

Can Intangible Factors Be Adequately Addressed in Transportation Planning? - A transport options assessment procedure.

Morris S. McFall,
Regional Councillor,
Environment Waikato

David J. M. Peart,
Regional Councillor,
Environment Waikato

Peter G. Russell,
Land Transport Planner,
Environment Waikato

Abstract:

The current benefit/cost ratio analysis is increasingly seen as being deficient in assessing intangible factors and externalities of roading projects in New Zealand. In 1993 Regional Councils were required to prepare a Regional Land Transport Strategy which identifies the future land transport needs of each region and state how these needs will be met in safe and sustainable ways

The Transit New Zealand Amendment Act 1992 requires Transit New Zealand to have regard to the provisions of Regional Land Transport Strategies when formulating the annual National Land Transport Programme. The Waikato Regional Land Transport Strategy identified the need for a procedure which has the potential to fully assess environmental, social and cultural factors associated with all major land transport projects, not just roading.

This paper presents a methodology for the analysis of intangibles and is called a Transport Options Assessment. The model is made up of five steps, including a weighted scoring option. The Waiomu Slip realignment case study illustrates how public submissions on adverse environmental and community effects can influence projects which have been primarily assessed on economic factors.

Review and project trialing of the methodology is suggested for possible inclusion as a requirement for all major land transport projects.

Contact Author:

Peter Russell
Environment Waikato
PO Box 4010
Hamilton East
NEW ZEALAND

Telephone : +64-7-856-7184
Fax : +64-7-856-8089

ATRF94

INTRODUCTION

The last ten years have seen major changes in the land transport industry in New Zealand, in organisational structures, administration, ownership of transport organisations and the way in which transport services are provided and funded.

In keeping with these changes in 1993 regional councils throughout New Zealand were required to prepare a Regional Land Transport Strategy for their region. The purpose was to identify the future land transport needs of each region and state how these could be achieved in safe, cost effective and environmentally sound ways.

To achieve the above means it is necessary to take into account economic, social, cultural and environmental factors when assessing the merits of new transport projects or developing new policy. The traditional cost/benefit analysis used in New Zealand is increasingly seen as having deficiencies with regard to assessing the full effects of projects.

This paper considers the current project evaluation procedure and outlines the process undertaken by Environment Waikato (Waikato Regional Council) in developing the first Regional Land Transport Strategy for the Waikato region. Four future land transport needs are discussed. From these needs, a procedure is identified for assessing all the potential effects of transport related projects, not just economic factors. It is called a Transport Options Assessment. The key elements of the assessment process is consultation. A case study is discussed which highlights how important public consultation is and proves that trade-offs can be achieved in balancing economic, environmental and social objectives.

REGIONAL LAND TRANSPORT STRATEGY

Requirement

Regional Land Transport Strategies are required under the Transit New Zealand Amendment Act 1992. Each strategy shall:

- identify the future land transport needs of the region,
- identify the most desirable means of responding to such needs in a safe and cost effective manner, having regard to the effect the transport system is likely to have on the environment, and
- identify an appropriate role for each land transport mode (including freight, public transport, cycling and pedestrians)

To achieve the purpose of the strategy it is necessary to ensure economic, social, cultural and environmental factors are taken into equal account when planning for any

new land transport project. A bias towards economic factors would not meet the legislative requirements of the Act.

The Strategy must be in effect for between three to five years but may be amended at any time in response to changing circumstances. As its name suggests, the strategy does not discuss air or sea transport, other than the links to and from airports and ports. However, it may include the infrastructure for barging, ferry and river transport.

Before finalising a Regional Land Transport Strategy, regional councils were required to consult with a wide range of agencies, including the public.

Sustainable Resource Management

The law by which the use of natural and physical resources are governed in New Zealand is detailed in the Resource Management Act (1991). This Act is far reaching in that it binds the Crown and all users of natural and physical resources (land, water, air, soils, minerals, energy, plants, animals and structures) to ensure that an integrated approach is taken to promote the sustainable management of those resources.

The Act defines sustainable management as the "*management of resources in a way or at a rate which enables people and communities to provide for their wellbeing while sustaining the potential of resources to meet the reasonably foreseeable needs of future generations; safeguarding the life supporting capacity of air, water, soil, and ecosystems; avoiding, remedying or mitigating adverse effects*"

Regional councils play a major role in the implementation of the Act. Primary responsibilities include management of water, soil, coastal and geothermal resources as well as pollution control. In addition they have responsibility for hazard mitigation, soil conservation and hazardous substances in their region. The general rules which govern how these primary responsibilities are undertaken is detailed in the Act however the actual manner of implementation is the responsibility of the council and is detailed in regional plans. Regional plans are developed in consultation with the public and reflect the communities aspirations for use of the resources in their region.

Under the Resource Management Act, and where specified in a regional plan, no person can use certain natural resources without first obtaining a resource consent from the regional council. The Act sets out a standard process for applying for a resource consent. Certain information is required when making application for a consent including an assessment of the impacts of the proposal on the environment. The assessment is to be in such detail as corresponds with the scale and potential impacts of the proposal on the environment. The information must include a description of the options available for undertaking the activity and those persons consulted about the proposed activity and how they or the community will be effected.

Links Between Legislation

Physical resources include all structures, therefore much of the land transport infrastructure (for example, roads, railways and cycleways) consist of physical resources. The development of transport infrastructure and the effects of this is the primary responsibility of district and city councils. Regional councils are responsible for ensuring that the management of the land transport infrastructure is integrated with that of other natural and physical resources. They must also ensure that adverse effects on the environment (the definition of 'environment' includes communities) are avoided, remedied or mitigated, while the best use of the infrastructure is maintained

Both Acts described above recognise the purpose of each other, for example:

"Nothing in a Regional Land Transport Strategy shall be inconsistent with the provisions of any Regional Policy Statement or plan in force under the Resource Management Act 1991"

Environment Waikato's Approach

A planning framework for the Regional Land Transport Strategy was developed (Figure 1) which recognises the relationships between the legislation and Council's functions.

Figure 2 illustrates the process adopted by Environment Waikato to achieve the consultative requirements of the Act.

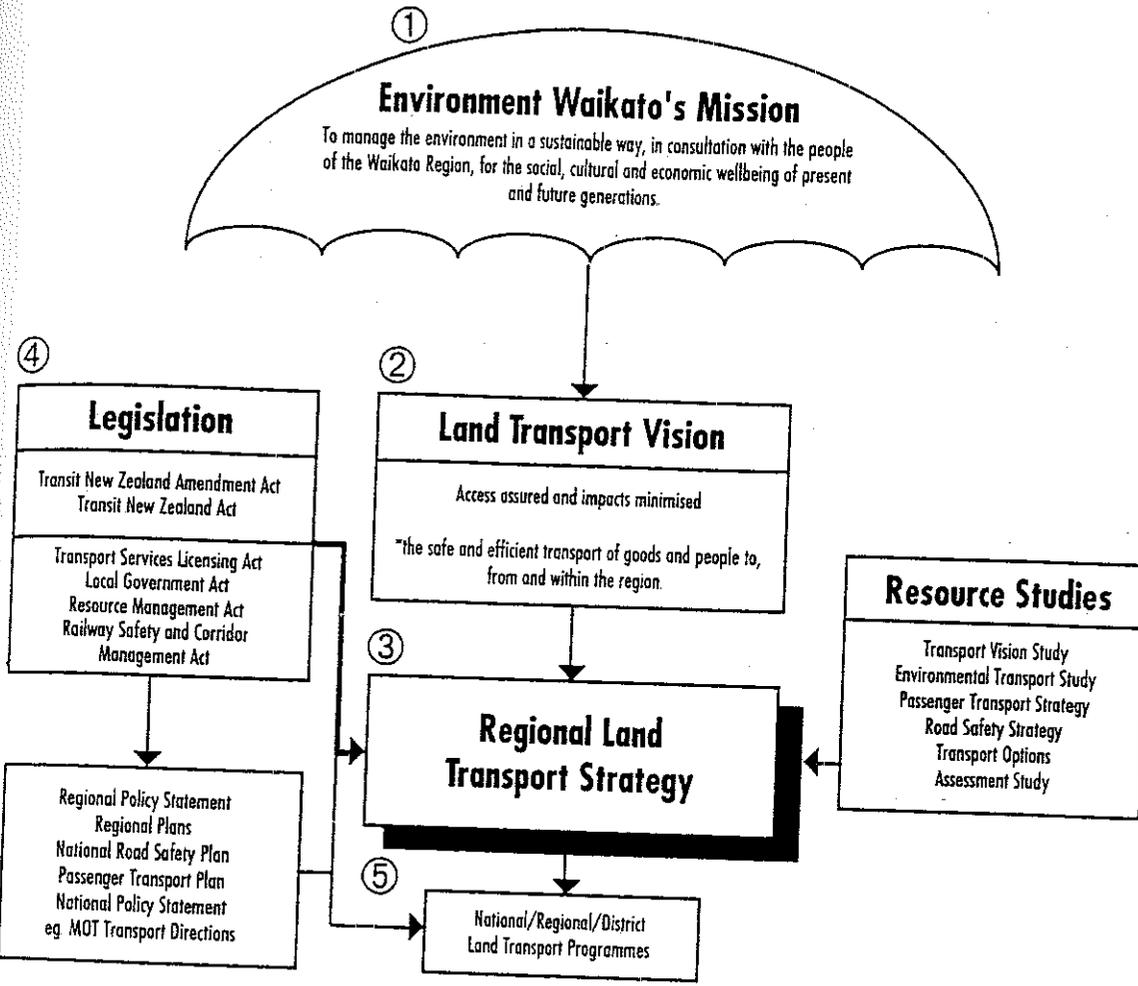
Transport Overview of the Region

The topography of the Waikato region (Figure 3) is extremely diverse ranging from mountainous country to lowland peat areas. The economy is based largely on rural and associated processing industries such as forestry, dairying and beef farming, mineral extraction and tourism. At the 1991 census the population of the region was 330,000

Road transport is the dominant mode and the 1600 km State highway network is vital to the regional economy. The region is one of the most heavily trafficked in New Zealand, particularly in terms of heavy vehicles. Due to its strategic location the region experiences significant through traffic. Traffic growth is steady, within the range of 2-5% per annum (Transit New Zealand, 1993)

The 400 route kilometres contained in the region's seven railway lines transports, on average 3,800,000 net tonnes per year and the approximate equivalent of 153,000 truck loads (612 truck loads per working day) if they were placed on the roading network.

There are over 200 registered passenger transport services operating in the region, including 20 subsidised bus services, four rail services, three total mobility schemes and



- 1 All activities are linked with the overall mission of Environment Waikato.
- 2 The vision is a clear statement of what Environment Waikato wishes to achieve with regard to Land Transport
- 3 The Regional Land Transport Strategy will be a statement of Environment Waikato's policies on how to achieve this vision. It is being developed through five separate resource studies
- 4 The Strategy is enacted under various pieces of legislation and national and regional statements and plans under the acts. Specifically the strategy must not be inconsistent with the provisions of the Resource Management Act
- 5 National land transport programmes shall have regard to the strategy and district land transport programmes shall be consistent with the strategy unless it is agreed that it is clearly impractical to do so

Figure 1 Regional Land Transport Planning Framework

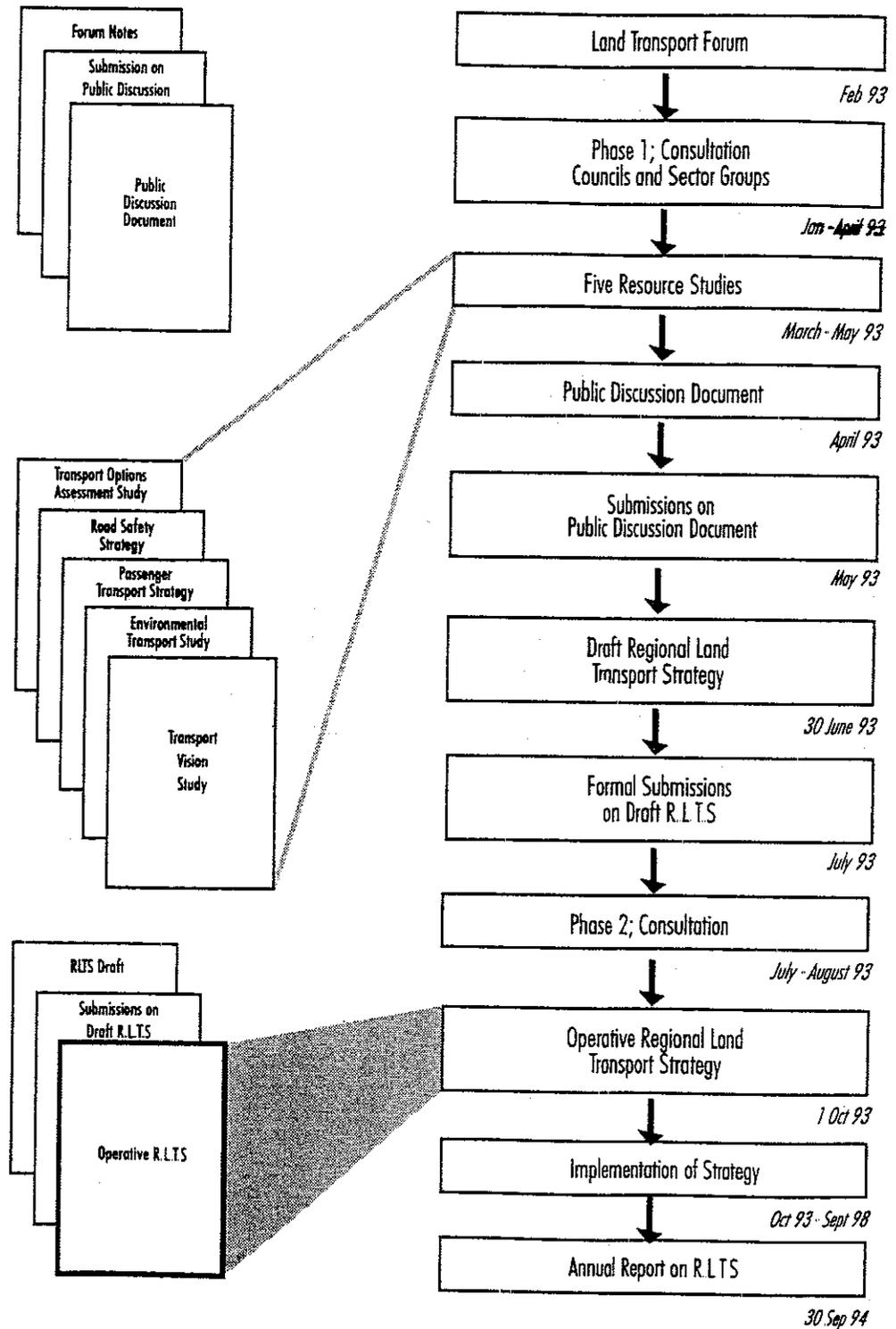


Figure 2 Regional Land Transport Strategy - Environment Waikato's Process

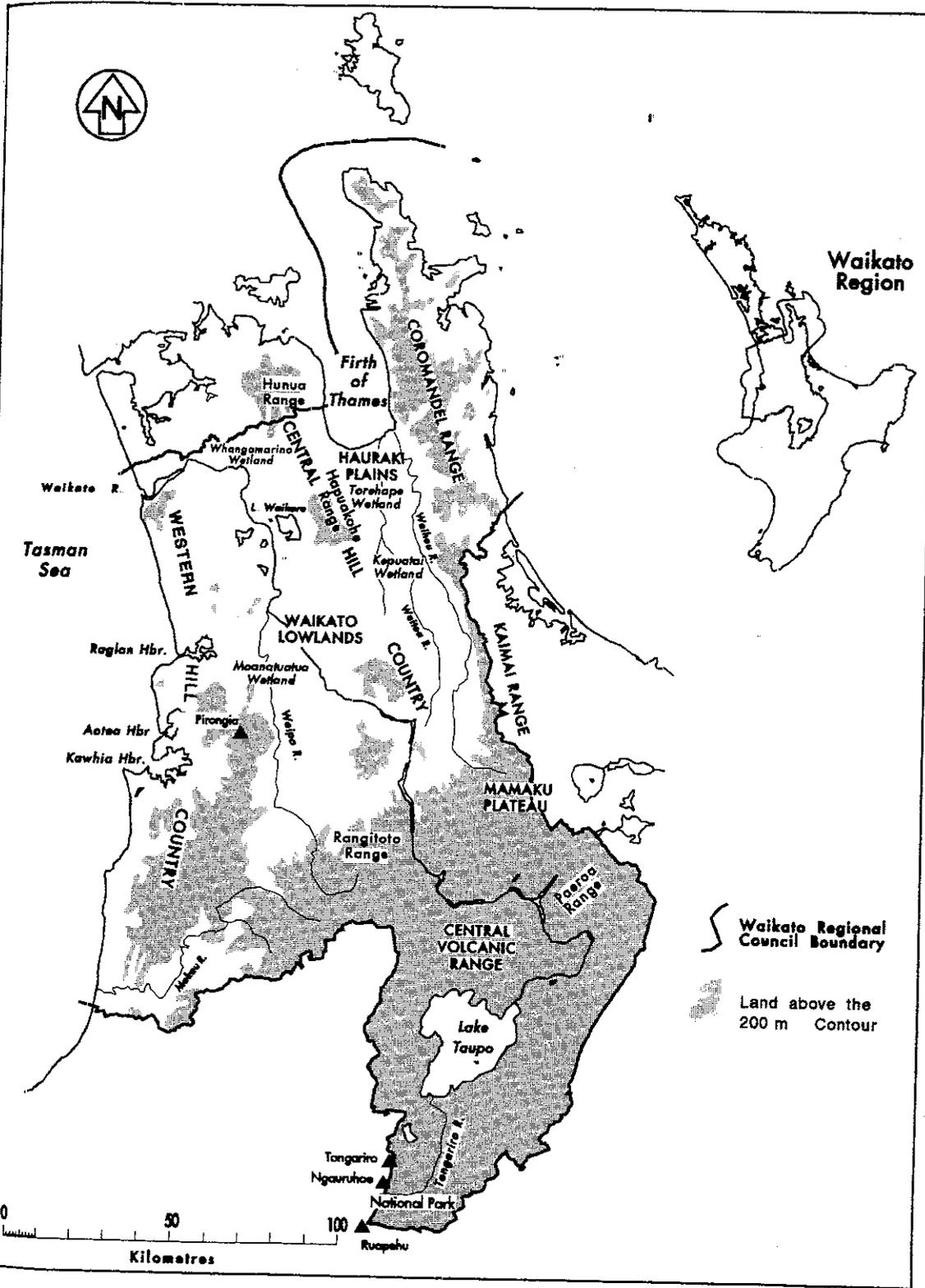


Figure 3 Topographical Areas of the Waikato Region

two ferry services. With Hamilton City (the only city in the region, population 100,000) at least 20,000 people regularly ride bicycles. Walking is perhaps the forgotten mode of land transport although it plays a vital role in meeting transport needs in urban areas.

Factors Influencing Land Transport in the Future

From the detailed consultation process undertaken during the course of the study fourteen factors likely to influence travel patterns and infrastructure development were identified as being significant over the next 20 years. They are summarised below:

- steady population growth (1% per annum) and an increasing 'ageing' population
- deflection of industry growth from Auckland to Hamilton
- significant increases in logging
- centralisation of the dairy industry and rationalisation of the meat processing industry
- Auckland is likely to be supplied with roading and building aggregate from the North Waikato area
- a two and a half fold increase in tourists coming to New Zealand is predicted, from 1 million to 2.5 million by 2010
- export tonnages through the country's biggest port, Port of Tauranga, are expected to double by 1998
- New Zealand Rail has been sold to an American led consortium committed to maintaining and enhancing the present rail system
- New Zealand's self-sufficiency in liquid fuels is predicted to drop from 51% to 6% by 2020 if no significant finds are made
- a 'safety culture' is likely to develop because of recent law changes aimed at reducing drink driving and speeding
- many people in the region are likely to experience further changes in their 'social condition' as a result of Government policy and other factors
- there is a growing public awareness of the need to minimise adverse effects of transport on the environment, following the 'Agenda 21' principles from the 1991 Earth Summit in Rio de Janeiro
- technological advances in vehicle design and alternative fuel development

- further international conflicts could affect the oil industry.

Four Future Land Transport Needs

With regard to the above factors four future land transport needs have been identified (Environment Waikato, 1993a). Under each need are the key objectives. The four needs are:

- i) An Efficient Land Transport System which Maintains and Enhances the Region's Economic Viability.

Objectives:

To cater for changes in the forestry, agriculture mining and tourism industries, make greater use of bulk freight movement (rail, barging), maintain and enhance the existing roading network (including links between transport modes and facilities) and the provision of adequate funding of the land transport system.

- ii) A Sustainable Land Transport System which Avoids, Remedies, or Mitigates Adverse Effects on the Environment and Energy Resources.

Objectives:

To minimise the adverse effects of land transport on communities, air quality, water quality and sensitive areas, the adverse effects of noise, debris and spillages, the adverse effects of hazardous substances transportation and reduce the reliance of land transport modes on non-renewable energy resources

- iii) A Multi-Modal Land Transport System which is Accessible for All People in the Region.

Objectives:

To maintain and enhance road, rail and water public passenger transport services and maintain and enhance access for private motorists, cyclists and pedestrians.

- iv) A Land Transport System which Ensures Safe Travel for All People in the Region.

Objectives:

A land transport system which ensures safer people, safer roads, safer vehicles and safer management systems.

CASE STUDY - WAIOMU SLIP ROAD ALIGNMENT

Background

State Highway 25 is the main arterial route to the Coromandel Peninsula, a very popular holiday destination in the Waikato region. During summer the population swells tenfold (from 25,000 to 250,000) which causes traffic backups and increases deterioration of road pavements. Over the rest of the year the road is an important link between settlements and is used by heavy vehicles carrying milk, stock, mussels and consumer items. The road is also increasingly popular for cycle tourists intent on travelling around the peninsula.

Issue

An area of State Highway 25, at Waiomu, has been periodically unstable for several decades. Transit New Zealand, who maintain the State highway network within New Zealand, were concerned at the continual threat of slips, the environmental damage it was causing, the disruption to traffic movement and the potential for loss of life.

Transit New Zealand wished to undertake remedial works to move the road from the line of the slip. Works would consist of construction of a new road adjacent to the present road by reclaiming 0.6 hectares of the coastal area. The reclamation would create a causeway along the beach and allow realignment of 400 metres of State highway. It was generally accepted that the community wanted a secure road link of a better standard.

The local community expressed concerns that the causeway option to bypass the slip was inappropriate and would result in excessive damage to the coastal area. As a result of this concern a hearing was held to consider the proposal. From the evidence presented it was clear that the visual environment of the coastal area in the vicinity of Waiomu Bay was considered to be of a high standard. However, it was also recognised that it had undergone considerable modification from a natural state due to the intrusion of the coastal road, the establishment of Waiomu settlement, the change in vegetation and the presence of the slip face. The proposal would result in further modification of the area.

The applicant undertook an environmental impact assessment which included an assessment of the visual effects of the proposal. Specialist evidence was provided that discussed the investigations undertaken to determine the nature of the slip and the circumstances under which the slip may be activated. Transit New Zealand identified seven options which they considered were potentially able to provide a reduction of the risk associated with the slip, and detailed why the option chosen was considered to be the most appropriate.

Opponents to the proposal did not consider that all the options had been adequately investigated and submitted that as a slip had not occurred recently it may have stabilised naturally. They were concerned that the proposed new road alignment would increase the road speed environment through the town. There was a general consensus that the works should not be undertaken unless restitution of the construction and adjoining site were also undertaken.

Considerable importance has been placed on the visual environment of the coastal area by the Regional Council. As such any development undertaken in the coastal area that effects the visual environment must remedy these impacts by reinstating coastal vegetation and by integrating the development into the existing visual environment.

Outcome

The decision was made to progress with the causeway option, however the design was altered to reflect the needs and wishes of the local community. The effects of the proposed reclamation were able to be mitigated or reduced to a minor level. Conditions placed on the consent required Transit New Zealand to undertake monitoring of the environmental effects, restoration of the areas affected and restrictions on further works that could be undertaken.

This case study highlights the need for detailed consultation to take into account the adverse effects of projects. It became clear that the economic benefit/cost analysis did not fully address local concerns.

The next section of the paper examines some of the shortfalls of the current benefit/cost system and recommends a process which takes into account such intangible factors.

TRANSPORT OPTIONS ASSESSMENT MODEL

The case study discussed in the previous section highlight the importance of public consultation and the need for a procedure for assessing projects which takes fully into account the environmental, social, cultural as well as economic factors influencing a project.

It could be argued that had such a procedure been in place prior to the consultation phase, the true costs of intangibles could have been "built into" the options possibly making the decision process clearer and less costly.

The aim of the Transport Options Assessment Model (Environment Waikato, 1993b) is to provide assistance in rationalising complex decisions involving choices between many variables. The following discussion examines the present analysis process, intangible factors and then advances an assessment process and an evaluation matrix.

Current Project Evaluation Procedure

Transit New Zealand's Project Evaluation Manual requires that the economic benefit/cost (B/C) ratio and the environmental effects of roading projects be assessed prior to funding from the National Land Transport Programme.

Current B/C ratios are derived by the performance of a standard economic balance sheet assessment based on calculations of the physical costs of constructing roads.

This involves determining the total value of the project benefits (\$) which is divided by the total value of project costs (\$) to produce a benefit/cost ratio. Where the ratio is greater than one, the project is deemed to be financially viable. This ratio is a good technique for assessing projects from a straight financial viewpoint as it provides the number of dollars of public benefit gained per dollar of project expenditure. Project approvals are decided according to the amount of funds available. For example in any one year projects above a B/C ratio of 2.5 may be funded but anything below this figure misses out. This threshold ratio is re-evaluated periodically.

The effects of roading projects on non-road users (externalities) and factors which are difficult to price (intangibles) are represented in the economical B/C evaluation. However, externalities will be missed because they usually require assessment in descriptive terms.

Intangibles and Externalities

Benefit/cost analysis is increasingly seen as having deficiencies when it comes to taking the full impact of a project into account. Assessing the benefits and costs associated with intangible factors such as air pollution, loss of habitat and cultural values is difficult as some intangibles are capable of quantitative measurement whilst others can only be described in qualitative terms. There is also concern that B/C models do not adequately cater for the needs of cyclists and pedestrians and these cannot always be addressed through the consultative process. Transit New Zealand is currently undertaking studies to evaluate the costs associated with some of the intangible factors (eg \$ per tonne of CO₂ emissions) in order that these can be built into the B/C calculation. The results from these studies are still some time away.

Proposed Procedure

The Transport Options Assessment process involves the use of a variety of methodologies and techniques to not only evaluate the individual options in terms of the defined criteria but also to carry out the assessment between options to identify a choice. The assessment process may therefore involve either a weighting to simulate trade-offs or to provide ranking between components; or it may simply involve a tabular list of each options attributes; or alternatively it may involve the assessment of economic costs and benefits between options. The methodology and techniques chosen therefore will

very much depend on the nature of the problem being dealt with. However in most cases the assessment method relies on some form of matrix approach

The process is made up of five steps (Figure 4) The are as follows:

Step 1 - Identification of Options

This step involves the development of options. Examples of options may range from consideration of alternative highway alignments to consideration of different mixes of transport modes within the network. This will be carried out through the Land Transport Strategy.

Step 2 - Scoping of Options

Step 2 involves a scoping phase to identify the issues, impacts and related measurement criteria. Public consultation may also be necessary to assist in the identification of issues and community values. This initial assessment may also provide the opportunity to discard, modify or eliminate any impractical options, or to identify any new ones.

Step 3 - Evaluation of Impacts and Costs

Step 3 involves the main evaluation exercise. Each confirmed option is subjected to a full evaluation in terms of the decision components and their associated criteria. In some instances the evaluation may simply be discursive or carried out against a simple checklist of community needs. For more complex decision problems the evaluation could involve the use of economic techniques such as cost benefit analysis or non-market valuation. However, whatever methodology is used the process involves an assignment of value to the various decision components (community, social, cultural, environment).

Step 4 - Assessment of Options

This is the Transport Option Assessment. The values identified in step 3 may need to be transformed onto a standardised scale (eg a scale of 1 to 5 where 1 = very high impact and 5 = very low impact), and in cases weighted to reflect preferences and trade-offs between decision components and attributes. The weighting process could include the use of Delphi methods or questionnaires to assess the preferences of experts and members of the public. Decision component attribute scores are then added up for each option. The option with the best score becomes the preferred choice.

Alternatively if the decision is simple the information developed through the evaluation process may provide sufficient rationale to justify a choice without the need to carry out an elaborate analysis. Simple tabular presentation of the information may be all that is required. However, in the case of the Land Transport Strategy a numerical matrix to illustrate the process was developed.

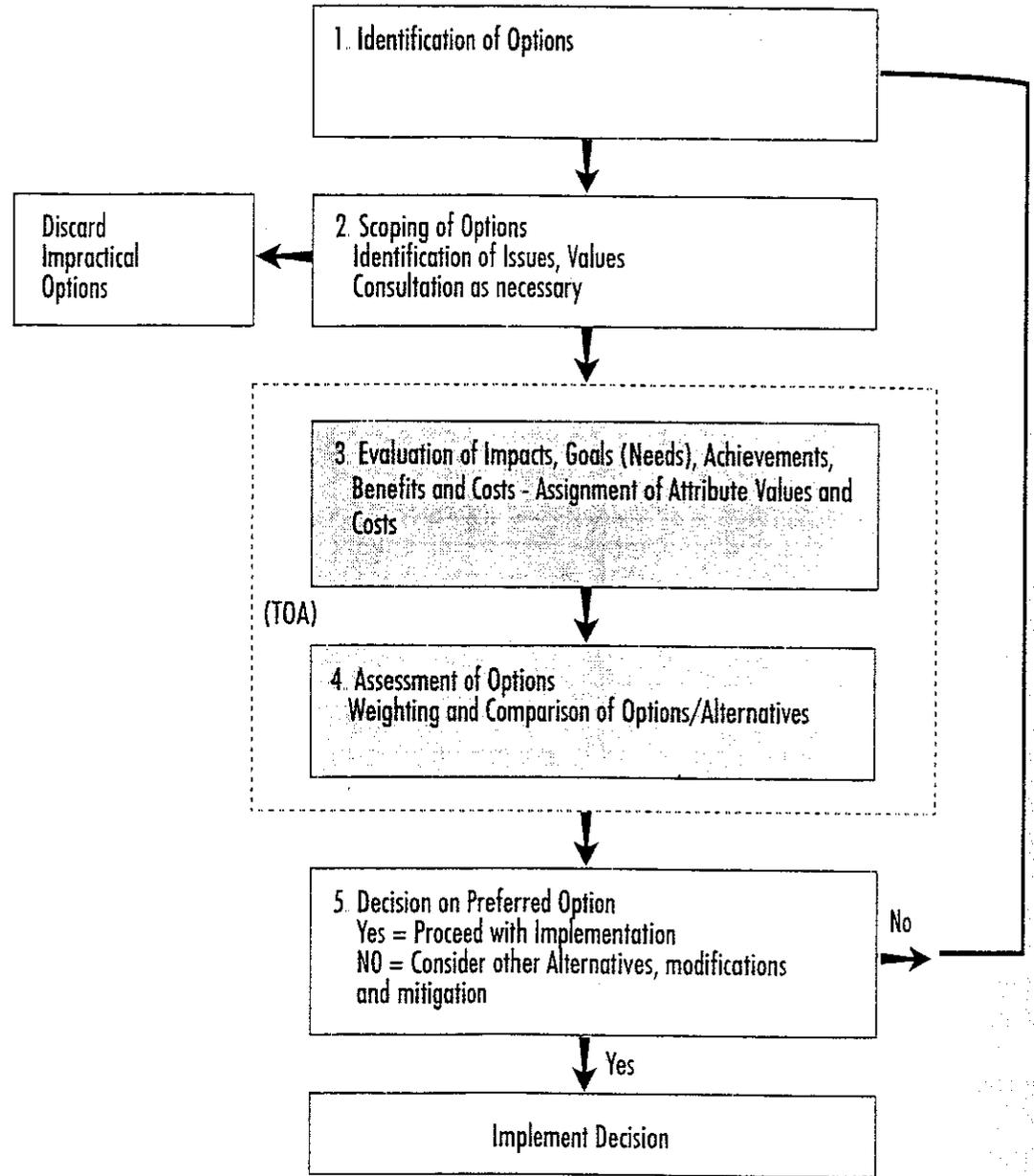


Figure 4 Transport Options Assessment Process

Step 5 - Decision Making

This step may simply involve confirming the matrix output or may alternatively result in the modification of an option to allow for mitigation effects and changes in valuations as a sensitivity analysis to test the model. A feedback loop is therefore required at this point.

A Practical Example

To see how the Transport Options Assessment will work in practice a scoring and weighting technique is illustrated by way of an example in Figure 5. It is made up of the decision components which are listed down the left hand side of the table. These components are not fixed in number and may be subdivided down to the level of detail appropriate to the decision involved. The options to be evaluated are then ranged out in columns extending to the right.

Each option is evaluated in terms of each decision component utilising the appropriate criteria and techniques to obtain information and data. In some instances this data might consist of CO₂ levels or noise emissions, the significance of which can be evaluated in terms of recognised standards. In other instances the data might consist of costs and benefits calculated according to various economic techniques and expressed as a benefit cost ratio or net present value index. In all cases these measurements need to be standardised for each decision component. This is achieved in the matrix by way of a standard scale numbered in this case from 1 to 5. The relative significance between the decision components is then addressed by a weighting process. These weights may be assessed by consensus using a panel of experts and lay persons or it may be determined by using questionnaire surveys as part of a public consultation programme. The weighted scores are then added up with the highest score indicating the preferred option.

Limitation of the Methodology

The proposed methodology is a first attempt to develop a consistent method of project ranking that can take into account intangible effects in a logical and systematic manner. It is also only one way of assessing intangibles and is an experimental model proposed for further trial by land transport agencies.

The proposed methodology makes no attempt to price environmental costs and benefits because little reliable New Zealand data is available.

The major limitation of the methodology lies in the fact that it has not yet been trialed in a real decision situation. It is also recognised that some elements of the evaluation can involve some degree of subjectivity. This requires recognition in developing and assigning the attribute scoring and weighting figures so that validation of the matrix can

EXAMPLE ASSESSMENT OF TRANSPORTATION OPTIONS FOR TRANSPORTING LOGS FROM THE SOUTH WAIKATO/TAUPO AREA TO THE PORT OF TAURANGA (N.B. THIS IS A HYPOTHETICAL EXAMPLE AND HAS BEEN PREPARED FOR ILLUSTRATION PURPOSES ONLY)

EVALUATION AND ASSESSMENT OF OPTIONS																																													
DECISION COMPONENTS	Attribute Scores																																												
	Option 1 Upgrading existing SH and District roading			Option 2 Rail only/road transport to railhead			Option 3 New private - Mamaku																																						
	Attribute Value	Weight %	Weighted Score	Attribute Value	Weight %	Weighted Score	Attribute Value	Weight %	Weighted Score																																				
1. Physical Environment																																													
i) Hydrological impacts - river systems	1	2	0.02	4	2	0.08	3	3	0.09																																				
ii) Wetland hydrology	2	1	0.02	4	2	0.08	2	5	0.10																																				
iii) Wetland ecology	3	5	0.15	4	15	0.60	1	5	0.05																																				
iv) River ecology	2	5	0.10	4	10	0.40	3	3	0.09																																				
v) Geological impacts/pedological impacts	4	10	0.40	4	4	0.16	3	2	0.06																																				
vi) Plant Ecology and wildlife habitats	2	5	0.10	4	5	0.20	5	10	0.50																																				
vii) Air quality: emission	4	2	0.08	4	3	0.32	3	2	0.06																																				
Total 1		30	0.87		30	1.84		30	0.95																																				
2. Community Environment																																													
i) Employment	3	5	0.15	2	5	0.10	3	5	0.15																																				
ii) Amenity impacts	2	2	0.04	2	2	0.04	4	2	0.08																																				
iii) District plan objectives	3	10	0.3	4	10	0.40	3	10	0.30																																				
iv) Landscape	2	2	0.04	1	2	0.02	1	2	0.05																																				
v) Maintenance of public access to transport system safety	4	10	0.4	5	10	0.50	4	10	0.40																																				
vi) Carers for industry (flexibility for users)	4	8	0.32	2	8	0.16	5	8	0.40																																				
vii) Maori/cultural sites	3	8	0.24	1	8	0.08	2	8	0.16																																				
viii) Noise impacts on residential communities	4	5	0.20	2	5	0.10	4	2	0.08																																				
Total 2		50	1.69		50	1.40		50	1.62																																				
3. Transport Economics																																													
i) Benefits - \$M																																													
Transport savings (time operating)		550.0			800.0			990.0																																					
Accident savings		52.0			50.0			98.5																																					
Community business benefits		10.0			20.0			25.0																																					
Total benefits		612.0			870.0			1,113.5																																					
ii) Costs - \$M																																													
Costs of construction/maintenance		5.2			2.2			150.0																																					
Transport costs (energy)		150.5			120.2			100.0																																					
Costs of property purchase		1.5			0			15.0																																					
Community business costs		30.0			80.0			15.0																																					
Total Costs		187.2			202.4			280.0																																					
Benefit/cost ratio		3.3			4.3			4.0																																					
Attribute score	3	20	0.6	4	20	0.8	4	20	0.8																																				
Total 3		20	0.6		20	0.8		20	0.8																																				
TOTAL 1+2+3		3.16			4.04			3.37																																					
Comments - Evaluation Methodologies																																													
<p>1. Decision components in column 1 will vary according to the nature of the projects, policies or scenarios being evaluated. They will need to be derived out of the Needs defined in the Land Transportation Strategy. These will evolve with time as Goals, Objectives and measurable criteria are defined.</p> <p>2. Expert evaluation - assessment of options based on attribute scale - report required: attribute scores are assessed by expert in terms of the following scale</p> <table border="1" style="width: 100%;"> <tr> <td>Achievement</td> <td>Very High</td> <td>High</td> <td>Medium</td> <td>Low</td> <td>Very Low</td> </tr> <tr> <td>Value</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </table> <p>3. Weighting factors can be determined from either a public consultation programme alternatively by a panel of experts or a combination of both. The weighting indicates the relative importance of the various components identified. These may remain fixed between options or alternatively they may vary.</p> <p>4. Changes in employment rated on scale 1-5 based on standardised scale (see note 2.) 1 indicates high loss of employment through to 5 indicating a high increase in employment.</p> <p>5. Regional land transport needs and regional plan and district plan goals and objectives may also be included as a decision component. The options may be evaluated against a standard scale indicating the level of achievement.</p> <table border="1" style="width: 100%;"> <tr> <td>Achievement Level</td> <td>Very Low</td> <td>Low</td> <td>Medium</td> <td>High</td> <td>Very High</td> </tr> <tr> <td>Value</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </table> <p>6. Benefits and costs are determined for each option in terms of the existing situation. All costs and benefits are hypothetical only and are for illustration purposes only.</p> <p>7. Where non-market goods can be valued (e.g. air emissions) in terms of benefits and costs or programmes and strategies analysis either as costs or benefits.</p> <p>8. The B/C ratio can be transformed on to a standardised scale on an assessment of preferred or desirable ratios. An example is as follows:</p> <table border="1" style="width: 100%;"> <tr> <td>B/C</td> <td>0-2</td> <td>2-3</td> <td>3-4</td> <td>4-5</td> <td>>5</td> </tr> <tr> <td>Value</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </table> <p>9. Conclusions: As a result of this evaluation and assessment OPTION 2 is the most preferred of the three under consideration, followed by OPTION 3.</p>										Achievement	Very High	High	Medium	Low	Very Low	Value	1	2	3	4	5	Achievement Level	Very Low	Low	Medium	High	Very High	Value	1	2	3	4	5	B/C	0-2	2-3	3-4	4-5	>5	Value	1	2	3	4	5
Achievement	Very High	High	Medium	Low	Very Low																																								
Value	1	2	3	4	5																																								
Achievement Level	Very Low	Low	Medium	High	Very High																																								
Value	1	2	3	4	5																																								
B/C	0-2	2-3	3-4	4-5	>5																																								
Value	1	2	3	4	5																																								

Figure 5 Example Transport Options Assessment 'Balance Sheet'

be maintained. It also requires the scoring to be underpinned by appropriate sourced data and investigations.

The matrix itself as presented here will require testing and refinement in order to define weighting and scoring procedures, its sensitivity over a range of decision environments and to define further the range of decision characteristics necessary to fully implement it within the context of Regional Land Transport Strategies

CONCLUSION

Economic benefit/cost ratios for roading projects do not provide a complete representation of the full effects of roading projects on affected communities.

The implementation of the Waikato Regional Land Transport Strategy has highlighted the need for a detailed process which ensures that intangible and external factors are considered equally in project assessments. The need for this approach became clear in the Waionu Slip case study. It is proposed that the Transport Options Assessment model procedure will become a requirement for all major land transport related projects in the Waikato region. Further refinement of the matrix could be carried out by implementing authorities and it is recommended that this mechanism is put to the test in a range of real decision situations.

This paper has also examined the changing nature of land transport planning in New Zealand to one of sustainable management of natural and physical resources. A key consideration is the balance between avoiding or mitigating adverse effects of land transport on the environment while maintaining the best use of the infrastructure.

The development of Regional Land Transport Strategies supports the intention of managing the land transport system in a sustainable way by insisting that detailed consultation is undertaken when undertaking projects or developing policy. This process will help ensure that future work will be both practical and reflect community aspirations.

ACKNOWLEDGMENTS

The authors wish to thank the personnel of the Land Transport Section of Environment Waikato for their contribution to this paper and their assistance in developing the Waikato Regional Council's operative Regional Land Transport Strategy, of which this topic is an important component.

Works Consulting Services Ltd, Hamilton assisted in the development of the Transport Options Assessment procedure

REFERENCES

- 1 Environment Waikato (1993a) Operative Regional Land Transport Strategy - 1 October 1993.
- 2 Environment Waikato (1993b) Regional Land Transport Strategy, Resource Document Five - Transport Options Assessment Study.
- 3 Transit New Zealand (1993) State Highway Strategy for the Waikato Region.

LRI147