THE FINANCIAL IMPLICATIONS OF FORESTRY LOGGING TRAFFIC ON RURAL ROADS

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FOREWORD

Over much of New Zealand's relatively short history, agriculture and forestry have appeared to be in conflict with each other. For decades after the first settlement by Europeans, the clearance of indigenous forest epitomised the push towards national development and the spread of population through the country. In more recent times, exotic plantings encroaching upon farmland have been viewed by some people as a reversion of land from its developed state. However polarised these perceptions may seem, for many years they exerted considerable influence on policy towards land use at the level of both national and local government.

Since the extensive land use debates in the 1970s, attitudes towards forestry have changed. In many respects forestry is recognised now as just another crop, competing for the use of land alongside other primary industries. Yet it retains some distinctive characteristics. It is not an irreversible land use change, but it does impose a longer time frame than traditional agricultural activities. Partly because of this long lead time before production and the size of operation needed to capture economies of scale, forestry may result in social and economic impacts on local communities over wide areas. And the final outcome of productive forestry from any individual site is a flow of logs or timber in comparatively heavier volumes than most other land uses produce, concentrated into relatively few years.

Because of these characteristics, questions remain as to the appropriateness of land use policies oriented predominantly to pastoral agriculture when dealing with forestry. The roading issue examined in this discussion paper is only one of these questions. Because it pertains to the formulation of local government policy towards the use of a finite and depletable resource, land, it is an issue in which the interests of policy analysts and natural resource economists converge. Consequently this work is being published both as part of the Policy Paper series of the Centre for Agricultural Policy Studies, and as one of the Discussion Papers in Natural Resource Economics issued by the Department of Agricultural Economics and Business.

This discussion paper is based on post-graduate research undertaken by Mr P.W.J.Clough, Research Officer with the Centre for Agricultural Policy Studies, towards his Diploma in Agricultural Economics. He was supervised by Dr A.D. Meister, Reader in Natural Resource Economics in the Department of Agricultural Economics and Business. The research was funded by the Forest Research Institute, and its relevance to both the forestry industry and to local territorial authorities was apparent in the interest shown at public presentations of the results.

On behalf of the authors we would like to extend appreciation to all those whose help and co-operation made this research possible. In particular, special thanks are due to:

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and countless other individuals in the forestry industry, the National Roads Board, and the Logging Industry Research Association, whose ideas and insight contributed to the progress of this research.

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Director, Centre for Agricultural Policy Studies

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I. INTRODUCTION

The period since the mid-1970s has witnessed an unprecedented growth in exotic forestry planting in New Zealand, with silvicultural practices aimed at felling most of these trees at between 25 and 35 years old. This has brought the prospect of a substantial increase in the volume of felled timber in the period 1995-2005, and with it the question of whether the physical infrastructure will be able to cope with the demands of forestry production. One aspect of this question is the ability of the rural roading network to carry logging traffic, raising concerns which, rightly or wrongly, exert a certain influence upon the formulation of land use policy at the local government level.

Responsibility for roads in rural areas is divided between central government (in the form of the National Roads Board) which administers the state highways and main arterial routes, and local authorities which administer the remainder of the rural road network. Some rural councils have identified a potential "problem" arising from a heavy increase in logging traffic on their roads at some future date: their revenues from rates and other sources may be insufficient to maintain their roads at their current standard. The discouragement of large-scale forestry (which, because of sheer size can afford the development of internal transportation systems) in favour of smaller dispersed plantings by some councils, has ironically compounded this problem, ensuring that future logging trucks will be channelled onto the public road network.

This discussion paper explores more thoroughly in a national context some of the questions relating to the financial impact of forestry logging traffic on public roads. These are:

a) how important is the roading issue in the formation of county policy towards forestry;
b) what measures have councils used in response to the roading problem, and how effective have they been;
c) what is the likely effect of logging trucks on the costs of maintaining rural roads;

d) what further research needs to be done to establish whether a roading problem exists, and how to remedy it?

This is not necessarily to imply that there is a roading problem in all counties, or that the problem is a real one in counties which perceive it as such. But if forestry is to be given equitable treatment in competing for land with other activities, it is important to find out how serious are the financial implications of forestry on rural roading, how influential are those implications in determining councils' attitudes towards forestry, and how those implications may be alleviated.

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II. BACKGROUND TO THE ROADING ISSUE

2.1 The Issues

The roading issue can be summarised as follows. Forestry, it is claimed, makes heavier demands on rural roading than agriculture, accelerating the requirement for maintenance and, in some cases, improvement or upgrading of rural roads. The principal source of revenue for local authorities is the rate struck on local property valuation. Some local authorities doubt if the rate revenue from properties in their territory will be sufficient to match the added costs of roading caused by forestry logging. Rate revenue from land converted to forestry from agriculture may paradoxically decline, and there are few other legal means by which local authorities can levy forestry operations in their territories. Some local councils have successfully approached forestry companies for extra financial assistance on an ad hoc basis, but some companies argue that they already pay a levy in the form of road user charges. Besides which, their operations are not profitable until harvesting takes place, whereas councils would prefer to upgrade their roads before logging commences. Faced with the prospect of added costs which will ultimately prove a burden on their ratepayers, local councils may attempt to restrict the encroachment of forestry into their territories by means of their jurisdiction of local land use planning.

The forestry roading issue can therefore be broken into three components:

i) the availability of finance to pay extra roading costs;
ii) the timing of such finance to anticipate peak forestry production;
iii) equity considerations with respect to who pays the added costs.

Rural residents frequently view forestry companies as profitable and undeserving of a "subsidy" on roading from local ratepayers. On the other hand, forestry companies point out that they pay road user charges on all the roads they use, but since the

average road maintenance cost per vehicle on the heavily used roads is less than that on the lightly used roads, there is effectively a transfer of funds to rural residents from the users of the major highways.

This last point stems from the fact that road user charges are effectively a tax on distance travelled and load carried, rather than strictly a "user pays" mechanism. The revenues from these charges are the major component of the National Roads Fund, out of which the National Roads Board makes disbursements to county councils in their capacity as local roading authorities. This grant aid is distributed according to the formula:

$$K1 + K2 \times \log10\ (P/LV)$$

where: P is the county's total basic roading programme;
LV is the three-year average of equalised net land values;
K1,K2 are constants determined by the NRB according to total revenue of the Fund and other spending commitments.

The position of land value in the denominator means that the higher a local authority's rateable value, the lower the contribution from NRB to roading expenditure, with the result that rural counties tend to receive a higher subsidy than municipalities.[1]

The assertion that logging trucks make heavier demands on rural roads than agricultural vehicles is supported by empirical studies of loads transmitted through the axles of the different types of vehicle (Major and Heine 1977), and of trip generation from different types of land use (King et al. 1980). It is now established that the wear effect transmitted to the road surface by a vehicle varies according to its weight and the configuration of its axles. The guideline which is currently used is the so-called "fourth power rule", which states that the wear effect on a road pavement increases approximately in proportion to the fourth power

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1 The formula is applied with the roading programme measured in thousands and the land value measured in millions of dollars, so that the logarithm, and the outcome, remain positive.

of the load transmitted through an axle. Certainly the wear effect of heavy commercial vehicles (HCVs) is far greater than that of cars, and in normal traffic streams where HCVs comprise more than five per cent of total vehicles, the effect of cars on road wear is negligible.

Averaged over the course of a forestry rotation period of 28 years, only dairying generates more trips per year than the equivalent area under forestry (Figure 1). A trip in this case is defined as the passage of a heavy commercial vehicle through a property's gateway to or from the public road system. The physical impact of forestry is compounded by the concentration of peak flows into a relatively few years of harvesting, as is illustrated in Figure 2 for one forestry regime with production thinning in the fifteenth year. With forestry, heavy load bearing traffic consists almost entirely of harvesting vehicles, but for agriculture both vehicles carrying inputs (fertiliser) and output (stock) come into this category.

For many county roads, construction standards vary along the length of the road and there is no clear relation between the durability of the road pavement or substructure and the flow of load bearing traffic along it (National Roads Board 1982). However, it is likely that an increase in heavy traffic, as from logging operations, will cause structural damage to such roads and bring forward the date at which reconstruction will be required, which is why some local authorities have sought extra funds for upgrading, and not simply maintenance.

2.2 Sources of Finance Available to Local Authorities

The principal source of revenue for local authorities is rates levied on occupiers of land within their territories, on the basis of property values set by the Valuation Department. The most common basis of rates in rural areas is that of "land value", which is the value of the land in grass as seen today, including invisible improvements such as draining and clearing, but excluding visible structural improvements such as buildings and fences. An alternative

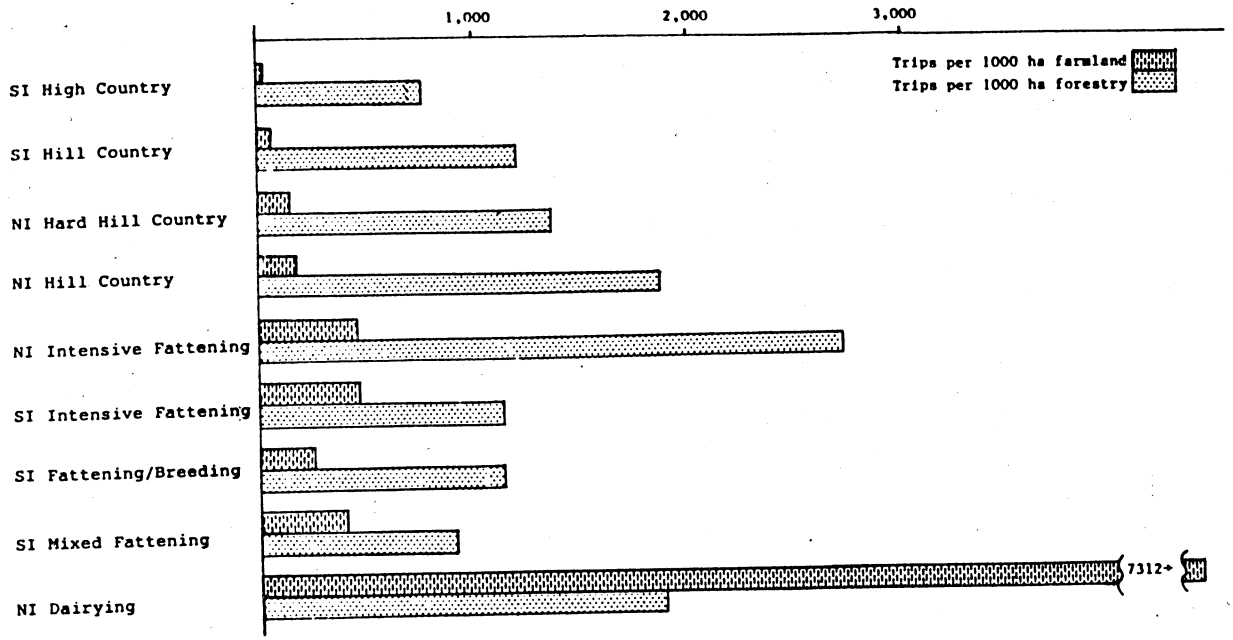
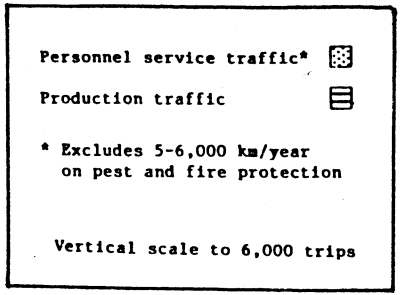
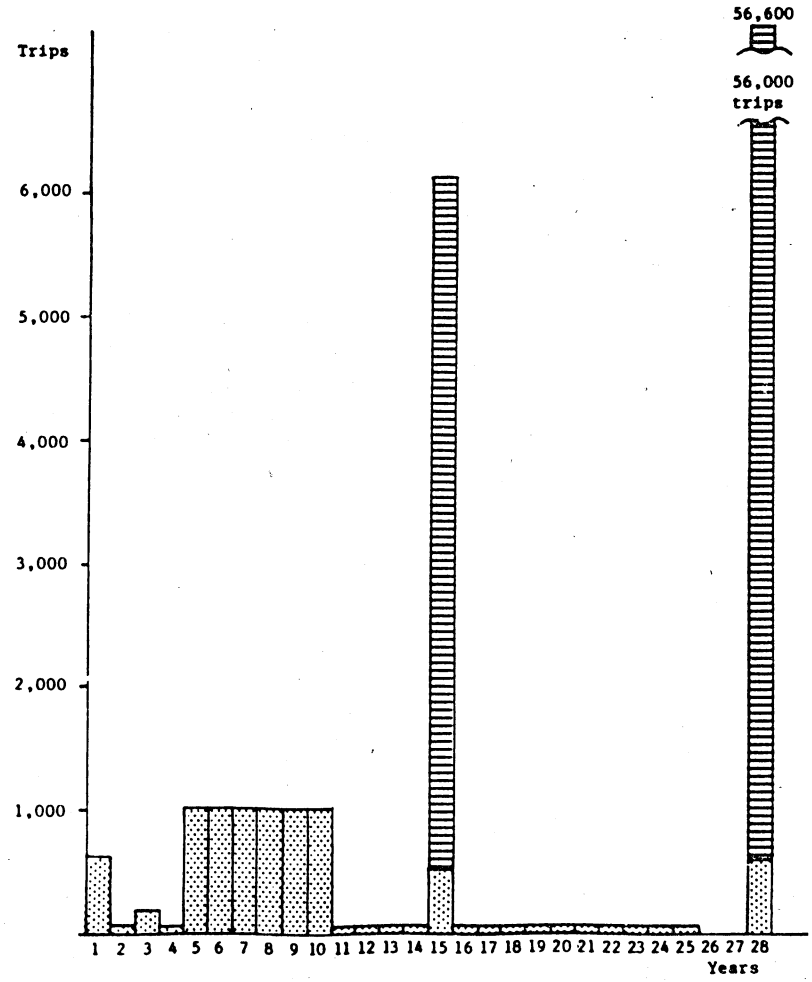


Figure 1: Heavy Vehicle Trips/1000 ha/Year From Farm and Forestry Land

Figure 2: Trip Generation per 1000 ha Forestry Through a 28 Year Rotation





basis is that of "capital value", which is the land value plus the value of such visible improvements. The capital value of a property reflects most closely its market or sale value, but government valuations rarely coincide with realised market values.

Section 28 (1) of the Valuation of Land Act (1951) stipulates that in both the assessment of capital value and land value the value of trees on the property should be specifically excluded. Section 147 (2) of the Local Government Act (1974) allows differential rating of a type of property defined on the basis of its use, zoning, area or such other distinctions as a council thinks fit, but not on the basis of type of occupier. So councils wishing to levy a higher rate on forested property to meet extra costs of roading can not distinguish between owner-occupiers, companies or other types of owner for this purpose.

Valuation procedure indicates that the effect of a change from pasture to trees is to lower the government valuation of a given block of land, other things being equal, because the grass component on which the valuation is based is eventually displaced by trees. This also means the difference between land value under grass and trees varies over the course of the trees' growth cycle. This is best illustrated by comparing a paddock recently planted with trees with the same paddock immediately after harvesting. In the former case, the paddock is still capable of being grazed and thus has a value virtually the same as an open grass paddock, but in the latter the paddock would be filled with stumps and require considerable work to restore it to its grassed value, so its land value would be lower.

This effect is difficult to verify empirically, since records of actual valuation changes are relatively few in number and relate to properties of varying size, terrain and other attributes. Under some circumstances, a property could simultaneously reduce its land value (and hence rating liability) and increase its capital value (and hence sale value) through conversion of pasture to forestry. Since many forest blocks or woodlots occupy only a small part of a property, their effect on the property's land value is likely to be negligible, and may only become apparent at a late stage in the tree growth cycle.

In most counties the effect of land conversion from pasture to forestry is likely to be small. Unless the tree planting is accompanied by specific improvements to the land (such as drainage and contouring) which would not have occurred to the land under grass, conversion of pasture to forestry is likely to reduce land values. Conversion of scrub to forestry is likely to increase rateable values, as is conversion of pasture to forestry with structural improvements in the few counties which levy rates on capital values. Where it exists, the "rating effect" of forestry could compound a roading problem, insofar as the rateable value is lowest in the years immediately prior to harvesting when counties may incur extra cost in road upgrading. But this would be only significant in counties with large forests and harvesting concentrated in a short period, and in most counties the depressing effect on land values is likely to be indiscernible.

Other sources of funds available to county councils for rural roading are limited. Local authorities are entitled to a development levy on major works in their areas, of up to 0.5 per cent of their capital value, but trees and ancillary developments associated with forestry are not sufficient to qualify as "major works". Section 17 of the 1949 Forests Act entitles local authorities to receive one fifth or one tenth of the net revenue or royalties received from the sale of timber from various categories of State Forest. This levy is usually extracted from the sawmiller or logging contractor. Rights to a timber levy, applying to areas of private land within an authority's territories, are granted under the 1974 Local Government Act. Both these levies, however, apply only to indigenous trees which have not been artificially planted, so neither offers any relief from roading requirements arising from exotic forestry.

Faced with relatively few means of supplementing their rating revenue for the purpose of improving roads, some local authorities may attempt to influence road use by restricting land use through the discharge of their responsibilities under the Town and Country Planning Acts of 1953 and 1977, for instance by making forestry a conditional use on certain classes of land, or attempting to make the logging operation itself a conditional use. Other means of controlling traffic open to local authorities include powers conferred on them under the Transport Act (1962) and the Local

Government Act. These include the right to set weight limits on bridges, the right to close roads to certain categories of vehicle, and the right to raise a levy to recover the extraordinary costs of wear and tear stemming from a specific user's use of the road. This last provision has yet to be legally enforced, and some doubt exists about the ability of a county to estimate the extraordinary costs associated with a single user.

For historical reasons, Crown Land is treated differently from private land. This is evident in the timber levy and the "fifths and tenths" levy noted above; it is also evident with respect to rates, since the Crown pays a grant in lieu of rates. In most cases this grant is not much different from the rates which would be due from the equivalent area of private land, since it is based on the county's rate demand. But whereas undeveloped land on a private property, no matter how apparently worthless, is assessed in the government valuation and thus contributes to rateable value, on Crown land such land is often classed as protection forest and is not part of the rateable value. In some circumstances, therefore, the grant received from Crown land is different from the rates which would be received from the same land in private hands.

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III. SURVEY OF COUNTIES' ATTITUDES TOWARDS FORESTRY AND THE ROADING ISSUE

3.1 Preliminary Considerations

From the foregoing background discussion, the degree of concern felt by rural councils on the roading issue might be expected to depend on a number of factors peculiar to the individual counties themselves. These include the county's predominant land type; the area of forest (both actual and potential); the stage of forests in their cycle of production; the initial condition of county roads; and the length of county road likely to be affected by logging traffic, given the alternative transport methods available. The attitude of councillors, planners and rural residents is another important factor, although by its nature less tangible and more changeable.

In their study of rural planning and forestry, Fowler & Meister asked the New Zealand Forest Owners Association on which land use capability (LUC) classes commercial forestry was considered to be economically and physically feasible. In general, forest owners consider classes I to III too expensive for forestry to be a profitable land use, whilst on class VIII land, which is generally steep and in remote locations, the logging operation would be two to five times more costly than on more suitable land. The most favoured land for forestry was on land classes V to VII, but more expensive class IV or III land would be acquired where special circumstances, such as proximity to processing plants, ports or very good roads reduced the costs of overall timber production (Fowler & Meister, 1983).

To establish whether there is any apparent relationship between these factors and county councils' concern over the roading issue, a survey of 19 counties was undertaken, using a combination of personal interviews and questionnaires directed at county clerks, engineers and planning officers. The counties selected were those which, in the opinions of people in the forestry industry, either had substantial plantings already in existence, or the potential for

significant plantings in the future. The term "forestry" in this sense refers to exotic forestry, since it is the perceived conflict between exotic plantings and farming which lies behind most of the planning restrictions placed on forestry.

The survey covered plantings of various age classes, from the well established forests of Taupo and Rotorua to much more recent, and rapidly expanding, forests in Northland. There was also a wide variation in the pattern of planting in the counties surveyed, from predominantly small and dispersed forestry blocks in some counties to concentrated forestry holdings in others. The survey covered both counties where state forest predominates and those where private forests are dominant.

3.2 Planning Restrictions Relating to Forestry

The District Scheme of each of the counties in the study was examined, and officers of the councils concerned were subsequently asked to explain the reasons behind the provisions relating to forestry in their schemes. Some of the schemes were fully operative, while others were still undergoing their quinquennial review, and in some the reviewed scheme was subject to appeal before the Planning Tribunal. Interestingly, most of the appeals encountered had been instigated by members of the farming community seeking to place further restrictions on forestry, such as conditional use status in the case of Rotorua and Whangarei counties. So the counties surveyed were not generally ill-disposed towards forestry, although to an extent that is self-evident from their status as counties with substantial forestry developments.

Most of the counties had specific clauses to restrict forestry on high quality land with potential for arable farming, although in view of the uneconomic returns obtained from planting high value land, in most cases such restrictions were unnecessary. In ten counties this was an outright prohibition, while in the others forestry was either a conditional use, or tightly defined as farm woodlots, shelterbelts, protection or amenity plantings which would not occupy a large area. In four counties forestry was a predominant

use in all zones, subject only to whatever restrictions might be used to protect the highest quality land.

Whilst many counties specifically commented that they did not favour conditional use procedures, a number of counties did impose "conditions" upon the predominant use status. Five counties required the submission of a forestry development notice prior to planting for approval by the Council. Such notices involve quite detailed management planning information, such as specifying areas planted, species planted, silvicultural management regimes and expected dates of harvesting. Four of the counties incorporated an area limit into their predominant use categories, stating that plantings greater than a certain area, or a certain percentage of the total land-holding area, would require conditional approval. A further method of restricting the predominant use status was by manipulating the definitions of the various forestry types. Whereas Hawkes Bay, Bruce and Rangitikei adopted a wide definition of farm forestry to encompass any forestry within the context of farming operation, Taumarunui and Wairoa both adopted a narrow definition, attempting to specify the maximum percentage of farm area which could be under trees. In the latter cases, the councils stipulated LUC land classes which could be planted. While such restrictions may be justified on social grounds in attempting to divert forestry development into a farm forestry context, they also appear to increase the likelihood that timber will have to be extracted over the public road system, rather than by internal forestry roading.

3.3 Provisions for Roading

Only six of the counties surveyed explicitly linked the clauses of their district schemes to the roading issue, although most of the other county schemes made some vague reference to roading. In Malborough and Hawkes Bay counties, the zoning of land, or its range of predominant uses, directly depended upon whether it had direct access onto a State Highway. Silverpeaks county employed a similar clause with respect to land adjoining State Highways or council's "notated logging routes", the latter being the county roads most likely to be used by, and most capable of withstanding, logging traffic from current areas of planting.

Other provisions made for the forestry roading problem, however, lie outside the field of the Town and Country Planning legislation. Alone of all the counties surveyed, Taumarunui has invoked sections of the Transport Act and the Local Government Act with it "Heavy Traffic Road User Fees Bylaw 1980", which sets out to extract from individual companies, in advance, the assessed cost of repairing the "extraordinary damage" to roading caused by the passage of their vehicles. The bylaw has not yet been used in practice, and there is still some doubt as to how it could be applied, in view of the National Roads Board's assertion that it would be impossible to estimate the extraordinary damage caused by a single road user. Moreover, the Taumarunui Council already acknowledge that the weight limits on bridges on their roads can not be enforced, so the bylaw is likely to give the country severe policing problems.

Perhaps because of these difficulties, seven of the counties had attempted at some stage to come to some form of voluntary agreement with forestry companies on roading cost sharing. The form of such agreements seems to have varied, as have the results obtained. Waimea County has undertaken several such agreements and seems completely satisfied with their outcome. While some of the smaller or less well-known operators may be bonded by the Council to ensure their compliance with the agreement, with most operators the Council has depended on mutual trust, and has so far not been disappointed. Voluntary agreements appear to be much more flexible than more formalised planning or bylaw provisions, and have been employed with success also in Rotorua and Waihohu. Hobson County has verbal agreements on cost-sharing, which are regarded with scepticism in some quarters. Whakatane County has attempted and failed in the past to secure a workable agreement, which has left the Council rather disillusioned with such measures. The experience of Waimarino County has also proved disappointing: the Council made an agreement with a forest company to cover damage by logging traffic, but failed to recover costs of damage caused by road construction by the company, since the heavy plant and aggregate trucks were not "logging traffic" and were not specifically included in the agreement.

Few of the counties surveyed had used differential rating as a means of increasing their revenues from forestry. Rangitikei County employs differential rating to discourage forestry on flat land, while Wairoa County introduced a scheme in April 1985, based on a property's capital value as a percentage of total county capital value. Taumarunui and Waihohu had both considered differential rating and admitted it might possibly be introduced in future, while Hokianga used to use differential rating but has since replaced it with a uniform rate.

3.4 Other Issues

Several other issues relating to forestry and roading were identified during the course of the survey. One of the most frequently cited reasons for a county's lack of specific provision for road upgrading was that the direction and flow of logging traffic simply was not known. This was particularly the case in counties with a high proportion of new plantings and few established forests. Uncertainty as to the most likely timber destinations was compounded by speculation concerning port or processing facilities, which made planning for logging routes at this stage seen futile. An example is the situation in Bruce and Silverpeaks counties, where logs are expected to be destined for Port Chalmers or Dunedin, but proposals to develop a new processing plant at Balclutha, if realised, could reverse the log traffic flows in much of the district. Faced with such uncertainties, counties tend to plan only as far as getting the logs onto the State Highways, upkeep of which is somebody else's problem.

Counties gave mixed response when questioned about the effect of forestry on their revenue from rates. Most county officers detected some change in rate revenue, but few considered that forestry resulted in a significant reduction in rates. In some cases, forestry increased the rateable value of a county: for instance in Malborough, where scrub-covered hillsides had been planted in pine; and in Taumarunui, where Maori land, previously not rated under council policy, was forested under joint venture arrangements and began to pay rates. In Rangitikei County, rates

revenue collected from forestry on the low-value sand-dune country was estimated to be far less than the fire prevention expenditure by the Council in that area. And the county manager for Marlborough directly questioned the level of rates with respect to roading, estimating the rate revenue collected per tonne at $0.04 from forestry land, $3.40 per tonne from plains land, $18.75 per tonne from un-topdressed hill land and $9.00 per tonne from topdressed hill land. In reply to the questionnaire he argued at length that the timber levy should be extended to exotic as well as indigenous trees; that the levy should be assessed on log weight, not board equivalents with up to 50 per cent wastage; and that Government and/or NRB should offer suspensory loans to enable local authorities to upgrade road prior to logging.

Two counties, Rangitikei and Silverpeaks, expressed concern about the effect of "transit traffic", i.e. logging trucks crossing their county roads from forests located outside their boundaries, from which they receive no rate revenue. In Silverpeaks this problem may be more apparent than real, since the forest in question, Berwick State Forest, straddles the county boundary with Bruce and is serviced on the Bruce side by a new road established with a developmental road grant.[2] In Rangitikei, one company threatened to transport its logs via the Napier-Taihape road, largely as a negotiating ploy between rail and road transporter, but the county may also have some timber from the Lismore Forest in Wanganui county crossing its boundary and using its roads. This could also conceivably be a problem in other counties if logging transport operators seek the shortest possible route to minimise their internal costs, as the Rodney County study suggested they might (McDermott Associates 1984).

Other issues of significance include the pattern of land use, the classification of roads and the paucity of communication between forestry concerns and local councils. This latter issue has been a decisive influence on some counties requiring management notices prior to afforestation.

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2 This government grant scheme was discontinued after 1984.

Several counties commented on the seemingly arbitrary reclassification of Class III roads to Class II in the early 1970s, and the difficulty encountered by a small local authority in policing weight restrictions on roads.[3] Finally, it should be noted that most of the alternative transport modes for logs - rail transport, internal forestry roads, barging in Northland or the Marlborough area - are only really feasible in large-scale, concentrated forestry blocks, so to the extent that Councils attempt to limit such developments in favour of dispersing forestry amongst farms, they may be creating greater burdens on their county roading network for future years.

3.5 Conclusions

The results of the survey suggest that roading for forestry does cause some concern for councils, but it does not seem to have affected the treatment of forestry in District Schemes very much. Its most obvious influence was in three counties (Marlborough, Hawkes Bay, Silverpeaks) where forestry is made conditional upon forest blocks having some direct access onto State Highways or council-designated logging routes.

Some county councils have attempted to find ways of recovering some of the costs of road maintenance caused by logging traffic. By far the most common response has been to come to some form of ad hoc agreement with the forestry companies concerned (Bruce, Hobson, Rotorua, Waihohu, Waimarino, Waimea, Whakatane). Not all of these agreements have been entirely successful from the counties' viewpoint, however, and two of the councils were rather disillusioned by previous experience with such agreements. One county (Taumarunui) has attempted to exact payment from companies by means of a bylaw created under the provisions of the Transport and Local Government Acts, but this has yet to be legally tested. Another county (Wairoa) has changed to a system of differential rating based on capital values in order to obtain a larger contribution from forestry companies.

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3 A similar situation exists at present as the Class II category is being eliminated.

The fact that the other surveyed counties have been acquiescent with the current situation does not necessarily mean that a roading problem is not perceived to exist. Neither have all the measures taken been satisfactory in removing the problem. But one of the most recurring comments from all the counties surveyed was that it is simply too early to know just what demands will be placed on their roading networks. In counties where the bulk of trees will not be harvested for some years hence it is difficult to get companies to commit themselves to harvesting dates, volumes and routes. Consequently councils find it difficult to make a case for financial contributions on the grounds of increased road maintenance costs.

Whereas one county (Rodney) has undertaken a detailed study of forestry's impact on county roads, many others do not have the resources to do anything about the issue and look to others for guidelines. This need for guidelines is reinforced by the varied success experienced by different counties in their agreements with individual forestry companies. Apart from guidelines on what to include or exclude from such agreements there is also a need to establish a clear and equitable method of cost sharing, so that once the principle of cost sharing is agreed, lengthy wrangling over details is avoided.

County councils' inactivity on the roading issue can be partly attributed to the institutional framework within which they are operating. There is no provision for local authorities to recover rate revenue from forestry operators who use their roads but pay rates to a neighbouring authority. Several counties referred to the difference between revenue obtained from State and private forested land of comparable type and area as noticeable, although few considered it significant. The different treatment of exotic and indigenous timber also appeared anomalous to some. Faced with this institutional framework many county councils have adopted a wait and see attitude, observing developments both within their own counties and those occurring elsewhere.

Although they share a common legislative framework, counties exhibit great differences with respect to most of the attributes which relate to the roading issue: land area and use capabilities, population and rating base, ease of terrain, materials and manpower

available for road maintenance and so on. The importance attached to the roading issue is dependent upon the perceptions of individual council members and officers: what is deemed an "acceptable" level of maintenance can vary greatly even between adjacent counties with apparently similar characteristics (National Roads Board 1982). So generalisations about county attitudes need to be treated with some caution, and the extent of the roading problem can best be ascertained by examining counties individually through case studies.

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IV. ASSESSING THE FINANCIAL IMPLICATIONS OF FORESTRY ON RURAL ROADING

The following section outlines a suggested methodology for assessing the financial implications of forestry on rural roading. First it identifies some of the basic engineering considerations underlying the issue, then it examines some previous studies which relate to the issue. Finally a methodological procedure is outlined which could be applied in specific counties where forestry is thought to present a roading problem.

4.1 Engineering Considerations

Most roads become obsolete in some respect (width, alignment, route) with time, so designing a pavement to last indefinitely is wasteful, both in the sense of diverting resources from more immediate needs and providing future infrastructure which may not be required. Current engineering practice therefore regards roads as "fatigue structures", designed to last a specific number of years. Every load effectively uses up some of the "design life" of the pavement, so that an unexpected increase in heavy traffic flows can accelerate the rate of road wear and hasten the date when reconstruction is required.

In New Zealand it is customary to estimate road wear in terms of the equivalent design axle (EDA), which is defined as the wear effect of a spaced twin-tyred maximum Class I axle load (8.2 tonnes). An equivalent amount of wear is created by a 5.4 tonne load on a single-tyred axle, or a 14.5 tonne load on a twin-tyred double axle. There are empirically derived tables relating vehicle payloads to units of roadwear for the different types of commodity loads encountered on the roads. So, given an estimated flow of commodities coming from a specified area served by a particular road, it is possible to estimate first, the number of trucks needed to transport

these commodities and second, the resultant wear effect on the road. From this information can be calculated the likely date of road reconstruction and/or the upgrading required to allow the road to carry the expected loads.

Since the design life of a road may be 20 years or more, commodity flows may need to be projected for some years ahead. In the case of through roads there is an implicit assumption required on the direction of flow of commodities to or from a given location along the road. Moreover, both the payload factors and load (wear) factors are based on observations of existing vehicles in existing conditions. A change in the regulations on maximum vehicle loadings would instantaneously change the payload factor and load transmitted to the surface, as would technological changes in truck design and tyre configuration. Despite these reservations, the methods outlined above provide useful and generally acceptable means of estimating road wear.

4.2 Previous Studies of the Forestry Roading Issue

Previous attempts to quantify the financial implications of forestry upon rural roading can be broadly divided into two types: macro-level and micro-level. The macro-level studies attempt to estimate at the national level the costs incurred in maintaining the roading infrastructure during growth in forestry traffic. The micro-level studies focus on the revenues received or costs incurred as a result of the use of particular roads in individual counties.

In 1982 the Ministry of Works and Development produced estimates of capital improvement requirements for roads and highways servicing the forestry industry, broken down into regions. The exercise does not appear to have been given much priority: the procedure and worksheets used in these estimates are no longer available and there has been no attempt to update or revise the estimates. In any case, they were only concerned with capital costs and ignored incremental maintenance costs.

Another macro-level study was conducted on behalf of the New Zealand Forest Owners Association (1981), to provide an aggregate assessment of the forestry sector's likely impact on county roads throughout the country between 1982 and 2005. Using estimates of length of county road used by forestry trucks and of expected maintenance and reconstruction costs, this study estimated cumulative spending on roads of $132 million (1981 values), which it compared to total payments by forestry through road user charges and rates of $74.5 million. Noting the uneven distribution of these forestry contributions between counties, road user charges and fuel taxes were advocated as more equitable than rates for meeting roading costs.

Several points and assumptions made can be criticised in this study, which is now out of date because of subsequent increases in road user charges. In any case, aggregate approaches do not address the question of distribution of revenues between counties, or the timing of revenues received and costs incurred. As indicated by the survey of counties, the perception of a logging traffic problem is limited to particular counties. It does not appear to be a general problem, so a generalised approach is not the most appropriate.

A micro-level study was conducted on the Ngaumu State Forest in the Wairarapa (Millen 1980), using the engineering principles outlined above to estimate the road wear generated by both logging traffic and agricultural traffic over a specified period along the road servicing the forest. The study aimed at estimating and allocating the costs of upgrading according to traffic levels generated by the different land uses. It was limited to a relatively small area and few roads, where incremental costs and traffic flows could be clearly identified. Some problems were encountered in applying the method in practice, but while the study's final results were not used, Masterton County Council and the New Zealand Forest Service did reach agreement on sharing costs on the basis of total EDAs generated by farming and forestry traffic.

When dealing with a wider area, or with a number of point sources for heavy traffic, a more complex model is needed to account for both the different origins of loads and for the cumulative effect of loads converging on a stretch of road from several

sources. Such a study has been attempted for Rodney County (McDermott Associates 1984). Information from the NZFS was obtained for all exotic forestry plantations, covering such aspects as location, species planted, area planted, site index and management regime. Production tables were used relating species to site index and age at harvest to produce yield per hectare figures which could then be converted to expected flows of truck loads from each location in particular time periods.

The road network in the county (including State Highways) was divided into 420 "links" joined by 120 "nodes". (A "node" is a road junction, a change from sealed to unsealed surface, or a point where forestry traffic would be expected to enter the public highway system). Each forest compartment was allocated to a node on the network and a computer route optimisation model was used to simulate flows of traffic through the network for two distinct processing scenarios. Potential problem areas on the road network were identified by applying current annual costs per EDA kilometre to the simulated flows, or by estimating the difference in discounted cost of reconstruction caused by the additional traffic shortening the life expectancy of the road.

Rodney County is fortunate in having a relatively large population, high rateable values and considerable resources at its disposal. While the study offers an impressive amount of detail (down to costs per road link), the approach used could be regarded as "over-designed" for use by a majority of New Zealand county councils. In practice a less detailed, more aggregated approach would be more useful to most councils in assessing whether they have a roading problem arising from forestry. To this end a methodology has been developed which is suitable for use on a micro-computer spreadsheet.

4.3 A Methodology for Examining the Financial Implications of Forestry on Rural Roading

This methodology has three basic stages:

a) estimation of forest yields;
b) estimation of the effect of these yields on the road network;
c) estimation of the financial impact over time on the county.

Stage (a) is similar to the corresponding stage in the Rodney County study; stage (b) develops the average EDA load per kilometre calculation used in the Ngaumu study; stage (c) estimates a cash flow for the county over time, so that the effect of incremental maintenance costs and accelerated reconstruction can be traced through the period of forest rotation. (See Appendix 1).

The methodology was developed in a case study of Rangitikei County, details of which are described elsewhere (Clough 1986). The suggested procedure is as follows:

1. Divide the county road network into a number of catchments feeding into likely destination points.
   Sections of sealed and unsealed road are considered as separate catchments, even where one feeds into the other.

2. Locate all forests (private and State) and allocate them to a particular catchment.
   Both State and private plantations must be allocated to the catchment which provides the most likely route to the logs' destination. Location details for both State Forests and private forest holdings are available from the NZ Forest Service.

3. Estimate likely production and timing of output from each forest holding.
   State forest production plans give a reliable indication of the volumes of output expected over future time periods. For private forests, production must be assessed on the basis of information in the NZFS private forest data base (Prifo), which covers location, area and species

planted, date planted and management function for each private woodlot known to be in the county.

4. For each separate time period, calculate the average loading per kilometre in each catchment caused by logging traffic.

The formula used in is an adaptation of the one used by Millen, to account for multiple-point sources;

$$\text{Average load per kilometre} = \Sigma \frac{w_i d_i}{D} \quad \text{tonnes}$$

where w_i = the weight of logs cut from a given holding,
d_i = the distance along the catchment roads from a given forest holding to the outflow of the catchment,
D = total distance within a catchment affected by logging traffic.

The calculations in the case study were done for 5 yearly time periods, in line with the age classes in the forestry data. For each time period the figure obtained was converted to a road-wear load by dividing by a payload factor to obtain the number of trucks required, then multiplying this figure by a load factor to obtain EDAs transmitted to the pavement. To do the last calculation, figures by Major and Heine (1977) were used. Although these figures may have become obsolete, they are still the only comprehensive set of figures available.

5. Establish a base year traffic flow, and project the non-logging traffic through each future time period.

The approach adopted for this study was to take the most recent traffic survey for the county, and update it for normal traffic growth at the rate of 3 per cent per annum. If no recent traffic survey is available the next best thing to use is recent traffic information from neighbouring counties.

6. Add the results of 4 and 5 to obtain total traffic flows for each time period and the proportions attributable to logging and non-logging traffic (in terms of EDAs).

7. Estimate the design life left in each catchment and date of reconstruction, and translate traffic flows into maintenance costs (on the basis of EDAs generated).
The translation of traffic load into maintenance costs is a problematic area. While in theory a "design life" can be estimated, in practice relatively few county roads are constructed to such standards, and even fewer have any close monitoring of how their design lives are being used up. In practice the best that may be achieved for each catchment is to ask the county engineer when he expects its principal road to require reconstruction. Projecting "normal" traffic flow EDAs to that date will give an estimate of EDAs remaining in the design life, so that the accelerated reconstruction from additional traffic (if significant) can be estimated. The choice of the principal road in each catchment is justified since this is the one which will collect traffic from its tributaries and so have the heaviest loads. Even if it does deteriorate at a faster rate than the rest of the catchment, its reconstruction will be crucial to the functioning of the catchment as a whole.

8. Establish the base year county roading programme, identifying local and National Roads Board contributions.
This step requires a county's programmed roading expenditure, averaged over a number of years around the "base" year to remove the effect of annual variations. The figures thus estimated should be broken down into as much detail as is available: by riding or roading district: by sealed road or unsealed road: by fixed costs and variable costs. Given such figures, it should be possible to derive average variable maintenance cost figures per kilometre for sealed and unsealed roads for each internal county roading district.

9. Estimate the proportion of programme attributable to forestry-affected roads or catchments.
   Although this allocation will be rather crude, in many cases, it should be possible to allocate the maintenance expenditure to the riding, or some other sub-county level.

10. On the basis of projected cost flows, calculate the "required" NRB and local contributions.
   The projected cost flows estimated in step 6 and 7 give a value for the roading network. Using the formula for total NRB contributions the level of rate income "required" by the county can then be calculated. For this purpose, the council's expenditure on non-roading services is assumed to stay constant in absolute value relative to the base year.

11. Compare "required" local contributions with projected "actual" contributions over time, taking into account changes in the county's rating base, previous levels of rate revenue and allocation within the county.
   This step requires a projection for each time period of rates collected in the county which contribute to the roading allocation (i.e. excluding special purpose rates).

12. Estimate likely changes in rating liability within the county, and the timing of costs and revenues pertaining to roads.

A schematic diagram of this approach, as applied in a case study to Rangitikei County, is given in Appendix 1. In practice, the size of such a model depends in part upon the number of separate catchments identified and the simplifying assumptions used. In a county such as Rangitikei, where a substantial proportion of the productive timber area is in small privately owned woodlots, the number of separate origin points was large resulting in around 40 separate catchments. The number of destinations could also have a complicating effect, but since the probable destination of future timber production was indeterminate, it was assumed that all logging trucks would travel to the nearest State Highway, at which point they would cease to be a concern to the County Council.

Once the forest yield has been estimated and resultant traffic flows converted to EDAs, the methodology is essentially a straight forward cash flow analysis. Current maintenance costs and construction costs are applied to the forecast traffic flows and incorporated into a projection of current county income and expenditure. Shortfalls in income in any particular year can be viewed as a loan which the county must raise to cover its expenditure, and the effects of such additional loans can be traced through the cash flow of successive years. This procedure generates a number of tables, the connections between which are illustrated in Appendix 2, but each stage is quite simple to apply, given the availability of suitable information.

4.4 Discussion of the Case Study

Rangitikei County has a rural area of 3,924 square kilometres, stretching from the central volcanic plateau to the coastal dunes of the southern North Island (Figure 3). Exotic forestry covers around 2 per cent of this area, but the pattern of planting indicates that forestry logging traffic may have significant impact on parts of the county road network. About a third of the forested area is on private landholdings, located along back roads throughout the county. The remaining two thirds is State Forest, the major plantation being Santoft State Forest. Heavy planting by both the State and private landowners on the sandy coastal dune country has resulted in about 80 per cent of the county's forested area being located in its two southernmost ridings.

The Rangitikei County Council has generally been favourably disposed towards forestry, employing unrestrictive planning ordinances. But it has some concern about the effect of concentrated logging traffic on the southern roads, particularly since the council incurs other costs (such as fire control over the private forests) in addition to roading which make demands on the rate revenues collected from those ridings. Another potential problem is that of logging traffic using their roads in transit from other counties. Under certain circumstances it is possible that logging traffic from the Lismore State Forest in neighbouring Wanganui

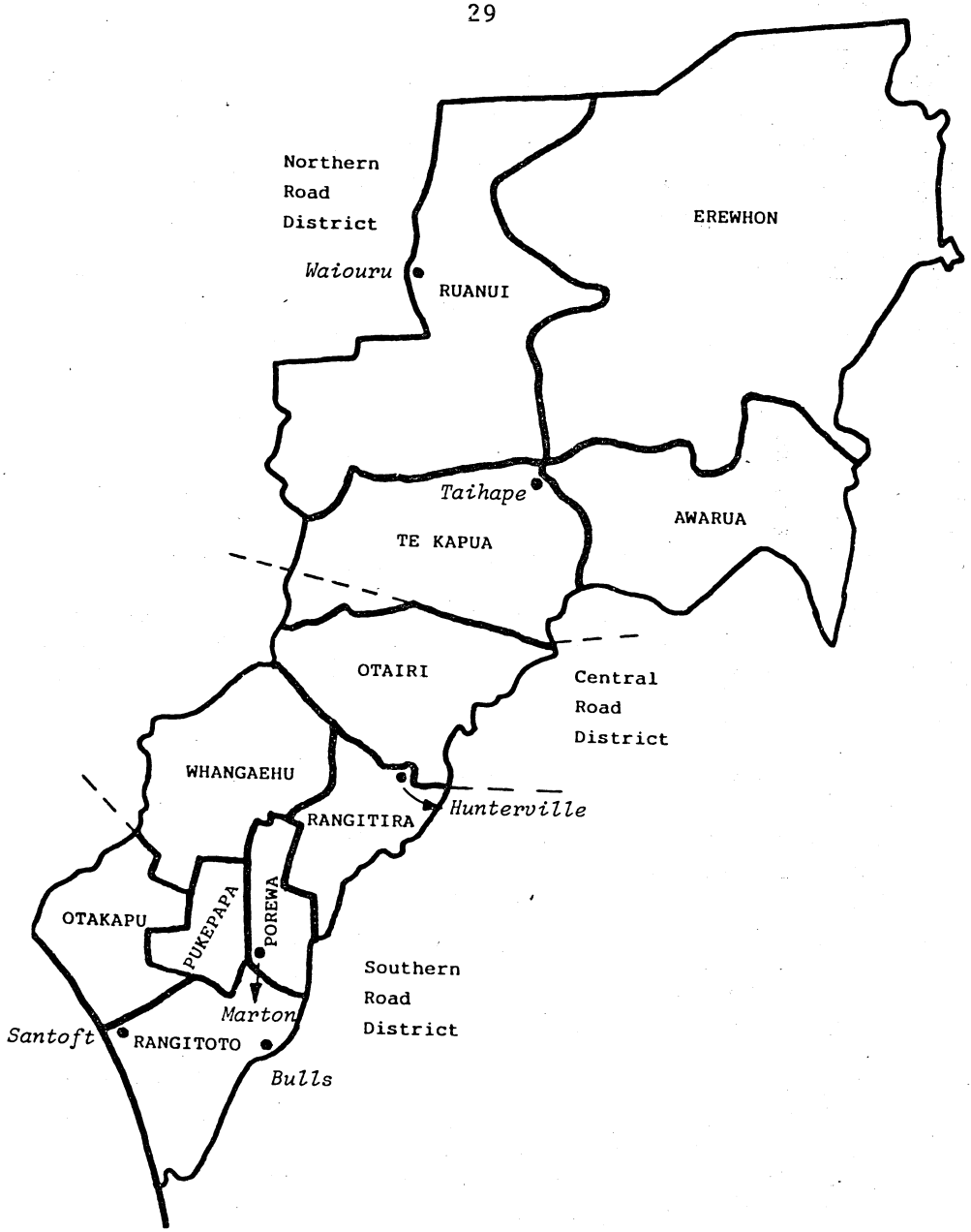

Figure 3: Ridings of Rangitikei County

County might be directed over Rangitikei's roads. Similarly, certain demand conditions (such as increasing log exports through the port of Napier) might encourage logging traffic from Rangitikei and elsewhere to use the county's Taihape-Napier road in preference to the State Highways via Taupo or Woodville.

The methodology outlined above was applied to data for Rangitikei County. Forest output from both State and private forests over the period 1986 to 2010 was calculated and allocated to specific road catchments and time periods. The incremental maintenance costs per kilometre associated with these extra loads were calculated, as illustrated in Table 1, and incorporated into the council's projected roading programme. Since the only item of capital expenditure which came up with any regularity was that of resealing, this was used as a basis for imputing a design life for roads affected by forestry traffic. The results of this calculation, illustrated in Table 2 with respect to roads in the southern ridings, suggested that reseal dates would not be brought forward significantly with the impact of logging traffic, unless accompanied also by increased non-logging traffic.

To put some of the results of the analysis into the perspective of overall county planning, the total variable road maintenance costs (adjusted for the projected logging traffic) were incorporated into a projected summary of county receipts and expenditures. Expenditures on the rural road account are met by NRB subsidies, seal rate, miscellaneous contributions and general rates, the latter being calculated as the balance of total receipts less the other receipts. This general rates allocation for rural roads was then transferred to a projection of the county's general funds and, since the total allocation must equal total funds, the total rates revenue required to meet the allocation was then calculated as a residual.

In the projections in the case study three scenarios with regard to NRB funding were analysed:

1. NRB subsidy projected at its level in the base period;
2. NRB subsidy moving in direct proportion to its share of subsidisable expenditure in the base period;

Table 1: Current Maintenance Costs and Logging Induced Costs (5 Year Periods - 1984/85 Dollar Terms)

DISTRICT:	SOUTHERN		CENTRAL		NORTHERN		TAIHAPE - NAPIER	
	Total km	$/km	Total km	$/km	Total km	$/km	Total km	$/km
Sealed	292.8	768.77	75.5	1148.78	132.4	793.41	13.3	1940.48
Unsealed	52.1	1509.91	132.5	1766.97	407.7	1358.32	50.2	2129.96
	$/yr	$/5yr	$/yr	$/5yr	$/yr	$/5yr	$/yr	$/5yr
Tot Sealed	225095.86	1125479	86732.89	433664	105047.48	525237	25808.384	129042
Tot Unseal	78666.31	393332	234123.53	1170618	553787.06	2768935	106923.99	534620
LOGGING INDUCED EXTRA COSTS:								
(Per 5yr)	$	$/km	$	$/km	$	$/km	$	$/km
1986-1990								
Sealed	13011.67	123.57	150.88	2.84	331.83	13.94	590.29	9.35
Unsealed	100.95	18.36	94.53	9.18	675.53	21.31	801.59	22.64
1991-1995								
Sealed	13512.96	160.11	23.31	1.84	0.00	0.00	154.31	5.61
Unsealed	0.00	0.00	57.82	9.18	0.00	0.00	601.95	27.91
1996-2000								
Sealed	14013.22	132.95	296.09	11.70	0.00	0.00	217.14	5.08
Unsealed	0.00	0.00	517.09	55.01	0.00	0.00	655.04	24.96
2001-2005								
Sealed	25123.99	180.49	277.27	3.78	1834.77	77.09	2430.97	30.79
Unsealed	429.33	104.72	728.10	19.73	10227.65	369.23	9437.33	191.85
2006-2010								
Sealed	24707.85	174.80	1571.05	17.95	6203.26	260.64	1695.01	24.98
Unsealed	107.82	46.88	1887.56	86.98	25339.82	914.79	6687.57	81.33

NOTE:
Total costs are the product of average costs and total kilometres at the current time;
Induced costs are a product of average costs by kilometres affected by logging in each period.

Table 2: Incidence and Present Value of Reseal Expenditures After Impact of Logging Traffic on Constant and Growing (3%) Base Traffic Flows

DATE	RESEALING EXPENDITURES (1984/85 $ TERMS) Current	With Logging Traffic		PRESENT VALUE OF FUTURE COSTS (r=10%)		
	No Logging	No Growth	Max Growth	NO LOG	NO GROWTH	MAX GROWTH
	$	$	$	$	$	$
1986				0.00	0.00	0.00
1987	321738.9	321738.9	321738.9	292492.83	292492.83	292492.83
1988	146133.9	146133.9	146133.9	120765.05	120765.05	120765.05
1989				0.00	0.00	0.00
1990				0.00	0.00	0.00
1991				0.00	0.00	0.00
1992				0.00	0.00	0.00
1993			654930.3	0.00	0.00	336110.23
1994	654930.3	654930.3		305524.98	305524.98	0.00
1995				0.00	0.00	0.00
1996				0.00	0.00	0.00
1997				0.00	0.00	0.00
1998				0.00	0.00	0.00
1999				0.00	0.00	0.00
2000			654930.3	0.00	0.00	165893.84
2001		321738.9	321738.9	0.00	77024.29	77024.29
2002	321738.9			70010.38	0.00	0.00
2003	146133.9	146133.9	146133.9	28905.29	28905.29	28905.29
2004				0.00	0.00	0.00
2005			654930.3	0.00	0.00	107081.10
2006				0.00	0.00	0.00
2007				0.00	0.00	0.00
2008				0.00	0.00	0.00
2009	654930.3	654930.3		73155.71	73155.71	0.00
2010				0.00	0.00	0.00
TOTAL 15yr	1122803	1122803	1777733	718783	718783	915262
Total 25yr	2245606	2245606	2900537	890854	897868	1128273

3. NRB subsidy on the same basis as 2, but in this case the general rates allocation was considered as fixed and the outstanding balance at the end of each year was carried over to the next.

The results of these three scenarios are presented in graphical form in Figure 4. Overall it appeared that the effect of logging on the current account activities of Rangitikei County would be small. With regard to the county's programme of capital works, it appeared that logging traffic in the southern ridings of the County may contribute to bringing forward the reseal dates for particular stretches of road (Table 2), but that the financial impact of such changes would still be relatively limited.

4.5 Comments on the Results and on the Application of the Methodology

At the general level, the methodology employed projections of the current situation rather than forecasts of future conditions. Estimates of logging traffic were based on the felling of current planted areas of forests, not on expected plantings in future years. Similarly, the county's current income from rates and other sources were simply projected forward. In view of recent developments within agriculture in general, it is likely that the income-earning potential of much rural land, and its government valuation, will in future be lower in real terms than the levels during this study's base year, 1984/85. Consequently it may be difficult for the County to sustain the current level of rating revenue in future years.

At a more specific level, several strong assumptions were made in the application of the methodology, mostly because of inadequate technical information. For instance, in estimating the flow of traffic other than that caused by logging, the traffic tally figures held by the County Council were too few in number, and too widely varying, to have full confidence in any representative figures from them. Similarly, the rate of growth (if any) to be expected in the non-logging traffic flows was open to conjecture, but this

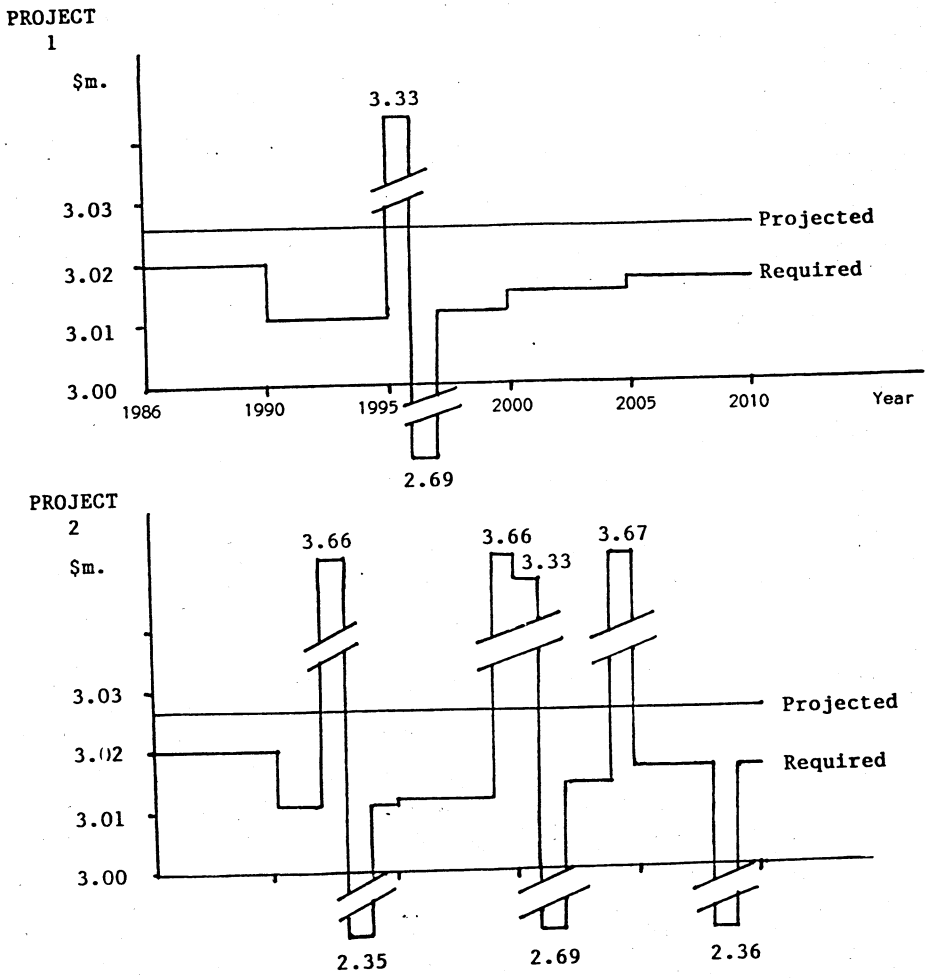

Figure 4: Projected and Required Rates After Allowing for Changes in Maintenance Costs and Reseal Programme

proved to be crucial to the results obtained. The alternative to the indirect traffic estimation procedure used would be to estimate total production from all land uses in a given area over the duration of the study period. While this might be feasible for a single road or limited area, over a whole county such a procedure would be time consuming and subject to a range of additional problems in predicting future land use and output.

A further drawback with the methodology employed is that it was more difficult than expected to infer certain critical values from the information available. The results of the Rangitikei case study were found to be more sensitive to the assumptions made about base flow traffic growth than they were to any feasible projected increase in traffic due to logging. Similarly, in practice it was found to be virtually impossible to impute a design life for the roads under study, or to accurately estimate incremental maintenance costs, largely because the county's current engineering and accounting practices did not enable this to be done. If this method is to be usefully applied to other counties in future, further work is required to remove the mismatch between the information requirements of the method and the information available in county records.

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V. CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

In examining the financial impact of forestry on rural roads, this paper has attempted a brief review of the administrative background, a survey of county council opinions, and the development of a methodology for application to the issue. Conclusions can be drawn under each of these headings.

The administrative framework within which forestry and rural roading operate is complex, being governed by several separate pieces of legislation. To the extent that forestry logging operations use the public road system, the costs on that road system are an externality for the forestry concerns. While funds are recovered from forestry operations and redistributed to the rural roading authorities, there is no inherent reason to suppose that the funds recovered will always equal the extraordinary costs incurred from logging traffic on particular counties' roads.

Problems for an individual county wanting to upgrade a road in anticipation of logging traffic could occur if it is unable to justify the extra expenditures to the National Roads Board as part of its basic roading programme. (Subsidies from the Board are tied to maintenance rather than expenditure on improvements; rate revenues are restricted to current purposes, not for expenditures made several years after they are collected). The Board to date has not been able to suggest a method of identifying extraordinary damage resulting from a single road user, so rural councils may find themselves unable to upgrade roads until after damage has occurred - by which time further social costs in terms of impaired safety or increased wear and tear on other vehicles would have been incurred.

Some of the legislation governing logging traffic on public roads appears inconsistent at first sight, for instance the levies chargeable on indigenous timber but not on exotic timber. Closer examination reveals that these differences stem from the creation of legislation to meet specific circumstances very different from those encountered today. Thus the timber levy and fifths and tenths from

Crown land were justified at the time of their inception because they applied to "undeveloped" forests which fell largely outside the system of local authority rates. But such forests are now much less significant in most regions of New Zealand, with the result that the treatment of indigenous timbers now appears rather anomalous.

From the review of the administrative background arises a whole series of questions about local authority rates. These include: what effect does the conversion of pasture to forestry have on land value; and why is there no means of incorporating the value of trees into government valuations? A further issue is the different treatment of Crown land and private land, particularly in view of the recent creation of new government corporations which are supposedly to be run on the same basis as their counterparts in the private sector. These questions are beyond the scope of this discussion paper, but suggest areas where further research may be useful.

With respect to the counties surveyed, it is noteworthy that the experience they have had with forestry companies has been very variable. Some counties have reached mutually satisfactory agreement with the companies; some have made less than satisfactory arrangements; and some have made no agreements with companies at all. Just why there should be this variation in experience is not addressed in this discussion paper, but could be researched further to identify a standard procedure and format which would satisfy both counties and companies.

From the results of both the survey and the case study, it became apparent to the authors that many of the roading "problems" could be overcome or at least minimised by better communication between forestry companies and councils and better monitoring of roading costs. It is understood that companies themselves often do not know 10 or 20 years before harvest time where the logs will go and where the processing facilities will be. However, it is obvious from the discussions we had that a lot more communication could take place, and that some warning to councils (perhaps a few years ahead of time) would avoid much of the conflict that has been experienced in the past.

The question of communication has been heightened by the removal of government supports for forestry and the resultant greater emphasis placed on market-led developments, which may require harvesting strategies to be switched quickly. Under these conditions, planning for the medium to long term ahead (say, beyond five years), is no longer feasible for local councils. Upgrading a road ten years in advance for a traffic flow which may never eventuate is in any case wasteful. An appropriate response from the county councils is not so much the development of strict long term plans, but rather the devising of flexible, robust strategies which are capable of handling a variety of future scenarios.

Most counties should be able to reach some accommodation with forestry concerns, given notice of when logging is likely. If market conditions are so good that companies have to extract at short notice, causing difficulties for a county's roading programme, it is reasonable to expect them to give some assistance to the county, either as a grant or a loan. The crux of the problem from a county's viewpoint is the suddenness of the upsurge on rates demanded. If this can be alleviated, or spread over a longer period, much of the roading problem is solved.

In general the roading issue does not appear to have been a major determinant of county council policy towards forestry. However, most counties surveyed had neither a clear idea of the potential impact of logging traffic, nor the resources to do much research into the issue. It is possible that the roading issue receives low priority, or is even "defined out" of serious consideration, because its main impact falls outside the time frame of many of the individuals involved.

The methodology developed to examine the roading issue proved inconclusive when applied to Rangitikei County because of fundamental gaps in the information available. These included:

a) the level of non-logging traffic on logging-affected roads;
b) the relationship between loads carried and road deterioration;
c) the magnitude and occurrence of capital expenditures on roads.

The implications of logging traffic for capital expenditure other than resealing (which were expected to be the major impact on the county's roading programme) remain unknown. In this respect, the roading problem as perceived by counties may be more of a technical problem than an economic one. As an illustration, it would not necessarily be cost effective for a county engineer to allow a road to use up its design life before reconstruction, as the design life approach assumes. Rather, the engineer could extend the design life and lower his costs by remedial measures before the road reached that stage. But unless there is reliable information on how traffic flows affect the road, it may not be possible to act until visual signs of deterioration occur, by which time added costs may already have been incurred. Greater confidence in the technical data available could assist engineers in anticipating the effects of extraordinary traffic flows with lower cost remedies.

It should also be noted that there are limitations to the design life approach to road construction. While the principle of roads having a definable life used up by the passage of traffic is widely recognised, the quantification of the various factors involved is open to some doubt. There is some variation in the manner in which road pavements fail, so that procedures such as the one described should be regarded as a source of guidance rather than a precise, prescriptive tool. This uncertainty also relates to the limited technical information on how road surfaces behave under varying conditions of loading and construction.

Nevertheless, the methodology outlined could be adapted to any county to give an indication of when and where logging traffic impacts are likely to be felt. It is less useful as a guide to cost sharing between users, simply because it is so difficult to identify how monies collected from rates, road user charges and other sources are collected and applied. The methodology ignores the effective cross-subsidy between road user charges collected on heavily used roads, and those redistributed to lightly used roads. To what extent agriculture, forestry and other road users contribute to, or benefit from, this cross-subsidy would require a detailed study of traffic patterns to be undertaken.

There is little guidance to be had from other industries on the financing of roads in rural areas. Most of the major construction schemes have internalised the cost of road construction. The nature of these projects is not particularly analogous to forestry, since the construction area is a point source, whereas forestry tends to be more dispersed and to spill over onto more roads.

However, from the viewpoint of county councils, the first concerns are how to identify the existence of a problem and, if one is found, how to establish its size and incidence. This paper can not claim to have answered these questions, but it has pointed to some of the complexities involved and suggested a procedure which could form part of an approach to the issue.

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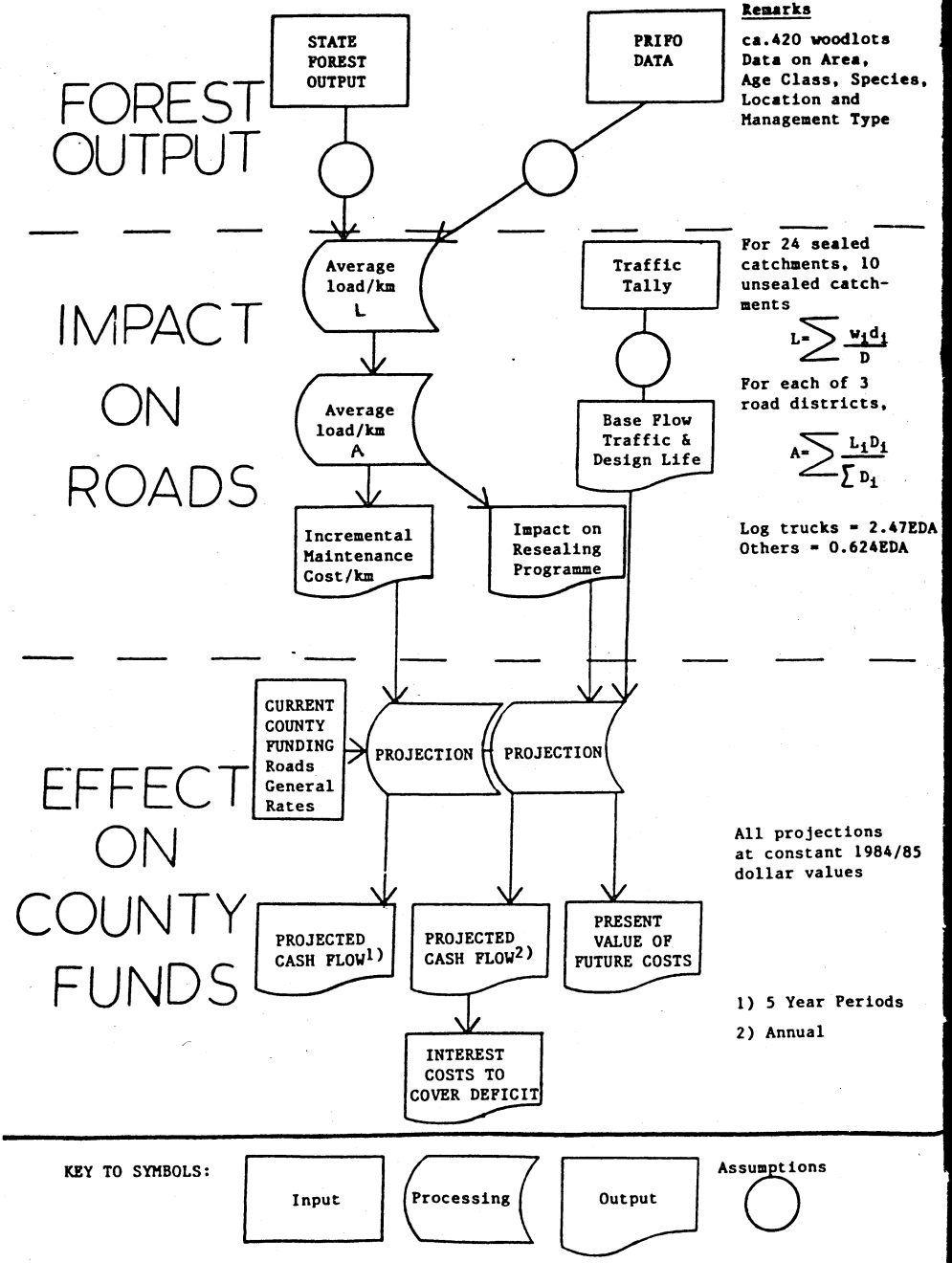
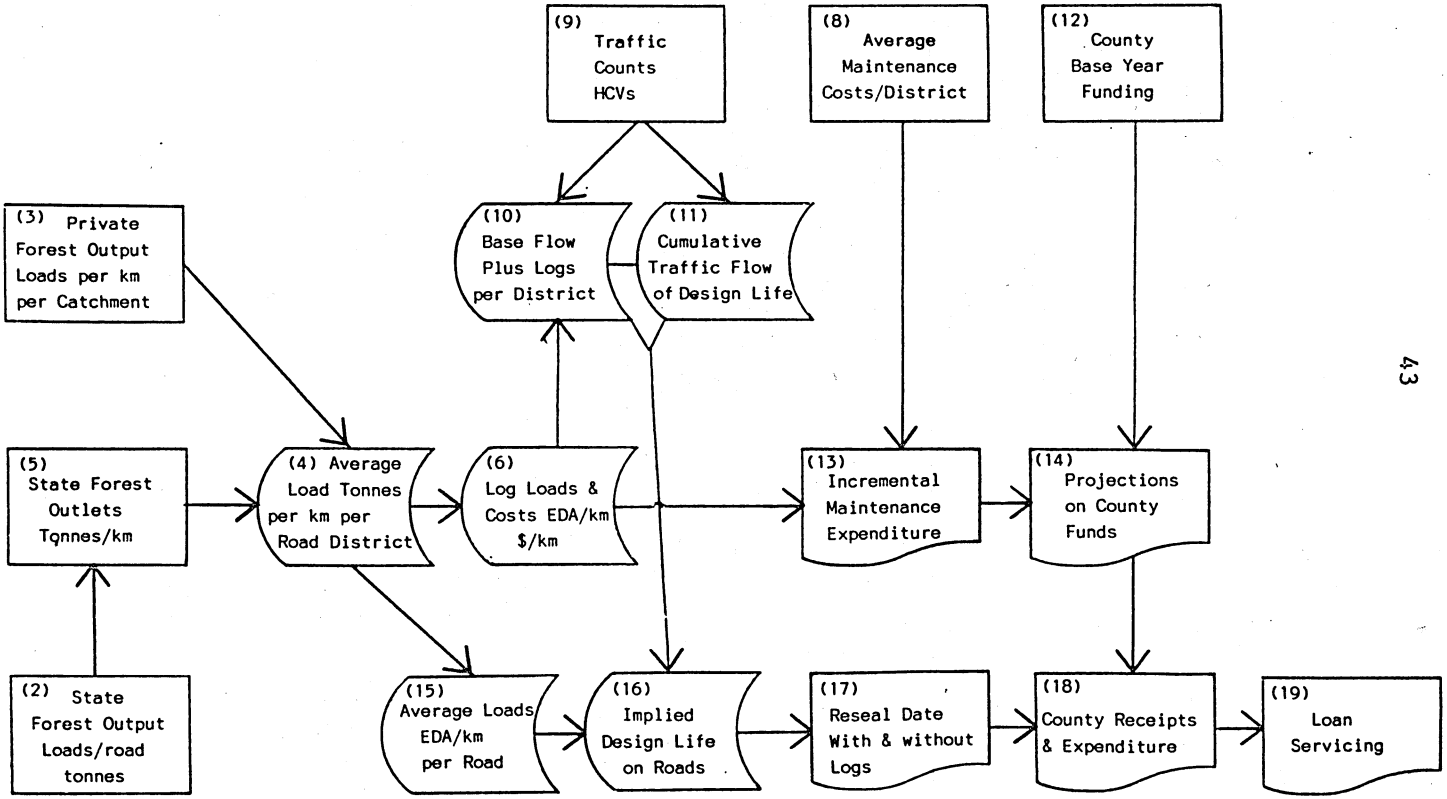
Appendix 1: Schematic Diagram of the Model Applied to Rangitikei County



Appendix 2: Flow-Chart of Linkages Between Tables



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