Comptroller and Auditor General

Report on Value for Money Examination

Development of the National Roads Network

March 1999

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The report was prepared on the basis of information, documentation and explanations obtained from the bodies referred to in the report.

The draft report was sent to the Department of the Environment and Local Government and the National Roads Authority and comments were requested. Where appropriate, comments received were incorporated in the final version of the report.

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Report of the Comptroller and Auditor General

Development of the National Roads Network

I have, in accordance with the provisions of Section 9 of the Comptroller and Auditor General (Amendment) Act, 1993, carried out a value for money examination on the development of the national roads network by the National Roads Authority.

I hereby submit my report of the above examination for presentation to Dáil Éireann pursuant to Section 11 of the said Act.

John Purcell
Comptroller and Auditor General

5 March 1999

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Abbreviations

Department	**Department of the Environment and Local Government**
ERDF	**European Regional Development Fund**
NRA	**National Roads Authority**
OPT	**Operational Programme for Transport**
PPP	**Public Private Partnership**

Summary

The National Roads Authority (NRA) was set up in 1994 to oversee the provision of a safe and efficient network of national roads. At the same time, a major roads investment programme also commenced, involving total expenditure of £1.2 billion (1994 prices) in the national roads network over the six year period from 1994 to 1999.

Evaluating Programme Impacts

For the four years from 1994 to 1997, actual expenditure on national roads was £792 million. This was in line with planned spending. Of the £718 million spent on national primary roads, 70% was used on projects to develop and improve four strategic corridors.

The EU provided an estimated 60% of the funding for primary road projects. This was considerably less than the 71% which had been expected from EU sources and the balance has been met by the Exchequer. The original plan assumed that more Cohesion Fund resources would be available for transport projects than the EU Commission has been willing to allocate. For a number of co-financed projects, there have been considerable increases in the estimated project cost which the Commission has not agreed to co-finance.

Measurable impact targets were set for expenditure on the strategic corridors but not for spending on other primary roads or on national secondary roads. The targets for the strategic corridors are based on the level of service (a mix of the average driving speed achievable and the extent of traffic congestion) and the potential reduction in overall journey time for the corridor.

The overall objective in relation to the level of service to be provided by the national roads network is a minimum average inter-urban driving speed of 80 kilometres per hour. For the 1994-1999 programme, the target was that the corridor length capable of delivering the target level of service up to 2005 should increase from 35% in 1993 to 53% in 1999. The NRA has monitored progress in achieving this target by measuring the length of roadway which is improved. While this is relevant, it takes no account of demand in terms of the growth in traffic and as a result, the net achievement of the programme may be less than expected.

A detailed survey of the level of service provided by the national roads system in 1995 is a useful point of reference for updating the effectiveness target and measuring actual achievement. There is also a case for setting level of service targets for individual routes.

A target reduction of 204 minutes in journey times for the four strategic corridors was set but no estimate was made at the inception of the plan of the actual journey times for the corridors. This makes the significance of any claimed achievement difficult to interpret.

The NRA expect that total journey time savings in the period 1994 to 1999 will be in the region of 175 minutes, rather than the target 204 minutes.

Evaluation of Road Improvement Projects

The achievement of value for money from investment in roads requires that priority should be given to road investment proposals which are likely to deliver the greatest economic benefits. Accordingly, the effectiveness of the pre-planning, design and evaluation of projects can be an important determinant as to whether optimal value is obtained from the portfolio of projects ultimately executed. The examination noted several factors which pose a risk to value for money at the pre-planning stage.

- The time taken from the original inception of a proposed project to the commencement of construction is very long, in many cases up to five years.
- Decision making is fragmented across a number of organisations at central government and local level and the network of policies and procedures contribute to delays which can significantly increase the estimated costs of projects.
- Up to now, there have been sufficient road improvement projects to absorb the available funding but the NRA has generally had only a few matured projects to choose between when making spending decisions. It has sharply increased the funding for planning and design work from £9 million in 1998 to £17 million in 1999.

The examination considered the criteria used by the NRA to evaluate potential projects. While all the criteria are relevant, no formal threshold levels for the criteria have been set and there is no ranking of their relative importance.

An economic evaluation model has been developed as part of the evaluation system. This involves computation of the internal rate of return (IRR) for proposed projects based on the forecasted costs and benefits over the expected economic life of the road. The economic model is used primarily for the initial evaluation of proposed projects. The benefits identified in the model are not used as targets for the subsequent measurement of effectiveness.

The examination compared the assumed time savings used in the calculation of IRR for ten projects with later estimates of time savings for those projects derived using a special methodology also developed by the NRA. This comparison revealed that in seven cases, the estimates used in the IRR computation were too high. Using the more reliable later estimates of journey time saving would produce a different prioritisation of road projects.

During the lengthy process of planning and design of projects, the expected costs and benefits of the project may change, thus altering the economic justification for the

project. While road projects are subject to review at any time, the examination found no case where a project was stopped at planning or design stage due to negative changes in the factors supporting its economic justification.

Control of Project Costs and Duration

Since 1997, the NRA has taken steps to improve its cost control systems and procedures, notably through the introduction of quarterly project reports and the issue of guidelines on project cost estimation to local authorities. The guidelines allow for large margins of error in the cost estimation process – up to 50% at the preliminary design stage and 25% thereafter.

The plan for the roads programme comprised a number of projects already underway and a list of projects in planning but did not preclude additions to the list. Of the 41 projects so far included in the programme, 32 were listed in the plan. These were estimated to cost £790 million (1994 prices). By mid-1998, the estimated cost of these projects (some completed and some still ongoing) was £971 million. The increases were significantly more than could be explained by inflation and have been attributed mainly to a combination of poor original estimates and allowing the introduction of major changes in scope and quality at the design stage.

The examination also noted a significant range in the unit construction cost of the major improvement projects completed between 1994 and 1997. For example, the cost per kilometre of motorway was between £3.2 million and £6.1 million while the cost for standard dual carriageways varied between £1.6 million and £6.8 million per kilometre.

Strategic Planning for National Roads Development

The establishment of the NRA and the experience of the current road development programme have led to a strengthening of the processes and procedures for the strategic management of roads development although the findings in this report indicate that there is room for further improvement. The continuing increase in traffic growth and the need to diversify the sources of funding and develop new models of roads provision present new challenges for the next investment programme. The availability of management information to track outputs and impacts against quantified targets is a prerequisite for measuring the achievement of future programme objectives. There is also a need for the NRA to benchmark its performance against its counterparts in other countries.

Development of the National Roads Network

1 Introduction

1.1 The provision of effective transport infrastructure has long been recognised as an essential requirement for economic and social development. The manufacturing industry, agriculture and food and tourism sectors of the economy are all heavily dependent on the existence of an integrated transport system to facilitate quick and reliable movement of people and goods within the island, by road and rail, and to and from external markets, through air and sea ports.

1.2 The development of economic activity and the creation of employment in more peripheral regions are also dependent on effective transport systems. The importance of transport links has increased with the abolition of restrictions on trade and the increasingly free movement of capital, goods, services and people under the single European market. Without action to reduce transport costs to and from the peripheral regions, this development could result in increasing concentrations of economic activity in the already developed central areas of the European Union (EU).

1.3 In 1994, the Government adopted an integrated programme of investment in both internal and access transport infrastructure, to be funded jointly by the EU and the Irish Exchequer. The programme envisaged that a total of £2.6 billion (in 1994 prices) would be invested in transport infrastructure in the period 1994 to 1999. Over 46% (£1.2 billion) of the planned expenditure was intended for investment in the national roads network.

The National Road Network

1.4 The national road network accounts for 6% of the 94,500 km of public roadways in Ireland. It consists of the most heavily used parts of the road system, carrying 37% of all road traffic. The national network is divided into two classes of roads.

- The **national primary roads** are the major long-distance through-routes linking the ports and airports, cities and large towns, serving major geographic regions and a high percentage of the total population.
- The **national secondary roads** are medium-distance through-routes connecting important towns, serving medium-sized to large geographical areas and providing links to the national primary roads to form a comprehensive network.

1.5 The remaining 94% of the public road system (the 'non-national' roads network) consists of roads in urban areas (accounting for 3% of the total road length), regional roads (12%) and local roads (79%).

Agencies involved in the National Roads Programme

1.6 The National Roads Authority (NRA) was established under the Roads Act, 1993 to secure the provision of a safe and efficient network of national roads. The Authority has no responsibility for the non-national roads, which are managed and maintained by the relevant local authorities.

1.7 The Roads Act, 1993 allows the NRA to undertake maintenance and construction work on national roads but the Authority is obliged, as far as possible, to arrange for local authorities to carry out such work. Consequently, local authorities act on behalf of, and under the supervision of, the NRA in managing the design, construction and maintenance of the national roads, including the responsibility for any required acquisition of land, management of construction projects and the agreement of road works contracts.

1.8 The Department of the Environment and Local Government (the Department) exercises overall policy supervision in relation to the national road network and provides Exchequer and EU funding to the NRA.

Value for Money in the National Roads Programme

1.9 Substantial investment in national roads under the 1994-1999 transport programme, and its predecessor, have had a very significant impact on the quality of Irish roads. Major bottlenecks have been removed from the national roads network, freeing the flow of traffic and reducing travel times on improved sections. However, traffic is growing quickly in response to economic growth and it is generally acknowledged that very considerable further investment in the national roads network is required to meet the needs of the economy.

1.10 While many road improvement projects may be desirable, there are not enough resources to undertake them all. In effect, choices have to be made about which projects should get priority. In such a situation, optimising value for money involves choosing the set of projects which delivers most benefits within the available funding.

1.11 The primary aim of the roads investment programme is to reduce journey times for travellers and thereby contribute to economic development. Evaluation of the effectiveness of the roads investment programme must consequently focus on the extent to which it impacts on journey times.

1.12 There are particular problems in trying to achieve efficiency in most infrastructural projects and programmes because the nature of the service provided is long-term but the bulk of the costs are borne up-front. Road projects typically adopt a twenty-year

horizon, in that they are designed to cater for forecast traffic levels twenty years on. The standard approach is to build roads to cater for those future levels of traffic but this usually means there is a some element of over-provision in earlier years.

1.13 Good project management and monitoring systems are required to ensure that maximum economy is achieved under the roads investment programme. When the required service for each project is provided at the least possible cost, more benefits can be obtained overall from the available level of resources.

Scope and Objectives of the Examination

1.14 The examination focused on achievement in the period 1994-1997, when almost £800 million was spent on national road projects and other improvements.

1.15 The overall objective of the examination was to establish if the systems, procedures and practices in place in the NRA were adequate to ensure that the national roads development programme was carried out economically, efficiently and effectively.

1.16 The examination focused in particular on

- how the roads development programme is evaluated and monitored in terms of the achievement of overall programme impact objectives
- the system for appraisal of individual project proposals and the selection of projects for funding
- project monitoring in terms of achievement of budget and time objectives for individual projects
- the adequacy of strategic planning for the development of national roads, particularly after the current programme finishes in 1999.

1.17 The examination looked only at issues related to the national roads development programme. Issues related to investment in non-national roads and in other transport sectors were not covered. The process used in deciding on how much funding should be allocated to each of the different transport sectors, or on the division of funding between national and non-national networks was not considered.

Examination Methodology

1.18 The examination was carried out by staff of the Office of the Comptroller and Auditor General. Information was obtained from documentation review, interviews with relevant personnel and written replies to queries by the NRA and the Department of the Environment and Local Government to formal requests for information.

1.19 Consultants from the Department of Civil, Structural and Environmental Engineering, Trinity College, Dublin and Goodbody Economic Consultants were engaged to provide assistance during the examination, in particular in relation to the methodologies used by the NRA for prior appraisal of projects and post-implementation evaluation of programme impacts.

2 Impact of the National Roads Development Programme

2.1 The plan for the development of the national roads specified the amount of funding which would be made available in the years 1994 to 1999 and the benefits anticipated as a result of the planned expenditure. In discussing the expected benefits, the plan indicated the level of service which would be provided to road users and the journey time savings to be achieved as a result of the investment in roads.

2.2 Since the expected benefits of the roads investment programme are unlikely to emerge unless the planned scale of investment takes place, this chapter first examines the extent to which the available funding is actually being used. This is followed by consideration of the arrangements for evaluating whether the planned impacts of the roads development programme are being achieved.

Expenditure on Road Investment

2.3 The roads development programme covering the six-year period from 1994 to 1999 provided for total funding of £1,099 million (1994 prices) for investment in the national primary roads and £114 million (1994 prices) for investment in the national secondary roads.

2.4 The primary road network was to be improved by a combination of major improvement projects (new roads, major realignment of existing routes, town by-passes and relief and ring roads) and a programme of smaller-scale integrated network improvements, including road widening, improvements to road pavement and drainage and safety measures. The investment in primary roads was to be concentrated mainly on four strategic corridors, linking the main centres of population and opening up good access routes from the more remote and cross-border areas to the primary air and sea ports (see Figure 2.1). Together, these strategic corridors account for around 1,570 km (57%) of the primary road network.

2.5 The strategy for investment in the national secondary routes was also to concentrate on the improvement of a small number of routes which were considered to be of particular importance for economic development. This included a number of roads which interlink the strategic corridors and roads with heavy tourism traffic, such as the Ring of Kerry. The work to be undertaken on these routes was similar to that proposed for the integrated network improvements on the national primary roads.

2.6 Table 2.1 shows the breakdown of expenditure on national road improvements over the years 1994 to 1997. Almost three-quarters of the expenditure has been on major road improvement projects on the primary roads.

Figure 2.1 National primary and secondary roads network

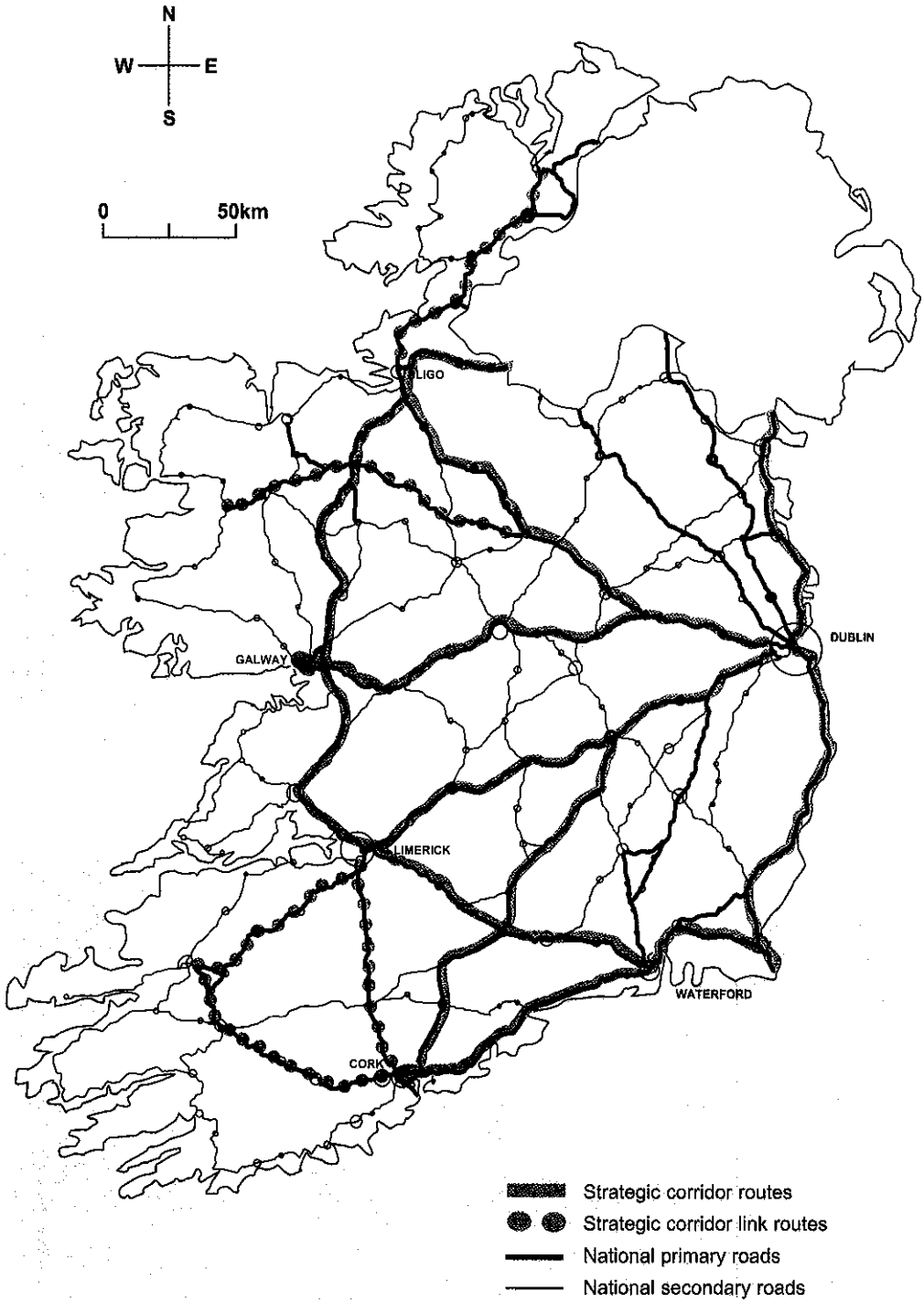


Table 2.1 Expenditure on national roads, 1994-1997, by measure

	Primary roads		Secondary roads	All measures
	Major improvements	Integrated improvements		
	£m	£m	£m	£m
1994	131	27	14	172
1995	145	29	17	191
1996	152	29	19	200
1997	158	47	24	229
1994-1997	586	132	74	792
(percentage of total)	*(74%)*	*(17%)*	*(9%)*	*(100%)*

Source: Department of the Environment and Local Government

2.7 Taking account of inflation[1], planned spending for the national roads programme in the period was around £791 million. Since actual expenditure totalled £792 million, the Department and the NRA have succeeded in spending the available funding.

2.8 The intention in the roads development plan was that at least 70% of the total expenditure on the primary roads would be allocated to the four strategic corridors, reflecting their economic importance. In the period 1994 to 1997, 70% of the spending on the national primary roads was used on projects and integrated network improvements on the strategic corridors.

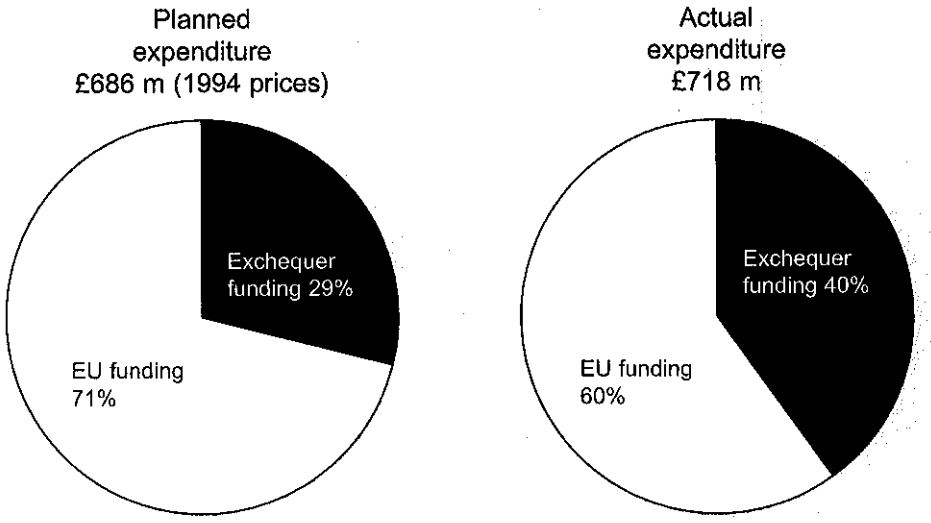
Drawdown of EU Funds

2.9 The national roads programme is funded from three main sources – the European Regional Development Fund (ERDF), the EU Cohesion Fund and the Irish Exchequer. Investments in the national primary roads may be financed by a combination of European and Exchequer funding or by Exchequer funding only. Investments in the secondary roads are mainly co-financed by the ERDF and the Exchequer.

2.10 The plan for the roads investment programme envisaged that an estimated 71% (£510 million) of the total investment in the national primary roads in the period 1994-1997 would come from EU sources (see Figure 2.2). The remaining £208 million was to be funded by the Irish Exchequer. Estimates based on analysis of actual spending suggest that EU sources provided only around £431 million in those years. The Exchequer provided £287 million which is around £79 million (or 38%) more than was expected.

[1] *In this report, the construction cost index produced by the Society of Chartered Surveyors is used to calculate inflation effects for capital spending.*

Figure 2.2 National roads programme expenditure on primary roads 1994 - 1997, by source of funding



Source: Analysis by Office of the Comptroller and Auditor General.

2.11 The extra Exchequer spending is not related to delays in claiming of EU payments. It has arisen for three reasons.

- The original expenditure plan assumed that up to 60% of the cohesion funding for Ireland would be available for transport projects (mainly national roads), with the balance being provided for environment projects. This was not agreed with the EU Commission at the time the roads development programme was drawn up. In the event, the Commission has insisted on a distribution of cohesion funding between transport and the environment on a 50/50 basis. This has meant a corresponding reduction in the amount of Cohesion Fund assistance available for national primary roads. Consequently, the Exchequer has to fund more projects without the benefit of EU co-financing if the programme's activity and impact targets are to be met.
- Up to 85% of the cost of projects approved for co-financing can be met from the EU's Cohesion Fund. In most cases, the EU Commission's commitment was to provide the maximum level of assistance based on the cost of the project as estimated at the time of the application. Subsequently, there were substantial increases in the estimated cost of a number of projects but only some of the increases were approved for financing from the Fund. Cost increases not accepted for funding by the Commission must be borne in full by the Exchequer.
- The EU Commission made allowances for inflation based on the EU-wide rate. Cost increases in the Irish construction industry were considerably higher. The difference has been met by the Exchequer.

2.12 The split between EU and Exchequer sources of funds may change as a result of spending over the final years of the programme but it is highly unlikely that the planned split will be achieved. The Department is confident that all available EU funding from the ERDF and Cohesion Fund will be drawn down. This can only occur if higher than planned levels of Exchequer expenditure are incurred.

Programme Impacts

2.13 The ultimate objective of investment in national roads is to contribute to economic development nationally and regionally, principally by reducing transport costs. The specific impact objectives adopted in the national roads development programme focus on the concepts of level of service provided by the roads network and journey time savings. (These concepts are described in Appendix A.)

2.14 The long-term objective is to achieve a minimum level of service which will permit an average travel speed of 80 km per hour on inter-urban sections[2] of the national primary roads network, including the strategic corridors. The programme does not contain an objective in such terms for the secondary roads network but in practice, the same level of service is regarded as a benchmark for evaluating the adequacy of the secondary roads network.

2.15 The NRA commissioned a study of the level of service provided by the national roads system. As Table 2.2 shows, 91% of the primary roads and 94% of the secondary roads were found to provide the target level of service or better in 1995. However, without investment in roads, increasing traffic volumes will reduce the level of service provided. For example, the study concluded that around 20% of the primary road network would fall below the target level of service by 1999 due to rapid traffic growth.

[2] *Inter-urban sections of the network are those where the national speed limits apply.*

Table 2.2 Estimated level of service provided by national primary and secondary roads, 1995

Average speed achievable[a]	Primary roads		Secondary roads	
	%	km	%	km
84 km/hour or more	41	924	66	1,548
80 km/hour	50	1,120	28	667
72 km/hour	9	204	6	131

Note:[a] Average speed achievable on inter-urban sections in normal conditions over the year. Speeds shown relate to standard two-lane roads. Higher average speeds would be achievable on sections of road which are of a higher specification i.e. dual carriageway or motorway.

Source: National Road Needs Study

Programme Targets

2.16 The resources available under the roads development programme, although considerable, were insufficient to achieve the overall level of service objective for the national roads network i.e. a minimum average inter-urban travel speed of 80 km per hour. Consequently, it was necessary to set impact targets for what could be achieved in the period 1994 to 1999 with the available investment funding. Table 2.3 summarises the specific impact targets set for the roads development programme.

2.17 The targets set for the strategic corridors are clear and precise and are expressed in terms which were relevant to the overall objectives for development of the national roads network. The impact indicators chosen are capable of measurement. Some of the targeted impact was related to projects already underway at the end of 1993 and it was recognised that the impact of projects not completed by the end of 1999 would carry over to later years i.e. 2000 or after. (A more detailed assessment of the targets set for the programme is given in Appendix B.)

2.18 The journey time savings target is a useful impact indicator for the roads improvement programme but it could be improved by setting it in the context of an overall estimate of the end-to-end journey time. Total end-to-end journey times for the strategic corridors at the start of 1994 were not estimated. This makes it difficult to assess how significant an impact the target journey time savings are likely to be. There was no impact target for non-strategic primary roads or for secondary roads.

Table 2.3 Impact targets for national roads development, 1994-1999

Part of network	Impact targets
Strategic corridors	
Level of service impact	● By end-1999, 53% of corridor length to be capable of delivering target level of service until at least 2005 (up from 35% at end-1993)
Journey time impact	● Reduce journey time on strategic corridors by a total of 204 minutes by 1999
	● Reduce total journey time variance
Other national primary roads	● No impact target set
National secondary roads	● No impact target set

Source: Operational Programme for Transport 1994-1999.

Monitoring Impact Achievement

2.19 By monitoring the extent to which the targets are being achieved, an organisation should reach a better understanding of what contributes most to, or impedes, its effectiveness and be able to take timely action to ensure that it achieves the maximum impact possible in the circumstances.

Monitoring Level of Service Achievement

2.20 At the end of 1993, it was estimated that 35% (549 km) of the strategic corridors' length had sufficient capacity, given the level of traffic anticipated, to deliver the required level of service until at least 2005.[3] The roads development programme 1994-1999 was intended to increase the proportion of the strategic corridor routes capable of delivering the target level of service to 53%.

2.21 The main way in which the NRA has monitored progress in relation to the achievement of this target is to track the length of roadways improved. This is useful as an output measure for the programme and it is reasonable to conclude that roads improved under the programme will deliver the required level of service until at least 2005. But because traffic is growing faster than anticipated, some of the network thought to be adequate at the end of 1993 may already have slipped below the target level of service so that the net impact of the roads development programme is less than expected.

[3] *The results of the 1995 survey and the associated analysis (see Table 2.2) suggest that the level of service provided by the national roads network was not as low as was estimated in 1993 when the level of service target for the roads development programme was set.*

2.22 The 1995 survey of the level of service provided by the national roads network, commissioned by the NRA, provides a useful and comprehensive database for measuring level of service impacts and for setting effectiveness targets. This should facilitate the setting of meaningful impact targets for each part of the network in the future and should also assist in monitoring programme performance.

Monitoring Journey Time Impacts

2.23 Spending on the four strategic corridors under the roads development programme was expected to reduce the journey time on the corridors by a total of 204 minutes by the end of 1999 (see Table 2.4). It was also expected that the variability of journey times would be reduced but no specific target was set in relation to this.

Table 2.4 Target journey time savings under roads improvement programme 1994-1999, by strategic corridor

Strategic corridor		Original (1994) target time savings (minutes)	Current (1998) target time savings [a] (minutes)
North/South	Border-Dublin (N1)	28	14
	Dublin-Wexford (N11)	12	13
	Rosslare-Cork (N25)	22	8
South West	Dublin-Limerick (N7)	33	26
	Dublin-Cork (N7/N9)[b]	40	35
East/West	Dublin-Sligo (N4)	40	45
	Dublin-Galway (N4/N6)[b]	13	21
Western	Sligo-Limerick-Waterford (N17/N18/N24)	16	13
All corridors		204	175

Notes:[a] *The current target journey time savings includes some time savings associated with projects not funded under the roads investment programme. Excluding these reduces the estimate of expected time savings by around 10 minutes.*

[b] *Journey time savings on parts of corridors shared by two routes are counted twice.*

Source: National Roads Authority

2.24 The NRA and the EU Monitoring Committee for the Operational Programme for Transport concluded around the end of 1998 that journey time savings will be significantly less than originally projected. The Authority now expects that the total journey time savings which will be achieved by end-1999 will be around 175 minutes, rather than the original target of 204 minutes.

2.25 The NRA have developed a model (referred to as RouteSim) for estimating average journey times on individual routes. While the model has the potential to provide estimates of end-to-end journey time savings, this has only been done for a few routes. In general, the model is employed to calculate expected transit time savings along the individual sections of road which are being improved. These savings are then aggregated as estimates of the target reduction in journey times on routes.

Conclusions

2.26 Lack of planned funding to carry out the intended work is one possible reason why a spending programme might not deliver the expected benefits. There was no such problem with the national roads investment programme over the period 1994 to 1997, when expenditure was on target. The proportion of programme funding provided by the Exchequer was significantly greater than was originally planned.

2.27 Most of the elements needed to allow the effectiveness of the roads investment programmes to be evaluated are in place but have not been fully implemented as an integrated effectiveness evaluation system. They should be used more actively in the setting of clear and measurable targets for future road investment programmes and in the subsequent monitoring of achievements.

3 Evaluation of Road Improvement Projects

3.1 A principle underlying the roads development programme was that priority should be given to road investment proposals which were likely to yield the greatest economic benefit. The application of this principle links the road project selection process to the achievement of effectiveness of the roads investment programme.

3.2 A list of major road improvement projects was included in the roads development programme plan. This included a number of projects which were already underway and a further indicative list of projects which were at various stages of preparation. Projects for inclusion in the programme were not restricted to those on the indicative list and were to be selected on the basis of certain criteria and procedures so as to achieve the target programme impacts within the available funding levels.

3.3 The objective for effective management of individual road improvement projects should be to ensure, as far as possible, that the expected benefits are delivered within the agreed spending limits. This requires systems to record the expected benefits of individual projects and to monitor and evaluate the extent to which they are achieved. Where it appears that projects have departed substantially from plans and will deliver poorer than expected value for money, action to remedy the situation or to avoid similar problems in the future may be required.

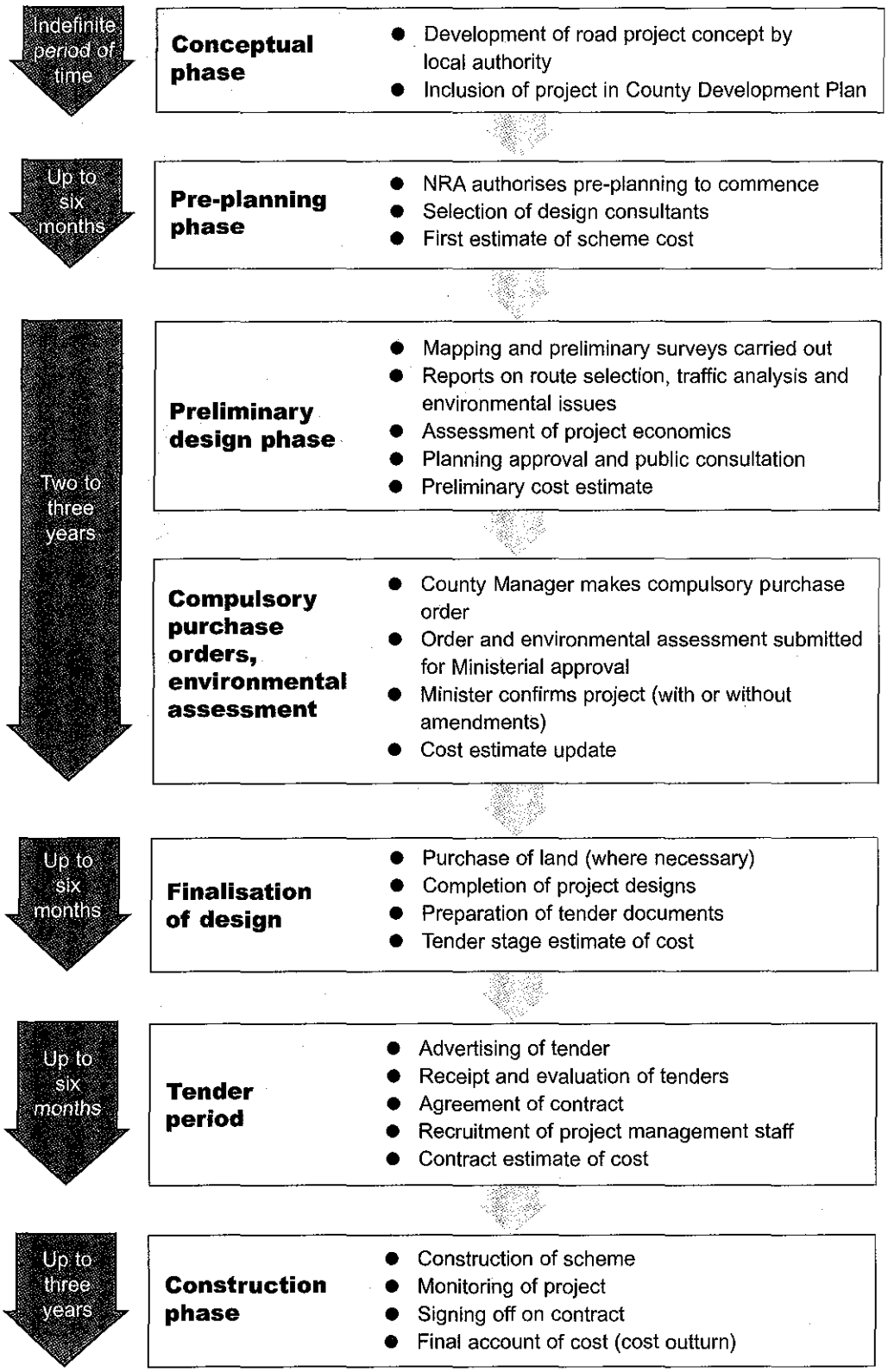
3.4 This chapter describes the various phases involved in planning and designing road construction projects. In that context, it then considers the adequacy of systems and practices within the NRA for evaluating the effectiveness of individual road investment projects.

Phases in Road Construction Projects

3.5 Figure 3.1 presents an outline of the phases and activities undertaken in carrying out a major road improvement project from initiation to operation, based on the NRA's current procedures. The diagram also gives a general indication of the amount of time involved in completing the phases, assuming no major difficulties are encountered.

3.6 Most current major road improvement projects emerged in response to recognition by the relevant local authorities of the need to deal with inadequate road capacity for existing or anticipated traffic, unacceptable delays, unsafe road conditions or urban planning pressures. The difficulty with this process for initiating national road projects is that it lacked strategic coherence and prioritisation. It was partly to introduce that kind of perspective and overview that the NRA was established in 1994.

Figure 3.1 Phases and main activities in major road improvement projects



3.7 Active planning begins when the local authority receives authorisation from the NRA to commence pre-planning for a project. This is effectively a decision in principle to back the project. From that point on, the NRA and the local authority are in regular contact about the development of the scheme.

3.8 One of the first tasks to be undertaken is the preparation of an estimate of the cost of the proposed improvements. This provides the basis for developing an early view of the relative attractiveness of the project in terms of the balance of costs and benefits. At each stage thereafter, the estimate of cost of the project is subject to review.

3.9 The process involved in moving a project from initial authorisation to the point where construction commences is very lengthy because of the amount and nature of the work to be done and because of the number of agencies involved in decision-making at different stages. This presents a risk to value for money. In normal circumstances, about four years is required to negotiate all the pre-construction stages. In some cases, the process could be completed in slightly less time but projects often take considerably longer. Elapsed times of five to eight years from pre-planning of major road improvement projects to completion of construction are not uncommon.

3.10 Proposed motorway schemes are subject to Ministerial confirmation, following public inquiry and environmental impact assessment. The last six schemes submitted to the Minister were confirmed subject to specified modifications, with the process taking from around four months in one case to almost two and a half years in another. Four of the six cases received confirmation (with modifications) in under a year. The factors considered in arriving at a decision include

- the report and recommendations of the inspector who conducted the public enquiry and the transcripts of evidence
- the environmental impact assessment
- objections to the scheme
- submissions in relation to the effects of the proposed development on the environment.

Selecting Projects for Funding

3.11 The principle of giving priority to the projects which are likely to yield the highest economic benefits is based on the presumption that there are several projects competing for inclusion in the programme when funding choices have to be made. This is not always the case. The planning and design of major road projects is, in itself, an expensive process. It would be undesirable to advance too quickly with plans if the funds required to carry them out are unlikely to be available. On the

other hand, too few matured designs for projects could result in funds which are available not being taken up or being used for projects which yield fewer benefits.

3.12 In the period 1994-1997, there were sufficient road improvement projects, including those already started in 1994, to consume the available level of resources. However, when decisions were being taken to start new projects, the NRA did not have a wide range of fully developed proposals. In that situation, the basis for the selection decision has been whether or not the available projects are satisfactory, rather than choosing the best of the competing projects.

3.13 The NRA is taking steps to increase the number of projects ready to proceed to construction stage. It is providing almost £17 million in 1999 for forward planning and design of major road improvement projects. This is almost double the level of funding provided in 1998 (£9 million). The Authority expects to maintain or increase the level of provision for planning and design in anticipation of increased availability of funding for investment in roads in future years.

Evaluation of Project Proposals

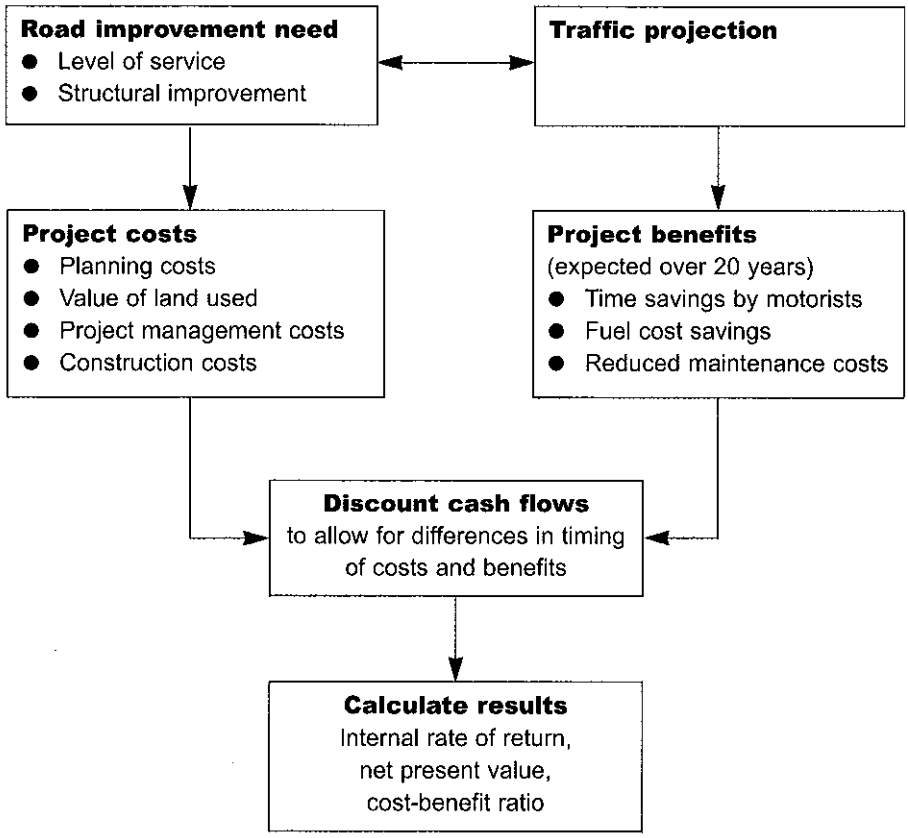
3.14 The NRA considers the following factors in assessing major projects for inclusion for funding under the roads development programme

- the impact the project will have on the overall road network
- expected transit time savings resulting from the project
- estimated internal rate of return from the project
- existing road condition
- accident risks
- regional balance.

3.15 The methodology developed for estimating the internal economic return (IRR) of road projects is relatively simple and easy to apply.[4] It involves measuring the benefits of a proposed road investment project over a 20-year project life in terms of estimated time savings and fuel cost savings arising for motorists using the new road section instead of the old road network. Monetary values are assigned to the projected benefits and these are then compared with the estimated capital cost of the scheme and the projected ongoing cost of maintaining the existing road(s) affected by the improvement work (see Figure 3.2).

[4] *A more detailed description of the economic evaluation methodology is given in Appendix C.*

Figure 3.2 Summary of NRA's economic assessment model for major road projects



3.16 The economic evaluation methodology does not incorporate benefits arising from reductions in road accident risks or environmental costs and benefits associated with projects. These factors have the potential to impact differently on individual projects and may alter their relative attractiveness. Incorporating them into the calculation of the IRR for projects could improve its usefulness as a project evaluation tool but it is recognised that there are practical difficulties in doing so.[5]

Threshold Values for Evaluation Factors

3.17 There is no formal statement of the minimum or threshold levels for the various evaluation factors which projects should reach if they are to be eligible for funding. Nor is there any statement of the relative weights given to the factors. Without such standards being set, it is difficult to develop a view of what kind of project is most desirable and delivers the most benefits.

[5] *This is discussed in more detail in Appendix C.*

3.18 The Department of Finance have specified a benchmark rate of return for public capital investment projects (5% in real terms). While this has not been formally adopted by the NRA as a threshold level of IRR which projects have to reach, it is generally accepted within the Authority that a project which was not expected to achieve at least that IRR would be unacceptable.

Identifying Project Targets

3.19 Evaluating the extent to which the expected project benefits are achieved depends on knowing clearly what was expected from each project under each of the factors considered when the projects are selected for funding. The NRA does not maintain a readily accessible database of the expected benefits from individual projects. This limits the Authority's ability to evaluate how effectively and efficiently projects are being implemented.

3.20 The NRA was asked to provide copies of the IRR estimates of each of the 41 major projects included in the roads development programme. The Authority provided currently anticipated, rather than target, IRRs for 34 of the projects. Of the seven projects where IRRs were not calculated

- Four were primary road projects commenced prior to 1994.
- Three were major projects on secondary routes costing an estimated total of £29 million. In general, economic analysis of secondary route projects was not undertaken in the past. The Authority has stated that all major secondary route projects are now subject to economic analysis.

3.21 In all cases where IRRs were provided, the current estimates are in excess of 5%. A few projects exceed this level by a small margin but most were considerably higher.

3.22 The IRRs provided were based on estimates of time saved by traffic travelling on the improved sections of road. For ten of the sections, the RouteSim model has also been used subsequently to estimate transit time savings. In most cases, the estimates used in the economic analysis were considerably higher than those suggested by RouteSim (see Table 3.1). Applying the RouteSim estimates in the economic analysis would consequently produce a very different listing of IRRs for the projects.

3.23 The NRA points out that RouteSim was not operational when many of the schemes examined were being planned and analysed. For future projects, RouteSim will be used to provide more accurate estimates of expected time savings.

Table 3.1 Estimates of time savings expected from selected road improvement projects

Project	Estimated time saving (minutes)		RouteSim estimate as % of original estimate
	projected in economic evaluation	calculated using RouteSim model	
Lucan-Kilcock	8.3	19.7	237%
Longford by-pass	3.8	4.7	124%
Roscrea by-pass	2.2	2.1	96%
Galway Eastern approach	1.7	1.5	88%
Portlaoise by-pass	5.7	4.7	83%
Mullingar by-pass	9.8	7.5	77%
Enniscorthy-Wexford	1.6	1.2	75%
Newbridge-Kilcullen	16.7	11.7	70%
Drumsna-Jamestown	4.4	2.6	59%
New Ross-Wexford	1.4	0.8	57%

Source: Analysis by Office of the Comptroller and Auditor General

Changes in Project Circumstances

3.24 As considerable periods can elapse between preliminary design and the issue of project contracts, the values associated with the factors used in evaluating projects (such as current or forecast traffic level) may change. In addition, cost estimates for projects can change substantially as the road designs are developed, particularly if planning delays occur.

3.25 If at any stage the economic argument for a project is seriously weakened (e.g. because it emerges at the tender stage that the expected construction cost will be much higher than originally anticipated), the option of not proceeding with the project at that time and assigning the resources to a more valuable project should be considered. Even when there has been considerable expenditure on planning and design, it may be better to treat that expenditure as a sunk cost and redirect the resources allocated to the project to one which is likely to deliver better value for money. If benefits not incorporated into the economic evaluation methodology (such as the strategic importance of the project or regional balance factors) are considered to outweigh the reduced economic return, this should be formally noted.

3.26 The NRA states that road project economics are subject to review at any stage when a revised estimate of construction costs becomes available. However, there is no evidence that any project was terminated because the expected costs were escalating or that reviews are undertaken when there are changes in factors other than cost (e.g. changes in forecast traffic growth or estimated time savings) which could influence the economic return on projects. The review process is not formally documented and since there is no clear original target estimate of economic return, it is difficult to establish the impact of changes in project circumstances on the IRR.

Conclusions

3.27 Most of the factors considered by the NRA when it is evaluating projects for funding relate to benefits which the project is expected to deliver in the future. The NRA is not in a position to easily monitor or evaluate the extent to which the expected benefits are delivered because it does not formally record the target benefits of individual projects.

3.28 The NRA has inherited and further developed an economic evaluation methodology which facilitates the estimation of economic returns from individual road improvement project proposals, based principally on expected time savings of travellers as a result of improvements. This could be used in identifying target economic benefits of projects and in monitoring and evaluating outturns. However, it is not currently used in this way by the NRA.

4 Control of Project Costs and Duration

4.1 The NRA is legally required, as far as possible, to arrange for local authorities to take on responsibility for improvement and maintenance works on national roads. Consequently, the Authority needs to have appropriate systems to monitor the extent to which the projects it is funding are delivered within the expected budgets and time frames.

4.2 Effective monitoring and control of projects requires the setting of clear, achievable budgetary and time targets against which progress can be measured. By identifying reasons why a project runs over on cost or is delayed, it may be possible to direct extra effort to dealing with the root causes of the problem or to change procedures and processes to avoid similar problems in the future.

Monitoring and Controlling Project Costs

4.3 The first estimate of cost of road improvement proposals is produced at the pre-planning stage. This is used in the economic appraisal of the proposal and informs the decision to spend resources on planning and design. Subsequently, as more information is gathered and a clearer picture of the requirements emerges, the estimate of project cost may change.

4.4 For many of the projects included in the roads investment programme 1994-1999, there was no effective system to monitor and track the changes in estimates of cost over the lengthy planning and design stages and to identify the reasons for such changes. In response to concern that there were significant increases in the estimates of cost of projects included in the roads investment programme, the NRA took steps at the end of 1997 to improve its cost control systems and procedures. These include the development of a new system of quarterly project reports for recording project cost information and the publication in May 1998 of guidelines for local authorities on project cost estimation.

4.5 The guidelines recognise that the first estimate of cost of a road scheme can be very imprecise because of a lack of relevant information and suggest that the final outturn cost for a project may be 50% more or less than the original estimate. The guidelines also suggest that by the time the preliminary design stage (including receipt of planning approvals and public consultation) is completed, this margin of uncertainty should be reduced so that the final outturn cost is more likely to be within 25% of the preliminary design stage estimate. These represent expected margins of error on cost estimates.

4.6 The guidelines reflect the considerable difficulties which are inherent in estimating the cost of long-term capital projects but could be improved in a number of ways.

- It is not clear from the guidelines whether the specified margins of error for cost estimates are intended to cover normal cost inflation. The treatment of inflation should be specified.
- There is an ambiguity about the way the guidelines are phrased which suggests that cost increases up to the limits of the margins of error would be acceptable. More emphasis should be given to the expectation that the final outturn on projects should be equally likely to fall above or below the estimate.

4.7 When the NRA undertakes an economic evaluation of a proposed project, it carries out a check of the sensitivity of the estimated IRR to adverse changes in capital costs and forecast traffic growth. While this is standard good practice in relation to such models, the test in relation to capital cost is limited to examining the implications of an increase of 10% in costs. This assumption appears to underestimate the risk of cost increases acknowledged in the NRA's own guidelines. In carrying out sensitivity analysis on economic assessments, the assumptions made should reflect more accurately the expected reliability of the cost estimates used.

Project Cost Increases on Roads Investment Programme

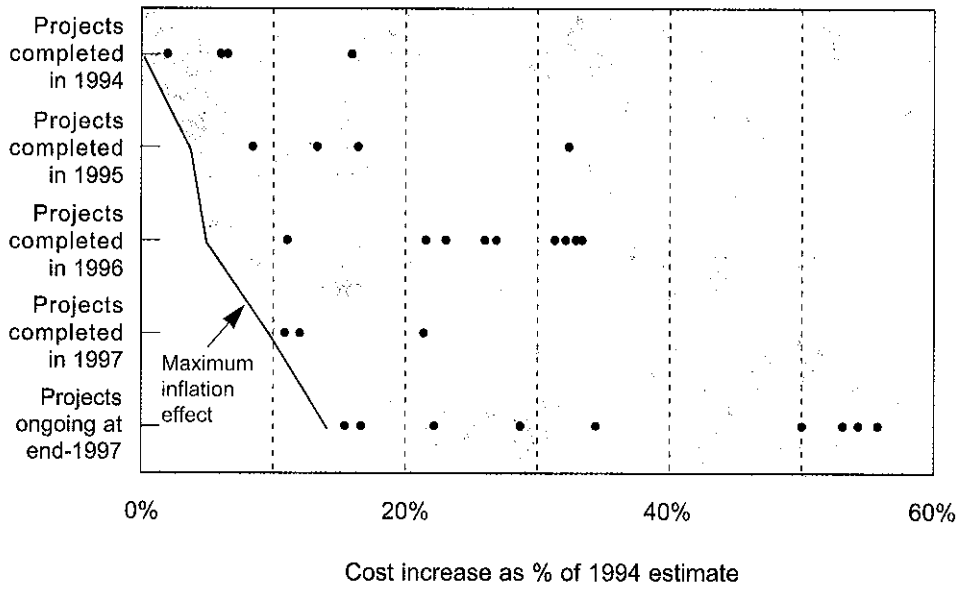
4.8 Some evidence of the extent to which costs have increased can be found by comparing the estimates of cost of projects at the start of the programme with the latest estimates of cost. The application for funding for the Operational Programme for Transport 1994-1999 (OPT) was prepared at the end of 1993. This presented estimates (in 1994 prices) of the capital cost of 32 of the 41 major projects completed under the programme in the period 1994-1997 or which are currently underway.[6] In July 1998, the NRA provided up-dated estimates of the final cost of projects. Comparing the 1993 and 1998 estimates indicates that substantial increases have occurred in the estimated cost of many projects. In all, the 32 projects undertaken are now estimated to cost over £180 million more than expected at the end of 1993. Since many of the projects are still underway, the final outturn on cost could involve further increases.

4.9 Figure 4.1 shows the percentage cost overrun for each of the projects, differentiating between projects completed in each of the years 1994 to 1997 and those which are still ongoing.

4.10 The original estimates of project cost were expressed in 1994 prices and did not include any allowance for inflation during the remaining life of the project. Figure 4.1 includes a profile of the maximum effect inflation could be expected to have on individual projects completed in each year. On that basis, the cost increases on few of the projects were close to the level which could be attributed to inflation alone.

[6] *The projects included in the roads investment programme up to the end of 1997 are listed in Appendix D.*

Figure 4.1 Increase in estimated cost of major road improvement projects included in the roads programme, 1994-1997



Source: Analysis by Office of the Comptroller and Auditor General.

4.11 The report on a mid-term evaluation of the OPT by independent consultants[7] identified this problem of cost estimate increases. They concluded that cost increases, over and above what might be due to inflation, occurred for three main reasons

- ***Cost estimation***

  Many of the cost estimates prepared for projects were found to be poor and there was a lack of consistency in the items which were included in costings. There was no provision for many of the difficulties which were likely to arise. In effect, there was a bias towards underestimation of costs.

- ***Design changes***

  Some projects increased in scope and quality after the project had been approved by the NRA to proceed to planning and design stage. This included increases in road section length, standard of landscaping, design of junctions, approach roads and structures. The consultants concluded that the system for project supervision relied on at the time by the NRA and by the Department of the Environment and Local Government had failed to prevent this happening.

[7] *DKM Economic Consultants, Operational Programme for Transport: Mid-term Evaluation, February 1997*

- ***Cost control***

  Once a construction project is underway, costs can escalate under the re-measurement system employed for civil engineering contracts in the Irish construction industry.[8] Fixed-price contracts are not used for large road projects although the option of moving to such a system is being considered. However, the report concluded that there was little evidence that cost control during construction had been particularly weak and found that claims by contractors had been resisted.

4.12 The report on the mid-term evaluation suggests that the primary difficulties in containing cost increases arise at the planning and design stage. The introduction by the NRA of cost estimation guidelines and control procedures should improve cost estimation for future projects and help in controlling any tendency to introduce unnecessary design changes or specification increases.

Unit Cost of Roads Provided

4.13 The differences in the nature and scope of projects undertaken dictate that there is no standard unit cost appropriate over the full range of road projects. Variations in the type of road to be provided, land acquisition cost, the environment in which the road is being built (urban/rural), the number of structures (e.g. bridges, roundabouts) and junctions required, physical difficulties that may be encountered in site conversion and other factors (e.g. environmental considerations) have a significant impact on project costs. For any type of road, unit costs are generally lower for a road section being built on a greenfield site than for an existing route being improved to the required standard while continuing to carry traffic.

4.14 The major projects undertaken and completed by the NRA in the period 1994-1997 are of three main types: motorways, standard dual carriageways and standard two lane roads. The remaining projects included major junction improvements and road interchanges and one-off projects like the Lee tunnel.

4.15 Table 4.1 shows the current estimated unit cost of major road improvement projects by type. The measure used is cost per kilometre of road section. The table also sets out estimates of unit cost for the different types of road construction adopted by the NRA in 1998 as guidelines for planning purposes. This indicates the higher costs associated with higher specification roads and shows that some projects undertaken cost up to twice the guideline amount for the road type in question. It also shows that there is considerable variation in the unit cost associated with different road projects where the same basic standard of road is being constructed.

[8] *In civil engineering contracts, the quantities of work to be carried out by the contractor are estimated provisionally at the outset and are subject to re-measurement as work is being executed. This re-measurement forms the basis for both interim and final payments under the contract.*

Table 4.1 Capital cost per kilometre for major road improvement projects, by type of road, 1994-1997

Type of road	Number of schemes 1994-1997	NRA cost guideline 1998 £m/km	Range of project costs 1994-1997 £m/km
Standard two-lane road	21	1.4	1 to 3.5
Standard dual carriageway	8	2.7 to 3.5	1.6 to 6.8
Motorway[a]	6	4 to 5	3.2 to 6.1
All road types	35	–	1 to 6.8

Note:[a] This table excludes the Northern Cross section of the M50, which is an urban motorway costing £7.5 million per km.

Source: NRA Guidelines on Project Cost Control, 1998; analysis by Office of the Comptroller & Auditor General

4.16 The new project control system introduced by the NRA should, if used properly, help it to identify which projects are expected to exceed the standard for the road type in question. The system should also provide a breakdown of cost estimates into their main components i.e. land acquisition, property acquisition, site investigation, design and statutory procedures, supervision of construction and construction. For projects at construction stage, more detailed information (e.g. in relation to the cost of earthworks, structures, pavement) is gathered. Over time, this should facilitate identification of reasons for departures from standard project costings.

Project Timing and Duration

4.17 Proper project planning should include time objectives for the provision of various categories of roads. These should be based on a combination of previous experience, best practice and a knowledge of the level of physical difficulty which can be encountered in the course of undertaking large capital projects. While it is difficult to predict the amount of time required to deal with planning and environmental matters, public consultation etc., targets should also include appropriate allowances for such matters. The anticipated duration of a project should always be a feature of proper planning with any variances being addressed and controlled through close monitoring. Time targets should also specify when a project is scheduled to be carried out.

4.18 Since road projects involve very protracted timescales, it is desirable early on to set a sequence of time targets covering both the planning/design stages and the construction phase. In general, formal time targets have not been adopted for completion of planning and design stages on road projects.

4.19 Of the 41 projects so far included in the roads investment programme, 32 were listed in the original plan. This included indicative time schedules for the construction phase of each project. There were no formal time schedule targets for the remaining nine projects undertaken.

4.20 Where time schedule targets were set, they can be used to derive target project durations. However, since the scheduled dates were expressed in terms of years rather than months, the target project durations are relatively imprecise. For example, a project scheduled for construction in the period 1994-1997 could be interpreted as starting at any time in 1994 and finishing at any time in 1997. Measured in months, this implies a project duration of between 25 months (December 1994 to January 1997) and 48 months (January 1994 to December 1997).

4.21 Construction work on most of the listed projects which were underway at the start of the programme or which were carried out subsequently was completed comfortably within the elapsed time indicated and in many cases, within the scheduled time.

Conclusions

4.22 Most of the major road improvement projects completed or undertaken in the period 1994 to 1997 cost more than planned, even when an allowance is made for inflation. This appears to have occurred because of significant under-estimation of costs when projects were first proposed and a lack of control at the project design stage.

4.23 New systems introduced by the NRA at the end of 1997 should help to improve project cost control. They should also assist in monitoring project performance in terms of meeting cost and time targets. However, these systems do not in themselves provide any incentives to local authorities to avoid cost escalation at the planning stage which may change the balance between costs and benefits. If cost escalation changes the relative economic priority of a project significantly before construction contracts are entered into, there should be serious consideration of the option of removing the project from the programme.

5 Strategic Planning for National Roads Development

5.1 In developing infrastructural investment programmes to avail of EU co-financing opportunities in the periods 1989-1993 and 1994-1999, there has been a gradual but significant change in the approach to development of the national roads system. There is an increased emphasis on the practical impacts which investment in roads is expected to deliver. There is also more focus on the combined impact of the programme than on the impacts of individual projects. The establishment of the NRA in 1994, as a central executive agency with a specific remit to secure the provision of a safe and efficient network of national roads, was a further step in developing a more strategic approach to the development of the national roads.

5.2 Most of this report has been concerned with a review of progress to-date on the roads investment programme 1994-1999. Since the programme started, the context for development of the national roads has changed considerably. It is therefore of interest to consider the extent to which appropriate systems are in place for planning and carrying out further investment in national roads so as to deliver the best possible value for money.

5.3 The accelerating need for investment in roads, changes in the availability and sources of funding and development of alternative methods of delivering the required level of service are major changes in the strategic environment in which roads investment decisions are made. The main factors are

- Road traffic is growing much faster than was anticipated when the roads investment programme 1994-1999 was adopted. This is associated with faster than anticipated economic growth and suggests that yet further investment in transport, including roads, will be required to sustain economic development.
- The National Road Needs Study (July 1998) was commissioned to identify the type of road needed throughout the national road network to cater for projected traffic levels and to identify the likely cost of the improvements necessary to deliver that system. This identified a programme of road improvement works up to 2019 at an estimated total cost of £6.1 billion.
- It is expected that the level of EU structural funds available to Ireland will fall when the Community Support Framework 1994-1999 expires. This means that a higher proportion of the public funding for investment in roads will probably be provided from national resources. There is likely to be a proportionate reduction in direct involvement by the EU Commission in road project selection and programme monitoring.
- New models for provision of public services involving partnerships between the public and private sectors are developing internationally. In their most developed form, these public-private partnerships (PPPs) are based on formal agreement of the level of service which the partnership is expected to deliver to the intended clients, with tasks (and their associated risks) shared between the partners, depending on who is best placed to deal with them. The provision

of target levels of service for road traffic on particular routes has been identified as a potential area for PPP ventures.

5.4 It appears inevitable that there will continue to be a high level of investment in improvements to the national roads system. Best value for money is likely to be obtained by building on the current focus on such investments as an overall strategic development programme, rather than as a disparate collection of individual projects.

5.5 A new roads investment programme is being drawn up in the context of an overall national development plan for 2000 and onward. While remaining fully consistent with the overall plan for transport investment, the plan for roads investment should be set out in an appropriate level of detail and should focus primarily on target impacts.

5.6 The NRA is currently considering the option of having a number of road improvement projects commissioned on a design/build basis, which is a limited form of PPP. In conjunction with the Department, the Authority should examine whether or not there would be advantages in terms of greater impact of any future roads programme in using innovative ways of undertaking road improvement work, such as PPPs and the direct commissioning of priority projects by the NRA itself, rather than through the local authorities.

5.7 The availability of relevant and timely management information is a prerequisite for maximising effectiveness and for measuring achievements. Within the NRA, significant steps have been taken to improve the quality of information gathered, particularly in relation to project costs. However, there is a more general need for the NRA to develop integrated and consistent information systems and to benchmark its own performance against that of similar organisations internationally. Improvements in the ability of the Authority to manage information should help it to carry out its functions in a more efficient and effective manner and facilitate the process of performance evaluation and accountability.

Appendices

Appendix A Impacts of Road Improvement Projects

The target impacts for the roads improvement programme 1994 to 1999 were expressed in terms of the concepts of level of service provided by the road system and journey time savings.

The Concept of Level of Service

The US Highway Capacity Manual defines six levels of service (LOS) provided by road systems or sections of systems. These range from 'LOS A', representing freeflow conditions to 'LOS F', where traffic is completely congested. Each level of service is associated with an average speed which would be expected to be achieved by traffic under normal conditions. The better the road, the higher the expected average speed. Thus, LOS D on a motorway should permit an average journey speed of 97 km per hour; LOS D for a standard two-lane carriageway should permit an average journey speed of 80 km per hour.

The following table provides a definition of levels of service for two-lane roads on level terrain.

Table A.1 Definition of level of service classification for two-lane road

Level of service	Average speed	Passing conditions	Driving conditions
LOS A Freeflow	93 km/hour	Passing demand well below capacity	Slow vehicles causing delay up to 30% of journey time
LOS B	88 km/hour	Passing demand approximately equal to passing opportunity	Driver delay up to 45% of time due to slower vehicles
LOS C	84 km/hour	Platoon formation occurs with passing demand exceeding opportunity	Driver delay up to 60% of time due to slower vehicles
LOS D	80 km/hour	Passing extremely difficult, with very high demand and limited opportunity. Platoon sizes of 5-10 vehicles.	Driver delay up to 75% of time. Disruptions cause major shock waves in the traffic system.
LOS E	72 km/hour	Passing becomes impossible with intense platooning	Driver delay over 75% of time. Any traffic disruption usually leads to congestion
LOS F Congestion	<72 km/hour	No passing - platoon flow	Congested traffic

Source: National Road Needs Study (1998)

The Concept of Journey Time Savings

A distinction can be drawn between overall journey time savings (i.e. between journey origin and destination) and the transit time savings in travelling along an individual section of the route which may have been improved. Some of the time savings made on individual sections may be lost if the traffic concerned is caught in bottlenecks further along the journey route. In some cases, existing problems in certain sections may be made worse, or new problems created, by speeding up the traffic flow on improved sections elsewhere.

Travel time (both for overall journeys and transit of road sections) may vary considerably depending on the time of day or day of the week the travel takes place. The time of year may also affect the travel time. This variation affects the predictability of travel time. Consequently, the impact objectives for particular road improvement works can relate to reduction in both average travel time and in the variability of travel time.

Appendix B Assessment of Impact Targets set for the Roads Investment Programme, 1994 to 1999

If performance targets are to serve a useful function in helping to achieve effectiveness in a spending programme, they need to be

- relevant to the programme objectives
- comprehensive i.e. there should be performance targets for each significant aspect of the spending programme
- precise and measurable
- related to the programme expenditure.

Relevance of Impact Targets

The main targets set in relation to programme impacts (see Table 2.3 on page 11) were expressed in terms of

- percentage of network capable of delivering the required level of service and
- journey time impact.

Both of these are relevant to the overall objectives for development of the national roads network. Improvements in these respects should contribute to regional and national economic development.

Targets of other kinds were also set relating to outputs and apportionment of spending. For example, length of network improved is an output indicator; proportion of spending directed to strategic corridors is a financial target. These are not impact indicators and so are not directly relevant to evaluation of programme effectiveness.

Comprehensiveness of Impact Targets

Meaningful impact targets were set for the primary network strategic corridors, on which a considerable proportion of the programme expenditure was targeted. There was no target for achievement of impacts provided as result of spending on the non-strategic primary roads, despite planned expenditure of up to £330 million on improvements. Likewise, while the roads programme was intended to result in the improvement of 5% of the national secondary road network, there was no specific target in terms of impacts on the network.

Precision and Measurability of Targets

The impact targets for the strategic corridors are precise and quantified. Consequently, achievement of those targets should be capable of measurement. A baseline estimate was given in relation to the level of service target but not for the journey time saving target.

Relating Impact Targets to Spending

In ideal circumstances, effectiveness evaluation would try to match impacts with the resources used to achieve them. This is difficult with a programme of multi-annual projects, such as the roads development programme, where some projects are partially completed when the programme commences and some are ongoing when the programme ends. In such situations, it is important to be clear about how the impacts of overlap projects are being treated. It is simpler to set targets for what is expected to be achieved in the period concerned than to estimate how much impact is attributable to different tranches of funding.

The impact targets set for the roads development programme took account of the impact of projects already underway and largely funded under the previous programme, the Operational Programme for Peripherality 1989-1993. Over 36% of the 344 km of road improvements in the period 1994-1997 were completed in 1994.

There will be carry-over impacts arising from projects which are largely carried out under the roads development programme but which will not be completed until after 1999. For consistency, these carry-over impacts have to be disregarded in evaluating performance of the 1994-1999 programme.

Appendix C The National Roads Authority's Methodology for Economic Evaluation of Major Road Projects[1]

The National Roads Authority (NRA) carries out economic evaluation of road improvement projects within a cost-benefit framework. In that context, projects are evaluated from an economic efficiency viewpoint in which costs and benefits are, in so far as possible, valued in monetary terms.

Cost-Benefit Method of Economic Evaluation

Cost-benefit analysis aims to measure the desirability of a multi-year investment project from the point of view of society as a whole through a comparison of all the costs and benefits of the project over its lifetime. Special emphasis is given to measuring the costs and benefits in monetary terms but non-monetary costs and benefits may also be taken into account in arriving at conclusions on the merits of a proposed project.

The costs and benefits of a project are usually estimated by comparing the situation which would obtain if the investment does not proceed (i.e. the no-change option) with the situation with the investment in place.

In the context of appraisal of road projects, elaboration of the costs and benefits of each option is usually based on a prediction of underlying traffic growth, with and without the proposed investment. Predictions are also made of the impacts of traffic growth on the level of service provided by the road system in terms of journey time costs, vehicle operating costs, accident costs and other impacts. For example, with regard to predicting the impact of traffic growth on journey time costs, the impact of traffic volumes on road speeds must first be calculated. This will give rise to a prediction of journey times which may be translated into journey costs by ascribing a value to time.

It is usual to assess the net benefits of proposed projects by considering immediate impacts on road users and non-road users. The range of benefits usually considered is shown in Table C.1.

The extent to which these benefits are subject to monetary valuation within cost-benefit analyses varies. Road user, safety and road maintenance usually have monetary values attached to them. Monetary values are often assigned to air quality and noise impacts but not to other environmental benefits.

[1] *This assessment of the economic evaluation methodology was prepared for the purpose of this examination by Goodbody Economic Consultants*

Table C.1 Range of impacts from road investment

Nature of impact	Measures of impact
Road user	Journey time Vehicle operating costs
Safety	Risk of accidents
Road maintenance	Road maintenance costs
Environment	Air quality Noise levels Severance of communities/services Visual intrusion Cultural heritage impacts Ecological impacts Land use impacts

Assessment of the NRA's Outline Cost Benefit Analysis Methodology

The NRA's outline cost benefit analysis measures the benefits of the proposed investment in terms of time savings and fuel cost savings and compares these benefits to the capital cost of the scheme and the ongoing cost of maintaining the affected road(s).

Costs and benefits over a twenty-year period are evaluated and the return on the investment is calculated using the internal rate of return, net present value and cost-benefit ratio criteria.

All projects that exceed a planned value of around £2 million are subject to the same outline cost-benefit analysis. The fact that many projects are subject to outline cost-benefit analysis only is a cause for concern because of the weaknesses in the procedure described below. Major road improvement projects should be subjected to a more comprehensive cost-benefit analysis.

Range of Benefits Considered

The outline cost benefit analysis does not consider the safety or environmental benefits associated with road investment.

Road Safety Benefits

The omission of road safety benefits most probably leads to an underestimation of the benefits of the investment. This is because

- modern roads are designed to a high standard and do not have the negative geometric features that contribute to raising road accident risks
- where roads are improved to the extent that they have grade-separated features or separated carriageways (e.g. motorways), the accident risk is reduced.

Data on the incidence of accidents on existing roads are compiled by the NRA and road accident risk associated with new roads is available based on international experience. Values to be applied to accident savings are available.[2]

The Road Needs Study, commissioned by the NRA, has recommended the inclusion of safety benefits in the economic analysis of road improvement proposals. The NRA should implement that recommendation.

Environmental Impacts

The impact on project economics of omitting environmental impacts is more difficult to ascertain. The impact varies with both the type of environmental benefit and the nature of the road investment. For example, by-pass construction which removes traffic from town centres will tend to reduce air and noise pollution associated with road traffic diverted away from resident populations. Fuel consumption and thus emissions may also be reduced if traffic speeds are raised from low levels. On the other hand, road construction in urban areas could have negative environmental impacts in terms of, say, severance of communities from local services such as shops and schools, visual intrusion and landscape effects. Thus, omission of environmental impacts has the potential to impact differently on individual projects and change their priority ranking.

The NRA states that environmental impacts of road improvement proposals are addressed in the environmental impact assessment process and that it is not general international practice to include environmental costs and benefits in economic evaluations. Nevertheless, it would be desirable, where possible, to include environmental impacts in economic evaluations to the extent that they are known. This is the approach recommended by the Department of Transport in the UK.[3]

[2] *See* ***CBA Parameter Values and Application Rules for Transport Infrastructure Projects,*** *DKM, Dublin 1994.*

[3] *UK Department of Transport,* ***Design Manual for Roads and Bridges Volume 11: Environmental Assessment***

Not all environmental benefits have been subject to valuation in monetary terms. However, considerable progress has been made in ascribing values to noise and air pollution.[4]

The other environmental effects are less amenable to monetary valuation at present. They are also impacts that are often site-specific and are more amenable to quantification in the context of the detailed road design and route choice decision. However, these other environmental effects should be considered when the cost-benefit analysis is being carried out and their impact assessed and quantified where possible.

Traffic Growth Factors

In predicting benefits over the project life, a standard traffic growth rate of 3% a year is used. For the no-change option, it is assumed that as traffic volumes grow, there is a corresponding growth in travel time. This is a source of concern for two reasons.

- As car ownership grows towards its saturation level, the rate of increase in car traffic volumes may be expected to slow.
- The rate of traffic growth may vary from one part of the road network to another. In particular, traffic growth rates may be larger near major urban areas. Differential traffic growth over time or space could impact on the relative priority to be accorded to projects.

The Road Needs Study recommended the use of route-specific traffic growth predictions. The NRA should adjust its cost-benefit analysis procedure to give effect to this recommendation.

Prediction of Travel Time Savings

Travel times in the no-change situation are assumed to grow in line with traffic growth. The rationale for such an approach is not clear. The impact of traffic levels on road speeds is complex: the relationship between these two factors is inherently nonlinear. In free-flow conditions, road speeds will be unaffected by increments in traffic volumes. However, once vehicles begin to conflict with one another, road speeds may decline sharply with traffic volume increments.

The proportionate relationship assumed by the NRA has the potential to underestimate the increase in travel times associated with increments in traffic volumes in the future when roads may be approaching their design capacity. To this extent, the procedure adopted may underestimate the benefits of the road investment. However, the procedure also assumes that travel times will increase

[4] *A recent report by the European conference of Ministers of Transport presents a useful summary of values to be applied to environmental effects. See:* ***Efficient Transport for Europe. Policies for Internalisation of External Costs****, ECMT, Brussels, 1998.*

proportionately in the immediate future. This may result in an overestimation of benefits in the short term and because of discounting of future benefits, these short-term benefits can have a significant impact on the results of the analysis.

The NRA should adopt a more rigorous approach to the prediction of travel times. This could entail the use of standard speed-flow relationships or application of the NRA's RouteSim methodology.

The Value of Time

The value of time used in the NRA's cost-benefit analysis is that proposed by the External Evaluator to the Operational Programme for Transport. While the method for deriving this value accords with international practice, there does not appear to have been any validation of the value in the Irish context. Given the importance of time savings in the appraisal of road investments, the NRA should consider commissioning some research in this area.

The value of time is normally differentiated between 'work journey' and 'non-work journey' purposes. Work journeys are usually valued at three to four times non-work journeys. It would appear that the cost-benefit analysis methodology employs a value of time which is invariant with the journey purpose profile of individual routes. This could impact on project selection in that the benefits estimated for projects on commuter and tourist routes could be exaggerated. It is recommended that the NRA employ a value of time which is sensitive to the journey purpose profile of different route types.

Under the NRA's current procedure, the value of time is held constant over the evaluation period. This is contrary to normal practice which suggests that the value of time grows in line with personal incomes. It also leads to an underestimation of project benefits. It is recommended that the NRA adjust future values of time, and other evaluation parameters, as appropriate.

Road Maintenance Costs

It would appear that the cost-benefit analysis methodology includes the maintenance costs of the existing road as a cost of the proposed investment. The rationale for this approach is unclear. Maintenance of the existing road would have to be undertaken for the no-change option also and thus should be netted out of the analysis.

Appendix D Major Road Projects included in the Roads Investment Programme, at end-1997

Scheme National Primary Roads	Route	Status at end 1997	Estimated cost £m	Length km
Strategic Corridors (including links)				
East/west corridor				
Lucan/Kilcock	N4	Completed 1994	65	17.6
Mullingar by-pass	N4	Completed 1994	22	10.5
Longford by-pass	N4	Completed 1995	10	5.4
Jamestown/Drumsna	N4	Completed 1996	10	7.2
Collooney/Sligo	N4	Ongoing	30	8.8
Curlews	N4	Ongoing	26	16.5
Swinford by-pass (link)	N5	Completed 1994	9	6.6
Galway Eastern Approach	N6	Completed 1996	8	3.5
Donegal by-pass (link)	N15	Ongoing	18	8
North/south corridor				
Balbriggan by-pass	M1	Ongoing	42	13.1
Dunleer/Dundalk	M1	Ongoing	98	16
Killarney Road interchange	N11	Completed 1994	5	2
Enniscorthy/Wexford	N11	Completed 1995	8	8.3
Arklow by-pass	N11	Ongoing	45	12
Minish/Curraglass (link)	N22	Completed 1996	17	10
Sliabh Riach (link)	N22	Completed 1996	11	6
New Ross/Wexford	N25	Completed 1997	9	8.2
Dunkettle/Carrigtwohill	N25	Completed 1997	54	10.6
South west corridor				
Newbridge/Kilcullen	N7/N9	Completed 1994	73	18.4
Roscrea by-pass	N7	Completed 1996	8	2.4
Portlaoise by-pass	N7	Completed 1997	49	13
Nenagh by-pass	N7	Ongoing	22	16
Kildare by-pass	N7	Ongoing	60	12
Naas Road interchange	N7	Ongoing	10	2
Naas Road widening	N7	Ongoing	8	5
Limerick northern relief	N7	Ongoing	8	3
Lee Tunnel	N8	Ongoing	105	1

Scheme	Route	Status at end 1997	Estimated cost £m	Length km
National primary roads strategic corridors (ctd)				
Western corridor				
Cork/Mallow phase 2 (link)	N20	Completed 1994	52	15
Setrights Cross	N18	Completed 1996	7	2
Other primary roads				
North Road Finglas	N2	Completed 1996	12	1.8
Broomfield/Castleblaney	N2	Completed 1996	9	8.8
Ardee/Aclint	N2	Ongoing	9	6
Cavan by-pass	N3	Ongoing	15	9.5
Bolton Hill	N9	Completed 1995	5	4.5
Grannagh	N9	Ongoing	16	1
Mulcon Valley	N28	Completed 1995	9	3
Northern Cross	M50	Completed 1996	74	9.8
Northern Cross extension	M50	Completed 1997	5	3.4
National Secondary Roads				
Bandon Road	N71	Completed 1995	14	8
Dundalk inner relief	N52	Completed 1996	10	3
Callan by-pass	N78	Completed 1997	5	3.5

Summary of major projects	Number of projects	Estimated cost £m	Length km
East/West strategic corridor	9	198	84.1
North/South strategic corridor	9	289	86.2
South Western strategic corridor	9	343	72.8
Western strategic corridor	2	59	17
All national primary road strategic corridors	29	889	260.1
Other national primary road projects	9	154	47.8
National secondary road projects	3	29	14.5
All major road improvement projects	41	1,072	322.4

Source: National Roads Authority