SUBURB-TO-SUBURB COMMUTING AND TRANSIT PLANNING:

A CASE STUDY OF SURREY, B.C.

by

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ABSTRACT

Rapid growth in suburb-to-suburb commuting has created a problem for transit providers: the dispersed commuting patterns are very difficult to serve with transit, and are characterized by low transit use. This thesis aims to determine which markets have the best potential for transit, and what factors could increase this potential.

Surrey, B.C. is typical of the rapidly growing areas where suburb-to-suburb commuting is most prevalent. Commuting between Surrey and other suburban areas has increased sharply in recent years. A detailed examination of commuting patterns within Surrey revealed the highly dispersed nature of the work trip flows; the only flows which were concentrated to any degree were those between nodes with relatively high population and employment densities. A correlation was found between density, especially employment density, and transit use. Inter-nodal trips, which already have the greatest transit use among suburb-to-suburb trips, will be a key market for transit in the suburbs. Inter-nodal express service would help to address complaints that suburb-to-suburb transit service is too slow and indirect. Trips to and from the nodes will also be an important market. Intra-nodal trips, which presently have low transit use, form another key market which could possibly be served by a paratransit shuttle service. In Surrey, efforts have begun to address the issue of suburb-to-suburb transit in a comprehensive manner, but there has been little substantive progress to date.

The case study results were used to develop a conceptual framework for suburb-to-suburb transit planning which could then be applied to other suburban areas facing similar problems. The framework calls for a wide array of transit and paratransit services, each filling a different market niche, which can be combined to create an integrated but flexible system. This system must be reinforced with land use strategies to promote greater densities, and more pedestrian and transit friendly design. Transportation demand management must also be used to encourage transit use by increasing the costs of driving an automobile. This three-pronged, comprehensive approach should allow transit to compete successfully in some suburban markets.

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GLOSSARY

Census metropolitan area (CMA) This is defined by Statistics Canada as a large urbanized core and adjacent urban and rural areas with a high degree of economic and social integration. It is used for statistical purposes.

Density Densities quoted in this thesis refer to gross densities, calculated by dividing the population or employment of some geographic unit by its total area. Net residential densities, which exclude vacant and other non-residential land, would be considerably higher.

Greater Vancouver Regional District (GVRD) This is a form of regional government made up of the eighteen municipalities and two electoral areas in Greater Vancouver. It has specified powers and functions, including transportation modelling and forecasting.

High occupancy vehicle (HOV) Usually refers to a vehicle with three or more occupants. This could be a car or vanpool, or a transit vehicle.

Single occupant vehicle (SOV) A private automobile with just one occupant, the driver.

Suburb As used here, this refers to any part of a metropolitan area outside the legally defined central city.

Suburb-to-suburb commute This is a trip which begins in one suburban area, and ends in the same or another suburban area.

Suburban Node This is a concentration of office, retail, residential, and other uses located in a suburban area. These have been called suburban employment centres, edge cities, regional town centres.

Transportation demand management (TDM) This involves a wide range of strategies aimed at changing people's travel behavior in order to reduce vehicle travel and congestion. This is accomplished by reducing the total number of trips made, shifting trips from single occupant vehicles to other modes, and lowering demand during peak periods.

Traffic zone (TZ) This is a small geographic unit used for transportation modelling and forecasting. The traffic zones used in this thesis are the same as those used by the Greater Vancouver Regional District in the *1985 Metropolitan Vancouver Origin-Destination Survey*.

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CHAPTER 1. INTRODUCTION

1.1 Problem Statement

Population and employment growth in the suburbs has long outstripped that of the central city, and suburban areas now account for not only the majority of residents, but also the majority of jobs in major North American metropolitan areas. As a result, suburb-to-suburb commuting has become increasingly dominant while the traditional commute to the central city continues to decline in importance.

This trend has some serious implications for the provision of transit service. Most suburban areas were built after the Second World War and consist of low-density, automobile-oriented development. In contrast to the single, compact employment centre of the traditional CBD, suburban employment tends to be much less concentrated and is generally scattered over numerous locations. Added to this is the rapid growth of service sector employment, which tends to be highly dispersed. The resulting commuting pattern is much more difficult to serve by public transit than a downtown-oriented radial pattern (which most transit systems have invested heavily in serving). Although the total number of suburb-to-suburb commuters is large, the highly dispersed nature of the trips means that the number of commuters on any one route is usually too low to be economically served by conventional transit. Because of this, most suburb-to-suburb transit commuters are faced with much poorer transit service than those bound for the central city: low service frequencies, lack of direct routes and inconvenient transfers are common. By contrast, the automobile is very convenient for suburb-to-suburb trips, and it is here that it has its greatest speed advantage over transit. Incentives such as free parking at virtually all suburban workplaces only add to the attractiveness of driving. As a result, transit accounts for only a very small fraction of suburb-to-suburb commutes.

Suburb-to-suburb commuting is not a new phenomenon; even in the late 1950s it was becoming important in some cities (Taaffe et al 1963). Taaffe compared travel patterns of commuters who worked in Chicago's western suburbs (referred to as "peripheral commuters") with those who worked in the CBD. The major finding of this study was the high degree of automobile dependence displayed by peripheral commuters. The mode split for CBD-bound commuters was 69 percent by transit and 30 percent by automobile, while for peripheral commuters the split was only 9 percent by transit and an overwhelming 84 percent by automobile (p. 122). Taaffe also found that suburban employees lived much closer to their work places than did CBD employees.

Many of the trends identified by Taaffe have become much more pronounced in recent decades. Pisarski (1987) undertook a comprehensive study of changes in U.S. commuting patterns between 1950 and 1980. He found that three major trends have affected commuting patterns during this period. The first major trend has been a 65 percent increase in the labor force due to population growth and an increasing participation rate. Secondly, more than two-thirds of both population and employment growth has been concentrated in the suburbs. Finally, there has been a boom in automobile use as vehicle availability per household increased from 1.0 in 1960 to 1.6 in 1980 despite shrinking household size. Collectively, these three trends have created an explosion in automobile commuting, particularly in the suburbs. The automobile's share of work trips increased from 70 percent in 1960 to 84 percent in 1980, while transit's share decreased from 12.6 percent to 6.2 percent (p. 6). Information from the recent 1990 U.S. Census indicates that this trend has continued with the automobile's share increasing to 87 percent and transit's share declining to 5.3 percent (Barringer 1992).

Some of Pisarski's findings are summarized in Table 1.1. He found that the suburb-to-suburb work trip was the fastest growing type of commute, accounting for 58 percent of commute growth between 1960 and 1980, and increasing its share of total commuting flows from 29 to 40 percent during the period. Commutes within the central city declined from 49 to 33 percent of the total during

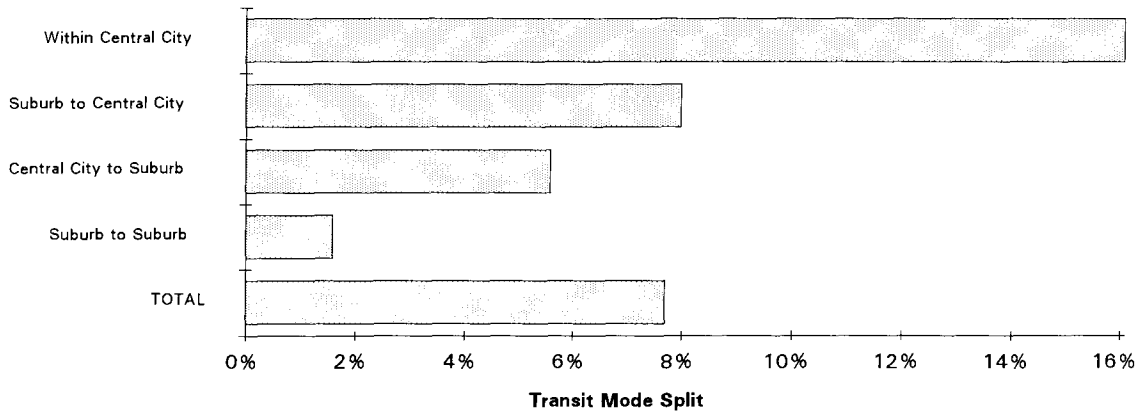
the same period. In metropolitan areas with more than 1 million people, suburb-to-suburb commutes accounted for 45 percent of trips in 1980 (p. 40). In fact, these numbers underestimate the growth of suburb-to-suburb commuting since many rapidly growing sunbelt cities include suburban areas within the boundaries of the central city. Between 1960 and 1980 the absolute number of suburb-to-suburb automobile commuters more than doubled, from about 10 million to over 25 million.

Table 1.1 Summary of U.S. Metropolitan Area Work Trip Flows, 1960-80.

Type of Flow	1960		1980		Percent Increase
	Trips (millions)	Percent of Total	Trips (millions)	Percent of Total	1960-80
Within Central City	18.8	48.6%	20.9	33.1%	11.2%
Central City to Suburb	2.0	5.2%	4.2	6.7%	110.0%
Suburb to Central City	6.6	17.1%	12.7	20.1%	92.4%
Suburb to Suburb	11.3	29.2%	25.3	40.1%	123.9%
TOTAL	38.7	100.0%	63.1	100.0%	63.0%

The problem for the transit industry is that this fastest growing segment of the commuter market is also the least likely to use public transit. Figure 1.1, which is again based on Pisarski's findings, clearly illustrates this. People who commuted to central cities in 1980 were six times more likely to use transit as those commuting to suburban jobs. Overall, transit's share of suburb-to-suburb trips was only 1.6 percent (Pisarski 1987, 40).

Figure 1.1 Transit Mode Split by Type of Commute



Another trend during this period, noted by Rosenbloom (1990), is the increasing number of elderly and poor that are living in suburban areas. These groups are often captive transit riders and there is a strong argument that government has an obligation to provide transit services for these groups so that they may better take advantage of the social services and employment opportunities that are increasingly located in the suburbs.

Suburban transportation problems emerged as a major issue during the 1980s, as growth in suburban traffic far exceeded any increases in the capacity of transportation infrastructure. In many high growth areas, what were once country roads are now major commuter routes. Between 1982 and 1987, the suburbs' share of metropolitan office space in the U.S. increased from 43 to 58 percent, and in some cities such as Phoenix, more than 90 percent of office space is in the suburbs (Cervero 1984, 536). Much of this development over the past 15 years has located in so-called suburban employment centres, concentrations of office, retail, and other uses which became a part of the suburban landscape of many cities. While these suburban employment centres have probably been the most severely affected, the rise in suburb-to-suburb commuting has created transportation problems throughout the suburbs.

1.2 Purpose

With suburban areas continuing to outpace central cities in population and employment growth, suburb-to-suburb commuting will likely become even more dominant in the future. If we wish to reduce our dependence on the automobile and the problems that go with it, we clearly have to address this problem.

According to a report by the Transportation Research Board (1987, 94), a research priority in the area of public transit should be to determine "...the circumstances most conducive to service reconfiguration and the service delivery patterns most cost-effective for targeting new [suburban]

markets...". This thesis will look at the growth of suburb-to-suburb commuting and investigate how such trips can be better served by transit. The central hypothesis for the thesis is that it is impossible for transit to comprehensively serve the entire suburb-to-suburb commuting market but that it can successfully compete with the automobile in certain niche markets. Transit's success in these markets can be enhanced with a variety of planning strategies. Specific objectives for the thesis include the following:

1. To look at the implications for transit of increased suburb-to-suburb commuting.

2. To determine which sub-markets of suburb-to-suburb commuting are the best candidates for transit service, and to determine what types of transit/paratransit service would be most suitable for each market niche.

3. To determine what strategies are most effective for increasing suburb-to-suburb transit use including the following:
   a) changes in land use such as employment or residential densities
   b) transportation demand management strategies such as road pricing or parking controls.

4. To investigate how different land use and trip characteristics such as population density or commute length affect transit use.

5. To study specifically the situation in Greater Vancouver and in Surrey as to how well suburb-to-suburb commutes are being served by transit and what improvements could be made

6. To derive from these investigations a conceptual framework for suburb-to-suburb transit planning.

1.3 Methodology

The first part of this thesis involves a review of relevant literature on public transit and suburb-to-suburb commuting. The next part of the thesis will be a case study of Surrey. Background information on commuting trends in Greater Vancouver and in Surrey will be collected, followed by more detailed information on suburb-to-suburb commuting in Surrey. Rather than attempt to collect original data, existing data on commuting and transit in Greater Vancouver will be used, including the *Metropolitan Vancouver Origin-Destination Survey* (GVRD 1987) and BC Transit's *Usage and Attitude Survey* (1992). Suburb-to-suburb commuting patterns in Surrey will be analyzed and potential markets for transit service will be identified. The relationship between transit use and density will also be further explored. In addition, a brief survey of planning agencies will determine what strategies are presently being employed in Surrey to deal with this issue. The results of the case study will be used to determine which transit strategies would be most effective for Surrey. From this process, a conceptual framework for suburb-to-suburb transit planning will be developed.

1.4 Assumptions and Limitations

The term "suburb-to-suburb" is used throughout this thesis to describe a trip that originates in one suburb and ends in the same or a different suburb. The emphasis here will be on those suburb-to-suburb trips which do not follow traditional radial commuting flows since these present the greatest challenge for transit. Such trips are sometimes termed circumferential commutes. It should also be noted that a suburb is defined here as any part of a metropolitan area outside of the central city. As was mentioned earlier, this can result in problems of comparability since the legal boundaries of the central city do not always coincide with what is "urban" versus "suburban" in character.

This study will be looking at work trips only. There are several reasons for this. Work trips account for the largest single travel demand, about 31 percent of all vehicle travel in Greater

Vancouver in 1985 (GVRD 1987). Their importance is further magnified because they tend to be concentrated during the two peak periods, and most transportation capacity problems are associated with these peaks. Due to the less variable nature of work trips, they are generally easier to serve with transit than any other trip type. Thus, this would be the logical first step in providing suburb-to-suburb transit service. A more practical reason for confining this study to work trips is that there is more accurate data available for these.

Most of the available literature on this topic is American; there are few Canadian studies from which to draw. Given the important cross-national differences between U.S. and Canadian cities in many aspects of transportation and urban form (Goldberg and Mercer 1986), it will be of interest to determine if the trends in suburb-to-suburb commuting documented in American cities also apply to Canada.

1.5 Thesis Organization

Chapter 2 reviews the literature that relates public transit and land use characteristics, and how land use planning can be used to encourage transit use.

Chapter 3 includes a review of the literature on the problems transit faces in the suburbs, the types of transit and paratransit that can be used for suburb-to-suburb commuting, and transportation demand management strategies which can be used to increase transit use.

Chapter 4 provides a general overview of Surrey and Greater Vancouver, the transportation system, and recent commuting trends and patterns.

Chapter 5 analyzes the suburb-to-suburb commuting flows in Surrey and determines which would be best suited for transit service. It also looks at the relationship between transit use and density.

Chapter 6 takes a look at the response in Surrey to the problem of increased suburb-to-suburb commuting. It also looks at public attitudes towards suburban transit.

Chapter 7 presents a discussion of the results from the Surrey case study, leading to the development of a conceptual framework for suburb-to-suburb transit planning.

Chapter 8 offers conclusions and the planning implications of the thesis, as well as recommendations for further study.

CHAPTER 2. LAND USE AND PUBLIC TRANSIT

2.1 The Relationship Between Transit and Land Use

There is clearly an important two-directional relationship between transportation and patterns of urban land use. New transportation modes have helped shape the historical development of cities, but at the same time, the success of these modes has depended on the land use environment in which they are operating. Transit is particularly sensitive to land use because it is less flexible than the automobile. Thus, transit faces a serious challenge operating in the low density environment of today's suburbs.

Deakin (1991) reviewed the land use/transportation literature. She first looks at the impact of transportation on land use and concludes that new transportation facilities can have an impact on land use patterns, but the magnitude of this impact is unclear. In terms of new transit facilities, she agrees with other authors (Knight and Trygg 1977; Taebel and Cornehls 1977) that supportive factors must be present for these impacts to occur. Perhaps more applicable to this study, Deakin also looks at the effect that land use can have on transportation demand, in particular she looks at the effect of government land use policies. She points to this as a prime area for future research. Most studies to date have focussed on specific projects and how such factors as density, development size, land use mix, and design features can explain differences in travel patterns. To date, however, she finds there has not been sufficient work done in this area, and so there is little empirical evidence from which to draw any firm conclusions.

One of the most comprehensive studies on the basic relationships between transit demand and patterns of urban land use was undertaken by Pushkarev and Zupan (1977). This study helped to demonstrate some of the difficulties of providing transit in areas of low density sprawl. Pushkarev and Zupan looked at several U.S. cities, but focussed on the New York metropolitan region. In some

ways this is a unique case, although many of the basic relationships they discovered are applicable elsewhere. They found a strong relationship between transit use and two aspects of urban form: residential density and the presence of large, high density central business district (CBD). Differences in population density could explain 57 percent of the variation in transit use, and when combined with differences in CBD size, could explain 79 percent of the variation (p. 26).

Their study showed that increasing residential density both increased transit use and reduced automobile use. As residential densities increase, the number of potential transit riders in a given area increases, allowing service levels to be raised. The better service, in turn, attracts even more riders, further increasing transit use and creating a positive feedback loop. The result is an exponential increase in the number of riders in a given area as densities increase. Pushkarev and Zupan found that in the U.S., no form of transit was economically feasible at densities below 3 dwelling units/acre (roughly equal to a gross density of 800 persons/km^2) except perhaps park and ride facilities. At these low densities, virtually all transit trips are to large downtowns. Transit use remained low up to densities of about 7 du/acre (2000 persons/km^2), but above this level there was a sharp increase in transit use, especially "local transit". A density of 15 du/acre (4500 persons/km^2), for example, could support frequent local bus service. The point at which transit use suddenly increases could represent some critical density above which the positive feedback loop goes into operation. Table 2.1 summarizes the relationship between residential density and the level of transit service supported.

Higher residential densities were also accompanied by a decrease in automobile use for work trips. For example, a ten-fold increase in density resulted in an 80 percent decrease in automobile use (p. 32). There was also a closely related decrease in automobile ownership rates. This is in part due to the increased attractiveness of transit because of the generally higher service levels in high density areas. Walking may also become an attractive alternative to driving at higher densities, since travel distances are generally much shorter. Automobile use may be further discouraged at high densities

Table 2.1 Transit Modes Related to Residential Density

Mode	Service	Minimum Necessary Residential Density (dwelling units per acre)	Remarks
Dial-a-bus	Many origins to many destinations	6	Only if labor costs are not more than twice those of taxis
Dial-a-bus	Fixed destination or subscription service	3.5 to 5	Lower figure if labor costs twice those of taxis; higher if thrice those of taxis
Local bus	"Minimum," ½ mile route spacing, 20 buses per day	4	Average, varies as a function of downtown size and distance from residential area to downtown
Local bus	"Intermediate," ½ mile route spacing, 40 buses per day	7	
Local bus	"Frequent," ½ mile route spacing, 120 buses per day	15	
Express bus —reached on foot	Five buses during two hour peak period	15 Average density over two square mile tributary area	From 10 to 15 miles away to largest downtowns only
Express bus —reached by auto	Five to ten buses during two hour peak period	3 Average density over 20 square mile tributary area	From 10 to 20 miles away to downtowns larger than 20 million square feet of nonresidential floorspace
Light rail	Five minute headways or better during peak hour.	9 Average density for a corridor of 25 to 100 square miles	To downtowns of 20 to 50 million square feet of nonresidential floorspace
Rapid transit	Five minute headways or better during peak hour.	12 Average density for a corridor of 100 to 150 square miles	To downtowns larger than 50 million square feet of nonresidential floorspace
Commuter rail	Twenty trains a day	1 to 2	Only to largest downtowns, if rail line exists

Source: *Public Transportation and Land Use Policy*, Pushkarev and Zupan, 1977.

because there is less space for storing and driving them and there tends to be more traffic congestion, further increasing the attractiveness of alternate modes.

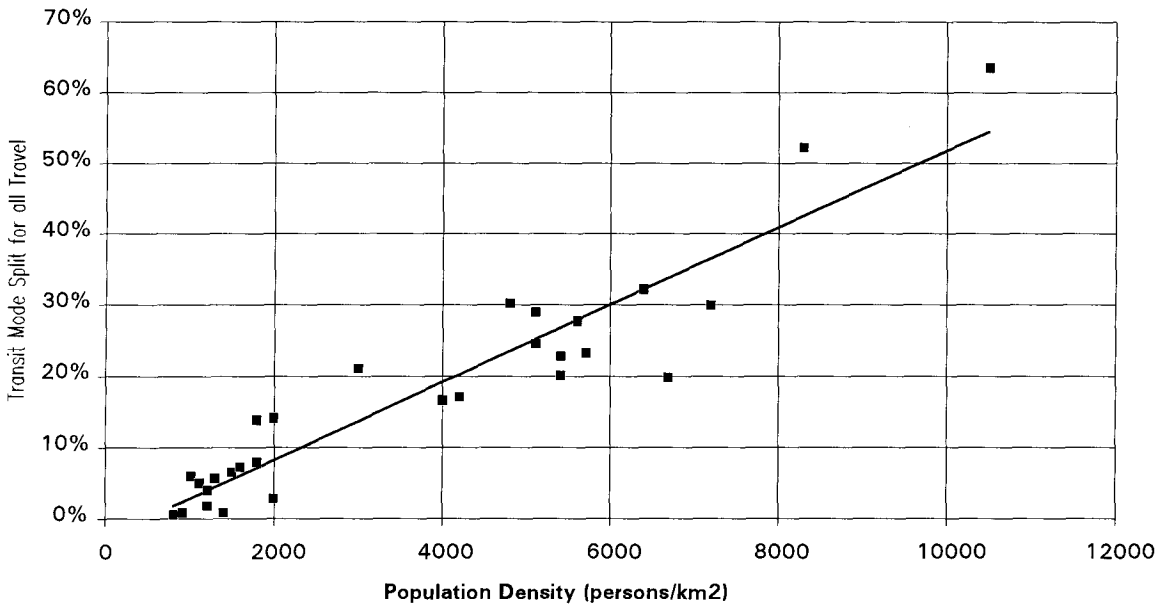
Pushkarev and Zupan also found that transit use for work or shopping trips to a non-residential node increased with the size and density of that node. They estimated that if a new downtown with 1 million m^2 of non-residential space were added to a community, transit ridership within a 5-8 km radius would be 50-70 percent higher than if the same amount of space was added as a traditional highway strip (p. 174). Changes in non-residential land use appeared to be even more important than increasing residential density. Doubling the size of a non-residential node from 1 to 2 million m^2 would increase transit use 3-4 times as much as doubling residential density from 15 to 30 du/acre (p.175). These findings agree with Hendrickson (1986) who found a strong correlation between transit use and the proportion of a region's labor force employed in the CBD, usually the largest and densest non-residential node in the city.

Newman and Kenworthy (1989) looked at various transportation and urban form parameters for 32 major cities in North America, Europe, Asia, and Australia. They found a strong positive correlation between population density and the proportion of total travel on transit. There was an even stronger correlation between transit use and job density. They also found a weaker but still significant correlation between transit use and percent of jobs in the CBD. These results support Pushkarev and Zupan's findings, and indicate that this strong relationship between transit use and urban form is not restricted to New York or even the United States. Figure 2.1 uses data Newman and Kenworthy collected from the 32 world cities to illustrate the relationship between population density and transit use.

What is the explanation for this relationship between transit use and non-residential land use characteristics? Large, dense nodes can best support frequent and convenient transit service, while at the same time, congestion and lack of parking often makes them relatively inconvenient for the

automobile driver. The effect of these nodes in encouraging transit use appears to decline rapidly with distance, so residential areas located close to these nodes will tend to have especially high levels of transit use. Thus putting more housing close to a downtown or a suburban node would be more effective than merely increasing densities throughout a region. For example, Pushkarev and Zupan found that doubling residential densities in an area from 5 to 10 du/acre would be 17 times more effective if the area is 1.5 versus 15 km from a 2 million m^2 non-residential node (p.175).

Figure 2.1 Population Density and Transit Use



It is clear from this discussion that transit will have a very difficult time competing in the low density environment of the suburbs. Increasing suburban residential densities should improve transit use, especially for local trips; however, higher employment densities appear to be even more important for improving transit's appeal. A combination of the two would likely be most effective.

2.2 Land Use Planning

Land use planning could be used to guide suburban development in a way that encourages greater transit use. This would involve promoting many of the urban form characteristics discussed

above, including higher population and employment densities, as well as greater centralization of employment (although not necessarily into a single centre). Several studies have looked at various types of urban form in order to determine which allows for the most efficient transportation system.

A study by Rice (1977) is particularly helpful because it looks at both highway and transit systems. Rice compared six urban forms (central core, homogeneous, multi-centred, radial corridor, linear, and satellite) using land use statistics from many cities to determine the land use configuration. He found that, overall, the multi-centred form resulted in the most efficient transportation system with the least number of person-hours for work trip travel and the shortest average work trip length. While transit use was not as high for the multi-centred model as for the central core, the radial corridor, or the linear forms, it was higher than for the homogeneous form, which probably most closely resembles the present situation in the suburbs.

Schneider (1981) looked at the role transit can play in encouraging the development of a polycentric urban form by providing enhanced accessibility to certain well defined nodes. In turn, Schneider believes, a city with several relatively high density nodes is better able to support an area-wide transit system since the high employment density in these nodes is easier to serve by transit, and makes transit use more attractive. If the nodes also include areas of high residential density, transit use among these residents, as Pushkarev and Zupan explained, can be very high. Thus the development of the polycentric city, which appears to be a natural market trend, should not be feared by the transit industry. Rather, it should be guided in such a way as to better support economical and efficient transit. In addition, the polycentric city has other advantages including reduced city-centre congestion, reduced total travel, and a greater degree of urbanity and self-sufficiency in the suburbs.

Schneider surveyed 46 metropolitan planning organizations throughout North America. He found that 36 of these had land use plans, with the majority envisioning a polycentric form for their cities (p. 50). The greatest amount of work and the most progress in implementing these plans was in

the two Canadian cities he surveyed, Vancouver and Toronto. In Vancouver, planning for a polycentric urban form was through the GVRD's Livable Region Program (1975). A similar plan was developed in Toronto by the Metro Toronto Planning Department (1976). A major goal of both plans was to create a balance of jobs and population in each part of the region. This would be accomplished by encouraging the development of suburban nodes. In Vancouver, these would consist of 4-6 regional town centres, while in Toronto, there would be a series of both major and minor centres. Thus, suburban residents could work and shop in their nearest centre, reducing the need to commute and relieving pressure on the transportation system.

Both plans would encourage suburban transit use through the creation of a more transit friendly urban form, with compact, mixed-use development in the nodes. In both cities, some of the major nodes would be linked with rapid transit, providing these nodes with good accessibility and helping to concentrate development in them. While the primary goal of the plans was to reduce commuting, they would make it easier for suburb-to-suburb commuters to travel by transit. Rapid transit links between suburban centres would carry some suburb-to-suburb commuters, and express bus service between those centres not connected by rapid transit was also suggested. Clearly, such regional land use plans could play an important role in increasing suburb-to-suburb transit use.

2.3 Suburban Nodes

In the last decade, suburban non-residential development has shown an increasing tendency to form relatively high density clusters. These have been called suburban employment centres, edge cities, suburban downtowns, and numerous other variations, but here they will be referred to simply as suburban nodes. They are usually dominated by office development; however, retail, hotel, and other commercial uses are also common, and some suburban nodes have a residential component as well. Most major North American metropolitan areas now contain one or more suburban nodes. Because of this trend, a large amount of the literature on suburban transportation now focusses on the

problems associated with these suburban nodes. It is worthwhile to look at this information because suburban nodes will likely play a key role in suburb-to-suburb transit planning. The nodes will be important transit destinations in their own right, but with their relatively high densities, they may also be one of the few viable markets for transit in the suburbs.

Cervero has looked extensively at transportation problems related to suburban nodes. In one study (1989), he found that land use characteristics had a major influence on the travel behavior at suburban nodes. The three most important variables were density, size, and land use mixture. Cervero found that in larger and denser nodes there was a greater reliance on transit, ridesharing, walking, and other alternatives to the automobile. It is important to note, however, that the automobile was the overwhelming travel mode in all of the 57 suburban nodes surveyed: the average transit split in the nodes was less than 2 percent, and only 4 nodes had a share greater than 7 percent, the U.S. metropolitan-wide average (p. 64). Suburban nodes in Canadian cities tend to have somewhat higher transit mode splits (often 10-20 percent), but they are still very much dependent on automobile traffic (Cervero 1986; Schneider et. al. 1979).

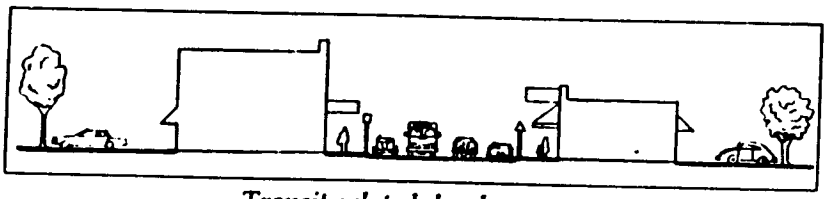
The degree of land use mixture in a suburban node was found to have the greatest influence on transportation behavior, and Cervero concentrates on this. He found that mixed use development can reduce transportation problems in a number of ways. Motorized travel can be reduced since mixed use suburban nodes allow for more internal trips, which can often be made by foot. For example, office workers do not need to drive to restaurants or shopping during their lunch hours. Commuters who do not need a car for midday errands are more likely to consider transit or carpooling. Because different uses are busiest at different times, traffic tends to be more evenly spread throughout the day at mixed use developments. This phenomenon of staggered peaks also allows for a greater degree of shared parking which reduces the overall need, and in turn can allow for higher densities and a more pedestrian oriented environment. Cervero (1988, 431) found that while a 10,000 m^2 office complex could be expected to generate 1230 vehicle trips per day, 10,000 m^2 of development divided equally

into office, retail, and apartments would generate only 1000 vehicle trips per day, not even taking into account further reductions from more internal walking trips. Cervero performed a regression analysis and found that as the amount of retail space in a complex increased and the dominance of office space declined, ridesharing, walking, and biking all increased.

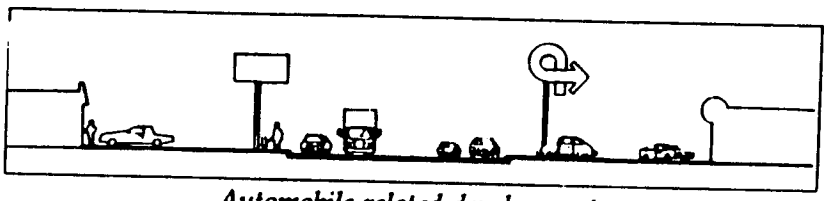
One of Cervero's (1989) major arguments is that the way suburban nodes are designed contributes to their automobile dependence. While they are dense by most suburban standards, distances are often too far to make walking convenient. Sidewalks are frequently lacking and it is often difficult to cross busy streets. The large amounts of surface parking is a feature of suburban nodes that distinguish them from traditional CBDs, and this makes walking distances even further. Transit stops are often in inconvenient locations, especially compared with parking. These design features discourage transit use among commuters to suburban nodes. They also leave driving as the only convenient alternative for midday trips, which further necessitates commuting by automobile.

The Snohomish County Transportation Authority (1989) prepared a set of guidelines for transit friendly design which can be applied to suburban nodes. These guidelines begin by shifting the priority from automobile drivers to transit riders and pedestrians (since transit riders end their trip on foot). Walking distances need to be reduced and walking needs to be made safer and more pleasant. This can be achieved through a number of measures. Better transit access into developments (i.e. door front service) reduces walking distances. Moving parking to the back of developments so the buildings can be brought up to the sidewalk also greatly reduces walking distances, and results in a more interesting and pleasant pedestrian experience, especially if buildings are outward-looking and provide an engaging streetscape. Walking can also be made safer and more pleasant by providing adequate sidewalks, weather protection, lighting, landscaping, and crosswalks. Barriers such as walls, berms, and parking lots also need to be eliminated. Bus stops themselves should include bus bays, seating, and shelter to improve safety and comfort for transit users. Some of these design features are shown in Figure 2.2.

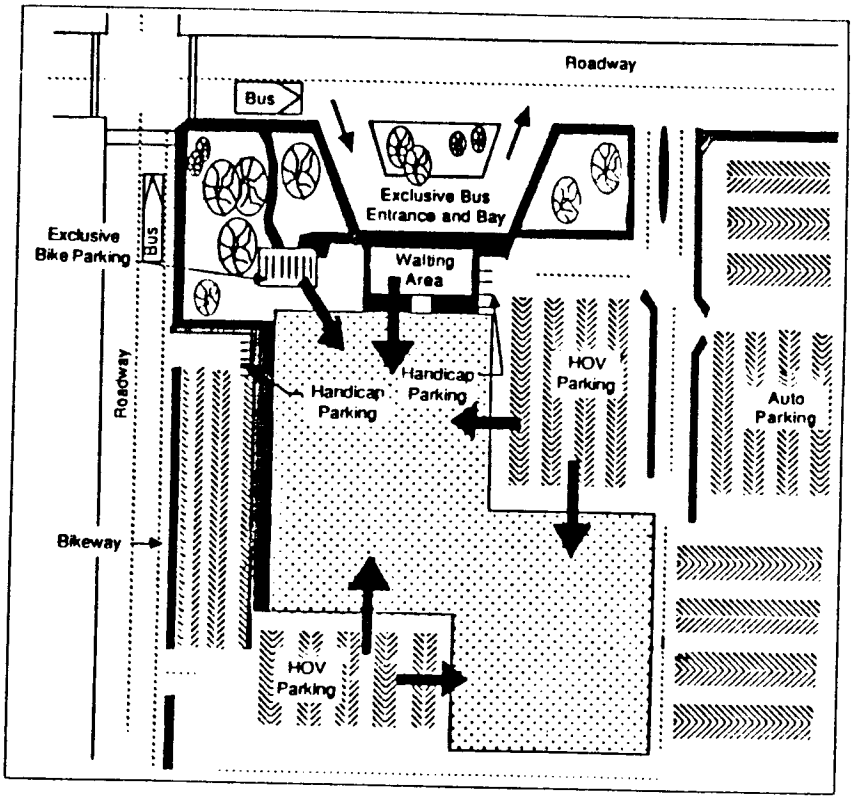
Figure 2.2 Examples of Transit Oriented Design



Transit related development



Automobile related development



Source: *A Guide to Land Use and Public Transportation for Snohomish County, Washington* Snohomish County Transportation Authority, 1989.

Hooper (1989, 2) looked at 6 typical suburban nodes: Bellevue (Seattle), South Coast Metro (Los Angeles), Southdale (Minneapolis), Parkway Center (Dallas), Perimeter Center (Atlanta), and Tysons Corner (Washington). The first 3 were classified as small suburban nodes while the latter 3 were classified as large. The only suburban node with a significant transit mode split was Bellevue (7 percent), while the share was below 1 percent for all the others. Lunch hour trips were twice as likely to be internal at large suburban nodes. However, most of these lunch hour trips were made by automobile: only 6 percent of these trips were made on foot (25 percent in Bellevue). Hooper found that automobile dependence for these midday and after-work errands was extremely important in discouraging transit and ridesharing. He makes a series of recommendations. Transit service should be improved, with the suburban node serving as a focus for radial bus service. He suggests a practical limit may be a 6 percent transit mode split. Complexes require a greater degree of clustering, with a reduction in the inward focus of the individual buildings. More attention must also be paid to the relationship between transportation and land use.

2.4 Summary

The literature indicates that there is a strong relationship between public transit and land use. High population and employment densities appear to be particularly critical in order for transit to be successful. One way to achieve these densities in the suburbs is through the development of suburban nodes. These nodes offer one of the best potential markets for suburb-to-suburb transit service since they help to reduce the dispersed pattern of suburban trips. In many North American cities, suburban nodes have evolved through market forces, but often these are not very transit friendly. They need to become even more compact, with a greater diversity of uses, and it must be easier to travel within them by means other than the automobile. Land use policies and guidelines can be used to help achieve these goals. Land use strategies, and suburban nodes in particular, will play a critical role in suburb-to-suburb transit planning.

CHAPTER 3. STRATEGIES FOR INCREASING SUBURBAN TRANSIT USE

3.1 Transit's Challenge in the Suburbs

While suburban transportation problems have become a major issue in the last decade, there is little optimism that conventional transit can play a significant role in solving these problems. Orski (1985), for example, believes that transit will be able to serve only a very small segment of the total travel demand in the suburbs, and as this suburban market becomes increasingly dominant, transit's share of the travel market will inevitably shrink. Cervero (1986) warns that conventional transit's future in the suburbs does not look promising.

A statement made at the annual meeting of the American Transit Association in 1940 is very prophetic and shows that the changes in urban form that have made transit uneconomic were not completely unexpected:

> Can we not pause long enough on this headlong decentralization process to see where we are going. The mass transportation industry is caught in a strong tide which is sweeping this and many other businesses toward disaster... [The] situation calls for strong expression and vigorous leadership (Cervero 1986, 105).

Fifty years later the transit industry is still struggling to adapt to these changes. Weigle (1988) argues that the transit industry twice failed to become a part of the post-war suburban boom: first in the 1950s and 1960s as people moved out to the suburbs, and again during the 1970s and 1980s as employment became suburbanized as well. Instead, transit has continued to concentrate its resources on the CBD-oriented market. While Weigle agrees that this is the market in which transit will continue to perform the best, it occupies a decreasing share of the regional commuter market; the opportunity for growth lies in suburbia.

In order for transit to grow in the suburbs, Weigle believes that it must market itself aggressively and play a more active role in the design stage of suburban development. It must establish itself in suburban areas as they are being developed, so it can better shape development patterns and travel habits of the residents. He believes that transit must be able to respond faster in the rapidly changing environment of the suburbs, possibly through joint ventures with the private sector. A key point he makes is that rather than attempting to provide comprehensive service, transit needs to identify and fill local market niches. This would help to establish a foundation for transit in the suburbs from which it could grow.

Schofer (1983) also discusses ways in which the transit industry will have to change to respond to suburban development. Like Weigle, he agrees that transit will have to tailor itself to specific markets. It will have to move away from fixed route, fixed schedule, line haul service towards paratransit and ridesharing. This would help make transit more efficient. In light of this, Schofer finds the trend toward building rail systems odd since most of the literature says that buses are cheaper in low density markets. He recommends deregulation and returning to the situation of many smaller providers, but with regional coordination. The private sector should be encouraged to become involved in transit through contracting out and private operators. Transit operators should not be afraid that private operators will "skim the cream"; often they help to reduce the deficit by taking over unprofitable routes. Overall, Schofer, like Weigle, believes the transit industry needs to be much more flexible and open to change.

Despite much pessimism, there appears to be a general consensus that transit does stand a chance in the suburbs if it becomes more willing to adapt to the circumstances. Future transit systems must be far more than standard buses on radial, CBD-oriented routes; they must include multi-destinational grid systems, paratransit, private involvement, and other innovations. Perhaps most importantly, the transit industry must also give up the idea of serving the entire suburban market, but

instead should concentrate on those sub-markets in which it can best compete. Only by making these changes will transit begin to make up the ground it has lost over the past five decades.

3.2 Suburban Transit Strategies

What types of transit strategies are most appropriate for suburb-to-suburb travel? The following is a summary of some of the strategies which have been discussed in the literature.

In very large cities, conventional transit, even rapid transit, might be viable for some circumferential suburban routes. Young (1984) cites an example in Chicago where suburb-to-suburb rapid transit is being considered. The Regional Transit System (RTS) wants to establish itself in the suburb-to-suburb market by building a rail beltway 24 km west of the CBD, connecting with the region's commuter rail network. The line would run through a 10x30 km corridor which contained 587,000 jobs in 1980, almost as many as the CBD, but spread out over a much larger area. This is the highest volume traffic corridor in Chicago's suburbs. The RTS projects 30,000 riders per day. Toronto is also planning a non-CBD rapid transit line which would stretch along the region's northern suburbs and connect several major suburban nodes.

Many of the proposals for suburban transit service are organized around suburban nodes. Huth (1983) advocates a multi-nodal urban form with well developed suburban transit service focussing on suburban nodes as well as the CBD. Such a multi-destinational transit system would consist of three types of transit service: (1) local service between nodes and their surrounding residential areas (2) express service between different nodes and from the nodes to the CBD (3) internal circulation within the nodes. Huth cites Minneapolis and Denver as examples of U.S. cities where this form of development is being encouraged. Vancouver has at least some of these features in its transit system, as will be discussed in later chapters.

Schneider and Smith (1980) also advocate a multi-nodal transit system. They suggest using regional shopping centres as nodes since these are important trip generators in their own right and they usually serve about 100-200 thousand people, which is also about right for transit nodes. A major advantage of a multi-nodal system is that by concentrating passengers into heavily-travelled corridors between the nodes, it provides the opportunity for improved high-frequency express service. Schneider and Smith also believe that such a system would be more user-friendly: people would learn that once a node is reached, other destinations throughout the urban area can be reached easily.

The transit networks described by both Huth and Schneider would likely use some form of timed focal point transfer system. Priest and Walsh-Russo (1983) stress this system as a way of creating a multi-destinational transit network that would greatly improve suburban transit service. Timed transfer points are nodes in the transit network where several routes converge, usually within a few minutes of each other, to allow for convenient transfers and thus better connectivity. These timed transfer points are usually located at shopping centres or other suburban nodes, tapping a market that transit has often ignored. The timed transfer points serve as hubs for local transit service and provide the connection with express services which operate to the CBD and sometimes to other transfer points.

Priest and Walsh-Russo cite Edmonton and Toronto as successful examples of this type of multi-destinational transit service. Vancouver's system also uses timed transfers in the suburban areas. Transit ridership in Edmonton increased by 45 percent in the five years following the introduction of a timed transfer system which allows 90 percent of the service area to be reached within 50 minutes (Cervero 1986b, 307). In Portland, two timed transfer points were introduced in 1979 and ridership in the area increased 40 percent (Priest and Walsh-Russo 1983, 42). There have been several examples where entire radial systems have been successfully converted into timed transfer systems, including Edmonton and Austin, Texas. Timed transfer systems seem to be particularly well suited for relatively low density areas where existing headways are typically 30

minutes (Bakker et al. 1991). A major drawback of using timed transfers is the difficulty and cost of scheduling such a system, and the need for all routes to have compatible service frequencies.

An alternative to the timed transfer system, but one that also provides multi-destinational service, is the grid transit system. Usually these systems are found in areas with high transit use since they generally work best with frequent headways. This is because, given the large number of transfer points, it is impossible to schedule the service so that transfers are timed in any way; thus waiting times tend to average one half the headway. In Vancouver, a grid system is used in the City itself, where service is most frequent. There may be potential for grid transit systems in areas of lower density and lower transit service, however. Nelson and O'Neil (1983) describe the case of Albuquerque, New Mexico, a city which had a population of about 400,000 in 1980 and a multi-nodal form with no dominant activity centre. Albuquerque introduced a grid transit system, with buses running on all major arterials at 30 minute headways. Transit passengers can now go nearly anywhere in the city with a maximum of two transfers. Most locations are served by at least two routes and users thus have a choice of routes when planning a trip, often catching whichever bus comes along first. Nelson and O'Neil report that the system is quite successful, indicating the possibility that such a system could be adapted for use in multi-nodal areas with relatively low transit use, including the suburbs.

Cervero (1986) advocates a combination of grid and timed transfer systems to replace existing radial transit systems in the suburbs. The result would be a cobweb-like network with high route interconnectivity and greatly enhanced service to important suburban nodes. The major goal would be to better serve the diffuse travel pattern of the suburbs and, in particular, to reduce the inconvenience of making transfers, which are a necessary part of transit when origins and destinations are so dispersed. Cervero points out that people perceive the waiting time during transfers to be three times as long as it actually is (p.12). The hybrid system that Cervero describes is the kind of flexible solution that transit will need if it is to be successful in the suburbs.

Cervero (1986, 103) also discusses some of the potential problems such a transit system would face. Often transit services do not penetrate suburban complexes because developers are reluctant for safety and image reasons, while transit authorities may fear headways will lengthen or schedules will suffer if buses are detoured into these complexes. Another problem results because timed transfers seem to need residential densities of 1200 to 2400 persons/km^2 in order to operate efficiently. While this is a relatively low density, most U.S. suburban areas have residential densities which are even lower, and thus have difficulty supporting timed transfer systems. For example, while 12 bus routes converge at South Coast Plaza in Los Angeles, only 5 percent of trips are by transit. A major problem is that only 21 percent of South Coast employees live within a 5 minute walk of a bus route, the maximum time most people will walk. Fairfax County, Virginia ran a cross-county bus service to Tysons Corner, a huge suburban node, in the early 1980s, but it attracted an average of only 6 riders per trip. Clearly it will take more than simply adding bus service to these nodes to improve transit use.

Another problem for transit, of course, is that of funding. Orski (1985) is a strong supporter of cooperative financing, in which the private sector helps to pay for transportation improvements. An example of this would be benefit assessment districts such as those established around transit stations in Los Angeles and Portland. These are a way of taxing landowners who benefit from nearby transportation improvements. In other cases, the private sector might pay for part or all of certain transit improvements which increase the accessibility of a development. To date, this has mostly involved rapid transit projects such as joint station developments, but this could conceivably be extended to other forms of transit or even paratransit.

3.3 Paratransit

Paratransit includes demand responsive services like shared ride taxis and dial-a-bus, as well as ridesharing such as car or vanpools. It is often suggested as a solution to providing transit service

in areas where densities and levels of demand cannot support conventional transit. Paratransit would also help reduce the need for transfers by providing more customized service; often this is "door-to-door". Most authors agree that paratransit must play a larger role if transit is to be successful in the suburbs (Reichart 1979; Schofer 1983; Orski 1985; Humphrey 1990). In order for paratransit to play this larger role, many believe that the monopoly of standard bus public transit needs to be broken by deregulating the industry and allowing more private sector involvement (Schofer 1983; Cervero 1986). Of course, there have been many examples of publicly operated paratransit services, but these have tended to have very high operating costs per passenger, particularly the demand responsive services such as dial-a-bus (Bhatt 1979). Rosenbloom (1990) surveyed 22 medium-sized U.S. cities and found that despite the many paratransit options available, only two of the cities were involved with non-traditional paratransit services.

Ridesharing may be a more promising and less expensive option for suburb-to-suburb commuting. Carpooling programs in particular can be provided at a low cost since they merely make use of a resource which at present is vastly underutilized: all the empty seats in private automobiles. Ridesharing is less expensive than driving to work alone. At the same time, it is generally faster, more comfortable, and more convenient than regular transit since it offers door-to-door, express service with a guaranteed seat. Ridesharing seems to be especially well suited to long commutes, where the cost of driving can be quite high and the distance required to pick up fellow passengers is small compared to the actual "line haul" trip. Teal (1987, 207) found that carpoolers in the U.S. had commutes that were 43 percent longer, on average, than those who drove alone. Most car and vanpools have a single destination, so large employers and employment concentrations make ridesharing more attractive (Stevens 1990). A potential problem with ridesharing programs is that they often compete directly with transit services, something which may or may not be desirable. Likely targets for ridesharing programs in suburban areas might be suburban nodes or a large isolated employer which presently has poor transit service.

Shuttle buses could represent an important means of circulation within suburban nodes, one that could help end the dependence on the automobile for midday trips. Higgins (1992) looked at several shuttle bus services in suburban nodes, office parks, and other locations in the United States. Many of these services were privately run, and most operated either as midday circulators or feeder services to rail and bus lines. Some had a fixed schedule while others were on demand; some services were free while others charged a small fare. He found that most of these services were costly and generally had low ridership, in most cases amounting to less than 2 percent of all employees. However, Higgins did find some successful examples. These tended to have certain characteristics: service frequency was at least every 10 minutes, parking in the area was usually restricted, and the shuttle buses did not compete directly with transit but they were connected to well used transit lines. Thus, shuttle buses may have some potential under certain circumstances.

Given that many potential suburban market niches consist of relatively small flows, paratransit might be an appropriate way to fill these niches. In many cases, paratransit could be combined with more conventional transit to fill a particular market need. For example, paratransit could be used as a feeder service to a timed transfer point in an area where population densities do not support full bus service (Cervero 1986). Roos (1979) describes this as the "family of services concept", which he advocates as an alternative to the "one size fits all" approach to transit provision presently used in most North American cities. Since no single service or provider can satisfy all of a community's transportation needs, a combination of different services and providers must be interfaced to produce an overall system, one that includes an array of both transit and paratransit services.

3.4 Transportation Demand Management

Transportation demand management (TDM) strategies include a broad range of measures aimed at changing travel behavior in order to reduce vehicle traffic and congestion. This can be accomplished in three ways: reducing the total number of trips made, shifting demand away from peak

periods, and shifting trips from single occupant vehicles (SOVs) to alternate modes. Here, the focus will be on those strategies which could shift suburb-to-suburb trips from SOVs to transit and paratransit. TDM can consist of mandatory, punitive measures which discourage SOV trips by increasing the cost or time involved (sticks), or they may be voluntary incentives which encourage alternative modes (carrots). Examples of the former include road pricing and parking management, while an example of the latter might be provision of priority lanes for transit and high occupancy vehicles (HOVs). Stick TDM measures are generally much more difficult to implement than carrot TDM. Because it actually changes travel behavior, TDM could be a very powerful tool for encouraging transit and paratransit use for suburb-to-suburb commuting.

Road pricing, by increasing the cost of using an SOV, is one of the most effective means of changing this behavior. Road pricing simply means applying tolls on the use of bridges and highways; these may be collected at standard toll booths, or by using more newly developed electronic sensor systems. The rate structure of the tolls can be used to shape travel demand. For example, car and vanpools could be encouraged by allowing these to travel toll free or at a reduced toll. The revenue generated from road pricing can be used to provide improved transit services as an alternative to driving. A major criticism of road pricing is its regressive nature: the impact of tolls would be much greater on low-income motorists than on those who could afford to pay (GVRD 1993). Long distance suburb-to-suburb commutes would be a prime target for road pricing.

Parking reforms can also be used to encourage alternatives to the automobile. Free employee parking is almost universal at suburban jobsites. This is a benefit that employers grant to automobile drivers, at a cost of hundreds of even thousands of dollars per space annually, while transit users generally receive no such subsidy. Pickrell and Shoup (1979A) estimate that 20 percent of those who drive alone would switch to transit or carpools if they were required to pay for their parking. They also recommend that if employers subsidize automobile drivers, they should extend this to transit users in the form of subsidized passes. There are also many actions which the public sector could

take to increase the cost of parking, including priced parking permits in designated areas, a direct tax on parking spaces, and increased rates at parking meters and municipally owned parking lots (GVRD 1993A).

Pickrell and Shoup (1979B) argue that minimum parking requirements result in more parking than the market would supply naturally, and have depressed the market value of a parking space, thus encouraging more people to drive to work. Reducing these requirements, or even putting a cap on maximum allowable parking (as has been done in Bellevue, Washington), would help to change this. Cervero (1991, 483) compared commuting habits at 83 different suburban office buildings and found that those with fewer parking spaces per employee did have a significantly lower automobile mode split. Instead of fixed limits, parking requirements could be negotiated with the developer in order to get more transit friendly development. For example, a reduction in required parking for a development could be granted in exchange for the provision of a bus loop. Another strategy is to provide preferential parking for employees who carpool to work. Parking reforms will be particularly difficult to carry out in suburban areas, where free parking is taken as a birthright and there are few alternatives to the automobile. These reforms will be easier to implement if they are accompanied by improvements in transit service.

Another increasingly common form of TDM involves setting trip generation ceilings or mode split targets. These may be voluntary, employer based programs, or they may be mandatory targets a developer commits to meet before approval for a project is granted (Orski 1985). The developer achieves these targets through measures such as ridesharing programs, staggering work hours, and parking management. Encouragement of transit use is usually an important element of these schemes.

Orski (1987) cites some examples where such traffic mitigation programs have been quite successful. In Pleasanton, California an ordinance required developers and employers to reduce peak SOV trips by 45 percent over four years, and in the first two years of the program they had already

been reduced by 36 percent (p. 470). In Silver Spring, Maryland a TDM district was established with a goal of 25 percent mode split for transit. The county provides incentives such as discount transit passes and HOV parking. These types of programs are often quite flexible; jurisdictions negotiate with developers, using carrots such as density bonuses and parking reductions, or sticks such as withholding development approvals. Cervero (1986) agrees with Orski on involving the private sector in TDM strategies. An innovative scheme being used by some municipalities in the San Francisco Bay area involves impact fee ordinances, in which developers pay a fee based on the expected traffic impacts a development will produce. This provides developers with an incentive to design and manage their projects in such a way as to encourage alternatives to the automobile.

Developers and employers in many suburban centres have banded together to form Transportation Management Associations (TMAs) to cope with transportation problems in suburban areas, as well as in response to the imposition of the regulations discussed above. TMAs are particularly prevalent in centres which are poorly served by transit. They assist members in traffic mitigation obligations, lobby for transport improvements, plan for long range transport needs, and operate transport services such as internal circulators, shuttle systems, or contract buses. There were 24 TMAs operating in the U.S. in 1985, a number which had grown to more than 100 by 1990 (Humphrey 1990). TMAs could play a crucial role in providing innovative transit service for suburb-to-suburb commuters.

To illustrate just how effective TDM regulations can be in reducing automobile dependence, Cervero (1991, 489) cites the example of Pacific Northwest Bell in Bellevue. Bell provides its 1150 employees with just 402 parking spaces, over half of which are reserved for car and vanpools. The company charges $60 per month for single occupant vehicles to park, but two-person carpools are charged only $45 per month and carpools of three or more park for free. At this particular office building, only 50 percent of employees solo commute while 37 percent rideshare and 12 percent use

transit. A block away at an office tower with 730 spaces for 650 workers, 85 percent of employees solo commute and only 8 percent rideshare.

A major study which compared eleven different sites (seven of them suburban) found that low occupancy vehicle trip demand can be significantly reduced by TDM strategies (U.S. Federal Highway Administration 1990). Trip rate reductions varied from 6 to 48 percent, with the average being about 20 percent. The degree of success did not appear to be related to the size or density of the sites. The specific strategies used in the traffic reduction programs, in particular the presence of legal or economic pressure to induce employers and employees to cooperate, had a much greater influence. Most importantly, a viable alternative to the single occupant vehicle must be present, and in order for this alternative to compete, subsidies for private automobiles, such as free parking, must be ended. While a 10 percent trip reduction has often been viewed as acceptable, this would be an insignificant contribution to the rapidly growing gap between transportation demand and road capacity, especially in suburban areas. However, the study concludes that much more significant trip reductions of 20 to 40 percent could become the norm rather than the upper limit if subsidies for drivers are eliminated and TDM programs are universally implemented to create a level playing field for all employers and all commuters. Guiliano (1992) agrees with this conclusion. While she found that most TDM programs had a minimal effect on traffic congestion, the effect was significant when programs were mandatory and strong incentives were present.

TDM strategies will play an important role in encouraging greater transit use for suburb-to-suburb trips. Providing transit or paratransit services for these trips is not enough; this must be combined with both land use measures and TDM strategies that both encourage transit use and discourage - even penalize - automobile use. These are difficult to carry out because they are politically unpopular and they require the cooperation of employers and developers in the private sector. However, if transit is to succeed in the suburbs, this kind of comprehensive approach is necessary since there is no one solution for the problems it faces.

3.5 Ending Automobile Dependency

The innovative suburban transit services, land use changes, and transportation demand management strategies discussed above represent only one step towards the larger goal of ending our dependence on the automobile. While these strategies play an important role, they should also be seen in context of the broader issues. Ending automobile dependency will require some fundamental changes in society's values and priorities. We must decide whether we will continue to design our cities almost entirely from the point of view of the private automobile, or if we will begin to give the same amount of consideration to alternative modes. It is essential that we change the way we assess all the costs and benefits of automobiles and public transit.

Newman and Kenworthy (1989) discuss many of these broader issues. They argue that transportation impacts on all aspects of how we live, and automobile dependence has created many far-reaching problems for our cities and our society. Some of these problems are directly related to the physical structure that automobiles have helped to create in our cities. For example, urban sprawl has created a need to travel long distances for everyday activities; this has led to increasing congestion and a massive waste of energy. It also means that people are spending as much or more time travelling as in the days before the private automobile. The automobile-oriented city creates problems not only for transit, but the long distances have also made walking and cycling impractical in most cases. In addition, sprawl creates massive requirements for roads which are extremely costly to build, use up huge amounts of land, and result in severe environmental impacts.

Automobile dependence also has many social impacts. There is severe hardship for children, the elderly, the poor, the handicapped, and others without access to an automobile. The separation of activities in our cities has also led to a loss of neighborliness and vitality. The excessive privacy and isolation which the automobile fosters has resulted in a lack of community, and this has contributed to an increase in crime and other social problems. From their discussion, Newman and Kenworthy

illustrate how the issues of transit and automobile use can have impacts far beyond the realm of what might be considered "transportation problems".

At present, our society is so highly geared towards the automobile that we often do not realize all the advantages we give to automobile use. Perhaps this is most obvious in the way we view funding and subsidies for our transportation system. A recent study estimated that the subsidy from governments and individuals to private automobile use costs each Lower Mainland resident roughly $1300 per year, which means automobile drivers are being subsidized for about 23 percent of their total costs (GVRD 1993B). The total subsidy for private automobiles is 7.5 times that for public transit in the region, and yet most people are more aware of the transit subsidy. If transit received the same subsidy as the private automobile, service levels could be vastly improved. These fundamental changes in our values and priorities go far beyond limited changes discussed in this thesis, but it is important to keep these larger issues in mind.

3.6 Summary

Transit will have to become more innovative if it is to survive in the suburbs. The traditional single centred system needs to be replaced with a multi-destinational one that better reflects the reality of the suburbs. Different types of transit services should be employed for different segments of the market; this includes the use of paratransit and ridesharing. These more innovative services must also be combined with transportation demand management strategies that will encourage people to switch from driving to transit. Transit can compete effectively in some suburban markets, but it will take a comprehensive approach to meet this challenge.

CHAPTER 4. CASE STUDY: BACKGROUND INFORMATION

4.1 Introduction

A case study approach was chosen to illustrate some of the implications for public transit of increased suburb-to-suburb commuting. The case study consists of three parts. In the first part (this Chapter), background information to the case study will be presented. The situation in Surrey will be put in context of Greater Vancouver and the changing commuting patterns within the region. In the second part of the case study (Chapter 5), commuting patterns to, from, and within Surrey will be investigated in greater detail, and the effect of land use patterns will be analyzed. The third part of the case study (Chapter 6) looks at the response to this issue in Surrey: what strategies are being used to provide transit service for suburb-to-suburb commutes, how is transit use being encouraged, and what are the public attitudes about transit service in Surrey? Overall, the case study gives both a regional and historical context to the issue of suburb-to-suburb commuting in Surrey, then provides a detailed picture of the situation and the response to it.

The case study approach was chosen for a number of reasons. First, it contributes to the empirical evidence on the impact of land use patterns on transit use, which a review of the literature has shown to be quite sparse. A detailed examination of the specific commuting patterns in Surrey should provide clues about the different variables which might affect suburban transit use, as well as which types of commutes are most amenable to improved transit service. By analyzing this information, potential markets for transit in Surrey can then be identified. Again, there have been few studies which have specifically looked at transit use for different types of suburban trips. A key reason for choosing a case study approach is that it can then serve as a model for other cities, leading to the development of a conceptual framework for suburb-to-suburb transit planning.

4.2 Surrey and Greater Vancouver

The District of Surrey is part of the Vancouver Census Metropolitan Area (CMA). For the purposes of the case study, the CMA has been divided into nine sub-regions, each consisting of one or more municipalities which are commonly grouped together and generally form a functional unit. Figure 4.1 shows these sub-regions and their constituent municipalities. Of these sub-regions, the North Shore, Burnaby/New Westminster, and Richmond will be referred to as the inner suburbs, while the remaining areas will be termed outer suburbs. Surrey, along with the City of White Rock, forms one of the outer suburban sub-regions. Most of the data presented in the case study refer to this combined area of Surrey and White Rock. It will be stated where this is not the case.

Surrey, which is located roughly 25 km southeast of downtown Vancouver, was chosen for the case study because it is fairly typical of the communities which are facing the most serious problems from the rapid rise in suburb-to-suburb travel. In terms of both population and area, Surrey is the largest suburban municipality in the Greater Vancouver region. As shown in Table 4.1, Surrey has grown rapidly as a major recipient of Vancouver's post-war suburbanization. During the last two decades in particular, it has accounted for a very large proportion (nearly 30 percent) of the region's population growth. It has also been the location for a smaller but growing proportion of employment growth in the region, as will be discussed in more detail later (GVRD 1991).

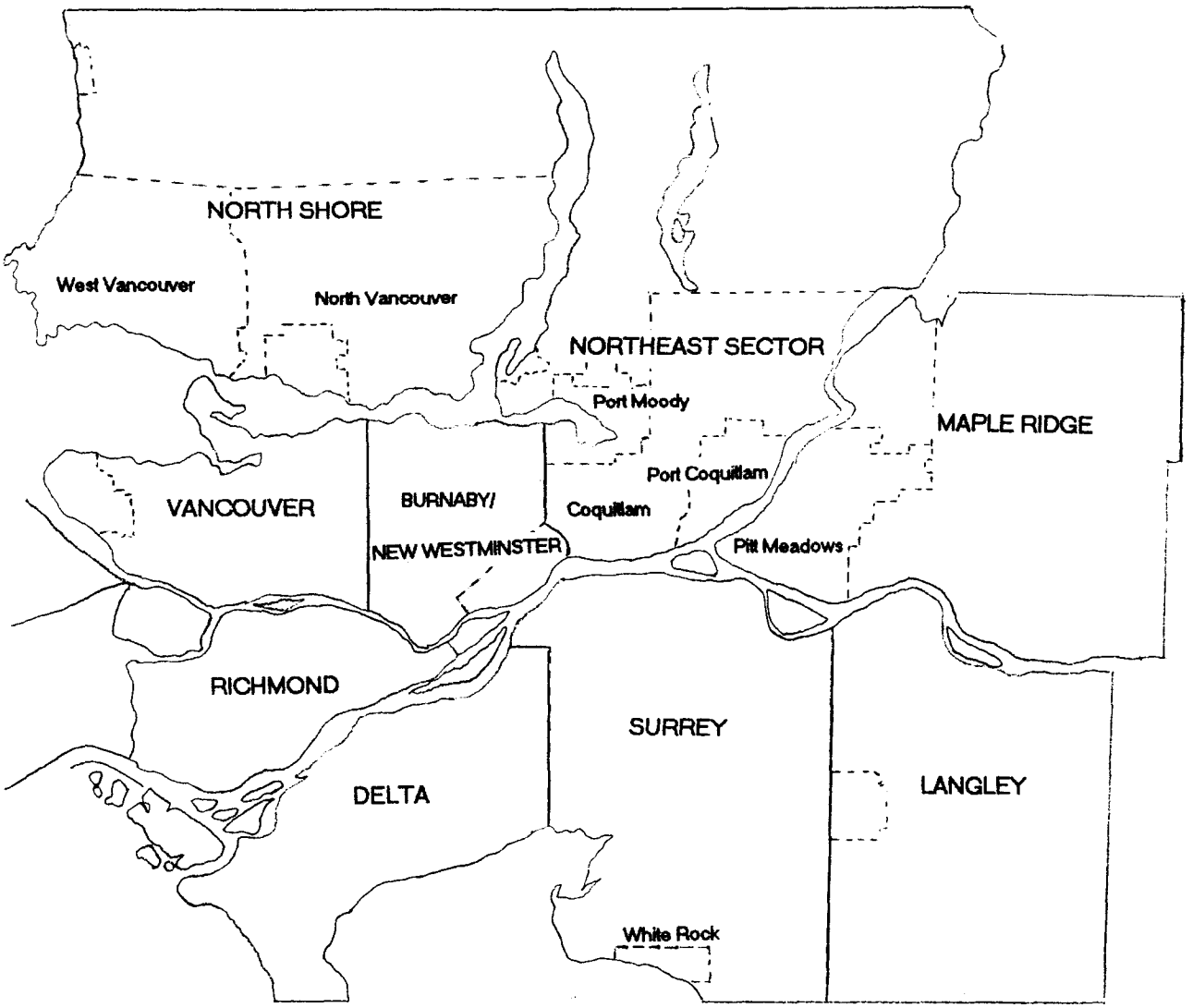
Table 4.1 Population Growth in Surrey, 1951-91.

	*Surrey		Vancouver CMA		% of CMA in Surrey
	Population	Increase During Previous Decade	Population	Increase During Previous Decade	
1951	33670		586054		5.7%
1961	77291	43621	827335	241281	9.3%
1971	108950	31659	1082185	254850	10.1%
1981	160688	51738	1268197	186012	12.7%
1991	261487	100799	1602502	334305	16.3%

*Includes White Rock

Source: Statistics Canada.

Figure 4.1 Vancouver CMA and its Component Sub-Regions



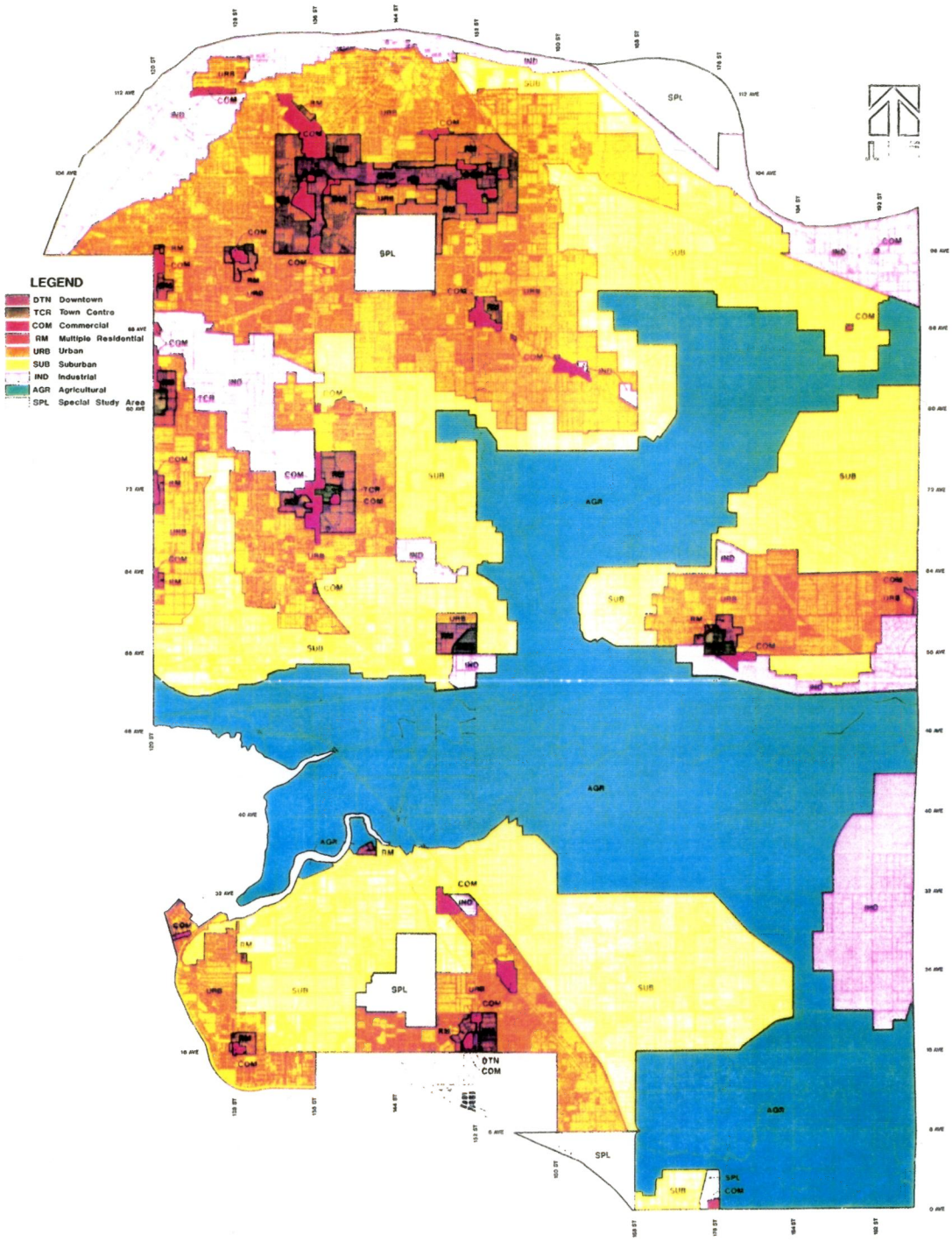
Surrey displays a high degree of suburb-to-suburb commuting due to its distance from downtown Vancouver and its central location among Vancouver's southern and eastern suburbs. Increasingly, Surrey is being viewed as the second city of the Greater Vancouver Region, and the major centre south of the Fraser River. Downtown Vancouver's location in the northwest corner of the region has helped to create a real need for such a second centre to serve the rapidly growing southeastern suburbs. The psychological and sometimes real barrier to commuting provided by the river has also helped to promote suburb-to-suburb commuting among South of Fraser municipalities. These conditions have made Surrey a very important player in suburb-to-suburb commuting in Greater Vancouver.

4.3 Urban Form

Like many suburban areas, Surrey is a sprawling community with a multi-nodal form. Surrey's Official Community Plan (1986) encourages this multi-nodal form through the creation of a series of town centres which act as foci for commercial and higher density residential development. The largest of these town centres is Whalley, which has also been designated a regional town centre in the GVRD's Livable Region Program. At present, Whalley consists mostly of a regional shopping centre, along with strip retail and commercial development, but it is projected to evolve into a much denser and more mixed-use "downtown" over the next 20 years. In fact, Whalley is now being promoted as Surrey City Centre, one of the future twin downtowns of the region (along with downtown Vancouver). The second order town centres include Guildford (home to Surrey's largest regional shopping centre), Newton, Cloverdale, and South Surrey/White Rock. Figure 4.2 shows Surrey's basic urban structure as outlined in its Official Community Plan.

Residential development in Surrey is predominantly single family (about 70 percent in 1986), but multiple family housing is becoming increasingly important. According to the Official

Figure 4.2 Surrey Official Community Plan Land Use Designations



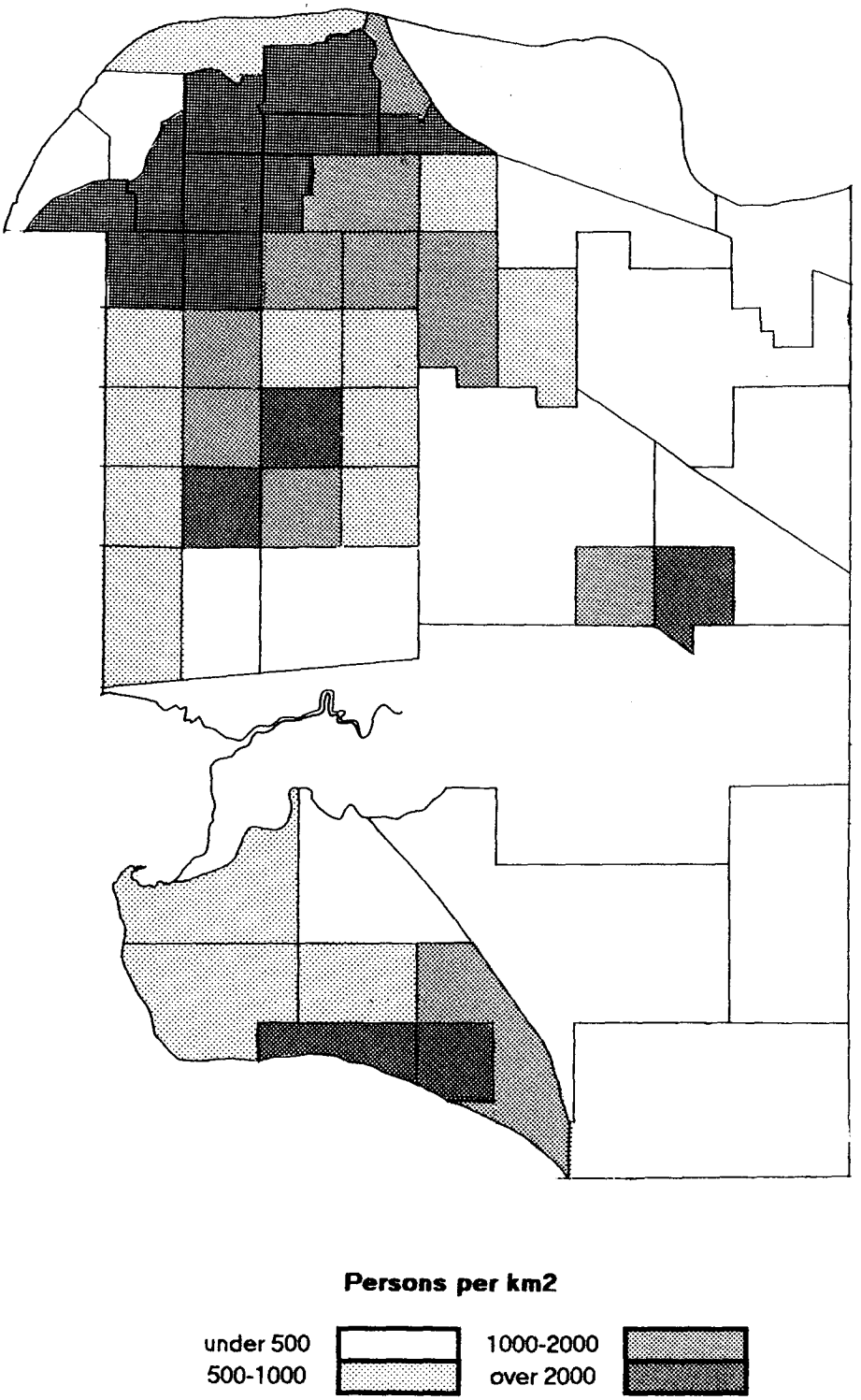
Source: Surrey Official Community Plan, Surrey Planning Department, 1986.

Community Plan, multiple family housing is encouraged in the town centre areas, with the highest densities in Whalley and Guildford. About 70 percent of multiple family housing is in the town centres, nearly 40 percent of it in the Whalley-Guildford area. Multiple family housing makes up about half the total housing in this area. Farther out from the town centres are larger areas of low to medium density housing designated as "urban". The areas designated "suburban" are for low density residential development and provide a transition between Surrey's urbanized area and the belt of rural agricultural land that runs through the centre of the municipality.

Population densities in Surrey are generally quite low, averaging 635 persons/km^2 in 1986. (All density figures presented here represent gross densities; net residential densities would be considerably higher.) As shown in Figure 4.3, there is considerable variation in population density within the municipality, however. There are three areas of higher density. The largest of these is North Surrey with about 127,000 people (65 percent of the total) at an average density of 1300 persons/km^2. This area is contiguous with North Delta to the west. South Surrey/White Rock has about 39,000 people also at an average density of 1300 and Cloverdale has a population of 8500 at a density of 1700. The remaining central and eastern part of the municipality makes up 55 percent of the land area, but contains only about 21,000 people with an average density of only 123 persons/km^2. This area is rural in nature with extensive agricultural land (much of it in the agricultural land reserve) and only scattered, very low density development. This large rural expanse separates South Surrey/White Rock from the remaining built-up area.

Overall, about a third of the area's population lives at densities above 2000 persons/km^2, about a third live at densities between 1000 and 2000, and about a third live at densities below 1000. The "average" Surrey resident lives in a neighborhood of predominantly single family homes with a density of about 1300 persons/km^2, or a net residential density of about 12 dwelling units to the hectare.

Figure 4.3 Population Density in Surrey, 1985



4.4 The Transportation System

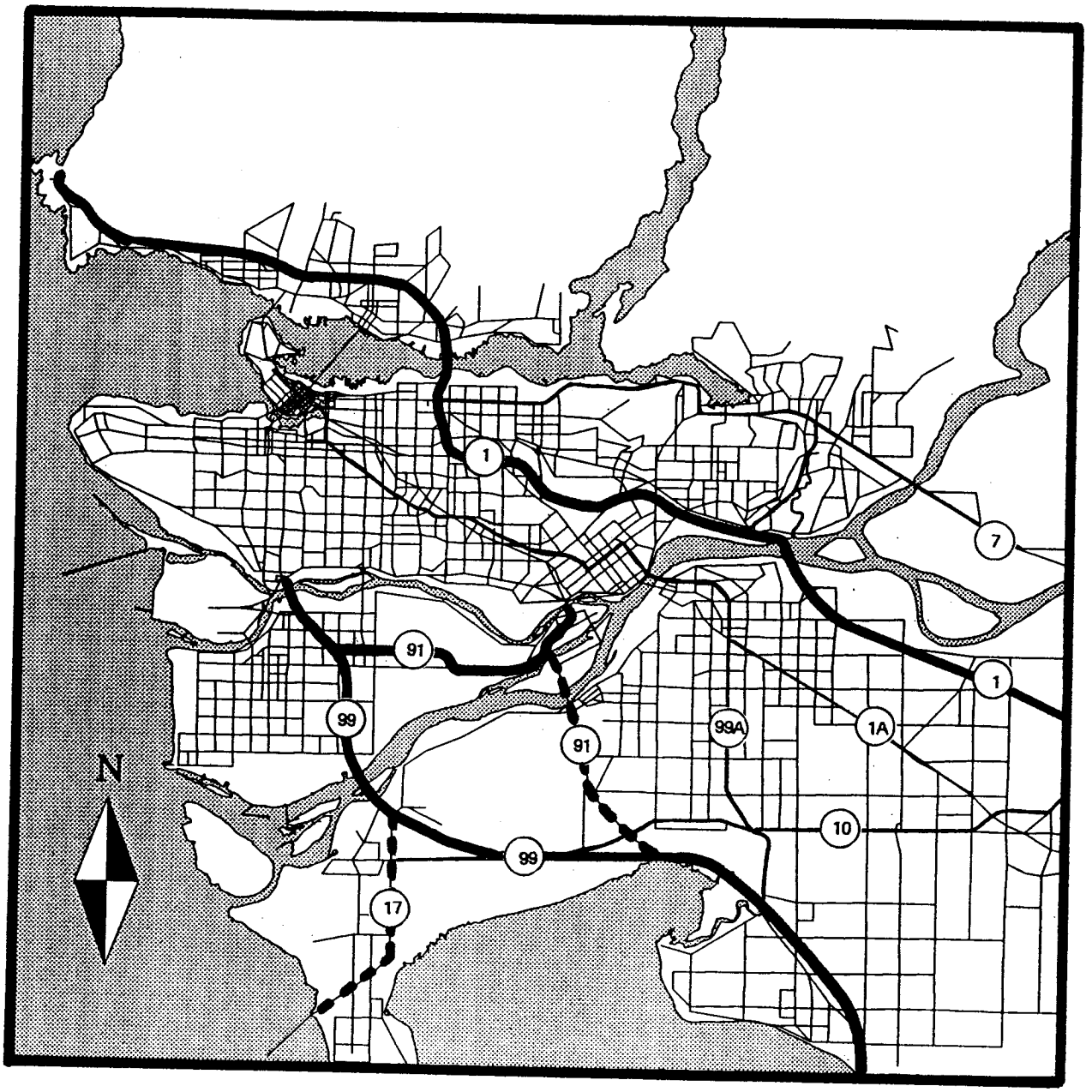
A brief overview of the transportation system in Greater Vancouver and in Surrey, with emphasis on the transit system, is helpful in understanding the discussion of commuting patterns which follows.

4.4.1 Roads

As shown in Figure 4.4, Greater Vancouver has a fairly limited freeway system, particularly within the City of Vancouver itself. A four km stretch of the Trans-Canada Highway skirting Vancouver's eastern border is the only freeway segment within City boundaries, and there are no freeway links to the CBD. Circumferential freeways or beltways, which have helped to encourage suburb-to-suburb travel in many cities, are also largely absent in Greater Vancouver. There are a few freeway segments, such as the Richmond Freeway (Highway 91) connecting Surrey and North Delta with Richmond, which serve a beltway function, but these constitute only fragments of a true beltway. Given its relative lack of freeways, Vancouver is more dependent on surface streets and arterials compared with most North American cities.

Several highways connect Surrey with the surrounding suburban municipalities. Three road bridges provide access across the Fraser River from Surrey to Burnaby, New Westminster, and Coquitlam; however, the bottlenecks which result tend to discourage travel across the river to some extent. Not surprisingly, Surrey enjoys the best access with the adjacent suburban areas of North Delta to the west and Langley to the east. North Delta is a continuation of the built-up area of North Surrey, and access is by numerous city streets. Built-up areas of Langley are separated from Surrey by extensive rural areas. The Trans-Canada Highway provides high-speed access between North Surrey and Langley, while Highway 10 and the Fraser Highway also link the two municipalities. Highway 99 provides good access from South Surrey to South Delta and Richmond. Access to

Figure 4.4 Highway System in Greater Vancouver



NETWORK CLASSIFICATION

Freeway
Expressway
Other Highways
Arterial Roads

Richmond from other parts of Surrey has been greatly improved with the construction of Highway 91 and the Alex Fraser Bridge. The existing freeway network is not really designed for travel *within* the sprawling municipality, and rapid growth has led to problems of traffic congestion.

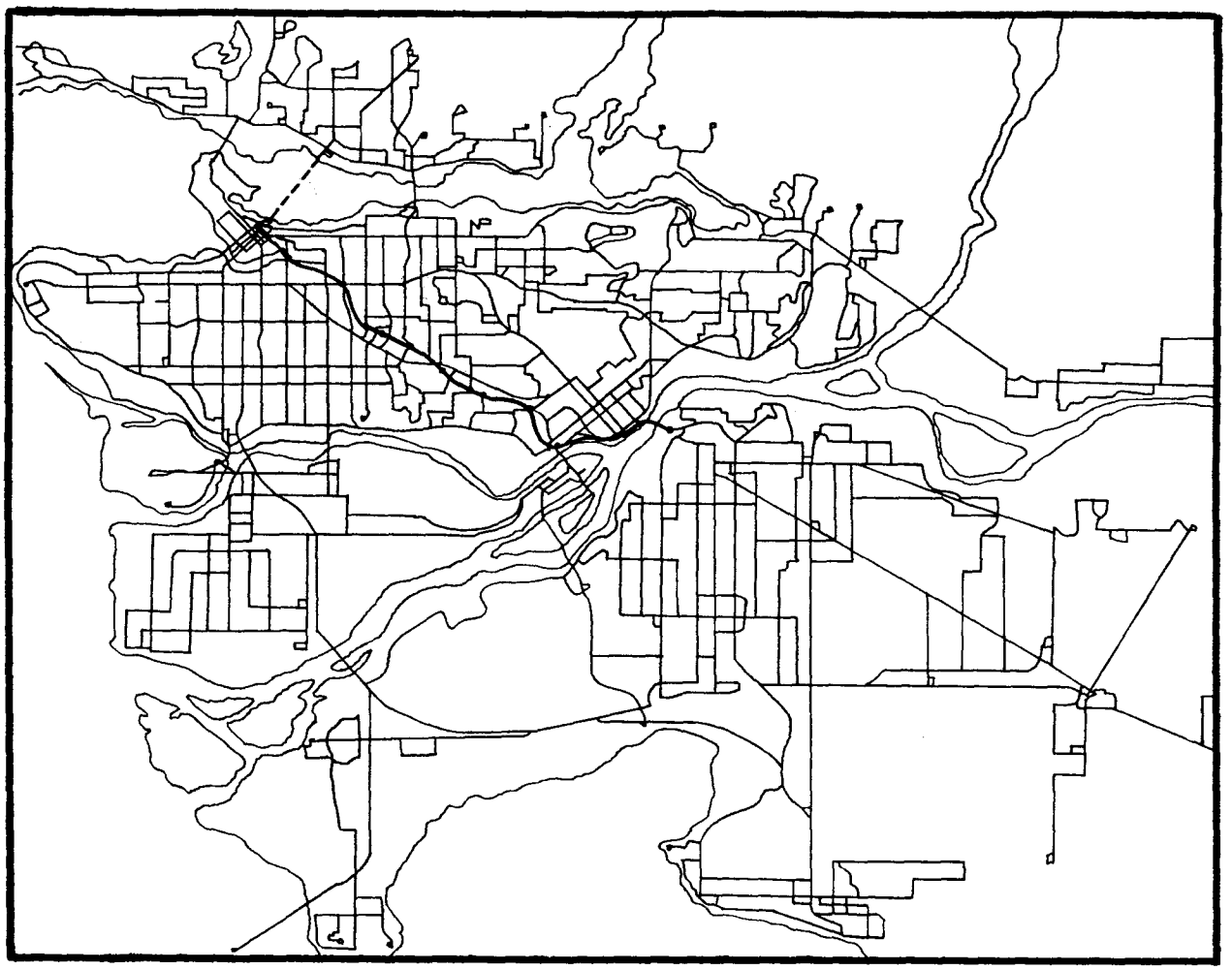
4.4.2 Public Transit

The *Metropolitan Vancouver Origin-Destination Survey* found that transit accounted for nearly 9 percent of 24-hour travel in Greater Vancouver and about 13 percent of work trips (GVRD 1987). This is fairly typical for a Canadian city, but is considerably higher than the average U.S. city. Greater Vancouver's transit system is operated by BC Transit and consists of both diesel and trolley buses, two commuter ferries, and a rapid transit line. The system carried about 128 million passengers in 1991/92.

Buses carry the majority of transit passengers in Vancouver. Within the city itself, there is a grid system consisting mostly of trolley buses. The north-south routes generally loop through downtown while the most east-west crosstown routes do not. In the suburban areas, where service is less frequent, the system is arranged around a series of major transit exchanges, often located at shopping centres. Local service operates between the surrounding suburban areas and the exchanges, most of which have express service to downtown Vancouver. There is also local or express services between some of the transit exchanges. Figure 4.5 shows Greater Vancouver's transit system.

SkyTrain, Vancouver's rapid transit line, forms the backbone of the system. The mostly elevated line runs 25 km from downtown Vancouver, through Burnaby and New Westminster, to Surrey. SkyTrain is closely integrated with the bus system; the majority of the 175 bus routes in the system connect with one or more stations. Many of the suburban transit exchanges are located at SkyTrain stations, with SkyTrain providing the express service.

Figure 4.5 Greater Vancouver's Transit System



SkyTrain Route ———

SeaBus Route - - - -

Bus Routes ———

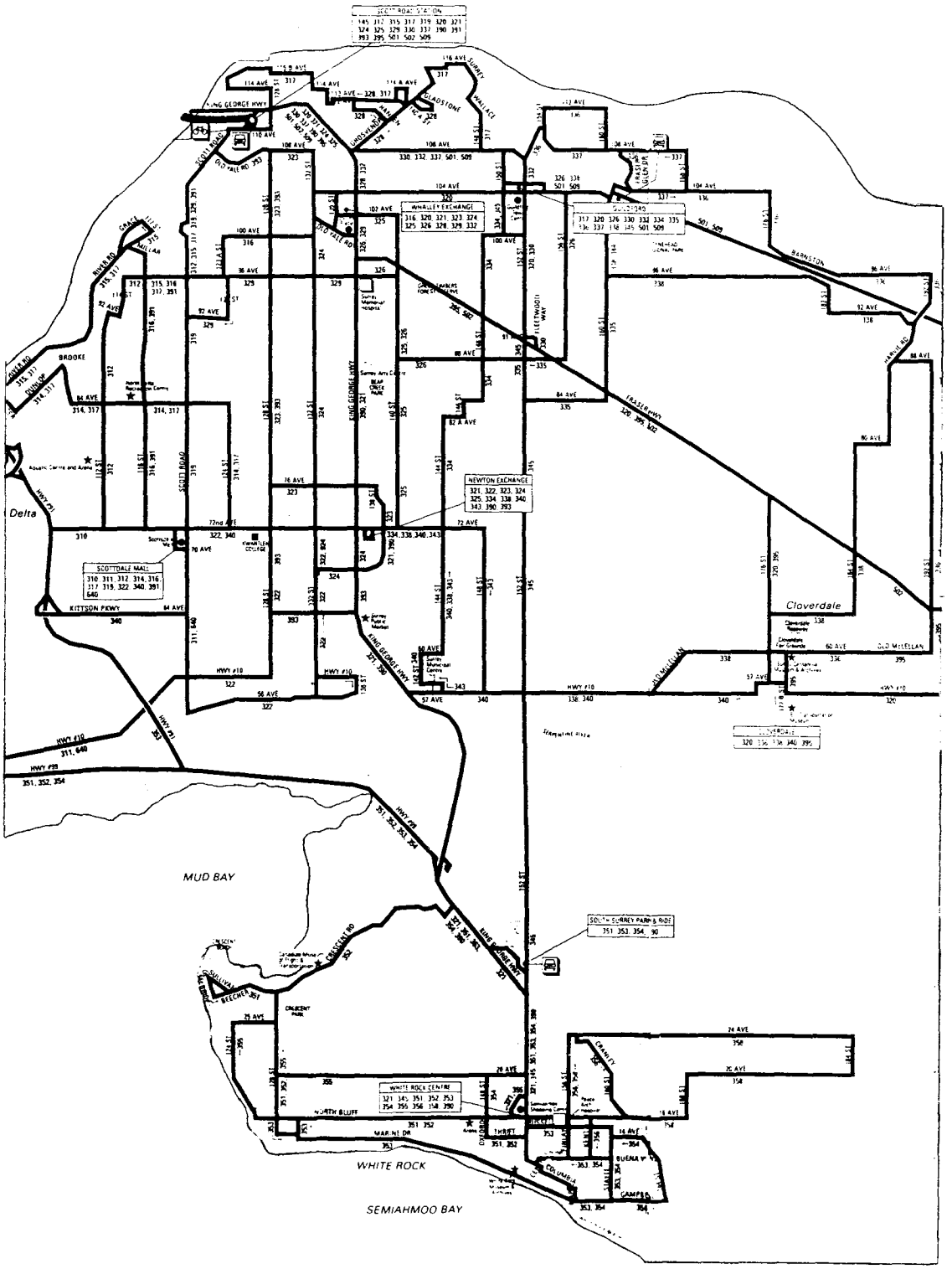
The transit system is strongly oriented to downtown Vancouver. This results in fairly good service for those suburb-to-suburb trips which follow traditional radial routes: the best example of this is the very high level of service for suburb-to-suburb trips along the SkyTrain line. However, for the majority of suburb-to-suburb trips, those which follow a more circumferential pattern, the service is generally poor. These types of trips are much more difficult to serve since they have such widely dispersed origins and destinations, and they cannot easily "piggyback" on the downtown-oriented services.

Transit service in Surrey is focussed on the Scott Road SkyTrain Station. From here, SkyTrain provides excellent express service to parts of New Westminster, Burnaby, and Vancouver. An extension of SkyTrain to Whalley will go into operation in 1994. Local bus routes in Surrey connect with at least one of the six transit exchanges located at the town centres. More frequent service connects the exchanges with each other and with Scott Road Station. Bus routes from North Delta and Langley also operate to some exchanges and to Scott Road Station, providing transit connections between Surrey and these adjacent suburban areas. To make these connections, one generally must first travel to one of the transit exchanges. As mentioned, the best suburb-to-suburb transit service from Surrey is to New Westminster and South Burnaby, along the SkyTrain route. Connections to other suburban areas generally involve circuitous routes or inconvenient transfers. Figure 4.6 details the transit system in Surrey.

4.5 Changing Commuting Patterns in Greater Vancouver

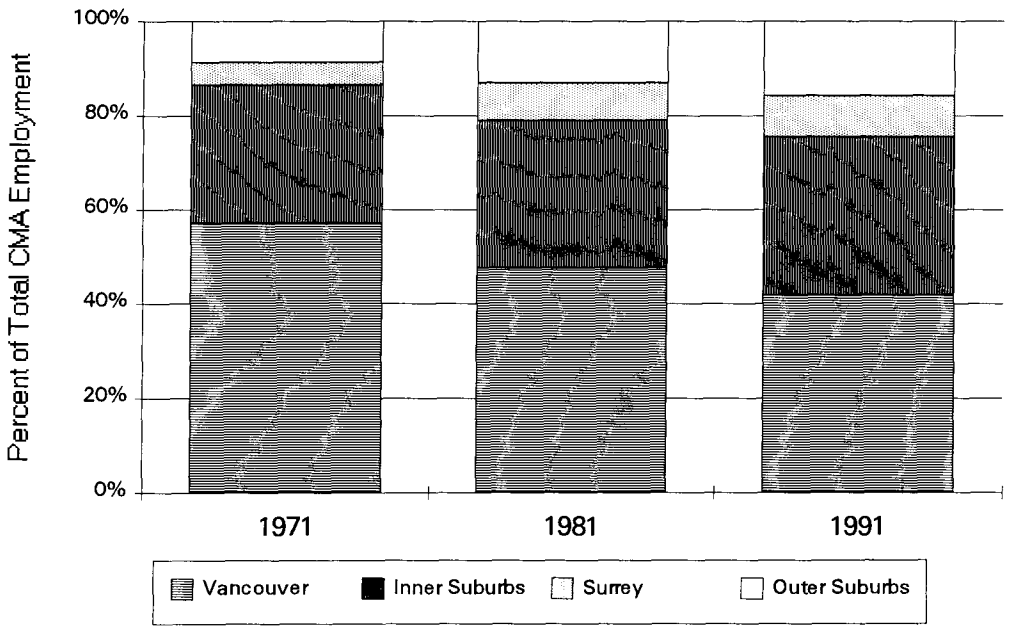
Before looking at the specific case of Surrey, it is helpful to first put the situation in a historical and region-wide context by examining the changing travel patterns and increasing suburb-to-suburb commuting in Greater Vancouver as a whole over the past two decades.

Figure 4.6 Transit Routes in Surrey



Like most North American metropolitan areas, Vancouver has experienced rapid growth in both suburban population and employment, leading to large increases in suburb-to-suburb commuting. Between 1971 and 1981, the share of regional employment in Vancouver's suburbs increased from 41 to 51 percent, and most of this increase occurred in the outer suburban areas (GVRD 1985). The employment share of the inner suburban areas increased slightly, from 29 to 34 percent, but all of this increase occurred in Richmond, while Burnaby/New Westminster and the North Shore maintained a stable proportion of regional employment. By contrast, employment in the outer suburban areas increased from 14 to 21 percent of the regional total. GVRD estimates indicate that these trends continued during the 1980s, with suburban areas accounting for 58 percent of regional employment in 1991. Of this, the inner suburbs accounted for 34 percent while the outer suburbs held 25 percent of the region's jobs. Figure 4.7 illustrates these changes.

Figure 4.7 Employment Distribution, 1971-1991



Source: GVRD, 1992.

Table 4.2 highlights another important trend during this period: an increasing tendency for people to live in one municipality and work in another. This type of commute grew at nearly three times the rate of commutes within a single municipality, and accounted for nearly 70 percent of work trip growth. The region is thus becoming more economically integrated. Obviously, this rise in long distance commuting has serious implications for transportation planning due to the increased pressure this puts on highways and other transportation infrastructure.

Table 4.2 Inter-Municipal Commuting Flows in Vancouver CMA, 1971-81.

	1971	1981	Increase 1971-81	% Increase 1971-81
Live and work in same municipality	204795	266730	61935	30.2%
Commute to different municipality	171195	315365	144170	84.2%
TOTAL	375990	582095	206105	54.8%

Percent Distribution	% of Total Flows 1971	% of Total Flows 1981	% of Increase 1971-81
Live and work in same municipality	54.5%	45.8%	30.1%
Commute to different municipality	45.5%	54.2%	69.9%
TOTAL	100.0%	100.0%	100.0%

Source: Statistics Canada

Types of work trips are further classified according to origin and destination in Table 4.3. Trips with suburban destinations, dominated by suburb-to-suburb trips, were clearly the fastest growing types, increasing at nearly twice the rate for all work trips. Suburb-to-suburb trips became the dominant type of commute during this period, increasing their share of total commuting flows from 35 to 44 percent while internal Vancouver trips dropped from 36 to 26 percent. Meanwhile, "traditional" commutes from the suburbs to Vancouver grew at roughly the same rate as for all work trips and maintained a constant share of about 22 percent. Suburb-to-suburb trips accounted for 61 percent of commuter growth in the region between 1971 and 1981.

Table 4.3 Commuting Flows in Vancouver CMA, 1971-81.

Commuting Flows	1971	1981	Increase 1971-81	% Increase 1971-81
Internal Vancouver	136255	150735	14480	10.6%
Suburbs-Vancouver	83455	125470	42015	50.3%
Vancouver-Suburbs	24450	47560	23110	94.5%
Suburb-Suburb	131830	258330	126500	96.0%
TOTAL	375990	582095	206105	54.8%

Percent Distribution	% of Total Flows 1971	% of Total Flows 1981	% of Total Increase 1971-81
Internal Vancouver	36.2%	25.9%	7.0%
Suburbs-Vancouver	22.2%	21.6%	20.4%
Vancouver-Suburbs	6.5%	8.2%	11.2%
Suburb-Suburb	35.1%	44.4%	61.4%
TOTAL	100.0%	100.0%	100.0%

Source: Statistics Canada

Vancouver appears to be fairly typical of large North American metropolitan areas in terms of suburb-to-suburb commuting. Such trips accounted for 45 percent of all commutes in U.S. metropolitan areas with more than 1 million people in 1980 (Pisarski 1987, 40). Among Canada's three largest metropolitan areas, suburb-to-suburb trips made up 48 percent of the total in 1981 (Statistics Canada 1983).

Figure 4.8 shows the transit mode split for the different types of commuting flows, based on the *Metropolitan Vancouver Origin-Destination Survey* (GVRD 1987). This survey will be used for a more in-depth analysis of Surrey's suburb-to-suburb commuting patterns in the next chapter. The key point to note from the figure is the very low transit use for suburb-to-suburb work trips: only 4 percent of such commutes were on transit compared with 13 percent for all work trips and 26 percent for work trips within the City of Vancouver. Thus, as Figure 4.9 illustrates, suburb-to-suburb commutes accounted for 46 percent of all work trips, but they made up less than 15 percent of transit work trips. The City of Vancouver is, by far, transit's most important market in the region; it is the destination for nearly 80 percent of transit work trips, and roughly half of all transit work trips have

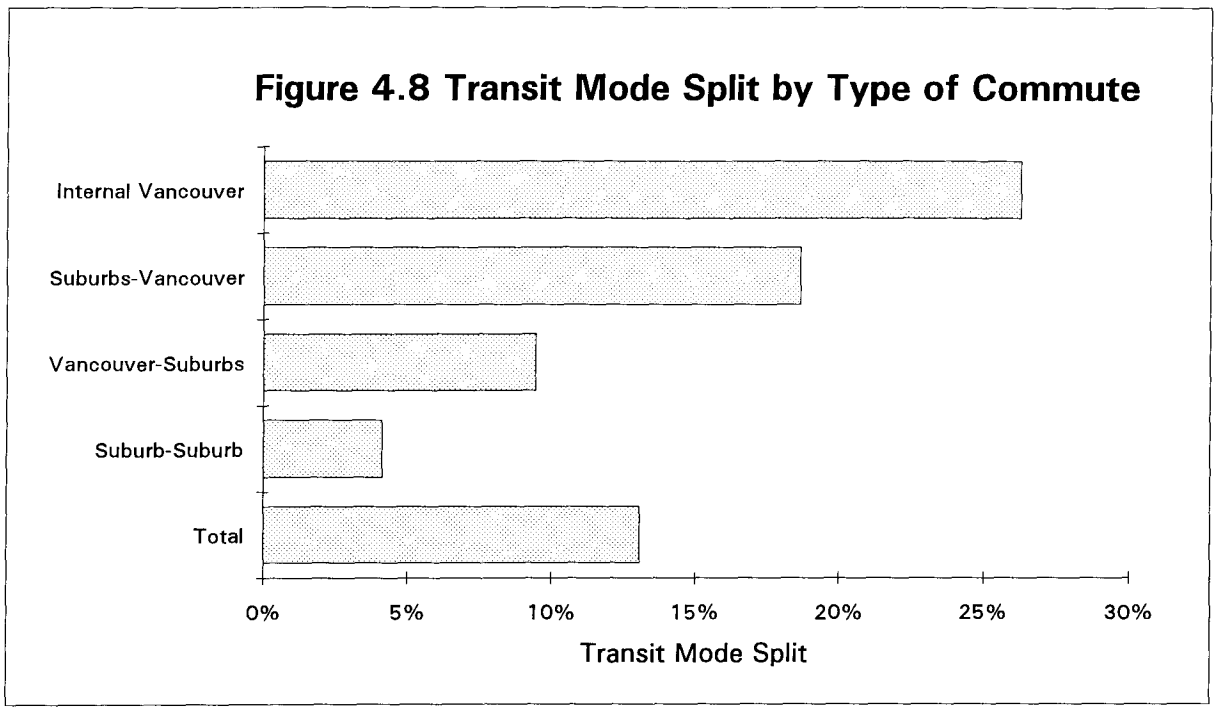


Figure 4.8 Transit Mode Split by Type of Commute
Internal Vancouver
Suburbs-Vancouver
Vancouver-Suburbs
Suburb-Suburb
Total
0%
5%
10%
15%
20%
25%
30%
Transit Mode Split

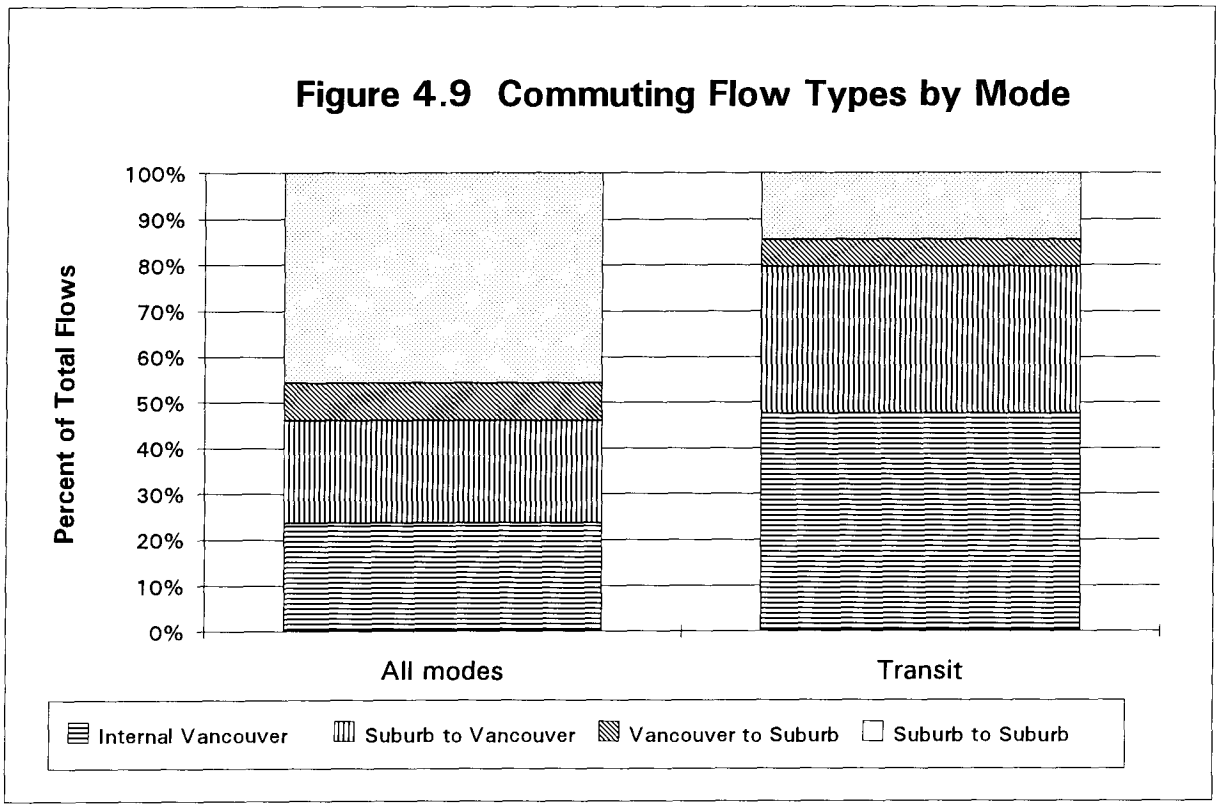


Figure 4.9 Commuting Flow Types by Mode
Percent of Total Flows
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
All modes
Transit
Internal Vancouver
Suburb to Vancouver
Vancouver to Suburb
Suburb to Suburb

both origins *and* destinations within the City. As was shown in Table 4.3, however, the internal Vancouver market is the slowest growing type of commute, and even the suburbs-to-Vancouver market is growing only half as fast as the suburb-to-suburb market. Thus, transit's growth potential in these markets is limited.

4.6 Summary

Greater Vancouver, like other North American cities, has seen a dramatic increase in suburb-to-suburb commuting over the past two decades. Similarly, Surrey, which plays a central role in the region's commuting patterns, is typical of other suburban areas experiencing rapid population and employment growth, along with the resulting transportation problems. The stage has now been set for a more detailed examination of suburb-to-suburb commuting in this key municipality.

CHAPTER 5. CASE STUDY: RESULTS

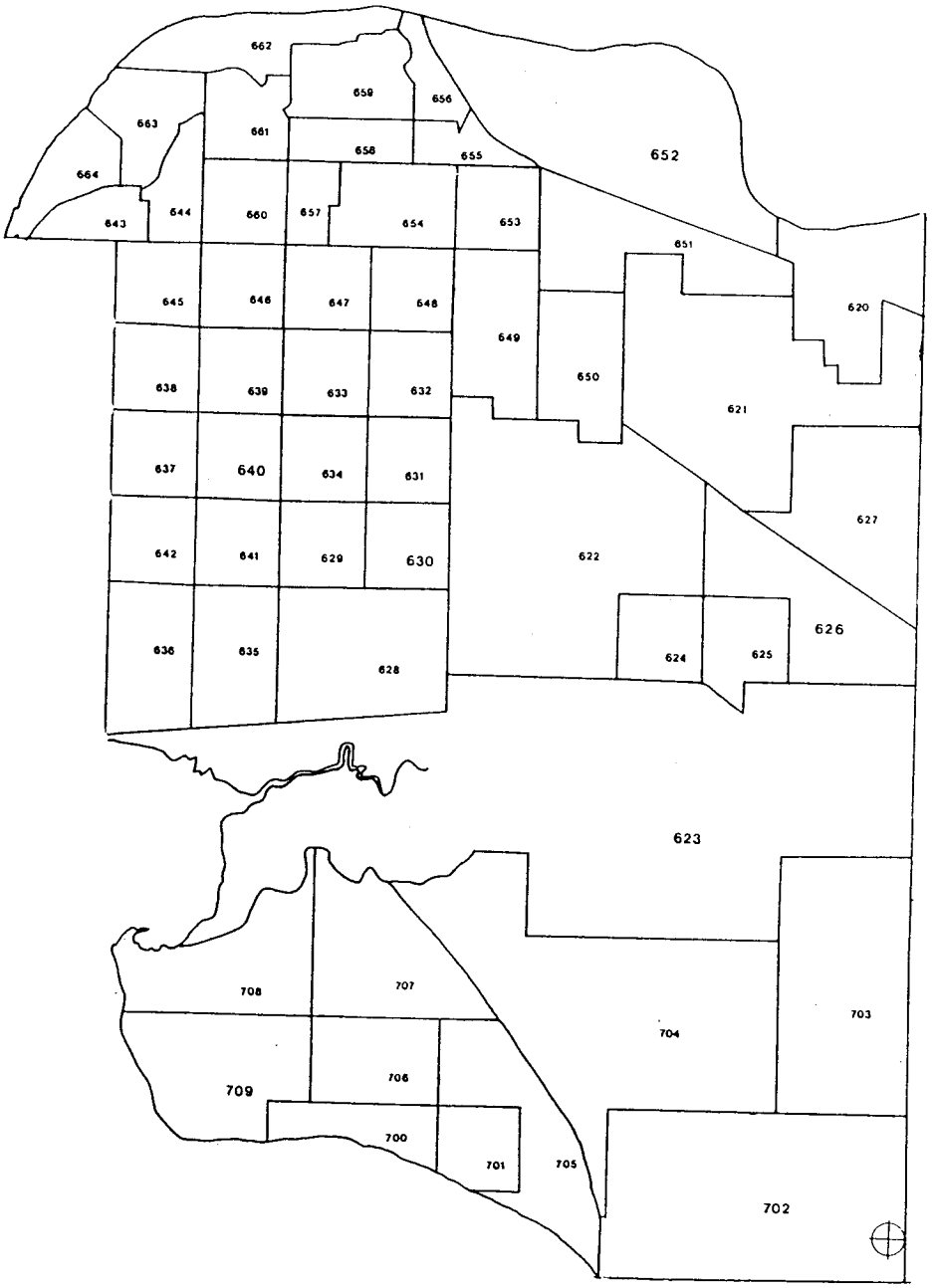
5.1 Introduction and Data Limitations

This second part of the case study involves a more detailed examination of suburb-to-suburb commuting to, from, and within Surrey. First some recent trends in the travel patterns of Surrey commuters will be reviewed. Work trip flow patterns and transit mode splits for different commute types will then be analyzed using data from the GVRD's *Metropolitan Vancouver Origin-Destination Survey*. The effect of residential and employment densities on transit use in Surrey will also be investigated.

Greater Vancouver has been divided into Traffic Zones (TZs), which are based on Census Tracts, and are used by the GVRD and its municipalities for transportation modelling and forecasting. In this part of the case study, data at the TZ level will be used for Surrey and White Rock, while the other suburban municipalities have been grouped into the same sub-regions as in Chapter 4. Most of the TZs in built up areas are about 2.5 km^2, larger in lower density areas. The 55 Traffic Zones in Surrey/White Rock had an average population of 3400 people in 1985. Figure 5.1 shows a map of Surrey Traffic Zones.

The information from the 1985 survey is beginning to get dated, especially in light of rapid population and employment growth in the region, as well as the introduction of SkyTrain and the reorganization of the area's transit system. The GVRD conducted a new origin-destination survey in the fall of 1992 and data on employment location from the 1991 Census will be released in 1993. Unfortunately, these new data were not available in time for this study. A brief section updating some of the factors affecting commuting in Surrey has been included at the end of the chapter. While there have been many changes, most of the basic relationships which are being investigated should remain

Figure 5.1 Traffic Zones in Surrey



the same. This study can serve as a base to describe the situation in 1985, and offers the opportunity for further study of the situation as conditions change.

There are certain limitations in the data. The *Origin-Destination Survey* was based on a sample of roughly 5 percent of the households in the Vancouver CMA. This sample size results in a relatively high margin of error for small disaggregate flows such as those between traffic zones. This is particularly a problem for transit flows, which tend to be much smaller than automobile flows. Wherever possible, data have been aggregated to reduce the margin of error. For this reason, the analysis looks at 24-hour work trip flows; while AM of PM peak flows would provide more information on the actual demand during these critical periods, the 24-hour data provide a larger sample size with less sampling error, yet still results in a good picture of commuting patterns in Surrey. Finally, the data used were only for vehicle trips, so cycling and walking trips will not be directly considered in the analysis.

5.2 Trends in Surrey Commuting Patterns

Further background to the 1985 situation in Surrey was provided by investigating recent trends in commuting patterns between Surrey as a whole and other sub-regions in Greater Vancouver. Table 5.1 shows the employment location for Surrey residents in 1971 and 1981. Rapid employment growth south of the Fraser River has resulted in a declining proportion of work trips that cross the river to the traditional employment locations in Vancouver, Burnaby, and New Westminster. The proportion of Surrey residents working in these municipalities declined from 45 to 35 percent during the period. By contrast, the share of Surrey residents working in their own municipality increased from 40 to 43 percent, and the proportion working in the neighboring South of Fraser suburbs of Richmond, Delta, and Langley increased from 9 to 16 percent. While Surrey's labor force doubled during this period, work trips to Richmond, Delta, and Langley nearly quadrupled. Work trips to South of Fraser locations (including Surrey itself) accounted for nearly 70 percent of commuter

Table 5.1 Commuting Flows for Surrey Residents, 1971-81.

Place of work	1971	1981	Increase 1971-81	% Increase 1971-81
Surrey	12375	27660	15285	123.5%
Vancouver	7240	13175	5935	82.0%
Burnaby/New West.	6770	9490	2720	40.2%
North Shore	540	1230	690	127.8%
Northeast Sector	1030	2150	1120	108.7%
Richmond	1115	4035	2920	261.9%
Delta	1035	3325	2290	221.3%
Langley	770	3275	2505	325.3%
Maple Ridge	70	300	230	328.6%
TOTAL	31060	64695	33635	108.3%

Percent Distribution

Place of work:	% of Total Flows 1971	1981	% of Total Increase 1971-81
Surrey	39.8%	42.8%	45.4%
Vancouver	23.3%	20.4%	17.6%
Burnaby/New West.	21.8%	14.7%	8.1%
North Shore	1.7%	1.9%	2.1%
Northeast Sector	3.3%	3.3%	3.3%
Richmond	3.6%	6.2%	8.7%
Delta	3.3%	5.1%	6.8%
Langley	2.5%	5.1%	7.4%
Maple Ridge	0.2%	0.5%	0.7%
TOTAL	100.0%	100.0%	100.0%

Source: Statistics Canada

Table 5.2 Commuting Flows by Mode for Surrey Residents, 1985.

Place of Work	All Modes	% of Total Flows	Public Transit	% of Transit Flows	Transit Mode Split
Surrey	19304	36.7%	864	23.5%	4.5%
Vancouver	11214	21.3%	1975	53.8%	17.6%
Burnaby/New West.	8311	15.8%	452	12.3%	5.4%
North Shore	1036	2.0%	107	2.9%	10.3%
Northeast Sector	2137	4.1%	29	0.8%	1.4%
Richmond	4409	8.4%	118	3.2%	2.7%
Delta	3244	6.2%	60	1.6%	1.8%
Langley	2689	5.1%	67	1.8%	2.5%
Maple Ridge	294	0.6%	0	0.0%	0.0%
TOTAL	52638	100.0%	3672	100.0%	7.0%

Source: GVRD, 1987.

growth. The trend in Surrey seems to be an increasing dominance of circumferential suburb-to-suburb commutes, while more traditional radial commutes to Vancouver and the inner suburbs are becoming relatively less important.

Table 5.2 shows employment locations for Surrey residents based on the *Origin-Destination Survey*, including a breakdown by mode. Because of differences in data collection, the absolute numbers are not directly comparable with those in Table 5.1, but the percentage distribution of total flows is comparable. The most important thing to note from Table 5.2 is the generally low rate of transit use by Surrey residents: the transit mode split for work trips was 7 percent, compared with 13 percent for Greater Vancouver as a whole in 1985. Not surprisingly, transit use from Surrey was much greater for trips to Vancouver (17.6 percent) than for trips to suburban destinations (4.0 percent). While Vancouver was the destination for 21 percent of all work trips from Surrey, it accounted for 54 percent of transit work trips made by Surrey residents. For work trips within Surrey, the transit mode split was 4.5 percent and this was the second largest transit market (24 percent of all transit work trips). Caution should be used when looking at the transit use between Surrey and some of the other suburban areas since inaccuracies may arise due to the small sample size. Overall, 3.6 percent of work trips between Surrey and other suburban areas were by transit. Transit use was particularly low for fast-growing circumferential commutes: Delta, Langley, and Richmond were the destinations for 20 percent of all work trips from Surrey, but only 6.6 percent of transit commutes from Surrey were to these areas.

The other side of Surrey's commuting picture involves those commuters who work in Surrey but live elsewhere in the region. Table 5.3 shows the place of residence for people who worked in Surrey in 1971 and 1981. During this period, employment in Surrey increased by 2.5 times. The outer suburban areas formed the fastest growing segment of Surrey's commuter market. Particularly impressive is the growth of commuters from Delta and Langley, which more than quadrupled, from 2230 to 9325 during the decade. The proportion of Surrey workers commuting from these two areas

Table 5.3 Commuting Flows for Surrey Workers, 1971-81

Place of Residence	1971	1981	Increase 1971-81	% Increase 1971-81
Surrey	12375	27660	15285	123.5%
Vancouver	1205	2795	1590	132.0%
Burnaby/New West.	1640	2960	1320	80.5%
North Shore	205	665	460	224.4%
Northeast Sector	730	1920	1190	163.0%
Richmond	300	830	530	176.7%
Delta	1335	5220	3885	291.0%
Langley	895	4105	3210	358.7%
Maple Ridge	110	480	370	336.4%
TOTAL	18845	46680	27835	147.7%

Percent Distribution

Place of Residence:	% of Total Flows		% of Total Increase
	1971	1981	1971-81
Surrey	65.7%	59.3%	54.9%
Vancouver	6.4%	6.0%	5.7%
Burnaby/New West.	8.7%	6.3%	4.7%
North Shore	1.1%	1.4%	1.7%
Northeast Sector	3.9%	4.1%	4.3%
Richmond	1.6%	1.8%	1.9%
Delta	7.1%	11.2%	14.0%
Langley	4.7%	8.8%	11.5%
Maple Ridge	0.6%	1.0%	1.3%
TOTAL	100.0%	100.0%	100.0%

Source: Statistics Canada.

Table 5.4 Commuting Flows by Mode for Surrey Workers, 1985.

Place of Residence:	All Modes	% of Total Flows	Public Transit	% of Transit Flows	Transit Mode Split
Surrey	19304	55.7%	864	64.8%	4.5%
Vancouver	2272	6.6%	106	7.9%	4.7%
Burnaby/New West.	2531	7.3%	165	12.4%	6.5%
North Shore	419	1.2%	0	0.0%	0.0%
Northeast Sector	1634	4.7%	42	3.1%	2.6%
Richmond	555	1.6%	0	0.0%	0.0%
Delta	3730	10.8%	138	10.3%	3.7%
Langley	3785	10.9%	0	0.0%	0.0%
Maple Ridge	420	1.2%	19	1.4%	4.5%
TOTAL	34650	100.0%	1334	100.0%	3.8%

Source: GVRD, 1987.

increased from 12 to 20 percent while the proportion commuting from Vancouver and Burnaby/New Westminster declined from 15 to 12 percent. Surrey residents held a majority of the jobs in the municipality throughout the period, although the proportion did decline slightly.

Table 5.4 is based on the *Origin-Destination Survey* and shows the place of residence for Surrey workers, broken down by mode. Transit use for work trips to Surrey is very low, considerably lower than for work trips from Surrey (3.8 versus 7.0 percent). Much of this difference can be accounted for by the sharp contrast in transit use between trips to and from Vancouver. While the transit mode split for work trips from Surrey to Vancouver was 17.6 percent, it was only 4.7 percent for Vancouver-to-Surrey work trips. This might indicate that the very high employment densities in downtown Vancouver are more influential on transit use than are the higher residential densities in Vancouver. This issue will be explored in more detail later. Overall, most transit work trips which ended in Surrey tended to be relatively short. Thus, 65 percent of these trips were made by Surrey residents while the next largest sources were residents of nearby Burnaby/New Westminster (12 percent) and Delta (10 percent). Only 8 percent of transit work trips to Surrey were made by Vancouver residents. Transit use to Surrey from other areas was negligible. This suburban workplace market offers tremendous growth potential, but also many challenges, for public transit.

Table 5.5 looks at Surrey's commuting balance, the number of people commuting into Surrey compared with the number of people commuting out of Surrey for each sub-region. As of 1981, Surrey was a net exporter of jobs to Vancouver and the inner suburban areas of Burnaby/New Westminster, the North Shore, and Richmond. By comparison, it had a fairly even commuting balance with the Northeast Sector and was a net importer of workers from the other outer suburban areas, particularly from Delta. These patterns clearly have important implications for transit planning. Transit service between Surrey and Richmond, for example, would need to focus on bringing Surrey residents to their jobs in Richmond while service to Delta or Langley would need a greater emphasis on Surrey as the place of employment.

Table 5.5 Commuting Balance in Surrey, 1981.

Origin/Destination:	Commute Into Surrey	Commute Out of Surrey	Commuting Balance
Vancouver	2795	13175	-10380
Burnaby/New West.	2960	9490	-6530
North Shore	665	1230	-565
Northeast Sector	1920	2150	-230
Richmond	830	4035	-3205
Delta	5220	3325	1895
Langley	4105	3275	830
Maple Ridge	480	300	180
TOTAL	46680	64695	-18015

Source: Statistics Canada.

5.3 Commuting Patterns: Traffic Zone Level

The Traffic Zone (TZ) data were used to provide a more detailed picture of commuting patterns both within Surrey, as well as between other suburban areas and specific parts of Surrey. Four origin-destination matrices (trip tables) were constructed. For internal Surrey work trips, origin and destination was recorded by TZ. For external suburb-to-suburb trips, the trip tables consisted of all work trips between each Surrey TZ and each of the other seven suburban sub-regions (as defined in Chapter 4). Trips between Surrey and Vancouver were not considered. In each case there was one table for all work trips and one for transit work trips.

Table 5.6 summarizes these commuting patterns, including transit mode split. A total of 53,536 suburb-to-suburb work trips were made to and from the 55 Surrey TZs. About 40 percent of the trips were internal, both beginning and ending in Surrey. Nearly one-tenth of *these* trips both began and ended in the same TZ (intra-TZ). The remaining internal Surrey trips began in one TZ and ended in another (inter-TZ). External suburb-to-suburb trips made up 60 percent of the total. Nearly two-thirds of these trips were from Surrey to other suburbs while just over one-third were from other suburbs to Surrey.

Table 5.6 Summary of Surrey Commuting Flows

	All Trips	% of Total Flows	Transit Trips	Transit Mode Split
Internal Surrey Trips	21014	39.3%	704	3.4%
Intra-TZ	1984	3.7%	0	0.0%
Inter-TZ	19030	35.5%	704	3.7%
External Suburban Trips	32522	60.7%	1185	3.6%
Surrey-Other Suburb	20495	38.3%	837	4.1%
Other Suburb-Surrey	12027	22.5%	348	2.9%
TOTAL	53536	100.0%	1889	3.5%

Source: GVRD 1985 Origin-Destination Survey

The transit mode split was consistently low for all commute types. There was little difference in transit use between internal and external trips. Transit mode split was highest for trips from Surrey to other suburbs, while trips from other suburbs to Surrey had a significantly lower mode split. Also of note is the 0 percent transit mode split for intra-TZ trips. Transit use is very low for these short suburban trips (which would generally be less than a kilometre given the size of most TZs). Low service frequencies are likely an important factor: the waiting time would be considerably longer than the travel time for such short trips, making transit a very unattractive option. Many of these trips would likely be made by walking or cycling and are thus not recorded in the data.

The TZ-to-TZ trips made within Surrey display a highly dispersed pattern. While the 21,014 internal Surrey work trips represent a large total flow of commuters, the number of trips between any given pair of TZs is generally small. Table 5.7 shows a distribution of such trips by size of flow between TZ pairs. Of course, the size of the TZs is quite arbitrary and this will affect the size of the flows; the point of Table 5.7 is simply to illustrate the dispersed nature of the commuting flows. As shown, TZ-TZ flows of less than 50 commuters accounted for nearly 75 percent of total work trips within Surrey. Only 24 out of 3,025 possible TZ pairs had flows greater than 100. Figure 5.2 shows two-way TZ pair flows of greater than 100 commuters, graphically illustrating the dispersed nature of commuting patterns in Surrey

Figure 5.2 Commuting Flows Between TZ Pairs
(100 or more trips)

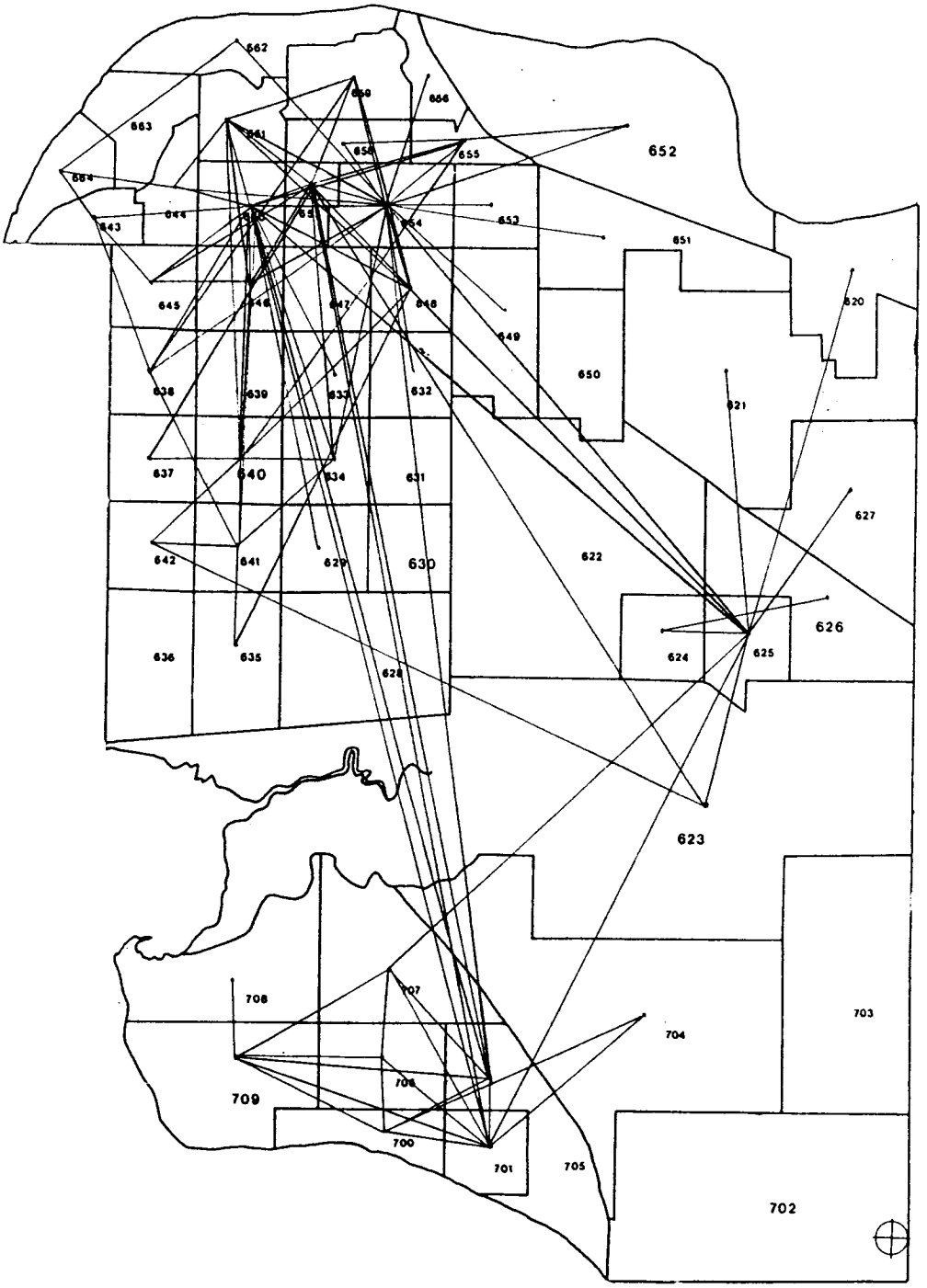


Table 5.7 Size Distribution of Commuting Flows Between Surrey TZ Pairs

Size of Flow	Number of Flows	Number of Trips	Percent of Total Trips
150+	10	2105	10.0%
100-149	14	1674	8.0%
50-99	81	5363	25.5%
0-49	2920	15651	74.5%
All Flows	3025	21014	100.0%

Source: GVRD 1985 Origin-Destination Survey

5.4 Nodal Patterns

While commuting patterns in Surrey are highly dispersed, there are some clusters of TZs which attract a greater concentration of work trip flows. Most of these TZs are located in and around the five Surrey town centres discussed in Chapter 4. Table 5.8 shows the top 25 TZs when ranked according to the total number of suburb-to-suburb work trips made to and from each TZ. Of the 25 TZs shown, 15 are located in the town centre areas; in fact, all of the first 12 TZs on the list are in town centres. Travel to, from, and between these nodes likely represents the most promising potential market for transit since these are usually the largest and most concentrated flows. If more travel can be routed through these nodes, they will become even more attractive for transit service. It is therefore helpful to examine the commuting patterns of these nodes in more detail. (In the discussion which follows, it should be noted that the terms node and town centre are used interchangeably.)

For the purpose of this study, all TZs that include part of a town centre were grouped together. The five town centres are Whalley, Guildford, Newton, Cloverdale, and White Rock (which includes the South Surrey town centre as defined in Surrey's Official Community Plan). The town centres are shown with their constituent TZs in Figure 5.3. This definition for the town centres results in overbounding; areas of lower density residential and even vacant land are sometimes included depending on the TZ boundaries.

Table 5.8 TZs Ranked by Total Suburban Flows

TZ	Internal Surrey		Other Suburbs		Total
	From TZ	To TZ	From TZ	To TZ	Suburban Flows
660	856	1774	747	1085	4462
654	541	2086	371	1453	4451
700	688	1594	418	320	3020
701	1223	902	550	215	2890
657	512	1173	212	578	2475
641	568	497	763	570	2398
661	579	714	612	466	2371
655	854	389	860	116	2219
640	275	1001	293	539	2108
634	787	345	822	72	2026
625	635	699	375	293	2002
705	1002	470	426	89	1987
646	810	266	738	135	1949
659	683	132	1074	0	1889
648	818	192	710	158	1878
645	410	301	804	239	1754
709	721	389	526	21	1657
638	176	613	292	525	1606
643	403	285	743	148	1579
658	348	477	535	166	1526
704	718	38	584	58	1398
662	246	336	416	343	1341
706	349	424	347	196	1316
637	245	259	517	195	1216
649	443	183	465	83	1174

Source: GVRD 1985 Origin-Destination Survey

Figure 5.3 Town Centres in Surrey
Defined by Traffic Zones

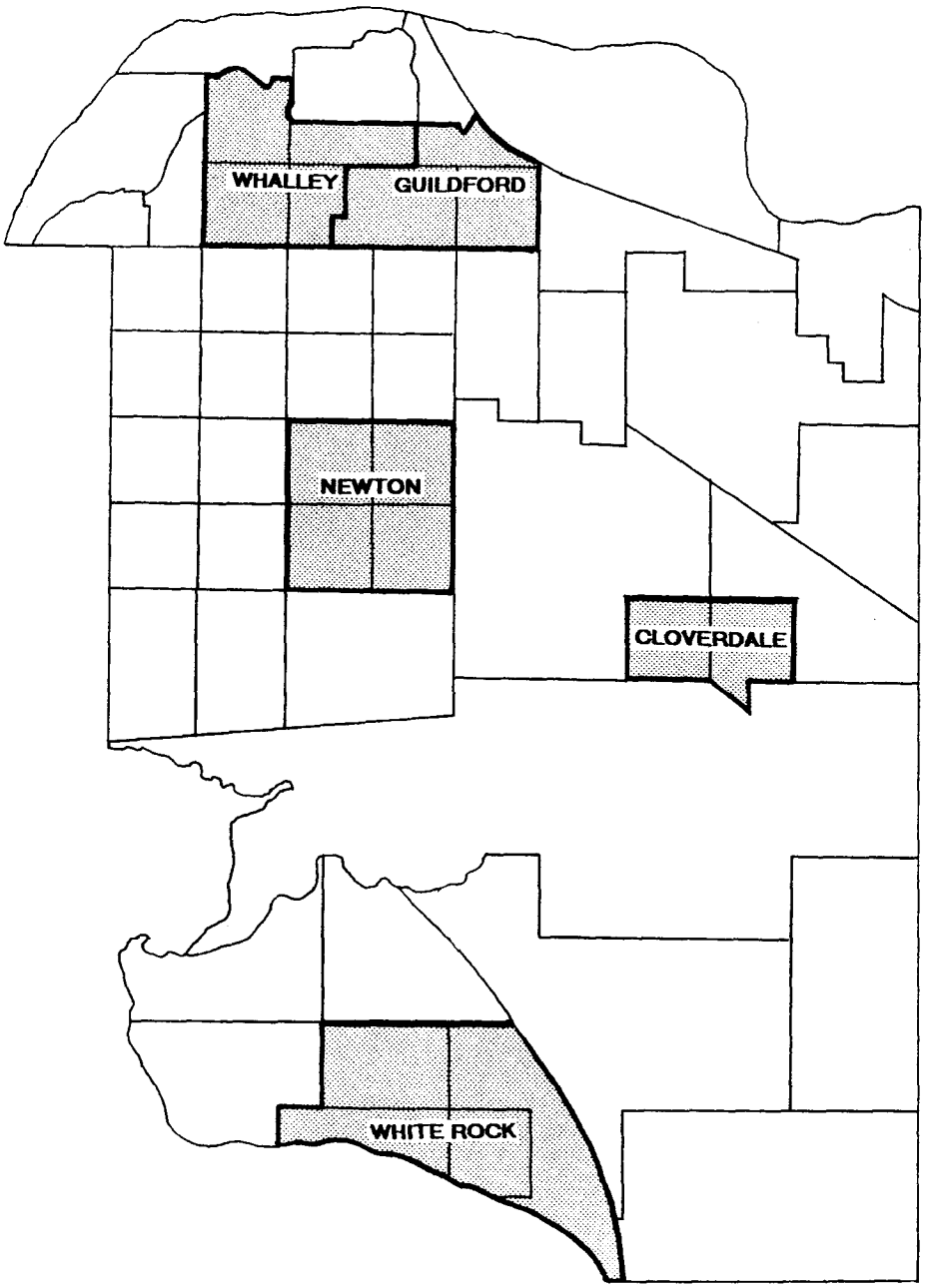


Table 5.9 summarizes some of the features of the five town centres. In 1985, these areas contained about 44 percent of Surrey's population and 58 percent of its jobs. Both population and employment densities are considerably higher in the town centres than in the rest of Surrey. As will be discussed in more detail later, this contributes to higher transit use for trips to and from the town centres. The transit mode split for all work trips originating in the town centres was nearly 50 percent higher than for the rest of Surrey. For trips going to the town centres the difference was even greater: transit use was about twice as high as for work trips to other Surrey locations.

Table 5.9 Summary of Surrey Town Centre Characteristics

	Population		Employment		Transit Mode Split	
	Total 1985	Per km2	Total 1985	Per km2	Origin	Destination
Whalley	19874	2322	6772	791	11.4%	5.2%
Guildford	12971	1782	4457	612	8.6%	5.5%
Newton	17251	1887	3516	385	10.6%	3.9%
Cloverdale	8696	1689	1415	275	0.0%	0.0%
White Rock	24201	1566	4200	272	11.2%	2.4%
Total Town Centres	82993	1821	20360	447	9.6%	4.1%
Other Surrey	104292	395	14521	55	6.7%	2.0%
Total Surrey	187285	605	34881	113	8.0%	3.2%

Source: GVRD 1985 Origin-Destination Survey

5.4.1 Internal Surrey Trips

The town centres form nodes which are very important in the overall commuting pattern within Surrey, as shown in Table 5.10. Nearly one-third of commutes within Surrey both began and ended in these nodes. Of these "nodal" trips, over half were made within a single node (intra-nodal) while the remainder were made between nodes (inter-nodal). Nearly half of all internal commutes were between the nodes and other parts of Surrey. Of these, about two-thirds were directed to the nodes while a third were from the nodes. The remaining commutes, which represented only about one-fifth of Surrey work trips, had neither an origin nor a destination in the nodes.

Table 5.10 Nodal Commuting Flows within Surrey

Flows:	All Trips	% of Total Flows	Transit Trips	Transit Mode Split
Nodal	6893	32.8%	361	5.2%
Intra-nodal	3861	18.4%	38	1.0%
Inter-nodal	3032	14.4%	323	10.7%
Between Nodes and Non-nodes	9765	46.5%	255	2.6%
Non-nodes to Nodes	6350	30.2%	232	3.7%
Nodes to Non-nodes	3415	16.3%	23	0.7%
Non-nodal	4356	20.7%	88	2.0%
Total Internal Flows	21014	100.0%	704	3.4%

Source: 1985 GVRD Origin-Destination Survey

Table 5.10 also includes information on transit mode split. The transit share for nodal commutes was about twice as high as for other commute types. The 5.2 percent mode split for transit is still very low, however, given the advantages transit has in this market (large, relatively non-dispersed flows) and indicates further potential for transit. Another important point to note from Table 5.10 is the much higher transit share for inter-nodal trips compared with intra-nodal trips (10.7 versus 1.0 percent). A similar argument can be made here as for the intra-TZ trips: transit use is very low for these short trips because of the ratio of access and waiting time to travel time. These short trips could represent a critical new market for transit and will be discussed in more detail later. It is not surprising that non-node to node trips have a much higher transit mode split than node to non-node trips (3.7 versus 0.7 percent).

Table 5.11 shows the total flows between the five town centres. Whalley is most important as both an origin and destination. The largest inter-nodal flows (200+ commuters) were to Whalley from Guildford, Newton, and White Rock, and from Whalley to Guildford and Newton. These large flows represent an excellent niche for transit. White Rock has a much greater proportion of intra-nodal flows than the other town centres, indicating perhaps it is less integrated with the rest of Surrey than are the other nodes.

Table 5.11 Commuting Flows Between Town Centres

From: \ To:	Whalley	Guildford	Newton	Cloverdale	White Rock	All Town Centres
Whalley	734	314	288	22	45	1403
Guildford	439	573	148	42	56	1258
Newton	446	134	483	95	83	1241
Cloverdale	19	95	38	291	38	481
White Rock	329	187	133	81	1780	2510
All Town Centres	1967	1303	1090	531	2002	6893

Source: GVRD 1985 Origin-Destination Survey

5.4.2 Trips Between Surrey and Other Suburbs

The flows between the nodes and other suburban areas also represent important markets for transit. Table 5.12 shows that about 41 percent of commutes from Surrey to other suburbs began in the nodes, while about 54 percent of other-suburb-to-Surrey trips ended in the nodes. Among trips to other suburbs, the transit share was much higher for those originating in the nodes (7.3 versus 1.9 percent). Among trips from other suburbs, however, the transit share was slightly lower for trips to the nodes (2.7 versus 3.1 percent). This is very surprising but could be due to sampling error.

Table 5.12 Commuting Flows Between the Nodes and Other Suburbs

	All Trips	Node/Non-node Distribution	Transit Trips	Transit Mode Split
Nodes to Other Suburbs	8348	40.7%	609	7.3%
Non-node to Other Suburbs	12147	59.3%	228	1.9%
Total Surrey to Other Suburbs	20495	100.0%	837	4.1%
Other Suburbs to Nodes	6448	53.6%	176	2.7%
Other Suburbs to Non-node	5579	46.4%	172	3.1%
Other Suburbs to Surrey	12027	100.0%	348	2.9%

Source: GVRD 1985 Origin-Destination Survey

Table 5.13 shows the flows from the seven suburban sub-regions to the five town centres in Surrey. Delta and Langley are by far the most important sources of commuters to Surrey, and the

Table 5.13 Commuting Flows From Other Suburbs to Surrey

From: \ To:	Whalley	Guildford	Newton	Cloverdale	White Rock	All Nodes	Non-nodes	Total Surrey
North Shore	56	73	65	0	18	212	203	415
Burnaby/New West.	387	292	166	0	46	891	1185	2076
Northeast Sector	281	423	65	16	79	864	700	1564
Richmond	109	46	42	0	55	252	176	428
Delta	780	325	535	81	415	2136	1483	3619
Maple Ridge	56	89	59	16	0	220	163	383
Langley	626	453	347	240	207	1873	1669	3542
TOTAL	2295	1701	1279	353	820	6448	5579	12027

Source: GVRD 1985 Origin-Destination Survey

Table 5.14 Commuting Flows From Surrey to Other Suburbs

From: \ To:	North Shore	Burnaby/ New West.	Northeast Sector	Richmond	Delta	Maple Ridge	Langley	TOTAL
Whalley	114	1161	287	193	195	24	132	2106
Guildford	86	700	366	147	99	0	226	1624
Newton	44	766	322	491	406	19	155	2203
Cloverdale	0	289	76	157	40	0	112	674
White Rock	41	501	37	627	205	0	330	1741
All Nodes	285	3417	1088	1615	945	43	955	8348
Non-nodes	636	5028	1082	2289	1342	109	1661	12147
Total Surrey	921	8445	2170	3904	2287	152	2616	20495

Source: GVRD 1985 Origin-Destination Survey

town centres are the destination for 50-60 percent of these commuters. Some of these flows are quite large and could represent excellent potential transit markets. For example, the flows from Delta and Langley to Whalley each consist of 600-800 commuters. It must be noted, however, that the trip origins within the sub-regions are likely to be quite dispersed, as is the case in Surrey. Not surprisingly, the largest flows to each town centre are from those sub-regions with the best transportation access to that centre. For example, Delta is the most important source of commuters to Whalley, Newton, and White Rock, while Langley is the most important source of commuters to Guildford and Cloverdale. Burnaby/New Westminster and the Northeast Sector are the next most important sources of commuters. Burnaby/New Westminster commuters appear to be less oriented to the nodes than those from other sub-regions. The primary nodal destination for Burnaby/New Westminster commuters was Whalley, for which there are already quite good transit connections. The primary destination for Northeast Sector commuters was Guildford (it is closest to the Port Mann Bridge which connects Coquitlam to Surrey). This was one of the largest flows and represents a potential market which currently has poor transit service. The North Shore, Richmond, and Maple Ridge are generally unimportant sources of commuters.

Table 5.14 shows the commuting flows from the town centres to the suburban sub-regions. By far the most important single destination was the more traditional radial commute to Burnaby/New Westminster, with its fairly good transit service from Surrey. However, as we have seen, this is one of the more slowly growing commuter markets. Richmond, which was the next most important destination, is a much faster growing commuter market and it has much poorer transit connections. There were particularly strong flows to Richmond from White Rock and Newton. The Northeast Sector was also an important and rapidly growing destination for Surrey commuters which again has poor transit connections. Most trips to the Northeast Sector were from North Surrey, with Guildford being the most important origin. Routes from South Surrey to Richmond and from North Surrey to the Northeast Sector might be good candidates for improved transit service. Of course the problem

again arises that destinations in Richmond, the Northeast Sector, as well as the other sub-regions are also likely to be quite dispersed.

5.5 Effect of Density on Transit Use

The literature contains numerous studies examining the positive effect of urban densities on transit use. However, in looking at this relationship, most of these studies have compared suburban areas with the central city or the CBD. An examination of the effect on transit use of different residential and employment densities within a suburban area, in this case Surrey, is therefore valuable because it may help to identify what types of suburban development are most amenable to transit.

The relationship between the residential density and transit use was investigated first, using gross population density for each Surrey TZ and the transit mode split for work trips originating in each zone. A linear regression was performed on the data, and transit use was found to be positively correlated with residential density, although the relationship was fairly weak. The R-Squared (coefficient of determination) was found to be 0.342, meaning that only 34 percent of the variance in transit mode split can be explained by differences in residential density. By comparison, Pushkarev and Zupan (1977, 26) found that residential density could explain 57 percent of the variance in transit use. Figure 5.4 shows this weak positive relationship between these two variables, and the considerable variation of the points around the regression line.

This weaker than expected correlation likely occurred for a number of reasons. The mode split data are subject to considerable sampling error due to the small sample size for transit riders in individual TZs. Another factor is the level of transit service, which obviously affects transit use. Some low-density TZs are bordered by well served transit routes, producing mode splits that are higher than expected based on density alone. A major source of weakness in the data results from the use of gross densities rather than net residential densities, which were not available. Most studies

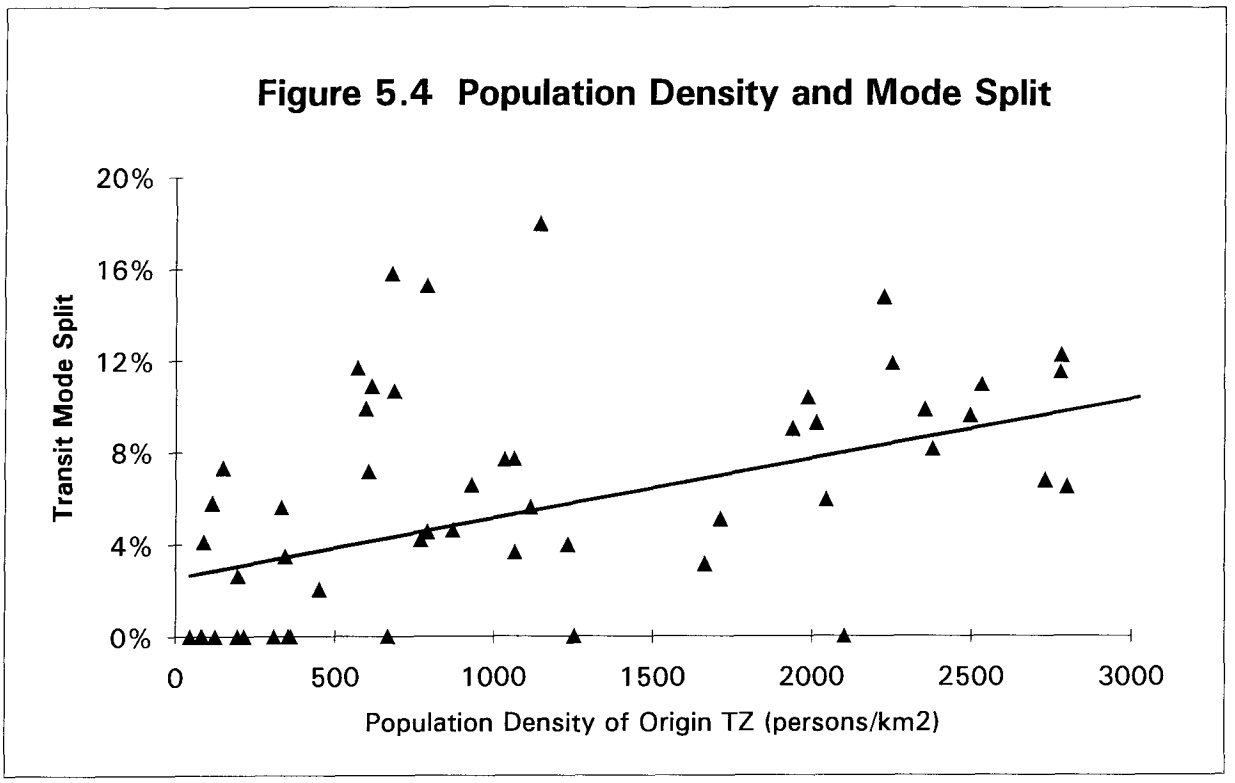


Figure 5.4 Population Density and Mode Split
Transit Mode Split
20%
16%
12%
8%
4%
0%
0
500
1000
1500
2000
2500
3000
Population Density of Origin TZ (persons/km2)

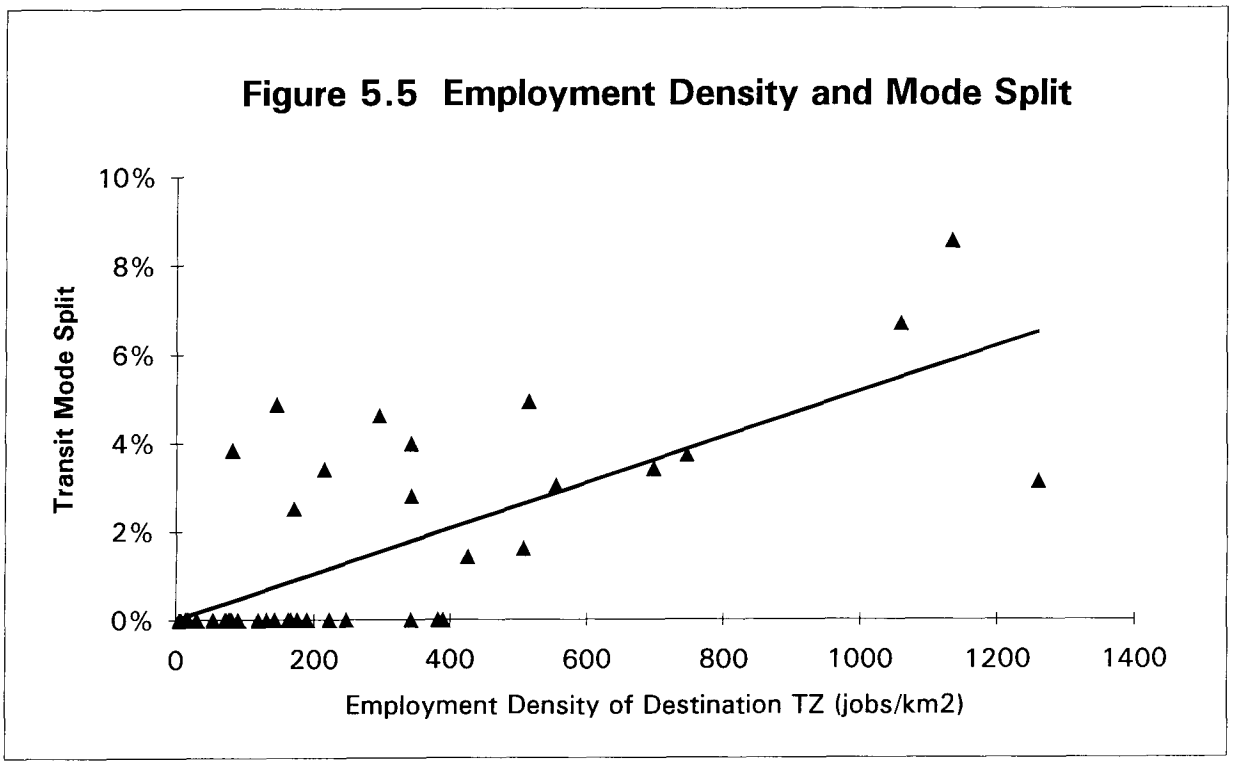


Figure 5.5 Employment Density and Mode Split
Transit Mode Split
10%
8%
6%
4%
2%
0%
0
200
400
600
800
1000
1200
1400
Employment Density of Destination TZ (jobs/km2)

have related transit use to net density, but this can vary for any given gross density depending on the amount of non-residential land in the TZ. For example, some TZs have a low gross density due to large tracts of vacant land, when in fact the majority of residents live in a small part of the zone at a relatively high net density. The three data points in Figure 5.4 which are furthest from the regression line represent such TZs (638, 640, and 709).

The relationship between transit use and population density is likely not a purely linear one. As was noted in Chapter 2, Pushkarev and Zupan found that there was a greater change in transit use at the upper and lower extremes of density. The Surrey data appear to support this. For trips originating in TZs with residential densities below 500 persons/km^2, the transit mode split was well below the mean for Surrey (3.2 versus 7.0 percent). In fact, the mode split was 0 percent for 10 of the 17 TZs in this density range. In the middle range of densities (500 to 2000), the mode split showed much more variability, and there was little or no discernible linear relationship. When densities exceeded 2000, the mode split averaged 9.5 percent, and the data points were once again more clustered around the regression line. Thus, transit use appears to be most sensitive to population density at the upper and lower extremes.

Next, the relationship between gross employment density, as measured by jobs/km^2 for each TZ and the transit mode split for work trips to each zone, was investigated. Linear regression analysis of the data indicates that there is a positive correlation between transit use and employment density. Figure 5.5 shows the relationship. The R-Squared was found to be 0.535, meaning that employment density can explain about 54 percent of the variance in the transit mode split. Thus the correlation with employment density appears to be stronger than with population density. This agrees with the finding earlier in this chapter that transit use was much higher for work trips from Surrey to Vancouver than vice versa. The effect on transit use of Vancouver's relatively high employment densities was greater than the effect of its relatively high population density.

As with population density, the relationship between transit use and employment density appears to be stronger at the extremes of density. Transit mode split was extremely low for employment densities below 200 jobs/km^2 (0.5 versus an average of 3.8 percent for all work trips to Surrey), and 27 of the 30 TZs in this range had a 0 percent transit mode split. The increase in transit use at higher densities was not quite so dramatic, with a mode split of 5.1 percent for TZs with employment densities above 500. The same sources of error discussed for population density apply to the employment density data as well. Employment density is even more susceptible to the error resulting from the gross densities, since employment is rarely spread evenly throughout a TZ.

These observed relationships generally agree with those of Pushkarev and Zupan who were comparing downtowns with suburban areas. The case study findings support the idea of threshold densities, above or below which there can be significant changes in transit use. In the case of Surrey, the lower threshold is most apparent, resulting in the most significant changes in transit use, with the mode split dropping sharply at population densities below 500 persons/km^2 and at employment densities below 200 jobs/km^2. Increases in transit use above the upper threshold were not as great as those observed by Pushkarev and Zupan, likely because there are few areas in Surrey with high population or employment densities. The case study also agreed with Pushkarev and Zupan in the finding that employment density had a greater effect than population density on transit use.

It is important to note that at least part of the difference in observed transit use can be explained by the greater level of transit service already in place in areas with higher population and employment densities. However, these high service levels are largely a result of the higher densities which made the transit service feasible in the first place; this relates to the positive feedback loop described by Pushkarev and Zupan in Chapter 2.

5.6 Surrey in 1993: An Update

Surrey has continued to experience rapid population and employment growth. The population of the Surrey/White Rock area increased from 187,285 in 1985 to 261,487 in the 1991 Census, an increase of 40 percent in just six years. Employment increased from 57,000 in 1986 to an estimated 71,000 in 1991 (GVRD 1992). There has been rapid development at the town centres. Whalley in particular is poised for spectacular growth with the arrival of SkyTrain in 1994. Growth has also been very rapid in Newton, which serves the area where much of the residential growth has been concentrated. There have also been some important changes in the transportation system between 1985 and 1993. The major change in the road system has been the addition of the Alex Fraser Bridge and Highway 91, providing much better connections from the Newton area to Richmond and to New Westminster. The major change in the transit system has been the addition of SkyTrain. This has been accompanied by improved and reorganized local service in Surrey to connect with SkyTrain.

5.7 Summary

This detailed investigation of suburb-to-suburb commuting in Surrey has resulted in some important findings. It has shown just how highly dispersed these work trips are, yet it has also revealed that there are some flows within and between the nodes which are more concentrated, and offer the most promising market for transit. Transit use was relatively high for the inter-nodal flows, but there is clearly room to expand transit's role. For the intra-nodal flows, transit use was extremely low; this represents a key market with great potential for improved transit service. There is also potential for better transit to serve fast-growing circumferential commutes between Surrey and other suburban areas like Richmond and the Northeast Sector. Finally, this investigation has shown that, even within a suburban area, there are important relationships between transit use and differences in density, particularly employment density.

CHAPTER 6. CASE STUDY: THE RESPONSE IN SURREY

6.1 Introduction

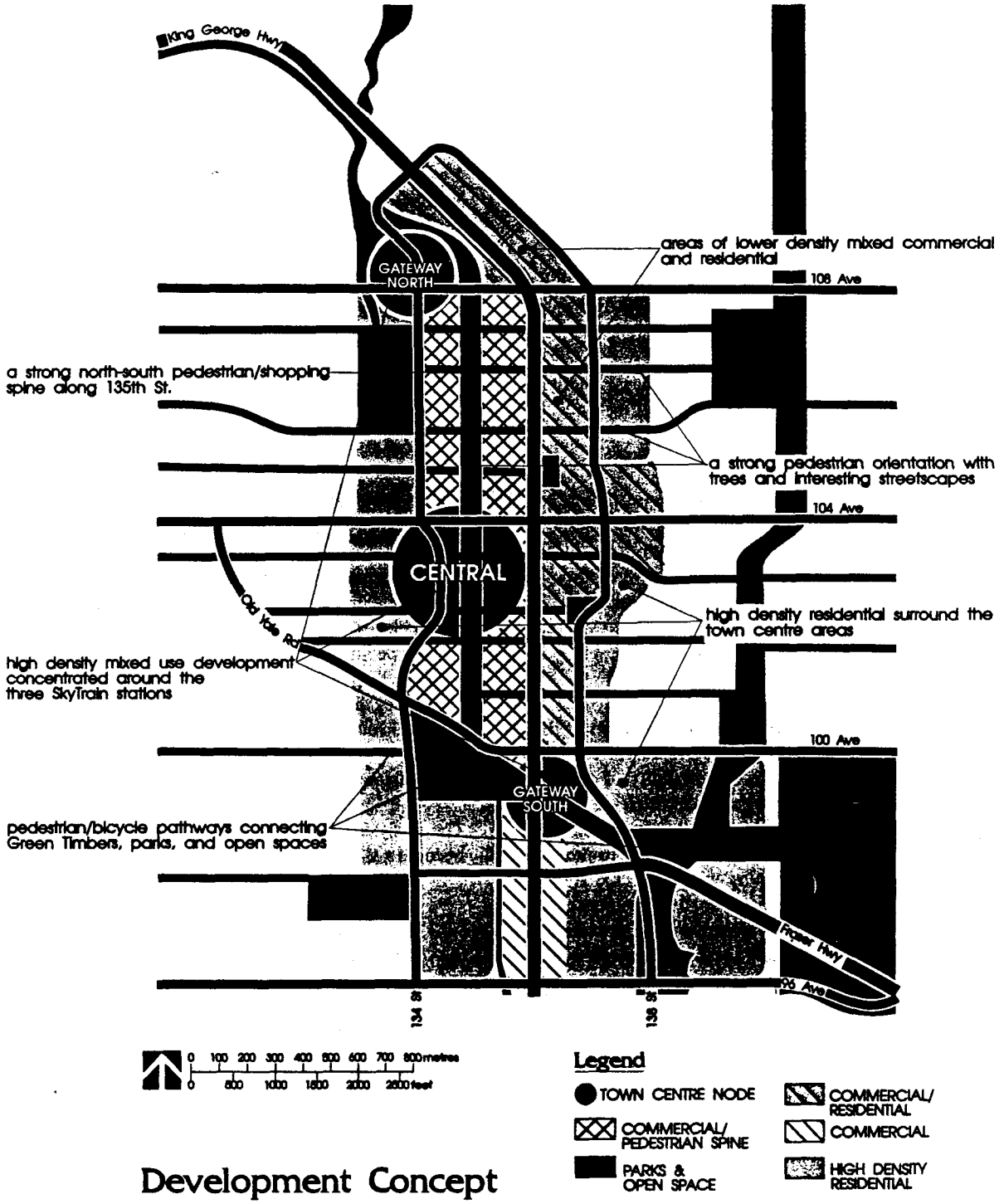
This final component of the case study will examine how Surrey, the GVRD, and BC Transit have responded to the challenge of promoting transit use for suburb-to-suburb commuting. Public attitudes toward transit in Greater Vancouver, which could provide some important insights on the most effective strategies to adopt, will also be reviewed. The information presented here should complement the quantitative analysis of the previous chapter, and help to create a clearer picture of the state of suburb-to-suburb transit service in Surrey.

6.2 The Response by the Municipality

Surrey's efforts to promote transit use have mostly been through land use strategies (Surrey Planning Department 1986 and 1992). In particular, Surrey plans to actively promote its town centres in order to prevent further sprawl and encourage a denser development pattern that is more pedestrian oriented and more easily served by transit. The Official Community Plan calls for net residential densities in the town centres to range from 30 to 330 units per hectare, compared with the very low densities of around 10 units per hectare in a typical single family area in Surrey.

Surrey is also beginning to promote transit and pedestrian friendly design features. These features are particularly evident in the design for Surrey's major town centre, Whalley, which is being developed along the SkyTrain route. Figure 6.1 shows the plan for Surrey City Centre (Whalley's new official name). It consists of high density commercial and residential development clustered around the SkyTrain stations. An important feature of the plan will be the creation a pedestrian oriented shopping spine along 135th Street which aims to move the focus of the community away from the automobile strip development along the King George Highway.

Figure 6.1 Plan for Surrey City Centre



Source: Whalley Town Centre Plan, Surrey Planning Department, 1992.

The municipality is also looking at ways to improve transit service between the town centres (Dickenson 1992). An HOV lane along 104th Avenue is currently being proposed to provide faster transit service between Whalley and Guildford, as well as to promote greater use of carpools. There are also a proposals for HOV lanes on the King George Highway connecting Whalley with Newton and White Rock, and on the Fraser Highway connecting Whalley with Langley. The ultimate goal would be a network of HOV lanes on the major arterials connecting Surrey's town centres. Currently, this initiative is at the conceptual stage. Surrey is also planning to reserve a right of way for any future rapid transit extension between Whalley and Guildford.

Surrey is just beginning to consider transportation demand management and currently there are no TDM strategies in place. One strategy being discussed would be to manage parking at the town centres. Surrey presently negotiates with developers to reduce parking requirements if it is believed that there will be substantial transit use to the development. It is also looking at restricting on-street parking in some areas to residents only (Lai 1993). The parking restrictions that Surrey is considering are meant to target commuters. However, there is concern, particularly among business owners, that any restrictions might discourage people from using the town centres. There are still conflicting views on this among municipal staff and the idea is at a very early stage of consideration (Dickenson 1992).

Only recently has Surrey even begun to face the challenge of encouraging greater transit use. The municipality has focussed largely on land use strategies, but even here the work is still mostly at the planning stage, with little substantive progress to date. Other strategies such as TDM are only just being considered. As Surrey's transportation problems worsen, a more comprehensive approach will likely be required.

6.3 The Response by BC Transit

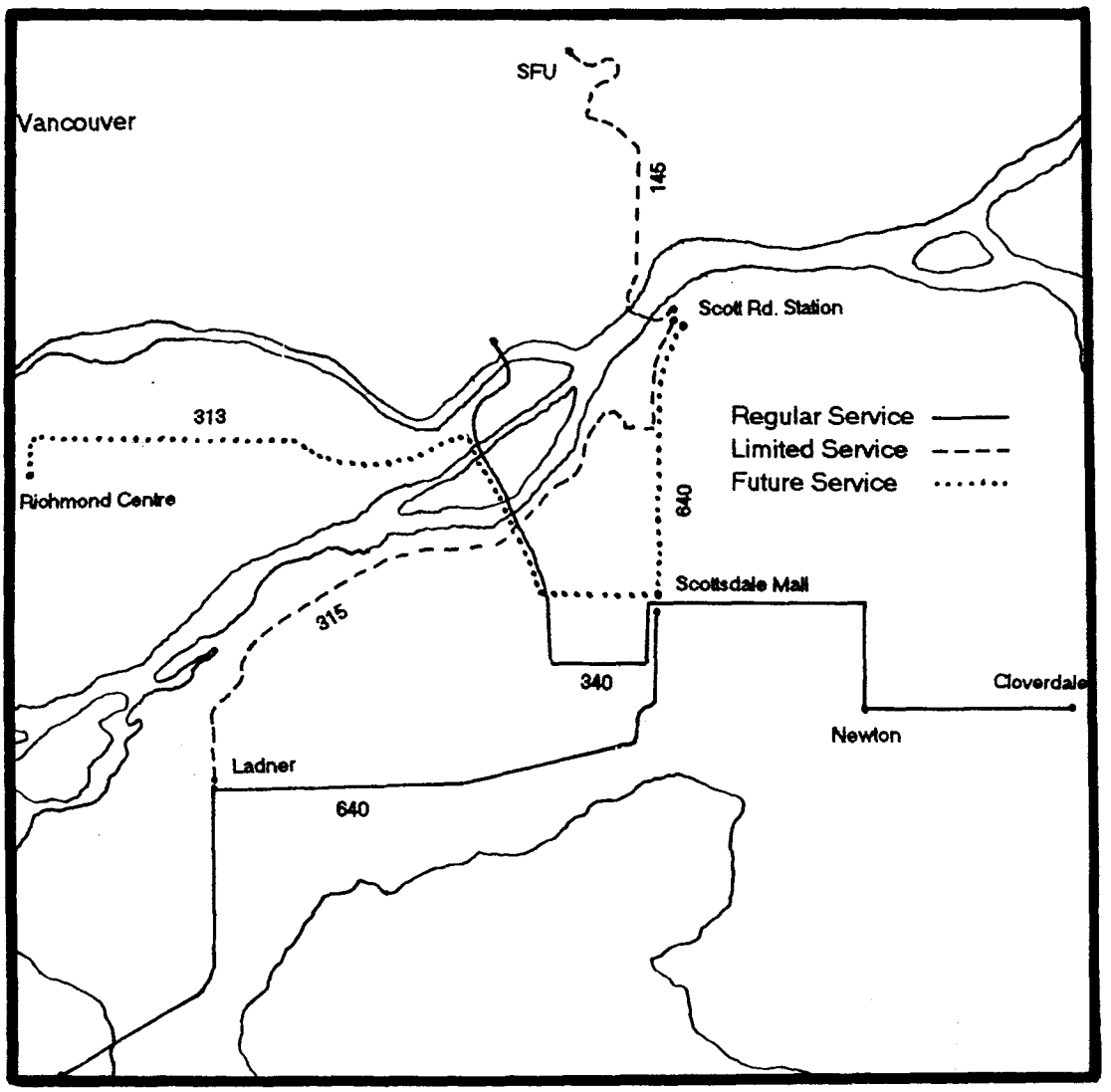
BC Transit is very aware of the increasing importance of suburb-to-suburb commuting and has been attempting to deal with the issue. However, funding limitations mean that it has had to move more slowly than it would like to in implementing any solutions (Kobayakawa 1992).

One imminent improvement to Surrey's transit system is the extension of SkyTrain from Scott Road to Whalley in 1994. This will greatly improve transit service to Surrey's major town centre, giving it more direct bus connections with other parts of Surrey, Delta, and Langley, as well as a rapid transit link with other regional town centres like Burnaby's Metrotown or downtown New Westminster. BC Transit also plans improved east-west services in North Surrey and North Delta, as well as better connections between town centres, as part of this reorganization of Surrey's transit system (BC Transit 1992B).

As was noted in Chapter 4, transit service in Greater Vancouver is predominantly oriented towards downtown. This orientation also allows for reasonably good service for those suburb-to-suburb commutes which follow the traditional radial routes in the direction of downtown Vancouver, such as from North Surrey to Burnaby, but service is much poorer for circumferential routes. Service on these routes is generally slow, indirect, and inconvenient. A typical Newton area resident, for example, would take over an hour and a half and require two transfers to go by transit to either Coquitlam Town Centre or Vancouver International Airport.

There are some circumferential routes connecting Surrey with other suburban areas, as shown in Figure 6.2. One of these connects Surrey with Simon Fraser University via Burnaby's Lougheed Mall. There are three routes from Surrey, through North Delta, to 22nd Street SkyTrain Station in New Westminster. Another two routes connect Surrey with South Delta. Service levels on all these routes are low, often just a few peak hour trips per day. Ridership is also generally low. BC Transit

Figure 6.2 Circumferential Transit Routes in Surrey



	Service to:	Service Level (peak)	(off peak)
Regular Service:			
340 Cloverdale/Newton/22nd St.	Delta, New Westminster	30 min.	60 min.
640 Scottsdale Mall/Ladner/Tsawassen	Delta	60 min.	60 min.
Limited Service:			
314 Scottsdale Mall/22nd St.	Delta, New Westminster	8 trips/day	none
315 Scott Road/Ladner	Delta	4 trips/day	none
145 Scott Road/SFU	Burnaby, Coquitlam	9 trips/day	none
Future Service:			
313 Scottsdale Mall/Richmond Centre	Richmond		
329 Whalley/North Delta/22nd St.	Delta, New Westminster		
640 Scott Road/Ladner/Tsawassen	Delta		

Source: BC Transit 1992-1993 Annual Service Plan.

is planning to improve service on some routes that serve circumferential commutes, as well as add new routes. However, other circumferential routes may be cut due to poor ridership. One proposed new route would be from Scottsdale Mall to Richmond Centre. This would be the first route to directly connect Surrey and Richmond, and tap this large commuter market.

BC Transit does provide inter-nodal service within Surrey. As discussed in Chapter 4, the network is designed around a series of transit exchanges located at the town centres, using a timed focal point transfer system. All bus routes in Surrey connect with at least one of these exchanges. There is a high level of service (15 minute headways) from Whalley to both Guildford and Newton, and this forms the core of Surrey's transit system. This core system is extended from Guildford to Cloverdale, and from Newton to White Rock with 30 minute service. This is shown in Figure 6.3. Other pairs of nodes, such as Guildford-Newton or Guildford-White Rock, have much poorer service despite relatively high demand levels. None of these inter-nodal routes is an express route, they all provide local service for points between the nodes. Inter-nodal routes which are not part of the core system tend to be indirect.

BC Transit (1992A) is also considering expanding its use of paratransit. It presently operates a paratransit "community service" in Maple Ridge using minibuses. These smaller vehicles better match the lower demand levels in low density suburban areas (although cost savings are not always that great). They are also less intrusive than standard buses, which are not welcomed in many suburban neighborhoods. These services emphasize comfort and convenience over speed. They stop directly in front of major destinations. BC Transit has identified several areas throughout Greater Vancouver where community services could be implemented, as shown in Figure 6.4. These services fall into two general types. One type could be used in low density suburban areas where demand does not warrant full service. These might operate as feeder services in these areas, connecting them to major transit routes. White Rock/South Surrey is a potential candidate for this type of service. Community services could also be used as circulators within town centres. Whalley is one of the areas

Figure 6.3 Inter-nodal Transit Service in Surrey

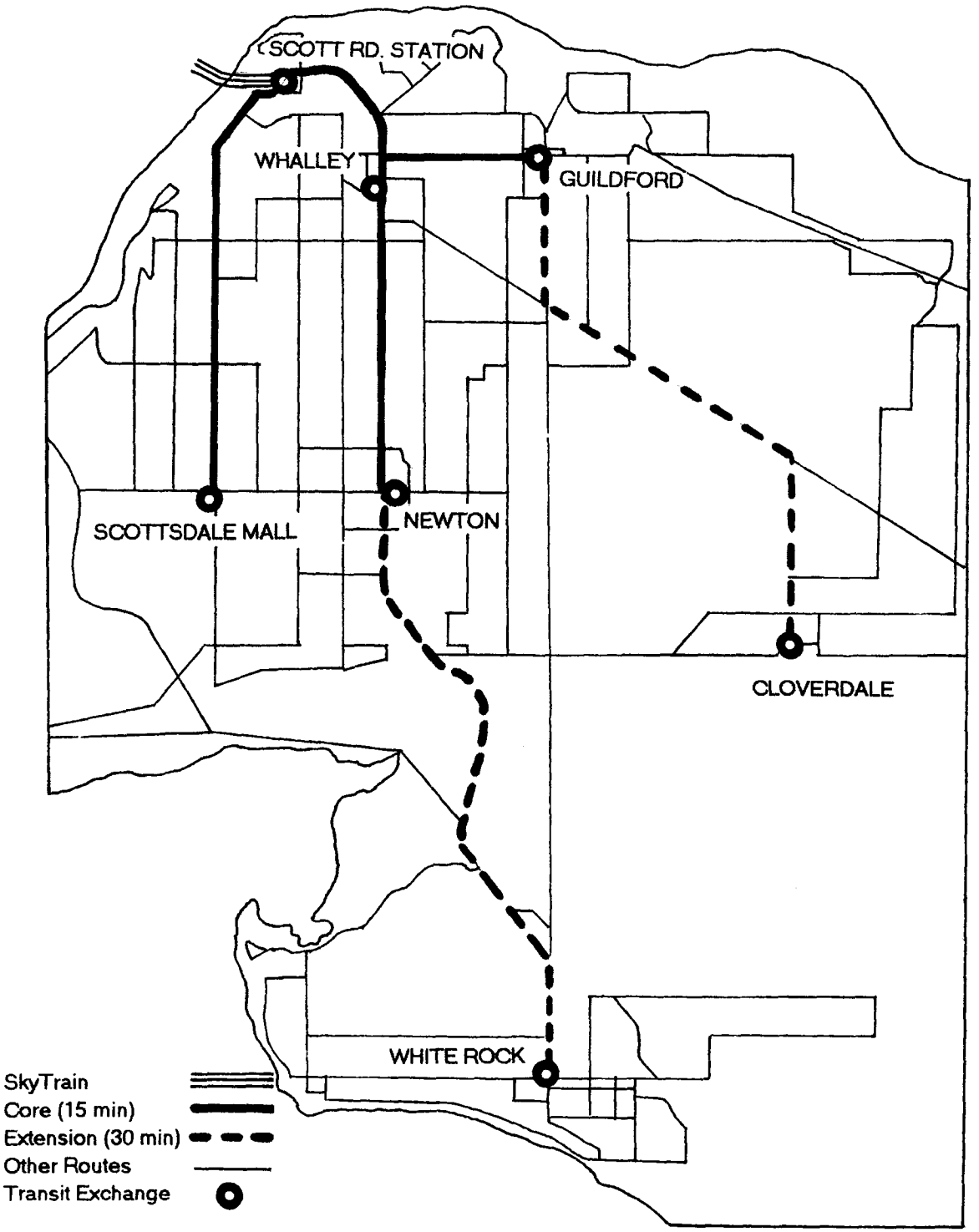
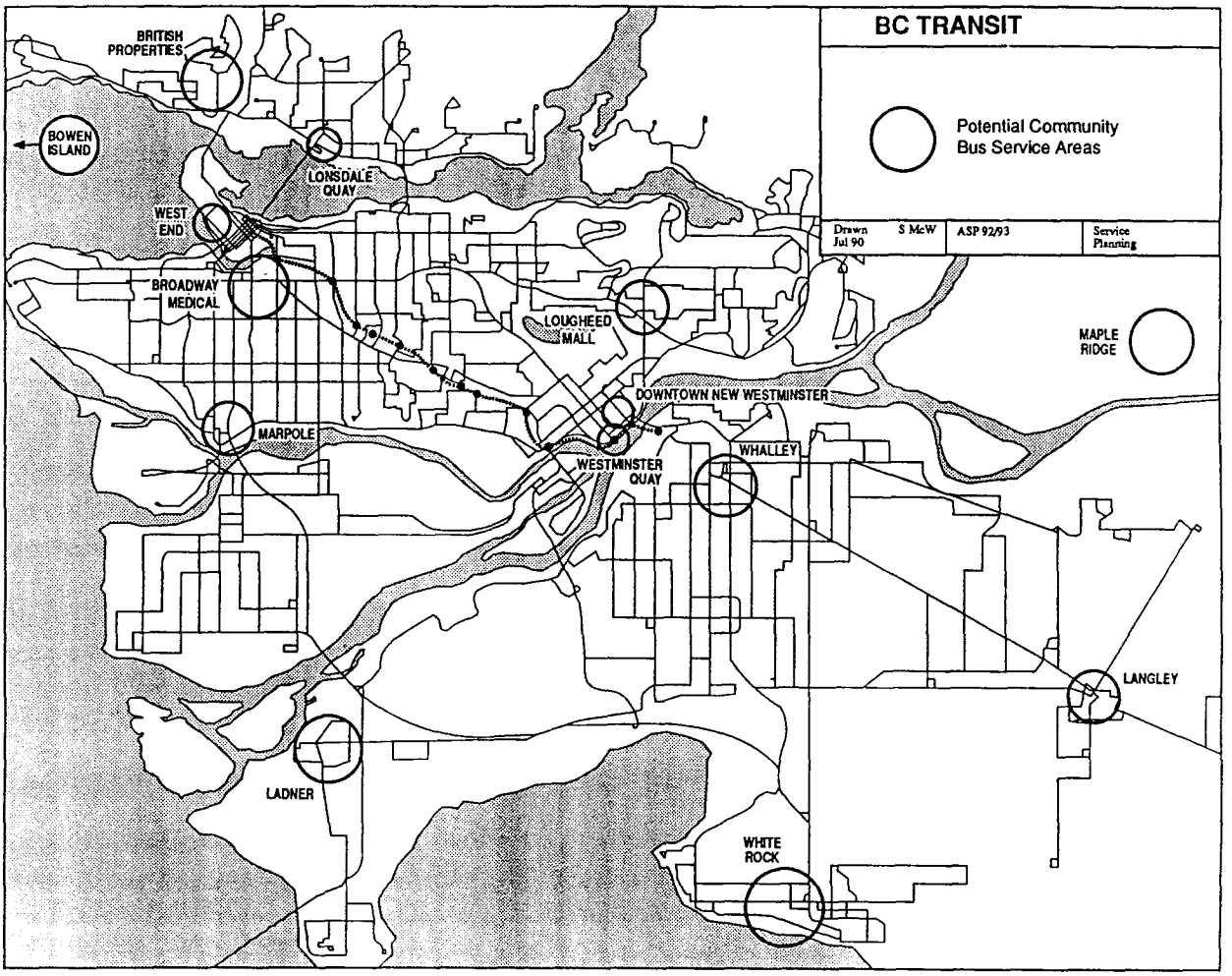


Figure 6.4 Potential Locations for Paratransit Service in Greater Vancouver



Source: BC Transit 1992-1993 Annual Service Plan.

being considered. This would help address the problem of getting around the town centres without an automobile.

In 1990, the Go Green program was initiated by BC Transit, with involvement from the Federal and Provincial Environment Ministries, as well as the Ministry of Transportation and Highways and the GVRD. The initial goal was to increase public awareness of the environmental problems associated with the automobile. This modest goal has been achieved mostly through an advertising campaign (Hodgson 1992).

An additional goal for Go Green - and one that will be more difficult to achieve - is to use TDM strategies to actually change travel behavior and reduce the use of single occupant vehicles. BC Transit and the GVRD are both considering various TDM strategies. One strategy involves a series of Employee Transportation Administration Seminars to teach representatives from regional employers about the basics of TDM, so they can then design a trip reduction plan for their companies. Eventually, major employers may be required to submit trip reduction plans. Ridesharing is one way to reduce trips, and this is being promoted through the Go Green Program. The initial focus has been to work with major employers in the region to help them set up car and vanpool programs. A carpool program to Scott Road Station is also being considered. In the longer term, a regional carpool matching service may be established. While BC Transit, like Surrey, is beginning to consider TDM strategies, actual implementation of these strategies has been minimal thus far (Smith 1992).

BC Transit's role is evolving beyond that of merely a transportation provider and there is an attempt being made to develop a more integrated transportation and land use planning process in the region. BC Transit has been working with the GVRD, the municipalities, and the provincial government on Transport 2021 to develop a long range transportation plan. This plan will look not only at new facilities, but will also assess the impact of various land use and TDM strategies. For example, one analysis using the GVRD's transportation planning model predicted that a package of

seven TDM measures could produce a nearly 50 percent rise in the morning peak hour transit mode split when compared with a no-TDM base case for the year 2021 (GVRD 1993).

6.4 Public Attitudes Towards Transit Service

Investigating public attitudes to transit may help explain why transit use is low for suburb-to-suburb trips, even when service is provided. It may also indicate the type of changes that must be made to convince suburban commuters to use transit. BC Transit's *Usage and Attitude Survey* (1992C) was a telephone survey of 1,979 people designed to gather information on public attitudes about transit. The results are discussed below.

Of those surveyed, 48 percent felt BC Transit service was quite good or very good. An additional 35 percent felt service was satisfactory. The main reasons people had for using transit were lack of alternative transportation (32 percent) and not wanting to worry about traffic (23 percent). In the Southeast suburbs (Surrey, Delta, and Langley), not wanting to worry about traffic, most likely involving a commute to downtown Vancouver, was the most important reason for using transit (34 percent). This indicates that worsening traffic conditions for suburb-to-suburb trips could significantly improve the attractiveness of transit. Longer suburb-to-suburb commutes would be more susceptible to this.

People were asked what factors would most influence them to use transit. Rapid transit service was the greatest motivator (66 percent rated this 4 or 5 out of 5). Other service improvements such as shorter travel times, express bus service, fewer transfers, and more frequent service also rated highly (58-60 percent). Next most important was helping the environment (57 percent), followed by increased traffic congestion (56 percent). Higher parking, gas, or insurance costs rated lower (44-50 percent). These results should be viewed with caution, however. While they seem to indicate that greater efficiency and speed of the transit system are better motivators than increased costs of driving,

many studies have found that survey responses can often be very different from actual behavior. For example, actual use of new transit facilities has been found to be only one-third to one-fifth of intended use (Couture and Dooley 1981). Because people tend to overstate their intentions to use improved transit services, measures which penalize automobile use would probably have a greater impact relative to service improvements than these results would indicate.

The survey asked about the importance of different transit service attributes and found that service frequency was most critical (77 percent rated it as important). On average, respondents felt that 12-14 minutes was a "reasonable" time to wait for a bus, 9-11 minutes when transferring. The next most important service attributes were travel time/speed (69 percent) and number of transfers needed (65 percent). Distance to bus stop (47 percent) and seat availability (42 percent) were relatively less important. Figure 6.5 compares the response in the Southeast suburbs versus the City of Vancouver. Frequency of service was relatively less important in the Southeast suburbs while seat availability, distance to bus stop, and the number of transfers was more important. This latter factor reflects the problem of the lack of direct service for many suburb-to-suburb trips.

Suburban residents had quite different attitudes than city residents about the existing transit service in their neighborhoods, as shown in Figure 6.6. Southeast residents were much less likely than Vancouver residents to feel that service frequencies were adequate, and only half as many Southeast residents could reach their destination without transferring. Not surprisingly, more Southeast residents felt that transit was less convenient than driving. However, Southeast residents were more likely than Vancouver residents to say that transit was faster than driving during rush hour (although this likely applied only to suburb-to-downtown trips). Southeast residents were also slightly more likely to agree that transit should be given priority over automobiles.

In terms of planning options, the greatest support was for more rapid transit lines and more suburb-to-suburb routes (73 percent for each). Support was lower for improved local area or

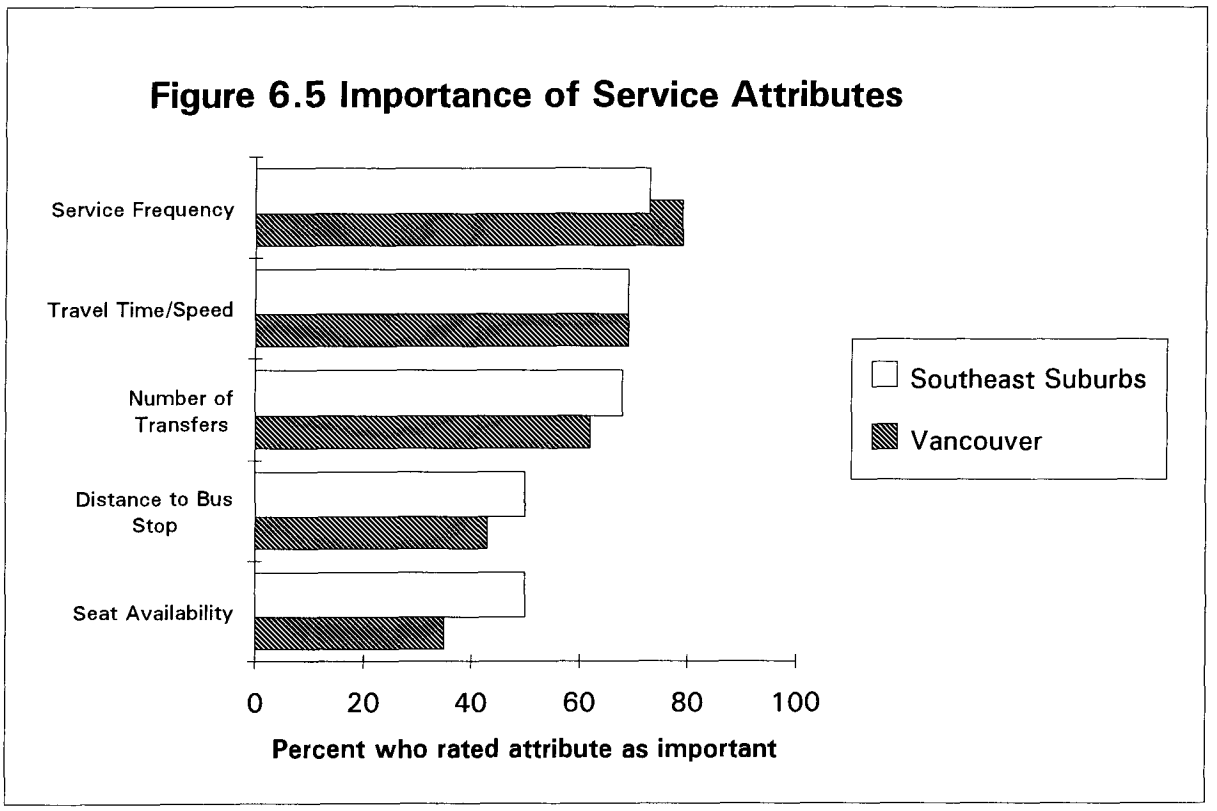


Figure 6.5 Importance of Service Attributes
Service Frequency
Travel Time/Speed
Number of Transfers
Distance to Bus Stop
Seat Availability
0
20
40
60
80
100
Percent who rated attribute as important
Southeast Suburbs
Vancouver

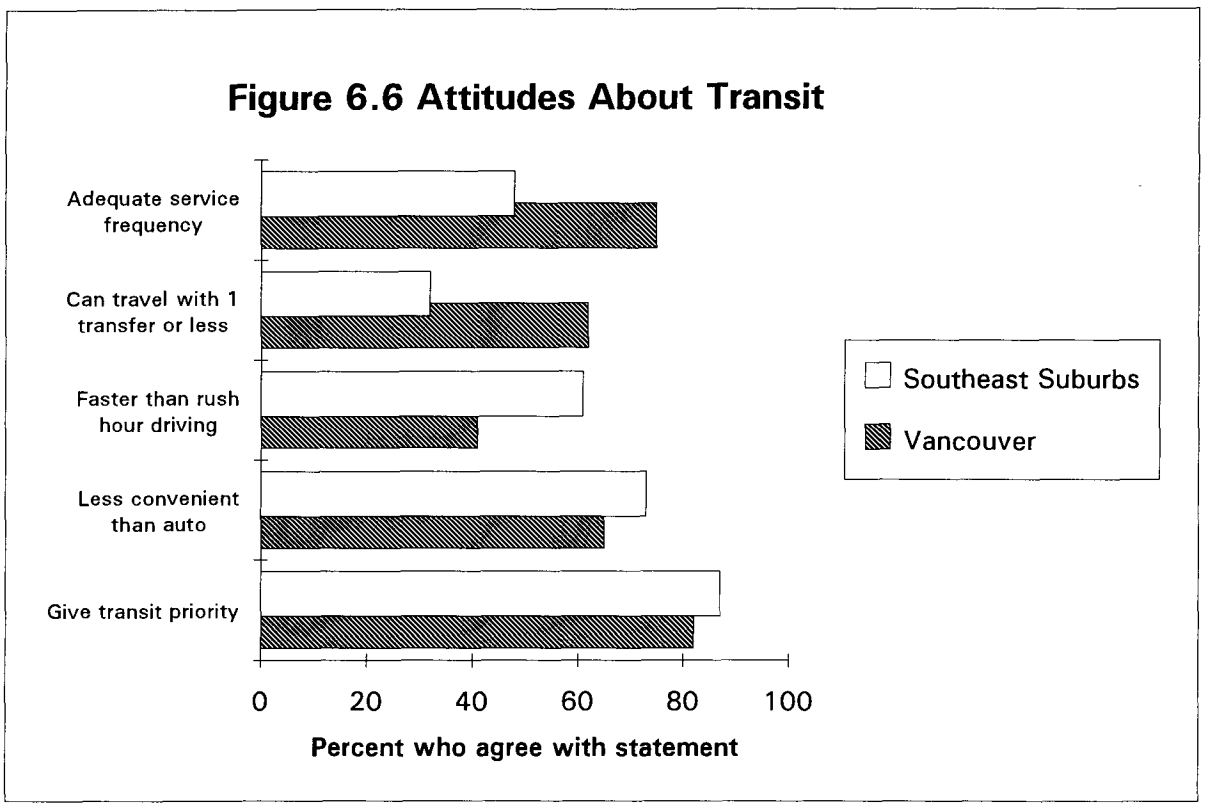


Figure 6.6 Attitudes About Transit
Adequate service frequency
Can travel with 1 transfer or less
Faster than rush hour driving
Less convenient than auto
Give transit priority
0
20
40
60
80
100
Percent who agree with statement
Southeast Suburbs
Vancouver

downtown service. There was also strong support (89 percent) for using other types of vehicles. Dial-a-ride was supported by 58 percent. These results indicate a strong level of support for improved suburb-to-suburb transit service. A recent survey for the United Way (Pendakur and Bowler 1987), looking at travel patterns for people living South of the Fraser communities, confirms this. People wanted better connections between the South of Fraser municipalities, especially to Richmond from Delta and Surrey. They wanted shorter waits for transfers or more direct buses routes for these trips. Improving suburb-to-suburb service appears to be a much greater priority for suburban residents than any improvements in downtown services, with which they are fairly satisfied.

While there is clearly demand for improved service, it is not so clear whether people are prepared to pay for it. In the United Way survey, people wanted greatly improved service at lower cost. Similarly, in the BC Transit survey, support for transit improvements declined markedly as costs increased. For example, while 86 percent supported the creation of bus lanes, this dropped to 60 percent if it meant replacing a lane of automobile traffic. In the Southeast, support dropped even more, from 86 to 52 percent. This represents a major dilemma for transit planners.

The results of the attitude survey provide some useful information for transit planners on the types of service improvements which would attract more suburban riders. A major theme was the desire for faster, more frequent, and more direct service between suburban areas. This points to the need for some type of suburb-to-suburb express service. One possibility, which will be discussed in greater detail in the next chapter, would be to consolidate some suburban transit routes into fewer but better served express corridors. The attitude survey also highlighted the problem that, in order to get this improved transit service, people do not seem willing to make sacrifices such as higher costs or longer distances to bus stops. This demonstrates how difficult it will be to solve the problems facing transit in the suburbs.

6.5 Summary

This review of the response in Surrey helps to provide a more complete picture of the suburb-to-suburb transit "problem" than that formed in Chapter 5. Transportation planners in Surrey and in Greater Vancouver have begun to take a more comprehensive approach to solving the problem of providing suburb-to-suburb transit service. Land use strategies have been formulated, innovative transit and paratransit services are being planned, and TDM strategies are being considered. To date, however, very little has actually been implemented. A survey of public attitudes shows that people are reasonably satisfied with the downtown-oriented transit service, but there is great demand for improvements in suburb-to-suburb service. The survey reveals why people use transit and what types of service attributes they consider to be important. It can thus serve as a helpful guide for transit planners. Unfortunately, it also shows that the desire for better service improvements does not necessarily translate into a willingness to pay for these improvements.

CHAPTER 7 THE PLANNING FRAMEWORK

7.1 Introduction

In this chapter, the results of the case study will be used to help decide which strategies for improving suburb-to-suburb transit service would be most effective for Surrey and other comparable suburban areas. As earlier discussion has indicated, there is no single solution to this problem; a combination of improved transit services, land use planning measures, and TDM strategies will be required. In the final part of the chapter, a conceptual framework for suburb-to-suburb transit planning will be developed based on the Surrey case study. This is meant to provide a way of applying the case study results more broadly, to solve similar problems in other suburban areas.

7.2 Strategies for Suburb-to-Suburb Transit

The most obvious way to promote suburb-to-suburb transit use is to improve transit service. The problems facing suburban transit indicate that merely increasing the levels of existing service would likely not be sufficient to make transit an attractive alternative to the automobile. What is needed is a greater range of innovative transit service options. According to the "family of services" concept which was discussed in Chapter 3, different services occupy different market niches, providing an overall system that better meets the full range of suburban travel needs. Table 7.1, which is based on the Surrey case study, summarizes the potential suburban markets for transit, along with the type of transit service which would most effectively fill each market niche.

Table 7.1 Transit Options for Different Commute Types

Commute Type	Transit Options
Intra-nodal (within the nodes)	Paratransit - shuttle service
Inter-nodal (between the nodes)	Conventional transit except paratransit where demand is low. Also express service - bus or paratransit depending on the level of demand.
Between the nodes and surrounding residential areas	Conventional transit if density and demand warrants Paratransit if density and demand are low.
Between non-nodal areas	Paratransit if density and demand warrants
Between nodes and other suburban areas	Express service between nodes and other suburban nodes (conventional transit or paratransit depending on demand)
Long trips between different suburban areas	Paratransit such as ridesharing No direct transit service

7.2.1 Conventional Transit

The most promising market for conventional transit in the suburbs is the inter-nodal market, such as the travel flows between the five town centre areas in Surrey. These are the only suburban flows which are concentrated at both trip ends and, as noted in Chapter 5, they displayed the highest transit mode split of any trip type in Surrey (10.7 percent). The relatively high population and employment densities in and around the nodes enhances their attractiveness as transit sub-markets. While this is a relatively small market, accounting for about one-seventh of all work trips within Surrey in 1985, there is potential for growth as the nodes increase in size and density. In Surrey, the transit system is already structured around the nodes, using timed focal point transfers, and parts of this market are served quite well (Whalley to Guildford and Newton). There is room for improved service levels, however, and this may be an area for BC Transit to expand its conventional service.

Providing service to the nodes from surrounding residential areas is another market where conventional transit might be viable. These flows are concentrated at only one end (the node) so the potential of this market is not so high as that of the inter-nodal market. At present, BC Transit attempts to provide conventional service to the nodes from nearly all areas of Surrey. Since the case study results confirmed that there is a significant increase in transit use when residential densities exceed 500 persons/km^2, any improvements in conventional transit service to the nodes should be focussed on areas with densities above this lower threshold. Areas with densities below 500 likely cannot support conventional transit service to the nodes, and alternative service options such as paratransit should be considered. In Surrey, about 30 percent of commutes were to the nodes from surrounding non-nodal areas, and roughly two thirds of these were from TZs with densities above 500 persons/km^2.

7.2.2 Paratransit

Paratransit is a more flexible option which could replace conventional transit service in certain sub-markets. One potential suburban market for paratransit, just mentioned, is providing service to the nodes from areas which cannot support conventional service. Another potential market is providing service within the nodes.

Paratransit might be a more viable means than conventional transit for providing service from some low density areas to the nodes (where it could connect with conventional transit services). Mini-buses with flexible routing and stopping procedures might be one option. BC Transit is already experimenting with these types of services in Maple Ridge. As was noted in Chapter 3, however, paratransit often results in minimal savings when compared with providing conventional transit service. One reason: labor costs, the largest component of transit expenses, are the same for a mini-bus as for a full size bus. Organized car and vanpools, which are well suited to serving commutes

with relatively dispersed origins converging on a single destination, may be a better option. They have a major advantage over other forms of paratransit in that their operating costs are very low, and they make more efficient use of existing private vehicles. They also provide fast, comfortable "door-to-door" service for the passenger.

A key potential market for paratransit could be serving trips within nodes in the form of a frequent internal circulator. The case study results highlighted the extremely low transit mode split for such trips; most people do not find it convenient to use transit for such short trips, given the ratio of access and waiting time to the actual travel time. Increased service frequency is a critical requirement for this market. Intra-nodal trips account for nearly one-fifth of all work trips made within Surrey, a proportion that could increase as the town centres grow. Another major role for a circulator would be to serve shopping, recreation, and personal business trips. This has the added benefit, discussed in Chapter 2, of encouraging more commuters to use transit, since they would no longer need their cars to make short midday trips. To date, little has been done in Surrey to serve this market, so there is great potential.

7.2.3 Express Service

Express transit service, which is used for suburb-to-downtown trips in many cities, including Greater Vancouver, also has potential in the suburb-to-suburb market. This would help to address a major complaint which suburban commuters voiced in BC Transit's *Usage and Attitude Survey*: that suburb-to-suburb transit is too slow, infrequent, and indirect. Almost by definition, express service would have to be inter-nodal since it requires a high level of demand, such as exists between the larger town centres (e.g. Whalley-Guildford or Whalley-Newton). Presently, most inter-nodal routes in Surrey double as local routes. More express-only routes could improve the appeal of transit. These express routes could be integrated into the timed transfer system already in operation in order to connect with local service (just as express services to downtown Vancouver presently do). As

Schneider and Smith pointed out in Chapter 3, such a system would concentrate even more of the total trips into heavily travelled corridors between the nodes, which could then support shorter headways between buses, longer hours of peak operation, and other improvements in service. Where demand between nodes is still quite low (e.g. Guildford-Cloverdale), paratransit, including ridesharing, might be a viable means of providing express service.

Since express service becomes more appealing with increasing trip length, longer commutes between different suburban areas (e.g. Surrey to Richmond) form another important market. Such trips accounted for more than 60 percent of Surrey based suburb-to-suburb work trips in 1985, and this proportion has been increasing. While express service would mostly serve trips between the nodes in different suburban areas, links with local service at timed transfer points could be used to tap even more of this large market. In some parts of Greater Vancouver, suburban inter-nodal express service is already provided in the form of SkyTrain, but express service could be provided between other nodes at far less cost using buses or paratransit. Potential markets for such express services might include Whalley-Guildford-Coquitlam Centre or Whalley-Newton-Richmond Centre. The case study results indicated that demand on these routes was relatively high and growing rapidly. Where demand levels are lower, ridesharing could provide the express service. As noted in Chapter 3, ridesharing becomes especially attractive for people making long trips, since travel costs increase with distance and passenger pick-up time decreases as a proportion of total travel time.

7.2.4 Land Use Strategies

The discussion in Chapter 2 indicated that existing suburban land use patterns are not at all conducive to high levels of transit use, often resulting in low ridership regardless of the services offered. Strategies to change this land use pattern and make it more amenable to transit use, thus, play an important role. These land use strategies generally involve increasing residential and employment densities, as well as improving suburban design.

There is general agreement in the literature that increasing population and employment density results in increased transit use, and the case study findings supported this. Given the very low densities prevalent in Surrey and other suburban areas, strategies to increase these densities will be an important means of encouraging greater transit use.

The case study results confirmed Pushkarev and Zupan's findings, noted in Chapter 2, that transit use does not increase steadily with increasing density. Instead, there appears to be upper and lower thresholds above or below which transit use sharply increases or decreases. In the middle range of density, there was considerable variation in transit use (indicative of the many other factors which influence transit use). These findings applied to both residential and employment density.

Given this non-linear relationship between transit use and density, targeting the nodes for increased density would appear to be more effective than a general or area-wide increase in density, as a means of encouraging greater transit use. That is, threshold densities (above which there is a sharp increase in transit use) could be more easily achieved in the nodes than throughout a suburban area. In fact, threshold densities could easily be exceeded in the nodes, providing a very favorable environment for transit. Both the literature review and the case study indicate that clustering *employment* into high-density nodes will have an even greater impact on transit use than increasing residential density. According to Pushkarev and Zupan, proximity of a residential area to a high density employment node is more critical than the actual residential density. Thus, a potential land use pattern might consist of nodes with high population and employment densities, surrounded by predominantly residential areas of medium density (but above the threshold level that would support transit service to and from the nodes). This pattern would encourage transit use, provide for a range of residential density choice, and allow open space and rural areas to be preserved.

The Surrey case study clearly illustrated that transit is virtually nonexistent at low densities. This suggests that it may be futile for transit to try to serve those trips which both begin and end in low density areas (i.e. residential density below 500 and employment density below 200). Even paratransit would not be viable in this market. Thus, determining which market niches have potential for transit service also means deciding which niches transit should not even attempt to serve. It is impossible for transit to serve all areas effectively.

Urban design can also be an important determinant of transit use that is particularly critical in the nodes. As was noted in Chapter 2, most suburban nodes, although they are denser than typical suburban development, are not very transit friendly, since they have been designed almost entirely from the point of view of the automobile driver. Urban design characteristics, such as widely spaced buildings and lack of sidewalks, are likely another reason for the extremely low transit mode split for intra-nodal trips: travelling around the nodes is inconvenient and possibly even dangerous for transit riders and other pedestrians, so most people drive. In order to achieve transit friendly design, guidelines must be developed and followed. As was seen in Chapter 6, Surrey's plans for its town centres, especially Whalley, promote the idea of transit friendly design, but there have been few concrete results to date.

7.2.5 Transportation Demand Management

Transportation Demand Management (TDM) is an important strategy for increasing suburban transit use, particularly in the suburban nodes. TDM is not a panacea, and as discussed in Chapter 3, its impact can vary. However, it can potentially have a large impact since it acts to change travel behavior. The impact is greatest when the program is mandatory and when there is a strong financial incentive involved. In addition, TDM is most effective when it is combined with improved transit services and land use strategies.

TDM strategies which make it more expensive to commute by single occupant vehicle (SOV) are generally the most successful. The results of BC Transit's *Usage and Attitude Survey* presented in Chapter 6 indicated that higher SOV commuting costs would persuade about half of Greater Vancouver commuters to consider taking transit. Reducing the availability of free employee parking in the town centres, which would eliminate an important incentive for driving, is one strategy being very tentatively considered in Surrey. The difficulty of implementing such a policy fairly is major barrier. Road pricing is another way of increasing the cost of driving, and thus encouraging alternate modes. This might be particularly effective for discouraging suburb-to-suburb commuting by SOV in Greater Vancouver given the many bridges which connect different suburban areas. Surrey and Greater Vancouver appear to be moving slowly towards adopting some of these strategies.

7.3 A Conceptual Framework for Suburb-to-Suburb Transit Planning

The case study findings clearly have broad implications, beyond the example of Surrey itself. A conceptual framework for suburb-to-suburb transit planning could be used to apply these findings, and develop transit strategies for other suburban areas facing similar problems.

7.3.1 Examples of Planning Frameworks

There have been previous attempts to produce a method for developing a suburb-to-suburb transit service strategy, and two of these will be discussed briefly below to provide some background to the development of the planning framework. The first is concerned mostly with identifying market niches for transit in the suburb-to-suburb market, while the other deals more with cost-effectiveness and implementation.

Khasnabis et al. (1990) used a Detroit case study to develop a procedure for matching unmet suburban travel needs with interested private sector providers. First they identified potential suburb-

to-suburb transit markets in the Detroit area using 1980 census work trip data. Suburban Detroit was divided into 41 zones and those zone pairs with the highest inter-zonal travel demand were chosen as potential transit markets (53 zone pairs in all). Travel times and densities were also factored in since it was postulated that these would affect transit use. The zone pairs were rank ordered by travel demand for peak period work trips, travel time (based on congestion levels and distance between the zones), population density at origin zone, and employment density at destination zone. Each pair was then scored, producing an overall ranking of the zone pairs as potential transit markets.

The second part of the procedure involved asking local transportation providers if they were interested in providing suburban transit services. Those that expressed an interest were then shown potential routes developed from the highest ranking zone pairs. Costs of providing service was estimated for five sectors and it was concluded that privately run transit service was feasible for these sectors.

Unlike the previous example, Rosenbloom (1990) considered both work and non-work trips in her framework for developing a suburban transit strategy. First, major concentrations of potential transit users were located, differentiating between work and non-work trips. The destination of work trips was determined by identifying suburban employment concentrations, while the origin of non-work trips was determined by identifying residential concentrations of likely non-traditional transit users (many of them transit dependent). The next step was to calculate the number of trips generated, and to estimate the potential non-traditional transit mode split for these trips. Potential routes were then determined. Although work and non-work trips were considered separately at the trip generation stage, the method also stresses the need to overlap work and non-work transit service at the route planning stage in order to meet the midday travel needs of transit commuters.

Rosenbloom also made an inventory of non-traditional services used by local transit authorities in 22 medium sized U.S. cities; these included vanpools, taxis, and paratransit feeder services.

Potential transit and paratransit options were then matched with the travel needs identified in the suburban area and the cost-effectiveness of the various transit service options was assessed. The final step would be to develop an implementation strategy.

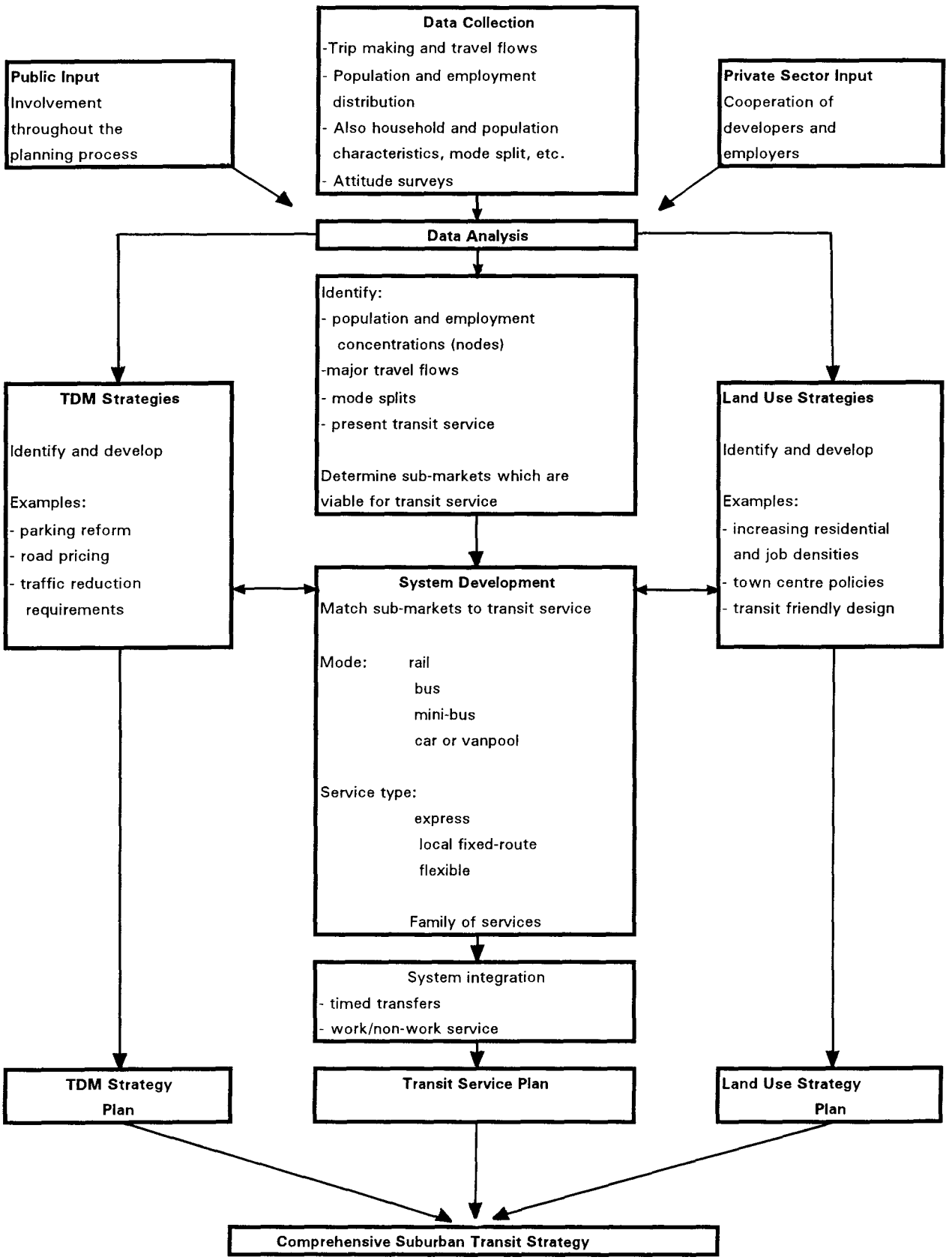
7.3.2 Outline of the Planning Framework

The following planning framework is an attempt to develop a generalized planning approach for a comprehensive suburban transit strategy. It was developed primarily from the Surrey case study. Figure 7.1 outlines the planning framework.

The first step in the process involves gathering information about the problem. Population and employment distributions and the associated travel patterns constitute critical information to be collected. Other useful information might include household and population characteristics, mode split, and public attitudes towards transit. The type of data collected will depend on the particular needs and problems which must be addressed (for example, whether to look at work trips only or peak period only). Most of this information can be obtained from an origin-destination survey if one has recently been undertaken in the community. Public input would also play an important role at this stage, and in later stages of the planning process. Likewise, private developers and employers need to play a greater role in finding the solutions to these problems.

The next step is to analyze the data. A major goal of this analysis is to identify which travel market niches are viable for transit service. Density is a critical factor, and concentrations of population and employment should be noted. These and other activity centres form the nodes, which play a key role for suburban transit. Analysis of the travel patterns should identify major travel flows between zones or groups of zones, with particular attention being given to those zones containing the nodes. An examination of current mode splits (along with current transit service levels) for different flows gives some indication of how amenable the flows are to transit service and the potential for

Figure 7.1 Conceptual Framework for Suburb-to-Suburb Transit Planning



expansion. Another important consideration might be the direction of the flows; whether they are balanced or predominantly in one direction will clearly effect the proposed service. The result of this stage will be the identification of a number of potential transit sub-markets, while other sub-markets may be abandoned.

In the system development stage, the potential sub-markets identified by data analysis are matched with the most suitable transit service. Different sub-markets will require different types of transit service, depending on factors such as level of demand, trip length, or trip purpose. Transit can be classified according to mode (including rail, bus, mini-bus, vanpool, and carpool), and service type (express, local fixed-route, or flexible paratransit). Each travel sub-market is matched with the most appropriate combination of mode, service type, and level of service. This family of services, each catering to a different sub-market, must then be integrated into a unified system. This involves such strategies as a timed transfer system to integrate local and express services. A system can also be integrated to serve both work trips during the peak periods and non-work trips during off-peak times. The final result of this stage is a transit service plan.

Since merely providing the service will not guarantee increased transit use, TDM and land use strategies must be developed concurrently to complement and strengthen the transit service plan. Results from the data analysis stage can be used to determine what TDM and land use strategies would be most effective. For example, how would commuters respond to increased commuting costs? Do the nodes need to be strengthened or redesigned? If TDM or land use strategies could improve the transit viability in a sub-market or encourage the use of a particular transit service, this information needs to be fed back into the process. Thus, there must be strong links of communication between the system development process and the TDM and land use strategy development processes at all stages in order to ensure an integrated product. The final stage of the process is to combine all three to form a comprehensive suburban transit strategy.

There are some constraints on this process which should be mentioned. One type of constraint results when the transit operator has certain public objectives which it must fulfill. For example, a mandate to serve the transit dependent population in the community may result in the operator providing service in sub-markets which would normally be abandoned as non-viable. Cost is undoubtedly the most important constraint on transit operators, and all transit services and strategies must be assessed for their cost effectiveness.

7.4 Summary

The results of the case study suggest that nodes or town centres will play an important role in suburb-to-suburb transit planning. The most promising suburban markets for transit appear to be serving inter- and intra-nodal trips, as well as trips to the nodes from surrounding areas. Increased use of express and paratransit services will also help transit expand its market. Combining these improved services with land use and TDM strategies results in a comprehensive transit service strategy. The generalized process for creating such a strategy was developed, resulting in a conceptual framework for suburb-to-suburb transit planning.

CHAPTER 8 CONCLUSIONS

8.1 Introduction

The case study findings confirm that Greater Vancouver has experienced a fundamental restructuring of its commuting pattern which has seen suburb-to-suburb travel become the dominant commuting flow in the region. Thus, Vancouver appears to be following a trend similar to that in many other North American cities. As in these other cities, circumferential trips between outer suburbs with burgeoning employment make up the most rapidly expanding commuter market. Unfortunately, these suburb-to-suburb trips, particularly when they do not follow traditional radial patterns, are extremely difficult to serve with transit, and generally have very low transit mode splits, as the case study demonstrated. The challenge for transit providers will be to create a comprehensive strategy that will allow them to tap this growing market.

8.2 Planning Implications

One assumption made at the beginning of this thesis was that transit should not attempt to serve all markets in the suburbs. Some markets are much more amenable to transit service than others; this was illustrated in the case study by the variations in travel demand, associated densities, and existing transit use for different suburb-to-suburb commute types. Transit can and should provide suburb-to-suburb service, but it must concentrate its efforts on those markets where it can better compete, and not waste its scarce resources trying to serve markets which are simply not viable.

Travel within, between, and to suburban nodes is a rapidly growing market, and one which likely holds the greatest potential for transit in the suburbs. The case study clearly indicated the importance of nodes for suburb-to-suburb transit service. As major activity centres, suburban nodes are important trip generators. This, combined with their higher densities, means that nodes account

for most of the concentrated flows in the suburbs. If the transit system is oriented to the nodes, travel can be concentrated even more into high volume corridors which support greater levels of service. A multi-nodal transit system would have three major components: inter-nodal, intra-nodal, and service to the nodes. Vancouver's system partly follows this structure, but improvements are needed.

Inter-nodal trips constitute a large, rapidly growing market which is more amenable to transit service than any other suburban commute type (as indicated by the high transit mode split for such trips in Surrey). This market could be better served if express service was provided between major nodes. Public attitudes clearly point to a desire for faster, more direct suburban transit routes, and this is one market where such a high quality service might be viable. The explosive growth of circumferential commuting has made longer distance inter-nodal service another potential transit market. At present, circumferential transit service between nodes in two different suburban areas is virtually non-existent. However, the case study indicated there is growing potential for such services, with the most promising routes from Surrey being Whalley-Newton-Richmond Centre and Whalley-Guildford-Coquitlam Centre. When demand does not warrant conventional transit service, this market could be served with paratransit or ridesharing.

Short intra-nodal trips, which presently display very low transit use, represent a key growth area for transit. In order to tap this critical market, some form of frequent shuttle service is required to reduce the ratio of access and waiting to travel time. A major reason many commuters resist any alternatives to driving is because they require their cars for midday or after-work trips. Thus, an efficient shuttle system would not only increase transit use for intra-nodal trips, but might also encourage more people to travel to the nodes by transit, since they would no longer need their cars once they had arrived.

There is no one type of transit service that offers the perfect solution for suburb-to-suburb transit. Instead, the "family of services" concept needs to be applied, in which different types of

transit and paratransit services occupy different market niches. These services can then be integrated to form a comprehensive system.

Land use strategies play a very important role in encouraging suburb-to-suburb transit use. The case study confirmed that transit use in suburban areas does increase with rising residential and employment densities. The correlation appeared to be strongest for employment density. The relationship between transit use and density was not linear. Transit use was extremely low below a certain threshold density and quite high at densities above an upper threshold, but the correlation with transit use appeared weaker in the middle range of densities. Nodes generate transit use because they have densities well above the upper threshold. The benefits of density can be enhanced by employing transit and pedestrian oriented design. Encouraging the development of mixed-use, transit and pedestrian oriented suburban nodes will likely be a major objective for any land use planning strategy.

Transportation demand management strategies are also important, particularly given their ability to actually change travel behavior. The key to success for TDM seems to be the use of mandatory economic measures which penalize automobile use rather than just encourage transit use. Parking reforms and road pricing are two types of TDM which could greatly impact the attractiveness of driving to work. Implementation of TDM strategies can be complex and politically unpopular, but the results can be significant.

Clearly, there is no single solution to the problem of encouraging transit use for suburb-to-suburb trips; there must be a comprehensive approach. This would combine innovative new transit services with TDM strategies to discourage automobile use, and land use strategies to create a more transit- and pedestrian-friendly landscape. In order to be successful, strong measures which both encourage transit use and penalize driving, must be complemented with the provision of a high quality alternative to the private automobile. The example of serving intra-nodal trips provides a good illustration of this comprehensive approach: an innovative paratransit service is combined with mixed-

use, pedestrian oriented development and TDM strategies, all of which combine to make it much easier and more attractive for people to get around without their cars. A similar approach needs to be applied to other suburban travel markets. Comprehensive also means that transit providers must become more involved with all aspects of the suburban development process. Greater cooperation with private developers and employers is needed to solve some of these problems. The planning framework presented in the last chapter outlines this comprehensive approach to the problem of suburb-to-suburb commuting, and provides a means for applying the lessons learned in this case study to other suburban communities facing similar problems.

8.3 Recommendations for Further Study

Very little work has been done in the field of suburb-to-suburb transit planning. The literature review indicated a need for more research in this area, and in particular, there are few Canadian examples. A parallel study in another suburban area of Greater Vancouver or another Canadian city would be helpful.

An update of the situation in Surrey using the 1992 GVRD Travel Survey and the 1991 Census would show the impact of SkyTrain, the Alex Fraser Bridge, and the rapid growth in Greater Vancouver, especially Surrey, over the past 7 years. A further investigation of other factors affecting suburban transit use (such as trip length) is also needed. While this study has looked at work trips only, it would be helpful to investigate other trip purposes and the potential for transit to serve these, since suburban nodes are important generators of non-work trips as well.

While the multi-nodal urban form advocated in this thesis produces greater transit use than suburban sprawl, it can be argued that it is less amenable to transit use than a highly centralized urban form. Further study is needed into the tradeoffs between a multi-nodal and a single-centred urban form in terms of transit use, minimization of total travel, and other factors.

8.4 Summary

This study has shown that the growth of suburb-to-suburb commuting is a serious challenge for the transit industry. While it is not reasonable to expect transit to serve all suburban travel markets, it will be able to compete with the automobile in certain sub-markets, particularly those involving suburban nodes, which will play a key role in suburb-to-suburb transit service. TDM and land use planning strategies will also be critical in making transit more competitive with the private automobile. If transit is to be successful in these suburban markets, it will require an innovative and comprehensive approach.

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