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Date June 17/93
ABSTRACT

Decisions made regarding road building have far-flung consequences. Spending money on roads means that other public goals such as farmland preservation, air quality improvement and provision of housing may be frustrated. In order for knowledgeable land-use decisions to be made, the full cost of roads needs to be examined.

This thesis explores the issue of roadway land costs from a professional planning point of view. A method for calculating roadway land costs is developed and is then applied to provincially-funded roads in the Greater Vancouver region.

The case study revealed that annual provincial roadway land costs amount to approximately $162 per automobile. Limited supplies of land and limited financial resources suggest that it may be time to examine approaches that would make it less necessary to add capacity to the existing road network. Expenditures on roads can be reduced by shifting from current "supply side" tactics. This thesis suggests various policies that could be enacted to effect such a change.
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1.0 INTRODUCTION

1.1 PROBLEM STATEMENT

Roads and other facilities provided for vehicles have a tremendous impact on the urban landscape. Indeed, one author has even suggested that urban planning has become nothing less than a "knee-jerk reaction" to the needs of the car (Mowbray 1968, 238). City residents need many different facilities. Among these many facilities are roads. Roads are a necessary part of a city's infrastructure and can thus not be totally eliminated. However, the use of land for roads entails a sacrifice because the land used for roads cannot be used for other purposes such as housing, park land, farmland or countless other possible uses. There is only a finite amount of land. When population increases, the pressures on land also increase. Road users often begin to exert pressure for improved facilities when existing roads become congested. With population increases and with more people acquiring automobiles and driving those vehicles greater distances each year, it does not appear likely that the demand for new roads will abate any time in the near future. Indeed there are many transportation experts who believe that demand for new roads will never end. Such beliefs are supported by the observation that the construction of new roads often only exacerbates problems since such construction creates additional demand. Why is demand for roads insatiable? A major reason is that the market is not currently signaling that roadway land is a scarce resource.

1.2 RATIONALE

If the reason behind current problems lies in the market sending incorrect signals, then the obvious solution would seem to lie in making the market send the "right" signals. How can that be done? It can only be done by first determining the full social costs of automobiles. Currently, there is not much knowledge regarding this issue. This creates problems because, as Norbert Wiener has said: "One of the great difficulties of policymaking in any field is that policies cannot be made indefinitely by dead reckoning. To sail a ship by dead reckoning alone, without sight of
the sun and stars, without the use of the lead, and without the possibility of a distant view of the coastal landfall means ultimately to run up on the rocks" (Wiener 1993, pp. 116, 117). In the interests of informed decision-making, it is important that the full costs of roads be acknowledged.

There remain many aspects of the social costs of automobiles that have not yet been fully explored. Land costs are among the least studied issues. The few studies which do address land costs often do so in a very vague manner and are generally based on many unexplained assumptions.

1.3 PURPOSE

The purpose of this thesis is to explore the issue of roadway land costs from a professional planning point of view. Recommendations will be made concerning policies that could be adopted by the provincial government to confront drivers with some of the costs they impose upon society. Attempts will not be made to define the ideal subsidy level or the precise costs that should be levied against drivers. Such recommendations could only be made once a comprehensive analysis of all costs and benefits of roads has been completed. Such an analysis is beyond the scope of this thesis. It should be emphasized that some level of subsidy may be deemed appropriate. After all, education and health care are not required to "pay for themselves." Society may decide that it is appropriate to treat transportation facilities in a similar manner. Such a decision should not, however, be made without understanding the costs involved. It is hoped that this thesis will add to the existing knowledge base and ultimately contribute to informed debate on the costs of roads.

1.4 METHODOLOGY

Roadway land costs will be explored by conducting a case study of provincially-funded roads of the Greater Vancouver region. Such an approach forces the researcher to confront the limitations of data availability and also raises awareness of the complexity of the relevant issues. The case study was limited to provincially-funded roads because that was a manageable study unit.
1.5 ORGANIZATION

The thesis begins with a review of the existing literature. This review identifies several costs that are typically considered attributable to roadways. Subsequent chapters deal with the most commonly used methods of calculating the identified costs. Within each chapter, a rationale is then given for selecting a particular approach to estimate costs in the Greater Vancouver region. A summary is given of the estimated total land costs of provincially-funded roads of the Greater Vancouver region. The thesis concludes with a brief overview of some policy implications.

1.6 DEFINITIONS

There are several terms in this thesis which may cause some confusion. In order to clarify the intended meanings, these terms have been explicitly defined below:

--Automobile refers specifically to privately-owned cars.

--Equity refers to impartial justice and fairness, and not to the net financial interest in property.

--The Greater Vancouver region is, within this thesis, defined to include the following municipalities: Burnaby, Coquitlam, Delta, City of Langley, District of Langley, New Westminster, Port Coquitlam, Port Moody, Richmond, Surrey, Vancouver, City of North Vancouver, District of North Vancouver, West Vancouver, and White Rock.

--HOV stands for "High Occupancy Vehicle" and is defined, in this thesis, to be any automobile containing more than one individual.
--Pecuniary roadway land costs are defined to include the tax revenue that is foregone on roadway property removed from the tax base, and financing costs associated with roadway land.

--Roadways include the paved surface of roads, as well as shoulders, ditches and any other land that must be purchased in order to build a road.

--Roadway land value refers specifically to the value of the land on which a road is built. This does not include foregone tax revenue or financing costs.

--SOV stands for "Single Occupancy Vehicle" and refers to an automobile containing a driver, but no passengers.
2.0 LITERATURE REVIEW

In the following section, several studies that have in some manner dealt with the issue of roadway land costs will be reviewed. This review will demonstrate how others have approached the topic.

Four studies have been selected for detailed analysis. These studies have all been conducted within the last ten years, so the impacts and considerations they deal with are fairly current. The studies cover a range of geographic locations. Two of the studies have Canadian localities as their focus; two have American focuses. The studies also represent different community sizes: one focuses on a province of 10 million people; another on the region of British Columbia's Lower Mainland; another on a U.S. county; and yet another on a medium sized city. The studies are written from a variety of perspectives. The authors include a public interest group, a private consulting group, a master's student and a practicing professional.

2.1 POLLUTION PROBE STUDY

In 1991, Pollution Probe published a report entitled "Costs of the Car: a Preliminary Study of the Environmental and Social Costs Associated with Private Car Use in Ontario." Pollution Probe is an Ontario-based public interest group which was founded in 1969. Its research and advocacy programs are geared towards pragmatic solutions to pressing environmental problems.

Pollution Probe focused on: government spending (for example: road construction, maintenance and policing); environmental damage and waste; health costs; and resource depletion. "Most information was collected from published research reports or articles describing such research" (Pollution Probe 1991, 3). Pollution Probe did not rely only on secondary information. Where necessary, additional information was obtained through "numerous in-person and telephone interviews... with government and industry officials" (Ibid.).
The Pollution Probe researchers focused on several aspects of land costs. First, they discussed the opportunity costs involved in using land for roads. The authors pointed out that the "car has had a great impact on Ontario's agricultural land. As more land is used for roads, parking lots, garages, car washes and car dealerships, less is available for agricultural activity" (Pollution Probe 1991, 9).

The value of land was considered an important 'cost.' Pollution Probe revealed that "successive Ontario governments have paved over a million hectares of land to construct the 160,000 kilometres of highways in the province. Assuming a conservative price of $1,000/hectare, this land would be worth over $1 billion at current market value." The authors did not go into great detail explaining how the $1,000/hectare value was calculated. The only explanation given was a subnote which mentioned that "prices for land vary across Ontario, depending on the quality of land and location. Prime agricultural land in southern Ontario can cost up to $3,500/hectare" (Pollution Probe 1991, 10).

Pollution Probe estimated that the total cost of the car to the Province of Ontario amounts to $8 billion per year. This figure does not include costs of global warming, stress due to traffic congestion, "car-related" court costs, Ontario Ministry of the Environment "car-related" spending or individual ownership costs (Pollution Probe 1991, ii). The authors of the report acknowledge that the omission of these costs will result in an underestimation of the real impact of cars. They excuse the omission of this data by explaining that "the true cradle-to-grave cost of the car is beyond the scope of (the) report, mostly due to the unavailability of sufficiently disaggregated statistics" (Ibid., 3).

Overall, the Pollution Probe study provides a good summary of some of the environmental costs of car use but it fails to go into great detail regarding land costs or other costs which are not directly linked to pollution effects. The focus on the environment is not, however, surprising given Pollution Probe's mandate to deal with environmental issues.
2.2 HANSON STUDY

In 1992, the American Planning Association published Mark Hanson's article on "Automobile Subsidies and Land Use: Estimates and Policy Responses." The study attempted to provide "an empirical approximation of aggregate automobile subsidies" (Hanson 1992, 60). The study focused on the mid-sized American city of Madison, Wisconsin.

Hanson believes "that automobile use in the U.S. has been subsidized directly through highway funding policies, and indirectly through externalities and petroleum subsidies" (Hanson 1992, 60). He adds his voice to those of the Pollution Probe authors when he states that long-term subsidies and other factors have encouraged a pattern of urban and regional sprawl that would not have occurred if it were not for the privileged position of the automobile. He believes that the U.S. transportation system has largely been based on and designed for the automobile (Ibid.).

Hanson suggested that the effects of subsidies have occurred without much notice from academics. He said that the literature has generally not made any "systematic attempt to empirically treat subsidies in aggregate (or) to consider their influence on urban form" (Hanson 1992, 61). He goes on to say that "there appears to be a widely held myth even among some transportation professionals, that highway users pay for all the direct and operating costs of highways through user fees such as fuel taxes and registration fees. [A]ny research that has been conducted has tended to be segmented and often focused on specific, complex subsidies that are difficult to measure" (Ibid.).

Hanson focused his research on issues that had previously only been dealt with in a very superficial manner. Wherever possible, Hanson used data that was specific to Madison or Wisconsin. In fact, part of his reason for selecting Madison as the focus of his case study was that extensive data were available for that city. However, Hanson did in some cases have to resort

---

1 In 1989 the population of Madison was 175,000.
to more generalized data. He stated that "where data (were) lacking for the specific case, regional or national averages (were) used to construct a set of reference conditions" (Hanson 1992, 65). Hanson excluded certain externalities from his calculations because of insufficient data. Among the excluded externalities were: community disruption due to physical barriers and noise; costs associated with urban reorganization; costs of larger regional and global impacts attributable in part to the automobile (such as acid deposition); and the costs of private parking subsidies. Costs which he did consider were: highway construction and maintenance costs, policing costs, environmental impacts such as air pollution and water pollution, personal injury costs, property damage, lost earnings, land use opportunity costs and petroleum subsidies (Ibid.).

Hanson examined both direct and indirect subsidies. He defined direct subsidies as being those "for construction, maintenance, and operation of highways that are not funded by user fees." Indirect subsidies were defined to "include air pollution and related aesthetic losses, water pollution, losses to society from human injuries, and opportunity cost of land used for the highway system" (Hanson 1992, 61). Hanson reminded his readers that the magnitude of "indirect subsidies is highly uncertain and methodologies to estimate them are controversial" (Ibid., 64).

Hanson considered land costs to have both "direct" and "indirect" components. He considered right-of-way acquisition to be part of construction costs, and therefore a direct cost (Hanson 1992, 63). Land opportunity costs were, however, classified as indirect costs (Ibid., 61). He said that "a land opportunity cost occurs when land, used for roads, could have been used for some other purpose" (Ibid., 66). He suggested that "because roads do provide mobility and access, a subsidy in the form of an opportunity cost occurs if more than a necessary or 'optimal' amount of land is dedicated to highways" (Ibid.). He considered the determination of the optimal amount of highways and congestion to be beyond the scope of his research.

Hanson concluded that foregone tax revenue should also be included in the calculation of land costs. He used foregone property tax revenue as "a conservative estimate of the opportunity
cost of land" (Hanson 1992, 70). Prevailing tax rates were then applied to the one third of the roadway land that he deemed unessential for basic road service. He estimated that foregone property taxes amounted to about $1 million (1983) dollars (Ibid., 66). This figure amounted to less than five percent of the total indirect subsidies that he tallied. He therefore came to the conclusion that "ignoring this cost would not significantly alter the overall subsidy levels" (Ibid.). He acknowledged, however, that "in larger cities with much higher land values and greater proportions of highways to land area, this cost might grow more than proportionally with population" (Ibid.).

Hanson reached the conclusion that indirect costs of automobiles to the Madison area amounted to $23 million per year. This was about twice the level of direct subsidies of $11.7 million (figures given in 1987 dollars). He acknowledged that there was uncertainty as to the precision of these values and therefore suggested that "the range of indirect costs could easily be from 50 percent lower to at least 100 percent higher" (Hanson 1992, 65).

2.3 LITMAN STUDY

Todd Litman developed, as part of his Master's thesis, a full cost transport computer model. In this model, he dealt with both direct and indirect costs. Among the many costs he discussed was the cost of roadway land.

Litman agreed with Hanson's contention that the opportunity cost of land must be taken into consideration when calculating the total cost of roads. When land is used for road right-of-ways, it cannot be used for other purposes. When other usage could have resulted in higher revenues, then the use of the land for roads may entail a loss to the public purse. This loss must, according to Litman, be counted as a road cost. He expanded on this point when he said that "since land used for roads is unavailable for other productive uses and earns no "rent" or tax revenue, the value of land dedicated to roadways, beyond that required for a minimal level of
access, can be considered a subsidy to driving" (Litman 1992, 11). Litman claimed that reports
that only consider the acquisition cost of land thus seriously under-represent true costs.

Litman estimated total roadway land costs to be approximately $.01-.03 per vehicle mile. Litman
claimed that this was the amount of money that would be needed to compensate society for the
land dedicated to roads. He took the value of $.015 per vehicle mile to be "a reasonable average
value" (Litman 1992, 11).

Litman did not appear to consider that the relative importance of fixed and variable costs
might play a factor in the per mile rates. For example, he does not mention that if fixed costs were
very high and variable costs minimal, a higher level of road usage (up to the point where more fixed
costs would be incurred) might actually decrease per vehicle mile costs since there would be more
vehicles among which the total costs could be dispersed. By ignoring this factor, Litman's
approach could conceivably overestimate the total cost. Traffic volumes are also an important
factor in per mile rates. If traffic volumes were taken to be quite high, and were in fact
significantly lower, the "per mile" approach could underestimate the total cost. The approach of
using per mile figures has significant limitations because such figures are heavily influenced by the
traffic patterns that prevailed at the time of the cost estimate.

Litman appeared oblivious to the fact that although land used for roads may no longer
generate property tax revenue, those roads may indirectly create tax revenues through license fees,
gas taxes and other vehicle-related taxes. Such taxes could not be collected if roads did not exist.
It thus appears that Litman considers only losses without acknowledging that there might be
revenue that could offset such losses.

Litman was more detailed in his evaluation of land costs than were Pollution Probe and
Hanson. Litman considered financing costs to be an important element of total costs. Neither
Pollution Probe nor Hanson mentioned this cost. Litman also went further than Pollution Probe and Hanson in that he allocated responsibility for different costs.
2.4 PEAT MARWICK STUDY

In 1992, Peat Marwick Stevenson Kellogg (Peat Marwick) was hired by TRANSPORT 2021 to conduct an analysis of the "full" costs of various modes of transport in the British Columbia Lower Mainland. This study was to help TRANSPORT 2021 staff develop recommendations for an effective long term transport plan for the Lower Mainland region (Peat Marwick 1993, 1). Peat Marwick used much of Litman's research as a basis for their study and engaged Litman as an Associate. Although much of Litman's approach was used, Peat Marwick used secondary data (including Litman's data) only when local data was not available.

Peat Marwick studied both private costs (such as vehicle operating costs and user charges) and public costs (such as environmental impacts) (Peat Marwick 1993, 1). The Peat Marwick study made no attempt to measure benefits unless such benefits directly offset particular costs.

Peat Marwick calculated the value of the land devoted to roads by applying, to the land, the average value per hectare that applied to the municipality in which the road was located (Peat Marwick 1993, 27). Peat Marwick decided that the value given to roadway land must be the land value which would prevail if the road did not exist. The average value per hectare figure that Peat Marwick obtained from the British Columbia Assessment Authority reflected the value given to the land by road access. Peat Marwick decided to discount that value by 70 percent to estimate the value of the land as it would have been without roads.

Peat Marwick's approach involves at least three assumptions. One assumption is that the value of land adjacent to roads is the same as the average value of land in a municipality. Peat Marwick acknowledged this assumption when they said that: "land assessments per hectare vary widely from area to area within a municipality" and that the average which was used for the calculations "may not be represented (sic) of land adjacent to roadways" (Peat Marwick 1993, 28). A second assumption, and one which is not acknowledged, is that discounting the average value of land would yield reasonable results. This assumption may create problems. The average value of
land is presumably heavily weighted by land that is not adjacent to major highways since most land parcels do not abut major roads or highways. This means that the average value of land is already considerably lower than the value that would be attached to land adjacent to a major road. Discounting even the average land value by seventy percent, means that the land adjacent to roads is being discounted twice: once as a result of using average assessed values, and then again when that average is discounted by seventy percent. A third assumption is that seventy percent is a reasonable discount rate.

Peat Marwick amortized land costs over ten years, but gave no rationale for selecting this time period. The value of the total land area required for roads wider than a basic seven meters (20,000 hectares) was estimated to be $19,284 million before discounting and $5,785 million once a seventy percent discount rate had been applied (Peat Marwick 1993, 27). The costs that the market does not capture are "experienced by more than municipal and provincial taxpayers"—they are paid for by "society in general" (Ibid.).

Peat Marwick concluded that roadway land values are difficult to assess. This difficulty can largely be attributed to the fact that, even among experts, there is no consensus on the method which should be adopted. Every method involves some assumptions and the assumptions will greatly affect the final values. It is thus not surprising that Peat Marwick freely admits that, of all the figures they calculated, the figures given for roadway land values are among those in which they have least confidence (Peat Marwick 1993, 11).
2.5 SUMMARY

The studies reviewed in this section all made at least some mention of the societal cost of roadway land. Although land costs were considered important enough to be mentioned in all the studies, several of the researchers stated emphatically that the figures given were very rough estimates. All the cost estimates that were given for roadway land rested on very general assumptions. In most cases the grounds for accepting the assumptions were not explained. It would appear that there is a need for a study that probes in greater depth the costs associated with roadway land.
3.0 TYPES OF ROADWAY LAND COSTS

The calculation of roadway land costs has not escaped the controversy and difficulties associated with the tallying of other road costs.

Recent studies have suggested that there are three types of costs that should be considered in the calculation of total roadway land values (Pollution Probe 1991; Litman 1992; Hanson 1992; Peat Marwick Stevenson Kellogg 1993). These three costs are: the value of the land, the taxes potentially foregone when previously taxed lands are removed from the tax base, and the interest that is potentially foregone when money is spent on roads.

Roadway land value is an important component of the total cost of roadways. Pollution Probe researchers discussed this cost when they revealed that Ontario had, over the years, "paved over a million hectares of land" that was deemed to "be worth over $1 billion at current market value" (Pollution Probe 1991, 10). Hanson also considered land value to be an important element in calculating subsidies to automobiles (Hanson 1992, pp. 60, 65). In 1993, Peat Marwick conducted an analysis of the "full" costs of various modes of transport in the Vancouver region. In this study, Peat Marwick considered the value of land used for non-basic roads to be a subsidy to drivers. Roadway land value generally seems to be considered an important component of total roadway costs.

Foregone property taxes are also often considered to be a cost of roadway land. Hanson is one researcher who believes that foregone tax revenue should be included in the calculation of land costs (Hanson 1992, 70). Litman is another researcher who mentioned that the loss of tax revenue on the land used for non-basic roads can be considered a subsidy to automobile drivers (Litman 1992, 11). This cost is, however, a different type of cost than is the cost of actually purchasing roadway land. Property taxes may only in some cases be considered "foregone." In many cases, the taxes that are lost are made up for in other ways. From a societal point of view, the building of roads does not always mean a loss of property taxes.
Foregone investment interest is another cost component that is sometimes attributed to roadway land (Litman 1992, 11). This cost is also considerably different from the cost of actually purchasing roadway land. Although it may appear, on the surface, as if no interest is earned on the money invested in roads, such interest often does exist, although in a slightly less conventional format than more traditional bond yields. The "returns to investment" can occur in such forms as travel time savings. From a societal point of view, there may indeed not be any real loss incurred from road investments.

Foregone investment interest and foregone property taxes cannot be classified as the same types of costs as the cost of roadway land. However, since foregone investment and property taxes are often alleged to be integral components of total cost, they are included as part of this thesis so that some appreciation can be gained for the extent of compensating revenue or benefits that are needed before such indirect costs will be "paid" for.

The next three sections will deal with the three costs identified in this section: roadway land value, foregone property taxes, and foregone investment interest. Each section will begin with a review and evaluation of existing and proposed methods of calculating these costs. A particular approach will then be selected for application to the Greater Vancouver region.
4.0 LAND VALUES

Land values are a major component of total roadway land costs. The land value must be determined before either foregone taxes or foregone investment interest can be estimated. Yet, despite its importance, there is no universally accepted method of arriving at an estimate of land values. A review of the literature reveals that there are at least four different ways of determining land values. Each of these has its advantages and drawbacks.

4.1 HISTORICAL COST METHOD

Historical costs are those which were originally incurred to build existing roads (Meyer 1971, 39). Data for such costs can be obtained by referring to files indicating the original purchase prices of all the lands involved.

One of the advantages of the historical cost approach is that it is relatively straight-forward. In addition, the data may, in some cases, be quite readily available. All one has to do to get the data is to research the prices at which the land was originally bought.

Historical costs could, however, only be considered equivalent to current costs if there were no such thing as inflation. Inflation necessitates adjustments to original costs so that they can be made comparable to present-day values. Under conditions of general price inflation, land values would be underestimated unless some adjustments were made (Meyer 1971, 39). Since there are currently no satisfactory land acquisition cost indices, the adjustment process can become rather problematic (Keeler and Small 1977, 9).

Another major disadvantage of the historical cost approach is that it does not necessarily reflect the current opportunity cost of roads. The roads may originally have been purchased at a very low price. Attaching this low cost to present roads denies the possibility that roads might bring greater returns if used for higher-value purposes. The historical cost approach assumes that
roadway land was being used for the current highest and best use even at the time it was originally purchased. This is a problem that is resolved by the opportunity cost method.

The serious conceptual flaws of the historical cost method and the availability of more generally accepted methods have meant that this approach is rarely used in practice. Lack of access to the Ministry of Transportation and Highway's files, means that this approach is not, in any case, a viable option for calculating roadway land costs for the Greater Vancouver region.

4.2 THE RATIO METHOD

Keeler and Small are among the researchers who have proposed alternatives to the historical approach. In an attempt to determine optimal road pricing, Keeler and Small estimated the total value of roads in the San Francisco Bay Area. To estimate the value of roadway land, they first researched how much money was spent on constructing roads between 1947 and 1972. These values were converted to 1972 prices using the California Highway Construction Cost Index (Keeler and Small 1977, 6). The costs were then added up, "under the assumption of a 'one-horse-shay' depreciation policy, with an estimated lifetime of 25 years" (Ibid.). To determine roadway land values, Keeler and Small then assumed that the ratio of land acquisition costs to construction costs would remain fairly constant over the years. Given this assumption, they were able to calculate the total value of roadway land. To do this, they merely took the total current value of construction costs (1947-72) and multiplied this total by the ratio of land/construction costs which held during the 1968-1972 period. Construction costs and land values were broken down into categories that reflected road types. So, for example, collector roads were not compared to freeways. Keeler and Small were able to gather this data because "some new roads (had) been built in very recent years in each county" and land acquisition costs for these roads were available (Ibid., 9).

The ratio method allows researchers to use relatively current data. This can be a definite advantage because it means that researchers do not have to devise arbitrary land acquisition cost
indices. The exclusive reliance on current data can, however, also have its disadvantages. For example, if the land cost/construction cost ratio does not accurately reflect the ratios that have applied historically, then significant distortions in the data may be expected. One way to circumvent this danger is to check the ratios which have applied historically. So, for example, instead of automatically assuming that a selected time period is reflective of others, studies can be done to see how much the ratio has changed over the years. If there are significant fluctuations, then it may not be wise to use a ratio which differs widely from the norm. This is not a moot point. After all, it has been well established that the ratio between housing construction costs and lot prices fluctuates quite a bit. It would not be surprising if the same phenomenon applied to roads.

Changing land cost/construction cost ratios may reflect changing land uses. If, for example, a new freeway was built through a suburban community within a given county in the 1968-72 period, land costs might account for a fairly high proportion of total costs. The proportion of land costs would not be as high as for a freeway in the central city, but it would certainly be more substantial than if the freeway were built through farmland. However, the area which is now suburban may, fifteen years ago, have been farmland. If a freeway was also built in that area 15 years earlier, Keeler and Small’s ratio method would retroactively apply the 1968-72 suburban ratio to an area that was rural when the road was built! This danger can be averted by not classifying the earlier road as a suburban freeway, but rather as a rural freeway.

Changing construction costs may also affect the land/construction cost ratio. Improved technologies may have made construction in recent years relatively cheaper than in earlier years. If a standard ratio were applied over a time period in which significant technological change occurred, the results would be inaccurate.

The ratio method, like all other methods, cannot be used unless sufficient data is available. Unfortunately, data may not always be readily available. The ratio method depends heavily on both
construction and land cost data being available on a highly disaggregated basis. Historical construction cost data must be available by time period, type of road, and location. The information needs for the determination of the land cost/construction cost ratio are even more stringent. Within a defined time period (such as the 1968-72 period used by Keeler and Small), a road of each type that will be analyzed must have been built within each defined geographical area. Keeler and Small's study, for example, would not have been possible if there were a county in which a freeway had not been built within the four year study period.

The method proposed by Keeler and Small is certainly innovative. If great care is taken to ensure that the assumptions being made are not highly unrealistic, then this method may present a reasonable evaluation of road costs. The method, however, requires extensive research, and as such may not be widely adopted. In the case of the Greater Vancouver region, this method cannot be used because historical costs are extremely difficult to obtain and because construction activity within the last few years has been too limited to allow for collection of sufficient data samples.

4.3 DISCOUNT METHOD

When it comes to finding a relatively simple method of determining land costs, researchers have often relied on quite different methods than those previously discussed. One quite common method appears to be to gather data on values for land adjacent to roads (through tax assessment rolls) and to then discount these values by a certain percentage to take into account the increase in land value that supposedly comes from being next to a major road. This approach has the benefit of being both quick and easy. It has been used by both Litman (1992) and Peat Marwick (1993).

One drawback of this approach is that the selection of the discount rate often seems highly arbitrary. Researchers do not always give reasons for choosing the rates they use. When explanations are given, these sometimes consist only of references to other studies which used similar rates. Adoption of rates used in other localities denies the possibility that the location under study may differ dramatically from previously studied areas. To be fair, some researchers do adjust
their numbers to reflect differences. But, such revisions require a thorough knowledge of both the locality to which the rate will be applied and the locality from which the numbers were originally taken. Adjustments also require a thorough knowledge of market influences and economics in general. Those who lack such knowledge would likely be making highly arbitrary adjustments.

The application of a discount rate implies that land will always increase in value once new access has been provided. This is doubtless not the case. Indeed, Mohring and Harwitz (1962) have demonstrated that land values may actually decrease. This is not a problem which need be inherent to this procedure. If, in a particular locality, it is expected that the value of land near the highway is actually less than that of unaffected land, then the rate could presumably be adjusted to reflect this. However, this, once again, requires an in-depth knowledge of the likely effects of highways in particular locations.

The discount rate method is attractive because it is relatively easy to apply. By using this approach (as was done in the Peat Marwick study), the value of roadway land can be determined quite quickly. It is important to recognize, however, that this approach is very arbitrary and involves many assumptions. If there is to be any assurance of accuracy, then the rate-setter must have considerable expertise in the area of highway economics.

4.4 OPPORTUNITY COST METHOD

Another method of estimating roadway land costs is to determine what it would cost to buy the land today. Such an approach takes into consideration the opportunity cost of using land for roads. Winch explains that the "opportunity cost of using land and buildings for a highway is the sacrifice of alternative uses" (Winch 1963, 16). Even roads that have been "acquired well in advance of requirements" have an opportunity cost (Ibid., 61). All land, both that purchased for the explicit and immediate purpose of building roads, as well as land held for potential future use, should be valued at "what the land would be worth if sold now for other purposes and no highway were built" (Ibid.). The relevant value is "that of the land if no highway is to be built, since that is
the value in other uses. If we take the value of adjacent land, which value takes account of expected development, we are really assuming that the opportunity cost of the land used is its value with the highway adjacent" (Ibid.). Winch therefore concludes that it would be preferable to avoid using adjacent land as an indicator of the value of roadway land, since this would overestimate the value of the land (Ibid.). Here he makes the assumption that roads always increase the value of adjacent land. Although some researchers agree that roads generally increase the value of adjacent land (for example, Winfrey), other researchers point out that this is certainly not always the case (Mohring and Harwitz).²

Under the opportunity cost method, the monetary value of any individual piece of land "is the most that some other user would be prepared to pay . . . that is, (the) current market value" (Winch 1963, 16). The total cost of the right-of-way is considered to be "the sum of the capitalized current market values of all the interests held in the land and buildings acquired," which can be "amortized over the anticipated life of the highway" (Ibid.). Winch explains that current market values can be determined by examining "past land sales in the area, adjusted for any rise in value over time caused by anything other than potential highway development" (Ibid., 61).

Use of the opportunity cost method might be accepted wholeheartedly in a perfect world in which no assumptions would have to be made. However, the world is far from neat and tidy and, as such, obtaining the data needed is often a difficult task. Sometimes the difficulties result in assumptions having to be made. Winch's approach requires several assumptions.

Winch assumes that it will be possible to find examples of similar land to which he can compare the roadway land. Plots of land are often quite unique and it may be rather difficult to find a strictly comparable plot of land. Plots "can differ with respect to both the quality and

²Regardless of the effects of roads on land, it is probably a good idea to avoid applying the value of adjacent land to the roads themselves. There does not appear to be any harm in taking a conservative approach in this regard and saying that, because roads may have some effect on land values, it is better to use land values which may not be thus contaminated.
location of the land itself and the amount, age, and productivity of the capital installed on it" (Burrows 1991, 61). This can create inconsistencies and can even provide an inducement to over invest. Burrows explains that there is the danger that:

lacking information on some of the major determinants of plot value, such as the net profitability of the goods produced by the capital installed, the valuer will view a plot as comparable because similar amounts of capital are installed on it. This would involve (an) . . . inducement to overinvestment . . . With diverse plots in the project locality, a plot owner may see such excessive investment either as a means of reducing the probability of his/her particular plot being acquired, or as a means of raising his/her compensation receipt in the event of a taking (Ibid.).

In addition to "comparable" land values potentially being affected by over investment, there is also the possibility that such values may be influenced by expectations of future development. In some cases, it may be quite a challenge to find a plot of land whose value is not affected by plans for future roads, or even rumours of such plans. Complications arise when "the very existence (or even the prospect of the existence) of government project plans influences the market value of land plots in particular localities" (Burrows, 1991, 60).

Winch assumes that researchers will be able to update historical land opportunity costs by adjusting "for any rise in value over time" (Winch 1963, 61). In reality, this approach is likely to cause problems since no suitable land acquisition cost index is available (Keeler and Small 1977, 9). Translating the costs of previous years into current values may therefore prove quite challenging. The only way to avoid this problem would be to calculate opportunity costs for the year that one is interested in. Thus, if a value for 1992 was desired, the actual values of the land in 1992 would have to be taken into consideration. One drawback of this approach is that the data collected in 1992 could not easily be converted to 2002 values if, ten years later, an update were required.

Yet another disadvantage of the opportunity cost method is that it does not necessarily take into account all the things that give value to land. For example, the market prices which are
used as indications of land values may not reflect personal attachment to the land, or various environmental benefits such as the oxygen enriching capacity of the trees on a land parcel (Burrows 1991, 60). It is worthwhile to note, however, that this factor is also not taken into consideration in any of the other evaluation methods discussed.

Winch's approach can be considered logical and correct in a theoretical sense. Unfortunately, it suffers from several drawbacks when attempts are made to use it for determining actual roadway land costs. The opportunity cost approach is, however, one of the few approaches that can be readily used under conditions of restricted data access.

4.5 CALCULATION OF LAND VALUES

The brief overview of some of the most commonly adopted methods of estimating land costs has revealed that there is no method which does not have clear disadvantages. The selection of a particular method will be dictated by the need for theoretical validity and by data availability. Even under the most favourable circumstances, the final numbers will be estimates rather than definitive bottom-line figures.

Given the need for a theoretically valid approach, the choices are immediately reduced to either the ratio method or the opportunity cost method. In choosing a method to assess land, the issue of data availability is also of utmost consequence. Limited access to data immediately precludes the ratio method. The only method that can be used for the Greater Vancouver region would appear to be some variation of the opportunity cost method. All the other methods require disaggregated data that are not readily available to researchers working without access to the British Columbia Ministry of Transportation and Highways' files.

The opportunity cost method uses current market values to estimate the value of roads. Current market values are available from the tax assessment rolls of the British Columbia Assessment Authority (BCAA). The most recent data available are the 1993 assessed values. The
1993 assessed values are the BCAA's estimate of the "most probable selling price of the property had it been for sale on July 1, 1992." Values are determined based on the physical condition and permitted use on October 31, 1992. The likely sales prices are determined by assessors who take into consideration such factors as: location, zoning, size, topography, shape, condition, sales of comparable properties in the area, and other factors that might affect the property's value (B.C. Assessment Authority 1992, 3).

Roads are not subject to taxes. There is therefore no need for the Assessment Authority to place a value on roadway land. This means that the assessment rolls do not contain information on the value of roads. Since roadway land values cannot be obtained from the assessment rolls, some other method of determining land values must be created.

It is generally agreed that the value of roadway land should be the value that would be in effect if the road did not exist. It is, however, very difficult to establish the value of land as it would be without the presence of roads. All properties are required, by law, to have road access (Land Titles Act, Section 75(1)(a)). This means that roadway land can not be readily compared to land with no access and then simply given the value of such property. Fortunately, such a comparison is not actually necessary. If all properties have some degree of access, then minimal access will not affect any given property in ways that all other properties are not also affected. In a sense, minimal access can be said to be incorporated in the basic value of property. It is access which goes beyond a minimal level that will change the value of the affected land. But, increased access will only add to the value of land if there are buyers who are willing to pay for increased access. If increased access serves potential owners no useful purpose, then it is unlikely that such individuals would be willing to pay a premium for it. It is unlikely, for example, that a residential property abutting on a major highway would be worth considerably more than a residential property located at a less 'accessible' location. Indeed, if the highway is of the "limited access" type, it may not even offer increased access. Rather than conferring benefits, the highway may actually be perceived as a nuisance--especially if it increases noise and air pollution. In such cases,
a highway may actually decrease adjacent property values. Land values would seem to increase only when owners can take advantage of improved access or exposure, either in the present, or in the future (by selling land at a high price to people who can benefit from the access or exposure). Thus it would seem to be a land-use change, rather than the road itself, which adds value.

Of course, land further away from the highway can also benefit from increased access offered by the new road. A 1960's study quoted by Rice found that transport accessibility accounted for from 10 percent to 16 percent of total property value (Rice 1993, 4). Even if access were improved once a new highway were built, the incremental benefit would often be less than the 10 to 16 percent cited by Rice since some basic road access would exist even without the new road. Since most arterials and major highways exist primarily to improve mobility rather than to provide access (Ministry of Transportation and Highways June 1992, D2), there appears to be little reason to believe that a new provincially-funded road would add considerable value by way of improved access.

To accurately assess the value of roadway land, it is important not to make any assumptions about the relationship between adjacent land values and actual 'opportunity' costs. The opportunity cost of the roadway land can be established by taking into consideration the likely use of land had a major road not been constructed. This can be determined by examining what land further away from the road is typically used for and what that land is worth.

Land parcels not directly affected by major roads can be found by examining legal maps available at Assessment Authority offices. For this thesis, an attempt was made to select parcels located in areas bordering on each of the provincially-funded roads, but still far enough away that the use of the parcels would not likely have changed due to the presence of the road. Samples of this sort were selected at roughly one kilometer intervals along each provincially-funded road. These samples were collected in such a way as to be fairly representative of the land uses in each area. The samples were selected from alternate sides of the road to take into account possible
differences in value that might result from varying exposures. Wherever possible, samples that
might be influenced by unique characteristics were avoided. Examples of such characteristics
included: waterfront exposures, locations close to hydro right-of-ways or railways, and presence
of stream beds. All these factors could result in values being unrepresentative. There are,
however, many influences on land values. Every lot is unique and, as such, it is very difficult to
find a perfectly 'typical' lot. To help ensure that values were not too unusual, land values that
were included were checked to see that their values did not deviate too much from those of
neighbouring lots. It should be noted that in some cases it was extremely difficult to find samples
that were in roughly the same neighbourhood as the roadway, but still far away from all major
roads. Some parts of the Greater Vancouver region are quite built-up. This means that it is
difficult to find land parcels unaffected by major roads. For example, in some parts of Burnaby, the
Lougheed Highway and Canada Way run in close proximity. Vast areas are thus influenced by
those two roads. However, in many cases, the high land values found in such areas may
accurately depict the opportunity cost of the road. Given the existing high level of access, the
prevailing uses would likely have been in existence even without some of the roads. As such, the
land used for a new road may well have an opportunity cost that is accurately reflected in existing
highly accessible lots.

After the values (dollars per hectare) of typical, non-adjacent land were found, these values
were then applied to the road areas. A six kilometer stretch of road would have roughly six
observations attached to it. An average dollar per hectare figure was calculated from these six
observations and then the average value was applied to the total road area to estimate the roadway
land value. Since the samples were taken at roughly equal intervals along the stretch of road, the
average value of the observations will reasonably depict the average land value for that particular
stretch of road. There is no need to apply a discount rate to the values since the samples used
were not directly adjacent to the roads, and were thus not unduly influenced by the road.
In calculating roadway land value, the applicable land values were attached to the full right-of-way rather than to only the paved surface. Provincially-funded roads are generally built to facilitate high-speed vehicle movement, rather than pedestrian access. Indeed in many cases, sidewalks are not built along major roads such as the Trans Canada Highway. In the case of major arterials and highways, it seems fair to assume that the right-of-way is provided exclusively for vehicle use. The shoulders and ditches that are part of a right-of-way are an integral component of the road. They exist for safety reasons, to provide for possible future widening, and to provide for snow removal and drainage. None of these factors directly serve the needs or interests of non-vehicle owners.

Using the opportunity cost method, the total value of roadway land in the Greater Vancouver region was found to be $3,660,923,687. Table 1 shows the results of the calculations by municipality. Appendix 1 contains a more detailed inventory of the values found to prevail along each roadway within each of the municipalities.
**TABLE 1:**
ESTIMATED ROADWAY LAND VALUES, BY MUNICIPALITY

<table>
<thead>
<tr>
<th>ROAD NAME</th>
<th>LENGTH (km)</th>
<th>AVERAGE WIDTH (m)</th>
<th>ROAD AREA (m²)</th>
<th>TOTAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnaby</td>
<td>70.25</td>
<td>41</td>
<td>2,913,129</td>
<td>$721,744,415</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>33.54</td>
<td>48</td>
<td>1,607,504</td>
<td>$270,872,498</td>
</tr>
<tr>
<td>Delta</td>
<td>80.37</td>
<td>49</td>
<td>3,933,819</td>
<td>$364,019,579</td>
</tr>
<tr>
<td>City of Langley</td>
<td>18.57</td>
<td>26</td>
<td>480,598</td>
<td>$32,763,016</td>
</tr>
<tr>
<td>District of Langley</td>
<td>72.36</td>
<td>51</td>
<td>3,711,336</td>
<td>$98,974,251</td>
</tr>
<tr>
<td>New Westminster</td>
<td>21.95</td>
<td>41</td>
<td>900,045</td>
<td>$201,557,495</td>
</tr>
<tr>
<td>North Vancouver (City)</td>
<td>4.81</td>
<td>46</td>
<td>219,916</td>
<td>$99,384,382</td>
</tr>
<tr>
<td>North Vancouver (District)</td>
<td>31.11</td>
<td>37</td>
<td>1,155,090</td>
<td>$347,712,413</td>
</tr>
<tr>
<td>Port Coquitlam</td>
<td>11.23</td>
<td>36</td>
<td>407,650</td>
<td>$60,117,196</td>
</tr>
<tr>
<td>Port Moody</td>
<td>19.07</td>
<td>45</td>
<td>851,450</td>
<td>$165,151,904</td>
</tr>
<tr>
<td>Richmond</td>
<td>55.09</td>
<td>40</td>
<td>2,224,220</td>
<td>$233,813,777</td>
</tr>
<tr>
<td>Surrey</td>
<td>148.27</td>
<td>43</td>
<td>6,322,533</td>
<td>$417,043,318</td>
</tr>
<tr>
<td>Vancouver</td>
<td>6.90</td>
<td>30</td>
<td>210,315</td>
<td>$113,149,232</td>
</tr>
<tr>
<td>West Vancouver</td>
<td>43.13</td>
<td>47</td>
<td>2,020,430</td>
<td>$509,662,141</td>
</tr>
<tr>
<td>White Rock</td>
<td>5.02</td>
<td>20</td>
<td>100,902</td>
<td>$26,958,068</td>
</tr>
</tbody>
</table>

**GRAND TOTAL** $3,660,923,687

Notes:
(1) The widths given are estimates of the right-of-ways. The right-of-ways are considered to include the paved surface, the sidewalks (where these exist), the shoulders and any other land purchased for road construction. The actual widths often vary considerably along each roadway. The widths given in this table are estimates of the "typical" width of each road. The estimates were based on data gathered from legal maps at the B.C. Assessment Authority offices.

Source: Ministry of Transportation and Highways (road names and lengths), B.C. Assessment Authority (approximate land values)

The length of time over which costs should be 'recovered' must be determined before roadway land values can be annualized. This time period is, in financial terms, typically called the amortization period. Although it is generally agreed that the "lifetime" of roadway land is infinity, it is considered good practice to expect repayment of costs in a shorter period (Meyer, Kain, and Wohl 1969, 178; Keeler and Small 1977, 9). Winch has pointed out that it is undesirable to place a debt burden on the people of the distant future who might not be able to meet the burden and might not even reap any benefits from the investment (Winch 1963, 100). Winch concludes that although "in practice highway routes are rarely abandoned . . . changing demand patterns can
considerably affect useful life. The period should therefore be limited to the foreseeable future in which there is no reason to fear that they will become obsolete. It is prudent to err on the side of underestimating this . . ." (Ibid.). Winfrey's arguments are similar to Winch's, but Winfrey goes further by actually suggesting that "20 years or so is a maximum future period for reliable forecasts of traffic volume, composition, and performance" (Winfrey 1969, 25). The British Columbia Ministry of Transportation and Highways states that although the life of the right-of-way is generally considered to be hundreds of years, the strategic planning for highways is based on twenty-year projections (Ministry of Transportation and Highways June 1992, 8). Since demand cannot be reasonably predicted beyond such a 20-year time period, it would seem wise to limit cost recovery expectations to this time-frame. If the land values given in Table 1 are amortized over 20 years, then the annual land value would be $183,046,184.

It should be emphasized that the figures given in this section are for the value of land as estimated by the opportunity cost method. Since data on the cost of initially acquiring the land is not available, the opportunity cost method was used to derive an estimate of the value of the land as it would be if it were purchased today. The costs of the land have already been accounted for in the budgets of the Ministry of Transportation and Highways. The object of this thesis is not to claim that these costs are not now considered but rather to determine the extent of roadway land costs.

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3 The Ministry of Transportation and Highways' budgets are, however, not sufficiently detailed to allow for use of those budgets in determining land values of particular roads. Therefore, other means, namely the opportunity cost method had to be used to estimate the land values.
5.0 PECUNIARY COSTS SOMETIMES ASSOCIATED WITH ROADWAY LAND

In addition to the value of roadway land, there are tangential societal costs which are sometimes attributed to roadways. These costs include foregone municipal tax revenue and foregone investment interest. These costs are often fully attributed to roads although there are arguments that society does not always bear such costs and that they should therefore not be considered 'real' costs. This dispute will be discussed in the following paragraphs.

5.1 FOREGONE MUNICIPAL TAX REVENUE

Publicly-owned roads are exempt from property taxes. Roads have a somewhat special status then, since most land is taxable. When taxable land is expropriated to be used for non-taxable roads, the tax base of local government appears eroded. Property tax losses are not insignificant since property taxes provide approximately 40 percent of local government revenue in Canada. It is the major source of revenue controlled by local government (British Columbia Assessment Authority, 1992). Since roads cover a large area of the total urban landscape, lost taxes can become quite significant. Lost taxes have the potential of being a "societal" cost if the loss of such taxes can only be made up for by increasing taxes on other individuals who do not benefit from the new road. Whether there is any justification in considering tax losses a road cost is a matter of considerable debate.

The Cases for and against Considering Lost Tax Revenues

The arguments for including lost tax revenues as a roadway cost centre primarily on the contention that failure to do so would result in inequities or economic inefficiencies.

Not taking lost revenues into consideration can result in inequitable and inefficient allocation of resources between the public and the private sector. It can also result in inefficient allocation between various public projects. Winch, for example, points out that:

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4Publicly owned land such as parks as well as some privately owned land such as church property is usually exempt from property taxation.
property taxation must be included as part of the cost of a highway in our planning analysis . . . because we are trying to determine how much of available resources should be devoted to highways. Highways and other uses are essentially competing for resources, which should go to that use where the utility yielded is greatest . . . If highways are to compete for these resources on equal footing, determining net yield by our cost and demand analysis, it is important that highways be subjected to the same overhead costs in the form of taxation that apply to other resource uses (Winch 1963 19).

There is considerable theoretical support for considering foregone tax revenues as a road cost. It is thus not surprising that such costs have sometimes been considered when cost studies have been prepared. There are several precedents for including foregone taxes as a community cost of roads (Winch 1963, 19; Shortreed and Berry 1968, 33-43; Meyer 1971, 33; Wachs 1981, 248; Hanson 1992, 66).

Winfrey, however, urges caution in calculating foregone taxes. He states that using formerly tax-generating lands for non-taxable roads does not necessarily result in a tax loss to the community. He believes that although such a loss may occur, it should not be assumed that it will occur.

Winfrey acknowledges that, on the surface, it would appear that the removal of land from the tax rolls would involve a loss of revenue. He states, however, that such a loss can be compensated for by gains which are also directly related to the roadway land taking. For example, adjacent land may increase in value if a new road is built. Such increases may be sufficient to offset any losses in tax revenue that occurred by removing roads from the tax rolls. In fact, in some cases, increased land values may even exceed the losses that were a result of land-takings. Winfrey points out that it would be wrong to ignore such increases while acknowledging losses similarly imposed (Winfrey 1969, 488).

Tax revenues lost from one location may also be compensated by increased tax revenues from other, more distant, locations within the same municipality (Winfrey 1969, 488). The total
values on the assessment rolls can, for example, be maintained at an equivalent or increased value if the owners whose land was expropriated reinvest their compensation money within the municipal boundaries. In such a case, the total assessed value of land within the municipality may not decrease. In a rapidly growing region such as Greater Vancouver it is, however, likely that such reinvestment would occur at the expense of other investment in the same land. If only a few parcels of vacant land remained, it is likely that they would have been occupied quite rapidly under any circumstances. If the displaced user did not buy the parcels—some other individual likely would. In such cases, the roadway land taking may result in a tax loss to the municipal finance department and an equal gain to those community members who would otherwise have paid the taxes.

Winfrey goes to the extent of saying that roadway tax revenue losses should not be considered even in cases where loss of tax revenue is not compensated by increases in other localities. Winfrey’s argument centres on the fact that it is not the total value of assessed property (which is what would be affected by removing land from the tax rolls) which determines the total value of taxes collected. Rather, it is the tax rate which establishes this (Winfrey 1969, 485). The tax rate is only set once a municipality has both prepared a budget and examined the total value of assessed property. Once both have been established, there is only one element of flexibility left—the tax rate. Winfrey explains that since "the tax rate is not determined until the budget is adopted and compared to the assessed value, or tax base", "the taking of privately owned real estate for public highway purposes by this action alone does not alter the real estate tax income of the taxing authority" (Ibid.). This is because, even with decreases in assessed values, incomes can be maintained by increasing the tax rate. Winfrey does admit that maintaining revenues in this manner results in a redistribution of tax burdens. If land takings result in a decreased tax base, then "the specific taxpayers giving up their property to the highway pay a significantly less amount (or none at all) and each of the large number of other owners of taxable property pays a slightly increased tax" (Ibid.).
Winfrey concedes that such reallocation of tax burdens is not without consequences. In this regard, he seems to be acknowledging some of the concerns expressed by Meyer, Wachs, and Winch. Winfrey points out, for example, that "who pays how much tax is a factor" when considering questions of fairness (Winfrey 1969, 486). He believes, however, that for the purpose of analyzing "the total effects of a governmental action, the real measure of consequences is its effect on total income or total expense" (Ibid.). He believes that it is "the net total tax income that is the net measure of the tax consequences and not what happens to one set or separate sets of citizens" (Ibid., 485).

**Calculation of Foregone Property Taxes**

The problem of determining when property taxes have been foregone has not been completely resolved. The crux of the problem lies in determining the *net* effects of land takings. In some cases tax losses will be compensated by tax gains that occur from reinvestment or land value increases. In other cases, this will *not* happen. There is no guarantee that compensation from roadway takings will be reinvested within the same municipality, especially in the Lower Mainland, where many municipalities are quite small and may thus offer only limited opportunities for reinvestment. If reinvestment *does* occur, it may well occur at the expense of investment that would have occurred under any circumstance. Other taxpayers may indeed pay higher taxes and thus make up for any loss associated with a highway, but this is still very much a societal cost. The municipality may not lose money if it is able to increase tax rates, but individual citizens will lose money and such a loss is therefore a cost that can be associated with the roadway land taking. Since there is no guarantee that the tax lost from roadway land takings will be made up for in other ways, it makes sense to at least calculate possible losses to determine how much tax revenue would need to be recouped.

Property tax rates are independently set by each municipality. Within each municipality, the rates vary depending on the use of the property. Residential uses are charged considerably less than business and industrial uses. Farmland is generally taxed at a slightly higher rate than
residential land. The following are rough averages of the rates applying to Greater Vancouver: residential--0.0098; business--0.0255; light industrial--0.0309; and farmland--0.0149. Appendix 2 contains a detailed listing of tax rates, by municipality and by land use type.

Accurately estimating lost taxes would require knowledge of the use to which all roadway land would have been put if the road were not built. This is difficult to determine. Even if this were known for individual parcels of land, it would become difficult to determine this for an entire road network. But, if some basic and not too unrealistic assumptions are made, these problems can be circumvented.

The object in determining the opportunity cost of roads is to establish what land use would have prevailed had major roads not been constructed. One assumption that can be made is that roadway land would not generally be used for business or industrial purposes. Since industry and business seem to prefer highly accessible and visible locations, it is unlikely that they would choose locations far from major roads. The presence of major roads attracts such uses; their absence repels them. In determining the most likely alternative use of roadway land, it therefore makes sense not to consider business or industrial uses. Since such uses are less common than other types of uses, statistics would also suggest that there is less probability of an alternative use being business or industrial than of being something else. Residential and farm uses would seem to be far more probable alternative uses of roadway land. As it happens, these two uses are taxed at somewhat similar rates. By applying the residential tax rates of each municipality to the estimated assessed roadway land value within that municipality, a rough conservative estimate of maximum foregone taxes can be derived.

Table 2 provides an estimate of maximum possible societal losses given the assumptions about roadway land value and prevailing mill rates. The actual tax loss experienced will of course

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5Farmland is generally assessed at quite a low value—so the amount of taxes paid per hectare of farmland is actually considerably less than that paid for residential land.
depend on a road's effect on the total value of taxable property. Land value increases and reinvestment may partially offset potential tax losses. By calculating the amount of taxes that may conceivably be foregone, some idea is at least gained of how much reinvestment and land value increases will be required for the lost taxes to be recouped. Of course, some of the "lost" taxes may also be compensated for by revenues obtained by gas taxes or other road-user fees. In the end, the societal costs of extracting land from the tax base may be far below what is indicated in Table 2.
### TABLE 2:
**FOREGONE MUNICIPAL TAX REVENUE**

<table>
<thead>
<tr>
<th>Municipality</th>
<th>1992 Residential Tax Rate (per $1000 assessed value)</th>
<th>1992 Land Value</th>
<th>Foregone Taxes (per annum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnaby</td>
<td>8.8</td>
<td>$721,744,415</td>
<td>$6,351,351</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>9.9</td>
<td>$270,872,498</td>
<td>$2,681,638</td>
</tr>
<tr>
<td>Delta (1)</td>
<td>11.9</td>
<td>$364,019,579</td>
<td>$4,331,833</td>
</tr>
<tr>
<td>City of Langley</td>
<td>12.4</td>
<td>$32,763,016</td>
<td>$406,687</td>
</tr>
<tr>
<td>District of Langley</td>
<td>11.6</td>
<td>$96,974,251</td>
<td>$1,124,901</td>
</tr>
<tr>
<td>New Westminster</td>
<td>11.3</td>
<td>$201,557,495</td>
<td>$2,277,600</td>
</tr>
<tr>
<td>North Vancouver (City)</td>
<td>9.0</td>
<td>$99,384,382</td>
<td>$894,459</td>
</tr>
<tr>
<td>North Vancouver (District)</td>
<td>9.9</td>
<td>$347,712,413</td>
<td>$3,442,353</td>
</tr>
<tr>
<td>Port Coquitlam</td>
<td>11.2</td>
<td>$60,117,196</td>
<td>$673,313</td>
</tr>
<tr>
<td>Port Moody</td>
<td>10.5</td>
<td>$165,151,904</td>
<td>$1,734,095</td>
</tr>
<tr>
<td>Richmond</td>
<td>8.8</td>
<td>$233,813,777</td>
<td>$2,057,561</td>
</tr>
<tr>
<td>Surrey</td>
<td>10.2</td>
<td>$417,043,318</td>
<td>$4,253,842</td>
</tr>
<tr>
<td>Vancouver</td>
<td>7.6</td>
<td>$113,149,232</td>
<td>$859,934</td>
</tr>
<tr>
<td>West Vancouver</td>
<td>8.6</td>
<td>$509,662,141</td>
<td>$4,383,094</td>
</tr>
<tr>
<td>White Rock</td>
<td>6.0</td>
<td>$26,958,068</td>
<td>$161,486</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>$35,634,147</td>
<td></td>
</tr>
</tbody>
</table>

Note: (1) Delta rate is the average of Ladner (12.1), North Delta (11.5), and South Delta (12.0)

Source: Tax Departments of respective municipalities
5.2 FOREGONE INVESTMENT INTEREST

When money is borrowed, there is often a charge involved. This charge is commonly known as 'interest'. If, for example, a provincial ministry borrows money to build a highway, the cost of the highway will include both the actual money borrowed and the interest that is charged on the loan. The interest payments can be classified as financing costs. Such costs are often overlooked when highway costs are examined.

Often, interest costs are only considered when these are part of the current expenditures of a particular department. This can result in an underestimation of total costs if the interest costs are not carried along with money transfers. An example may be helpful in illustrating this. When a highway department is given funding for a particular project, this money is then viewed as paying for the costs of the road. No further charges are applied. This may, however, be an inaccurate portrayal of real costs if the larger government body had to borrow money in order to provide a department with the funding for a new highway. Somewhere in the allocation of funds, the real cost of the money has been overlooked. To determine the full cost of roads, it is important that these costs be tracked down.

Furthermore, some researchers suggest that even if money is not borrowed to fund a particular road, there is still a cost involved. The money that is spent on the roads could have earned interest had it been otherwise invested. The foregone interest may in some cases be considered a cost that should be applied against roads. Douglass Lee emphasizes this point when he states that: "normally, any long-lived business investment is expected to earn a rate of return at least equal to the interest rate on borrowed funds" (Douglass Lee 1989, 6). When financing costs are ignored, roadway costs can be considerably understated. It is important, however, to acknowledge that investment returns may be of a non-conventional type. For example, it could be argued that society gains a "return on investment" in the form of travel time savings or other
societal benefits. To insist that using land for roads always implies a societal investment loss is therefore incorrect.

In order to gain some perspective on the extent of benefits that are necessary to compensate for potential losses in interest revenue, it is necessary to determine the likely maximum foregone investment returns. To determine this, a value must be placed on forgone future streams of cash flows. The value applied is commonly called the discount rate (Stubbs et al. 1984, 121). Although there is general agreement that a discount rate should be applied, there is little agreement or definitive evidence to suggest the adoption of any particular rate. Lack of agreement does not, however, excuse analysts from considering this matter for, as Wohl has pointed out: "prescribing an 'appropriate' discount or interest rate, while difficult, is of crucial importance to matters of economic efficiency, investment planning, and decision-making" (Wohl 1972, 30). Unfortunately, "as long as the methodological controversy continues the choice of any rate may be criticized as somewhat arbitrary and 'dangerous'" (Stubbs et al. 1984, 121). The choice between rates is perhaps most arbitrary if analysts applying the rates do not understand the consequences of their particular choices. Since it appears that a rate must, in the end, be selected, it is important to at least understand the potential consequences of different choices.

The choice of a discount rate can affect choices between projects with very different expenditure time lines. For example, a high discount rate penalizes long-term projects that have very high initial expenditures. Very low rates can over encourage such projects (Stubbs et al. 1984, 121). Discount rates can also affect allocations of funds between generations. A high discount rate can mean that current benefits are valued more highly than ones that would affect future generations. A low discount rate will, on the other hand, encourage investments that might benefit the future while imposing a high initial cost on the current generation (Davis 1990, 124). Discount rates also impact allocations of funds between the public sector and the private sector. If the rate applied to public sector investments differs substantially from that applied to the private sector, then allocations between the two may not be made in the most economically efficient
manner (Davis 1990, 123). Future uncertainties and risks can also be valued differently depending on the choice of discount rate. For example, a high rate discounts future uncertainties more than does a low rate (Winfrey 1969, 27).

Hirschleifer has suggested that some consideration be given to the fact that the public sector tends to be overly optimistic in its perception of returns and risks. To counteract this over optimism, Hirschleifer recommends that the discount rate be at least equal to the prevailing market rate (Hirschleifer in Wohl 1972, p. 35). He pointed out, for example, that "even for utility investments in the private sphere, we have seen that the capital market will supply funds only for projects promising (with the average degree of riskiness experienced in that sector) to yield around 9 or 10 percent. Unfortunately, public investment decision processes have on the whole a far worse record of over optimism, so that the lowest discount rate for public projects we would recommend in practice, unless and until their record improves, is around 10 percent" (Ibid.). Meyer also supports the idea that conservative discounting procedures may be a good antidote to public sector over optimism (Meyer 1971, 214).

Considering the impact of discount rates, it is not surprising that the debate over the selection of the rate continues. The fact is that one can not avoid choosing a rate. Even if one assigns a rate of zero, this will have an effect on the choices to be made. The question that should be answered is: what is the preferred rate (Daiute 1970, 65)?

**Calculation of Foregone Investment Interest**

Given the on-going controversy and lack of unanimous recommendations for any specific discount rate, the best response may be to analyze project sensitivities to several rates. Daiute (1970) has been one supporter of this approach. Keeler and Small actually adopted this method in their 1977 study of land value costs. In their study, they used two alternative rates: 6 percent and 12 percent (Keeler and Small 1977, 9). If the variation in rates results in significantly different conclusions, then this may suggest that the precision of the analysis is limited (Daiute 1970, 64).
For this thesis, two rates were chosen: 6 percent and 10 percent. The 6 percent figure represents the March 1993 rate of return on a 12-month Treasury Bill. That figure represents a prevailing market rate. A somewhat higher figure of 10 percent was also selected for consideration in response to the contention among some experts that conservative discounting procedures should be applied to public works projects so that public-sector over-optimism can be counter-acted. Table 3 shows the financing costs that could be attributed to roadway land if the rates of 6 percent and 10 percent were used.

**TABLE 3: FORGONE INTEREST**

<table>
<thead>
<tr>
<th>MUNICIPALITY</th>
<th>LAND VALUE</th>
<th>FOREGONE INTEREST at 6%</th>
<th>FOREGONE INTEREST at 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnaby</td>
<td>$721,744,415</td>
<td>$43,304,665</td>
<td>$72,174,442</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>$270,872,498</td>
<td>$16,252,350</td>
<td>$27,087,250</td>
</tr>
<tr>
<td>Delta</td>
<td>$364,019,579</td>
<td>$21,841,175</td>
<td>$36,401,958</td>
</tr>
<tr>
<td>City of Langley</td>
<td>$32,763,016</td>
<td>$1,965,781</td>
<td>$3,276,302</td>
</tr>
<tr>
<td>District of Langley</td>
<td>$96,974,251</td>
<td>$5,818,455</td>
<td>$9,697,425</td>
</tr>
<tr>
<td>New Westminster</td>
<td>$201,557,495</td>
<td>$12,093,450</td>
<td>$20,155,750</td>
</tr>
<tr>
<td>North Vancouver (City)</td>
<td>$99,384,382</td>
<td>$5,963,063</td>
<td>$9,938,438</td>
</tr>
<tr>
<td>North Vancouver (District)</td>
<td>$347,712,413</td>
<td>$20,882,745</td>
<td>$34,771,241</td>
</tr>
<tr>
<td>Port Coquitlam</td>
<td>$60,117,196</td>
<td>$3,607,032</td>
<td>$6,011,720</td>
</tr>
<tr>
<td>Port Moody</td>
<td>$165,151,904</td>
<td>$9,909,114</td>
<td>$16,515,190</td>
</tr>
<tr>
<td>Richmond</td>
<td>$233,813,777</td>
<td>$14,028,827</td>
<td>$23,381,378</td>
</tr>
<tr>
<td>Surrey</td>
<td>$417,043,318</td>
<td>$25,022,599</td>
<td>$41,704,332</td>
</tr>
<tr>
<td>Vancouver</td>
<td>$113,149,232</td>
<td>$6,788,954</td>
<td>$11,314,923</td>
</tr>
<tr>
<td>West Vancouver</td>
<td>$509,662,141</td>
<td>$30,579,728</td>
<td>$50,966,214</td>
</tr>
<tr>
<td>White Rock</td>
<td>$26,958,068</td>
<td>$1,617,484</td>
<td>$2,695,807</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$219,655,421</strong></td>
<td><strong>$366,092,369</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: BC Assessment Authority (land values)

Lest the impact of interest rates be taken too seriously, it is important to remember that considerations other than the interest rate may well be more influential in governments' investment decisions. For example, it is often suggested that factors such as the magnitude of time delay costs (Daiute 1970, 76) or the selection of benefits and costs included for analysis (Meyer 1971, 214-215) can exert a greater influence on project feasibility than the discount rate. Meyer has, for
example, pointed out that "for many sorts of public projects, project justification will hinge on the inclusion of external and social effects not readily quantifiable and, more importantly, typically subject to political pressures and oftentimes considerable exaggeration" (Ibid.).

It is worth reiterating that the figures given in Table 3 do not necessarily reflect societal losses occurring from investment in roads. The returns on roadway investment may manifest themselves in indirect ways. The numbers given are merely indicators of the extent of benefits that would be necessary to compensate for potential losses.
6.0 LAND COST ALLOCATION

Once roadway costs have been determined, methods of allocating these costs can be examined. There is unfortunately no easy way to allocate costs. In fact, a review of the literature reveals that no method exists that does not suffer from some degree of arbitrariness. Many methods of cost allocation suffer from either theoretical or practical limitations. These limitations have contributed to on-going debate on this issue.

6.1 ALLOCATION BETWEEN ROAD USERS AND OTHER BENEFICIARIES

The cost responsibility of road users as a group must be determined before determining how much of total costs automobile drivers in particular should be responsible for. Road users include drivers of automobiles, buses, trucks, delivery vans, motorcycles and other vehicles. But, road users are not the only beneficiaries of roads. The general public may benefit "because of the broad economic and social benefits derived from . . . expansion of . . . transportation facilities" and local property owners may benefit if their property values are increased as a result of road improvements (Westmeyer 1952, 382; Locklin 1972, 625). There is much debate on the issue of cost allocation between these sectors. Westmeyer has acknowledged that there is actually no logical basis for making allocations and that "the method used will have a profound effect on the final result" (Westmeyer 1952, 383). He goes on to state that "differences of opinion on this point alone may lead competent and unbiased students to reach entirely different conclusions, and it provides an opportunity for the special pleader to reach any conclusion he wishes" (Ibid.).

6.2 ALLOCATIONS AMONG ROAD USERS

Westmeyer's pronouncement would, by itself, sound a death knell for defensible cost allocation but the indictments against allocations extend even further. For, even once costs have been allocated to road users as a group, further break-downs are necessary in order to determine how much of that total can be attributed specifically to automobiles. Westmeyer has said that, "here, again, the possibility of wide variations in estimates exists" (Westmeyer 1952, 383). Locklin agreed: "numerous methods of dealing with this question have been proposed; but many, if
not all of them, are subject to criticism on theoretical or practical grounds, or both" (Locklin 1972, 632). One of the difficulties of making allocations is that it is not known whether such allocation "should be made on the basis of vehicle miles traveled, ton miles carried, or some other measure of frequency of use". This "is a problem on which there are sharp differences of opinion" (Westmeyer 1952, 383).

6.3 APPROACHES USED IN PRACTICAL STUDIES

Despite the difficulties, several individuals have attempted to allocate costs. Their approaches have varied somewhat but all seem to be rather arbitrary. The particular approach adopted depends on such considerations as "the objective of the costing, the data available, the knowledge of the underlying engineering relationships, and the analytic and numerical computational aids at hand" (Meyer 1971, 40). Locklin seemed to believe that in addition to these factors, politics also play an important role. He stated that "whatever may be the most desirable basis for dividing responsibility for highway support between general taxpayers and highway users, the actual division of responsibility at a given time is the result of political forces" (Locklin 1972, 628). The political effects would likely be witnessed in scenarios where data is to be used to determine pricing schedules.

In his 1992 study, Litman acknowledges that not all roadways are built to accommodate automobiles. In fact, he claims that "a more reasonable estimate is that 60 to 75 percent of roadway land is required for automobile use" (Litman 1992, 11). His decision to attribute only part of the land costs to automobiles results from his belief that a minimal level of access is needed regardless of the extent of automobile traffic. This minimal service level is to provide for such things as emergency vehicles and delivery vans. Litman believes that a lightly paved, single lane of roadway can adequately serve such needs (Litman 1992, 7). He points out that such a road represents the level of road investment which consumers typically select when they themselves must pay for road construction (Ibid.). He assumes that anything above this level would therefore be built in response to the extra needs of automobiles. In his belief that automobiles can not be
held accountable for all roadway land costs, he differs slightly from Voorhees and Holtzclaw. Litman quoted both of these sources as attributing all roadway land costs to automobiles.

Peat Marwick consultants concur with Litman’s belief that not all roadway land costs can be attributed to automobiles and that a minimal level of access needs to be defined. Peat Marwick went a little further than Litman in that they actually defined the width of a minimal access road. Peat Marwick believed that a 7-meter wide road would be adequate to provide minimal service. Road widths in excess of this were considered to be catering to the demands of automobile drivers (Peat Marwick 1993, 26). Peat Marwick calculated the roadway land attributable to automobiles by subtracting the land required to provide minimal service from the amount of land that is actually devoted to roads (Ibid.). This approach assumes that all existing roads are required for minimal service to be provided. In reality this may not be true. There is the possibility that some roads could be altogether eliminated, while still maintaining minimal access. Many houses are, for example, served by both lane ways and roads. Only one of these is necessary to provide basic property access. Peat Marwick’s approach will over-estimate the minimal road needs to the extent that the seven meter road requirement is applied to superfluous roads.

Hanson seemed comfortable with assuming that most costs could be attributed to private automobiles. He said that "while the same streets are used for buses, trucks, and other commercial vehicles, usage is overwhelmingly by automobiles and other personal vehicles" (Hanson 1992, 64). The Pollution Probe Study did not allocate costs.

6.4 ALLOCATING COSTS IN THE GREATER VANCOUVER REGION

A review of the literature demonstrates that, to date, no approach has been deemed completely appropriate. Theorists do not consider any particular approach to be perfectly suitable. It is thus not surprising that those given the task of deriving bottom-line figures are forced to rely on rather arbitrary methods. Litman and Peat Marwick are among those who have attempted to find methods that would yield rough estimates. Litman’s and Peat Marwick’s approaches do not
yield precise results. But, since no other approach can be said to do so, it makes little sense to adopt other, more complicated approaches, if they are no more theoretically appropriate than the approaches adopted by Litman and Peat Marwick.

Since automobiles are not the only users of public roads, it is important not to attribute the total cost of roads to automobile drivers. To determine the portion of road costs that can be attributed to automobiles, it is important to examine the standard that would be required if it were not necessary to provide for automobiles. Other road users include buses, trucks, emergency vehicles and bicycles. Basic access for these users can be provided with a 7-meter wide road. Two-directional traffic could easily be provided for with two 3.5-meter lanes. Any width in excess of this can thus be attributed to automobiles.

Some experts argue that it may not make sense to apply the 7-meter right-of-way to all links in a road network (Rice 1993). It has been suggested that high-capacity, high-speed facilities such as expressways are not needed to provide basic access. The implied conclusion is that such facilities can be completely attributed to demands from automobile drivers. Although this makes theoretical sense, non-automobile users do in fact use such facilities and it would therefore not seem fair to charge automobile drivers with the full costs of providing such facilities. The British Columbia Ministry of Transportation and Highways (1992) states that automobiles make up 82 percent of 'typical' traffic on rural highways. Similar figures were not available for urban highways, but a quick afternoon survey of Kingsway revealed a similar breakdown. If cost responsibility were allocated based on traffic composition, then automobile drivers could be held responsible for about 82 percent of costs. Interestingly, this approach would yield a cost breakdown quite similar to that obtained by using the 7-meter minimum access approach. An examination of average widths of roads given in Table 1 reveals that many provincially-funded road right of ways are about 40 meters wide. If the minimum access of seven meters is subtracted from this width, then 33 meters can be attributed to automobile users. Those 33 meters represent 83 percent of the total width—a figure very similar to that indicated by the traffic composition
approach. Table 4 represents the costs that could be attributed to automobiles if a rate of 80 percent were applied.

**TABLE 4:**

**COSTS ATTRIBUTABLE TO AUTOMOBILES**

(Assuming 80% Cost Responsibility)

<table>
<thead>
<tr>
<th>MUNICIPALITY</th>
<th>LAND VALUE</th>
<th>FOREGONE ATTRIBUTABLE TO CARS</th>
<th>INTEREST (at 6%)</th>
<th>TAXES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnaby</td>
<td>$577,395,532</td>
<td>$34,643,732</td>
<td>$5,081,081</td>
<td></td>
</tr>
<tr>
<td>Coquitlam</td>
<td>$216,697,998</td>
<td>$13,001,880</td>
<td>$2,145,310</td>
<td></td>
</tr>
<tr>
<td>Delta</td>
<td>$291,215,663</td>
<td>$17,472,940</td>
<td>$3,465,466</td>
<td></td>
</tr>
<tr>
<td>City of Langley</td>
<td>$26,210,413</td>
<td>$1,572,625</td>
<td>$325,350</td>
<td></td>
</tr>
<tr>
<td>District of Langley</td>
<td>$77,579,401</td>
<td>$4,654,764</td>
<td>$899,921</td>
<td></td>
</tr>
<tr>
<td>New Westminster</td>
<td>$161,245,996</td>
<td>$9,674,760</td>
<td>$1,822,080</td>
<td></td>
</tr>
<tr>
<td>North Vancouver (City)</td>
<td>$79,507,506</td>
<td>$4,770,450</td>
<td>$715,567</td>
<td></td>
</tr>
<tr>
<td>North Vancouver (District)</td>
<td>$278,169,930</td>
<td>$16,690,196</td>
<td>$2,753,882</td>
<td></td>
</tr>
<tr>
<td>Port Coquitlam</td>
<td>$48,093,757</td>
<td>$2,885,625</td>
<td>$538,650</td>
<td></td>
</tr>
<tr>
<td>Port Moody</td>
<td>$132,121,523</td>
<td>$7,927,291</td>
<td>$1,387,276</td>
<td></td>
</tr>
<tr>
<td>Richmond</td>
<td>$187,051,022</td>
<td>$11,223,061</td>
<td>$1,646,049</td>
<td></td>
</tr>
<tr>
<td>Surrey</td>
<td>$333,634,654</td>
<td>$20,018,079</td>
<td>$3,403,074</td>
<td></td>
</tr>
<tr>
<td>Vancouver</td>
<td>$90,519,386</td>
<td>$5,431,163</td>
<td>$687,947</td>
<td></td>
</tr>
<tr>
<td>West Vancouver</td>
<td>$407,729,713</td>
<td>$24,463,783</td>
<td>$3,506,475</td>
<td></td>
</tr>
<tr>
<td>White Rock</td>
<td>$21,566,454</td>
<td>$1,293,987</td>
<td>$129,189</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$2,928,738,948</strong></td>
<td><strong>$175,724,337</strong></td>
<td><strong>$28,507,318</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: (1) Calculated as the sum of lost taxes and foregone interest

Source: BC Assessment Authority (land values)

There are many techniques that can be used for allocating costs among road users. Table 4 indicates the results of the traffic composition/minimum access methods. The costs allocated to automobiles may be somewhat lower with the use of other approaches. Litman, for example, suggested that automobiles are responsible for only 60 to 75 percent of costs (Litman 1992, 11). Figures closer to those given by Litman would be obtained if consideration is given to the size of the vehicle using the roads. According to such an approach, a large truck would be considered equivalent to three or four cars. Such an approach differs substantially from the traffic
composition approach which allocates all vehicles equal cost responsibility. If consideration is
given to the size of vehicles, then the share of costs attributable to cars would go down to about
70 percent. Given that there is currently little agreement on methodologies of allocating costs, it
may perhaps be wise to indicate a range of cost responsibility. It seems reasonable to suggest
that automobile drivers are responsible for between 70 to 80 percent of roadway land costs.
7.0 TOTAL ROADWAY LAND COST

The individual components of roadway land costs have now been calculated. These components can be added up to determine the total cost of provincially-funded roadway land in the Greater Vancouver region. The land value of provincially-funded arterials and highways totals $3,660,923,687. Of this total, $2,928,738,948 has been attributed to automobiles. In 1992, there were 999,419 registered and insured vehicles in the Greater Vancouver Regional District. Of this total, 97,587 were insured for business purposes (GVRD Development Services June 1992, 63). If it is assumed that all registered vehicles not insured for business purposes are privately-owned automobiles, then the number of such automobiles totals 901,832. If it were assumed that all roads were built within the past twenty years, and that costs were amortized over a 20-year period, then the annual value of roadway land could be said to be $162 per vehicle.

An annual maximum societal loss of $255,289,568 could result from lost taxes and foregone investment interest. Of this total, $204,231,654 can be attributed to automobiles. If the total costs are apportioned among all automobiles not insured for business purposes, then each automobile would be accountable for annual land-related "pecuniary" costs of $226.

The figures given in this thesis are estimates. Some of the approaches that have been used have led to rather conservative costs estimates, while others have likely led to possible overestimates. It is important to acknowledge the effect of the approaches so that others can view the given costs in their proper light.

Conservative approaches were used in: establishing land values (non-adjacent land values were applied to roads); determining lost taxes (lowest tax rates were applied); and in determining financing costs (low interest rates were applied).

The twenty year amortization period and the 80 percent cost allocation may have resulted in overestimates of annual cost responsibility per automobile. The amortization period has a great
influence on annual roadway land value costs. In this thesis, it was assumed that all roads were built within the amortization period of twenty years. The value of the land was thus amortized over those years. If a longer amortization period were adopted, the annual costs would be lower. Of course, not all roads were actually built in the last twenty years. Some roads were built before 1972. The costs of such roads should therefore already have been fully amortized. It is, however, difficult to determine which roads predate 1972. As such, an assumption has been made that all roads have been built within the last twenty years. To the extent that this is incorrect, land costs will be overestimated.

The cost allocation method chosen for this thesis could also result in overestimation of automobile drivers' responsibility for roadway land costs. To the extent that such drivers are actually responsible for less than 80 percent of roadway land costs, their responsibility will have been overestimated.

The point of this thesis has not been to determine the precise cost of roadway land. Such a task would be virtually impossible. The values given are estimates. It should be emphasized that some of the foregone investment interest and property tax may have been compensated for by various means. As such, the societal cost of lost taxes and foregone interest are likely to be far less than the maximum figures that have been given in this thesis. The contribution of this thesis has been to explore the issues involved in determining the cost of roadway land—something that has not previously been done in any comprehensive manner. By discussing the issues and by providing rationales for selection of particular methods, the door has been opened for further debate on transportation costing issues in the Greater Vancouver region.
8.0 POLICY IMPLICATIONS

Given the high cost of roads, it is worthwhile to find ways to reduce the need for such roads in the future. This is especially relevant given the current climate of fiscal restraint and environmental concern.

8.1 WHY MONEY SPENT ON ROADWAY LAND IS A CRITICAL ISSUE

Road expenditures are an issue because of the impact that such expenditures have on other societal goals.

Using land for roads means that the land is not available for other uses. Among the many alternative land uses are agriculture or housing. The building of new roads threatens the preservation of agricultural land. As the population grows, there will be more pressure to use farmland for urban development. Since 1974, 5.5 percent of the land in the Agricultural Land Reserve has been removed for other uses (Seelig and Artibise 1991, 10). By 2006, the supply of all vacant Greater Vancouver land zoned for single family housing will have been exhausted (Jim Chim, class lecture, October 1992). The construction of roads encourages sprawl and thus the rapid urbanization of what little land remains. Instead of using scarce land for roads, such land could be used to provide more housing. At the very least, road-building could be reduced so as to discourage further sprawl and delay housing shortages. With the growing pressure on agricultural lands and the looming shortage of land for housing, does it make sense to use so much land for roads?

Road building also runs counter to the public goal of protecting air quality. Environmental concerns of Greater Vancouver residents have been expressed in such documents as Creating Our Future (1990) and Clouds of Change (1990). Both reports suggest that automobile traffic is a significant threat to the quality of the environment. Increasing the road supply will result in an increase in traffic. Land devoted to roads thus contributes directly to a deterioration of the
environment. The *Clouds of Change* document states that "over 80% of atmospheric pollutants in the Greater Vancouver Regional District come from 'mobile sources'" (City of Vancouver, 1990, 17). Each vehicle has a considerable effect. Table 5 indicates each vehicle's contribution to atmospheric pollution. The numbers become even more dramatic when they are multiplied by 999,419 to take into account the total number of vehicles in the Greater Vancouver Region. Society's addiction to automobiles is a major obstacle to reducing atmospheric pollutants. Automobiles, like people, are concentrated in cities. It is no wonder then that the *Clouds of Change* report stated that "our ultimate success or failure to achieve a sustainable relationship with the biosphere may well be determined by our cities" (Ibid., 21).

**TABLE 5: EACH VEHICLE'S ANNUAL EFFECT ON ATMOSPHERIC POLLUTION**

<table>
<thead>
<tr>
<th></th>
<th>Kilograms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocarbons:</td>
<td>13.5</td>
</tr>
<tr>
<td>Carbon Monoxide:</td>
<td>99.5</td>
</tr>
<tr>
<td>Carbon Dioxide:</td>
<td>1,517</td>
</tr>
<tr>
<td>Nitrogen Oxides:</td>
<td>7.0</td>
</tr>
<tr>
<td>Sulphur Oxides:</td>
<td>0.14</td>
</tr>
<tr>
<td>Particulate Matter:</td>
<td>0.12</td>
</tr>
</tbody>
</table>


Although extensive provision for automobiles may be favourable to individuals, the impact of such provisions extend much beyond the individual. As Seelig and Artibise have pointed out, "we live in a global community where seemingly isolated actions have global consequences" (Seelig and Artibise 1991, 8). Some of these consequences may be quite negative. Do residents of the Lower Mainland have a responsibility to take global consequences into consideration when planning to meet their transportation needs? Public forums on this issue would suggest that many residents do indeed feel such a responsibility. But how can this responsibility be translated into action?
While certain individuals embrace the philosophy of global concern, the majority continue to pump gas into cars and demand more road space on which to drive those cars.

There is currently little personal incentive for people to change their habits and thereby become less car-dependent. Individuals benefit from car usage, and therefore continue to use their cars. Meanwhile, society as a whole often suffers serious negative consequences. This situation seems paradoxical to those who believe that the interests of society as a whole are best served if all individuals within the society pursue their self-interest. The idea that the sum of individual interests will equate with the best interests of society is often thought to be a core concept of capitalism. After all, did Adam Smith not say that an individual, although only intending to act for "his own gain", is "led by an invisible hand to promote . . . the public interest" (Smith [1776] 1937, 423)? Garret Hardin has suggested that "Adam Smith did not assert that this was invariably true, and perhaps neither did any of his followers. But he contributed to a dominant tendency of thought that has ever since interfered with positive action based on rational analysis" (Hardin 1968, 1244).

Hardin insisted that the pursuit of individual gain does not necessarily produce the best outcome for society as a whole. He believed that individuals will not necessarily treat common property such as the air, water, or roads in a manner that is conducive to the interests of society as a whole. In fact, he asserted that when all individuals pursue their own best interests "in a society that believes in the freedom of the commons," society is headed toward ruin. He stated that although the individual may benefit "from his ability to deny the truth," the "society as a whole, of which he is a part, suffers" (Hardin 1968, 1244).

Hardin stated that the "tragedy of the commons" arises when principles that may apply to use and allocation of privately-owned resources are applied to public goods such as the environment (Hardin 1968, 1243). Hardin explained that "the air and waters surrounding us cannot be readily fenced, and so the tragedy of the commons as a cesspool must be prevented by
different means, by coercive laws or taxing devices that make it cheaper for the polluter to treat his pollutants than to discharge them untreated" (Ibid., 1245). Currently, the interests of the individual are best served by discharging untreated sewage.

Relying on the "invisible hand" may work tolerably well when resources are abundant and demand for those resources is low. The principle of the "invisible hand" does not work nearly as well when resources are scarce and demand high. Hardin pointed out that "using the commons as a cesspool does not harm the general public under frontier conditions, because there is no public; the same behavior in a metropolis is unbearable" (Hardin 1968, 1245). Since land is a scarce commodity, and demand for that land is high, it may be time to re-examine the principles by which it is allocated.

Hardin's essay on The Tragedy of the Commons dealt primarily with the "freedom to breed" and the consequences this had for society as a whole. He said that "to couple the concept of the freedom to breed with the belief that everyone born has an equal right to the commons is to lock the world into a tragic course of action." It is not too far-fetched to apply the same statement to the "freedom to drive." Hardin did not hesitate to recommend that some freedoms be restricted. He pointed out that society already accepts the restriction of, for example, the "freedom" to rob a bank. Hardin stated that "the man who takes money from a bank acts as if the bank were a commons. How do we prevent such action? [W]e seek the social arrangements that will keep (the bank) from becoming a commons. That we thereby infringe on the freedom of would-be robbers we neither deny nor regret (Hardin 1968, 1247). Hardin suggests that "as the human population has increased, the commons has had to be abandoned in one aspect after another" (Ibid., 1248). Has society now come to the point where it needs to stop treating the road network as a "commons"?

The effects of road-building are both immediate and long-lasting. By building a road, a certain amount of land is used up that could have been used for other purposes. This is the
immediate effect. The longer term effect is that the very act of building the road perpetuates the need for roads. The longer term effects of road-building are not always acknowledged. Often, people see road-building as a solution to the problems of congestion. But, adding capacity does not necessarily alleviate congestion. New roads may temporarily take the pressure off a burdened system, but the very existence of a new, relatively uncongested road will usually attract additional trips that would not previously have been contemplated. This adds to traffic. With time, the system will, once again, be operating beyond desirable capacity. The result? More roads will be demanded. This "no-win" situation becomes firmly entrenched if gas tax revenues are reserved exclusively for new construction. If gas-taxes are ear-marked for new road construction, the system will perpetuate itself. More gas taxes will result in more freeways which will result in more suburbs and more cars—which will in turn produce more gas taxes to be invested in more roads. Thus a vicious cycle is started (Dantzig 1973, 112).

How society uses land is a good gauge of its priorities. This was pointed out by E.F. Schumacher who said that "among material resources, the greatest, unquestionably is the land. Study how a society uses its land, and you can come to pretty reliable conclusions as to what its future will be" (E.F. Schumacher in Seelig and Artibise 1991, 39). Current land use indicates that our society is enamoured of the car. Land taken up by roads already exceeds 25 percent of the total area of Vancouver; 7 percent of the Pacific Fraser Region (Seelig and Artibise 1991, 60). What does this say about the future of the Greater Vancouver region?

The decisions made regarding road building have far-flung consequences and have an impact on future quality of life. Spending money on roads means that other public goals such as housing, farmland preservation and air quality improvement may be frustrated.
8.2 THE ROLE OF PUBLIC POLICY

It is public policy that guides the provision of roads. As such, policy must be considered when examining the current provision of roads and the course that should be pursued in the future. Public policy is the "bridge" that links the present situation with future desired outcome.

Transportation can not be changed in isolation because it is very much related to other issues such as where we live and work. To be most effective, a good strategy will therefore require an effort that is sustained by coordinated policies.

Public policy can be used to make it in peoples' self-interest to engage in behavior that serves the best interests of society as a whole. Such an approach can help overcome the "tragedy of the commons" that was described by Hardin.

Solving problems is a three step process. The first step is to recognize that a problem exists. Next, possible solutions must be identified and a choice made. Then, action must be taken. To complete the first two steps without following with the third, may create more knowledge, but it will hardly solve the problem. A person who goes to a dentist complaining about bad teeth may be told that lack of brushing is a major contributor to the problem. If that person then goes home only to continue previous bad habits, the problem will not be solved. This analogy can be applied to public policy: unless action is taken, little will change. Residents and politicians of the Greater Vancouver region have identified some problems associated with current transportation patterns and also several possible solutions. But, to reach the goals, certain things must change. Changed outcomes require changed actions.

8.3 A FRAMEWORK FOR ACTION

If society is serious about reducing the negative consequences of roadway spending, then there are several existing policies that should be re-examined and several new ones which ought to be considered. Policies can be adopted at many levels. For the purposes of this analysis, the
focus will be on the provincial level since this thesis has dealt with provincially-funded roads. It is important, however, to recognize that for effectiveness to be maximized, policies at the provincial level must be matched with compatible policies at the municipal and regional levels.

**The Province’s Current Approach to Dealing with Roadway Demand**

The British Columbia Ministry of Transportation and Highways has, until now, maintained a supply-side orientation. The Ministry of Transportation and Highways has generally focused on alleviating congestion by constructing new roads or widening existing ones. The underlying assumption is that the demand for roads must be catered to.

To some extent, efforts have been made to counter the demands for roads by emphasizing the role of public transit. However, the construction of new roads usually seems to take precedence. One Ministry publication stated that "a functional transportation system in Vancouver now requires added investment to major roads so as to balance and facilitate the upgrades that are being made to the transit network" (Ministry of Transportation and Highways (vol. 5) 1988, 6.25). Although new roads can indeed facilitate the provision of improved transit service, such roads can also act to reduce the public’s incentive to use transit. Once extra capacity has been created, people may no longer see a need to reduce automobile use. Although the Ministry report speaks of increasing transit service (Ibid., 9.5), it does not really address how to get people to use that service. As long as more roads are provided, it is unlikely that people will shift to public transit.

Although the Ministry has generally pursued supply-side tactics, they do admit that "it will not be possible to relieve all congestion" (Ibid., 6.26). Relief of congestion by constructing more roads appears, however, to be a major goal despite the Ministry’s admission that "the extent of the needs for new and improved transportation infrastructure as outlined in the recommendations . . . clearly exceeds the financial resources of the Province in the short run (Ibid., vol. 1, 1.21).
Part of the reason for the Ministry's supply-side approach may be that their mandate deals exclusively with the road network. They do not have direct influence over all transportation policy. The Ministry has indicated that the "lack of co-ordinated transportation policy encompassing roads and transit in the region, coupled with the division of decision-making between the Ministry of Transportation and Highways, municipalities, and BC Transit often makes it difficult to determine an appropriate balance of roads versus transit in a corridor" (Ministry of Transportation and Highways (vol. 5) 1988, 9.6).

The Ministry has readily admitted that they are constrained in their current approach to dealing with demand for more roads. The limitations are both financial and organizational. Given such constraints and further constraints imposed by the limited supply of land, it makes sense to review alternative strategies.

**Alternative Approaches**

One of the keys to reducing the need for new roads is to reduce the amount of traffic that is using existing roads. This can be done in numerous ways. Ultimately a comprehensive strategy that involves the concerted efforts of municipal, regional and provincial governments or authorities will work best. This section will, however, concentrate on the actions that could be taken by the provincial government.

The most successful policy would probably involve the simultaneous application of several different tactics (Downs 1992, 146). For the purposes of analysis, several different policies will be examined before a particular combination will be recommended for consideration. The following paragraphs include a discussion of some of the approaches most commonly used to deal with traffic congestion. These approaches can be separated into demand-side tactics (which attempt to reduce the need for new roads by reducing the amount of traffic) and supply side tactics (which attempt to alleviate congestion by providing more facilities or more efficient facilities). Appendix 3
provides Down's (1992) ratings of various approaches. A discussion of the relative merits of all approaches would require a thesis in itself and is certainly an area that is ripe for further study.

Garret Hardin has suggested that taxes are a suitable device for making it in peoples' self interest to pursue the public good. He suggested that temperance be created by coercion (Hardin 1968, 1247). In the interests of democracy, any coercion ought to be mutually agreed-upon. Society has traditionally agreed to accept taxation because "we recognize that voluntary taxes would favour the conscienceless" (Ibid.). Trying to reduce demand for new roads by appealing to conscience rather than peoples' pocketbooks would favour the conscienceless. The province can use taxes to diminish the need for new roads by making drivers less enthusiastic to take to the road. In order to reduce roadway land consumption, society need not forbid driving— it need only make it increasingly difficult or expensive to do so.

One way to make driving more expensive is to increase taxes. There are several types of taxes. Table 6 places taxes into several categories.

**TABLE 6: MOTOR VEHICLE TAX CLASSIFICATION**

<table>
<thead>
<tr>
<th>ACQUISITION</th>
<th>OWNERSHIP</th>
<th>INDIRECT USE</th>
<th>DIRECT USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Tax</td>
<td>Registration Fee</td>
<td>Fuel Tax</td>
<td>Tolls</td>
</tr>
<tr>
<td>Value Added Tax</td>
<td>Personal Property Tax</td>
<td>Cordon Tolls</td>
<td>Parking Fees</td>
</tr>
<tr>
<td>Transfer Tax</td>
<td>Driver's License Fees</td>
<td>Supplementary Area License</td>
<td>Weight Fees</td>
</tr>
</tbody>
</table>


It is not always easy to select a perfectly suitable tax. Quite often, tradeoffs must be made. For example, although differential fees (such as those listed in the last two columns of Table 6) are more difficult and costly to implement than fixed fees (such as those listed in the first two columns), the differential fees have the benefit of being more equitable and efficient (OECD 1985, pp. 16, 95).
The appropriateness of a given tax will depend on the aim of the tax. Essentially, the taxing authority must ask itself what it hopes to achieve by imposing a new tax. Is the aim merely to raise money? Is the aim to reduce usage? Is the aim to price a "public" good? The answers will determine which tax is most appropriate. An example will illustrate this concept. Flat fuel taxes may be quite appropriate for charging for emissions, noise and accident rates. The amount of fuel tax that a driver pays will be more or less directly related to the distance driven by that driver. Emissions, noise, and accidents are also more or less related to distances driven. It therefore makes sense to use fuel taxes as a pricing mechanism for these externalities. Fuel taxes may not, however, be appropriate to relieving congestion and thus reducing the peak period traffic demand that results in demand for extra roads (OECD 1985, 65). Congestion costs are higher at some times than at others. The rate at which fuel is taxed is not dependent on the time of day that a driver uses the fuel. As such, flat fuel taxes may not be a good way to price peak-period road use. Fuel taxes also present problems in that they may encourage people to switch to more fuel-efficient cars to reduce the negative impact of higher gasoline taxes. Although that would help reduce gasoline consumption, it may not necessarily discourage driving. Another consideration should be the potential for evading the tax. This is a problem particularly in the Greater Vancouver region where drivers can, by purchasing gas in the United States, avoid paying stiff fuel taxes. It would seem that fuel taxes might not be the most effective way to discourage driving.

Roadway land consumption can be reduced if fewer people drive. One way to reduce the number of people who drive is to increase the attractiveness of public transit. This can be done by managing the supply and pricing of parking spaces. "Restrictions on parking space can improve the performance and profitability of public transport both by reducing the opportunity for car commuting and by making more road space available for public transport vehicles" (OECD 1985, 36). Currently, there is only "a weak correlation between a price based on the duration of parking and the preceding trip characteristics (length, time, locations)" (Ibid., 115). For parking to be used as a mechanism for road pricing, existing parking fees must be restructured. The OECD has suggested that one method of doing this would be to divide parking fees into two parts. One part
would ration scarce road space. This part would account for road congestion and would vary according to time of entry and departure. The collection of "road use fees" at existing parking booths would eliminate the need to spend money on installing new collection points on major roads and would also have the advantage of charging for the use of all roads, and not just roads that might be tolled. The second part of the parking fee would ration scarce parking spaces and would therefore vary according to demand for parking space. Such a pricing scheme has not yet been tried anywhere (Ibid., pp. 18, 92).

Tolls can also be used to price roads. The provincial government is now contemplating using tolls to finance repairs to the Lion's Gate Bridge. Although tolls have periodically been used to finance construction, they have not yet, in the Greater Vancouver region, been used to price roads. Tolls would likely discourage unnecessary trips. This would, in turn, reduce the need for future expansion of facilities. A few urban areas such as New York City and San Francisco already have quasi-government authorities empowered to levy tolls (OECD 1985, 102). Tolls, however, suffer from the potential to transfer congestion onto untolled roads (Downs 1992, 56). The potential for transference could be partially averted in the Greater Vancouver region by placing tolls on bridge or tunnel crossings. For many journeys, the only way of avoiding such crossings would be to forego the trip. Tolls would have a disproportionate effect on low income earners. The effect on low-income earners could, however, be tempered by offering transportation tax credits. It would take very high tolls to discourage higher-income drivers from using the tolled roads. Such individuals place a high value on their time. The toll charge for such people might easily be paid for out of the extra earnings derived during the time that would otherwise have been spent on a more congested road. Despite the drawbacks, tolls can be very effective. One expert has estimated that "peak-hour pricing might reduce traffic on toll roads by 20% or more" (Downs 1992, 56).

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6 It has been suggested that road space could be charged by installing, in all vehicles, a device that would indicate where the vehicles originated from (O'Connell 1973, 76). With indications of both "home base" and the destination, such a device would allow parking fees to reflect the distance driven. This would have the advantage of charging for any road space which may be used—not just tolled roads. Such an approach would help prevent drivers from switching to residential or other non-tolled roads when tolls are imposed on major roads.
Some of the disadvantages of tolls can be overcome by systematic roadway pricing. Full roadway pricing would, for example, help prevent traffic from transferring from tolled roads to untolled roads. Such pricing would charge all drivers—not just those who use tolled roads or those who park their automobiles. Roadway pricing would charge each user the marginal social cost of each trip. The cost may vary according to time and place of travel. Roadway pricing could take such variances into account far more easily than could tolls or parking charges. Electronic metering would be one method of charging for the use of roads. Electronic metering would be equitable in the sense that it would charge people fees that vary according to the burden placed on the system. Full roadway pricing would not eliminate congestion, but would reduce congestion substantially below present levels (Downs 1992, 52). Practical, affordable techniques of implementing such a pricing scheme have yet to be made widely available. Advances in micro-electronics and a planned demonstration in Hong Kong do, however, suggest that such measures may be possible sometime in the future (OECD 1985, 126). Road pricing has received some criticism for its inequity, inefficiency, and invasion of privacy.

If the goal of taxes is to reduce use of vehicles, it makes little sense to tax ownership. Sales taxes, registration fees, and license fees are all acquisition or ownership taxes rather than "use" taxes. In order to have a functional road network, a certain number of roads must exist. It makes sense that all beneficiaries should help pay for the basic system. Flat taxes may be used for this purpose. There are, however, many costs that are incurred only to provide for peak period demand. Is it fair to tax all people equally regardless of the costs they impose on the system? Quite aside from the issue of fairness, such a system does little to encourage decreased use of the roads. To reduce demand for new roads, it is preferable to opt for use-related fees rather than fixed fees. Fixed fees merely encourage people to make maximum use of their initial investment. People currently have an incentive to make the most of all the money they have paid to purchase, insure, register and license their vehicles. People rationalize that each time they use their automobile, they are helping to make the most of their "fixed" investment. By increasing costs
associated with usage (the variable costs), it is likely that many 'optional' trips could be
discouraged. Drivers "perceive operating costs poorly, special fees that are clearly related to given
trips (e.g. tolls, parking charges, supplementary licenses) are better perceived by users and are
more likely to influence travel behavior" (OECD 1985, 96). A reduction in trips would have the
ultimate result of decreasing the need for new roads. The provincial government can help reduce
the need for new roads by relying more heavily on use-related taxes, and less heavily on fixed fees.
Use-related taxes, may, however, cost more to collect. More study is needed to determine
whether the extra costs would outweigh the benefits gained by reducing road demand and
increasing equity.

In addition to tactics that attempt to reduce demand by appealing to peoples' pocket books
(market based approaches), there are tactics that attempt to force reduction in car trips (regulatory
approaches) (Downs 1992, 23).

One regulatory tactic that receives frequent mention is that of restricting the days on which
automobiles can be driven. One way of doing this would be to restrict automobile usage according
to license plate numbers.7 For example, on Mondays, all automobiles bearing license plates with
numbers ending in 1 and 2 would be banned from the roads. On Tuesdays, the affected license
plate numbers would be 3 and 4, and so on. If each automobile were banned from the road one
day per work week, this would immediately reduce traffic by 20 percent. There are, however,
several problems with this approach. There are commuters who would experience exceptional
hardship from such a regulation. If workplaces or homes are not well-served by transit and if ride-
sharing is not possible, then such an approach would not seem reasonable. If "non-driving" days
were based on license plate numbers, then individuals possessing more than one vehicle could
merely switch automobiles on days when their "usual" automobile was banned from the roads.
The problems potentially incurred with multiple automobile ownership could be averted if all
vehicles registered to a particular household were given license plates ending with the same

7This has been tried on a voluntary basis in Calgary, Alberta.
number. All drivers, regardless of income, would be affected by the regulation, and none could circumvent it by "buying their way out." If this approach were adopted, then a driver would have to find alternate means of transportation on the "non driving" day. To make this tactic slightly more palatable, drivers could be given some choice in the selection of their "automobile free" day.\textsuperscript{8} Enforcement could take place with periodic spot checks, much like the drinking/driving laws are now enforced. Rather than imposing fines (which would place high income earners willing to pay the fine at an advantage), the penalty for driving on "banned" days, could be very stiff--confiscation of the offending driver's license for a stipulated time period. The stiffer the penalty, the less likely that drivers would be willing to take the risk of driving on banned days, and the less will be the need for enforcement. Drivers who could prove a legitimate and indispensable need for their car could be provided with exemptions.

Another regulatory approach to reducing demand for road space is to impose mandatory densification on newly developing suburbs. This tactic would not have immediate effects on traffic congestion, but would have significant effects over the long run (Downs 1992, 97). It would be much more difficult to densify areas that are already built up. The relatively slight decreases in traffic congestion that would occur from doing so would not likely warrant the high costs of the densification.

So far, the approaches discussed have aimed to reduce demand for roads by either regulating use of roads or by providing market incentives to reduce demand. There is, however, also the possibility of adopting approaches to more effectively accommodate demand by introducing supply-side tactics.

The construction or designation of more High Occupancy Vehicle (HOV) lanes is one supply-side tactic. Such an approach would seek to discourage the use of Single Occupancy

\textsuperscript{8}For example, when drivers register their vehicles and receive license plates for their cars, they could be given some choice as to the number selected. The number selected would determine which days would be "non-driving" days.
Vehicles (SOV) and would thereby enable more efficient use of existing facilities. A vehicle takes up the same amount of road space whether it has one occupant or four. If the same number of people as currently use the roads could be carried in fewer cars, the number of automobiles on the road would be reduced, congestion would be alleviated and the need for many road-widenings could be averted. If people enjoy speedier travel in HOV lanes, then ride sharers will receive some compensation for the time that it takes to pick up and drop off additional passengers. HOV lanes can also be used to increase the relative attractiveness of public transit use. People often claim that they do not use transit because travel by bus or train is slower than travel by car. If HOV lanes could confer significant time savings, then more people may be persuaded to travel by bus. HOV lanes need not necessarily be added to the existing road network. Such a tactic would be quite costly and would therefore delay implementation. An alternative would be to convert existing lanes to HOV lanes. This would increase congestion in other lanes, and would make transit relatively more attractive. There is of course the danger that those who continue to ride in the SOV lanes will become angry and frustrated with the increased congestion and then push for retraction of such a policy (Downs 1992, 40).

Another supply-side remedy would be to use technological solutions to make more efficient use of existing roads. Such tactics might include better signal timing, TV monitoring, electronic signs, and ramp signals (Downs 1992, 152).

Unfortunately, the approaches which will likely be most effective in reducing demand are also those approaches that would likely be considered least acceptable. Many punitive measures would not "be in force long enough to have a major impact because those politicians who introduced the measures would be booted out at the next election" (O'Connell 1973, 2). Demand-side tactics—including the most effective ones—have poor political acceptability (Downs 1992, 151). The most effective supply-side tactics would require less traumatic institutional change than the most effective demand-side tactics (Ibid., 150). From a political perspective, it makes sense to rely on supply side tactics. It is, perhaps, not surprising then that this has traditionally been the
approach adopted by the Ministry of Transportation and Highways. There are, however, also shortfalls to the supply-side approach. Supply side tactics are generally far more costly to society and they are generally less effective in reducing congestion than are demand side tactics.

**Recommended Policy**

Intractable congestion combined with limited supplies of land and limited financial resources suggest that it is time to examine approaches other than traditional supply-side tactics. Before an alternative strategy can be recommended, it is important to define the criteria which should ideally be met by a new policy. A new policy should obviously be deemed to have the potential to significantly reduce traffic congestion. In other words, it ought to be effective. This effectiveness should be achieved at minimal implementation cost. It is also important that the policy not disproportionately affect those least able to pay. Finally, it is important that a new strategy be flexible enough to adjust to changes that occur over time, and between municipalities. Finding a policy that meets all these objectives is certainly a tall order. Once the criteria of political acceptability is added, the difficulties become even greater. It may be difficult to completely fulfill all of the above objectives. The definition of the goals does, however, help in ranking the acceptability of various approaches. Obviously, the approaches that are selected will depend on the values considered most important by the policy-setter.

The implementation phase should start with the less onerous policies. Such policies might, for example, include changing tax laws to make employer-provided transit passes a tax-free benefit or increasing advertising to encourage ride-sharing. If such tactics do not prove sufficiently effective, they should be followed by implementation of some of the least "regressive" market approaches. The success of such measures should be monitored carefully. If traffic reduction objectives can not be accomplished with such measures then more regulatory measures may need to be implemented. The object should not be to price or regulate cars out of existence since automobiles will still be necessary for some trips. The goal should rather be to limit automobiles to those trips for which they are best suited. Peak hour use would generally not be one of those
uses. It is peak hour usage that is responsible for most of the demand on provincially-funded roads. At non-peak hours, those roads are often operating below capacity. To reduce future roadway land costs, it is therefore peak hour trips which should be targeted. The goal should be to reduce traffic sufficiently to minimize the need for new construction. In order of implementation, recommendations are as follows:

1) Change tax laws to make employer-provided transit passes a tax-free benefit
2) Place *peak-hour* tolls on all bridge and tunnel crossings in the Greater Vancouver Region
3) Impose a *peak-hour* parking tax surcharge for parking in areas that are well-served by transit and receive a lot of traffic (such as Downtown Vancouver)
4) Introduce full road pricing

In order to minimize the regressive impacts of market approaches such as peak hour tolls and parking taxes, transportation tax credits could be offered to those earning low incomes.\(^9\) Such tax credits should not, however, completely cancel the effect of price increases. If complete refunds were offered then the charges would have little effect on driving behaviours. To be most effective, the charges should still be sufficient to discourage unnecessary driving. The point is that the charge necessary to discourage those of lower incomes from driving is less than that required to change the behaviours of wealthier individuals. The purpose of the road charges is to change behaviours; not to raise revenue.

Most of the policies which have been suggested are fairly harsh. But, if British Columbians are serious about reducing congestion, such measures will be necessary. Less drastic policies have repeatedly proven unsuccessful in reducing congestion and thereby reducing roadway land consumption.

\(^9\) Such transportation tax credits could be offered by allowing people earning under a certain income to deduct a "transportation amount" from their taxable income.
Traditionally, supply side measures have been used to cope with congestion. Such measures have often involved using more land for roads. Increasingly it is being realized that supplying more roads does not eliminate congestion. The repeated failure of such "supply-side" tactics suggests that it may be time to adopt other approaches. Such approaches may include ones that focus on changing people's behaviours and thus changing the demand for roads. All the recommendations that have been given focus on changing demand for roads.

The recommended policies cannot be implemented overnight. There are several reasons for that. First, some of the tactics will require installation of special equipment. Second, the public will require time to adjust to the idea of being charged more directly for the use of roads. It therefore makes sense to start with policies that would be the least politically unpopular and the least expensive to implement. If it becomes apparent that such policies are sufficient to result in desired traffic reductions, then the more drastic measures may never be needed. On the other hand, if the less drastic measures prove insufficient, then pressure may be exerted for harsher action. The gradual approach also makes sense because it "has a greater chance of eventual success than aiming at the perfect solution on the first go" (OECD 1985, 113).

8.4 POSSIBLE IMPLEMENTATION PROBLEMS

Policy is effective only to the extent that it can predict peoples' reactions. People are, however, fairly unpredictable. Unpredictability is particularly prevalent when a large number of options are available. It is important to remember that people have a wide variety of choices even with the implementation of any of the suggested policies. People may not necessarily react to policy changes by reducing their automobile travel. Drivers' reactions can include switching mode, changing time of travel or route, foregoing the trip entirely, or paying the newly imposed toll or fee (OECD 1985, 95).
The key to changing peoples' behavior is really to change their attitudes. If public attitudes are changed, then public policies may not even be necessary. Without a change in attitude, it is actually unlikely that public policies to reduce roadway land consumption will even be implemented. After all, the steps that would be required to reduce the Greater Vancouver region's consumption of land for roads would not likely be politically or socially popular. Politicians implementing severely unpopular measures would not likely be re-elected. The policies implemented by unpopular politicians would therefore be rather short-lived.

Full road-pricing is not likely to be politically popular. Even in Sweden, where government control is fairly widespread, road-pricing is ranked as the least desirable method of reducing traffic. Table 7 shows Stockholm politicians' and administrators' relative preferences for various policy methods of reducing traffic.
It is interesting to see that the least intrusive methods generally receive the most acceptance. Incentives appear more acceptable than disincentives. The OECD concludes that "the lesson seems to be that one should start on a small scale and make gradual extension of whatever road pricing device is chosen. People have to get used to paying directly for road use, and it has to be demonstrated that the price system works without too much administrative cost. The gradual approach has a greater chance of eventual success than aiming at the perfect solution on the first go" (OECD 1985, 113).

It is important to remember that there are reasons for peoples' current behaviour. Many people live in the suburbs and commute vast distances because the suburbs are the only place where they can afford the home and the lifestyle that they desire. Increasing the costs of driving would force changes. Some of these changes may not be considered particularly desirable. By increasing the costs of driving, the total costs of living in the suburbs and the total costs of living closer to work might be made more equal. However, this new, more "equal" cost may still be higher than the cost of currently living in the suburbs. Presuming that incomes do not change, this new higher cost may not be affordable to some people. To make ends meet, people may have to resort to other changes such as car-pooling, taking transit, or finding jobs closer to where they live. Such changes are usually considered disruptive and unpleasant.
For real change to occur, rather significant life-style changes would have to be accepted. Life-style changes are never easy nor are they usually particularly popular when they are made necessary by political decisions. Garret Hardin has commented that "infringements made in the distant past are accepted because no contemporary complains of a loss. It is the newly proposed infringements that we vigorously oppose; cries of 'rights' and 'freedom' fill the air. But what does 'freedom' mean? Individuals locked into the logic of the commons are free only to bring on universal ruin; once they see the necessity of mutual coercion, they become free to pursue other goals" (Hardin 1968, 1248). This is something that Vancouver's *Clouds of Change* (1990) report commented on. In that report it was stated that: "without a major initiative of public discussion and education, efforts to reduce emissions of atmospheric pollutants will be seen by many as an infringement of 'my' individual 'freedom' to, for example, commute to work in my car by myself. With substantial discussion and involvement, most people will realize that our most important shared 'freedom' is literally our freedom to breathe" (City of Vancouver, 1990, p. 67).

To facilitate implementation, it is suggested that the positive aspects of change be emphasized. One benefit would be that congestion would be reduced and land that might otherwise be used for roads could be used for other purposes. Also, the revenue collected from directly charging drivers for road use, could be used to reduce other taxes. Small suggested a further benefit when he said that policies such as those recommended could restore the highway system "as a functioning component of the system of urban production, making the entire urban economy run more smoothly and providing its members with higher incomes" (Small et al. 1989, p. 86). While on the surface, the recommended policies may appear rather draconian, that initial impression can be softened by stressing the significant advantages of such policies.

No policy will have a lasting impact unless the majority of the public supports it. Downs has suggested that three requirements must be met before the recommended policies can be successful. First, traffic congestion must be perceived as enough of a problem that people will
look for a cure. Second, the public must understand that only a "rather painful cure will work". Third, anticongestion feelings must be strong enough to cause politicians to act (Downs 1992, 164). Currently, it would seem that the first condition has been met: people are indeed aware that a problem exists. The second and third conditions have not been met. Many people are still under the impression that problems can be solved by constructing more roads. Before the public can support "demand side" measures, they must have increased knowledge of both the costs of roads and the futility of catering to the insatiable demand for more roads. This thesis is a compilation of information that could be used to increase such knowledge.
9.0 CONCLUSION

Society must ultimately decide whose rights and what rights are most important. It would appear that current land use patterns cannot continue without significant effects upon the quality of life of both current and future generations, not just in the Lower Mainland, but also in more distant locations. Are Lower Mainland residents willing to sacrifice vast amounts of land to continue to enjoy the individual privileges of driving? Should governments continue to meet the insatiable demands of automobile drivers or should they instead adopt a broader approach to transportation—an approach in which access to transportation is considered a necessary right, but one in which that transportation need not always be in the form of an automobile?

There is considerable evidence that the Greater Vancouver region’s reliance on automobiles is incurred at significant cost. These costs can be reduced if certain changes are brought about. A major barrier to change has been the lack of a perfect alternative. Garret Hardin has summarized the constant battle between change and the status quo. He stated that "it is one of the peculiarities of the warfare between reform and the status quo that it is thoughtlessly governed by a double standard—automatic rejection of proposed reforms is based on one of two unconscious assumptions: (i) that the status quo is perfect (ii) that the choice we face is between reform and no action; if the proposed reform is imperfect, we presumably should take no action at all, while we wait for a perfect proposal" (Hardin 1968, 1247). The status quo is obviously not perfect. There is at least the option of gradually implementing changes that would decrease automobile usage. Given the high costs of our current automobile dependence and the vast benefits of reducing this dependence, does it not at least make sense to try?

A more realistic assessment of the land costs associated with existing and proposed roads will hopefully prod society onto using limited resources in a manner that will confer the greatest benefits upon both present and future citizens.
BIBLIOGRAPHY


_Land Titles Act._ RS Chap. 219.


### APPENDIX 1:
SUMMARY OF ESTIMATED ROADWAY LAND VALUES, BY MUNICIPALITY

<table>
<thead>
<tr>
<th>ROAD NAME</th>
<th>LENGTH (km)</th>
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<th>VALUE ($/ha)</th>
<th>TOTAL VALUE</th>
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<td>48,000</td>
<td>$2,044,400</td>
<td>$9,813,120</td>
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<tr>
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<td>70</td>
<td>702,100</td>
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<td>$52,882,172</td>
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<tr>
<td>Knight St.</td>
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<td>75</td>
<td>533,250</td>
<td>$1,291,200</td>
<td>$68,853,240</td>
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<td>Annacis Is. Hwy.</td>
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<td>70</td>
<td>122,500</td>
<td>$1,216,956</td>
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<tr>
<td>Richmond Freeway</td>
<td>31.00</td>
<td>24</td>
<td>744,000</td>
<td>$1,076,000</td>
<td>$80,054,400</td>
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<tr>
<td>No3 Road&amp;Bridgeport</td>
<td>3.7</td>
<td>20</td>
<td>74,370</td>
<td>$982,000</td>
<td>$7,303,134</td>
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<td><strong>Subtotal</strong></td>
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<td></td>
<td></td>
<td></td>
<td><strong>$233,813,777</strong></td>
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</tbody>
</table>

... continued
### APPENDIX 1 continued . . .

<table>
<thead>
<tr>
<th>ROAD NAME</th>
<th>LENGTH (km)</th>
<th>WIDTH ROAD AREA (m)</th>
<th>ROAD AREA (m²)</th>
<th>VALUE ($/ha)</th>
<th>TOTAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>Campbell River Rd.</td>
<td>1.61</td>
<td>20</td>
<td>32,361</td>
<td>$354,000</td>
<td>$1,145,579</td>
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<td>10.04</td>
<td>26</td>
<td>261,040</td>
<td>$604,712</td>
<td>$15,785,402</td>
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<td>Scott Rd. (east side)</td>
<td>11.33</td>
<td>10</td>
<td>113,300</td>
<td>$831,748</td>
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<tr>
<td>Ladner-Langley Hwy.</td>
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<td>26</td>
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<td>Vancouver-Blaine Hwy.</td>
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<td>61</td>
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<td>Trans-Canada Hwy.</td>
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<td>75</td>
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<td>King George Hwy.</td>
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<td>Fraser Hwy.</td>
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<td>20</td>
<td>283,008</td>
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<td>Ladner-Langley Hwy.</td>
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<td>26</td>
<td>25,220</td>
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<td>Pacific Hwy.</td>
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<td>56</td>
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<td>Campbell River Rd.</td>
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<td>20</td>
<td>48,441</td>
<td>$354,000</td>
<td>$1,714,811</td>
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<td>Marine Dr. etc</td>
<td>9.25</td>
<td>20</td>
<td>185,925</td>
<td>$1,740,968</td>
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<tr>
<td>152 Street</td>
<td>2.41</td>
<td>27</td>
<td>64,588</td>
<td>$1,483,804</td>
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<td>$417,043,318</td>
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<td>VANCOUVER</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cassiar Connector</td>
<td>6.90</td>
<td>30</td>
<td>210,315</td>
<td>$5,380,000</td>
<td>$113,149,232</td>
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<td></td>
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</tr>
<tr>
<td>Trans Canada Hwy.</td>
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<td></td>
<td></td>
<td></td>
<td>$99,384,382</td>
</tr>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Trans Canada Hwy.</td>
<td>12.31</td>
<td>60</td>
<td>738,600</td>
<td>$2,690,000</td>
<td>$198,683,400</td>
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<td>Fern St.</td>
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<td>20</td>
<td>48,240</td>
<td>$2,367,200</td>
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<td>Mt. Seymour Pk. Rd.</td>
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<td>251,250</td>
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<td>117,000</td>
<td>$3,443,200</td>
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<tr>
<td>WEST VANCOUVER</td>
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<td></td>
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<td></td>
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<tr>
<td>Marine Dr. Addition</td>
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<td>2,080</td>
<td>$4,734,400</td>
<td>$984,755</td>
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<tr>
<td>Taylor Way</td>
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<td>55</td>
<td>62,150</td>
<td>$2,259,600</td>
<td>$14,043,414</td>
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<tr>
<td>Garibaldi Hwy.</td>
<td>5.31</td>
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<td>159,300</td>
<td>$215,200</td>
<td>$3,428,136</td>
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<tr>
<td>Marine Dr.</td>
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<td>13</td>
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<td>$4,923,776</td>
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<tr>
<td>Trans Canada Hwy.</td>
<td>30.83</td>
<td>50</td>
<td>1,541,500</td>
<td>$3,120,400</td>
<td>$481,009,660</td>
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<td>CypressBowl Pk Rd.</td>
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<td>50</td>
<td>245,000</td>
<td>$215,200</td>
<td>$5,272,400</td>
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<td>Subtotal</td>
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<tr>
<td>WHITE ROCK</td>
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<tr>
<td>Marine Dr.</td>
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<td>$26,958,068</td>
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<tr>
<td>GRAND TOTAL</td>
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<td></td>
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<td>$3,660,923,687</td>
</tr>
</tbody>
</table>

**Notes:** (1) The widths given are for right-of-ways, which include the actual road and the shoulders, ditches, and other land that must be purchased before a road can be constructed.

Data sources: Ministry of Transportation and Highways (road names and road lengths), BC Assessment Authority (approximate land values)
APPENDIX 2:
SAMPLE MILL RATES, BY MUNICIPALITY
(per thousand dollars assessed value)

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Residential</th>
<th>Business</th>
<th>Light Industrial</th>
<th>Major Industrial</th>
<th>Farmland</th>
</tr>
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<tbody>
<tr>
<td>Burnaby</td>
<td>8.8</td>
<td>26.2</td>
<td>31.0</td>
<td>42.0</td>
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<tr>
<td>Delta</td>
<td>27.2</td>
<td>31.0</td>
<td>28.9</td>
<td>34.0</td>
<td></td>
</tr>
<tr>
<td>Annacis</td>
<td>12.1</td>
<td>30.1</td>
<td>31.1</td>
<td>35.4</td>
<td>16.9</td>
</tr>
<tr>
<td>Ladner</td>
<td>12.0</td>
<td>27.8</td>
<td>16.5</td>
<td>29.9</td>
<td>29.9</td>
</tr>
<tr>
<td>North Delta</td>
<td>11.5</td>
<td>28.2</td>
<td>28.3</td>
<td>34.4</td>
<td>18.1</td>
</tr>
<tr>
<td>South Delta</td>
<td>12.0</td>
<td>27.8</td>
<td>28.3</td>
<td>34.4</td>
<td>18.1</td>
</tr>
<tr>
<td>District of Langley</td>
<td>11.6</td>
<td>27.2</td>
<td>29.7</td>
<td>29.9</td>
<td>13.9</td>
</tr>
<tr>
<td>North Vancouver</td>
<td>9.0</td>
<td>22.3</td>
<td>30.7</td>
<td>36.8</td>
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<tr>
<td>Port Moody</td>
<td>10.5</td>
<td>29.7</td>
<td>39.0</td>
<td>49.7</td>
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</tr>
<tr>
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<td>10.2</td>
<td>25.7</td>
<td>26.6</td>
<td>29.9</td>
<td>13.9</td>
</tr>
<tr>
<td>West Vancouver</td>
<td>8.6</td>
<td>22.9</td>
<td>24.5</td>
<td>26.7</td>
<td></td>
</tr>
<tr>
<td>Coquitlam</td>
<td>9.9</td>
<td>29.1</td>
<td>33.2</td>
<td>43.4</td>
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</tr>
<tr>
<td>Langley</td>
<td>12.4</td>
<td>23.7</td>
<td>24.6</td>
<td>24.9</td>
<td>13.5</td>
</tr>
<tr>
<td>New Westminster</td>
<td>11.3</td>
<td>29.5</td>
<td>38.2</td>
<td>41.6</td>
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</tr>
<tr>
<td>North Vancouver</td>
<td>9.9</td>
<td>23.8</td>
<td>36.3</td>
<td>45.8</td>
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</tr>
<tr>
<td>Port Coquitlam</td>
<td>11.2</td>
<td>29.5</td>
<td>31.1</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>Richmond</td>
<td>8.8</td>
<td>22.0</td>
<td>32.0</td>
<td>33.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Vancouver</td>
<td>7.6</td>
<td>28.8</td>
<td>39.6</td>
<td>42.0</td>
<td></td>
</tr>
<tr>
<td>White Rock</td>
<td>6.0</td>
<td>13.1</td>
<td></td>
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</tr>
</tbody>
</table>

Data Source: Tax Departments of respective municipalities
# APPENDIX 3:
DOWN'S RATINGS OF POLICIES FOR REDUCING TRAFFIC CONGESTION

<table>
<thead>
<tr>
<th>Policy A</th>
<th>Effectiveness</th>
<th>Costs</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extent</td>
<td>Impact</td>
<td>Direct to</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>commuters</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Supply Side

- **Rapidly removing accidents**
  - Extent: Variable
  - Impact: Great
  - Costs: None
  - To all: Minor
  - Required: None
  - Implement: None
  - Ease: Easy
  - Political: Good

- **Improving Highway Maintenance**
  - Extent: Broad
  - Impact: Moderate
  - Costs: None
  - To all: Moderate
  - Required: None
  - Implement: Cooperative
  - Ease: Hard
  - Political: Moderate

- **Building added HOV lanes**
  - Extent: Variable
  - Impact: Moderate
  - Costs: None
  - To all: Moderate
  - Required: None
  - Implement: Cooperative
  - Ease: Hard
  - Political: Poor

- **Upgrading City Streets**
  - Extent: Variable
  - Impact: Moderate
  - Costs: None
  - To all: Moderate
  - Required: None
  - Implement: Cooperative
  - Ease: Hard
  - Political: Poor

- **Building new off-road transit systems, expanding existing ones**
  - Extent: Narrow
  - Impact: Minor
  - Costs: Minor
  - To all: Moderate
  - Required: None
  - Implement: Cooperative
  - Ease: Hard
  - Political: Poor

- **Increasing public transit usage by improving service, amenities**
  - Extent: Narrow
  - Impact: Minor
  - Costs: None
  - To all: Moderate
  - Required: None
  - Implement: Cooperative
  - Ease: Hard
  - Political: Poor

- **Coordinating signals, TV monitoring ramp signals, electronic signs, converting streets to one-way**
  - Extent: Narrow
  - Impact: Minor
  - Costs: None
  - To all: Minor
  - Required: None
  - Implement: Moderate
  - Ease: Good
  - Political: Poor

## Demand Side

- **Instituting peak-hour tolls on main roads**
  - Extent: Broad
  - Impact: Great
  - Costs: Great
  - To all: None
  - Required: Regional
  - Implement: Moderate
  - Ease: Poor
  - Political: Poor

- **Parking tax on peak-hour arrivals**
  - Extent: Broad
  - Impact: Great
  - Costs: Great
  - To all: None
  - Required: Regional
  - Implement: Hard
  - Ease: Poor
  - Political: Poor

- **Eliminating income tax deductability of providing free employee parking**
  - Extent: Broad
  - Impact: Great
  - Costs: Great
  - To all: None
  - Required: Cooperative
  - Implement: Moderate
  - Ease: Poor
  - Political: Poor

- **Providing income tax deductability for commuting allowance for all workers**
  - Extent: Variable
  - Impact: Great
  - Costs: None
  - To all: Minor
  - Required: None
  - Implement: Easy
  - Ease: Poor
  - Political: Poor

- **Increasing gasoline taxes**
  - Extent: Broad
  - Impact: Moderate
  - Costs: Moderate
  - To all: Minor
  - Required: None
  - Implement: Easy
  - Ease: Poor
  - Political: Poor

- **Keeping densities in new growth areas above minimal levels**
  - Extent: Broad
  - Impact: Moderate
  - Costs: Minor
  - To all: Minor
  - Required: Regional
  - Implement: Hard
  - Ease: Poor
  - Political: Poor

- **Encouraging formation of TMAs, promoting ride-sharing**
  - Extent: Narrow
  - Impact: Moderate
  - Costs: None
  - To all: Minor
  - Required: Cooperative
  - Implement: Hard
  - Ease: Moderate
  - Political: Poor

- **Encouraging people to work at home**
  - Extent: Broad
  - Impact: Minor
  - Costs: None
  - To all: None
  - Required: None
  - Implement: Moderate
  - Ease: Good
  - Political: Poor

- **Changing federal work laws that discourage working at home**
  - Extent: Broad
  - Impact: Minor
  - Costs: Minor
  - To all: Minor
  - Required: None
  - Implement: Moderate
  - Ease: Moderate
  - Political: Moderate

- **Staggering work hours**
  - Extent: Variable
  - Impact: Minor
  - Costs: None
  - To all: Cooperative
  - Required: Moderate
  - Implement: Moderate
  - Ease: Moderate
  - Political: Moderate

- **Clustering high-density housing near transit station stops**
  - Extent: Narrow
  - Impact: Minor
  - Costs: None
  - To all: Cooperative
  - Required: Moderate
  - Implement: Hard
  - Ease: Moderate
  - Political: Moderate

- **Concentrating jobs in big clusters in areas of new growth**
  - Extent: Narrow
  - Impact: Minor
  - Costs: Great
  - To all: Regional
  - Required: Hard
  - Implement: Poor
  - Ease: Poor
  - Political: Poor

- **Increasing automobile license fees**
  - Extent: Broad
  - Impact: Moderate
  - Costs: Moderate
  - To all: Minor
  - Required: None
  - Implement: Easy
  - Ease: Poor
  - Political: Poor

- **Improving the jobs-housing balance**
  - Extent: Broad
  - Impact: Moderate
  - Costs: Moderate
  - To all: Regional
  - Required: Hard
  - Implement: Poor
  - Ease: Poor
  - Political: Poor

- **Adopting local growth limits**
  - Extent: Narrow
  - Impact: Minor
  - Costs: None
  - To all: None
  - Required: None
  - Implement: Easy
  - Ease: Good
  - Political: Poor

---

*a. Policies are listed within categories in descending order of effectiveness*