubts as to whether such effects should be included in an economic appraisal due to the risks of double counting and jobs merely transferring from one area to another rather than being created. Double counting can arise when direct and indirect impacts of a scheme are included; the indirect effects may occur later and really be the transfer of the direct benefits from users to jobs. Development may attract jobs from another area, as happened in London Docklands, where a "rates holiday" attracted employers from elsewhere in London - notably the majority of national newspapers.

While the inclusion of job changes specific to an area in a strict economic appraisal would probably be incorrect, undoubtedly in some circumstances the government places a priority on jobs in certain areas through the creation of development corporations. There could then be some justification for considering the impact on jobs in deprived areas or those targeted for regeneration.

How, or if, such effects should be valued is another problem. The correct measure would be to value each job created at the difference between wages paid and the opportunity cost of the labour. This value will vary between areas according to local unemployment, so the transfer of jobs from one area to another may have benefits. Where job creation is an explicit objective of the authority concerned the most appropriate measure may be the costs of alternative methods of job creation.

The Sheffield Supertram Assessment Study (1988) applied a value of £15,000 to each job predicted. In justifying the use of this figure the study quotes estimates of £27,000 per job created by Development Area policies and £23-30,000 per job created by Enterprise Zone policies. The inference is drawn that central government places a considerable value on jobs created in such areas. It is then possible for Sheffield to present their valuation as a conservative one.

The prediction of job numbers and their nature has to be the first step. There is then some doubt as to the correct value to apply. The number of jobs should be given in the framework.

4.4 Distributional Impacts

The distributional impacts of transport investments are not explicitly considered in the majority of appraisal techniques; however, they do contain implicit value judgements. The distributional implications of current appraisal techniques were considered in Chapter 2.

It is necessary to state at the outset that the complete identification of the final incidence of costs and benefits is impossible. In many cases the final distributional impact, particularly between socio-economic groups will be most difficult to trace through. There is also an increased risk of double counting where

the direct impacts on travellers are included alongside the indirect distributional consequences.

The minimum requirement for an assessment of the distributional consequences of an investment is the disaggregation of the effects by impact groups, an issue discussed further in chapter 5. For example where bus users are an affected group, the decision maker may wish to give their gains/losses a greater weight than those accruing to other groups. The next step would lie in some study of the incomes of those gaining or losing from a scheme. A rough assessment of the distributional impact in spatial terms may be made using socio-economic classification in the census data.

We recommend that where costs and benefits are disaggregated by income group the valuations appropriate to that group are utilised. Values of time are available in such a form (MVA et al 1987). Ideally, all NPV's calculated would sum such costs and benefits using distributional weights - that is, relative weights attached to costs and benefits according to their incidence in line with decision-takers distributive priorities. However, both the difficulty in measuring the ultimate incidence of effects and problems in obtaining distributive weights make such a procedure problematic.

4.5 Conclusions

This section contains in Table 4.1 a summary of the impacts discussed above together with the recommendations for treatment. For the majority of impacts it is not currently feasible to give a monetary value, accidents being the major exception. However, for a number of impacts a partial money value may be obtained and recorded. Where this is done it must be remembered that the value given does not represent the full costs of the impact.

Table 4.1 Summary of Externalities and their measurements

Impact	Recommended treatment
1 Planning Blight	(a) Number and type of properties affected (b) Nature of blight
2 Disruption during construction	(a) Calculation of time and operating cost changes to road traffic, £ (b) Environmental impacts discussed below
3 Land take	(a) Number of properties demolished (b) Area land taken, description use (c) Purchase cost £ (d) Relocation or replacement cost where appropriate £
4 Noise	(a) Number and type of properties/people experiencing changes in L_{10} 18 hour d (B) A bands - similar presentation of L_{10} 6 hour d(B)A for nighttime noise (b) Cost of any double glazing provided
Vibration	(a) Change in proportion of heavy vehicles in traffic, change in total volume
5 Air pollution	(a) Where severe impacts anticipated, air quality report (b) Changes in traffic flow, density and speed to be used to estimate air pollution
6 Community Severance	(a) Money value of time changes to pedestrians and cyclists (b) Maps of major flows and type of person affected - to identify trip suppression by those no longer able to make the journey (c) Severity classification
7 Threat and Intimidation	(a) Physical description (b) Traffic flow thresholds (c) Number pedestrians and cyclists affected
8 Visual Intrusion	(a) Classification of severity (b) Number of properties and people affected (c) Mitigating costs (e.g. landscaping) £

9 Accidents	(a) Financial valuation as in COBA (but includiding effects of mode switching)
10 Energy	(a) Aggregate energy consumption (b) CO_2 emissions resulting
11 Accessibility	(a) Time and money contours by purpose/person type
12 Existing businesses	(a) Likely impact on turnover of changes in access and egress (b) Impacts of increasing rental values
13 Redevelopment	(a) List environmental improvements
14 Job creation	(a) Number of jobs created, split into temporary and permanent

5. PRESENTATION

In this chapter we discuss issues of presentation, section 5.1 considers forms of presentation, while 5.2 gives a suggested framework.

5.1 Framework Appraisal

The MEA presents a framework appraisal which considers scheme effects as they impact on a variety of groups. These impact groups are listed below:-

(a) the effects on travellers
(b) the effects on occupiers of property
(c) the effects on users of facilities
(d) the effects on policies for conserving and enhancing the area
(e) the effects on policies for development and transport
(f) financial effects

These groups are then further subdivided as appropriate to the scheme in question. For example, travellers could be subdivided by mode, which would allow the implications for public transport to be separated out. A sample appraisal from the MEA is given in appendix C. The categories used could cover most issues of concern in an urban area. However, they do not directly address distributional issues.

The approach taken in the Birmingham Integrated Transport Study, reported in Jones et al (1990), defines the impact groups so as to reveal the distributional implications of schemes. The groups are:

(a) Spatial groups
(b) Socio-economic groups
(c) Mobility groups
(d) Journey purpose groups
(e) Modal groups
(f) Economic sector groups
(g) Organisations responsible for transport provision & operation

If effects are considered as they impact on such groups, the distributional impacts of a proposal should become clear. Table 5.1 illustrates the impact groups and the effects to be considered; those of relevance to each group are marked. Thus, when schemes are to be appraised, each of these effects must be assessed as to its significance in that particular scheme context prior to more detailed study. The table acts as a checklist as well as a framework, ensuring that all possible impacts are screened for, prior to a comprehensive analysis.

TABLE 5.1 THE EVALUATION FRAMEWORK

Impact	a Spatial	b Socio Economic	c Mobility	d Purpose	e Modal	f Economic	g Operator
Objective:							
Efficiency							
Capital		•	•	•	•		•
User time		•	•	•	•		
Operating cost		•	•	•	•		•
Accidents							
Accessibility							
Local	•			•		•	
Parking	•			•		•	
Regional	•				•	•	
National	•				•	•	
International	•				•	•	
Environmental							
Noise	•				•	•	
Pollution	•				•	•	
Severance	•				•	•	
Townscape	•					•	
Land consumption	•				•	•	
Danger	•				•	•	
Insecurity	•				•	•	
Economic Regeneration	•	•				•	
Practicability							
Finance							•
Planning							•
Land availability							•
Operation							•

From Jones et al 1990

While at first glance the impact groups in the MEA and BITS framework, appear to be very different, there is infact a high degree of compatability. Impact groups (a) to (c) in the MEA (that is travellers, occupiers of property and users of facilities); correspond closely to BITS categories (e) and (f) (that is modal groups and economic sector groups). An element of BITS' category (g), organisations responsible for transport provision, can be found in the MEA under group (a) travellers, where changes in the operating costs of bus operators are included. The other BITS categories (spatial, socio-economic, mobility and journey purpose groups) really provide additional ways of disaggregating the data to identify the distributional impacts. In order to avoid double counting it would be preferable to present this information in subsidiary tables.

5.2 Issues and Recommendations

Table 5.2 shows a method of integrating the two approaches. Each impact is linked to those groups and sub-groups which are most likely to be affected. Each marked cell contains an impact to be considered, though not all will be relevant to every scheme, and some may be considered too minor to be appraised fully. However, this provides a comprehensive checklist of impacts. The disaggregate groups under each heading should be designed to be relevant to the options: for example LRT might join the modal split, while users of facilities might include hospitals or theatres.

The framework approach provides a useful starting point for an appraisal that is thorough in its coverage of externalities. It is amenable to the addition of various categories of benefit/disbenefit. The impact groups themselves may be defined in order to identify distributional effects. The degree of disaggregation feasible in the framework will be determined largely by data quality and availability. This is particularly so when considering distributional issues, where data on the affected population may be limited and accurate identification of the incidence of benefits and costs difficult. Part of such a framework is already expressed in money terms; other externalities could join them in the future.

The framework suggested takes some initial steps towards monetary valuation of externalities. However, the majority are measured in physical, quantitative and qualitative units other than money. Hence, the question of the correct weight to be given to environmental and other externalities in the appraisal remains open. The inclusion of a number of partial money values at least provides a lower bound to the value of externalities, thus improving the information available to decision makers.

Table 5.2 **Impact Groups**	**Users of Different Modes**					**Occupiers of Property**				**Users of Facilities**		**Operators & Government**				
Disaggregate Groups	Car	Bus	Rail	Cycle	Walk	Reside -nts	Indus- try	Comm- erce	Soci- al	Shop- pers	Commun -ity Centre	Bus Oper- ator	Rail Oper- ator	Freight Opera- tors	Local Author- ity	Central Govern- ment
Supplementary Tables	Journey Purpose/Spatial/Mobility Group/Socio-Economic					Spatial/Socio Economic				Spatial/Socio-Economic						
IMPACTS Planning blight				•		•	•	•	•	•	•				•	
Disruption during Construction	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
Land take						•	•	•	•	•	•					
Noise and Vibration				•	•	•	•	•	•	•	•					
Air pollution				•	•	•	•	•	•	•	•					
Community Severance				•	•	•	•	•	•	•	•					
Threats and intimidation		•	•	•	•											
Visual intrusion				•	•	•	•	•	•	•	•					
Accidents	•	•	•	•	•											
Energy	•	•	•													
Accessibility	•	•	•	•	•					•	•					
Existing businesses						•	•	•	•	•						
Regeneration						•	•	•	•	•						
Job creation						•	•	•	•						•	
Capital cost												•	•		•	•
Time changes	•	•	•	•	•							•	•	•		
Operating cost changes	•	•	•									•	•	•		

6 ISSUES IN SCHEME COMPLEXITY AND MODELLING

This chapter addresses a number of issues raised elsewhere in the report or which might be expected to arise in the development of the appraisal where future work may be required.

6.1 Uncertainty

In this section the implications of placing a value on uncertainty in any evaluation are considered. Uncertainty can arise in many ways, which themselves may be categorised in many ways. Of concern here are two sources of error, namely

(a) error in outturn magnitudes
(b) error in unit valuations

It is commonplace to handle (a) by producing high and low forecasts, which need to be based on sensible alternative scenarios covering a range of exogenous variables. But (b) is rarely addressed.

It is frequently the case that one can reasonably specify the range within which a particular valuation is likely to lie, without being able to value an item at all precisely. In that case, it is also useful to undertake sensitivity analysis of the extent to which the outcome of the project would be affected if the values in question differed. Such an analysis will be aided by the use of a computerised decision support system; it leaves the ultimate question of valuation where it truly belongs in the political process.

6.2 Definition of Impact Area

There is a remaining question of how the geographical area of impact should be defined. For major schemes and for strategic decisions the whole city will be the appropriate area; for smaller schemes the question must be addressed carefully. In principle the area under consideration needs to be large enough to include reassigned traffic.

6.3 Range of Impacts

The framework approach provides for considerable disaggregation of the costs and benefits. However, the costs of providing a full framework for small schemes could be disproportionate to the scheme benefits. It should be possible to assess beforehand which impacts need to be disaggregated. Where schemes impact on a fairly homogeneous population, for example, a traffic calming scheme, detailed disaggregation of impacts will not be necessary. This issue was covered in some detail in the preceding chapter.

6.4 Modelling Issues

The comprehensive nature of the appraisal and the range of schemes to be

appraised necessitate the inclusion of a number of effects generally excluded or given superficial consideration. The need to obtain data and develop predictive models is clear. For instance, the evaluation of impacts on cyclists and pedestrians requires knowledge in the first instance of any time gains or penalties experienced. This would require surveys of current flows and the development of models to predict their response to change, including diversion to or from other modes. TRRL have already provided guidelines on the impact of various forms of pedestrian crossing on road crossing times, which may provide a useful base.

While standard formulae may be applied to predict accident rates on certain types of road, the influence of the modal split has been neglected. Data on accident rates by mode at the local level would provide a useful starting point. The diversion rates between modes for specific schemes will be forecast and the impact on accident rates predicted. Any accidents caused or avoided by a scheme could then be valued at the standard Department of transport rate.

Schemes which place or remove restrictions on the movements of vehicles will have a number of impacts of interest, where suitable models may not yet be available. A recent article by Brown et al (1991) discusses the areas where more information is required. Impacts on pedestrians and cyclists have already been discussed in this report but, the effects on cars and freight vehicles are also of relevance here. The need to know how people will react to changes in parking policy and the cost or benefit to them. The impact of restrictions on freight movements need to be considered in relation to the freight operators reaction. Are they able to adjust easily or will they incur additional costs not reflected elsewhere, such as the purchase of smaller vehicles to avoid a weight restriction.

We also referred above to the importance of reliability to travellers; further work on forecasting the effects of schemes on road and public transport reliability will be needed.

6.5 Valuation

Valuation methods are available for the majority of externalities. However, further research will be required in order to establish standard values for use in appraisal. A large amount of research has taken place in Europe and the USA in order to derive money values for environmental impacts. A number of countries have taken a step further and adopted some form of valuation for environmental impacts. In Sweden monetary value are used to determine the MSC of transport. Environmental factors included are noise valued through hedonic pricing methods and air pollution valued via an alternative cost approach. In the Netherlands petrol is subject to pollution taxes, specifically relating to air and noise; with the revenue used for abatement measures and research. In the UK the SACTRA has been looking at the issue of environmental appraisal in trunk road assessment and is due to report in 1992.

It is possible that standard values of nationwide applicability will prove to be impossible to establish, in which case it will be necessary to obtain local values,

and some values will need to be established for a particular scheme. For example, the value of open space in urban areas is likely to vary considerably according to what it is used for, who uses it and the availability of alternatives.

6.6 Conclusions

While there are issues to be resolved when assessing schemes of different complexity and certain aspects of modelling impacts, there is no doubt that the framework approach is the logical way forward to a comprehensive appraisal technique, providing an evaluation technique for use by Local Authorities that should be acceptable to the Department of Transport.

7. SUMMARY AND RECOMMENDATIONS

7.1 Authorities will be in a better position to make good strategic choices if a consistent approach to appraisal is used across the range of policy options.

7.2 Existing methods of appraisal suffer from a number of weaknesses, of which the most important are:

(a) different methods of appraisal being applied to road and public transport schemes, and to large and small schemes;
(b) inadequacy of and inconsistency in the treatment of externalities;
(c) lack of attention to cyclists and pedestrians;
(d) use of the fixed trip matrix assumption in circumstances where it is inappropriate;
(e) Wide differences in the availability of finance for public transport and roads, large and small schemes, and capital and current expenditure, and in the criteria for allocating such finance.

7.3 We recommend use of a consistent and comprehensive multi-modal framework for evaluation and financial assessment which

(a) has a clear relationship to strategic objectives;
(b) is applicable to policies, major schemes and minor schemes, with appropriate adjustment to the level of detail;
(c) adopts a common approach for all modes;
(d) is applicable to all types of highway scheme;
(e) takes into account modal interations;
(f) takes accounts of wider area effects.

7.4 We show how such a framework may be presented, in terms of matrices of types of effect by incidence group, covering both those costs and benefits which may be valued in money terms and those for which appropriate valuations are not yet available.

7.5 We illustrate how financial appraisals may be drawn out of the wider cost-benefit analysis, and used to determine the feasibility of alternative schemes or packages of schemes. We see the appraisal process as one of obtaining the best cost-benefit results feasible within the financial constraints applied, and argue that these financial constraints should be applied consistently.

7.6 We identify a number of areas in which existing models will not be able to provide the necessary data inputs, and further work will be needed. Foremost amongst these are:

(a) pedestrian and cycle movements and diversions between these and other modes.
(b) effects on traffic levels of environmental traffic management, parking controls and other traffic restraint mechanisms;

(c) effects of schemes on the variability of road and public transport journey times.
(d) effects of schemes on accident levels on all modes.

7.7 We recommend that the next stage of the development of the appraisal system should be a series of case studies of road and public transport schemes of varying complexity. Much of the information for these case studies will be available from existing studies but in some cases, particularly those listed in the previous paragraph, existing data will be deficient. The aims of these studies will be:

(a) to study the data requirements for the preparation of the appraisal framework, and to develop ways of satisfying these data requirements from a combination of existing models, new models and more ad hoc approaches.
(b) to clarify further the exact presentation and level of detail required for schemes of varying sizes and types, in the light of decision-taker's requirements.

7.8 We are aware that the proposals in this report could generate an enormous amount of exceedingly complex information. It is particularly important that the next phase of the study maintains close cooperation with decision-taking authorities, in order that the information produced should be appropriate to, and in a useful form for, practical decision taking.

REFERENCES

Allsop R.E. (1983) Fares and Road Casualties in London Report to Transportation and Development Department, Greater London Council, by Transport Studies Group, University College London.

Bates J and Lowe S (1989) Criteria for Public Sector Support in Urban Public Transport. Presented at Summer Meeting of PTRC.

Bates J, Brewer M, Hansan P, McDonald D & Simmonds D (1991) 'Building a Strategic Model for Edinburgh' paper to PTRC SAM, Transportation Planning Methods Seminar.

Brown M., Evans R. & Black I. (1991) The evaluation of traffic management and parking schemes: whither now? in Traffic Engineering and Control, March 1991, pp 110-119

Colin Buchanan and Partners (1984) Economic Evaluation Comparability Study.

Dawson RFF (1967) The Economic Assessment of Road Improvement Schemes. Road Research Laboratory Technical Paper No 75

Department of the Environment (1970) Mathematical Advisory Unit Note 179. Generalised Costs, and the Estimation of Movement Costs and Benefits in Transport Planning. P McIntosh and D Quarmby.

Department of the Environment (1989). The Effects of Acid Deposition on Building - Building Materials in the United Kingdom. Report from Building Effects Review Group.

Department of Transport (1976) Transport Policy - Volume 2.

Department of Transport (1977) Advisory Committee on Trunk Road Assessment Report. (Chairman Sir George Leitch). HMSO, 1977.

Department of Transport (1981) COBA

Department of Transport (1981). Traffic Appraisal Manual

Department of Transport (1982a) Public Transport Subsidy in Cities. Cmnd 8735, HMSO

Department of Transport (1982b) Urban Public Transport Subsidies: An economic assessment of value for money - Summary Report.

Department of Transport (1983) Manual of Environmental Appraisal

Department of Transport (1985) Section 56 Grants for Public Transport. Circular

2/85.

Department of Transport (1987) Transport Statistics 1976-86 HMSO.

Department of Transport (1989) Annex B Guidance Notes, Transport Policies and Programme Submissions for 1990/91. Circular 1/89.

Department of Transport (1989) Section 56 Grant for Public Transport, Circular 3/89

Department of Transport, British Rail, London Regional Transport and London Underground Ltd (1990). Central Rail Study - A report on further work 1990. Working Paper.

Department of Transport (1991a) "Transport Policies and Programme Submissions for 1992\93 - Information Required on Individual Major Highway Schemes." Highways Policy and Local Roads Division.

Department of Transport (1991b) 3\89 Annex A to Department of Transport Circular.

Docklands Forum/Birkbeck College (1990) Employment in Docklands

Fowkes A.S. and Wardman, M. Values of overcrowding and departure time variations for intercity rail travellers. Technical Note 229. Institute for Transport Studies, University of Leeds

Glaister S (1981) Fundamentals of Transport Economics. Oxford, Blackwell.

Halcrow Fox & Associates (1990). Proposed Department of Transport Criteria for Section 56 Grants, Phase 1: Final Report. Report to Passenger Transport Executive Group.

Hopkinson P.G., Nash C.A. & Wardman M. (1990) Prospects for valuing the environmental effects of road transport in monetary terms, PTRC SAM 1990.

House of Commons (1968) Transport Act. HMSO.

House of Commons. Third Report of the Select Committee on Transport. Session 1986-7. Financing of Rail Services.

Jones D., May A.D. & Wenban-Smith A. (1990) Integrated Transport Studies: lessons from the Birmingham Study, in Traffic Engineering and Control, pp 572-576, November, 1990.

Mackie P J, May A D, Pearman A D and Simon D (1988). A Computer-aided Priority Assessment Technique for Local Authority Transport Projects. PTRC SAM 1988.

The MVA Consultancy, Institue for Transport Studies, University of Leeds and Transport Studies Unit, University of Oxford (1987) "The Value of Travel Time Savings" Policy Journals, Newbury, Berkshire.

Marks P, Fowkes A.S, and Nash C.A (1986) Valuing Long Distance Business Travel Time Savings for Evaluation: A methodological Review and Application. seminar on Transportation Planning Methods PTRC, SAM

May A D, Turvey I G, and Hopkinson P G (1985) Studies of Pedestrian Amenity. ITS Working Paper 204.

May A D, Roberts M & Holmes A (1991) 'The development of inegrated transport strategies for Edinburgh' paper to PTRC SAM, Transport Policy Seminar.

Nash C.A, Hopkinson P.G, Tweddle G, Preston J (1991) Evaluation of Road and Rail Projects: Issues and New Developments.

Nash C.A ed (1990) Appraising the Environmental Effects of Road Schemes - A Response to the SACTRA Commitee ITS Working Paper 293

Nash C.A. and Bowers J.K. (1988) Alternative Approaches to the Valuation of Environmental Resources in Turner R.K. (ed) Sustainable Environmental Management, Belhaven Press, London.

Nash C.A., Hopkinson P.G., Tweddle G. & Preston J. Evaluation of Road and Rail Projects: Issues and New Developments, forthcoming

National Audit Office (1988) Department of Transport, Scottish Development Department and Welsh Office : Road Planning. Report by the Comptroller and Auditor General, HMSO, 688.

Pearce D.W. & R.K. Turner (1990) Economics of Natural Resources and the Environment, Harvester Wheatsheaf.

Pennington G., Topham N. & Ward R. (1990) Aircraft Noise and Residential Property values adjacent to Manchester International Airport, in Journal of Transport Economics and Policy, Vol XXIV, No 1, January 1990, pp 49-60

Sheffield Supertram Assessment Study Phase 2 (1988) Technical Note 21.9, Non-User Benefits.

Sheffield Supertram Assessment Study Phase 2 (1989) Technical Note 21.12, Assessment of Individual Non-User Benefits.

Transportation Planning Associates (1991) 'A Review of Traffic and Economic Appraisals of Local Authority Highway Schemes' Final Report to the Department of Transport.

Thurlow G (ed) (1990) Technological Responses to the Greenhouse Effect. Watt Committee Report Number 23, Elsevier Applied Science, London.

University of East Anglia/Rendell Planning Environmental Appraisal: A Review of Monetary Valuation and Other Techniques Report to TRRL.

Williams H.C.W.L (1976) Travel Demand Models, Duality Relations and User Benefit Analysis. Journal of Regional Science. Vol 16 No 2 pp 147-166.

APPENDIX A

Birmingham City Council
Engineers Department

ANNEX 1

07 JAN 1991

3rd January 1991

Professor A D May
Institute for Transport Studies
The University of Leeds
Leeds LS2 9JT

Dear Tony

COMMON TRANSPORT INVESTMENT APPRAISAL

Further to my letter of 28th December Centro have suggested minor amendments to the proposal, the amended version is as follows.

1 **Problem**: Present evaluation procedures for DTp transport investment appraisals are built up from totally different bases and result in inordinately long assessments for public transport schemes.

a. Highways is subject to nationally laid down criteria and appraisal techniques with DTp taking a strong lead.
b. Public Transport - BR financial assessments are totally market orientated. Section 56 rules are a mixture of financial and economic assessments.

2 **Study Issues**: Major urban areas are subject to enormous transport pressures where a market orientated approach leads to inefficiency, duplication and inequitable systems.

An investment appraisal method is needed to satisfy the requirements of authorities which would want to make judgements as to priorities between schemes and an appropriate package of measures. Such an approach should be acceptable to DTp and needs to be on a common basis.

3 Cost-benefit appraisal:

(a) Costs.

Private	Public
Total travel costs	Public transport user costs
including parking costs	Operating costs (time and vehicle)
accident costs	net of revenues
(true) maintenance costs	Infrastructure costs
External costs	Freight costs

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Your Reference

Our Reference 151/CH/TIN/SV
Mr C Haynes

(b) Assessment of Benefits (and Disbenefits)

Public and Private:-
User benefits both in operating costs, time savings, accident savings, maintenance costs.
Non-user benefits related to decongestion, environmental impact, development impacts, energy audit, community benefits.

4 **Financial Appraisal**

The costs and benefits should be subject to a separate financial appraisal to take account how the project/system can be financed in respect to both public and private investment - fares, subsidy, taxes, grants, financing costs.

5 **Specific Matters for comment (not exhaustive)**

Suppressed Demand
Peak Spreading
Subsidy Effects
Pricing Policies
Development Effects
Company Car
Impact Groups
Taxation Effects
Energy Impact
Area traffic reassignment/ redistribution
Person valuations (not vehicles)
Standardisation of variables

6 **Timescale and Details of Proposal**

It is envisaged that the commission would initially consist of a suggested investment appraisal framework with alternative approaches. The timetable would be:

Accept Proposal	January 1991
Report	End of March 1991

The appraisal method will need to allow for DTp's approach to ensuring consistency between authorities and would make use of standard values, discounting procedures that could be widely accepted.

I look forward to your draft proposal on 11 January 1991.

Yours sincerely

Chris Hayes

cc: Mr D Blackledge
Centro

ctia.doc/gen2

Appendix B - Consumer Surplus Calculations

General Principles

Suppose that we consider the demand for a single travel movement, and we represent this demand T as a function of the generalized cost C, as in Figure B1. Then a reduction in cost to C' will lead to an increase in demand to T'. The change in consumer surplus is given by the sum of the two areas A and B, and this can be used as a measure of the benefit of the reduction in generalized cost (see Glaister, 1981 Chapter 2 for a formal demonstration of this). Provided that we can reduce the components of generalized cost to a common scale, it does not matter whether the reduction from C to C' is achieved by, for example, lower fares, faster travel times, greater comfort or whatever.

We now propose that the consumer surplus measurement corresponding to A + B in Figure B1 is re-interpreted as:

[(A+C) - (C+D)] + (B+D).

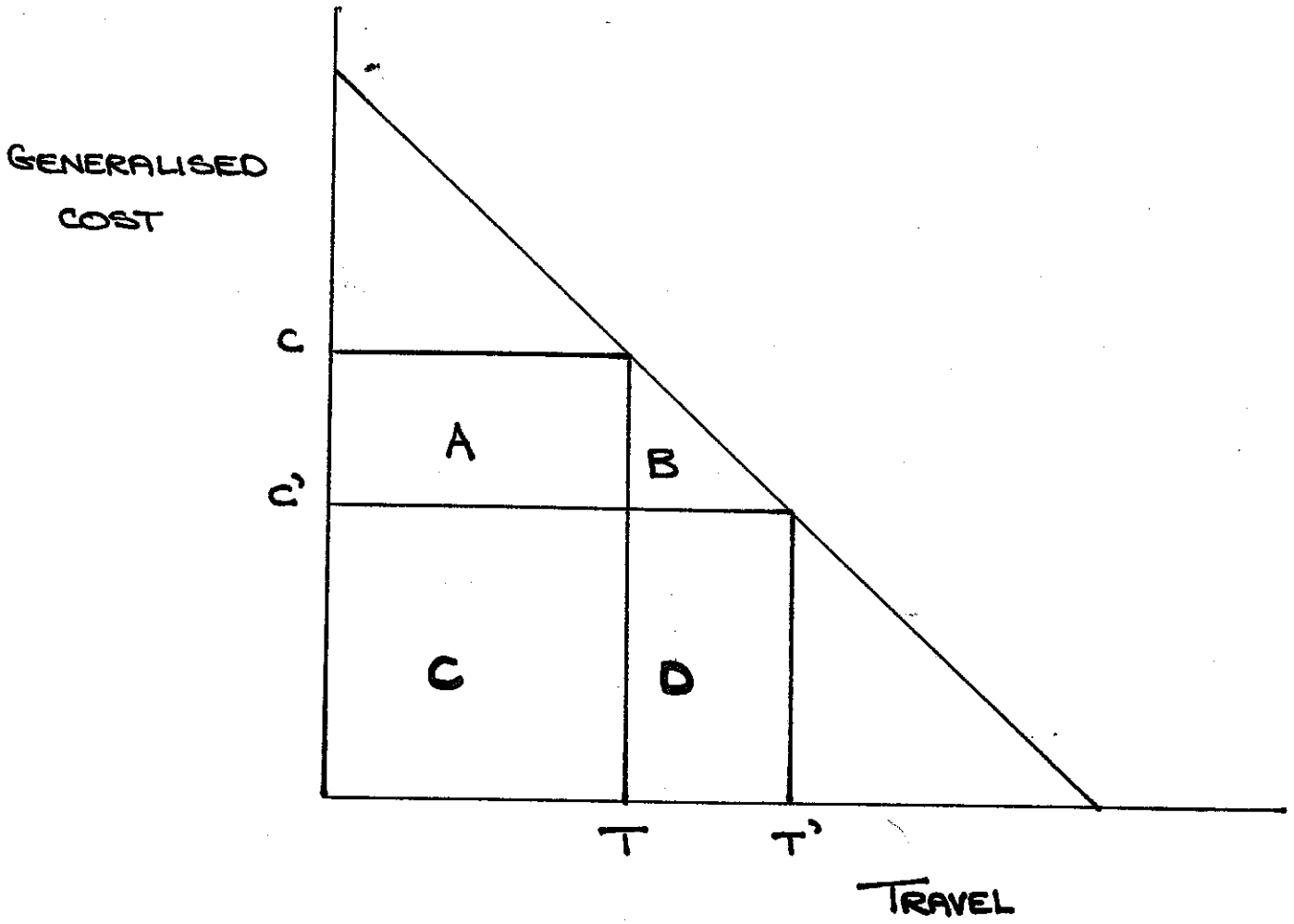
The term [(A+C) - (C+D)] is a measure of the value of the change in consumption, while the term (B+D) can be interpreted as the average worth of the change in travel for all those who alter their travel behaviour in any way (for example, by a change of mode, or destination, or a greater frequency of travel). These terms Table 3.1 in the main texts illustrates this.

The main reason for making this distinction is that it identifies the change in consumption that takes place. This has direct relevance for Government and, especially, Transport Operators inasfar as it relates to money costs. For example, a reduction in fares may increase or decrease Travellers' money expenditure on public transport (ie revenues), depending on the elasticity of their demand. Such changes represent both part of the benefit to Travellers and part of the costs to Transport Operators and Government, in opposite directions. It is exactly such quantities which are required for financial appraisal.

Another reason is that certain groups of Travellers appear not to perceive all costs correctly (the classic example is that of private motoring costs). It can be shown that the correct way to deal with this is to use perceived costs in the calculation of the 'worth' items, but the full costs in the calculation of the change in consumption.

A distinction which is perhaps more conventional in transport evaluation is that between 'existing' travellers and new or 'generated' travellers. When the appraisal relates clearly to a simple change to the transport system, such as a single new link, this intuitively appealing distinction has much to commend it. But as soon as the change in the system becomes more complicated, the distinction between existing and new travellers quickly becomes untenable, as travellers switch between modes, destinations etc. The distinction between consumption and worth identifies the total change in resources consumed, together with a component for

FIGURE B1 Effects of a cost change on travel



travellers who change their behaviour, without needing to identify whether they are diverted from elsewhere or totally new travellers.

In line with this approach, it is no longer possible to identify the benefits accruing to users of particular parts of the transport system (eg public transport users) since those who use public transport after a change in the system may not be the same as those who use it before. Benefits can only be unambiguously attributed to groups of travellers in this way if their behaviour can be explicitly identified in both before and after situations.

There remains, nonetheless, some interest in identifying where the benefits occur. In line with this, we can disaggregate the various benefit components in the Table according to what the source of benefit is - principally, where and when within the system the cost changes are occurring; it may be useful to distinguish the mode of travel and the time of travel (eg peak vs off-peak) and by kind of time saved (eg waiting or in-vehicle time). If desired, this distinction (source of benefit) could be made by extending the framework vertically.

As a result of setting up such a framework, the following advantages are obtained:

a) A full CBA is available, with further indications about the incidence of benefits and costs

b) A full financial appraisal is available, since the costs and revenues for Operators are included in the framework

c) The treatment of taxation can be incorporated straightforwardly in the framework

d) Because of the level of disaggregation, it is possible to apply global modifications to different sections of the Framework to incorporate different assumptions, by, in particular,

i) applying different values of time to selected columns in the Table (in general, changing the balance between non-monetary and monetary benefits)

ii) applying different shadow prices of finance, possibly distinguishing between current and capital costs (in general, changing the balance between Traveller and Non-Traveller benefits)

In this way, the elements in the Framework provide a succinct summary of the main effects of the policy being evaluated, while allowing the decision-maker the flexibility to apply different weightings to different elements in the Table.

Rule of a Half and Exact Formulae

As is shown for example by Williams (1976), if $T_\xi(\mathbf{C})$ is the demand function for a travel possibility ξ (for example, travel from i to j by mode m in time period t), where **C** is a matrix of the generalized costs of all such travel possibilities ξ, then the benefit (change in consumer surplus) relating to any proposed transport package which changes **C** to **C'** is given by

$$\Delta S = - \Sigma_\xi \int_C^{C'} T_\xi(C) \; dC$$

and for **marginal** changes this can be approximated by the formula

$$- 1/2 \; \Sigma_\xi \; (T_\xi + T'_\xi).(C'_\xi - C_\xi)$$

in which T'_ξ is the shorthand for $T_\xi(\mathbf{C'})$, or, more familiarly, in terms of a suitable transport model which distinguishes origin-destination movements by mode (m) and time period (t).

$$- 1/2 \; \Sigma_{ijmt} \; (T_{ijmt} + T'_{ijmt}).(C'_{ijmt} - C_{ijmt})$$

Where a demand curve can be explicitly formulated, integrating under the demand curve to obtain consumer surplus remains a possibility. However it can be shown that the so-called rule of a half is a very good approximation to the true surplus provided the change in cost can be regarded as "marginal". With the crucial exception of the introduction of a new mode, this is normally the case in any urban transport assessment.

Components of Benefit

The fact that the benefit formula can be linearised in this convenient way opens the door to further modifications: specifically, it allows the component parts of C_{ijmt} to be identified. It is typical, therefore, to distinguish between benefits which represent time savings and those which represent money savings. Note that the true benefit formula does **not** allow this to be done: in general, there is no variant on the integral formula which can distinguish benefits by the components of **C**.

Now the fact that the money component of benefits can be distinguished leads to a number of considerations which are often confused. We refer first to discussions about "transfer payments". Suppose that a given transport improvement merely relates to a change in fares with no change in demand. Then travellers incur a loss, or gain, which is exactly compensated for by an increase, or reduction, in operators' revenue. In such a case, it appears unnecessary to take this element of benefit into account. A similar argument has been raised in respect of the tax elements in, for example, fuel prices.

Suppose again that a transport improvement results in time savings for certain

(ijmt) categories, with consequent changes in demand, but with no associated change in money costs. Then it is easily seen from the approximation formula above that the net money benefits must be zero.

Such considerations have led to a practice whereby money benefits are ignored in the cost-benefit analysis of public transport schemes. However, this simplification is in fact only valid in the two restricted cases given - either that there is no change in fares (between the base and 'with scheme' cases), or that there is no change in demand (the fixed matrix approach). When fares change and demand changes (the general case) then it can be shown that there are money benefits to travellers who change their behaviour which do not cancel out "on both sides".

There is in any case a more important principle involved: the benefits to travellers should represent all the benefits associated with a given transport proposal. If a large amount of the benefits are subsequently cancelled out by corresponding elements on the cost side, that can of course be reflected in the final balance. Since fares changes should be treated on a consistent basis with any other transport changes, it is essential to define benefits in a way that does not prevent this. And we reiterate the point made earlier, that such practice is in line with the true (integral) benefit formula, which does not permit money benefits to be separated.

Taxation

The same approach, it seems, should apply to the treatment of taxation. A pound saved in petrol represents a pound saved to the traveller (we return to the question of tax levels varying between sectors below), regardless of the fact that much of the cost of petrol represents fuel tax. However, in the final cost-benefit calculus, the corresponding loss to the Government needs to be offset against the money benefit enjoyed by the traveller. The recommendation is therefore that both elements should be distinguished explicitly, rather than netted out from the start.

Strictly speaking, allowance should be made for different incidence of taxation. In practice, this is a marginal correction, and likely to be well inside the error margin of the calculations. Nevertheless, it has become conventional practice to make the correction. The most logical approach is to measure all benefits and costs **net** of indirect taxation in the non-transport sector. For non-private sector travellers (ie travel made on behalf of corporate bodies) the correction can be ignored, since (most) indirect taxes can be reclaimed. It is therefore only necessary to deflate the benefits accruing to non-business travel to take account of the average level of indirect taxation in the non-transport sector (typically, by a factor of 1.15). Note that, inasfar as values of time are based directly on willingness to pay calculations, these will be expressed in terms of "non-transport sector pounds", and therefore will also need to be deflated. It is important to check, however, that this has not already been done (eg in the DTp recommended values).

"Behavioural and Evaluation values"

The exact formula for consumer surplus requires the appropriate value of **C** in the

demand function, and in principle could be disaggregated by individuals to take account of different values of time etc. For the rule of a half approximation to be valid, any such calculation would need to be similarly disaggregated. But the fact that the rule of a half allows the components of benefits to be distinguished makes it possible to substitute the 'weights' applied to the various elements. This is recommended by the Department of Transport in the case of COBA.

In fact, most of the Department's practice in this respect relates to the so-called 'resource cost correction' which deals with taxation and 'unperceived' costs relating to car use. We have argued that these corrections should **not** be made to the benefits, but should be taken account of in a full consideration of the countervailing costs. If this is done, there is no need to interfere with the weights explicitly for these reasons. The more important case relates to the so-called 'equity' value of time, whereby all savings in non-working times are valued the same for all categories of traveller. This does raise a genuine problem, though it is unlikely that much demand modelling will in fact make use of variation by values of time, so that in many cases the problem disappears.

APPENDIX C PUBLIC INQUIRY FRAMEWORK - FROM THE MANUAL OF ENVIRONMENTAL APPRAISAL

PUBLIC INQUIRY FRAMEWORK

Date Prepared: June 1983

Group 1: Travellers			Modified Blue		Modified Green		District Council		Do Minimum 1	
Sub-Group	Effect	Units	High	Low	High	Low	High	Low		Comments
Car Users	Time savings	£m (PVB)	4·63	2·36	3·80	2·16	4·19	2·38	0	Notes A, B and C apply to the first nine lines A. Each column shows the improvements of the particular route over the "do-minimum" option. Hence the "Do Minimum" entries are zero. B. Present value of benefits (PVB) are for 30 year periods from the expected date of opening and discounted to 1979 prices at 7% pa. C. It is assumed that national average figures for vehicle occupancy and for accident rates and costs will apply.
	Vehicle operating cost savings	£m (PVB)	−0·14	−0·12	+0·23	+0·20	0·00	0·00	0	
Users of Light Goods Vehicles	Time savings	£m (PVB)	1·06	0·60	0·98	0·54	1·09	0·62	0	
	Vehicle operating cost savings	£m (PVB)	−0·05	−0·04	+0·03	+0·03	−0·06	−0·05	0	
Users of other Goods Vehicles	Time savings	£m (PVB)	0·96	0·54	0·42	0·24	0·13	0·08	0	
	Vehicle operating cost savings	£m (PVB)	−0·05	−0·04	+0·02	+0·02	−0·02	−0·02	0	
Bus Operators and passengers	Time savings	£m (PVB)	0·64	0·36	0·56	0·32	0·74	0·42	0	
	Vehicle operating cost savings	£m (PVB)	−0·01	−0·01	0·00	0·00	−0·02	−0·02	0	
All vehicle travellers	Value of accident savings	£m (PVB)	0·25	0·17	0·18	0·13	0·18	0·13	0	
	Reduction in casualties:−									The figures indicate the probable total reduction in casualties over the whole of the 30 years assessment period if the national average rates and distribution between groups apply to each alternative. They take no account of the safety implications of the detailed design of the new routes.
	Fatal	number	5	4	4	3	4	3	0	
	Serious	number	42	29	31	22	31	22	0	
	Slight	number	77	53	56	39	56	39	0	
	Driver stress		Low		Moderate		Moderate		High	
	View from road		Scenic		Agricultural		Agricultural		Residential	
	Traffic delays during construction	£m (PVB)	−0·02	−0·02	−0·02	−0·02	−0·28	−0·02	0	Figures are calculated using the same assumption on traffic composition as for travel benefits. No detailed survey has been undertaken
Pedestrians 2 (5000–8000 pedestrian movements per day will be affected)	Change in amenity		Pedestrianisation of Town Centre and removal of heavy traffic will improve the quality of the adjacent streets		As modified Blue		As modified Blue		A 20% increase in traffic will reduce amenity in the town centre	
	Safety		Segregation of pedestrians and vehicles will improve safety		As modified Blue		As modified Blue		With a 20% increase in traffic the danger of accidents to pedestrians in the town centre will increase	
	Severance (New)		Severe: Several footpaths diverted		Moderate: Pedestrians will have to use subway to reach hospital		As modified Green			

1 This heading will be 'Do Nothing' for many schemes.

2 If the effect on cyclists is thought to be important a separate sub-group should be included.

Group 2: Occupiers

Sub-group	Effect	Units	Modified Blue	Modified Green	District Council Route	Do Minimum	Comments
Residential	Properties demolished	Number	13	3	2	1	Properties demolished on Blue route are Circa 1900. The cost of property acquisition and demolition is included in Group 6
	Noise	Number of houses experiencing increase of:					The changes in noise are the difference between the forecast for each option for 2008 and the existing levels. The units are dB(A)L_{10} 18 hr. 6 am–midnight. Allowance has been made for the presence of noise barriers in calculating these figures. The figures in parentheses are for those houses entitled to double-glazing
		more than 15 dB(A)L_{10}	0	1	6	0	
		10–15 dB	22 (5)	27 (6)	39 (10)	0	
		5–10 dB	52	52	40	0	
		3–5 dB	220	225	270	300	
		Number of houses experiencing a decrease of:					
		more than 15 dB(A)L_{10}	0	12	11	0	
		10–15 dB	138	248	181	0	
		5–10 dB	266	142	117	0	
		3–5 dB	300	350	200	0	
	Visual obstruction	Number of properties within 300m of centre line. Subject to:–					
		Severe	3	4	3	No change	
		Significant	8	6	10	No change	
		Slight	15	21	18	No change	
	Visual intrusion		Slight intrusion to 20 houses	Moderate intrusion as River crossing is visible from 50 houses	As modified Green	No changes	Report of Landscape Advisory Committee gives more detailed information
	Severance						
	a. Relief to existing severance		*Substantial* Slight	*Moderate* Severe	*Moderate* Slight	*None* None	
	b. Imposition of new severance						
	Disruption during construction		10 houses within 100m of site will be affected for 6 months	10 houses within 100m of site will be affected for 6 months	12 houses within 100m of site will be affected for 6 months	None	
Industrial Premises			3 premises will experience an increase in noise of approx 4dB(A)L_{10} but since they are engaged in engineering work, this increased noise will not affect their operations	As modified blue	As modified Blue	No change	
Commercial Premises							
a. Office Buildings	Noise increase	Number subject to increase of more than 5dB(A)L_{10}	1 This building is double-glazed and the increase is, therefore, not noticeable to occupants	1	1	3	Average office occupancy on the new routes is 100–200 people. 'Do Minimum' route will affect 600–800 office workers
	Noise decrease	Number subject to decrease of more than 5dB(A)L_{10}	6	7	4	0	
	Visual obstruction	Number of properties within 300m of centre line Subject to:					
		Severe	0	0	0	No change	
		Significant	0	0	1	No change	
		Slight	1	1	2	No change	
	Severance						
	a. Relief to existing severance		Substantial Improvement	Moderate Improvement	Moderate Improvement	No improvement	
	b. Imposition of new severance		None	None	affecting 150 people	None	
	Disruption during construction		None	None	Access to 2 buildings affected for 3 months	Access to 3 buildings affected for one month	
b. Shops *1*	Noise increase	Number subject to increase of more than 5db(A)L_{10}	2	2	3	18	
	Noise decrease	Number subject to decrease of more than 5dB(A)L_{10}	27	31	29	8	
	Visual obstruction	Number of Properties within 300m of centre line Subject to:					
		Severe	0	0	0	0	
		Significant	0	1	2	0	
		Slight	2	1	1	0	

NOTE:
1 Entries in this sub-group relate to the interests of the people who own or work in shops. The effects on shoppers are given in Group 3.

Group 2: Occupiers (continued)

Sub-group	Effect	Units	Modified Blue	Modified Green	District Council Route	Do Minimum	Comments
Shops (contd.)	Severance a. Relief to existing severance b. Imposition of new severance		Some improvement 1 shop severely affected	Some improvement Slight	Some improvement Slight	No improvement None	
	Disruption during construction		Pedestrian access to 20 shops affected for 3 weeks	Pedestrian access to 15 shops affected for 4 weeks	Pedestrian access to 20 shops affected for 4 weeks	Road improvements will affect 60 shops for 3 months	
Schools and Hospitals a. Barchester Primary (233 pupils in 1978)	Noise Effect on 1 classroom where noise has been a particular problem	dB(A)L_{10}	Reductionof 5dB(A)L_{10}	Reduction of 5dB(A)L_{10}	Reduction of 2dB(A)L_{10}	Increase of 3dB(A)$_{10}$	Based on maximum traffic flow expected on a normal working day within 15 years after opening
	Severance		Moderate improvement to existing access	As modified Blue	Slight improvement to existing access	Increased traffic flow will hinder access to school	
b. Horton Cottage Hospital (40 beds Accident Unit and Outpatients Dept. open weekdays only)	Noise increase	dB(A)L_{10}	3dB(A)L_{10}	3dB(A)L_{10}	6dB(A)L_{10}	No effect	Based on maximum flow as defined above
	Visual obstruction		Slight to Outpatients Dept.	Slight to Outpatients Dept.	Slight to Outpatients Dept.	No change	
	Disruption during construction		None	Access to Hospital disrupted for 1 month	Access to Hospital disrupted for 9 months	None	
Farming		1 Number of Farms affected by land take	12	10	11	0	
	Land take	Hectares of land: Grade 2 Grade 3A	 6·8 25·0	 10·3 19·5	 12·2 20·3	 0 0	Based on MAFF land Classification. Compensation included in Group 6
Open Space a. Horton Golf Course (area 46 hectares)	Land take	Hectares	0	5·7	1·9	0	Effect on Users appears in Group 3
b. Low Road Methodist Chapel (area 2·8 hectares)	Land take	Hectares	0·6	0·6	1·0	0	Effect on Users appears in Group 3

NOTE:
1 In certain circumstances farms can be affected by severance where there is no land-take. In this case they should be included in this entry with a note to the effect in the comments column.

Group 3: Users of facilities

Sub-group: users of:-	Effect	Modified Blue	Modified Green	District Council Route	Do Minimum	Comments
a. Town Centre Shops High St./Market St. (100,000–160,000 shoppers per week)	Reduction of vehicle/pedestrian conflict	Reduces and diverts traffic sufficient to allow pedestrianisation	As modified Blue	As modified Blue	Existing vehicle/ pedestrian conflict will increase with traffic growth in town centre	Based on updated County Council 1967 Shopping Study amended in County Structure Plan
b. Community Centre (i) Civic Theatre. (Used by average of 300 people each week in 1982)	Change in traffic noise in auditorium	5dB(A)L_{10} reduction	3dB(A)L_{10} reduction	3dB(A)L_{10} reduction	To maintain current noise level will require extensive sound proofing and air conditioning	Reductions are mainly in peak traffic periods and significant mainly at weekends
(ii) Public Library. (Used by average of 1,200 people each week in 1982)	Change in traffic noise in reading room	3dB(A)L_{10} reduction	3dB(A)L_{10} reduction	3dB(A)L_{10} reduction	Existing noise will increase with traffic growth	
(iii) Day Care Centre. (Used by average of 600 old age pensioners and helpers each week in 1982)	Effect on access for the elderly	35–40% reduction in traffic	35–40% reduction in traffic	35–40% reduction in traffic	40% increase in traffic will make pedestrian access more difficult	Average age of members is 74 years
c. Warren Street shops (60,000 shoppers per week)	Convenience of customers	No facilities on new route	As modified Blue	As modified Blue	No effect	
d. Horton Golf Club (382 members in 1981)	Reduction of amenity due to land take	No effect	Reduced to 17 holes. Substantial redesign and construction could restore it to 18 holes but would require closure for 2 growing seasons	Remains at 18 holes but edge of course adjacent to 12th hole is taken	No effect	No other golf courses are locally available
e. Sailing Club (106 members in 1981)	Reduction in amenity (visual intrusion, sailing conditions, etc.)	7·6m embankment and river bridge effectively prevents sailing on last 200m of course	8·5m embankment and river bridge effectively prevents sailing on last 100m of course	7m embankment and river bridge cut sailing course approx. in half	No effect	Few sailing clubs in the area. Recently built club house supported by Sports Council
f. Horton Hunt (236 members in 1980)	Severance	2 fox runs north of town severed	As modified Blue	As modified Blue	No effect	
g. North Waxton Ornithological Society (57 members in 1981)	Loss of abandoned gravel pits	Gravel pits partly filled. Proximity of new road will disturb birds	As modified Blue	Eastern part of gravel pits filled. Proximity of new road will disturb birds	No effect	
h. Barchester Fishing Club (85 members in 1981)	Loss of fishing rights in gravel pits	Gravel pits partly filled preventing fishing	As modified Blue	Eastern part of gravel pits filled leaving only a quarter of original area for fishing	No effect	
i. Low Road Methodist Chapel (Average congregation 35)	a. Noise increase	5dB(A)L_{10} increase	3dB(A)L_{10} increase	9dB(A)L_{10} increase	No effect	These increases are less on Sundays
	b. Visual obstruction	6m embankment 30m from church	As modified Blue	8m embankment 25m from church		
	c. Severance from main part of town	Slight severance	Slight severance	Moderate severance	No effect	Land take effects appear in Group 2. Compensation in Group 6

Group 4: Policies for conserving and enhancing the area
(Views expressed are those of the relevant Authority unless otherwise stated)

Policy	Authority	Interest	Modified Blue	Modified Green	District Council Route	Do Minimum	Comments
a) To protect the Hill Street Outstanding Conservation Area	Dartshire CC Barchester DC	Improvement of the environmental quality of the conservation area and reduction of pedestrian/vehicle conflict	Reduces and diverts traffic sufficient to allow pedestrianisation	As modified Blue	As modified Blue	Traffic levels will increase with time to detriment of cobble square	DOE designated area as Outstanding in 1976. Contains one Grade I and three Grade II listed buildings
b) To protect other listed buildings outside Conservation Area	DOE Dartshire CC Bartshire DC	Effect on Wattle Hall a grade II listed building	Road in 1m cutting 500m from house	Road on 1·3m embankment 300m from house	No effect	No effect	Listing is based on interior fittings and ceilings
c) To preserve Antiquities	DOE Dartshire CC Barchester DC	Effect on tumuli: number destroyed	3	3	2	0	The area has numerous tumuli of the same period. There will be opportunity for the Dartshire Archeological Society to excavate
d) To protect Landscape in Avon Valley	Dartshire CC Barchester DC Orford PC National Tourist Board	Effect on view from Orford Church referred to in Wilton's Poem "Across the Lea"	No effect	Road on 1m embankment 600m from Church (no comment received from County Council)	Road on 2m embankment 500m from Church	No effect	Report of Landscape Advisory Committee covers Orford Church which has a Saxon Arch and Georgian Choir Stalls and is linked in legend to Hereward the Wake
e) To restore derelict land in the Avon Valley	DOE Dartshire CC Barchester DC	Restoration of abandoned gravel pits. Hectares affected	6 unaffected, 9 can be used for spoil tips and restored	8 unaffected, 7 can be used for spoil tips and restored	10 unaffected, 5 can be used for spoil tips and restored	No effect	See also Dartshire CC Policy on Country Park. See also British Waterways Board Policy on canal network
f) To create a Country Park Leisure Centre adjacent to River Avon West of Barchester	Proposed and supported by:– Dartshire CC Barchester DC Sports Council Countryside Commission Opposed by:– Horton PC	To create a Country Park and Leisure Centre along river bank and to incorporate disused gravel pits	Would prevent the creation of Country Park. Water based sports could not be developed	As modified Blue	Area of possible Park would be much reduced and overshadowed by road on high embankment	No effect	The Country Park appears as a policy in the County Structure Plan and District Council Local Plan. The creation of a Leisure Centre has potential for grant aid
g) To maintain and improve national canal network	British Waterways Board	Use of disused gravel pits as regulatory reservoirs	Less potential capacity for use as balancing reservoir	As modified Blue	Substantially less potential capacity for use as balancing reservoir	No effect	
h) To protect the habitat of rare plants	Dartshire Botanical Society *1*	Habitat of Cypripectium leitchum (orchid)	Destroys habitat	No effect	No effect	No effect	Only 4 known habitats in England. A full ecological report is available.

Note:
1 Assessment of particular impacts by local bodies should be included in the framework only where they have expert knowledge which is not available elsewhere.

Group 5: Transport, development and economic policies
(Views expressed are those of the relevant Authority unless otherwise stated.)

Policy	Authority	Interest	Modified Blue	Modified Green	District Council	Do Minimum	Comments
Transport a) To improve trunk roads to ports	Department of Transport	Ease of Access from manufacturing Centre to the port	Big Improvement	Big Improvement	Some Improvement	Increasing delays expected	White Paper on Road Policy 1980
b) To relieve local traffic problems in Barchester	Dartshire CC	Convenience of local traffic	Most effective; removal of through traffic will give scope for local traffic management measures	As modified Blue	Slightly less effective. Off peak traffic may continue to use existing route	No benefit	Dartshire CC is Highway Authority
c) To concentrate heavy goods vehicles on suitable roads	Department of Transport	% Transfer of HGVs to new route from existing route	40 – 60%	35 – 55%	20 – 30%; junction layout and location discourages transfer	No effect	
d) To improve safety and to upgrade the London to Camelot line	British Rail	Removal of Heton level crossing	Removes the need for the crossing	Crossing remains	As modified Green	As modified Green	Removal of crossing would obviate the need for local authority small scheme improvement at Heton scheduled for 1988 cost £500,000 at 1979 prices
e) To maintain river Avon navigation	British Waterways Board	Temporary effect of bridge construction on navigation	Slight reduction of head room will occur at one bridge construction site for short periods	Slight reduction of headroom will occur at bridge construction sites for short periods	As modified Blue	None	Licence under Navigation and Waterways Act required
f) To maintain viable rural bus transport system in south Dartshire	Dartshire CC Bus Operators	Effect on service reliability	Improvement	Improvement	Improvement	Increased traffic delays will reduct the bus-service reliability	
Development & Economic a) To develop Barchester as Regional Shopping Centre	Dartshire CC Barchester DC	Improve accessibility to and the amenities of shopping centre	Improves access and provides for pedestrianisation in area, but will disbenefit shops in Warren Street accelerating the decline of this twilight area	As modified Blue	As modified Blue but the effect on Warren Street shops is less severe	Current traffic congestion and delivery difficulties will increase	Policy contained in County Structure Plan and District Council Local Plan
b) To limit growth in south of County and encourage new employment and housing in villages of Scapton, Haydon, and Wettering	Dartshire CC	Effect on rural northern sector of Dartshire	Improves access to Scapton, Haydon and Wettering as well as north of County	No effect	Improves access to Scapton, Haydon and Wettering as well as north of County	No effect	County Structure Plan policy
c) To safeguard identified commercially workable gravel resources in the River Avon Valley	DOE	Gravel beds underlying river flood plan to west of Barchester	None	3·2 hectares affected	2·8 hectares affected	None	County Structure Plan policy. Time would permit the extraction of the gravel prior to construction
d) To encourage all existing non conforming industry to relocate and all new industry to locate on the Barchester Industrial Estate	Proposed by Barchester DC Opposed by Dartshire CC	Effect on access to Industrial Estate	Improves access	Improves access	No effect	No effect	Both the District and County Councils favour concentration of new and non conforming industry on industrial estates, but Dartshire would prefer growth at Blaydon City rather than Barchester. Non conforming industry is that not compatible with the general land use in the area

Group 6: Financial Effects

Sub-group	Interest	Units	Modified Blue	Modified Green	District Council	Do Minimum	Comments
Department of Transport 1	Construction costs	£m (PVC)	4·70	4·60	5·80	0·70	Costs are discounted from years of expected expenditure to 1979 at 1979 prices (PVC = present value of costs, PVB = present value of benefits, NPV = net present value)
	Land costs	£m (PVC)	1·90	2·10	2·00	0·40	
	Compensation costs	£m (PVC)	0·30	0·30	0·40	0·08	
	Maintenance costs	£m (PVC)	0·03	0·03	0·03	0·01	Excess maintenance cost due to additional length of road or improved lighting, signing etc
	Total cost	£m (PVC)	6·93	7·03	8·23	1·19	
Total quantified monetary benefits		£m (PVB)	High 7·27 Low 3·80	High 6·18 Low 3·62	High 5·95 Low 3·32	0	Includes savings in time, vehicle operating costs and accidents. Taken from Group 1
Net present value compared to do minimum		£m (NPV)	+1·53 −1·94	+0·34 −2·22	−1·09 −3·72	0	

1 Construction costs should include preparation and supervision costs.