Monograph 46

Transit-Supportive Development in the United States: Experiences and Prospects

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Executive Summary

Many American suburbs and exurbs are hostile environs to transit users and pedestrians. Campus-style office parks, walled-in residential subdivisions, and mega-malls are often designed so that it is difficult to access them or get around by any means other than the private automobile.

In recent years, there has been a chorus of calls to redesign America's suburbs so that they are less dependent on automobile access and more conducive to transit riding, walking, and bicycling. One prominent movement, neotraditionalism, borrows many of the successful elements from turn-of-the-century American communities, like gridiron streets, commercial cores, and prominent civic spaces. Another, transit-oriented development (TOD), focuses the entire community on a central transit facility. To date, relatively few such projects have broken ground. The handful that have are too new to carry out in-depth evaluations of their transportation impacts.

This report examines recent experiences in the U.S. with transit-supportive developments—projects which, by design, give attention to the particular needs of transit users and pedestrians. The study focuses mainly on experiences in the suburbs and exurbs of large U.S. metropolises, which in most cases are served only by bus transit. Assessments are carried out at three levels — individual sites, neighborhoods, and communities. Since in the course of the research we found fewer U.S. examples of transit-supportive developments in bus-only suburban-exurban environs than popular accounts might have us believe, the study gives particular emphasis to implementation issues — how recent market and regulatory factors have influenced the transit-supportive design movement.

Site-Level Analyses

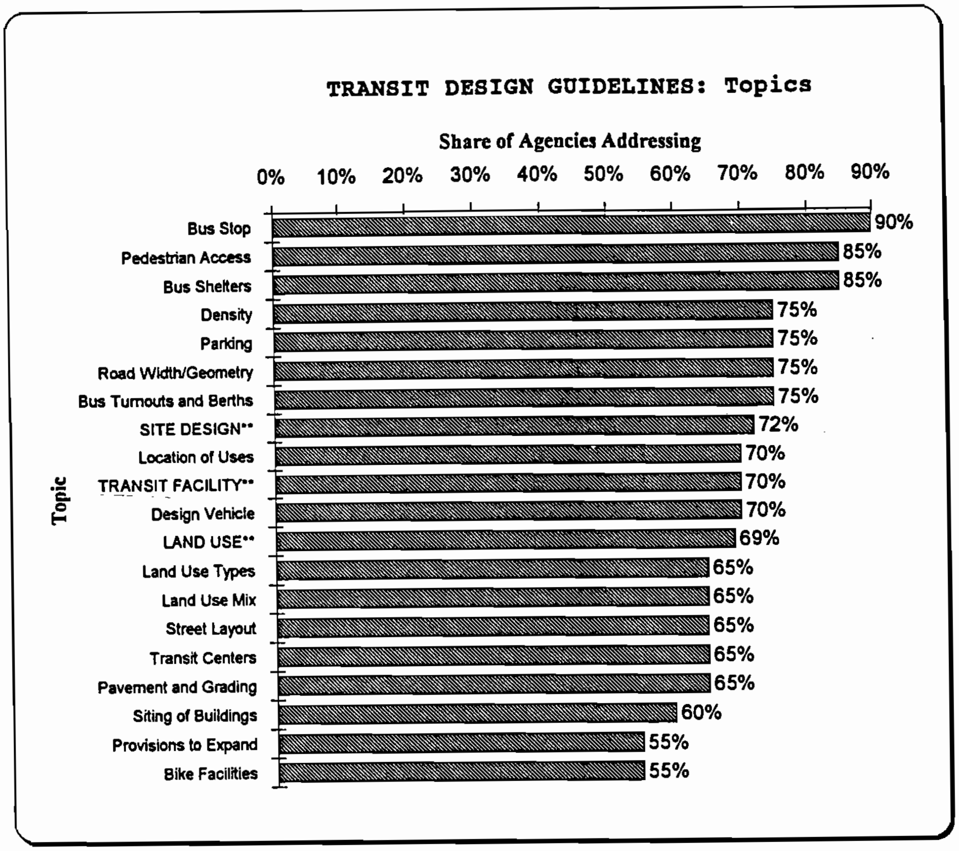
In order to study transit-supportive designs at the site level, a national survey was conducted that elicited information from U.S. transit agencies on local real estate projects that are friendly to transit users and pedestrians. The survey also gathered useful background information on transit-supportive guidelines themselves.

In all, around one-quarter of the surveyed U.S. transit agencies had guidelines, and around one-half of the guidelines have been approved or endorsed by a local policy body. Most guidelines are devoted to some combination of three topics: transit facilities design, site design, and land use (Figure E1). Around 70 percent of guidelines give at least some attention to all three topics. Levels of treatment varied greatly, however. Around 85 percent of guidelines contain illustrations and offer recommendations on the design and placement of bus stops and shelters, while only 65 percent suggest minimum densities for transit and only 40 percent address specific land-use programs that are

TRANSIT DESIGN GUIDELINES:

TOPICS

Topic	Share of Agencies Addressing
Bus Stop	90%
Pedestrian Access	85%
Bus Shelters	85%
Density	75%
Parking	75%
Road Width/Geometry	75%
Bus Turnouts and Berths	75%
SITE DESIGN**	**72%**
Location of Uses	70%
TRANSIT FACILITY**	**70%**
Design Vehicle	70%
LAND USE**	**69%**
Land Use Types	65%
Land Use Mix	65%
Street Layout	65%
Transit Centers	65%
Pavement and Grading	65%
Siting of Buildings	60%
Provisions to Expand	55%
Bike Facilities	55%



** Represents average percentage for each topical category.

Figure E1

Transit Design Guideline Topics

conducive to transit usage. Over 40 percent of guidelines set standards for transit facility designs, but only around 10 percent contain any standards for urban design or land-use planning.

From the survey, a surprisingly small number of specific real estate projects outside of rail corridors could be identified by transit officials that were genuinely transit supportive. While not a complete list, fewer than 30 transit-supportive sites were identified nationwide; most of these, moreover, incorporated micro-design features (e.g., on-site benches at bus stops and special staging areas for buses) rather than embracing macro-design elements aimed at shaping travel behavior (e.g., dense, mixed-use developments). Overall, the national survey provided few promising leads for finding "transit-friendly" sites that could be evaluated in terms of impacts on ridership and service delivery. It did, however, provide a compendium of good transit-supportive design practices as well as good examples of guidelines themselves. Based on criteria related to clarity of text, effective use of illustrations, quality of technical information, and integration of materials, eight areas had exemplary guidelines: Austin, Texas; Denver, Colorado; Montreal, Quebec; Reno, Nevada; Sacramento, California; Seattle, Washington; Snohomish County, Washington; and Portland, Oregon.

More in-depth analyses were carried out on the ridership characteristics of transit-supportive sites in five metropolitan areas: Chicago, San Diego, San Francisco, Seattle, and Washington-Baltimore. Besides the fact these areas have been at the forefront of promoting transit-sensitive site planning and designs, they were chosen also because travel data were available for the tenants of several transit-supportive projects. For the most part, differences in transit ridership rates were fairly modest across sites. Wherever transit-supportive projects were clearly outperforming other nearby similar projects, there were always extenuating circumstances. In suburban Chicago, for example, around one-third of workers at the new "transit-friendly" Sears headquarters in Hoffmann Estates commute by bus or vanpool/carpool, much higher than in any other outer suburban workplace in the region; however, these shares are due more to Sears' aggressive TDM program, the size of the company, and the carry-over of prior transit commuting habits among those who transfered from the Sears Tower in downtown Chicago. A number of offices and mixed-use centers in Bellevue, Washington, that have densities and site features supportive of transit average substantially higher shares of non-drive-alone commuting than in nearby campus-style developments; however, Bellevue's strict parking controls have as much to do with these outcomes as anything. Several transit-supportive retail and mixed-use projects in the Bay Area, San Diego, and greater Washington average ridership that is 8-15 percent higher than comparison sites, however in most of these instances the projects are near rail stations. Transit-supportive designs and rail service seem fairly compatible, in part because most rail-served areas are comparatively dense; for bus-only settings, however, the relationship between transit-supportive design and ridership is more tenuous.

To date, perhaps the biggest impact of the transit-supportive movement has been on local policy-making, such as the passage of Washington state's Growth Management Act and Baltimore's Access by Design program. Once such initiatives gain a momentum of their own and once sagging real estate estate markets begin to perk up, promotional campaigns like the marketing of transit-friendly guidelines will likely begin exerting stronger influences on development practices. The challenge will then rest with the public sector to mount good quality transit services which take advantage of transit-sensitive residential, office, and mixed-use developments.

Neighborhood-Level Analyses

The next level of analysis involved a comparison of commuting characteristics of transit-oriented versus auto-oriented neighborhoods in the San Francisco Bay Area and Southern California. Transit neighborhoods averaged higher densities and had more gridded street patterns compared to their nearby automobile counterparts. Efforts were made to match neighborhoods closely in terms of median household incomes and, to the extent possible, transit service levels to control for these effects.

For both metropolitan areas, pedestrian modal shares and trip generation rates tended to be considerably higher, in some cases well over 50 percent higher, in Transit than in Auto neighborhoods (Figures E2 and E3). Transit neighborhoods had decidely higher rates of bus commuting only

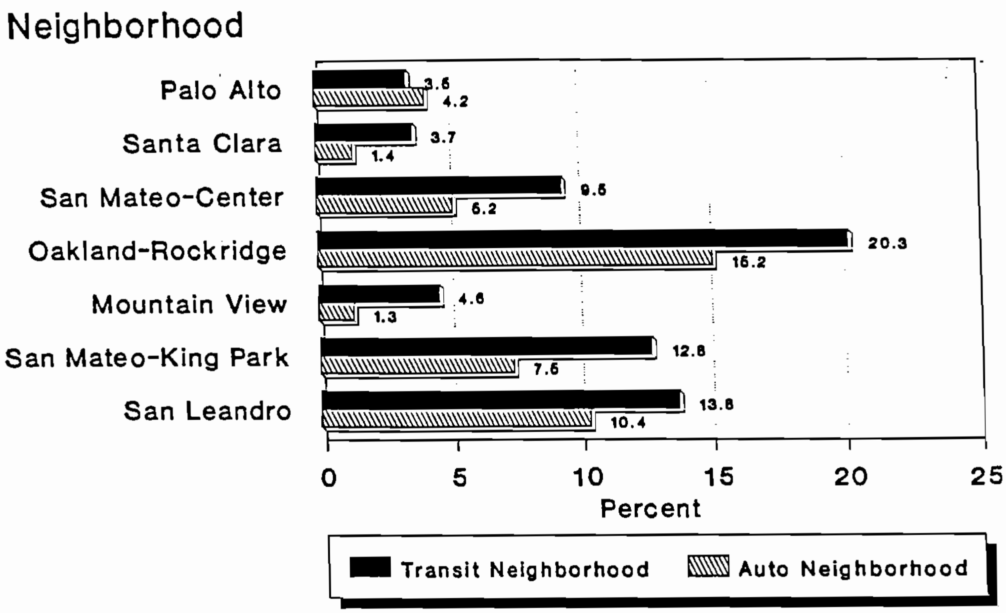


Figure E2

Neighborhood Comparisons of Transit Modal Splits, San Francisco Bay Area, 1990 Work Trips

in the Bay Area; in Southern California, both groups of neighborhoods had comparable transit modal splits and trip generation rates. On the whole, however, Transit neighborhoods won over larger shares of commuters to alternative modes than their Auto counterparts— for example, even in Los Angeles, Transit neighborhoods averaged around 50 more transit work trips per 1,000 households than Auto neighborhoods, controlling for household incomes and residential densities.

The general absence of strong and decisive relationships was no doubt due to several factors. One, finding true neighborhoods that met both differentiation and control criteria was problematic. Second, traditional transit-oriented neighborhoods probably have the biggest influence on non-work trips, particularly shop trips. Even if near-perfect matched pairs were obtained and shop travel data were available, it seems unlikely that bus transit modal splits will ever differ markedly among neighborhoods. However, when combined with pedestrian, bicycle, and carpool/vanpool travel, non-drive-alone shares are likely substantially higher in transit-oriented neighborhoods for many non-work trips.

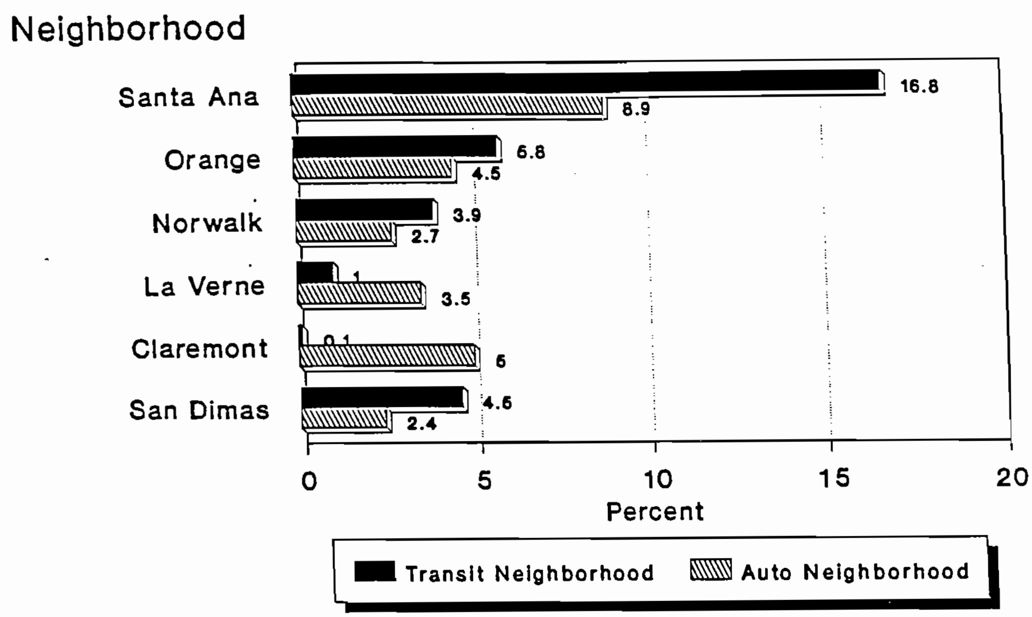


Figure E3

Neighborhood Comparisons of Transit Modal Splits, Los Angeles Region, 1990 Work Trips

Community-Level Analyses

At the community scale, the research focus shifted away from micro-design questions and more toward probing the ridership influences of structural elements of the built environment, like land-use compositions and levels of jobs-housing balance. One comparison was drawn between the commuting behavior of residents from ten traditional U.S. communities versus those of the metropolitan area at-large. Traditional communities averaged substantially higher shares of walk and bicycle travel as well as shorter trips. On average, larger shares of residents commuted by transit in traditional communities than did residents of the typical regional suburb, however not in all cases (Figure E4). The study of Edge Cities found that densities and mixed land-use compositions paid off only if Edge Cities are served by rail transit.

The bulk of the community-level analyses concentrated on planned communities. America's new towns were found to be fairly self-contained, averaging relatively large shares of residents working within the community. This produced shorter average commutes in new towns. Balanced new towns had slightly lower shares of transit and drive-alone commuting. In general, America's new communities seem to enjoy only modest mobility benefits.

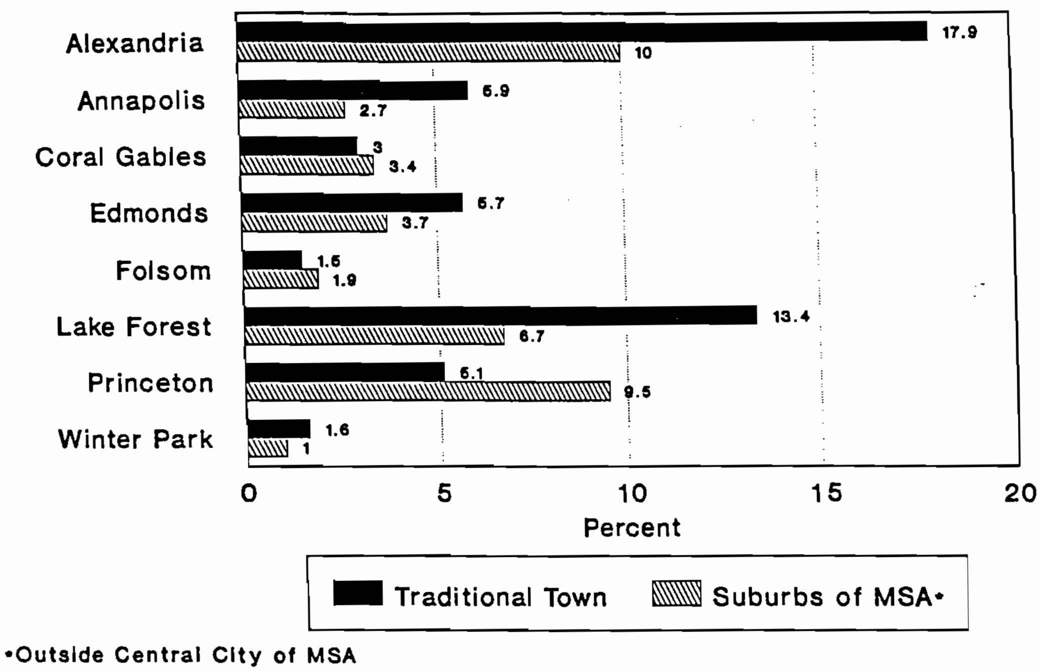


Figure E4

Transit Shares of Work Trips in Traditional Communities and Surrounding Suburbs, 1990

The best evidence on the link between community planning and commuting is from Europe. In general, an inverse relationship was found between how self-contained and balanced communities were and the share of work trips made by transit users. Britain's more recent new towns, epitomized by Milton Keynes, are highly balanced and theoretically self-contained, yet they are auto-dependent and average high levels of annual VMT per capita. In stark contrast are new towns outside of Paris and Stockholm. In both metropolises, satellite new towns are linked to the regional core by rail transit. While numerically balanced, new towns outside of Paris and Stockholm are not self-contained; rather, external commuting by residents and workers far exceeds internal commuting. Importantly, the external commuting that takes place is predominantly by rail transit, resulting in low annual vehicle-miles-traveled (VMT) per capita.

Experiences abroad suggest that having good quality rail or dedicated line-haul service is the key to luring new-town commuters out of their cars in substantial numbers, with such land-use considerations as density, neotraditional designs, jobs-housing balance, and self-containment of secondary significance. This is particularly so when regions have a built form similar to that of Paris or Stockholm —a strong, pre-eminent regional core orbitted by satellite centers that are radially linked to the core by fixed guideway services. In both instances, this regional form is the direct outcome of pro-active regional planning. Where regional planning is absent and development patterns are more diffuse and random-like, the opposite will result — commuting between communities will predominantly and almost unavoidably be by drive-alone automobile, even if rail services exist.

Conclusions

At the site level, there is little evidence that transit-friendly design features, like front-door bus staging areas and internal pathways, have much, if any, measurable impact on transit demand. Such micro-elements seem to be too "micro" to exert any meaningful influences on travel choices. More macro-factors, like densities and cost differentials of transit versus automobile commuting, are far more powerful determinants of how people travel. Once commuters have opted for a travel mode, micro-design features probably have some affect on secondary travel choices, such as during the midday. Thus someone commuting alone might be more inclined to walk to a restaurant several blocks away in a transit-and pedestrian-friendly setting than in a blatantly auto-oriented environment. However, the presence of micro-design features, in and of themselves, are too weak to shape the more fundamental decision of how to arrive at work.

The ability to evaluate the impacts of transit-supportive designs is confounded by the fact that all transit-friendly environments have transportation demand management (TDM) programs in place. Every office park or residential enclave with on-site transit shelters, front-door bus staging areas, and internal pathways also has an active, often ambitious, TDM program. Transit-supportive designs and TDM complement each other and no doubt mutually benefit. However, we believe that most of the differences in modal splits between transit-supportive sites and comparison sites are due to TDM programs rather than elements of the built environment. Overall, transit-supportive designs are helpful and well-intentioned, though fairly meaningless without good quality transit and rideshare services and pro-active measures that reduce auto-dependency.

To date, the transit-supportive design movement has had a bigger impact on the public than the private sector in many parts of the country. This has mainly been in the form of convincing local planners of the importance of considering the needs of transit vehicles and pedestrians in the review of development proposals. For the most part, the economic downturn of the late-1980s and early-1990s has slowed down the transit-oriented design movement since relatively few large-scale commercial projects are being built. However, when urban real estate markets begin warming up again, a number of jurisdictions will be well-positioned to see that whatever gets built is highly conducive to transit riding and walking. The burden will then shift to public transit agencies and private providers to ensure that good-quality transit services are delivered.

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The views and opinions expressed in this report are those of the author and do not necessarily reflect those of our sponsor. We alone are responsible for any errors or misinterpretations that may be contained in this report.

Chapter One

Transit-Supportive Development in the United States: Issues, Opportunities, and Research Approach

1. Introduction: Background and Study Purpose

The built environments of many American cities and suburbs are suited mainly for automobile travel. Low densities, segregated land uses, bountiful parking supplies, and circuitous street layouts encourage those with access to a car to drive alone. The spectacle of solo-drivers inching along packed freeways during the morning peak stems, to some degree, from the fact that America's cityscapes compel most people to drive.

Some observers attribute America's growing dependency on the private automobile primarily to suburbanization. Rapid increases in suburban population and employment over the past two decades have dramatically changed the spatial pattern of commuting. From 1980 to 1990, suburban population grew 26 percent in the 50 largest American MSAs; suburban employment growth was even more dramatic —49.2 percent. As a result, the majority of commute trips today both begin and end in a suburb (Eager, 1993). Mass transit and most other modes have a difficult time competing with the private automobile in an environment of scattered origins and destinations, as suggested by recent journey-to-work statistics. Nationwide, transit ridership fell from 6.4 percent of commute trips in 1980 to 5.3 percent in 1990 (Pisarski, 1992). Among suburban residents commuting to work, moreover, transit's market share fell by 0.6 percentage points during the 1980s in the 50 largest U.S. metropolitan areas (Cervero, 1993) —from 2.4 percent to 1.6 percent. And while 12 of these metropolitan areas saw transit usage increase in absolute terms during the 1980s, all except Houston, Dallas-Ft. Worth, San Diego, and Orlando witnessed declines in transit's market share of commute trips.

While changing origin-destination patterns have contributed to mass transit's eroding market share, the physical characteristics of origins and destinations themselves have certainly had a significant impact as well. Most residential subdivisions built since the 1960s have been designed as Planned Unit Developments (PUDs) where residents enjoy privacy, single-family living, and wide-open spaces —however, at the expense of being totally dependent on their cars to reach retail stores, restaurants, workplaces, and most other destinations. At the extreme have been the walled-off, security-controlled PUDs that often require anyone wanting to access a transit stop or reach a neighboring subdivision to endure long, circuitous treks.

Many workplaces are even less hospitable to transit users and pedestrians. Today, freestanding office complexes and campus-style business parks are the principle addresses of corporate America, dotting suburban landscapes throughout the U.S. Average employment densities in these places tend to be a fraction of those found in downtowns (Cervero, 1986). Most suburban offices, moreover, provide 1.0 to 1.5 (usually free) parking spaces per employee. And over 95 percent of floorspace is usually taken up by office functions. Traditional downtowns, by contrast, have a rich mix of offices, shops, restaurants, cinemas, banks, and other activities congregated together; while downtown workers can easily walk to a restaurant or store during lunch, those working in most campus-style office parks are virtually stranded in the midday if they do not drive to work. Contemporary shopping centers are perhaps the least friendly environments for transit or pedestrian access. Often bus riders are dropped off at the periphery of parking lots, forcing them to wade long distances through a sea of parking to reach stores. The perimeters of many shopping malls do not even have sidewalks. Except for those too young, old, or poor to own and drive a car, bus transit is largely ignored as a serious travel option by suburban shoppers.

In recent years, there has been a chorus of calls to redesign America's suburbs so that they are less dependent on automobile access and more conducive to transit usage, walking, and cycling. Phrases like neotraditional developments, traditional neighborhood designs (TNDs), pedestrian pockets, and transit-oriented developments (TODs) have been coined to describe a new design motif that creates attractive environments for walking and transit use. The neotraditional designs of architects like Andres Duany and Elizabeth Plater-Zyberk borrow many of the successful elements of turn-of-the-century transit communities and traditional towns like Princeton, New Jersey, and Annapolis, Maryland. Peter Calthorpe's Pedestrian Pocket schemes adopt many of these same principles, though the centerpiece of Calthorpe's projects is a rail transit station. Among the hallmarks of these transit-friendly and pedestrian-friendly environments are a commercial core within walking distance of a majority of residents, a well-connected (typically gridiron) street network, narrow streets with curbside parking and back-lot alleys, mixed uses, and varying densities of housing (Lerner-Lam, 1992; Bookout, 1992; Beimborn and Rabinowitz, 1991).

While transit-oriented designs have received considerable attention, both in the popular media and among professional architects and planners, little is currently built on the ground. In a recent review of new suburban projects in the U.S. with exemplary site designs, Rabinowitz et al. (1991) rated only four projects as having a high potential for good quality on-site transit services: Brambleton in Loudon County, Virginia; Laguna West in Sacramento, California; Lexington Park in Polk County, Florida; and Sutter Bay in Sutter County, California. Since all of these and similar projects are either in the early construction or planning stages, a careful evaluation of the transit ridership impacts of such large-scale developments will have to wait a number of years. In general, it is too early to assess the transportation impacts of most neotraditional, transit-oriented communities in the U.S.

Still, if transit-oriented designs are to be widely promoted and gain credibility as a viable approach to increasing transit usage and reducing automobile dependency, more and more evidence on their impacts will be needed. The purpose of this report is to help make some contribution in this area. Specifically, this study examines the experiences with transit-supportive designs and developments in the U.S. at different scales of analysis — the individual site level, the neighborhood level, and the community level. Experiences are examined in terms of both site design (e.g., building configurations, street layouts, and on-site provisions for pedestrians and buses) and land-use patterns (densities and mixtures of uses). Case studies are drawn mainly from large U.S. metropolitan areas which have been actively promoting transit-oriented designs and have had some success in bringing them about. European experiences with transit-supportive development are discussed as well.

While particular attention is given to uncovering evidence on how transit-supportive site designs and land-use patterns have impacted transit demand, the study also addresses how public agencies have sought to promote these developments and the barriers that have stood in the way of implementation. The emphasis given to institutional processes and implementation barriers grew out of the fact that as the research proceeded, it became evident that there were fewer U.S. examples of transit-supportive sites, neighborhoods, and communities than the popular press might have us believe. This, then, posed the question: "why not?" To address this, the primary medium used to date to promote transit-supportive designs — guidelines prepared and distributed by transit agencies — are examined in terms of content and how they have shaped the decisions of real-estate developers and public agencies.

Several caveats about this research are in order. One, this study focuses mainly on experiences with transit-supportive developments in the suburbs and exurbs of large metropolitan areas, in part because this is where most new projects are being built and where the challenges of reducing automobile dependency are the greatest. Second, emphasis is given to sites and neighborhoods that are served mainly, and in most cases exclusively, by bus transit. Many urban rail stations in the U.S. are already surrounded by dense, mixed-use neighborhoods with limited parking supplies and a continuous network of sidewalks. The challenges of designing in staging areas for buses, attractive spaces for pedestrians, and a denser assortment of land uses is qualitatively different (and certainly more difficult) in suburbs that are served only by bus transit than in rail-served urban centers. Lastly, the term "transit-supportive" is used throughout this report to refer to built environments that are conducive to transit riding and walking.[1] Thus, the phrase "transit-supportive sites" or "transit-supportive developments" refers to places with site designs and land-use patterns that are meant to promote transit riding and walking. Walking is lumped with transit in this phrase since all transit trips involve walking to some degree to access stops, stations, or destinations. By default, all transit-friendly environments must also be pedestrian-friendly.

2. A Brief History of Transit-Supportive Developments in the United States and Abroad

Streetcars and Turn-of-the-Century Transit Suburbs

The first transit-supportive developments in the U.S. were the streetcar suburbs. In the late 19th century, numerous private developers built streetcar lines to the outskirts where they had extensive real estate holdings, spawning massive decentralization, mainly of middle-class households seeking to escape the irritations of inner-city living. In areas as diverse as greater Boston and Los Angeles, streetcar lines not only guided urban growth, but also allowed for the physical separation of home from work and of social classes (Schaeffer and Sclar, 1980). According to Middleton (1966, p. 44):

> "... more than any other development, the electric streetcars contributed to the growth of America's suburbs. Population growth followed car lines, and a new trolley line extension invariably increased land values. Not infrequently, real estate syndicates built electric railways just to promote their land developments."

Between 1880 and 1920, when streetcar mileage multiplied, population in U.S. cities of over 10,000 people jumped from 11 million to nearly 45 million, or almost one-half of the national total (Smith 1984). Urban rail ridership increased from 600 million to 15.5 billion trips annually over this period. Smerk (1967) estimated that as much as one-quarter of the U.S. population still resides in urban and suburban areas whose spatial organization was shaped by the streetcar. One study found that early streetcar lines had a profound influence on urban form in America. Based on a statistical analysis of 28 U.S. cities from 1890 to 1910, Harrison (1978) found that each additional mile of streetcar line per capita was associated with a 3.2 percent increase in the share of single-family housing additions for the regions.

Examples of early railroad and streetcar neighborhoods include Back Bay in Boston, Riverside near Chicago, and Roland Park in Baltimore. The success of these early streetcar neighborhoods, designed by the likes of Andrew Jackson Downing and Frederick Law Olmstead, was dependent on pedestrian access to transit for connection to downtown jobs and neighborhood services, since they were built prior to the invention of the automobile (MNCPPC, 1992). Many of these neighborhoods featured small cottage houses, had a distinctive pattern of streets, focused on a civic space to instill a sense a community, and sought to preserve and enhance the natural environment. In order to attract early residents to distant suburbs, these communities were designed as safe, secure, and attractive places —notably with the placement of the transit depot and public space in the heart of the community and the use of restrictive covenants and other development standards to control the physical environment. These early neighborhoods were also sized to allow convenient walking distances to transit.

Not all transit-oriented developments built during this period were the idyllic villages many urban dwellers who moved to them had hoped for. The lack of subdivision regulations combined with land speculators' drive to reap profits at the expense of environmental considerations meant many projects were devoid of basic urban provisions like street lights, plumbing, and schools (Gallion and Eisner, 1986).

Self-Contained Neighborhoods and Communities

During the early to mid-1900s, increases in population, household incomes, mobility, and inner-city poverty led to a movement which called for the construction of self-contained, self-sufficient communities, to be linked together by raillines. Ebenezer Howard, in *Garden Cities of Tomorrow* (1898), first advanced the model of building satellite new towns of about 30,000 persons separated by greenbelts and connected by inter-municipal railways. Howard's vision was to build socially and economically self-sustaining communities that could relieve London from overcrowding and accommodate some of its poor, and at the same time apply value-capture principles to finance infrastructure and services (Hall, 1988). The physical elements of his plans featured curvilear and grade-separated passageways, mixed though physically separated land uses, and naturalistic landscape designs, hardly what many neotraditionalists would today embrace as a transit-friendly setting.

Many of Howard's followers borrowed from and extended the notion of building safe, peaceful satellite communities surrounded by greenbelts, such as embodied in the plans for Radburn, New Jersey, by Henry Wright and Clarence Stein, for Greenbelt, Maryland, and more recently for new towns like Columbia, Maryland, Reston, Virginia, and The Woodlands, Texas. Most of these places were designed on a superblock scale with houses grouped around a series of cul-de-sacs and linked by walkways. They also adhered to a strict, hierarchical classification of streets, with major thoroughfares placed on the perimeter of the community. And unlike Howard's Garden Cities, they were not planned as self-contained towns; they were more like dormitory villages, with the source of employment for residents usually in nearby cities. Nor was transit a prominent feature of these places. A few self-contained communities of this era which did focus on a rail station were Forest Hills, New York, Back Bay, Massachusetts, and Hampstead Garden Suburb in England (MNCPPC, 1992). In Forest Hills, the community transit station was surrounded by small shops, eateries, schools, churches, and open space. Compared to Radburn and other garden cities of the time, these transit-oriented places were more human-scale and had a finer grained mixture of land uses. Communities like Forest Hill and Back Bay helped foster the notion that a neighborhood consists of the catchment area that is served by an elementary school.

The model of self-contained satellite communities served by rail transit is perhaps no more fully developed than in Stockholm, Sweden. There, over a dozen master-planned suburban new towns are linked to central-city Stockholm by rail services. Most new towns have a balance of housing and jobs and feature a full array of urban services, including typically a child-care center for every ten residences. These new towns are mainly a product of closely coordinated regional planning and rail transit investment. Following World War II, Stockholm County government, which owned over 70 percent of the region's land, embarked on an urban spillover plan, seeking to direct future population and industrial growth to new towns constructed around and at the same time as the new regional rail network. The aim was to avoid a dormitory town environment and to make satellite communities as self-contained and balanced (both socially and in terms of jobs and housing) as possible.

Recent Transit-Supportive Developments

The common theme of contemporary models of community design that are transit-supportive is to build places that reduce dependence on the private automobile. The aim is to reorient subdivision development away from the PUDs and cluster development of the 1960s and 1970s toward patterns reminiscent of earlier streetcar suburbs and pre-World War II traditional communities.[2]

Today's neotraditional designs view the neighborhood as the basic building block of a community. A five-minute-, or one-quarter-mile walk, defines the scale of neighborhoods in all of these schemes. To achieve this, average densities are high by suburban standards — in the form of single-family houses on small lots, residences above storefronts, accessory units and "granny flats," and high shares of townhouses and multifamily units.

In addition to a mix of housing types, most neotraditional communities feature a fine-grained integration of commercial services into residential neighborhoods, formal open spaces, and prominent siting of institutional uses like civic centers and schools. Town centers, urban quarters, and gridiron streets oriented as much to pedestrians as to motorists are other common features.[3] Neotraditionalists Andre Duany and Elizabeth Plater-Zyberk have been particularly critical of contemporary zoning ordinances that separate land uses and engineering standards that dictate wide streets and abundant parking. Their response has been to write Traditional Neighborhood Design (TND) ordinances, which to date have been adopted by planning boards in South Florida, southern New Hampshire, and northern California.

Brambleton and Cascades in Loudon County, Virginia, and the Kentlands in Gaithersburg, Maryland, are examples of recently developed new communities that have embraced these neotraditional design concepts, though transit does not play a very prominent role in either place. More transit-oriented contemporary designs can be found in Sacramento, California, where county planners have adopted "Transit-Oriented Developments," based on the Pedestrian Pocket concepts of Peter Calthorpe, as the design norm for all new suburban developments. Sacramento County's updated General Plan expressly aims "to promote strong linkages between transit and land use by facilitating the development of higher residential densities and commercial intensities at transit stops and along transit corridors." Currently, developers of six large-scale mixed-use projects in the Sacramento area, including Laguna West and Dry Creek Ranch, have opted for TODs. Their projects feature mixed-use urban cores served by bus transit and maybe eventually LRT, moderate residential densities within the traditional one-quarter-mile walking radius of the main transit stop, main streets lined with shops, and various pedestrian amenities like interior pathways and narrow street crossings. In contrast to the more dogmatic theories of other traditional neighborhood designers, the pedestrian pocket and TOD schemes in Sacramento are conceived as one alternative to auto-dominated development rather than a mandate for change.

Beyond master-planned communities and new towns, less has been written about recent experiences with building other kinds of transit-supportive environments, such as on individual sites and parcels. Such experiences are explored in Chapters Three and Four of this report.

3. Current Policy Environment for Transit-Supportive Development

Today's policy environment is perhaps more conducive to promoting transit-supportive development than ever. In recent years, important federal and state laws have been passed that will reinforce and likely heighten interest in coordinated transit and land-use planning in years to come. The 1991 national surface transportation act (ISTEA) and federal and state air quality regulations stress the importance of increasing transit ridership in major urban centers. ISTEA requires state departments of transportation and metropolitan planning organizations (MPOs) to assess transportation and land-use decisions in relation to one another. ISTEA also sets aside a dedicated "enhancement" fund that is targetted at promoting innovative programs that improve environmental conditions, which include initiatives to more closely link land-use and transit development. The 1990 Clean Air Act Amendments also identify land-use initiatives as potentially effective means of reducing ambient pollution levels in non-attainment areas, which currently numbers over one hundred nationwide. The recent Americans with Disabilities Act (ADA), moreover, will likely work toward promoting closer physical integration of transit facilities with surrounding communities so as to guarantee everyone equal access to rail transit facilities.

A number of states also passed legislation during the 1980s that promotes stronger linkages between transportation and urban development. New Jersey, Vermont, Florida, Oregon, and Washington passed statewide growth management laws that stipulate adequate infrastructure, including roads and transit facilities, must be in place to support future growth. Oregon passed legislation in the 1980s that sets urban growth boundaries for Portland and other urban centers, and ties state grants to local coordination of transportation and land-use plans. California recently enacted AB471, which requires all cities and urban counties to prepare a Congestion Management Plan. A key component of this plan is a requirement that local land-use decisions be assessed in terms of how they will affect regional transportations systems. California's stringent air quality requirements have also pressured extreme non-attainment areas like Los Angeles County to more closely integrate land-use and transportation planning. California's local air quality boards can conduct indirect source reviews on the transportation and pollution impacts of large activity centers like shopping malls; if such development exacerbate existing conditions, building permits can be revoked or appropriate mitigation measures can be imposed.

At the local level, more and more communities are using design guidelines in reviewing and acting upon new development proposals, a trend that is discussed later in this report. Increasingly, local regulations, like trip-reduction ordinances and adequate public facilities ordinances, grant credits to employers and developers who introduce provisions like on-site bus shelters and shower/locker facilities for cyclists.

In summary, a legislative environment has evolved in recent years that provides greater opportunities for promoting transit-supportive designs and land-use programs than any time in the past. The challenge rests with local planners, developers, and transit agencies to exploit these opportunities to their fullest.

4. Possible Benefits from Transit-Supportive Development

The primary transportation benefit of building places that are more friendly to transit users and pedestrians is that they could convert more automobile trips to transit trips. Such shifts would in turn likely produce a number of secondary benefits:

- *Improved mobility and environmental conditions*: Ridership increases could relieve traffic congestion along roads paralleling transit lines and reduce automotive tailpipe emissions. Communities with a mix of jobs, housing, and shops nearby as well as within walking distance of transit stops could further reduce air pollution to the degree there are fewer short automobile trips. Currently, in the San Francisco Bay Area, an estimated 80 percent of suburban residents who ride the BART rail system access stations via private automobile (Sedway and Cooke, 1989). These suburban transit users do little to improve air quality or conserve fuel since emission and fuel consumption rates are relatively high for short automobile trips due to cold starts and hot evaporative soaks. For a five-mile journey, the typical distance of a park-and-ride trip to a rail station, around 85 percent of hydrocarbon emissions are due to cold starts and hot soaks (Cameron, 1991). To the degree transit-supportive development induces more walk access, it could yield important air quality benefits.

- *Increased supplies of affordable housing*: Virtually all transit-supportive developments feature higher-density housing which lowers the per unit dwelling cost. Most large U.S. metropolises suffer from a shortage of affordable housing, forcing many moderate-income people, young families, and first-time home-buyers to reside on the exurban fringes. Those living and working in transit-supportive environments might also no longer need to own a second car, freeing up more income for housing consumption.

• *Increased income to transit agencies*: Higher ridership would increase farebox income, thus reducing the reliance of transit agencies on outside support. Income can also be generated from land and air rights leases, station connection fees, benefit assessments, and other forms of value capture (Cervero et al., 1992). At the Ballston station in Arlington, Virginia, and the South Dadeland station in suburban Miami, Florida, regional transit agencies receive more than $200,000 annually in air-rights lease and connection fee revenues from adjoining large-scale mixed-use projects. To the extent that benefits of being near a transit station are capitalized into higher land values and rents, local governments from communities with transit-supportive developments should also receive more property tax and value-added income.

• *More efficient urban form*: Transit-oriented developments also generally promote infilling and densification, thus helping to preserve natural resources, including open space and agricultural land. Physical and social infrastructure costs could also be contained to the extent that development is less sprawled.

• *Other social benefits*: Transit-oriented developments could also be a catalyst to urban redevelopment. When combined with other social programs like job training, developments with good transit services could encourage more private investments in decaying urban centers. Transit-oriented development would also provide more live-travel options for older Americans and empty-nesters, disabled persons, and other transit-needy groups. Rather than living in an auto-oriented suburbs, more Americans might opt to live or work in a transit-oriented traditional setting if given the choice.

In summary, transit-supportive development offers an opportunity to help redress some of the nation's most pressing urban problems, including air pollution, shortages of affordable housing, traffic congestion, inner-city decay, physical barriers to mobility, and costly sprawl. These secondary benefits will be limited, of course, by the degree to which residents, workers, and customers of transit-oriented developments actually patronize transit. This question is addressed throughout the remainder of this report.

5. Research Approach and Report Organization

The focus of this study is to examine the impacts of transit-supportive developments on transit demand and, to the extent that few examples of such developments in suburban settings served only by bus transit exist, to explore what barriers have stood in the way of such projects. The research is organized around the following three scales of analysis to provide a full spectrum of insights into the relationship between transit-supportive designs and transit usage: individual sites and projects (micro-scale); neighborhoods (intermediate-scale); and communities (macro-scale). The remaining chapters of this report explore the relationship between types of transit-supportive development and transit usage at these three scales of analysis, in addition to addressing important implementation issues.

Chapter Two presents a literature review on what we currently know about the influences of land use on transit ridership and travel behavior. Past research findings are summarized at all three scales of analysis.

Chapter Three focuses on the site level. Its purpose is twofold: one, to identify suburban, bus-served sites that are considered locally to be good examples of transit-supportive development; and two, to summarize the contents of guidelines which have been prepared to date to promote transit-sensitive designs and land-use plans and to showcase some good examples of these guidelines. The first task — identification of sites — was conducted through a national survey of all large U.S. transit agencies. Besides identifying candidate sites and providing any available ridership statistics on these sites, transit officials who have been actively involved in promoting transit-supportive development were queried regarding what physical design and land-use elements they feel are most important to transit in the suburbs. The latter part of the chapter summarizes the relative emphasis given to different topics in the guidelines of 19 North American transit agencies. Since all of these transit agencies have done the most to encourage developers to promote transit at the project design stage, they were viewed as fertile areas for mining good examples of transit-sensitive planning.

Based on the national survey and results from Chapter Three, five metropolitan areas that have been at the forefront of promoting transit-supportive development were chosen for follow-up case studies. Case study summaries are presented in Chapter Four. In all five case studies, some evidence is presented on the impacts of transit-supportive sites on transit modal splits and trip generation rates. Where possible, modal splits at commercial and office sites that are transit-supportive are compared to those of more traditional, auto-oriented suburban sites that are otherwise comparable. Where paired comparisons were not possible, statistics are compared to county or suburban averages. In addition to investigating ridership impacts, the evolution of planning for transit-supportive developments is discussed in each case study. Views and reactions of local developers to these design ideas are also summarized for each case.

Chapter Five presents the results of a neighborhood-level analysis of land-use and transit ridership relationships. Using 1990 journey-to-work census data from the San Francisco Bay Area and Southern California, matched-pair comparisons are drawn on differences in transit modal splits between transit-oriented and auto-oriented residential neighborhoods.[4] To the degree possible, neighborhoods are paired to control for the affects of income and transit service intensity on modal splits.

The macro-scale analysis is presented in Chapter Six. Here, matched-pair comparisons are also used to explore how different kinds of built environments influence modal splits, using community-level data. One analysis compares differences in land-use and transportation characteristics of nine master-planned U.S. new towns and nearby semi-planned communities. Differences in levels of jobs-housing balance (e.g., self-containment) and modal splits are compared between new towns and the control communities as well as between new towns themselves. Similar relationships are explored for planned communities outside of Stockholm, Paris, and London, providing insight into how public policies shape outcomes.

Chapter Seven summarizes the research results and draws policy insights from the findings. Recommendations are presented on how to best promote transit-supportive developments in the future. Directions for future research are also suggested.

Notes

[1]Other terms used to describe these kinds of built environments are "transit-sensitive," "transit-serviceable," "transit-friendly," and "transit-oriented." Often these terms are used interchangably.

[2]PUDs are premised on the basis that the entire community rather than an individual lot should form the basic unit for planning. In 1971, the Urban Land Institute defined the PUD as a residential project with dwelling units grouped into clusters, allowing an appreciable amount of land for open space (Bookout, 1992). Within a single development, all of the amenities for comfortable residential living are normally provided, including schools, shopping, public parks, and churches. Residential land uses are often well separated from shopping and other activities. Streets are normally curvilinear, connected by numerous cul-de-sacs. PUDs embody a higher level of regulation and planning than any previous approach to large-scale residential development.

[3]Neotraditional design principles differ from those of garden city designs in one important way —they encourage the commingling of automobile and pedestrian activities. The garden city planners wanted to separate the automobile from the human environment by providing distinct and grade-separated rights-of-way for vehicular and non-vehicular travel, by laying projects on a superblock scale, and by reorienting housing away from streets. Most neotraditionalists want to return the automobile to the common area, but change the street design so that it functions for the lowest common denominator, mainly the pedestrian (McNally and Ryan, 1992).

[4]Whereas the site level analyses presented in Chapters Three and Four focus on commercial and office uses, the neighborhood level analyses presented in Chapter Five focuses on the travel behavior of residences rather than workers.

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Chapter Two

Previous Research on Impacts of Land Uses and Built Environments on Travel Demand

1. Introduction

A body of work has been carried out to date on how urban densities, walking environments, and other characteristics of cities affect transit demand and travel behavior. Past work has concentrated on a range of transit modes, though most attention to date has been given to bus and heavy rail transit.

This literature review is organized around the three primary scales of analysis in which research has been conducted to date: macro (city/regional), intermediate (corridor/activity center), and micro (station area/neighborhood/site). These scales match how the research results of this study are presented in later chapters. While much of the literature cited in this review is drawn from a U.S. context, findings from some of the more important international studies are discussed as well.

2. Macro-Level Analyses

American Studies

In a seminal study, *Public Transit and Land Use Policy*, Pushkarev and Zupan (1977) developed a set of "land use thresholds" that are necessary to financially justify different types of transit investments, based on inter-modal comparisons of transit unit costs and inter-city comparisons of transit trip generation rates. They found the key land use determinants of transit demand to be the size of a downtown (in non-residential floorspace), distance of a site to downtown, and residential densities. To justify a light rail line, for instance, Pushkarev and Zupan concluded that minimum residential densities of 9 dwelling units per acre were needed to serve a downtown with at least 20 million square feet of non-residential floorspace. The Pushkarev and Zupan findings probably have less relevance today since most U.S. metropolitan areas are multi-centered, thus diminishing the importance of the size of the CBD. The use of data from the New York region has also raised doubts about the generalizability of the findings. Still, this work is cited and used frequently in feasibility studies of proposed rail projects, in part because hardly anything else is available.

In another cross-city comparison of six U.S. metropolises (ranging in size from Springfield, Massachusetts, to the New York region), Smith (1984) found that transit trips rose most sharply when residential densities increased from around 7 to 16 dwelling units per acre. In the case of Greater New York, for instance, this residential density jump increased average weekday transit trips per person from 0.2 to 0.6. At residential densities of 100 dwelling units per acre, Smith found that each New York resident was averaging around one mass transit trip per day.

An early study concluded the opposite about the relationship between density and transit usage. In an econometric analysis of 1973 NPTS data, Peat, Marwick, and Mitchell (1975) tested a number of demand functions in an attempt to estimate per capita passenger miles for both bus and rail transit.[1] The authors concluded that ". . . for both bus and rail systems, the explanatory variables of average square miles per capita (the inverse of average population density), price, and headway were not sufficient to explain very much of the variation among urbanized areas in the demand for transit services." The study suggested that socioeconomic characteristics of residents explained far more of the observed variation in modal split.

Lastly, a macro-level study of American new towns examined differences in VMT per household, a topic that is addressed in Chapter Six of this report. Part of the rationale for new communities has been the possibility of reducing travel by the planned juxtaposition of complementary land uses. A comparison of travel behavior in 15 new communities with 15 "semi-planned" control suburbs showed no discernible reduction in VMT or transit usage from planned designs, except in the category of recreational trips (Burby et al. 1974).

Another body of regional-scale work that has investigated how land-use environments affect travel behavior has involved simulation modeling. Among the organizations conducting such studies have been the Southern California Association of Governments (SCAG), the Association of Bay Area Governments (ABAG), the Metropolitan Area Planning Council in Boston, Massachusetts, the Puget Sound Council of Governments in Seattle, Washington, and the 1,000 Friends of Oregon in Portland. All of these studies have estimated the regional consequences of alternational land-use plans and site-specific urban design improvements on travel behavior and highway conditions. To date, simulations suggest that urban design measures can reduce trip-making within and outside of suburban activity centers, and that reconcentration of growth in existing urban centers provides the greatest mobility benefits.

International Studies

Several notable studies with an international focus have examined the impacts of urban form on travel behavior. Using international comparisons of U.S., European, and Asian cities, Newman and Kentworthy (1989) found that U.S. cities like Phoenix and Houston averaged roughly four to five times as much fuel consumption per capita as comparable size European cities. The authors also found a strong relationship between density and energy consumption within metropolitan areas. For the New York region, for instance, Manhattanites average 90 gallons of fuel consumption per capita annually, compared to 454 gallons per capita in the outer suburbs. This work has been criticized, however, notably over the lack of statistical controls that account for other factors influencing fuel consumption, such as differences in the fuel efficiencies of U.S. versus foreign fleets (Gordon and Richardson, 1989; Gomez-Ibanez, 1991). Regardless, the analysis has spurred healthy debate within public policy circles about the appropriate role of central planning versus market forces in responding to pressing environmental and energy consumption problems.

Pucher's (1988) comparison of transit modal splits for 12 countries in Western Europe and North America underscored the importance of public policies on shaping travel choices. On average, European cities were found to be on the order of 50 percent denser with substantially more mixed-use neighborhoods than their American counterparts. Pucher found the percentage of all trips made by the automobile to be more than double that of the majority of western European countries, most of which have per capita incomes comparable to the U.S.'s. America's 3.4 percent of national transit modal split for all trips was also around half of that found in European countries. Pucher attributed transit's success in Europe more to supportive urban development and automobile taxation policies than to transit subsidies.

As a counterpart to the U.S. study on new towns, Potter (1984) conducted a similar review of British new town experiences. Potter found that communities designed for good transit access enjoyed higher ridership and more efficient services. Compared to two low-density, auto-oriented new towns (Milton Keynes and Washington), two transit-friendly communities (Runcorn and Redditch) averaged per capita transit ridership levels that were nearly 30 percent higher. They also enjoyed far more frequent bus services at one-third the deficit per rider of their auto-oriented new town peers. (See Chapter Six for further details.)

Among cities in developing countries, Curitiba, Brazil, is often heralded for its close integration of regional transit and urban development patterns. In the 1960s, Curitiba, a city of around 2.5 million, implemented a plan that restricted high density to five "antennae" radiating from the city center. Complementing the density plan, five transportation axes offer bus-only services on dedicated median lanes, speeding riders among city sectors and providing easy transfers to concentric-routed neighborhood buses.

Early on, Curitiba's city government, led by its progressive mayor, Jamie Lerner, bought a great deal of land and purposefully zoned it for the very tight-density areas needed to support transit. This was followed by the development of a 514 transitway network that supports articulated and privately owned buses.[2] Other relatively inexpensive measures were introduced, including automated fare collection, bus pre-emption of traffic signals, and a raised transfer-waiting tube that cuts down on dwell time taken for collecting fares and stair-climbing. The all-bus system currently handles 12,000 passengers per hour per direction on express lines, a volume that rivals that of many U.S. rail systems. As a result of the close coordination of land use and busway programs, Curitiba's transit ridership has grown from 25,000 per day in 1970 to 1.3 million daily users today (Lerner, 1993).

3. Intermediate-Scale: Corridors and Activity Centers

Overview Studies

The emergence of suburban downtowns and edge cities over the past two decades has spawned a number of investigations into how these built environments influence travel behavior (Baerwald, 1982; Long Island Regional Planning Board, 1984; Cervero, 1984, 1986; Orsk, 1985; Leinburger and Lockwood, 1986; Giuliano and Small, 1990). Several studies have concentrated on the impacts of various land-use and physical design features of activity centers on travel behavior along a number of dimensions, with particular focus given to impacts on transit usage.

In an analysis of suburban activity centers in metropolitan Toronto, Pill (1983) found dense office and residential subcenters like North York and Scarborough to be vital in maintaining multi-directional flows on the regional rail transit network. These centers were found to have captured nearly three times as many transit trips for work purposes and around twice as many for shopping purposes as other non-CBD locales in metropolitan Toronto. Cervero (1986) documented the effects of rapid suburban office growth during the 1980s on travel behavior, finding that most (low-density, single-use) campus-style office parks with abundant free parking averaged transit modal splits under 2 percent, a finding also confirmed by Fulton (1986) in his analysis of inter-suburban commuting in the U.S.

Several recent studies have enriched our understanding of how the built environments of suburban activity centers influence travel behavior. Hooper's (1989) survey of six mixed-use activity centers across the U.S. found transit modal splits to be consistently below 1 percent, except in the case of the densest center, Bellevue, Washington, where the modal split was around 9 percent (Table 2.1). Hooper also found considerable variation across individual properties within centers. In the case of Bellevue, for example, 37 percent of workers carpooled and 12 percent rode bus transit at an office project which restricted and charged for parking. At a nearby building where parking was plentiful and free, only 11 percent of workers either shared rides or patronized transit. Cervero's (1991) statistical analysis of travel characteristics to sites from the NCHRP suburban activity centers data set revealed that building densities had the dominant influence on modal splits, followed by land-use mixing and parking supplies.

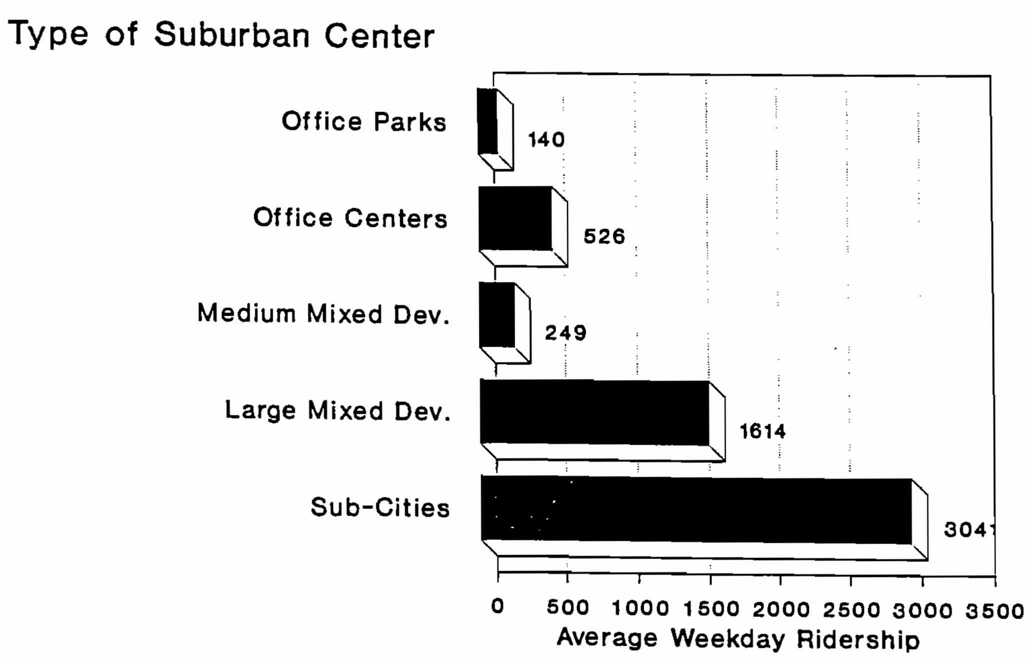
In another study, Cervero (1989) classified America's largest suburban activity centers on the basis of the size, densities, land use composition, and site designs/amenities, finding all of these factors to be significant predictors of transit modal choice, with densities being the dominant factor. The incidence of ridesharing and transit usage was the highest in suburban work settings with the largest retail components. Dense, mixed-use suburban downtowns (sub-cities) averaged more than 20 times as many transit commute trips by their workforce as sprawling, low-density, and single-use office parks (Figure 2.1). Earlier work on subcenters in the greater Houston area reached similar

Table 2.1

Characteristics and Work Trip Modal Splits of Selected U.S. Suburban Activity Centers

Center	Distance from CBD (Miles)	Density: Commercial sq.ft./ Acre	Density: Employ-ment/ Acre	Percent Employee Commuter Trips by: Drive-Alone Auto	Percent Employee Commuter Trips by: Transit
Bellevue (Seattle)	10	17,500	43.2	73.9	8.8
South-Coast Metro (Orange County, CA)	45	12,931	29.9	92.5	0.0
Parkway Center (Dallas)	10	12,834	25.9	94.2	0.2
Perimeter Center (Atlanta)	12	10,344	29.3	93.0	0.5
Tysons Corner (Washington, D.C.)	12	21,138	30.6	89.2	0.7
Southdale (Minneapolis)	10	7,292	20.7	92.1	0.8

Source: Hooper (1989)



Source: Cervero (1989)

Figure 2.1

Differences in Transit Work Trip Modal Splits Among Five Classes of Suburban Employment Centers

conclusions about the importance of mixed uses in shaping mode choice (Rice Center for Urban Mobility Research, 1987).

A more recent study in the Washington, D.C., area found denser and more mixed-use employment centers to be more transit-dependent. Among workers with similar incomes, 55 percent of those working in downtown Washington commuted by mass transit, compared to 15 percent of those working in a suburban downtown (Bethesda) and only 2 percent of those working in a suburban office park (Rock Springs Park) (Douglas, 1992).

Density and Travel Behavior

Several studies have focused specifically on the relationship between the employment and commercial densities of activity centers on travel behavior. On balance, research consistently shows density to be one of the most important determinants of transit modal choice, regardless of the scale of analysis.

Two recent studies of subregions in the San Francisco Bay Area underscore the importance of urban densities in influencing travel behavior. Using 1981 superdistrict data in the Bay Area, Harvey (1990) found a strong negative exponential relationship between residential densities and the amount of vehicular travel — a doubling of densities results in a 30 percent decline in VMT/household. Holtzclaw (1990) found a similar relationship across five Bay Area communities with similar income profiles. Using data from smog check odometer readings and trip logs, Holtzclaw found that residents of a dense part of San Francisco logged, on average, only one-third as many miles on their private vehicles each year as residents of Danville, an East Bay suburb. Both authors concluded that every doubling of resident densities reduce annual VMT by 20 to 30 percent.

Mixed-Use Developments and Travel Behavior

Cervero (1989) cited land-use mix as an important factor in influencing employee commuting choices at 57 large U.S. suburban employment centers. His analysis found that a substantial retail component increases transit and ridesharing by around 3 percentage points for every 10 percent increase in floorspace devoted to retail-commercial uses. The strongest influence on modal choice was between projects with virtually all floorspace taken up by offices and projects where offices took up no more than three-quarters of building area. Recent research, moreover, shows that trip generation rates should be adjusted downward when mixed land uses are present. In a comprehensive study of mixed-use sites in Colorado, the ITE Colorado Section Technical Committee on Trip Generation (1987) recommended reducing ITE peak hour rates by 2.5 percent when applied to mixed-use developments.

Jobs-housing balance has also gained policy attention in recent years as a mixed-use development strategy which could yield mobility dividends; however, evidence to date is scant. In his analysis of 57 U.S. suburban activity centers, Cervero (1989) found that centers with some on-site housing averaged between 3 to 5 percent more commute trips by walking, cycling, and transit than otherwise comparable centers without on-site housing. Nowland and Steward (1991) present evidence that reducing jobs-housing imbalance can improve mobility along corridors to the central city core. They found that although substantial new office construction occurred in central Toronto between 1975 and 1988, much of its impact on peak-hour work trips entering the area was offset by accelerated housing construction. Over half of downtown Toronto housing additions were occupied by people working there, thus allowing mobility conditions to stabilize while office space nearly doubled.

Other researchers have found little evidence that jobs-housing balances reaped mobility benefits. Giuliano (1991) analyzed the location of jobs and housing in a number of metropolitan areas and concluded that the relationship between jobs-housing balance and commuting holds only in very general terms. Because residential locations are influenced by many factors other than proximity to work and given the trend toward two-earner households, Downs (1992) argues jobs-housing balance tactics have little impact on traffic congestion, though he notes they might be worth pursuing for other reasons, such as increasing socioeconomic and cultural diversity of American suburbs.

4. Micro-Scale: Neighborhoods, Station Areas, and Sites

To date, three lines of research have been conducted at a neighborhood scale on how land uses influence transit trip-making: (1) studies of transit modal shares and ridership gradients around station areas; (2) the impacts of traditional neighborhood developments and transit-oriented developments on ridership; and (3) determinants of pedestrian walking distances.

Transit Usage by Proximity to Stations

In a study of ridership among housing and commercial developments near four rail stations in Edmonton and Toronto, Stringham (1982) found transit modal splits to be about 30 percent higher for apartments than single-family units. He also found the "walking impact zone" to be as far as 4,000 feet from a station, a distance that can accommodate around 1,200 acres of development, sufficient to create moderate-size transit-oriented communities of 30,000 to 40,000 population.

A study of ridership levels for office, residential, and hotel structures near Washington Metrorail stations found surprisingly high transit modal shares for radial trips that paralleled the rail system (JHK and Associates, 1986, 1989). For example, around 25 percent of those working at the Silver Spring Metro Center (near the Silver Spring station) patronized transit for work trips. Modal shares varied significantly by place of origin, however. If the worker was coming from Washington, D.C., the transit modal share was 52 percent, whereas if the trip originated in Montgomery County the transit split was only 10 percent. The study also found a number of housing projects near suburban Metrorail stations where the transit modal splits exceeded 50 percent, though in all cases this was only for work trips headed to Washington, D.C., or other places on the Metrorail line. Overall, the share of trips by rail or bus transit declined by around 0.65 percent for every 100-foot increase in distance of a residential site from a Metrorail station portal.

Both the Washington and Canadian studies found that transit modal splits for offices located near suburban rail stations were considerably lower than that of residences near the same stations, perhaps reflecting the availability of sufficient parking at the suburban businesses surveyed. For developments near rail stations, JHK and Associates (1987, p. 1) concluded that "the most significant factors affecting the percent of trips by transit are: (1) the location of the site within the urban area and on the rail system; and (2) the proximity of the building to a Metrorail station entrance." The origin-destination patterns of trips were found to be crucial— "poor transit accessibility at either end of the trip results in poor transit ridership between those pairs (p. 1)."

A recent examination of housing and office developments near rail stations in California has confirmed and extended these earlier findings (Cervero et al., 1993). For housing near rail stations, the principal determinants of whether station-area residents will commute by rail transit were found to be the size (office-commercial square footage) of the destination and whether parking fees are exacted. In the Bay Area, 92 percent of those living within one-quarter of a mile of a BART station and heading to a job in San Francisco where parking costs over $2 per day commute via rail transit. If the workplace is in major East Bay employments centers like Oakland, Berkeley, Walnut Creek, or Pleasant Hill (all served by BART) where parking fees are exacted, the odds of station-area residents commuting by BART is 45 percent. For virtually any other Bay Area workplace location where parking is free, fewer than 2 percent of station-area residents commute via BART. Clearly, if transit-based housing is to reap mobility and environmental dividends, it must be matched by transit-based office development and commercial clustering.

Impacts of Traditional Designs

The second line of neighborhood-level research has sought to empirically measure the extent to which traditional and neotraditional neighborhood designs influence travel behavior. These are typically neighborhoods that either grew around a streetcar or commuter line system, or, in the case of newer communities, are designed to function like older transit-based neighborhoods. As discussed in Chapter One, the central idea is to build suburban places that are less dependent on the automobile and that are attractive environments for walking, ridesharing, and using transit.

Several empirical investigations have sought to measure the degree to which traditional-like communities effect travel behavior; however, these efforts have been hampered by the fact that most neotraditional communities are still under construction, or being planned. Thus, work to date has focused mainly on comparing travel behavior between long-established traditional communities and nearby 1960s-style suburban neighborhoods. Kulash et al. (1990) demonstrated how grid network designs can result in more direct routing of vehicles in traditional suburban subdivisions — a comparison of two contrasting neighborhoods showed VMT could be reduced by 43 percent with rectilinear street layouts. More recent simulations by Stone and Johnson (1992) and McNally and Ryan (1993) confirmed that grid networks can reduce VMT and average trip lengths, though they estimated reductions in the 10 to 15 percent range.

A study of San Francisco Bay Area travel found a dramatic difference in mode choice between standard suburban developments and traditional, pre-World War II neighborhoods with mixed uses and moderate to high densities (Fehr and Peers Associates, 1992). In traditional neighborhoods, 23 percent of trips were made on foot and 22 percent were by transit. In comparison, suburban residents made only 9 percent of trips by foot and 3 percent by transit. A follow-up study of suburban village centers proposed for Stockton, California, estimated there would be 25 percent fewer daily automobile trips and 33 percent less VMT in a community utilizing the suburban village center concept. Another empirical study of several California communities, however, found no significant difference in the share of walking trips to retail centers among neotraditional versus conventional suburban neighborhoods (Handy, 1992).

A study of trip generation rates of traditional developments in New England disclosed that trip generation rates were substantially below the norm. Using trip data compiled for two traditional neighborhoods in Portsmouth, New Hampshire, the authors found the average daily traffic (ADT) generated by these neighborhoods to be about 50 percent lower than the ADT predicted by the latest version of the *ITE Trip Generation Manual* (White Mountain Survey Company, 1991).

A recent study in Montgomery County, Maryland, provides some insight on the travel characteristics of traditional neighborhoods that are served directly by rail transit (MNCPPC, 1992). The authors compared transit modal splits between three transit-oriented traditional neighborhoods (served by the B&O commuter railroad or a trolley line) and three nearby newer neighborhoods with a branching system of streets designed for auto access. The study found that residents of the transit-oriented communities patronized transit between 10 percent and 45 percent as much as residents of nearby auto-oriented neighborhoods.

Studies on Pedestrian Access

A number of studies, besides those examining ridership by walking proximity to stations, have examined factors influencing walking behavior. As mentioned earlier, since all transit trips involve some degree of walking to access stops or stations, research on pedestrian behavior is highly relevant. To be transit-friendly, built environments need to be pedestrian-friendly as well.

Untermann (1984) has conducted in-depth work on Americans' walking behavior. His research shows that most people are willing to walk 500 feet, 40 percent will walk 1,000 feet, and only 10 percent will walk half a mile. These figures do not specify purpose of the walk trip, however; for more crucial trips, such as to work, the Stringham study suggests that acceptable walking radii might be farther. Untermann and others have shown that acceptable walking distances can be stretched considerably (perhaps as much as doubled) by creating pleasant, interesting urban spaces and corridors. This is perhaps reflected by the irony that many Americans will go to great lengths to find a parking spot close to the entrance of a shopping mall, but have no problem walking one or two miles once inside the mall. Average walking distances, moreover, are longer in urban centers —60 percent of walk trips in downtown Boston are over one-quarter mile and the average walking distance in Manhattan is one-third mile (Fruin 1992).

Untermann contends a ten-minute, or 2,300-foot, walk is the maximum distance Americans are willing to walk, while Canadians and Europeans are more apt to walk farther.[3] Untermann's research also shows that transit passengers are less sensitive to walking distances as service frequency increases. Additionally, demographics also have some bearing on willingness to walk—research shows females, those without driver's licenses, and young people are more amenable to walking.

Studies of activity centers in greater Houston underscore the importance of pedestrian amenities as well as the land-use environment in influencing pedestrian behavior (Rice Center, 1987; Cervero, 1993). Downtown Houston has four times the employment density and 23 percent more sidewalks along arterials than Uptown, a suburban activity center six miles west of downtown. And compared to West Houston's Energy corridor, an axial strip along the Katy Freeway corridor dotted with office parks, downtown Houston is nearly ten times as dense and averages 76 percent more sidewalks. Downtown Houston also has skywalks and such pedestrian amentities as parks, civic plazas, benches, street sculptures, and protection from the elements through overhangs and trees. The built environment is also more interesting downtown, consisting of an assortment of street-level shops, eateries, and storefronts. Conversely, walking in Uptown and the Energy Corridor requires long waits at busy intersections, wading through expansive surface parking lots, and passing undistinguishable urban spaces. As a consequence, walking/cycling accounts for around 30 percent of all trips (made outside of buildings) in downtown Houston, compared to 7 percent in Uptown and only 1.9 percent in West Houston. The research estimated that every 10 percent increase in pedestrian amenities (e.g., lineal feet of sidewalk, number of benches) is related to a 15 percent decline in motorized trip-making.

Site Level Analyses

Few evaluations of transit demand have been conducted at the individual site/building level. The NCHRP suburban activity centers data set has yielded several studies that reveal the sensitivity of transit demand to building densities, on-site services, and parking supplies for individual parcels and buildings (Hooper, 1989; Cervero, 1991).

Several site-level studies have examined what happens to commuting behavior when downtown office workers are relocated to a suburban work location. Cervero and Landis (1992) found that transit modal splits fell from 58 percent to 3 percent for office workers who were relocated from downtown San Francisco (well-served by BART) to three suburban campus locations (that were poorly served by bus). Similar work of office relocation impacts in England (Wabe, 1967; Daniels, 1972, 1981) and Canada (Ley, 1985) found that commute distances typically fell slightly after jobs moved to the suburbs; however, there was a far more dramatic switch in commuting modes, from public transit to the private automobile.

5. Summary

A body of research has emerged over the past two decades that shows a modest to moderate degree of elasticity between land-use changes and travel behavior. Work to date on these relationships has been conducted at all scales of analysis and for most forms of mass transit (though the bulk of attention has been given to heavy rail and bus transit).

At the macro-level, inter-city comparisons have been drawn to show that density indeed matters —transit trips increase as an exponential function of residential and employment densities. The best evidence on how careful coordination of land-use planning and transit development can affect travel choices is from abroad— in cities like Stockholm, Sweden, and Curitiba, Brazil, high rates of transit usage are a result of government introducing land-use controls that concentrate urban growth in defined linear corridors that are well-served by rail or buses operating on dedicated rights-of-way.

Within metropolitan areas, recent research has focused on travel characteristics of suburban activity centers. The density and size of activity centers have been found to be the strongest determinants of travel behavior, though factors like levels of land-use mixing and parking supplies also have some influence. Several studies have shown that a doubling of residential densities correlates with reductions in annual vehicle miles travelled in the range of 20 to 30 percent. Evidence on the sensitivity of trip generation rates and modal splits to changes in land-use mixtures is sketchier.

At an even smaller scale of analysis, research to date has focused on land use and trip-making relationships in traditional versus auto-oriented neighborhoods and around rail transit stations. Matched-pair comparisons in several metropolitan areas as well as hypothetical simulation show transit-oriented neighborhoods average less VMT per household (anywhere in the range of 10 percent to 45 percent) than auto-oriented ones. Evidence also points to higher incidences of walk and transit modal splits in more traditional neighborhoods. Several studies around transit stations confirm that proximity and, to a lesser extent, building density influences modal splits. The strongest predictor of whether individuals living near a rail station will patronize transit, however, is their destination —if they are heading somewhere served by rail, than the odds are high. Thus, for transit-oriented development to produce significant mobility benefits, the evidence suggests that both origins and destinations of trips must be within close walking distance of facilities— another indication that clustered and balanced environments are crucial in winning over customers to mass transit.

Compared to the other scales of analysis, far less is known about how land use and urban design features influence travel choices at the individual site or building level. This is perhaps because at this scale it is difficult to introduce the necessary statistical controls to isolate out the influence of the physical environment. The next two chapters explore the relationship between physical design, land use, and travel behavior in suburban U.S. settings served by bus transit. This is followed in later chapters by studies into these relationships at the neighborhood and community levels.

Notes

[1]NPTS is the National Personal Transportation Survey, a nationwide survey of some 30,000 to 45,000 households that has been conducted every six to eight years by the U.S. Department of Transportation and U.S. Bureau of the Census.

[2]Of the 514 kilometers, 53 kilometers are for express articulated lines, 294 kilometers are for feeder lines, and 164 kilometers are for interdistrict services.

[3]A mile can be walked in about 20 minutes at the brisk pace of three miles per hour, which translates to 265 feet per minute. In typical urban settings with intersections, grades, and other pedestrian traffic, the average pace tends to be slower.

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Chapter Three

Design Guidelines as a Tool to Promote Transit-Supportive Development

1. Introduction

To a large degree, urban and suburban built environments are the cumulative result of many separate decisions on how to design and build on individual parcels of land. It follows that transit-supportive development occurs first and foremost at the individual site level.

This chapter examines design guidelines prepared by transit agencies in the United States and Canada. In general, transit agency design guidelines promote the physical development of properties and sites (and, to a lesser degree, subdivisions and corridors) in a manner that supports transit services. Our primary reason for examining the guidelines was to identify metropolitan areas that in recent years have been at the forefront in promoting transit-supportive site designs and land use patterns. These areas were considered likely candidates for mining "good examples" of transit-supportive development and, we hoped, uncovering site-level evidence that such practices affect travel demand. Analyzing guidelines therefore helped us identify metropolitan areas for the more detailed case study evaluations presented in the next chapter.

Additionally, the guidelines in and of themselves were of interest because they have emerged as perhaps the most visible and prevalent means by which agencies seek to inform and assist public and private development decisions. Accordingly, this chapter also examines the potential usefulness of design guidelines as a tool for promoting transit-supportive development patterns and practices.

To carry out both objectives, we first prepared and disseminated a national survey to 165 transit agencies throughout the United States and Canada in order to identify those agencies which have prepared transit-supportive guidelines. More central to this research, the survey sought to identify transit supportive real estate projects around the U.S. for further study. Survey responses provided information about the reasons agencies prepared their guidelines; the overall content and uses of the guidelines; enforcement methods; and agency perceptions on the extent to which guidelines have actually influenced private development decisions to date. The survey also yielded insights into what factors have prevented some transit agencies from producing design guidelines.

More detailed evaluations were then conducted of design guidelines prepared and adopted by 19 of the 26 transit agencies with guidelines. These agencies, which are listed in Appendix A, provided us with a copy of their guidelines along with their survey responses. The 19 agency guidelines were examined in terms of their function, content, and form. Analyzing the *function* of guidelines illuminated the multiple purposes and users they serve. In terms of their *content*, we examined the extent to which agencies focus on transit, site design, and land-use issues. Finally, with regard to *form*, we assessed how agencies have refined document styles and formats over the years. The results of our analysis are presented in this chapter. Good examples of guidelines that provide practical recommendations and use graphics effectively to communicate and present ideas are highlighted in the last section. This chapter ends with a summary of transit-supportive design principles commonly agreed-upon in the agency guidelines.

2. National Survey

A survey was prepared, pre-tested, and then sent to 165 transit agencies across the United States and Canada. The first mailing took place in March 1993, followed by two rounds of mailbacks.[1] For the most part, only transit agencies with over 50 buses were surveyed, although a few smaller ones were included as well. This yielded survey responses across a wide range of transit operator size classes. The survey was sent to the managers or directors of transit agency planning or market development offices. They were encouraged to complete the survey or have the staff member who was actively involved in preparing the guidelines do so. In most instances, either the managers themselves or senior planners filled out the survey. A copy of the survey is shown in Appendix B.

In all, 105 (63 percent) of the agencies that received a survey responded.[2] It is likely that the response rate was affected by whether or not an agency had guidelines. The high response rate allowed a fairly complete picture to be drawn about the number and types of guidelines that exist.

3. Who Has Design Guidelines?

Of 105 agencies responding to the survey responses, 26 (25 percent) indicated that they had design guidelines as of Spring 1993. Another 12 were in the process of preparing them.[3] Thus, it is possible that around 40 North American transit agencies will have prepared design guidelines by mid-1994. Figure 3.1 shows that interest in transit-supportive guidelines grew steadily in the early and mid-1980s and picked up momentum in the last few years.

Of the 26 existing guidelines, 12 are formal documents that have been approved or endorsed by a local policy body, most typically the transit agency's Board of Directors. Of course, since transit boards have no direct control over land use decisions, most endorsements carry little political or legal weight regarding development decisions.

The survey revealed that at least ten transit agencies which do not have their own in-house guidelines often refer real estate developers to guidelines prepared by other organizations. Overall, then, nearly half of the respondents make use of design guidelines, either their own or those borrowed from other entities, to promote transit-supportive development.

The survey also revealed that 65 percent of the agencies without guidelines who are not currently developing them nevertheless have considered doing so. The two most common reasons

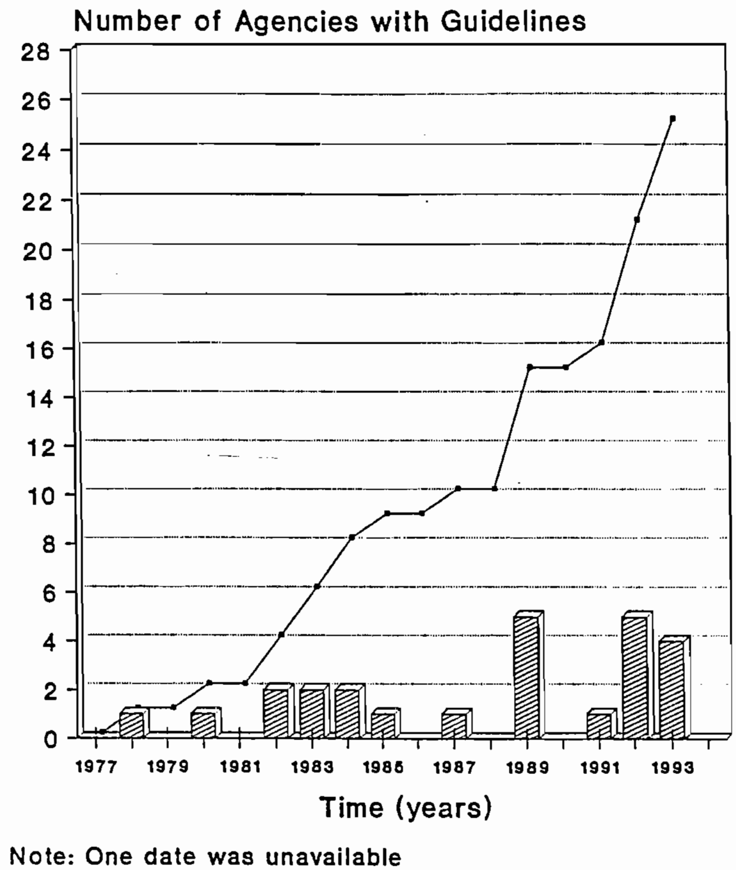


Figure 3.1

Cumulative Number of Agencies with Guidelines by Date of Publication

these agencies gave for not preparing guidelines were fiscal, budgetary, or personnel constraints (70 percent), and the view that guidelines and land-use matters were beyond the transit agency's mandate (49 percent).

Table 3.1 lists agencies which currently have guidelines, along with their titles and release dates. The titles themselves indicate that guidelines are devoted mainly to transit facility designs (such as transit centers and bus shelters), to land use and site plans, and to the broader topic of "development." Transit agencies with guidelines vary in fleet size from extremely small (City of Scottsdale with three buses) to very large (the Maryland Mass Transit Administration with over 900 buses). Table 3.2 contains the list of agencies that are in the process of developing guidelines as of June 1993.

While guidelines have been prepared in most geographic regions of the U.S. and Canada, transit agencies on the West Coast are particularly well represented in the survey responses (Map 3.1

Table 3.1

Agencies with Design Guidelines (as of June 1993)

Agency	Title of Design Guideline Report	Release Date
A/C Transit (Oakland CA)	Guide for Including Public Transit in Land Use Planning	4/83
Austin Capital Metropolitan (Austin TX)	Transit Design Guidelines	1989
B.C. Transit/Victoria & Small Com. (Victoria CAN)	Guidelines for Public Transit in Small Communities	9/80
Capital District Transp. Auth. (Albany NY)	Development & Transit, A Cooperative Venture	1/82
Chapel Hill Transit (Chapel Hill NC)	Chapel Hill Design Guidelines	3/93
Central Contra Costa Transit (Concord CA)	Coordination of Property Dev. and Transit Improvements	1984
Central Ohio Transit Auth. (Columbus OH)	The Development and Transit Connection, A Design Manual	10/83
City of Mississauga (Mississauga CAN)	Transit Planning Guidelines	1984
City of Scottsdale (Scottsdale AZ)	Design Standards & Procedures	9/92
Denver Regional Trans. Dist. (Denver CO)	Suburban Mobility Design Manual	2/93
	Transit Facility Design Guidelines	9/87
Fresno Area Express (Fresno CA)	Facilities and Development Standards	6/91
Mass Transit Admin. of Maryland (Baltimore MD)	Access By Design	9/89
Monterey-Salinas Transit (Monterey CA)	Development Review Guidebook	1985
Montgomery County Ride-On (Rockville MD)	Access by Design (by MTA; listed above)	9/89
Montreal Urban Community Tran. (Montreal CAN)	Guide D'Amenagement Urbain	1993
New Orleans Regional Transit (New Orleans LA)*	**	**
Orange County Transit Dist. (Santa Ana CA)	Design Guidelines for Bus Facilities	6/92
PACE Suburban Bus Division (Arlington IL)	PACE Development Guidelines	10/89
Regional Transp. Comm./Citifare (Reno NV)	Planning for Transit: A Guide to Community and Site Design	6/92
Riverside Transit Agency (Riverside CA)	Design Guidelines for Bus Facilities	4/92
Sacramento Regional Transit (Sacramento CA)	Draft Transit & Land Use Coordination Guidelines	4/92
Seattle Metro (Seattle WA)	Encouraging Public Transportation Through Effective Land Use Actions	5/87
Snohomish Co. Transp. B. A. (Lynnwood WA)	A Guide to Land Use & Public Transportation	10/89
Suburban Mobility Au. (Detroit MI)	Designing for Transit: A Transit Design & Criteria Standards Manual	4/82
Transit Auth. of River City (Louisville KY)	**	1978
Tri-Cty Metro. Transp. Dist. (Portland OR)	Planning and Design for Transit	3/93

* New Orleans uses a computer program that aides with transit facility design.
** Unpublished report, internal memo, mimeo, or unknown report/date

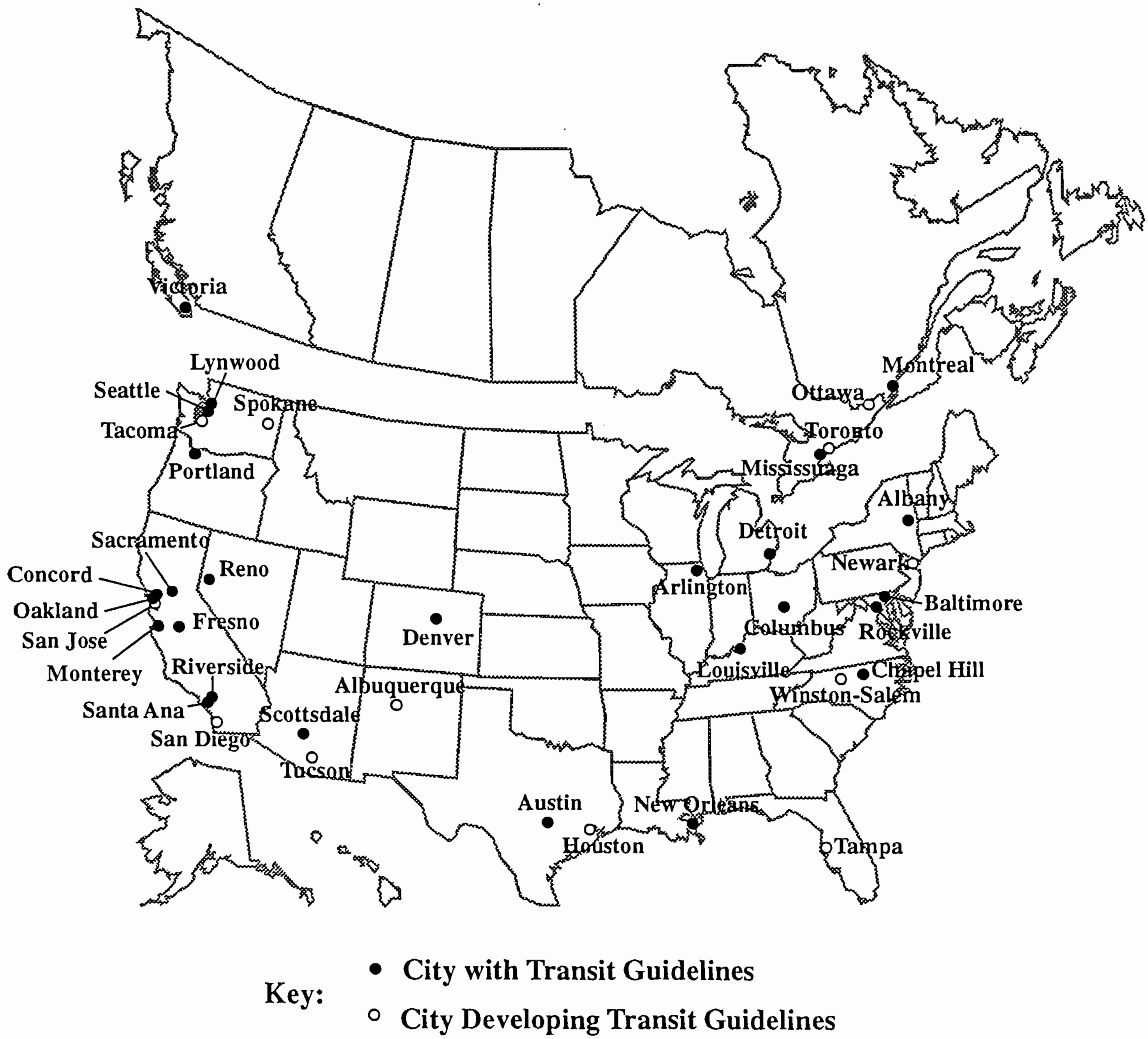
Table 3.2

Agencies Developing Design Guidelines (as of June 1993)

Agency	Title of Design Guideline Report	Release Date
Hillsborough Area Reg. Transit Auth. (Tampa FL)	**	**
Houston Metro. Transit Auth. (Houston TX	Developers Handbook	Fall 1993
New Jersey Transit Corporate (Newark NJ)	Rail Station Area & Transit Planning Handbook	Fall 1993
Ottawa-Carelton Regional Transit (Ottawa CAN)	Transit Guideline/Design Manual	**
Pierce County Pub. Trans. B. (Tacoma WA)	**	**
San Diego Metro. Trans. Dev. (San Diego CA)	Designing for Transit	7/93
Santa Clara County Transp. Auth. (San Jose CA)	Transit Oriented Development Design Concepts	**
Spokane Transit Authority (Spokane WA)	**	**
Sun Tran of Albuquerque (Albuquerque NM)	**	**
Sun Tran (Tucson AZ)	**	**
Toronto Transit Commission (Toronto CAN)	Guidelines for Structures Impacting on TTC Facilites	**
Winston-Salem Transit Auth. (Winston-Salem NC)	**	**

** Unpublished report, internal memo, mimeo, or unknown report/date

This may be due in part to the rapid population and employment growth in these regions and the development pressures that accompany rapid growth. It may also be due to the fact that West Coast cities have less intensive transit services than older, more dense eastern cities.



Map 3.1

Cities with Transit-Supportive Design Guidelines in the U.S. and Canada

4. Why Develop Transit Design Guidelines?

Survey Results

Transit agencies cited a variety of reasons why they prepared and use design guidelines. Three rationales were mentioned most often: (1) to influence and guide private development decisions —46 percent; (2) to create physical environments that will improve transit services (e.g., reduce dwell time at bus staging areas or backtracking within subdivisions by eliminating circuitous roadway patterns) —42 percent; and (3) to inform and aid public entities, especially in the project review process, and promote coordination between local agencies and transit providers— 31 percent.

Review of Transit Design Guidelines

Detailed examination of the 19 design guidelines we received further illuminated the purposes served by developing design guidelines. In general, guidelines are aimed at a wide variety of prospective users, including planners, engineers, landscape architects, developers, architects, elected officials, and any other interested person. Each group is likely to have a slightly different reason for consulting transit design guidelines. For example, a traffic engineer may need technical specifications for locating bus turnouts along a new road, while a planning commissioner may be interested in the potential transit impacts of a proposed change in zoning densities.

However, it is also clear that the agency itself stands to benefit from the use of its guidelines by outside groups. Agency objectives are therefore another important consideration in the development of transit design guidelines.

The following is a brief summary of the many functions transit design guidelines serve for both transit agencies and their target users.

- *Provide Technical Information.* Most design guidelines give concrete guidance to planners and engineers on the physical dimensions and operating requirements of transit vehicles. This may include setting specific standards or providing practical suggestions for designing sites in order to promote transit access. In this sense, guidelines are a technical resource serving a narrow group of specialized users. As the operator of the transit system, the transit agency clearly benefits by sharing this essential knowledge with the appropriate persons.
- *Enhance Coordination Among Groups.* Guidelines often explicitly encourage developers and public officials to consult with the transit agency in the preparation of development plans. By providing detailed design alternatives and recommendations, guidelines enable all participants to come to the table with a common base of knowledge and ideas. This facilitates discussion and encourages joint participation in designing for transit.
- *Encourage Long-Range Planning For Transit.* Agency guidelines tend to emphasize that consultation among the various stakeholders should occur at the earliest stages of the development planning process. This is important to ensure that

transit is perceived as an integral part of a development project or plan, rather than appended as an afterthought.

- *Advocate Transit-Supportive Policy Decisions.* Few agencies have direct control over local development decisions affecting the efficiency and effectiveness of transit service. Most do have an indirect, consultative role in the development review process, however. Transit agencies can use design guidelines to convey policy recommendations to key elected officials and other public agencies with oversight responsibilities.
- *"Sell" Transit-Supportive Design to the Private Sector.* Because compliance with transit agency guidelines is normally voluntary, many agencies use guidelines as a marketing device to promote the private economic benefits of transit-supportive development. In this sense, guidelines are used to "sell" transit as a commercially attractive —and viable —alternative to auto-oriented design.
- *Encourage Transit Considerations During Project Review.* Besides influencing developer decisions, guidelines are also sometimes targeted at local planning offices which routinely review and act upon petitions for building permits and land use changes. Guidelines produced by transit agencies provide a set of principles and examples local planners can use in reviewing projects and perhaps negotiating plan revisions.
- *Educate the General Public About Transit Issues.* Transit design guidelines can be used to promote broad understanding and awareness of the fundamental economic and physical factors affecting the quality and cost-efficiency of transit service. This educational function becomes increasingly important where public input strongly influences the development process, and where agencies are heavily reliant on voter-approved funding.

It appears that transit agencies are becoming more aware of the multiple uses and users of their guidelines, as reflected by the sophistication and breadth of several more recently-produced guidelines.

A transit agency can go a long way toward meeting many of the foregoing objectives merely by developing and disseminating its recommendations. Most agencies, however, also devote a portion of their guidelines to an explicit discussion of the rationale behind their recommendations and the benefits of carrying them out. In addition, some agencies provide detailed information on how to plan, finance, and implement transit-supportive design elements. There are potential drawbacks to attempting to make design guidelines serve as an all-purpose resource. Cramming too much information into the guidelines can make the document unwieldy. There is also the possibility that some details will be too complex for some users, but too simplistic for others.

5. What Do Guidelines Cover?

There are no conventions governing the basic technical content of design guidelines. Individual agencies are free to determine what topics they will cover and in what detail. Typically, however, most design guidelines focus on one or more of three core topics: Land Use, Site Design, and Transit Facility. These categories encompass the following topics:

LAND USE	SITE DESIGN	TRANSIT FACILITY
Land use types	Siting of buildings	Provisions to expand transit
Land use mix	Parking	Transit centers
Density	Street layout	Bus stops
Location of uses	Road width/geometry	Bus shelters
	Pedestrian Access	Bus turnouts and berths
		Pavement and grading
		Bike facilities
		Design vehicles

We reviewed the 19 sample guidelines to assess the extent to which they covered individual topics listed above. For each topic, it was determined if the agency: (1) addressed it at any level; (2) provided general recommendations or visual illustrations; and (3) set specific standards. A matrix of topics and agencies was then constructed. This facilitated comparison of the overall content and scope of individual agency guidelines. It also enabled us to determine the relative frequency and level of detail with which different topics were addressed by the guidelines as a whole. Results are detailed below.

Scope of Transit Design Guidelines

On average, around 70 percent of the reviewed guidelines devoted at least some attention to land use, site design, and transit facility issues. Overall, then, most transit agencies have fairly comprehensive guidelines. In general, newer guidelines encompass more topics than older guidelines, which tend to emphasize transit facility matters far more than other issues. In part, this may reflect a more pro-active approach by transit agencies in addressing land use and design issues which have an indirect but substantive impact on the transit system.

However, there was significant variation in the extent to which individual agencies covered each of these three major topical categories. For example, one agency devoted the bulk of its guidelines to transit operating requirements. Another covered the same information, but gave equal attention to land use and site design practices. Still another agency focused predominantly on project design and location issues.

The guidelines also varied in the detail with which they address specific topics, if at all. For example, one agency devoted the bulk of its guidelines to bus-turning templates, while another ignored vehicle dimensions altogether. One agency went into exhaustive detail on subdivision design, while another gave only a passing mention to the impact of street hierarchy on efficient transit service.

Topics Addressed in Agency Guidelines

One consequence of the variation in guideline detail is that specific transit design topics are not uniformly covered by all agencies. Certain topics are covered by most guidelines, while others are addressed in only a few. Survey respondents reported that their guidelines gave the most attention to bus shelters, bus stop locations, and bus turnouts (Figure 3.2). Street layouts, density, location of land uses, sidewalks, and provisions for transit expansion also received significant attention, according to our survey.

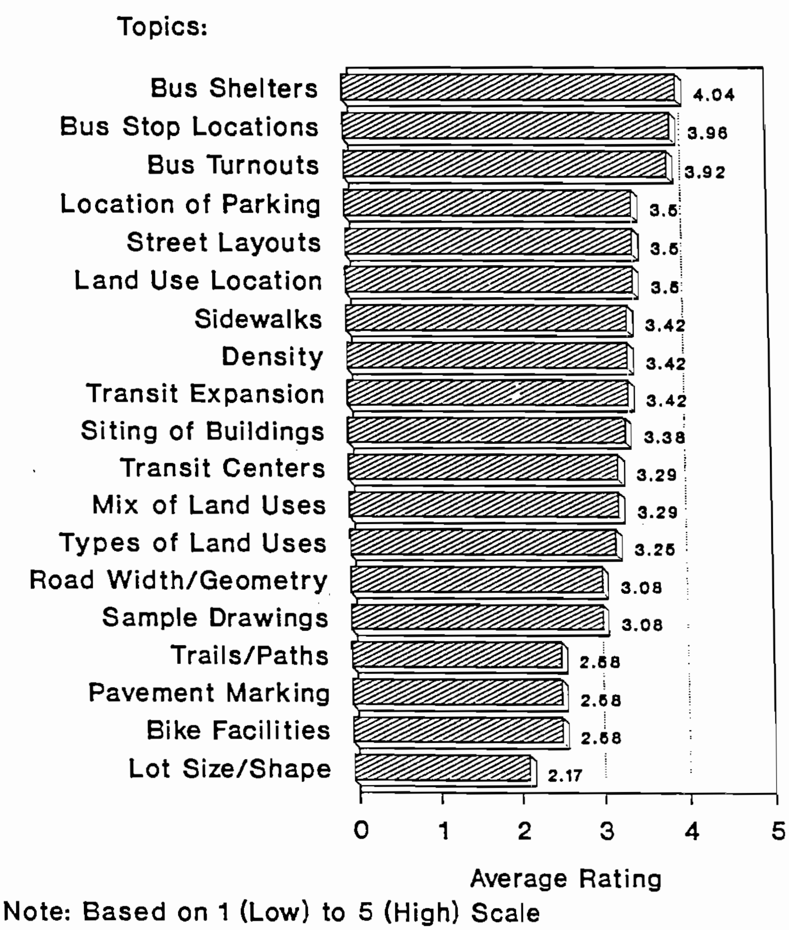
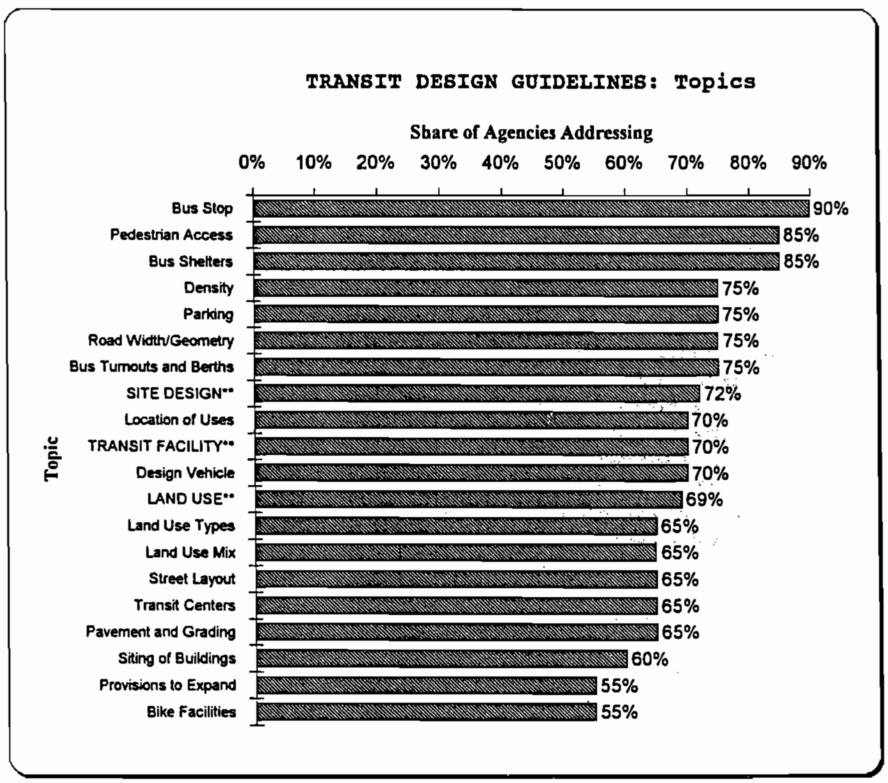


Figure 3.2

Rating of Degree of Attention Given to Topics in Guidelines

For the most part, our detailed review of 19 guidelines concurs with the national survey responses. As illustrated in Figure 3.3, the most common components of transit agency guidelines are those directed at enhancing or making physical access to and by transit possible. These included guidelines for bus stops (addressed by 90 percent of the 19 transit agency guidelines studied), shelters (85 percent), pedestrian access requirements (85 percent), and design vehicle criteria (70 percent). Factors concerning the operation of buses in traffic, such as bus turnout and berthing requirements and road width, were discussed by 75 percent of the agencies. Certain types of transit facilities were less commonly discussed. Transit centers, for example, were considered in only 65 percent of the guidelines. Bicycle facilities and provisions for expanding transit service were the least frequently covered topics; both topics, however, were addressed in at least half of the guidelines reviewed.

Topic	Share of Agencies Addressing
Bus Stop	90%
Pedestrian Access	85%
Bus Shelters	85%
Density	75%
Parking	75%
Road Width/Geometry	75%
Bus Turnouts and Berths	75%
SITE DESIGN**	**72%**
Location of Uses	70%
TRANSIT FACILITY**	**70%**
Design Vehicle	70%
LAND USE**	**69%**
Land Use Types	65%
Land Use Mix	65%
Street Layout	65%
Transit Centers	65%
Pavement and Grading	65%
Siting of Buildings	60%
Provisions to Expand	55%
Bike Facilities	55%



** Represents average percentage for each topical category.

Figure 3.3

Transit Design Guidelines: Topics

Among site design and land use topics, density and local parking policies received the greatest attention, having been mentioned at some level by 75 percent of transit agencies. All other land use and site design topics received less attention, but were nonetheless covered by at least 60 percent of all agencies.

From this analysis, it can be concluded that most transit agencies focus primarily on topics directly related to their physical operating requirements. However, many are also attentive to the conditions which indirectly but substantively affect transit service.

Illustrations and Recommendations

As noted above, we sought to determine if transit agency guidelines provided visual examples or detailed suggestions to help convey their ideas to guideline users. The purpose was to focus on guidelines that not only discuss a given topic, but provide the reader with more detailed and practical guidance as well. Figure 3.4 indicates that basic transit facilities were most likely to be dealt with in detail. This is consistent with the agency's primary mission as transit system operator and its authority and expertise on such matters.

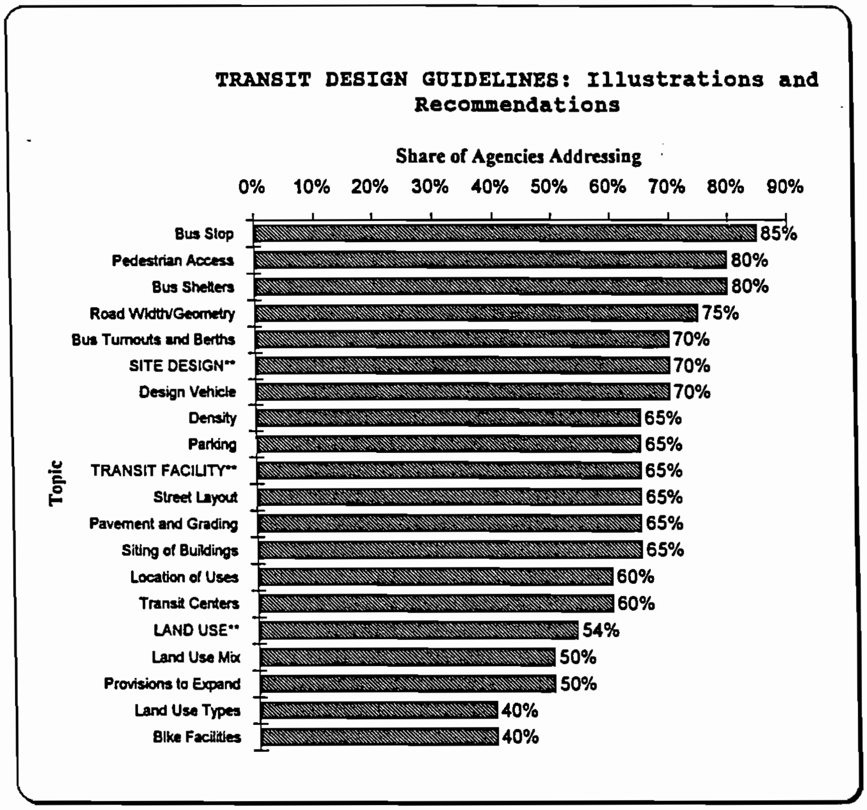
Most agencies also promoted and illustrated specific site design practices. Pedestrian access was the dominant concern in the "site design" category, with 80 percent of all agencies having addressed this topic in detail. Land use topics were less likely to be given detailed attention, with only slightly more than half of all agencies dealing with these matters. An exception is the topic of density, which was addressed in detail by 65 percent of the agencies. In part, there may be some reticence among transit agencies in addressing land use matters which traditionally are outside their purview. However, this could change as transit agencies take on a more active role in promoting transit-supportive development.

Transit agencies used an extensive array of visual aids, including drawings, templates, maps, tables, charts, photos, and other graphics interspersed throughout the text of the document to illustrate specific points and recommendations. Graphics used to illustrate transit facility matters tended to have a technical focus. These usually included drawings of design vehicle dimensions and operating requirements.

Most agency guidelines devoted significant attention to the placement and construction of bus stops and bus shelters. A common element of most guidelines was a table or drawing that illustrated the pros and cons of near-side, far-side, and mid-block bus stop placement. Recent passage of the Americans with Disabilities Act, which mandates accessibility of transit facilities by patrons in wheelchairs or with other mobility limitations, is likely to entail even more specific technical detail in transit facility design guidelines.

Site design topics were generally well-supported by graphics integrated with text recommendations. One of the more common techniques was to illustrate both good and bad design practices.

Topic	Share of Agencies Providing Illustrations/ Recommendations
Bus Stop	85%
Pedestrian Access	80%
Bus Shelters	80%
Road Width/Geometry	75%
Bus Turnouts and Berths	70%
SITE DESIGN**	**70%**
Design Vehicle	70%
Density	65%
Parking	65%
TRANSIT FACILITY**	**65%**
Street Layout	65%
Pavement and Grading	65%
Siting of Buildings	65%
Location of Uses	60%
Transit Centers	60%
LAND USE**	**54%**
Land Use Mix	50%
Provisions to Expand	50%
Land Use Types	40%
Bike Facilities	40%



** Represents average percentage for each topical category.

Figure 3.4

Transit Design Guidelines: Illustrations and Recommendations

For example, several agencies used a set of two or more drawings of street configurations to compare those which impede transit access with those that facilitate access. This approach is useful because it clearly and simply depicts the physical implications of alternative designs. It also helps convey the pragmatic basis for agency recommendations on site and subdivision design, some of which might be contrary to conventional practices.

Agencies illustrate ideal land use practices such as mixed-use development and clustering along transit corridors through bird's-eye view maps showing the distribution of uses in space, and by site-level drawings showing the multiple land uses integrated with transit. Illustrations of recommendations concerning density were comparatively rare, perhaps because it is more difficult to visually represent density concepts. However, some agencies have produced good examples of such illustrations, as shown in Section 9 of this chapter.

Standards

Finally, in the review of 19 guidelines, we examined whether agencies set standards for individual transit-supportive development topics. A standard was defined as an explicit design criteria which was specific, measurable, and could be applied in most circumstances. An example would be a minimum standard street width of 55 feet for a proposed subdivision to accommodate a conventional bus. Another example would be a minimum density standard of 8 dwelling units per acre to support transit services running on 30-minute headways.

As shown in Figure 3.5, standards were most commonly set for transit facility topics than for land use or site design matters. Bus stop standards and design vehicle dimensions were both addressed by 65 percent of transit agencies. Standards for bus shelters and bus turnouts and berths were set by 60 percent of the guidelines. Pavement and grading standards, which ensure roadways can support and allow safe operation of transit vehicles, were set by 55 percent of agency guidelines.

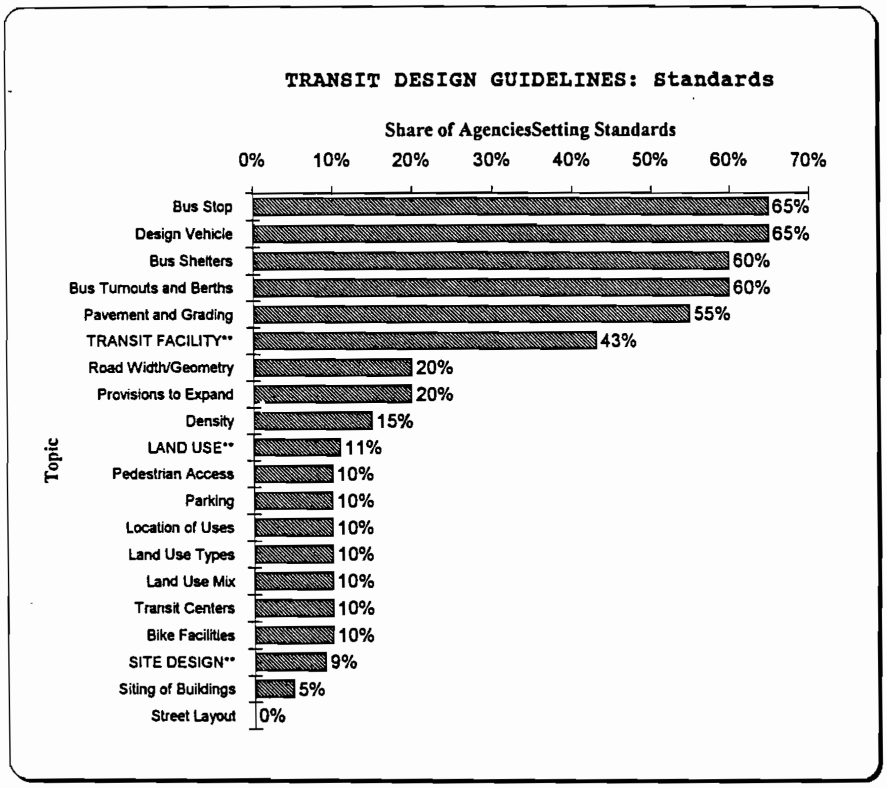
Standards were significantly less likely to be set for all other topics. Density standards were slightly more common than for any other land use or site design topic, with 15 percent of agencies setting them. Most of the remaining issues included standards by only 10 percent of agency guidelines.

Instead of specific standards, agencies tended to make general recommendations for land use and site design topics. Again, this is to be expected; agencies rarely if ever have any official oversight over these matters. However, it is important to recognize that it is inherently difficult to set standards where a potentially infinite range of design variations is possible. It is more appropriate in such situations to set general guidelines and principles which can be flexibly applied on a case-by-case basis. Thus, for example, while 60 percent of the guidelines we reviewed set some general criteria for transit centers, which can be structured in many different ways, only 10 percent set specific standards for such facilities.

6. Level of Guideline Enforcement

To what degree do transit agency design guidelines have any "teeth" in influencing how real estate projects are designed? This is difficult to answer based on the national survey responses—some respondents indicated that guidelines are carefully adhered to while others reported they are only advisory and thus have had little real impact. For the most part, guidelines appear to carry little legal weight in directing developers to build transit-friendly projects. As shown in Figure 3.6, only 8 percent of the respondents from agencies with guidelines stated their guidelines were

Topic	Share of Agencies Setting Standards
Bus Stop	65%
Design Vehicle	65%
Bus Shelters	60%
Bus Turnouts and Berths	60%
Pavement and Grading	55%
TRANSIT FACILITY**	**43%**
Road Width/Geometry	20%
Provisions to Expand	20%
Density	15%
LAND USE**	**11%**
Pedestrian Access	10%
Parking	10%
Location of Uses	10%
Land Use Types	10%
Land Use Mix	10%
Transit Centers	10%
Bike Facilities	10%
SITE DESIGN**	**9%**
Siting of Buildings	5%
Street Layout	0%



** Represents average percentage for each topical category.

Figure 3.5

Transit Design Guidelines: Standards

"legally binding" inputs that must be adhered to in the local review of development proposals.[4] Around one-quarter of the agencies stated that their guidelines were "often required" or "recommended" by local planning agencies. Guidelines were completely "unenforced" in 31 percent of the cases.

Figure 3.6 also shows the level of guideline enforceability by whether or not the guidelines are approved documents. Official approval seems, at best, to be only slightly related to whether the documents carry any legal weight or real influencing power. For example, out of the twelve approved guidelines, five (42 percent) are required or binding as inputs into project review while three (25 percent) are only advisory and not enforceable.

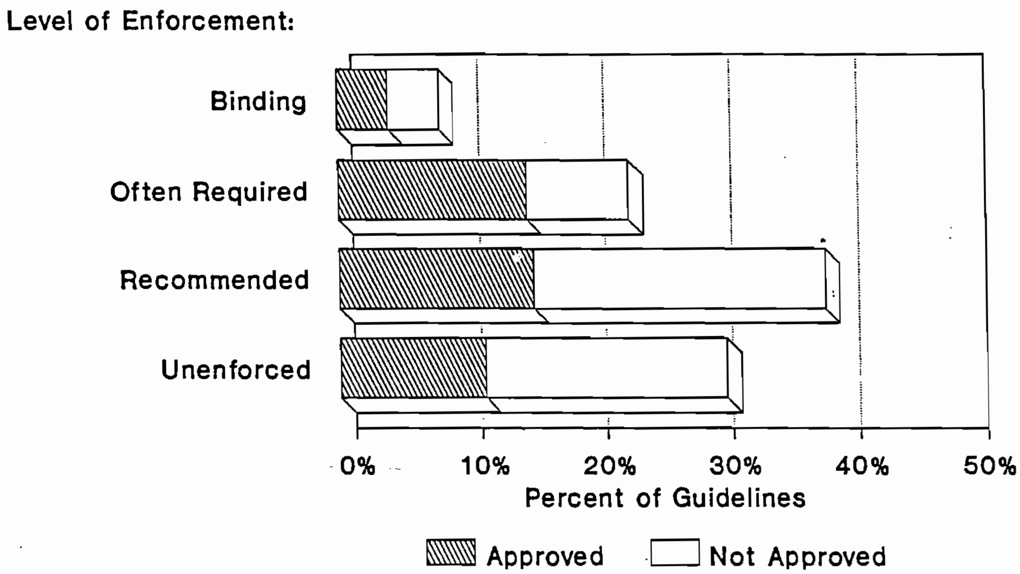


Figure 3.6

Level of Guideline Enforcement by Whether or Not Guidelines are Approved

7. Influence of Guidelines on Project Development

In the national survey, respondents were asked to identify local developments that they believe were significantly influenced by or attempted to adhere to agency design guidelines. While this was unavoidably a subjective question, we nonetheless felt that those who work most closely in the area of promoting transit-supportive development would be in the best position to judge whether any specific projects have been influenced by guidelines. Table 3.3 lists projects which at least one respondent felt had been influenced by their guidelines.[5]

Perhaps what stands out the most is the fact that the list is fairly short. While design guidelines have been around for a number of years and have received a fair amount of attention in urban planning circles, transit officials who have been pioneering this effort evidently have a difficult time pointing to specific examples of projects that have been influenced. In fact, over half of survey respondents from agencies with guidelines could not identify even one project as having been influenced by design guidelines. Table 3.3 is no doubt only a partial listing and a fairly subjective one at that. Moreover, the projects listed are ones that have incorporated, often to a modest degree, facility design features that promote on-site bus services, such as providing benches at bus stops and designing in special drop-off lanes for buses. Few of the listed projects are examples of land-use environments that are conducive to transit riding (e.g., dense, mixed-use centers).

Table 3.3

Projects Influenced by the Design Guidelines

City, State	Project	Project Type	Development Stage
Riverside, CA	Riverside Marketplace	Mixed use	Nearly complete
Riverside, CA	Desert Hills Factory Stores	Retail Stores	Complete
Riverside, CA	Mission Grove	Industrial	Complete
Scottsdale, AZ	Basha's -	Retail	Construction
Scottsdale, AZ	Newhall 3000	Residential	Planning
Montgomery Cty, MD	Montgomery Mall Transit Center	Mall	Complete
Portland, OR	102nd and Burnside	Housing/Office/Medical	Planning
Seattle, WA	Redmond Town Center	Retail Center	Stalled
Seattle, WA	Issaquah	Mixed Use	Planning
Seattle, WA	Auburn 500	Shopping Center	Planning
Seattle, WA	Sunset Ridge	Office	Complete
Baltimore, MD	Beltway Bus Center	Office/Warehouse	Complete
Baltimore, MD	Owings Mills Corporate Campus	Mixed Use	Complete
Baltimore, MD	Pulaski Commerce Park	Office/Warehouse	Partially Complete
Columbus, OH	Mill Run Development	Mixed Use	50% Complete
Albany, NY	Latham Farms Trasnfer Center	Retail	Construction
Albany, NY	Latham Circle Mall	Mall	Complete
Albany, NY	Crossgates Mall	Mall	Negotiation
Arlington Heights, IL	Sears "Prarie Stone"	Mixed/Office	Phase I Complete
Arlington Heights, IL	Kane County Judicial Center	Government Building	Nearly Complete
Arlington Heights, IL	Cantera	Mixed Use	Construction
Denver, CO	Broadway Marketplace	Retail	Construction
Denver, CO	Crossroads Mall	Retail	Complete
Denver, CO	Highlands Ranch	Residential	60% Complete
Lynnwood, WA	Colby Crest	Mixed Use	Complete
Lynnwood, WA	Mill Creek	Shopping Center	Complete
Lynnwood, WA	Canyon Park	Shopping Center	Complete

Overall, the national survey provided few promising leads for finding "transit-friendly" sites that could be evaluated in terms of impacts on ridership and service delivery. Because of this, Chapter Four presents case examples of several metropolitan areas that have been at the forefront of promoting transit-supportive development, though not necessarily having many good transit-friendly examples of suburban projects that are served by bus only. In general, this survey suggests there are few significant examples of transit-supportive suburban projects in the U.S. or Canada outside of rail-served urban centers, at least in the areas where transit-supportive designs have been actively promoted and marketed.

In addition to identifying projects designed according to the principles and specifications of published guidelines, survey respondents were also asked to identify, more broadly, types of land uses and real estate projects that they believe have been influenced to some degree by design guidelines. Figure 3.7 reveals that respondents believe guidelines have impacted the designs of shopping malls and retail plazas the most and industrial projects the least. Next most influenced were office sites and business parks, followed by residential and mixed-used projects. Thus, while survey

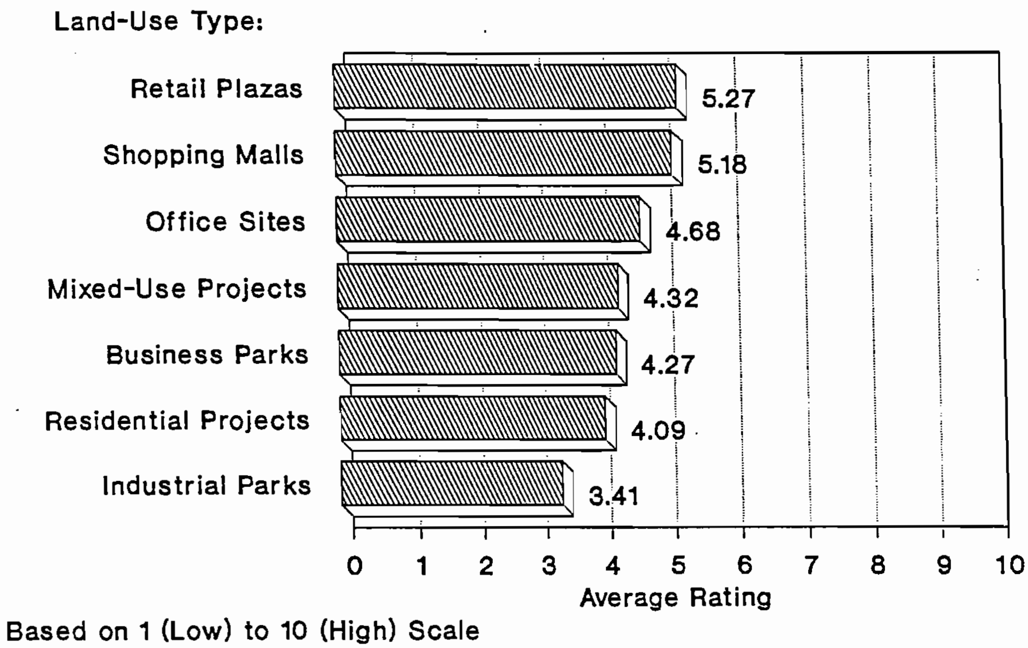


Figure 3.7

Rating of Design Guideline's Influence on Different Classes of Land-Use Projects

respondents had a difficult time pinpointing specific projects directly influenced by site designs, they felt that certain types of projects have been influenced more than others— specifically, shopping malls and retail plazas more than industrial parks and residential subdivisions.

Lastly, respondents were asked to assess the degree to which they believe specific urban and site design initiatives in their region have produced any tangible benefits to date. Thus, respondents were queried about whether transit-friendly designs really matter — do they improve walking environments, increase ridership, or produce any other benefits. According to respondents, the quality of the walking environment has been influenced the most (Figure 3.8). Around one-third of the respondents felt design initiatives had a significant impact on transit services and operations. Less affected have been aesthetics, ridership, and community cohesion.

8. Developer Attitudes Toward Design Guidelines

Transit agencies were asked to evaluate the overall response of the development community toward their guidelines. Generally, transit officials felt that developers were indifferent or in some instances slightly supportive of the guidelines. In general, as long as guidelines continue to carry little legal clout, developers will likely be fairly indifferent toward them.

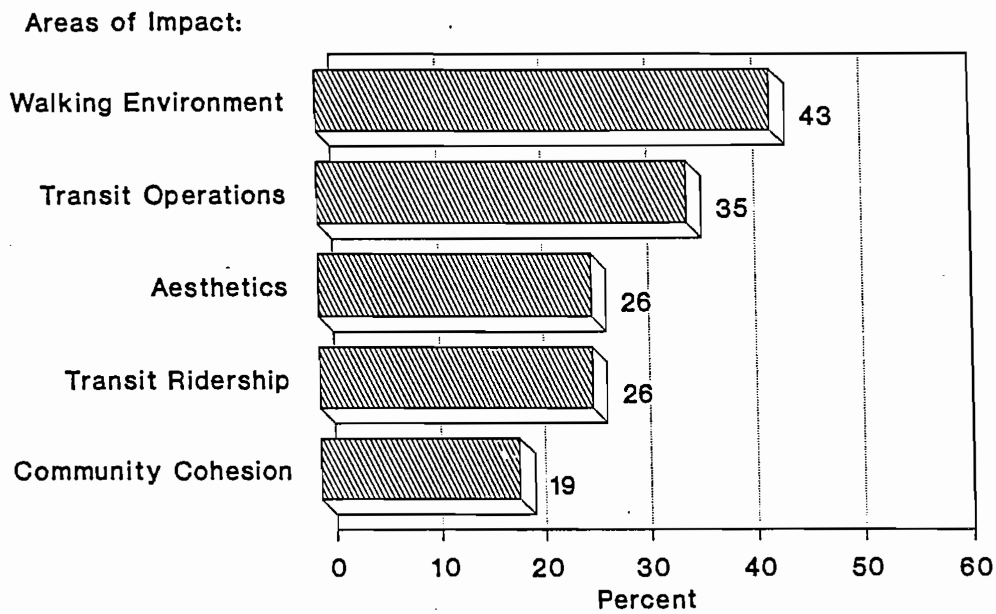


Figure 3.8

Percent of Survey Respondants Who Believe Design Guidelines Have Significant Impacts

The national survey also queried transit officials on why some local developers have ignored transit-supportive guidelines and principles. The major reason given was that transit-oriented projects were not economically feasible (41 percent of respondents). Related to this was the view that developers could not obtain financing for such projects (stated by 32 percent of respondents). The effects of these and other factors that have impeded transit-supportive development are examined more closely in Chapter 4.

9. Preparing Transit-Supportive Design Guidelines

Despite their limited impact to date on actual development projects, design guidelines nonetheless are a useful tool for encouraging transit-supportive development. Under the right market conditions, they could over time begin to yield far more substantial dividends.

This closing section attempts to accomplish two things. First, it suggests how to improve guideline presentations by highlighting some "good examples." Second, it assimilates much of the information contained in the guidelines into a summary of commonly agreed-to "Good Practices."

Formats and Styles

Based on our review of design guidelines, it is obvious that many transit agencies study documents prepared in other regions before developing their own. This appears to create a cumulative effect as unique or innovative elements from guidelines in one region are incorporated into new guidelines produced in another. On the one hand, this approach enables agencies to draft increasingly sophisticated guidelines. However, it can be problematic if agencies merely expropriate whole portions of guidelines generated in other transit regions. There is the risk that it will result in an incoherent, cumbersome, or contradictory patchwork of elements which obviate the purpose of the guidelines. Agencies in the process of developing or revising guidelines should be cautious about borrowing from other documents. Rather, guidelines should be tailored to reflect the specific circumstances of each transit agency's jurisdiction.

With that caveat in mind, it is possible to identify general formats and styles to increase the accessibility and effectiveness of transit design guidelines. As noted previously, most guidelines have multiple functions and multiple users. The challenge for transit agencies is to develop guidelines that are both technically detailed and broadly accessible. Based on the evolution of guidelines over the years, it appears that transit agencies have found the following approaches to be most useful:

- Text is non-academic and understandable by lay persons.
- Document is organized by subject area with clear headings.
- Illustrations are provided — simple line drawings appear to work better than photos or detailed engineering drawings.
- To the extent possible, technical details are provided in the document, rather than promised "after consultation with agency planners."
- Overall style and presentation is polished and professional.

Checklists are also an important and effective device. Eight of the 26 surveyed agencies with guidelines used some sort of checklist for developers or planners. Checklists give developers a convenient reference list to consult when they are putting together a real estate project. From the agency's perspective, this can facilitate their awareness of and compliance with good development practices. Other users may find checklists helpful in identifying the key issues to be considered in designing for transit.

Good Practices

In examining the guidelines now in use around the U.S., it became apparent that they share many common themes. The following is a summary of those design and land use practices that most agencies agree are transit-supportive.

Land Use

- Mix transit-compatible land uses on single sites and near transit stops. Mixes may take the form of first-floor retail with office and residential above, or it may involve integrating housing, office, retail, industrial, and recreational uses over a larger area.

- Encourage densities that can support transit. Some generally agreed-upon thresholds are:

  Residential Densities

  - At least 7 units per acre is necessary to support bus service every 30 minutes;

  - At about 30 units per acre, bus service every 10 minutes becomes possible.

  Employment Densities

  - The threshold for employee-based local bus service is approximately 50-60 employees per acre when the total employment base is 10,000 or more;

  - Floor-to-area ratios (FAR) should exceed 2 to justify frequent service.

- Site high-density development close to transit stops and routes. Densities should gradually decline with distance from the stops, and non-transit-compatible (low-intensity) uses should be located away from transit stops.

- Situate new developments along transit routes in existing urban or suburban activity centers. These centers should be mixed-use and transit-oriented in nature (or they should be gradually converted if they are not).

- A quarter-mile is usually the maximum distance that a person will walk to a transit stop; thus, new developments should be located within a quarter-mile of a transit stop, and preferably much closer where possible.

Site Design

- Minimize the distance between a main building entrance and the nearest transit stop. There should be a direct, paved pedestrian route from the stop to the entry.

- Retail and office buildings should be located near the roadway (i.e. setbacks should be minimized) with parking in the back or on the side.

- Pedestrian-oriented retail uses should be located along the roadway.

- Gridiron, or modified grid, street patterns are preferred to cul-de-sac or curvilinear streets. Street systems should have a clear functional hierarchy, including local, collector, and arterial streets.

- Connect neighborhoods and transit stops with direct pedestrian walkways. Where soundwalls surround a neighborhood, the wall surface should be staggered to create entrance/exit points. In the case of a cul-de-sac, walkway easements should be used to shorten the distance to nearby bus stops.

- Configure streets to allow for through and efficient movement of buses; avoid cul-de-sacs, branch roads, and excessive circuitity.

- Abundant free parking should be discouraged. Walking distances from parking facilities to buildings should be no closer than the nearest transit facilities.

- All buildings should be oriented toward transit stops. Front and rear lot setbacks should be modest.

- Non-connected, adjacent development parcels should be linked by new roadways when possible.

Pedestrian and Transit Facilities

- All geometrics on roads serving a development should be designed to accommodate transit. Special attention should be given to turning radii, road widths, and pavement depths where future bus routes are expected.
- To encourage walking, there should be generous landscaping, paved walkways, and safe street crossings.
- Link all buildings and transit stops with continuous sidewalks. Sidewalks should abut all roadways.
- Bike racks, lockers, and showers should be made available at work sites.
- Transit shelters and other transit stop facilities (i.e. route information stands, trash cans, and benches) should be appropriately sited.
- Locate bus stops at least every one-quarter mile. Also locate new developments within one-quarter mile of bus stops. Often one-quarter mile is treated as the maximum walking distance to a transit stop, although the more realistic 500-1,000 foot maximum walk for bus transit is sometimes mentioned.
- All buildings, walkways, and transit facilities should be accessible to the handicapped.
- Give transit passenger safety and security a high priority.

Good Examples

Table 3.4 lists eight design guidelines that are exemplary documents based on the criteria of: clear text, good illustrations, inclusion of detailed technical information, and well-integrated materials. Any transit agency interested in preparing an in-house set of guidelines would find value in any one of these documents.

The following illustrations (Exhibits 3.1 through 3.8) were selected as "Good Examples" that use particularly effective graphics in conveying transit-supportive ideas. Exemplary presentations are shown for the following areas:

1. Mixed Use/Shared Facilities
2. Density
3. Site Layout
4. Subdivision Design
5. Auto Strip-to-Transit Conversion
6. Transit Facility Amenities

10. Closing

Transit-supportive design guidelines have emerged as a useful promotional and marketing tool. Their major impact seems to have been in raising public awareness about the value of transit-

Table 3.4

Transit-Supportive Design Guidelines: Good Examples

Agency	Location		Title of Guidelines	Year
Capital Transit	Austin	Texas	(1) Transit Facility Design Guidelines; (2) Planning Considerations for Transit Integration	1989
Denver RTD	Denver	Colorado	(1) Suburban Mobility Design Manual; (2) Transit Facility Design Guidelines	1963
Montreal UCT	Montreal	Quebec	Guide d'Amenagement Urbain	1993
Reno RTC	Reno	Nevada	Planning for Transit: A Guide to Community and Site Design	1992
Sacramento RTA	Sacramento	California	Draft Transit and Land Use Coordination Guidelines	1992
Seattle Metro	Seattle	Washington	(1) Encouraging Public Transportation through Effective Land Use Actions; (2) Metro Transportation Facility Design Guidelines	1991
Snohomish County Transit	Lynwood	Washington	A Guide to Land Use & Public Transportation	1991
Tri-Met	Portland	Oregon	Planning and Design for Transit	

CRITERIA FOR EVALUATION:

Text	Clear, concise, well-organized; avoids jargon.
Illustrations	Crisp graphics; conveys standards and concepts effectively.
Technical Information	Clearly presented; gives standards, guidelines; comprehensive; detailed.
Overall Effectiveness	Text and graphics well-integrated; appropriate for target users.

supportive site designs and assisting local planning offices in reviewing development proposals. Overall, transit officials were unable to identify many local projects which are unequivocally transit-friendly in their designs. The next chapter explores the relationship between land uses, urban design, and travel behavior for five metropolitan areas that have pioneered efforts to promote transit-supportive suburban developments.

1. Mixed Use/Shared Facility

Comments:

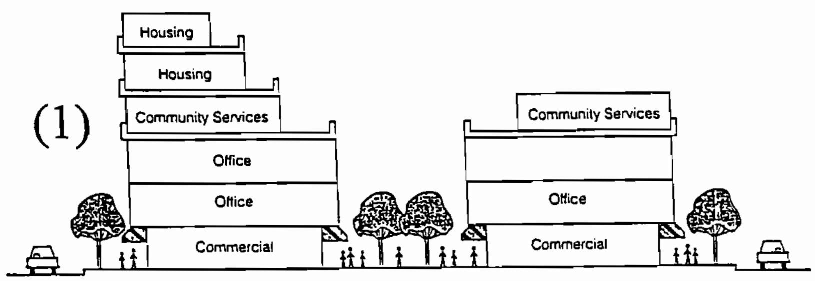
Mixed Use/Shared Facility development can be depicted from both a vertical and spatial perspective:

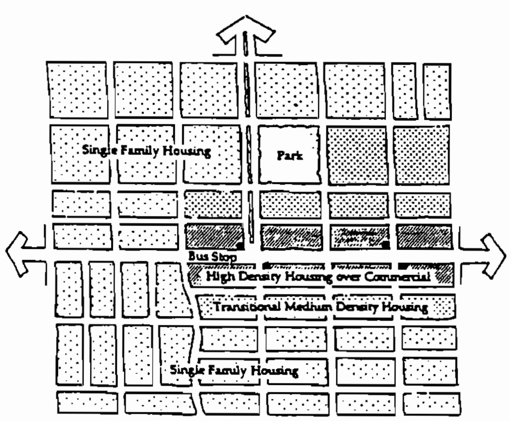
(1) Vertically integrated land uses, featuring street-front commercial and office uses, apartment units on upper levels.
from Denver RTD, "Suburban Mobility Design Manual" 1993, p. 13

(2) Overhead perspective on spatial integration of uses.
from Seattle Tri-Met "Planning and Design for Transit" 1993 p. 95

(3) Combined elevation and site lay-out examples.
from Snohomish Co. Transit, "A Guide to Land Use & Public Transportation" 1991 p. 7-15

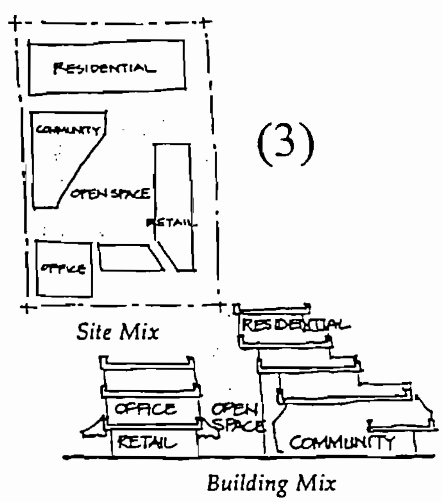
(1)





Urban Corridor

(2)



(3)

Exhibit 3.1

2. Density

Comments:

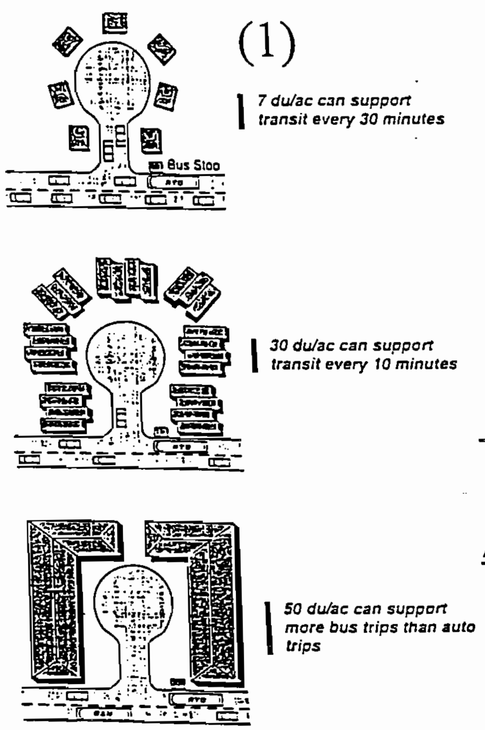
The relationship between land use densities and transit can be illustrated in terms of:

(1) Relationship of density to the level of transit service.
from Denver RTD, "Suburban Mobility Design Manual" 1993, p. 11

(2) Methods to increase densities.
from Sacramento, "Draft Transit and Land Use Coordination Guidelines" 1992, p. 26

(3) Desirable spatial distributions of various land use densities.
from Montreal STCM, "Guide d'Amenagement Urbain," 1993 p. 2.3

(1)



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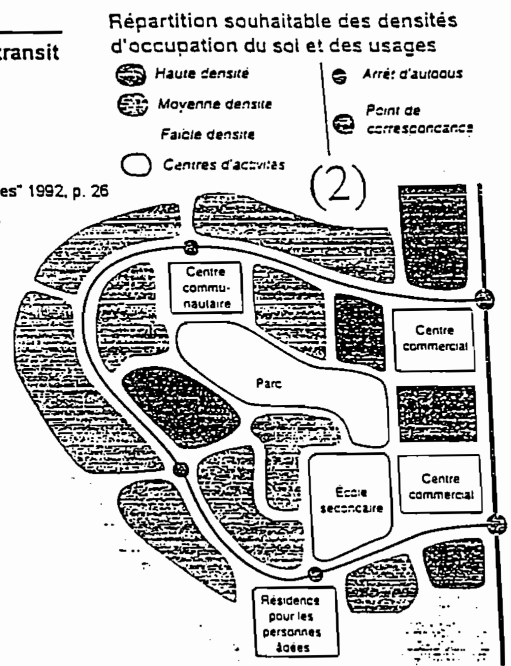

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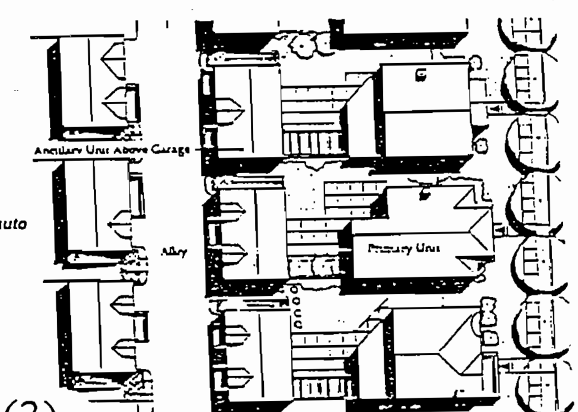


Exhibit 3.2

3. Site Layout

Comments:

It is helpful to depict both desireable and undesireable examples of site designs:

(1) Location of parking, building, bus stops, etc. to encourage transit use.

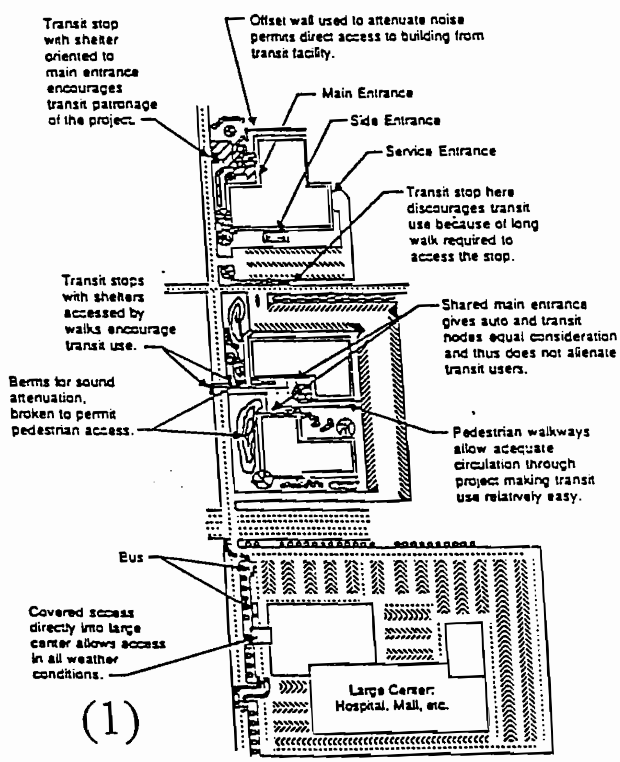
from Austin Capital Transit, "Planning Considerations for Transit Integration" 1989 p. 3-5

(2) Siting buildings in relation to the street.

from Snohomish Co. Transit, "A Guide to Land Use & Public Transportation," 1991 p. 8-7

(3) Pedestrian access.

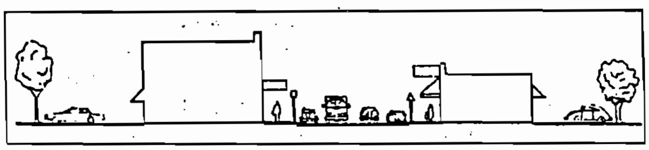
from Washoe County "Planning for Transit: A Guide to Community and Site Design" 1992, pp. 18-19.



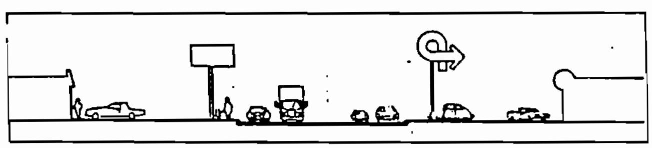
(1)

Exhibit 3.3

3. Site Layout (continued)

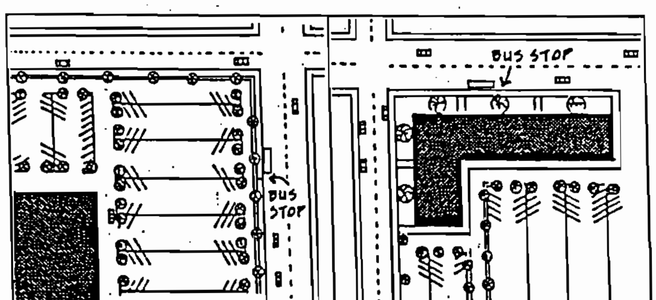


Transit related development



Automobile related development

(2)



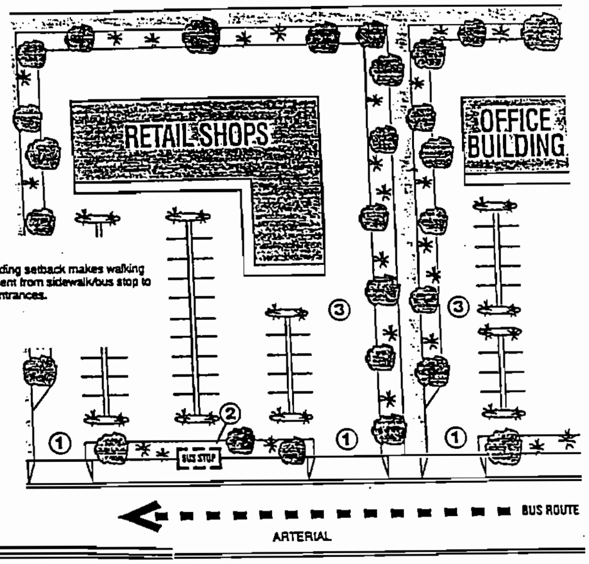
Undesirable
Buildings separated from street by parking

Desirable
Parking behind building

Exhibit 3.3 (continued)

3. Site Layout (continued)

SITE DESIGN DISCOURAGING TRANSIT USE



NOTES

① Lack of pedestrian facilities between sidewalk/ bus stop and building entrances creates conflicts between vehicles and pedestrians.

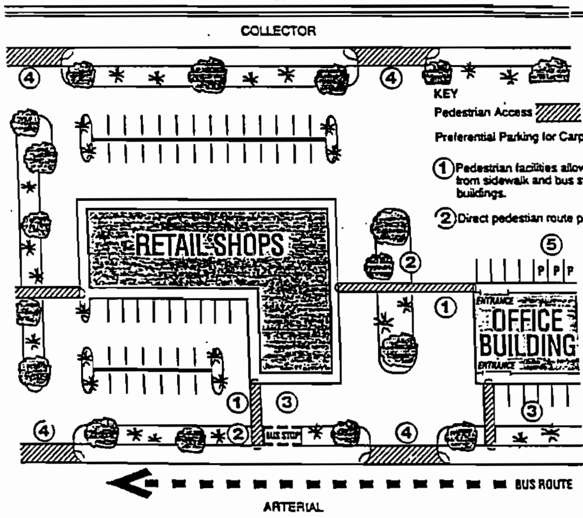
② Pedestrians take shortest route i.e. through landscaping.

③ Large building setback makes walking inconvienient from sidewalk/bus stop to building entrances.

Not to scale

(3)

SITE DESIGN ENCOURAGING TRANSIT USE



KEY

Pedestrian Access

Preferential Parking for Carpools P P

① Pedestrian facilities allow for safer movement from sidewalk and bus stop to and between buildings.

② Direct pedestian route protects landscaping.

③ Setback reduces walk distance and makes using transit more convenient.

④ Reduced number of driveways possible through shared access; reduces pedestrian/ vehicle conflicts and improves arterial flow.

⑤ Preferential parking for carpools close to office building entrances.

Not To Scale

Exhibit 3.3 (continued)

4. Subdivision Design

Comments:

Subdivision design examples should focus on pedestrian access to transit, and the efficient movement of transit through a subdivision.

(1) Illustrate maximum distance most people will walk to a bus stop.

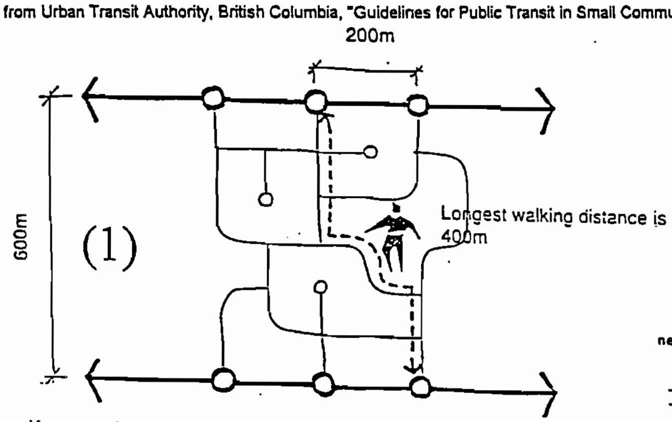
from Ontario Ministry of Transportation,"Transit-Supportive Land Use Planning Guidelines" p. 45

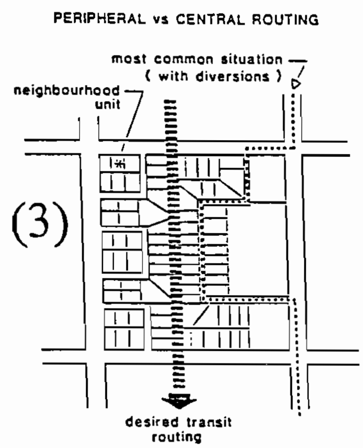
(2) Identify design features which conflict with pedestrian access.

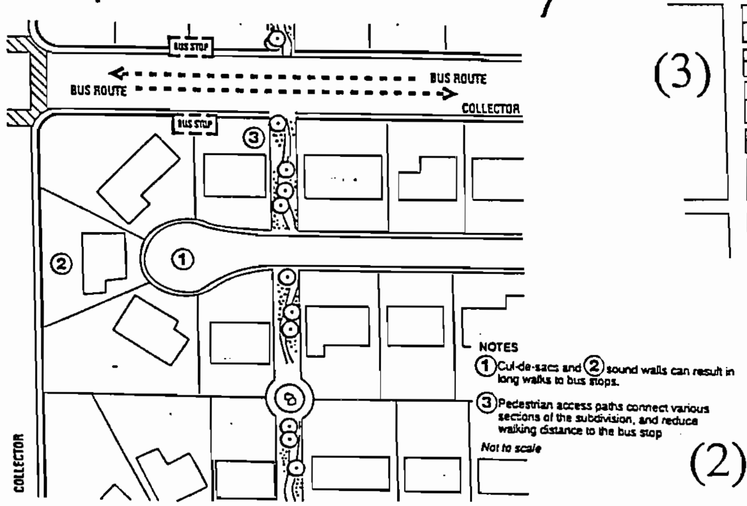
from Washoe County (Reno) RTC, "Planning for Transit: A Guide to Community and Site Design" 1992, pp. 16.

(3) Illustrate street layouts that facilitate efficient bus service.

from Urban Transit Authority, British Columbia, "Guidelines for Public Transit in Small Communities," 1980 p. 25







Discussion of issues associated with pedestrian paths in subdivisions is provided on page 15

Exhibit 3.4

TRANSIT-SUPPORTIVE DESIGN GUIDELINES
Illustrations

5. Auto Strip-to-Transit Conversion

Comments:

To illustrate how an auto-oriented area can be "retro-fitted" to become more transit-oriented, a series of drawings can be used to good effect. The following example depicts the original pattern, interim drawings depicting improvements over several phases, and the final outcome.

Snohomish County Transit, "Technical Paper 3" 1993

Current Conditions: Typical Strip Commercial Area

The area is centered on the intersection of a major arterial and a local street. The development pattern is typical of strip commercial areas, consisting of commercial businesses with parking located in front of the buildings, a large grocery store in a strip mall with a large parking lot in front, vacant land, small-scale auto dealerships, and gas stations.

Much of the parking is located on the public right of-way, and cars have uncontrolled access to parking areas from the arterial street. There are short sidewalk segments along the arterial street and part of the local street, a marked crosswalk at the signalized intersection, and two bus stops with small shelters on either side of the arterial street.

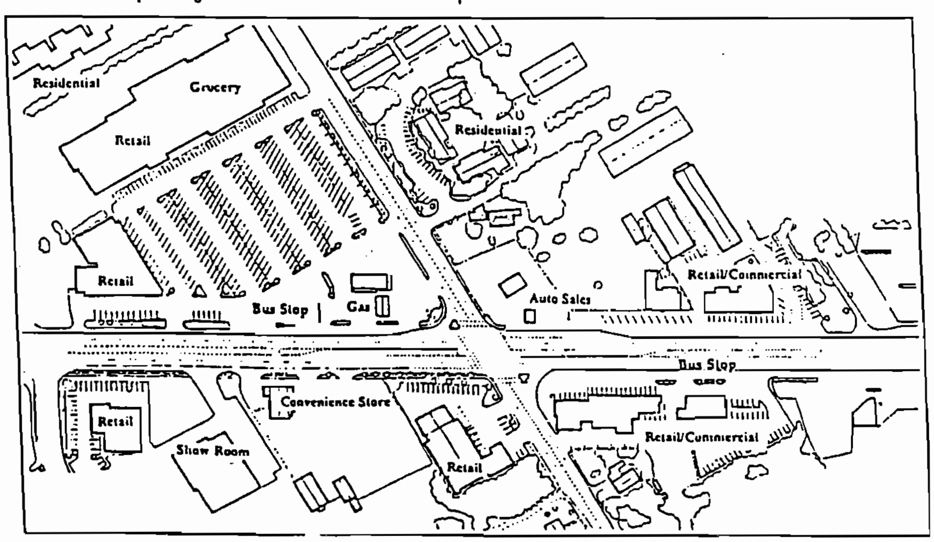


Exhibit 3.5

5. Auto Strip-to-Transit Conversion (continued)

Phase I: First Five Years

At the end of the first five-year period, the city has completed the following improvements:

- Installed sidewalks and lighting throughout the area;
- Improved the pedestrian crossings at intersections;
- Consolidated a number of driveways;
- Planted landscaping including street trees; and
- Eliminated parking in the public rights-of-way.

The business and property owners have concentrated on these improvements:

- Awnings, entrances, facades, signs, and lighting improvements;
- New landscaping;
- New parking areas; and
- On-site walkways to conform to the Americans with Disabilities Act.

The transit agency has moved its bus stops to better locations, and has increased the bus service along the arterial street.

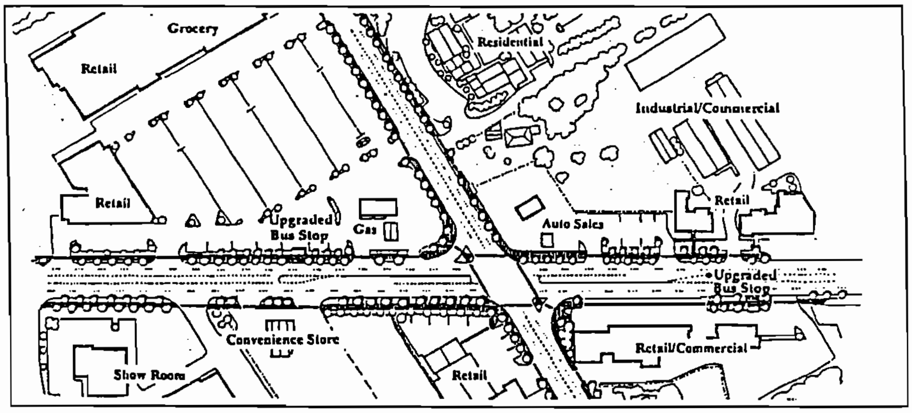


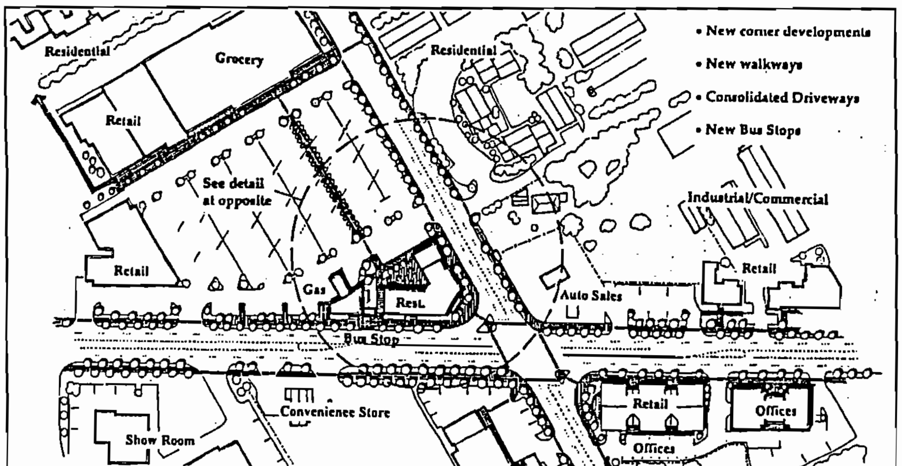
Exhibit 3.5 (continued)

5. Auto Strip-to-Transit Conversion (continued)

Phase II: Second Five Years

At the end of the second five-year period, the city has improved the arterial street to five lanes, including curb and gutter, and has consolidated driveways.

The public improvements have renewed interest in the area and land values have increased. New businesses have opened in existing buildings, and new commercial buildings have replaced older buildings and vacant land. The northeast corner, originally a service/gas station, has been redeveloped into a new building that has a restaurant, retail spaces and a gas station. The new building has several small pedestrian plazas, a courtyard adjacent to the sidewalk, and a new bus stop. This development anchors the corner for the pedestrian and connects to a new landscaped walkway. The walkway continues through the parking lot to the entrances of the stores in the shopping center. Parking for this new development is shared with the shopping center, since the spaces at the west end of the lot were never occupied.



Phase III: Third Five Years

The city has improved the local side street by adding curbs and gutters. The transit agency has further improved bus services.

Several new developments have been built, and several additions have been made to the existing buildings. A two-story apartment project has been developed along the west side of the arterial street. On the southeast corner, a new mixed-use complex in a two-story building features underground parking, a courtyard, and an office and community-center building in the rear. The community-center houses a senior-center, day-care center, community meeting rooms and social service offices.

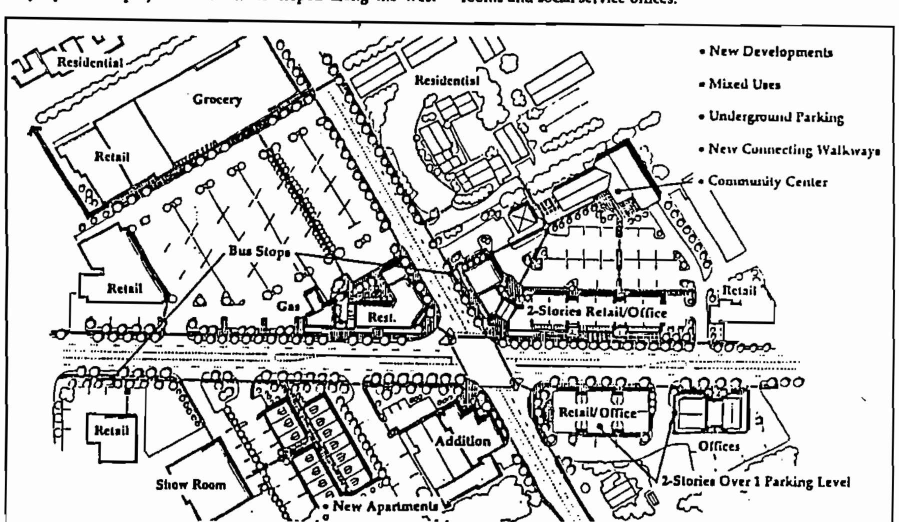


Exhibit 3.5 (continued)

6. Transit Facility Amenities

Comments:

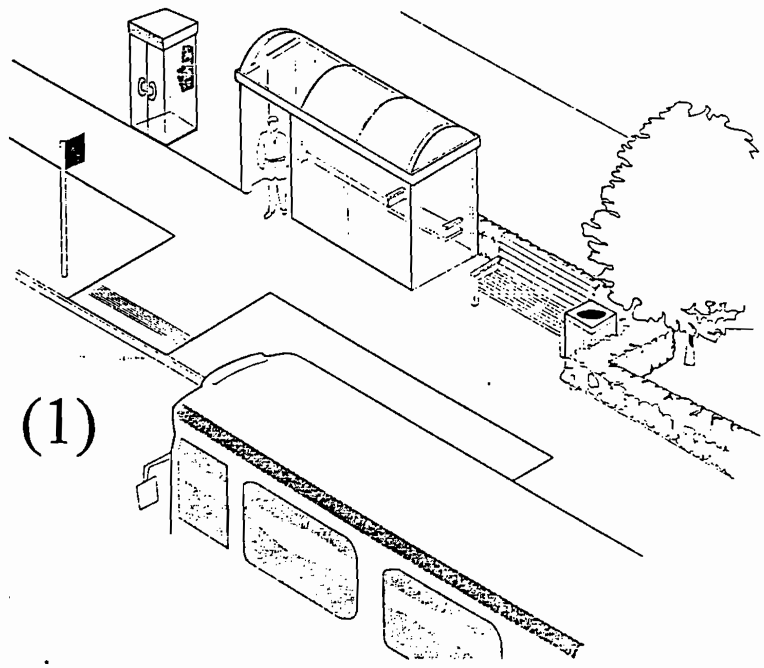
Illustrations should depict not only the functional design of bus shelters, bus stops and transit centers, but also amenities that encourage passenger use.

(1) Include amenities provided by the city, phone company, etc.

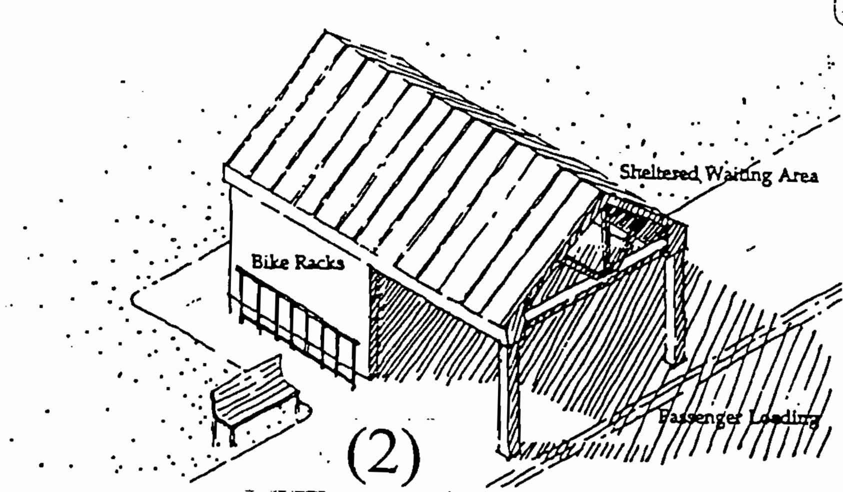
Montreal STCM, "Guide d'Amenagement Urbain," 1993 p. 5.6

(2) Creative integration of amenities with transit facilities

Sacramento County, "Draft Transit and Land Use Coordination Guidelines" 1992, p. 61



(1)



(2)

Exhibit 3.6

NOTES

[1]The list of transit agencies was chosen from APTA's directory of U.S. transit properties.

[2]Some agencies were surveyed but their responses were later discarded because the services were not particularly representative (i.e., they were exclusively demand-responsive, private, or served a very small geographic area).

[3]Montgomery County Ride-One was the only agency of the 26 that did not write their own guidelines. But they actively employ guidelines prepared by the Maryland Mass Transit Administration (MTA).

[4]The strongest form of enforcement given by the respondent was used in creating this table; thus, some of those that were listed as binding or required also may have listed recommended or unenforced.

[5]Public-sector facility projects listed on the survey responses, such as park and ride lots and light rail projects, were not included in the list.

[6]This is based on assigning a rating of 8 or above, where 1 represents no impact and 10 indicates a very high impact.

Chapter Four

Case Studies of Transit-Supportive Development at the Site and Activity Center Levels

1. Introduction

Insights into the planning of transit-supportive developments in the U.S. and the impacts of these efforts can perhaps best be gained by examining case experiences. This chapter focuses on five U.S. metropolitan areas (MSAs) which have been at the forefront of promoting transit-sensitive development in suburban settings: Chicago, San Diego, San Francisco, Seattle, and Washington-Baltimore. In each of these areas, there are at least several suburban projects (usually office and commercial developments) that are viewed by local planners and transit officials as transit/pedestrian-friendly. Equally important, travel data were available for the tenants of many of the transit-supportive projects, providing some insight into how land use and site design characteristics are associated with travel demand.[1] While there are transit-supportive suburban sites in many other U.S. metropolitan areas, the five MSAs examined in this chapter stand out for these reasons: local agencies have actively promoted transit-friendly site designs in recent years; there are clusters of sites designed for ease of transit access and with transit-supportive densities and land-use mixes; and travel data are available for some of the sites.

For comparative purposes, travel characteristics of transit-supportive sites (e.g., modal splits) are contrasted to those of other nearby sites which are similar except that they are more auto-oriented in their designs or land-use patterns. Where there were no available "control" sites for studying travel demand impacts, comparisons were made to citywide or regional averages. In some instances, better insights could be gained by looking at clusters of sites, or activity centers. In addition to identifying and addressing the impacts of suburban sites and centers with transit-supportive designs or land-use characteristics, the case studies also address implementation issues. This was, in part, because there were not as many identifiable suburban sites served by bus transit only that are clearly transit-supportive, at least as defined in the previous chapter. While many sites had some features that were conducive to transit-riding and walking, like ground-level retail or perimeter sidewalks, they also typically had many standard features of an auto-oriented suburban design, such as one parking space per employee or horizontally scaled building designs. This, then, raised the question: "why are there currently so few genuinely transit-supportive developments in suburban bus-served settings?" To address this, all of the case studies examine existing market and institutional barriers, drawing on interviews with local planners, developers, and other stakeholders.

2. Growth and Travel Trends in the Five Metropolitan Areas

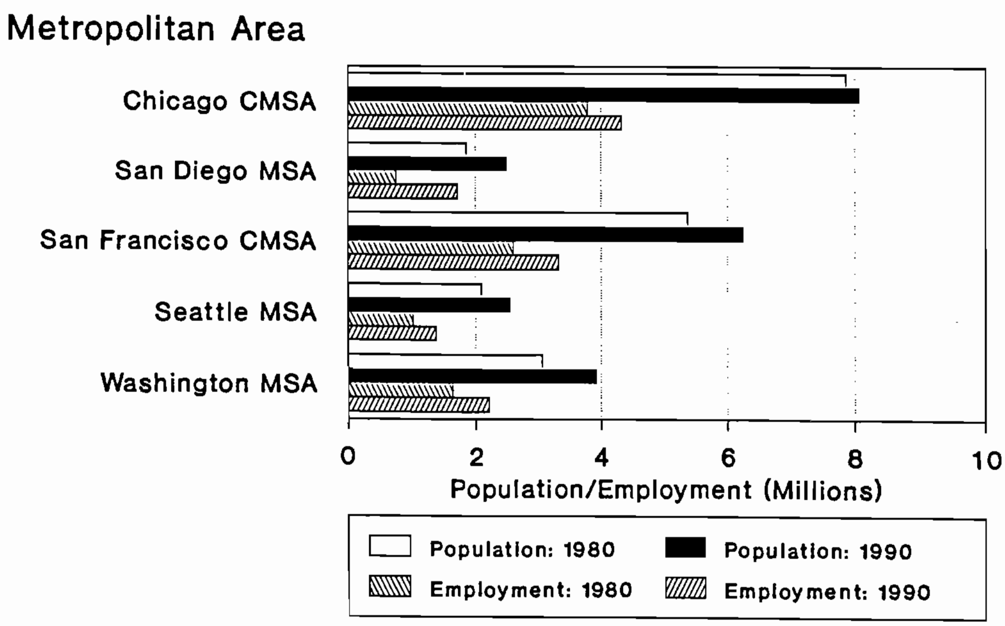
It is perhaps no coincidence that these five metropolitan areas grew rapidly during the 1980s, especially in the suburbs. It is likely also no coincidence that transit's market share of commute trips fell in these areas, again most prominently in the suburbs. The combination of rapid growth and transit's falling fortunes has no doubt sparked considerable interest in promoting transit-sensitive site designs and land-use patterns in each of these areas.

Figures 4.1 and 4.2 show that, with the exception of the Chicago metropolitan area, both population and employment grew faster during the 1980s in these MSAs than for the nation as a whole.[2] In each area, moreover, population and employment grew faster in the suburbs than in the central city (Figure 4.3). Within the suburbs, job growth outpaced population growth in each area, except in greater San Francisco. Suburbs grew the fastest in the San Diego region. Seattle had the fastest growth in suburban employment relative to its increase in suburban population.

Rapid growth in suburban jobs and housing means that more and more commute trips in these areas are between suburbs, as opposed to the traditional suburb-to-downtown radial commute. Transit has a difficult time competing with the private automobile in an environment of geographically dispersed origins and destinations (Cervero, 1986; Fulton, 1986; Pisarski, 1987). As shown in Figure 4.4, transit's share of total commute trips fell more rapidly in four of the five MSAs than for the nation as a whole during the 1980s; only in the case of San Diego did transit maintain its market share (which was no notable feat since San Diego's transit shares are quite low by national standards). This is despite the fact that four of the five metropolitan areas have regional rail transit systems; in the cases of San Diego and Washington, D.C., rail mileage expanded significantly during the 1980s.[3]

Transit was not alone in losing ground to the drive-alone automobile in the commuter market. Figure 4.5 reveals that non-SOV shares (which include all forms of ridesharing, walking, and cycling, in addition to transit) fell between 5 and 10 percentage points during the 1980s in these five areas. Most of this was due to the drop-off in carpooling and vanpooling, which fell by 7.1 percentage points in greater Washington, D.C., and 6.5 percentage points in greater Seattle.[4]

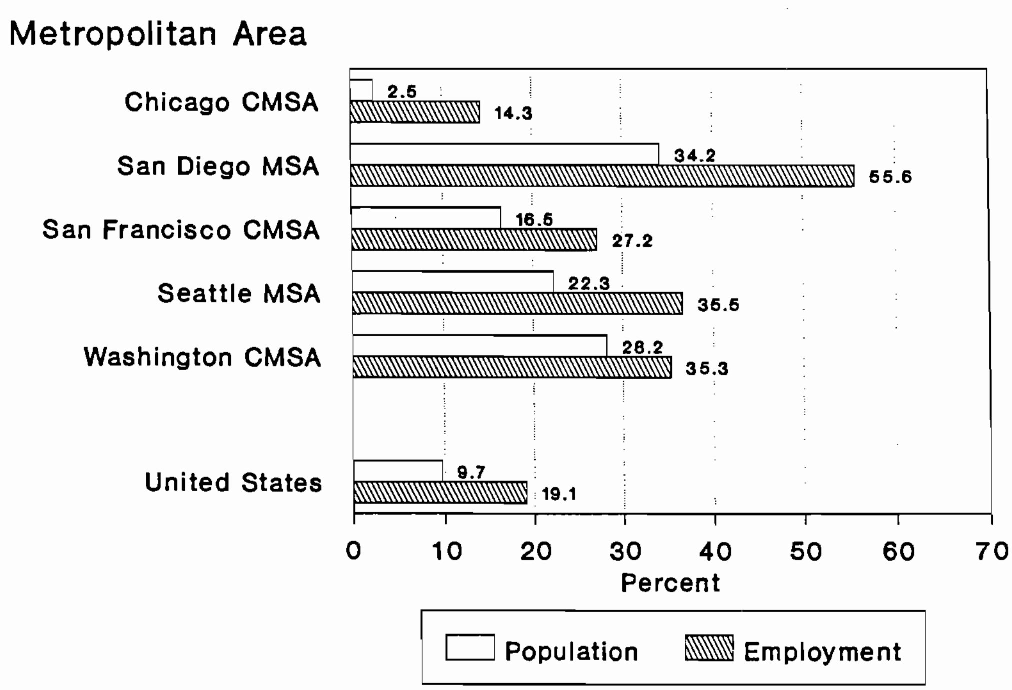
Transit and other commute alternatives generally fared no better in the suburbs. Among suburban residents, transit's market share fell in four of the five MSAs; only in San Diego were there larger shares of suburbanites commuting by transit in 1990 than in 1980 (Figure 4.6). Transit commute trips by suburban residents did increase in absolute numbers in four of the metropolitan areas, though not as fast as employment and, with the exception of San Diego, not as fast as population. In several cases, the increase in trips by suburbanites were substantial. In metropolitan Washington, D.C., daily transit trips by suburban residents increased from 129,000 in 1980 to 192,000 in 1990 (48.8 percent). Most of this gain was in the inner-suburban ring, particularly in Maryland jurisdictions; outer ring jurisdictions showed general declines in transit commuting (Pisarski, 1992). The largest percentage increase in transit trips by suburban workers was in greater San Diego —



Source: U.S. Census, 1980 & 1990

Figure 4.1

Metropolitan Population and Employment, 1980-90



Source: U.S. Census, 1980 & 1990

Figure 4.2

Growth in Metropolitan Population and Employment, 1980-90

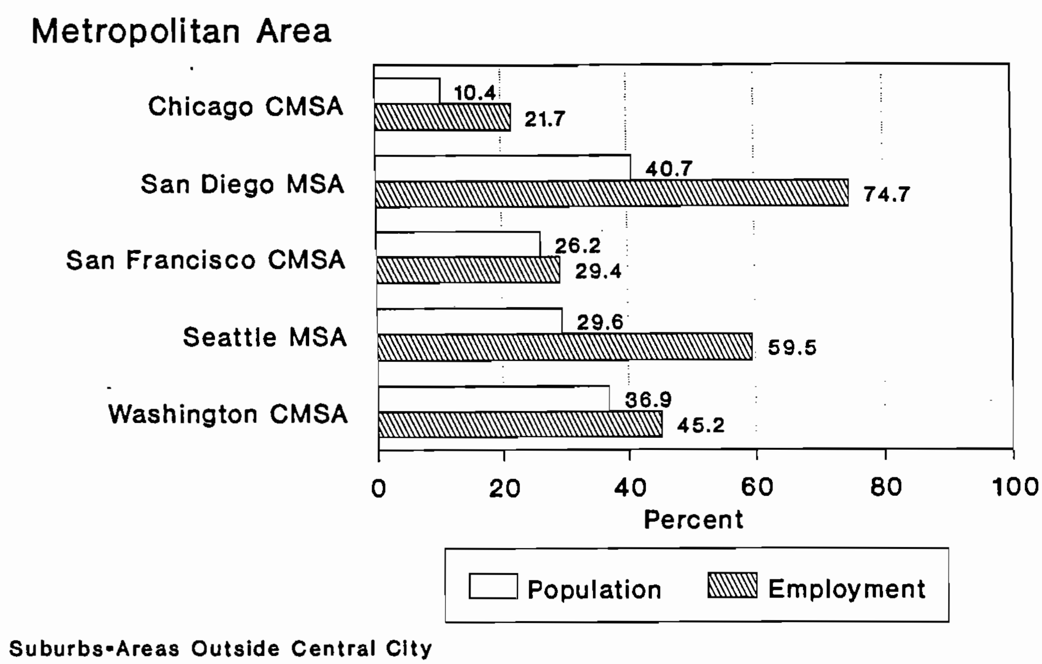


Figure 4.3

Changes in Suburban Population and Employment as Percent of Metropolitan Totals, 1980-90

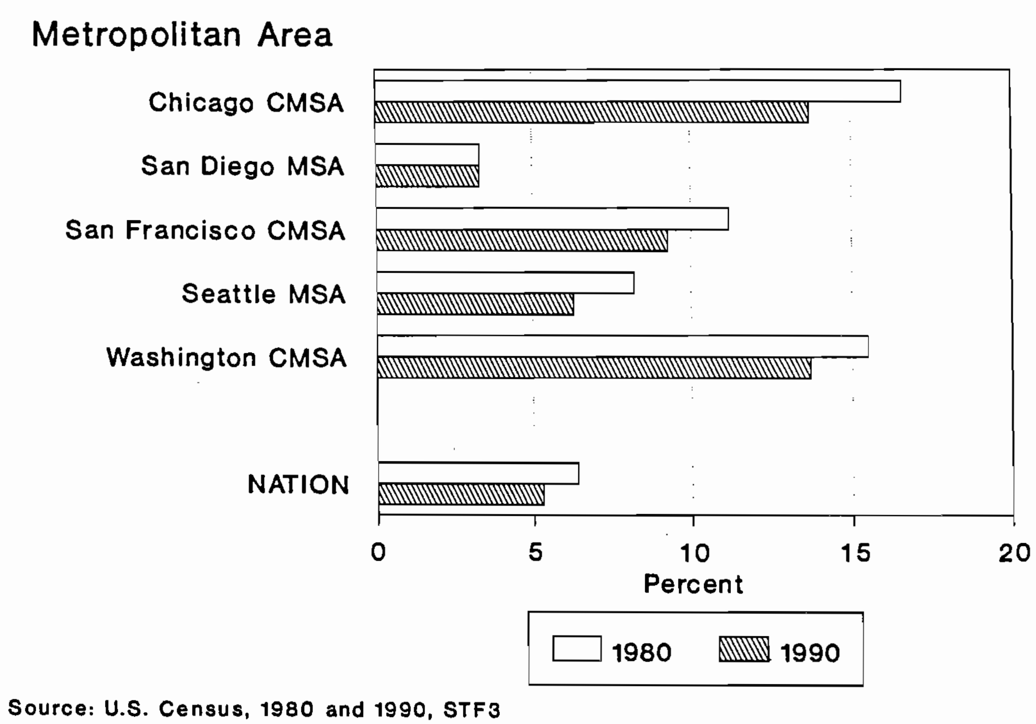
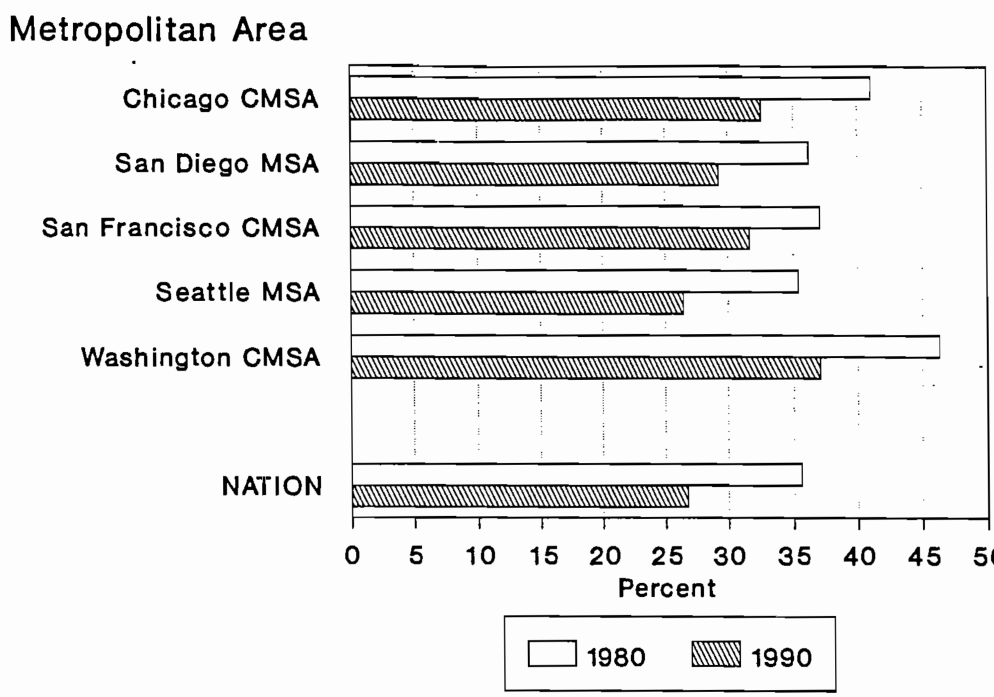


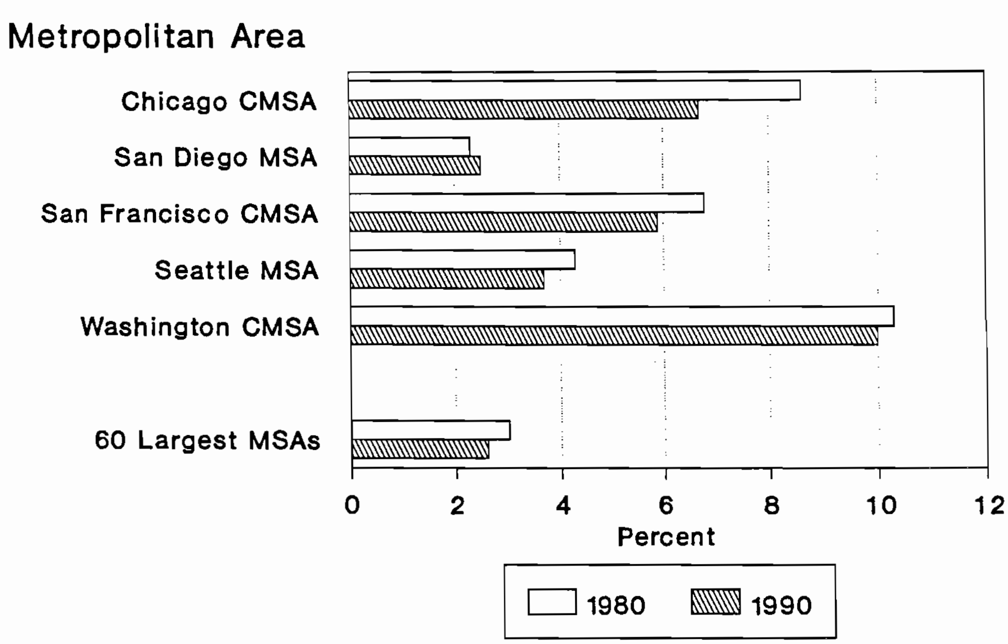
Figure 4.4

Transit Share of Work Trips, 1980 & 1990



Non-SOV = Non Single Occupant Vehicle

Figure 4.5
Non-SOV Share of Work Trips, 1980 & 1990



Source: U.S. Census, 1980 and 1990, STF3

Figure 4.6

Transit Share of Work Trips by Suburban Residents, 1980 & 1990

from 9,950 daily commuters in 1980 to 16,850 in 1990 (69.0 percent increase). For all non-SOV modes combined, Figure 4.7 shows that the market share of commute trips fell approximately by equal amounts in all three metropolitan areas. In sum, the drive-alone automobile increased its dominance as the major commuter mode in all five metropolitan ares during the 1980s, particularly so in suburban markets.

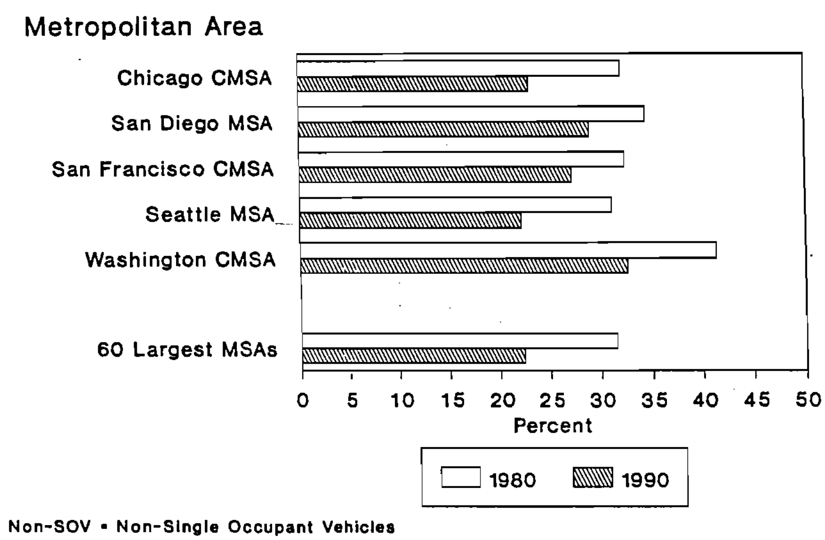


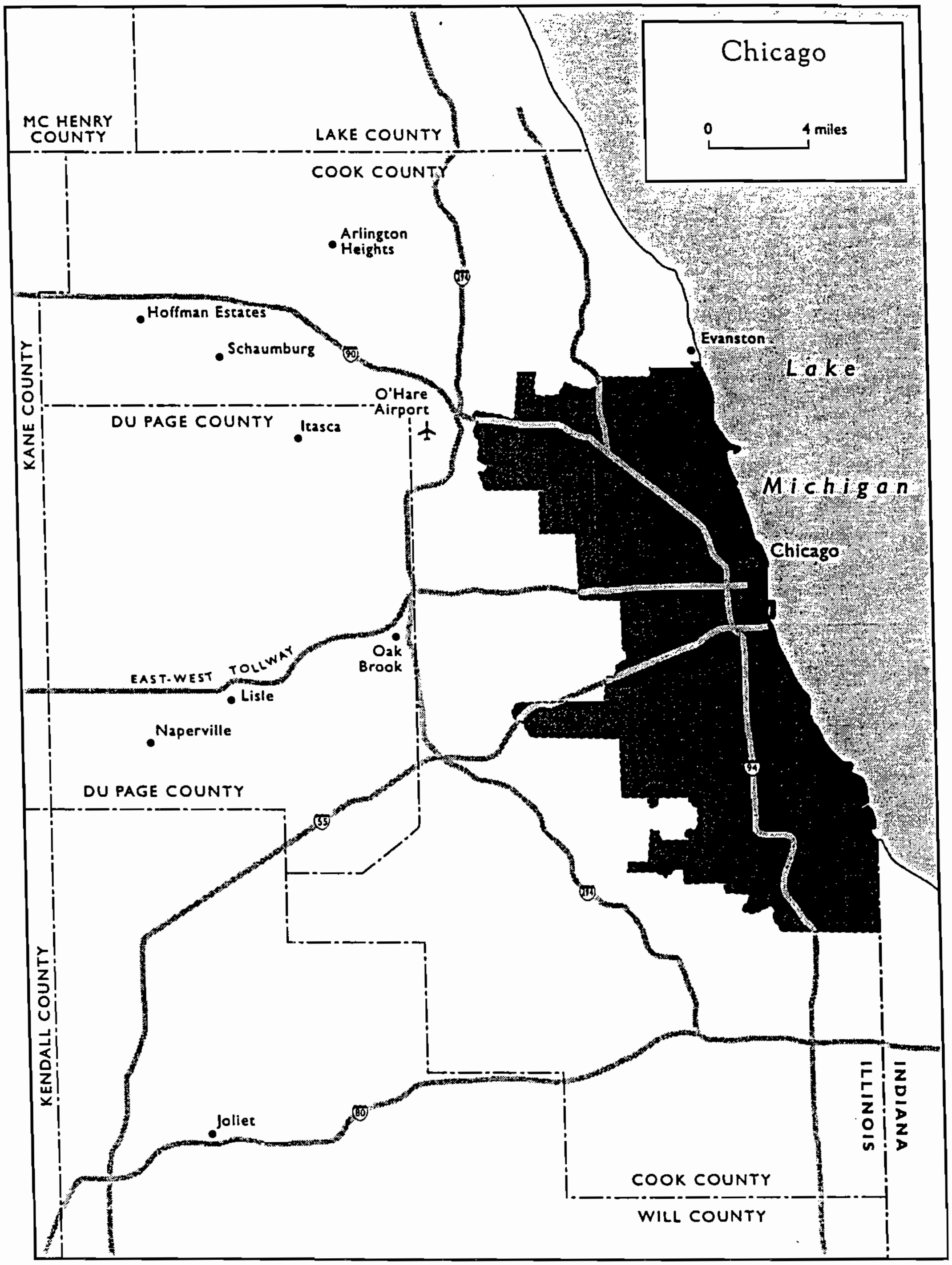
Figure 4.7

Non-SOV Share of Work Trips by Suburban Residents, 1980 & 1990

3. Chicago Area Case Study

Rapid suburban growth in the Chicago region over the past two decades has put transportation and land-use planning issues on center stage. Changes have been dramatic. Between 1970 and 1990, 165 municipalities in the six-county region, most in outlying areas, gained over one million residents, while 90 municipalities, mostly at or near the region's center, experienced a net loss of 771,000 (NIPC, 1992). During the same period, the suburban share of the region's employment grew from approximately 44 percent to 61 percent.

Several corridors and townships have received the lion's share of employment growth outside the city of Chicago since 1980: the Interstate 88 East-West Tollway between Oak Brook and Naperville; the village of Schaumburg; the Chicago O'Hare Airport area; and the Lake-Cook corridor straddling the line between these two counties, among others (Map 4.1). For the most part, much of the employment growth in these areas has been housed in an assortment of master-planned office parks, company estates, light-industrial parks, retail centers, and other freestanding commercial complexes. The densest suburban clusters are found in Oak Brook, Schaumburg, Itasca, and around



Map 4.1

Chicago Area Case Study

O'Hare Airport; while some office towers exceed 20 stories in these places, wide distances separate most buildings and parking is so abundant (and often free-of-charge) that the vast majority of workers solo-commute. Site layouts, building placements, circulation paths, and service levels in many of these areas do little to welcome mass transit vehicles or users. A 1986 survey, for instance, showed that only 1 percent of commuters who worked along the Interstate 88 corridor used some form of public transportation (Dunphy, 1987).

The Chicago region, like most of the country, has been grappling with an economic downturn since the late 1980s; thus, little new commercial and office space has been added in recent years. The only notable building activities have been in the outermost ring, fueled by corporate relocations to areas like the US-45 corridor in Lake County and the Prairie Stone project in Hoffmann Estates (where Sears recently moved), 37 miles from downtown and 8 miles farther out than Schaumburg, which during the heydays of the 1980s was considered the fringe. While their predecessors were not particularly transit-friendly, every effort is being made to ensure these new developments do not commit some of the same design sins of the past. This section reports on these efforts.

3.1. A New Generation of Transit-Supportive Development in Chicago

One of the first efforts to promote transit-supportive development in the Chicago region was mounted by the DuPage County Development Department in the mid-1980s. At that time, the agency formed a committee of public and private interests to look at design issues along the Interstate 88 corridor. Guidelines soon followed that called for higher densities than those typically found at campus-style office parks (FARs exceeding 0.3), orienting building entrances to main roads, building sidewalks that connected new projects, and placing parking toward the rear of buildings. By the time the guidelines were completed, however, Du Page County's office growth had already slowed considerably; thus, local interest in transit-oriented development waned.

In 1988, PACE, the suburban Chicago bus transit planning and operating authority, produced their *Development Guidelines,* which has since gained wide recognition as a very useful document on how to develop transit-supportive projects. This was partly an outgrowth of PACE's creation of an in-house Marketing and Development office whose principal charge is to find ways of increasing transit usage at new suburban developments. In addition to preparing the guidelines, PACE's Marketing and Development office created a ten-minute slide/video show on the virtues of transit-friendly designs. PACE makes staff, the guidelines, and the video available to real estate developers and local planning offices interested in learning more about the subject.

Since PACE began its marketing campaign in the late 1980s, with the exception of Prairie Stone, the huge office park in Hoffman Estates for The Sears Company, no large-scale office projects have come on-line in the suburban Chicago market. Most of the new development that has occurred has taken the form of much smaller stand-alone, built-to-suit structures. Consequently, suburban Chicago, which has one of the most pro-active transit agencies in the country in terms of advocating transit supportive development, has few examples of such projects on the ground.

3.2. Prairie Stone Project

In 1992, Sears Merchandise Group moved the major portion of their operations to the Prairie Stone project in Hoffman Estates. The Sears complex consists of 1.9 million square feet of building space on a 200-acre site. Sears is the largest tenant of the 786-acre Prairie Stone project, which is being developed by Homart Development. This master-planned project is to be built over a 20-year period, creating as much as 12 million square feet of office, retail, hotel, and light industrial space occupied by up to 45,000 workers.

The threat of this many workers coming to their tranquil village alarmed the residents of Hoffman Estates, prompting the village to place conditions on the project that would restrict the number of single-occupant vehicles accessing the site. The annexation and development agreement between Sears and the Village of Hoffman Estates stipulated that measures would be implemented to reduce anticipated peak-hour traffic volumes by 20 percent. Sears would be prevented from developing the site to its maximum capacity if this goal was not met. Sears constructed 4,000 parking spaces, less than the 5,000 or so workers expected to work at the Merchandise Group facility. The company was also required to establish a Transportation Management Association (TMA) and hire a ride-share coordinator (Grzesiakowski, 1993).

Sears and Homart have committed themselves to physically integrating transit into the Prairie Stone development. In consultation with PACE officials, Sears designed and built bus staging areas in several portions of the building (Photo 4.1). One bulb-shaped staging area drops bus passengers off at the main entrance to the complex and is designed to allow a conventional bus to make a 360° turn. While these staging area represent a significant effort on the part of a major suburban employer to integrate transit into the worksite, they do not sum up to what neotraditional urban designers would call a transit-oriented development. The Sears building is still clearly sited, designed, and landscaped for chiefly automobile access and circulation. On-site services include several shops, a cafeteria, bank, cleaners, hair salon, health club, and restaurant; still, most employees use cars to get to any attractions outside the complex.[5] The only other significant transit-related design feature within the Prairie Stone project is a fairly centrally located Transit Center with eight bus bays and an enclosed waiting area, all constructed on a 1.7-acre plot.[6]

For the purpose of evaluation, Prairie Stone and the Sears complex can be defined as transit-supportive in the narrow sense that physical features were provided to accommodate buses on-site and ease the process of using bus transit. These physical designs seem fairly inconsequential, however, when compared to the intensity of transit connections to the site in 1993 (at least relative to most outer Chicago work settings): four fixed routes; ten subscription bus runs utilizing 13 buses;

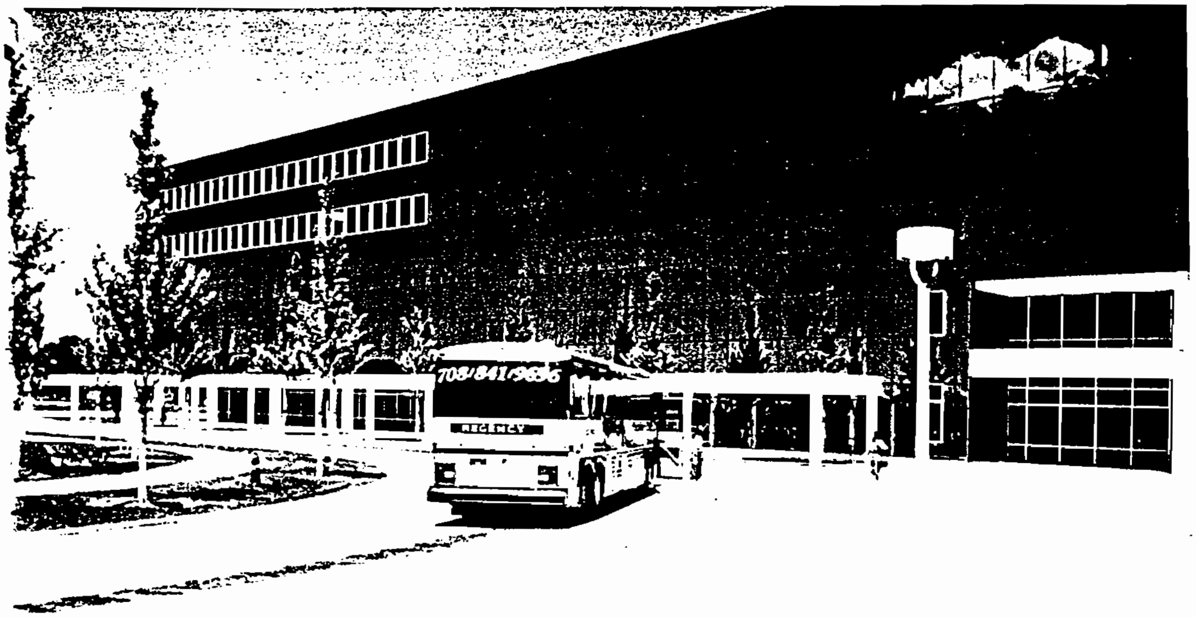


Photo 4.1

Prairie Stone Complex: Staging Area in Front of Sears Building's Transit Lobby

and 44 vanpool groups (which carried 57,700 riders in 1992). PACE operates the fixed-route services and contracts out most subscription and vanpool operations. Also, vanpools receive preferential parking in a garage adjacent to the complex (where parking is free-of-charge to all).

A 1993 survey by PACE revealed that around 1,500 workers per day, or 32 percent of the Sears workforce in Prairie Stone, commute to work by bus or vanpool. While impressive, it is unlikely that much, if any, of this market share is attributable to physical or design attributes of the site. Far more important have been:

- The intensity and quality of customized transit and vanpool services.[7]
- The previous tendency of employees to commute by transit —when they worked at the downtown Sears Tower, 92 percent of Merchandise Group employees commuted by public transportation, primarily CTA and Metro rail services.
- The size of the company, which made coordination of transportation options in particular neighborhoods much easier and increased the odds of successful ride matches.

The one land-use-related factor that has likely encouraged non-SOV (non-single-occupant vehicle) commuting is the inclusion of ancillary and employee-support services on the site. In that surveys show that around 40 percent of suburban office workers make two or more off-site personal business trips during the midday each week, having some midday trip attractions within a complex increases the likelihood that workers will leave their cars at home and commute by some other alternative (Cervero, 1989).

The 32 percent transit and vanpool modal split at the Sears site far exceeds the 1990 non-SOV market share of work trips for the Chicago metropolitan area (28.6 percent) as well as for the region's suburban residents (17.3 percent). It also exceeds averages for other corporations that relocated from downtown to the suburbs and exurbs in recent years. A recent survey of a company that relocated its 235 workers to an office park in Itasca (around ten miles closer in than Hoffman Estates) found that the transit and vanpool modal split fell from 91 percent when the company was downtown to 20 percent one year after the move (Figure 4.8). Unlike the Sears complex at Prairie

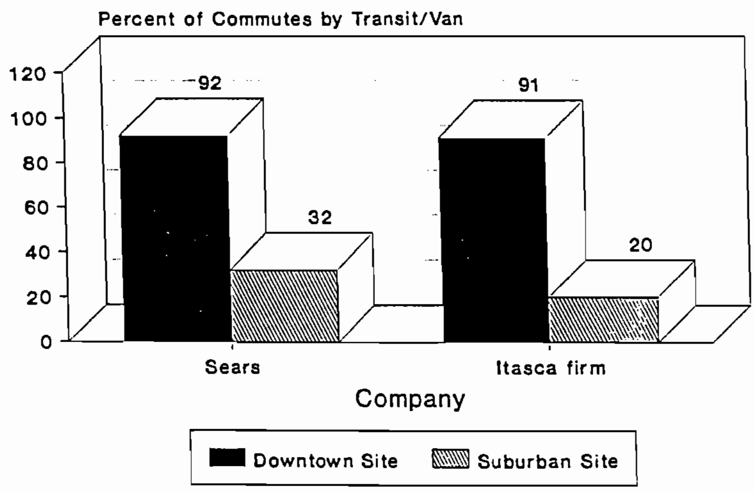


Figure 4.8

Before-and-After Work Trip Modal Splits, Two Chicago-Area Employers

Stone, no transit-oriented features were designed into this firm's Itasca site; the only initiative taken to reduce solo-commuting was to coordinate employee ridesharing. Besides differences in transit service intensity (the Itasca firm is served by a single fixed-route bus on 30-minute peak headways), the 12 percentage point difference in transit/vanpool modal splits between these two sites is most likely attributable to Sears having many more employees as well as a mixture of land uses at its site.

3.3. Other Transit-Supportive Designs

Among the few other commercial projects built in Chicago's suburbs in recent years, the only transit-supportive features introduced were fairly modest provisions to accommodate buses on-site or facilitate pedestrian access. Projects, other than at Prairie Stone, that have been cited by PACE as having transit-sensitive designs are:

- Central Park office development in Lisle: bus staging area at building main entrance and design of internal roadway to allow through-bus service.
- Woodfield Mall in Schaumburg and Charlestown Mall in Kane County: bus staging area at main mall entrances and construction of perimeter sidewalks (Photo 4.2).
- Motorola plant in Arlington Heights: Road geometries and front-entrance staging areas designed to accommodate buses.[8]

All of these design treatments have produced very marginal improvements in on-site bus operations; thus, their impacts on transit usage or walking have been fairly inconsequential.

Photo 4.2

Front-Entrance Bus Access at the Woodfield Mall, Schaumburg, Illinois

3.4. PACE's Perspective on Transit-Supportive Development

There is a significant gap between what PACE has been aggressively promoting over the past five or so years and what is being built on the ground. Representatives from PACE indicated that one of their biggest frustrations is that their *Development Guidelines* have no "teeth." Of some 265 different municipalities in the PACE service area, only 12 regularly require developers to incorporate transit facilities specified in the guidelines. Of those, only four have actually written this requirement into their zoning codes. The township of Lisle, midway between Oak Brook and Naperville along the East-West Tollway, has done more than any other locality to promote transit-supportive designs.

Lisle planners use a check list and review sheet to evaluate each proposed project in terms of its transit supportiveness. PACE staff are also asked to comment on all projects reviewed by Lisle's planning office.

Because of the lack of enforcement authority, PACE has adopted a strategy of coaxing the development community into using its design guidelines. PACE has three full-time "Market Development Representatives," who are actively involved in outreach efforts to convince developers that transit-supportive projects make good economic sense. While the effort is good-intentioned, the atmosphere in the suburban Chicago development community is still so apathetic toward transit that even the most minor changes can seem a major victory. In Lisle, for example, where a firm recently leased space for its national headquarters at the Central Park complex, PACE's promotional efforts resulted, as noted earlier, mainly in the paving of the back of the building to allow for through-bus service. The bottom of a stairwell in the back of the building was converted into a transit entrance by transforming what had been a backdoor fire exit into a transit staging area. Clearly, transit was a priority for neither the developer in the way the physical structure was built, nor the tenant in having chosen to locate there. Nevertheless, it might be argued that even those very modest transit provisons would not exist were it not for PACE's pro-active stance.

3.5. Transit in a Stalled Market: The Developer's Perspective

We also conducted detailed interviews with the intended targets of PACE's design guidelines, suburban office producers and consumers. Because of tight credit, overbuilt real estate, and a general atmosphere of risk aversion, few developers expressed much interest in transit-supportive designs. Most would consider such designs only when pressed to do so by local governments in order to expedite their projects through the review process.

Whatever new commercial development gets built in coming years will likely be built-to-suit. Office consumers, therefore, may play a more pivotal role in the future prospects of transit-supportive development than suppliers. This could be a mixed blessing. On the one hand, since most seekers of build-to-suit space tend to be large firms looking to locate back office operations, transit officials and local planners may have an easier time matching companies with transportation demand management (TDM) strategies and getting the company to do employee transit outreach earlier. On the other hand, large corporations that can afford build-to-suit projects tend to prefer large surface buildings in stand-alone settings. Thus, while it may be easy to do TDM outreach, it may be extremely difficult to coax developers and employers into agreeing to site designs and building placements that ease transit usage or bolster pedestrian activity.

Even less receptive to transit-friendly design principles have been developers of residential subdivisions. Many planned residential developments place more emphasis on security and privacy than accessibility; in fact, the emphasis on the former tends to be at the expense of the latter. In the case of one Lake County developer, he quickly rejected PACE's request to build a sidewalk around the perimeter of the project. Several developers have actually fought against PACE placing a bus stop adjacent to their projects, ostensibly because their tenants and customers are not typically transit riders.

3.6. Local and Regional Perspectives on Transit-Supportive Development

We conducted interviews with staff in the City Planning Department of Hoffman Estates, where the Prairie Stone development is located, as well as with staff of the Northeastern Illinois Regional Planning Commission (NIPC), to get a local as well as a regional picture from the public sector perspective. While there was a strong sense of accomplishment among Hoffman Estates planners regarding their influence on the Prairie Stone project, both sets of interviews also suggested a sense of impotence at the local and regional planning levels.

Officials from the Village of Hoffman Estates indicated the Village's desire to see that new residential development currently being planned in the vicinity of Prairie Stone be transit-serviceable. However, the only pressure the Village might be able to exert on the project would be simply requiring the developer to use a road network that allows for adequate on-site bus penetration. To require other amenities (e.g., bus shelters, pedestrian paths), let alone a neotraditional site design, would not be received well in the development community, for the good reason that public transit service generally does not exist in the area at all. The understandable reaction of the developer is "first provide the bus service, then I will worry about putting in transit stops." There is sort of a vicious circle operating in suburban Chicago and no doubt elsewhere in the U.S.— no transit service is provided because densities are too low and site designs are not easily transit-serviceable, but the densities are planned low, with unserviceable designs, because there are no transit services. Local governments and planning agencies feel powerless to intervene in, much less stop, this cycle, and consequently generally do not try.

On the regional side, interviews revealed a kind of despair about the activities of local governments. As long as suburban and exurban governments continue luring businesses and development away from urbanized areas with tax incentives and other inducements, development will continue to be automobile-dependent. NIPC planners were skeptical about the likelihood of incorporating transit into the design of suburban developments, unless that development is near an existing rail line. Yet despite the fact that suburban Chicago has numerous traditional, gridded towns laid out along radial rail lines that feed Chicago, only 5-10 percent of new growth over the last 30 years has actually occurred in these areas.

The regional planning agency, NIPC, has very limited real powers, and controlling sprawl and coaxing development along existing rail infrastructure are not among them. To the extent that NIPC has any ability to influence suburban growth, it is through its non-binding and advisory *Strategic*

Plan for Land Resource Management (1992), and its authority over regional sewage infrastructure; as long as new development does not violate the regional sewage plan, NIPC's board takes a blind eye toward the physical and land-use features of the project. Being entirely dependent on the state for funding, not only does NIPC lack the purse strings to influence private investment decisions and confront issues of sprawl, but is also would likely meet stiff political opposition if it tried. Consequently, in the current political climate, it, like most regional planning bodies, can do little more than be a passive observer of the auto-oriented development taking place on the region's periphery.

3.7. Case Summary

Only modest gestures have been made by Chicago's development community to date to create transit-supportive suburban work and living environments. Most aim to improve on-site bus access and reduce vehicle dwell times. Transit and vanpooling modal splits at the new Sears office in Prairie Stone are comparatively high (around 32 percent), though this is mainly attributable to factors other than physical design or site layout — such as the provision of extensive transit service options and the inclination of many Sears employees, who previously worked downtown, to ride transit.

Despite near heroic efforts on the part of PACE to promote transit-friendly developments, the outlook is for a continuation of auto-oriented designs. Many new office occupants are owner-tenants who view transit access as far down the priority list of factors to consider in designing and siting a project. Other than including some on-site services and land-use mixtures, few recent projects have incorporated any design elements that could be construed as transit-supportive. Overall, only small steps have been taken to date to make suburban workplaces transit-oriented, though should the Chicago area's commercial real estate market turn around anytime soon, PACE seems well positioned to parlay early experiences into much more substantial gains.

4. San Diego Area Case Study

The San Diego metropolitan area has no less than four site design manuals: one produced by the North County Transit District, providing primarily technical specifications for various facilities; one produced by the Metropolitan Transit Development Board with assistance from both the City of San Diego and San Diego Transit, containing both design specifications and more general suggestions for creating more transit-oriented communities; one produced by Calthorpe Associates (1992) for the City of San Diego, "Transit-Oriented Development Design Guidelines," focusing primarily on land-use and urban design issues; and one produced by the County of San Diego Department of Planning and Land Use, focusing on administrative and regulatory reform necessary to enhance transit-oriented development. Given the slightly different focus of each of these design guidelines, they should be seen as complementary, not competing, documents.

4.1. San Diego's Assertive Policy Environment

With all this focus on integrating transit into the physical design of new and existing developments, San Diego County was a natural place to look for examples of transit-supportive site design. Indeed, San Diego has some of the most innovative examples of inter-agency and inter-governmental cooperation to be found anywhere in the United States. County-wide, a number of transit-supportive projects are in various stages of planning and completion. The City of San Diego is among the most aggressive at legislating programs aimed at reducing drive-alone vehicle miles travelled. It has formally adopted policies endorsing "Transit-Oriented Developments."[9] The purpose of the policy is:

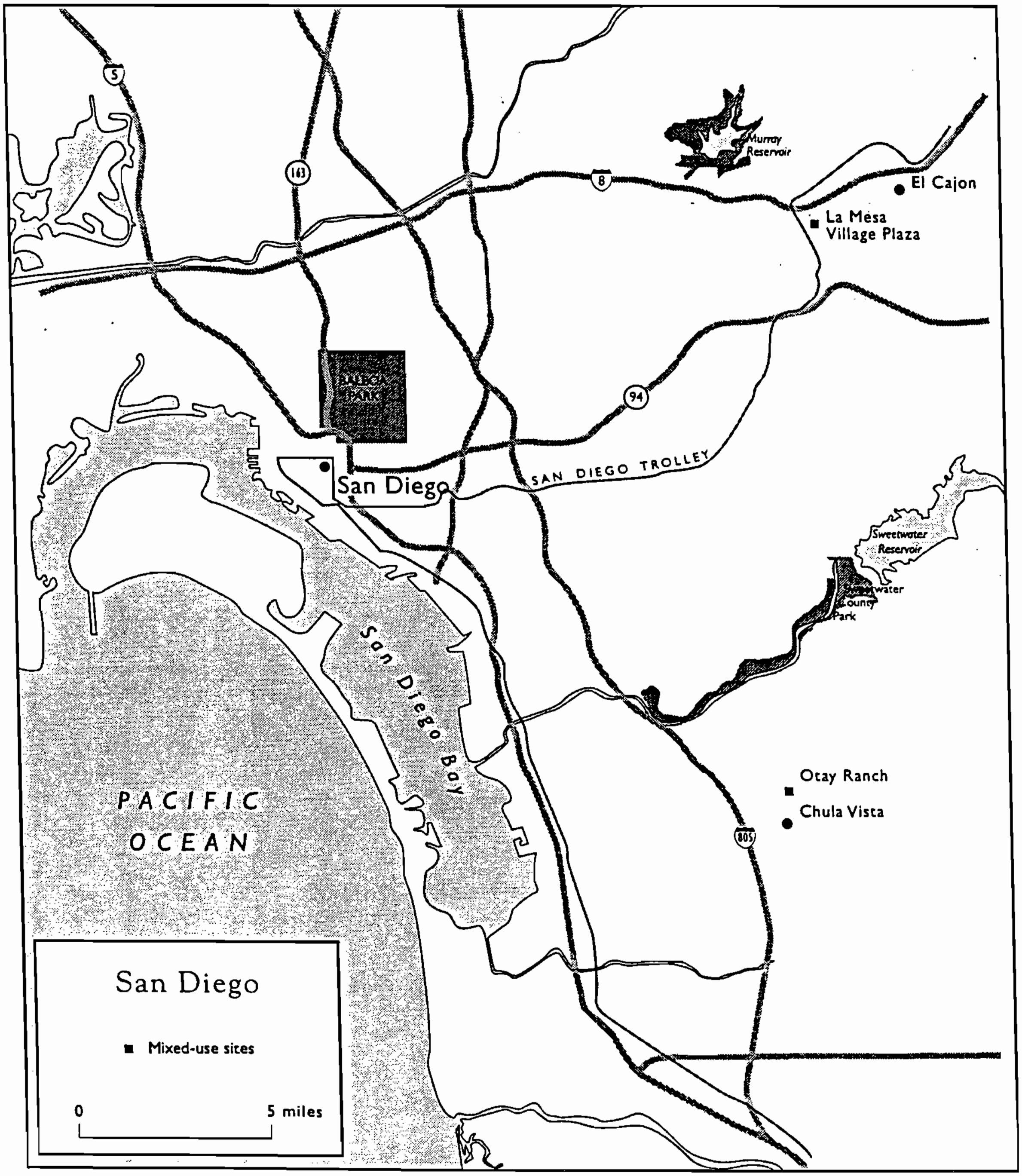
> to direct growth into compact neighborhood patterns of development, where living and working environments are within walkable distances. This development pattern is designed to support the substantial public investment in transit systems, and result in regional environmental and fiscal benefits over the long term. (p. 1)

This policy statement authorizes governmental agencies to proceed with demonstration Transit-Oriented Development projects. The policy is formulated around Peter Calthorpe's "Transit-Oriented Development Design Guidelines," which was formally adopted by the city council along with the policy statement itself. In addition, San Diego has been particularly aggressive in cutting down on drive-alone trips to the downtown area, via such techniques as granting shared-parking breaks to developers, using maximum parking zoning, and pro-actively seeking shared development opportunities in transit-supportive design.

4.2. Unincorporated San Diego County: Otay Ranch

One example of pro-active governmental participation under way is the Otay Ranch project in Otay Mesa, an unincorporated part of San Diego County located adjacent to the cities of San Diego and Chula Vista. (See Map 4.2 for regional location.) Frequently, unincorporated portions of counties are the portions on the fringes of metropolitan areas most at risk of being developed in an ad-hoc, parcel-by-parcel (and consequently auto-centric) manner, because opposition to projects under county jurisdiction are by definition more diffuse than opposition to those that come under local authority. At Otay Ranch, a coalition of public agencies formed a working group with the developer, Baldwin Development Corporation, to insure that the area would be developed according to transit-supportive and environmental principles. Included in the working group are representatives from the cities of Chula Vista and San Diego, the County of San Diego, and the Metropolitan Transit Development Board.

The project was originally submitted to the County of San Diego as a large-scale, mixed-use development by the Baldwin Corporation. These plans included an on-site monorail, but had no other particular provisions for transit. In response to this plan, the affected jurisdictions formed a permanent Otay Ranch Project Team. This team has been pro-actively working to create a transit-



Map 4.2

San Diego Area Case Study

supportive environment, using the following strategies (in contrast to more conventional planning efforts):

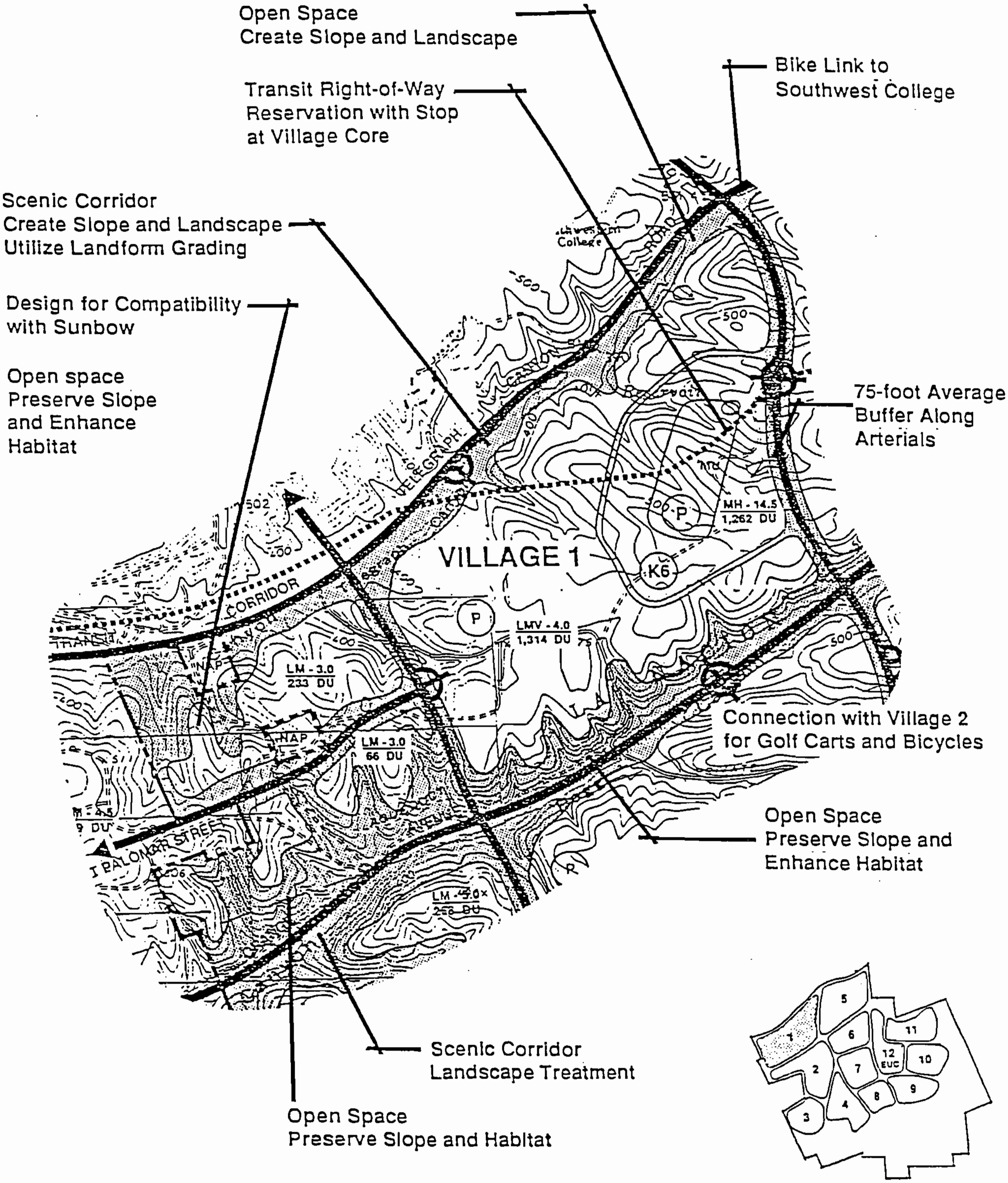
- early formation of working group to allow interagency participation at early stages.
- early formation of citizen participation groups, so that public input occurs during plan formation period, instead of during the plan review period.
- urban design charettes conducted early on by such notable designers as Andres Duany, Allan Jacobs, and Peter Calthorpe both to get feedback from the public and participants in the development process, and to educate the developer and the public at large on land-use, density, and design issues.

While the project is still in the entitlement stage, it is already clear that these strategies have paid off. Little opposition exists to the proposed densities of the project, according to members of the Project Team, densities which are significantly higher than those normally built in suburban fringe areas.

As of mid-1993, the program for the 23,000 acres comprising the site included twelve "Village" clusters, having average blended densities of 18 dwelling units to the acre.[10] (Map 4.3 shows a typical village land-use plan.) Five of the village clusters will be serviced directly by the San Diego Trolley; the remaining seven will either be connected by feeder bus routes or by landscaped pedestrian villages, but even these villages will be designed on the Pedestrian Pocket concept. One of the village clusters will actually be a major regional mixed-use (residential/retail/office) node close to the trolley line, with residential densities reaching nearly 36 dwelling units to the acre close to the trolley line. This node will also have conventional, freeway-servicing commercial facilities. In all, a total of 27,000 dwelling units are projected at full build-out— between 30 and 50 years away— of which 2,500 will be located in the regional node. While detailed commercial or office square footage projections are not available at the present time, nearly 1,200 acres of non-residential use is envisaged for the project as a whole, with an additional 148 acres of non-residential use possible, pending negotiations between the San Diego County and the city of Chula Vista.

The planning process for Otay Ranch and the concerns of its participants provide early clues to future planning issues, as institutional resistance to transit-supportive development recedes and planners and developers begin working in earnest at a more sophisticated level to create integrated, mixed-use communities. Certainly, the conventional stereotypes about the planning process and NIMBY reactions do not necessarily apply. For instance, according to officials from the city of Chula Vista, much of the public input has apparently been advocating higher, not lower, densities.

The developer, as well, has embraced the high-density concept. Baldwin Corporation concerns are less with density per se as they are with being able to produce an adequate array of residential product types. Specifically, Baldwin Corporation seems particularly concerned about the medium-density housing niche (10 to 20 dwelling units per acre). The issue came up when the Chula Vista Board of Supervisors and City Council asked that a greater portion of the population of each village



Source: Robert Bein, William Frost and Associates.

Map 4.3

Otay Ranch: Typical Village Land-Use Plan

be within walking distance of the light rail line, thereby forcing the product mix toward the extremes (more high- and low-density, and less medium-density). Baldwin Corporation concerns were not the density or even the marketability of the density. Rather, their concerns were product and neighborhood diversity. Given that Baldwin is a for-profit developer, and consequently more sensitive to the demands of the market than the other participants in the planning process, their position may indicate a shift in market preference — at least in the San Diego market area — toward diversity and choice in housing product, and away from conventional density considerations.

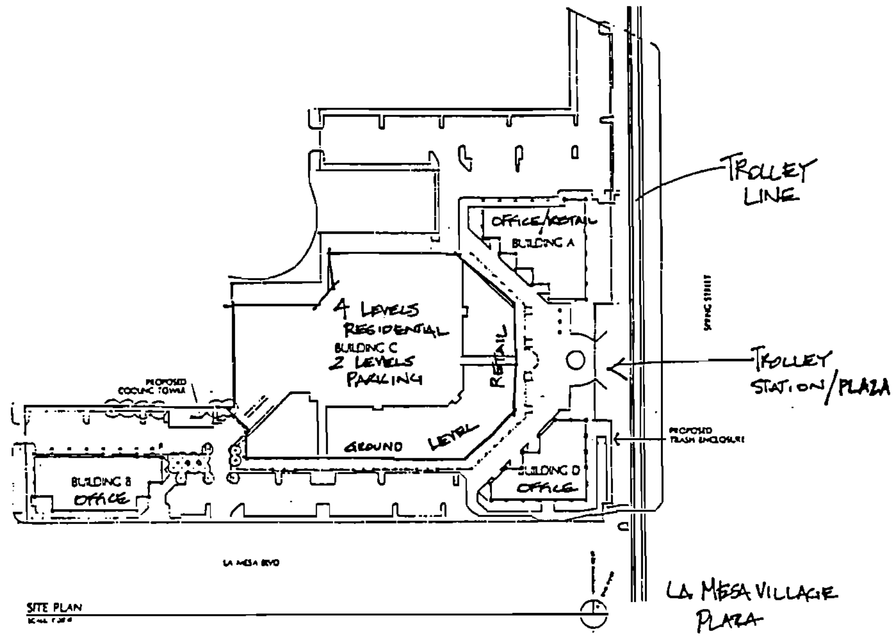
Other conflicts in the development process are also indicative of shifts in the traditional battle lines. Currently, the developer and MTDB are negotiating the issue of who will cover the costs of extending light rail to the site.[11] While covering the costs of infrastructure extension to a site has been a perennial battle issue in planning since the field's inception, it is only recently that light rail (or, indeed, transit in general) has re-emerged as a valid infrastructure component over which to fight.

4.3. San Diego Trolley Transit Oriented Development: La Mesa Village

La Mesa Village Plaza is a mixed-use, office/retail/residential complex in La Mesa, at the San Diego Trolley's Spring Street station. It is strongly oriented toward the transit station; disembarking transit passengers exit onto a small plaza with ground-floor retail on three sides (see Photo 4.3 and Figure 4.9). The retail is supported by 90 residential units and over 20,000 square feet of office space.

Photo 4.3

La Mesa Village Plaza and Spring Street Station



SITE PLAN

Source: Domeny Cecil Associates.

Figure 4.9

Site Plan for La Mesa Village Plaza

Technically speaking, La Mesa Village Plaza is not a "TOD," since its planning and program pre-date the planning of the extension of the San Diego Trolley by several years. But the site design and orientation was subsequently altered to incorporate the transit stop into the project. A comparison of modal share data for this site relative to the surrounding area suggests that even these late efforts to integrate the transit station into the design paid off.

In 1992, 7.7 percent of all trips by La Mesa Village Plaza's residents were by public transit; for work trips, the modal share was 9.3 percent. This is significantly higher than the 1990 2.5 percent work trip modal share for residents of suburban San Diego as a whole, the 2.6 percent work trip modal share for the city of La Mesa, or the 2.3 percent work trip modal share for the census tract in which La Mesa Village Plaza is located.[12] Automobile trip modal shares by La Mesa Village Plaza's residents, on the other hand, are comparatively low. Drive-alone mode share for La Mesa Village Plaza constituted 81.4 percent of all work trips, while for the San Diego suburban area they constituted 85.4 percent, for La Mesa City, 89.7 percent, and for the census tract, 90.6 percent. In short, La Mesa Village Plaza produces roughly 10 percent fewer automobile trips to work than the surrounding area.

While these numbers are encouraging, transit-supportive development even in San Diego has a number of strong obstacles to overcome. Foremost among these are residents' and developers' perceptions and biases about transit service, safety, and desirability of transit customers. In a recent travel behavior survey conducted throughout the San Diego area, a high number of respondents in the service area of the San Diego Trolley indicated threats to safety, as well as the presence on the trolleys and around the stations of a high number of "undesirables," as primary among their reasons for not using transit. Indeed, a manager of La Mesa Village Plaza indicated in an interview that the mere presence of transit on-site raised operating costs of the project well above those for similar-sized sites that were not located near transit. Much of these costs are associated with increased security needs (e.g., surveillance cameras), as well as higher expenses for repairs and maintenance. The manager felt that these costs were not offset by the increase in value or increased revenue that should accompany proximity to transit.

4.4. Conclusion

The San Diego region has one of the most successful transit-oriented suburban mixed-use project in the U.S., namely La Mesa Village Plaza. Because of local government's pro-active stance, the future for transit-supportive development is bright. A package of progressive site design guidelines and transit-oriented development policies now exists that, because of the rather surprising degree of regional consensus, will likely find success in shaping future real estate development decisions in the region. To the degree the Otay Ranch is a bellwether of San Diego's coming built form, the prospect for public transportation and other alternatives to automobility is encouraging indeed.

5. San Francisco Bay Area Case Study

The San Francisco Bay Area experienced rapid population (16.5 percent) and employment (27.2 percent) growth during the 1980s. A large part of this growth was in the form of suburban auto-oriented development, such as large-scale office parks, walled residential subdivisions, commercial strips, and mega-malls. During the 1980s, around 70 percent of both population and employment growth occurred outside of San Francisco, Oakland, and San Jose. Suburban work trips increased 25 percent over this period. The overwhelming majority of new suburban trips were by automobile — from 1980 to 1990, the suburban transit modal split fell 1 percentage point, while the share driving alone went up 5 percentage points. One result has been increased regional traffic congestion, which according to Hanks and Lomax (1991) increased 32 percent from 1982 to 1988, measured in daily vehicle-miles of travel per freeway lane-mile. In 1988, the level of traffic congestion in the Bay Area was ranked second only to Los Angeles.

In response to these trends, several public entities have, over the years, embraced transit-supportive design concepts. In 1983, Alameda-Contra Costa County Transit (AC Transit) published one of the first design guidelines in the U.S., titled "Guide for Including Public Transit in Land Use Planning." The following year, Central Contra Costa Transit issued a brief report titled "Coordination of Property Development and Transit Improvements." Also in 1984, the city of Pleasanton passed one of the nation's first trip reduction ordinances, mandating that large employers reduce their peak hour trips by 45 percent over a four-year period. Other rapidly growing cities in the region soon followed suit, including San Ramon and Alameda. Recently, Alameda County has set stringent employer Transportation Demand Management (TDM) standards through its Congestion Management Agency. The Bay Area Air Quality Management District has also instituted an employer-based trip reduction requirement. Lastly, both AC Transit and the Santa Clara County Transportation Authority are currently in the process of writing new design guidelines.

Collectively, these initiatives have altered the way developers and firms do business in the Bay Area. Developers now must consider alternative modes, including transit, when planning and designing a real estate project. Businesses must do the same when contemplating a new lease. The net result has been the addition of many transit and pedestrian-friendly elements, such as bus shelters, bus turnouts, sidewalks, jogging paths, and bike lanes, to many large-scale projects. Office parks with commercial-retail uses on the site have also become common.

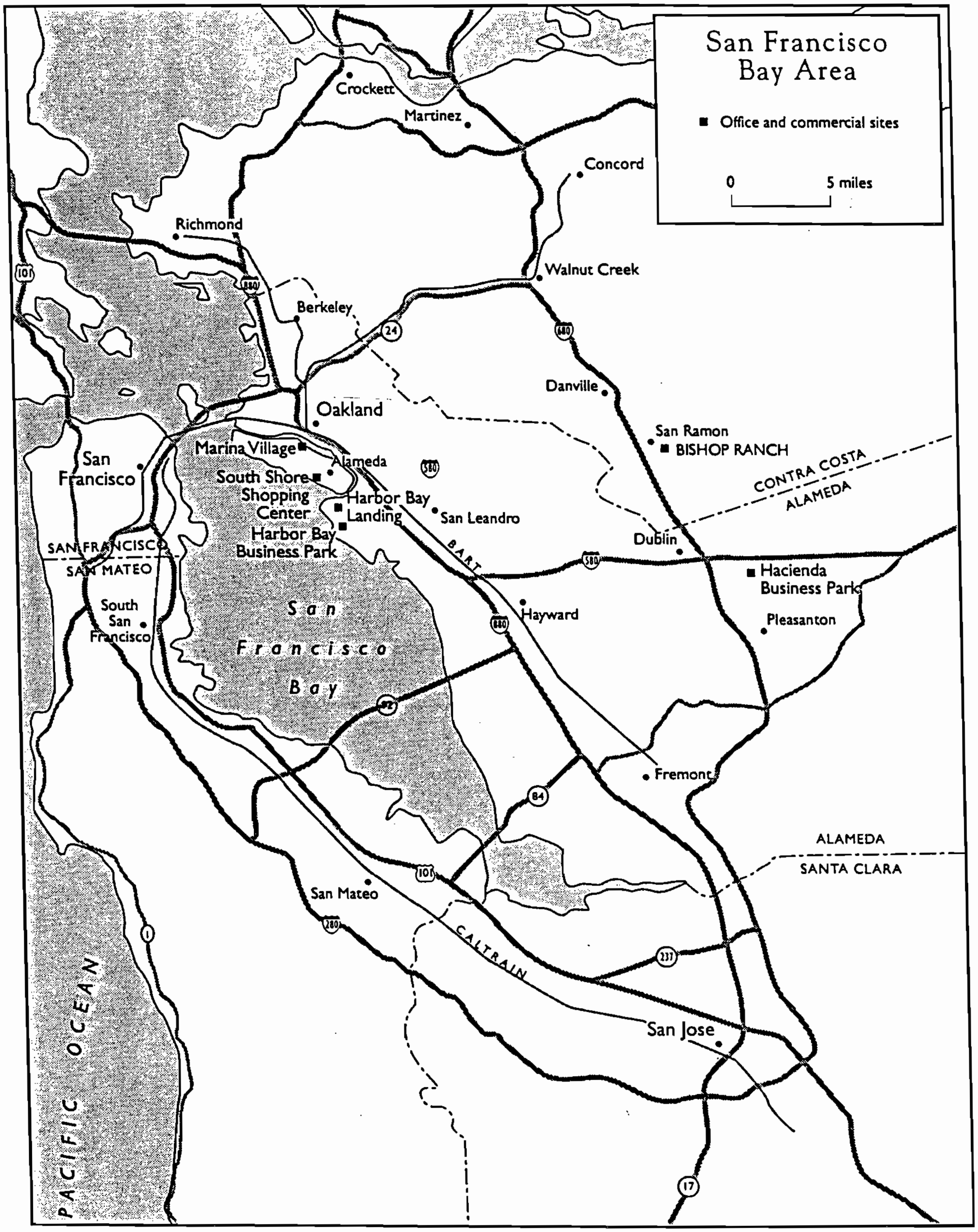
Despite these efforts, no single development in the Bay Area stands out as transit-supportive on all fronts. While developments like Bishop Ranch and Hacienda Business Park in the East Bay have extensive sidewalk networks, bus shelters, bike racks, and showers on-site, both projects are enveloped by an abundance of free parking, average extremely low employment densities, and are interconnected by wide boulevards. In most Bay Area suburbs, it is rare to find a direct, paved walkway from a bus stop or nearby residential development to an office building entrance. However, transit- and pedestrian-supportive principles are slowly making their way into the Bay Area's development practice. To explore what changes have occurred and what benefits have accrued, several office and retail projects in the cities of Alameda, Pleasanton, and San Ramon are next examined.

5.1. Alameda: A Suburb in the City

The city of Alameda is located just across the inner harbor from downtown Oakland (Map 4.4). It is a relatively mature suburb and is nearly built out. The city's population grew 20 percent during the 1980s. Alameda passed a trip reduction ordinance in 1990 that stipulates major employment centers must reduce their peak hour trips by 30 percent over a five-year period. Surveys used to measure compliance with the ordinance provide a useful data source for analyzing the mode choice decisions of Alameda's workforce.

Large-Scale Office Projects in Alameda

The building boom of the 1980s spawned two large-scale office parks in Alameda— Marina Village and Harbor Bay Business Park. Marina Village is a 205-acre mixed retail/office/residential development located near Alameda's inner harbor. It features a 37-store shopping center, 178 housing units, and business tenants in the fields of software development, biotech, and finance. Harbor Bay Business Park is part of a 916-acre multi-use development located on Bay Farm Island. The 314



Map 4.4

San Francisco Bay Area Case Study

acre campus-style business park contains approximately 1.2 million square feet of largely spec office space. Tenant types include research, light manufacturing, sales, and general office. The remaining 560 acres on Bay Farm Island contain a neighborhood shopping center and 2,800 housing units. Table 4.1 presents some of the main land-use and market characteristics of Alameda's two major office parks. Despite a slumping local real estate market, the table shows Marina Village has maintained a high occupancy level.

Table 4.1

Physical Characteristics of Marina Village and Harbor Bay Business Park, 1991/92

	Marina Village	Harbor Bay
Existing Floor Space (million sq. ft.)	1.2	1.2
Employees per 1,000 GSF	2.5	1.2
Current Gross FAR	0.2	0.1 (0.4 at buildout)
Parking Spaces per Employee	1.3	2.6
Parking Rates (per month)	FREE	FREE
Mixture of Uses On or Near Site	YES	NO
Conditional Buildings	YES	YES
TDM Program	YES	YES
Occupancy Rate (%)	97	70
Floor Space at Buildout (million sq. ft.)	**	5.5
Percent Employee Commute Trips by Transit*	8.0	5.7
Percent Employee Commute Trips by Non-SOV modes*	21.6	12.9

* Source: Metro Dynamics, Inc. (1992), and K.T. Analytics, Inc. (1992)
** Undetermined at present

While both projects are designed principally for auto access (e.g. abundant parking, low densities, and spacious building setbacks), the developers have still sought to 'level the playing field' by designing in various pedestrian and transit amenities. For example, both projects encourage walking on the site with continuous sidewalks that link all buildings and transit stops (Photo 4.4). Considerable attention is also given to landscaping, with generous amounts of street trees, shrubs, public plazas, and open spaces. Bus shelters and bus turnouts dot both developments. Harbor Bay's developers have even built a bus-only connection into the park from a nearby residential neighborhood. They also operate a ferry service from Bay Farm Island to downtown San Francisco.

Of the two, Marina Village rates slightly higher in terms of "transit-friendliness" because of: its close proximity of residential, shopping, office, and restaurant uses on or near the site; extensively landscaped pedestrian provisions; and slightly higher commercial and residential densities (Table 4.1). Marina Village has a locational advantage as well — it is only 8 minutes by bus from downtown Oakland's main BART station, while a bus ride from Harbor Bay to the nearest regional transit hub is 20 minutes.[13]

Photo 4.4

**Bus Shelter at Harbor Bay Business Park:
Direct Pathways from Bus Shelter to Buildings**

In the early 1990s, the share of Marina Village workers commuting by transit was high compared to Harbor Bay's share as well as the city and county resident-worker average.[14] Harbor Bay's work trip modal split was comparable to Alameda City's and two percentage points above the county's (Figure 4.10).[15] On the other hand, ridesharing and walk/bike modal shares were below both city and county averages. Because both parks have active TDM programs in place, it is difficult to attribute their high transit performance to physical design characteristics. Still, their transit-supportive forms no doubt complement TDM.[16]

The residential portion of Marina Village is also very supportive of transit. At around 10 dwelling units per acre, densities are high enough to support 30-minute bus service. All units are within four short blocks of a bus stop, and retail shops are within easy walking distance as well. Excellent lighting and 24-hour security promote evening walking and off-peak transit use. While only about 2 percent of Marina Village employees live on-site, many residents do work elsewhere in the city of Alameda.

In summary, the city of Alameda's two largest office centers have successfully integrated transit- and pedestrian-supportive design principles. Furthermore, even though both are spread out campus-style developments, transit modal shares are equal to or higher than that of the city of Alameda and well above Alameda County's.

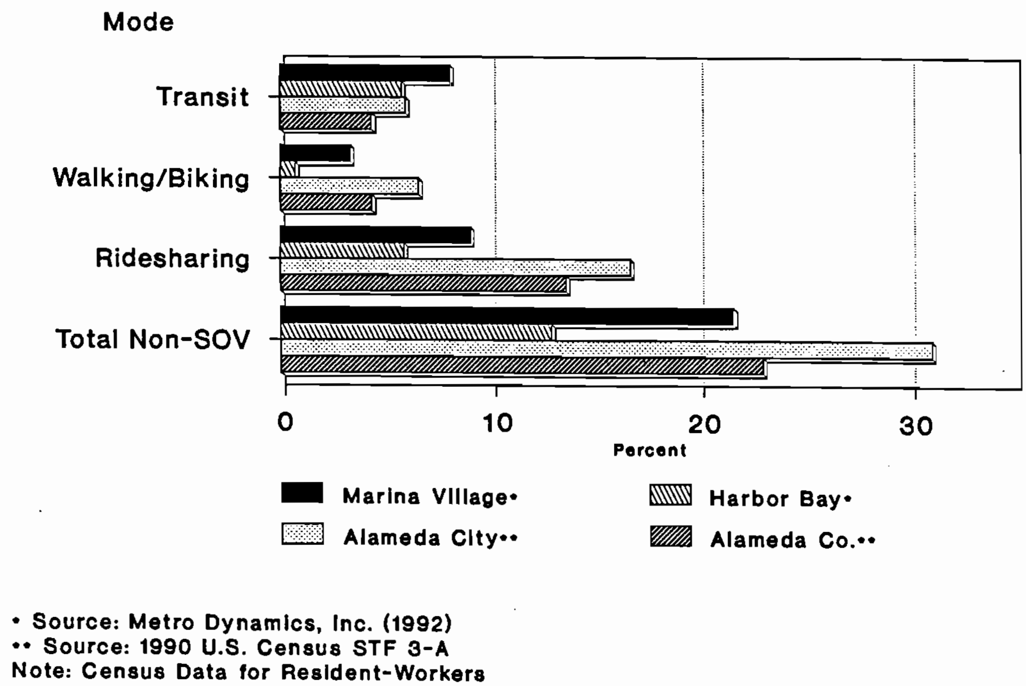


Figure 4.10

Alameda Office Developments: Percent Work Trips by Non-SOV Modes

Large-Scale Retail Developments in Alameda

Two Alameda retail projects, South Shore Shopping Center and Harbor Bay Landing, also stand out for their sensitivity to bus transit needs. The South Shore Center is an older, outdoor shopping mall located on Alameda's bay side. A few small transit improvements were made in 1986 when the center was expanded by 100,000 gross square feet. It has 90 shops, including department and clothing shops, grocery stores, restaurants, and small-scale retail. Harbor Bay Landing, a newer, neighborhood-scale shopping center on Bay Farm Island, is part of the 916-acre Harbor Bay development. It contains a grocery store, a drug store, service retail, and realty/medical offices.

The site layout of the South Shore Shopping Center allows buses to deliver and pick up passengers at the main mall entrances. Buses need not circle the mall or retrace their paths, thus improving operating efficiency (Figure 4.11). Numerous bus routes penetrate the site and stop adjacent to the mall, giving bus patrons shorter walks than auto drivers. Stops are well situated at mall entrances. Bus shelters and building overhangs provide safety and protection from the elements (Photo 4.5). Bike riders have the benefit of storage racks and nearby bike paths. Furthermore, moderate density residential neighborhoods surround the mall. These features appear to be paying off—among all mall shoppers, 13 percent ride transit and 2 percent walk or bike.[17] These modal shares compare well even against two East Bay rail-based shopping centers, El Cerrito Plaza and Bay Fair Mall (Figure 4.12). While these two developments lie near BART stations and have high rail and bus

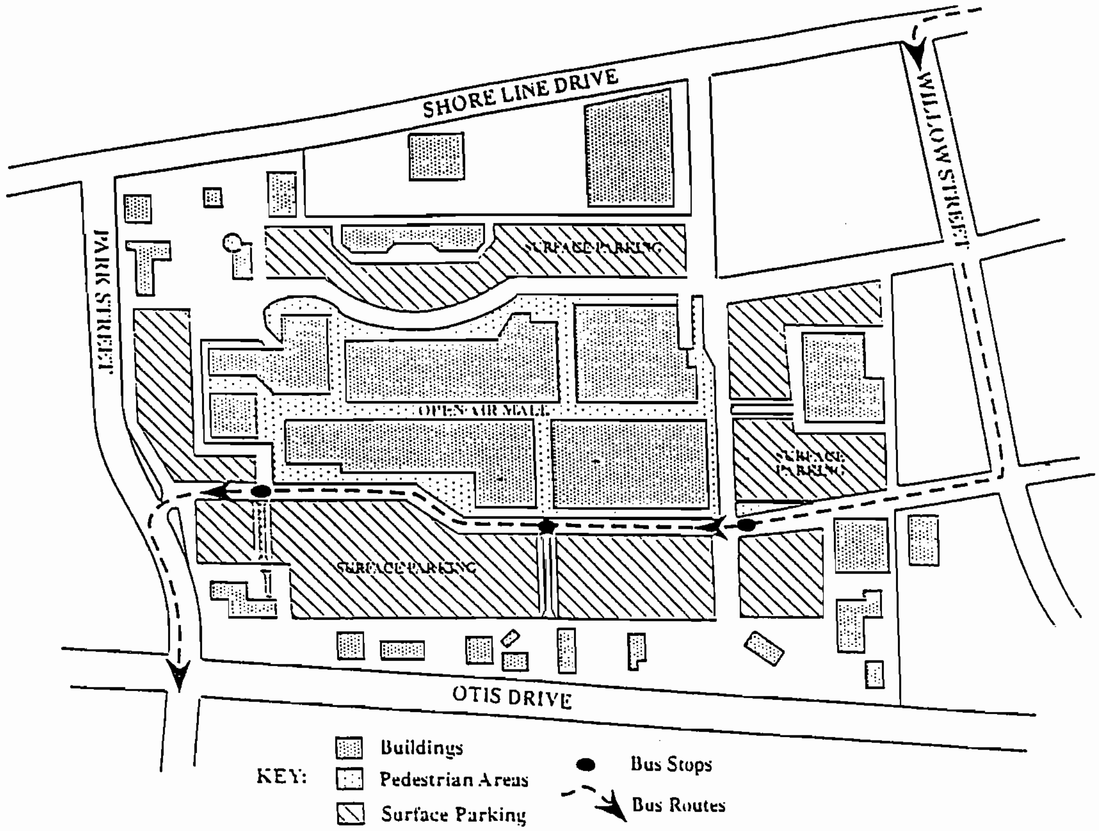


Figure 4.11

South Shore Shopping Center Site Plan and Transit Routes

Photo 4.5

"Transit-Friendly" South Shore Shopping Center: Bus Shelters, Building Overhangs, Convenient Stop Locations, and a Transit-Servicable Layout

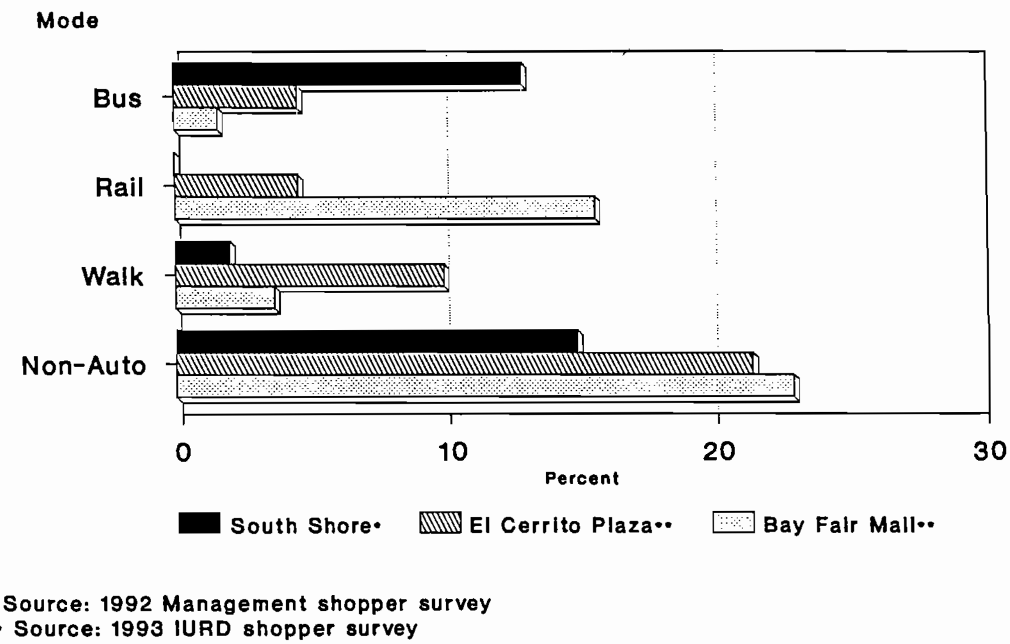


Figure 4.12

Shop Trip Transit Modal Shares for South Shore Center, El Cerrito Plaza, and Bay Fair Mall

service levels,[18] South Shore Center still has a higher share of shoppers arriving by bus than either of them and a higher transit (bus and rail) share than El Cerrito Plaza.

That transit patrons are well served at this shopping center is also supported by the 15 percent transit modal share for work trips by mall employees (Figure 4.13).[19] Also, 10 percent of employee work trips are by foot or bike. In all, 42 percent of South Shore Center's work force take some non-SOV mode to work, around twice as high as the Alameda County average.

The Harbor Bay Landing shopping center has also incorporated certain transit and pedestrian supportive design elements, including bus shelters, walkways, generous landscaping, limited curb cuts, bike racks, and transit benches. While well intentioned, these amenities have been unable to compensate for the site's somewhat remote location and limited bus services— virtually no employees commute to work by bus. Harbor Bay Landing's physical design and setting is far more conducive to walking, enhanced by a local park adjacent to the site and the close proximity of nearby residences. In 1992, 16 percent of Harbor Bay Landing's employees walked or biked to work. Another 12 percent carpooled. Overall, the non-SOV share for commute trips to Harbor Bay Landing was 32 percent.

Both of these projects have very high mode shares when compared to a large tri-anchor suburban mall recently surveyed in the San Ramon/Pleasanton valley area of Alameda County— at this comparison mall, only 5 percent of the workers used transit, 5 percent carpooled, and 1 percent

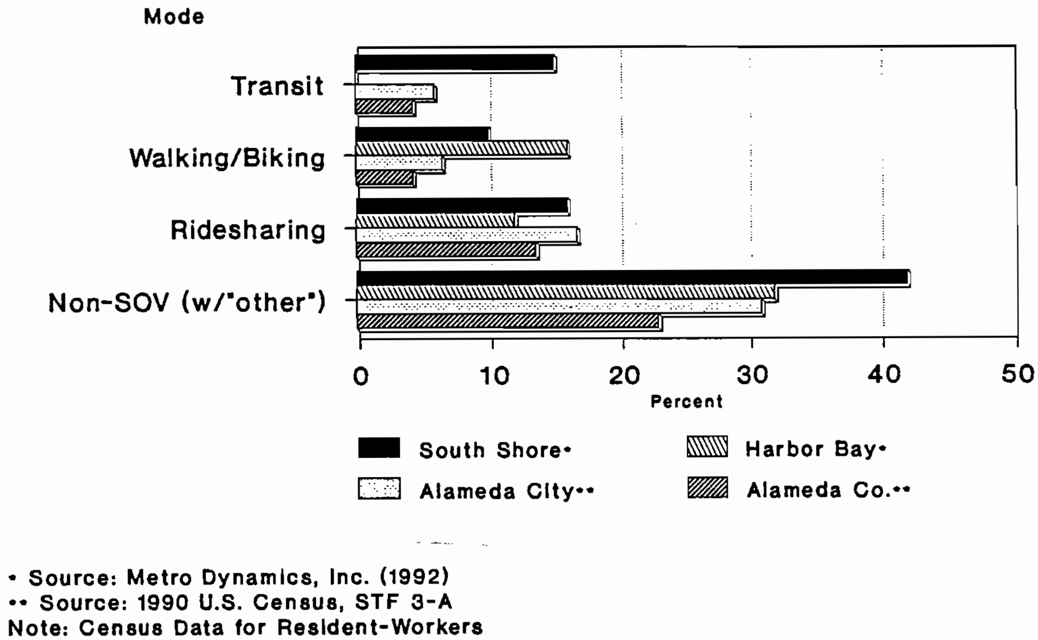


Figure 4.13

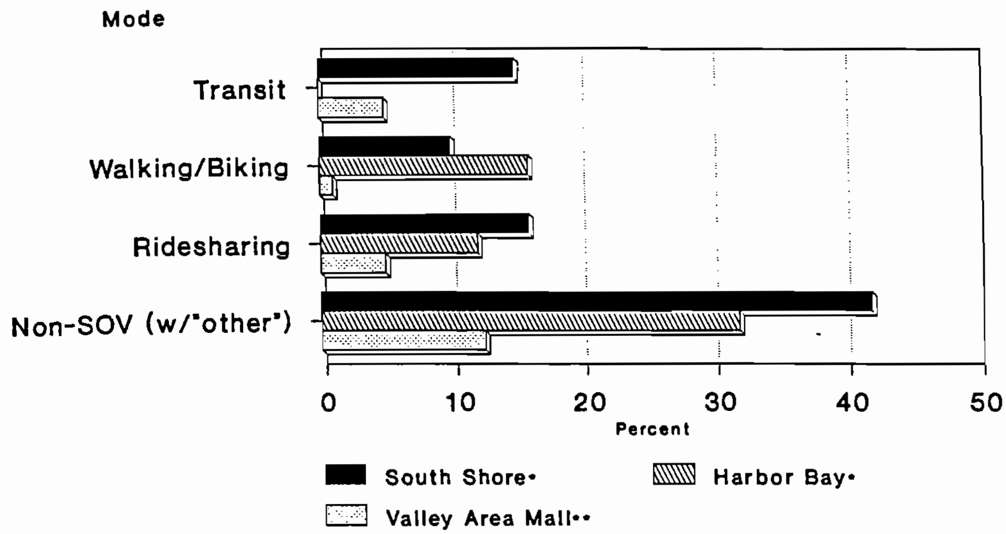
**Alameda Shopping Developments:
Percent of Employees Commuting by Non-SOV Modes**

walked or biked (Figure 4.14).[20] This comparison mall has a standard design, with parking surrounding the mega-structure, a series of access roads, and a mall loop road, all of which make efficient transit operations difficult. Express buses serving the mall stop on the loop road, thus requiring long walks to the mall itself. Local buses in the area enter the mall road system and circle around the mall building stopping at various mall entrances, but to do this they must traverse nearly a mile of mall perimeter and interior roads.

5.2. Pleasanton and San Ramon: The New Suburbs

Pleasanton and San Ramon are situated beyond the hills that rim the east side of the San Francisco Bay in an area known as the Tri-Valley. Both cities experienced phenomenal growth during the 1980s and in many ways were the archetypes of the decade's office building boom that transformed once-tranquil suburbs. Between 1980 and 1990, Pleasanton's population grew 44 percent, and between 1985 and 1991 its employment more than doubled from 13,500 to 27,200. San Ramon saw equally strong growth during the 1980s — its population increased 58 percent and its employment grew from virtually nothing to over 12,000.[21]

Rapid growth in both communities sparked several managed growth initiatives. In 1984, the Pleasanton city council passed one of the nation's first and most comprehensive trip reduction ordinances, requiring firms with 50 or more employees and all multi-tenant complexes to shift 45 per-



• Source: Metro Dynamics, Inc. (1992)
•• Source: City of Pleasanton (1992)

Figure 4.14

Alameda Shopping Developments Compared to a Large Suburban Valley-Area Mall

cent of their workforce to off-peak travel or to alternate commute modes over a four-year period. Furthermore, employers with over 100 workers and all complexes were required to staff on-site transportation coordinators. In 1987, Pleasanton limited the number of new residential units that could be built to only 650 per year.[22] Proposed residential development at Bishop Ranch actually led to the incorporation of the city of San Ramon so that local residents could control the project. Because of stiff opposition, the residential component of the plan was dropped and replaced by office and retail uses. In 1990, San Ramon followed Pleasanton by passing its own trip reduction ordinance.

Hacienda and Bishop Ranch Office Parks

During the 1980s, many new office complexes were added to the Tri-Valley area, including two of the largest in Northern California— the Hacienda Business Park in Pleasanton and the Bishop Ranch Business Park in San Ramon. The Hacienda Business Park is a large mixed-use development with about 4.8 million square feet of office and industrial space, two retail shopping plazas, and around 150 housing units on a 861-acre site. Included in this breakdown are medical, government, hotel, retail, office, and light industrial uses thinly spread throughout the park, connected by wide arteries. Some of the project's land use and commuting characteristics are summarized in Table 4.2.[23]

Hacienda was actually one of the first mega-scale suburban office parks to put commercial and support services on the site, including a child development center, a centrally located retail plaza, and a hotel. The developers had hoped to phase in higher office densities, in-fill retail, and a

Table 4.2

Physical Characteristics of Hacienda Business Park, Bishop Ranch Business Park, and Office Park X, 1992/93

	Hacienda	Bishop Ranch	Office Park X
Existing Floor Space (Million sq. ft.)	4.8	6.0	0.6
Employees per 1,000 GSF	2.3	2.5	2.6
Current Average FAR	0.35 to 0.60	0.30 to 0.45	0.25 to 0.40
Parking Spaces per Employee	1.8	1.4	1.5
Parking Rates (per month)	FREE	FREE	FREE
Mixture of Uses On or Near Site	YES	NO	YES
Conditional Buildings	YES	YES	YES
TDM Program	YES	YES	YES
Occupancy Rate (%)	83	95	95
Floor Space at Buildout (Million sq. ft.)	10-11	8.5	**
Employees at Buildout	25,000	28,000	**
Percent Employee Commute Trips by Transit*	3	3	0
Percent Employee Commute Trips by Non-SOV modes*	25	25	9

* Sources: City of Pleasanton (1992) and City of San Ramon (1993)

** Developer does not have detailed buildout plans at present.

mix of residential complexes throughout the site, but the poor local real estate market and local opposition thwarted these efforts. For example, the city of Pleasanton rejected a plan for high-density development around a new BART rail station to be located on the northern border of the site. Still, the office park's developers have been able to build thousands of residential units in neighborhoods surrounding the office park over the last decade. The opening of the new BART station adjacent to the site could dramatically affect the area's land use and transportation relationships. A shuttle serving the entire park is planned and rail mode shares conceivably as high as 10 percent have been projected for Hacienda's work force (based on current express bus pass distribution).[24]

Early on, Hacienda's developers were committed to transit-friendliness not only in the land-use mix but also in the project design. The site is laced with sidewalks, bus shelters, bus turnouts, bike racks, and bike lanes, many of which were built in advance of new buildings (Photo 4.6). Because of the market downturn, today one finds sidewalks, bus turnouts, and bus shelters fronting completely vacant parcels where spec office buildings were to be built. Some pathways provide direct access to nearby office buildings. All buildings on the site have preferential parking for HOVs and many have showers for cyclists.[25]

The 585-acre Bishop Ranch Office Park is also a mega-scale office project that houses several large corporate tenants (Table 4.2). The Bay Area's sluggish office real estate market has stalled Bishop Ranch's expansion plans, though a hotel was recently built and two large-scale discount retailers are slated to begin construction soon. A bus transit center is also planned for the site.

Photo 4.6

Hacienda Park Bus Shelter:
Transit Amenities like Bus Shelters were Built in Advance of Demand

Transit and pedestrian supportive features at Bishop Ranch include bus stops and shelters, paved walking and biking paths, showers and bike lockers, and a nicely landscaped setting. Also, most buildings provide generous staging areas for front-door bus access.[26] The linear layout of the site also makes north-south bus routing simple, with no need for excessive loop road detours. These provisions, like those of Hacienda, were a result of the developer's forward-looking attitude toward transit. They have also been used as a marketing tool in attracting new tenants.

Some critics argue these transit-friendly provisions are mere window-dressing that do little to overcome the overall massive scale and spread out landscapes of both projects. Both Bishop Ranch and Hacienda have such low densities that walking to other buildings or to shopping areas during lunch breaks is impractical for most employees. Streets are wide, parking is free and abundant, and building scales are monumental. Thus, the overall physical landscapes of both projects encourage most workers to drive their cars. Still, transit provisions are ample and highly visible at both office developments, especially compared to most other Bay Area employment centers.

TDM has also been aggressively promoted at both Hacienda and Bishop Ranch. Both projects feature free local and BART express bus services, transit ticket sales, ridesharing, and many commute alternatives marketing efforts. Most buildings at Hacienda have designated transportation coordinators, and Bishop Ranch staffs two full-time transportation coordinators.[27] Both Hacienda and Bishop Ranch operate BART express bus services, with headways of around 30 minutes in the peak and 60 minutes off-peak.[28]

For purposes of assessing the transportation benefits of Hacienda's and Bishop Ranch's site designs, comparisons can be drawn against a nearby "transit-unfriendly" office park in Pleasanton, which we will call Office Park X. In addition to office space, Office Park X features on-site retail shops, a fitness center, and a conference center. As with all Pleasanton developments, it also has a TDM program in place. However, Office Park X has relatively few transit provisions, such as bus shelters and benches. Bike facilities are also lacking. Moreover, the site is far from most existing transit routes (with the exception of one local route), and little effort has been made to materially improve bus services in the area. Lastly, the one route serving the development stops on a major arterial bordering the site, forcing some riders to walk well over a quarter mile to their workplace.

Commuting at Hacienda and Bishop Ranch

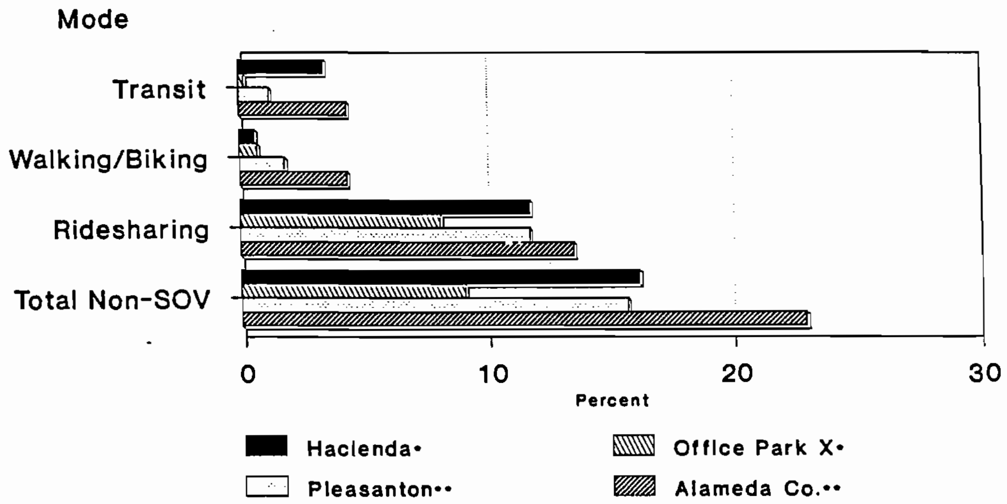
Figures 4.15 and 4.16 compare recent work trip modal splits for employees at both office projects to their respective citywide and county averages. Both the Hacienda Business Park and Bishop Ranch Business Park projects averaged higher rates of employee transit and non-SOV travel than the typical worker in their respective cities.[29] Bishop Ranch also surpassed the Contra Costa County average, while Hacienda fell short of the Alameda County average. Hacienda does, however, average significantly higher shares of workers who transit commute, carpool, and vanpool than Office Park X. Both Bishop Ranch's and Hacienda's high non-SOV mode shares likely stem more from TDM initiatives than from physical design factors. Still, according to coordinators, developers, and planners who were interviewed, physical design elements have played a supportive role in wooing some workers into buses, carpools, and vanpools.

Site-Level Comparisons

Two specific sites within Hacienda Business Park stand out in terms of their different approaches to promoting transit — Building Complex X and a comparison site called Building Complex Y. Comparisons of modal splits between these two nearby sites underscores the greater importance of TDM initiatives than on-site design features in shaping workers' commuting choices.

Building Complex X is transit-supportive because: it is near a retail center; it has good near-site transit provisions (shelters and transit furniture); a walkway directly connects a nearby transit stop and the building; and the building itself is not set back too far from surrounding roadways. Building Complex X also has an active TDM program and an on-site coordinator.

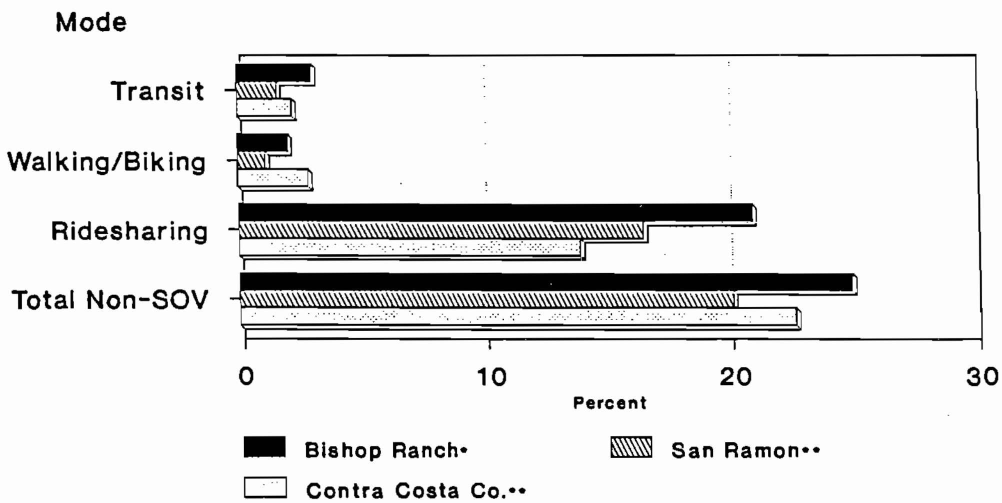
In contrast, Building Complex Y is not as well designed for transit service. Vast stretches of parking and wide roads surround Building Complex Y. Also, retail and service uses are over a half mile away, and there are no direct walkways from the perimeter roadway bus stops. The company occupying Building Complex Y has attempted to offset these shortcomings by routing BART express



• Source: City of Pleasanton (1992)
•• Source: 1990 U.S. Census, STF 3-A
Note: Census Data for Resident-Workers

Figure 4.15

Work Trips by Mode for Hacienda Business Park, Office Park X, Pleasanton, and Alameda County



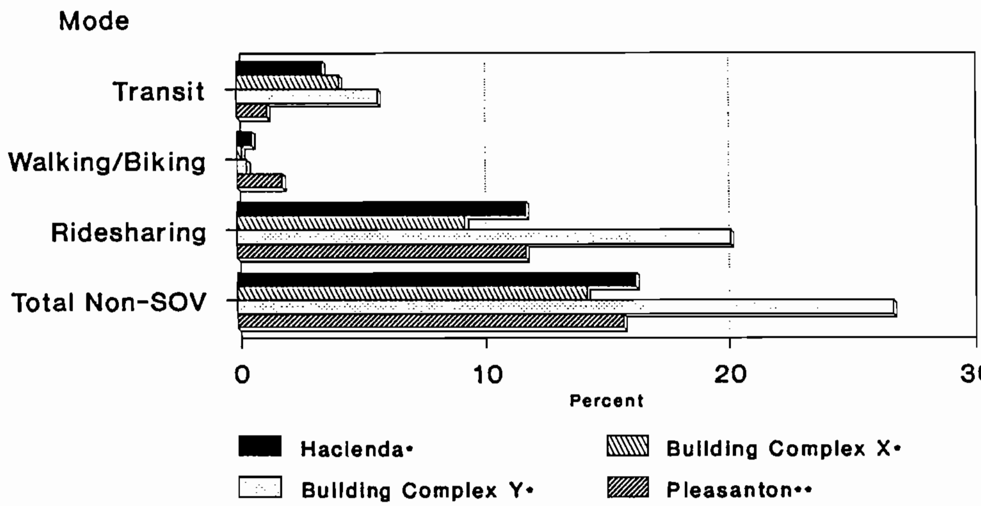
• Source: City of San Ramon (1993)
•• Source: 1990 U.S. Census, STF 3-A
Note: Census Data for Resident-Workers

Figure 4.16

Work Trips by Mode for Bishop Ranch Business Park, the City of San Ramon, and Contra Costa County

buses through the development. Buses stop at two building entrances on the Building Complex Y property. Furthermore, Building Complex Y contains a gym, a cafeteria, and a very large landscaped courtyard area for eating and relaxing outdoors. Building Complex Y's tenant sponsors an ambitious TDM program, staffed by a full-time on-site coordinator.

The 1992 transit, walk, and carpool/vanpool modal splits for these two projects are shown in Figure 4.17. For both projects, the mode shares for transit are much higher than for the city and Hacienda Office Park as a whole. Interestingly, Building Complex Y has a higher transit modal split than Building Complex X, despite having a less transit-supportive built environment. Apparently, Building Complex Y's "to the door" express service and TDM initiatives have had a greater influence on commuting choices than Building Complex X's superior transit-oriented design?[30]



• Source: City of Pleasanton (1992)
•• Source: 1990 U.S. Census, STF 3-A
Note: Census Data for Resident-Workers

Figure 4.17

Comparison of Work Trip Modal Shares for Specific Sites at Hacienda Business Park

5.3. Conclusion

The Bay Area experienced rapid growth during the 1980s that led to more and more traffic congestion. In the midst of this, some progressive cities and developers tried to come to grips with the need to reduce the dependence on the single-occupant vehicle. These efforts have taken the form of transit-supportive office and retail centers as well as a host of TDM initiatives. The most common transit-supportive provisions are sidewalks, bus shelters, bike lanes, and other access- and facility-related improvements. Some consideration has also been given to infill development and mixing land uses. As time goes on, it is likely that site design and land use issues will gain more and more attention in the Bay Area. The handful of office and retail projects that have taken the lead in this area provide some evidence that when combined with meaningful TDM programs, good site design can play an important supporting role in increasing alternative modes of travel.

6. Seattle Area Case Study

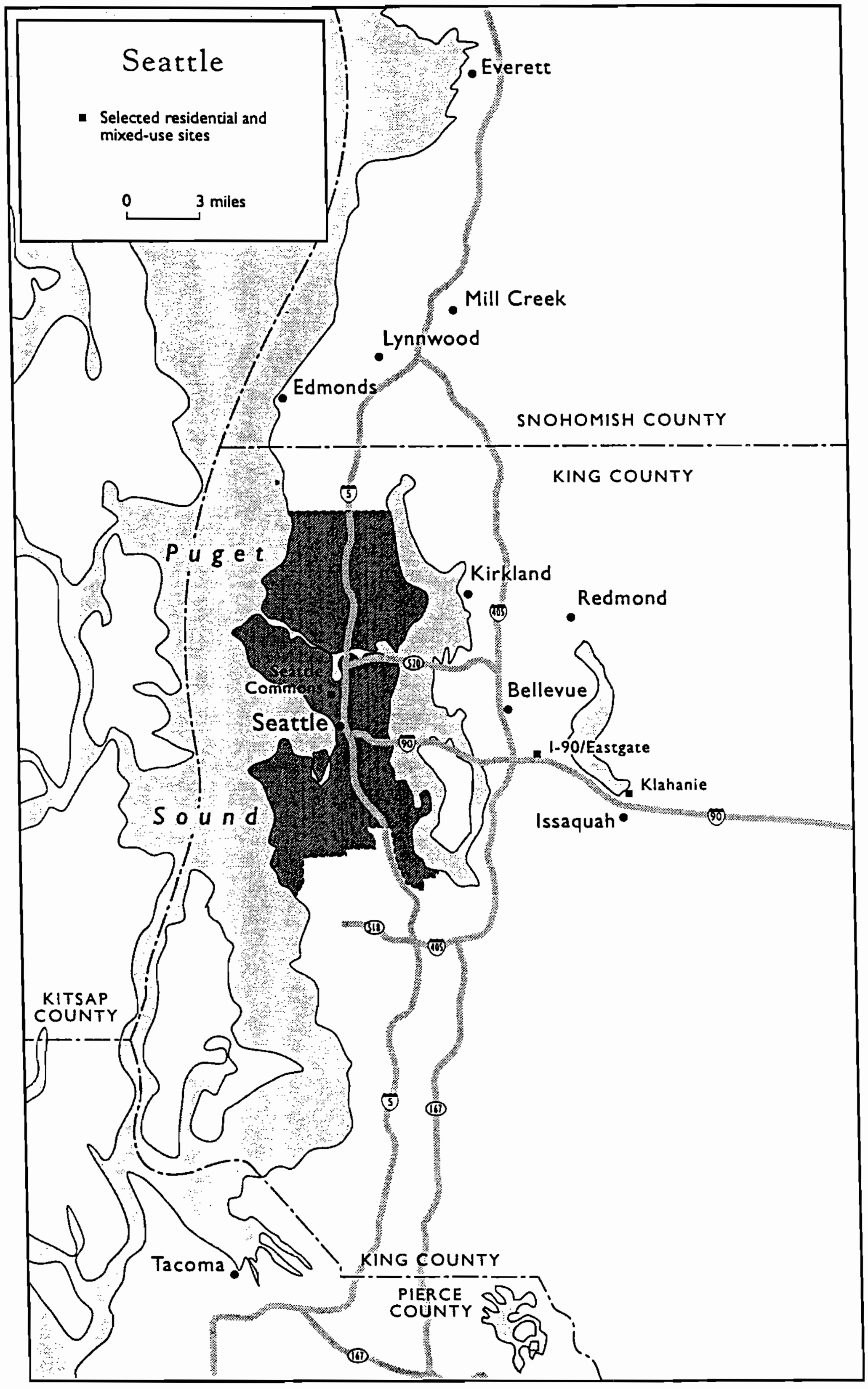
In the greater Seattle region, two areas which have experienced rapid suburban development and have pioneered efforts to create transit- and pedestrian-friendly living and working environments are Snohomish County and the city of Bellevue, to the north and east of Seattle, respectively (Map 4.5). The case summary in this section examines experiences and impacts related to the planning and implementation of transit-supportive projects in both of these areas. Other exemplary Seattle-area projects that are in the planning and development stages are also discussed.

6.1. Snohomish County: Pioneering Transit-Friendly Site Designs

Snohomish County, just to the north of Seattle, is a typical low-density, auto-dominated suburban setting. It is atypical, however, in that a small group of local transit planners have managed to elevate transit-sensitive design concepts toward the top of the local and, to some degree, state political agenda on transportation. As a result, several recent mixed-use projects are transit-oriented in their designs and a number of local jurisdiction now embrace transit-sensitive principles and carefully scrutinize proposed new developments for their transit-friendliness.

In response to rapid growth (the County's population grew from 337,700 to 465,600 between 1980 and 1990), mounting traffic congestion, and declining transit ridership, SNO-TRAN, the agency responsible for long-range transportation planning for the County, completed a plan in 1989 that called for fairly bold measures: increasing population and employment densities, balancing and mixing land uses, and providing sidewalks and bike lanes to connect activity centers. For a traditionally auto-oriented suburban county, this was a radical departure from business as usual. The plan was followed by the publication, *A Guide to Land Use and Public Transportation* (1991), that, with its liberal use of graphics and illustrations, quickly gained recognition as one of the best "how-to" guides for designing transit-friendly projects. The guide was so well received that the Federal Transit Administration reproduced and distributed it nationwide as a National Technical Information Services (NTIS) document.

To further promote transit-supportive designs, SNO-TRAN staff, in cooperation with Seattle Metro, prepared a 12-minute slide show and video, "Transportation Choice by Design," that is available to local planning departments and development industry events. SNO-TRAN's board president joined the local and national speakers' circuit to promote these principles and to show SNO-TRAN's video. A milestone for SNO-TRAN was when around 30 planning commissioners throughout the



Map 4.5

Seattle Area Case Study

County met at a Sunday breakfast in late 1992 to view the video and discuss the merits of more closely coordinated transportation and land use development.

Recent Transit-Friendly Projects

Because of the Seattle region's soft commercial and office real estate markets, these well-intentioned initiatives have had relatively little impact on the local real estate industry to date. One notable exception is the recently completed Colby Crest project, a five-story mixed-use development just outside of downtown Everett (the County's largest city) (Photo 4.7). With 67 affordable apartment units and a ground-floor retail complex, Colby Crest was chosen by SNO-TRAN as the county's

Photo 4.7

Everett's Colby Crest: Dense Housing Above Ground-Floor Retail

most transit-friendly new development in 1992.[31] Besides mixed uses, other transit-friendly features of Colby Crest include siting of the building near the street and placement of building entrances adjacent to an existing bus line; a density (around 45 dwelling units per acre) sufficient to support bus services operating on 20-minute headways; placement of parking beneath the building; and the limiting of auto access to a rear alley. At the award presentation, SNO-TRAN officials noted that "Colby Crest shows how simple, traditional design can balance the needs of transit riders, pedestrians, and cyclists with those of automobile drivers."

Several other recent developments in Snohomish County have adopted transit-friendly designs:

- Mill Creek Shopping Center (Mill Creek): developers retrofitted a conventional suburban shopping plaza with interior and perimeter sidewalks, and improved landscaping.
- Harbor View Plaza (Edmonds): a mixed-use development with office, apartments, and ground-floor retail. This project was ranked second by SNO-TRAN in its 1992 design competition.
- Canyon Park Shopping Center (near Lynnwood): developers constructed an interior park and ped-way system in the middle of and around the existing parking lot (Photo 4.8).

Photo 4.8

Canyon Park Shopping Center: Interior Pedestrian Pathway

While no travel data are available for any of these projects, SNO-TRAN and other local officials estimate that transit modal splits are probably very small, likely in the neighborhood of 0.5-3.0 percent. Colby Crest, however, is thought to have around 20 to 25 percent of tenants who walk or ride buses to nearby jobs in downtown.[32] In the case of the two retrofitted shopping centers, only transit-dependent populations patronize transit regularly for shop trips. In most instances, the county's transit services are not intensive enough to attract large numbers of transit users, despite some good site designs. Without good-quality transit services, good-quality site designs cannot be expected to attract many transit users.

Biggest Impact: Public Sector Initiatives

By far, SNO-TRAN's pro-active stance on transit-supportive development has had its greatest impact on public policy, at the local, regional, and state levels. SNO-TRAN's Guide is cited, quoted, and in some cases adopted by reference in many local ordinances, land use codes, and plans. Everett's recent "Traffic Mitigation Ordinance" and Lynwood's vision statement for the future ("Lynwood Legacy") refer directly to the Guide. Within Puget Sound, a new transit-oriented regional plan adopts many of the principles advanced in SNO-TRAN's Guide. And at the state level, the new Growth Management Act and Washington DOT *Design Manual* reference the Guide directly.[33] The State's Transportation Improvement Board, which is responsible for developing the State TIP, apply transit and pedestrian-friendly criteria in scoring proposed highway and transit projects. According to local observers, the state's new Commute Trip Reduction Law was also influenced by transit-friendly design principles.[34]

Barriers and Opportunities

SNO-TRANs officials believe the first phase of promoting transit-friendly development has been accomplished: shaping local, regional, and state policy. The second phase will occur when the revised ordinances and rules are applied in the evaluation of new real estate projects, which should bring about more transit-supportive designs. This phase, however, will likely have to wait for economic recovery and a more buoyant local real estate market. Only one large-scale project, the one million square foot Canyon Park office complex, is currently being designed according to transit-supportive principles. The developer has chosen to limit parking below normal suburban standards and design in on-site transit provisions; however, this was done more out of necessity in order to get the project approved than out of a belief that these features will improve the project's marketability. Most of the County's developers and lenders express some skepticism about the benefits of transit-supportive designs.

If the commercial real estate market recovers sometime soon and more transit-friendly projects are designed, the third phase will need to kick in if significant ridership gains are to occur: a major expansion of countywide transit services. This could be as much of an uphill climb as winning over developer support. Presently, the boards of neither Community Transit or Everett Transit, the County's two transit operators, have endorsed SNO-TRAN's Guide, though staff refer to and use the Guide in reviewing local development projects. Because of budget constraints, some local observers doubt that transit services will be dramatically expanded anywhere within the County anytime soon.

In close, Snohomish County has been at the forefront of raising the Seattle region's awareness of the potential benefits of pedestrian and transit-friendly designs. This is a remarkable achievement for a moderate-size suburban County with limited planning resources and owes much to the commitments and strong beliefs of several local planners. Still, these efforts have yet to produce tangible dividends outside of influencing the revision of local ordinances and the passage of new regional plans and state laws. Should the regional real estate market turn around, Snohomish

County will be in as good a position as anywhere to ensure that whatever gets built is transit-supportive.

6.2. Bellevue: A Dense, Mixed-Use Suburban Center

The eastern shore of Lake Washington, known locally as Eastside, was one of the fastest growing areas in the Seattle region during the 1980s. From 1980-90, the city of Bellevue grew from 73,900 to 86,900 residents. Employment grew even faster over this period, from 39,200 to 51,500.

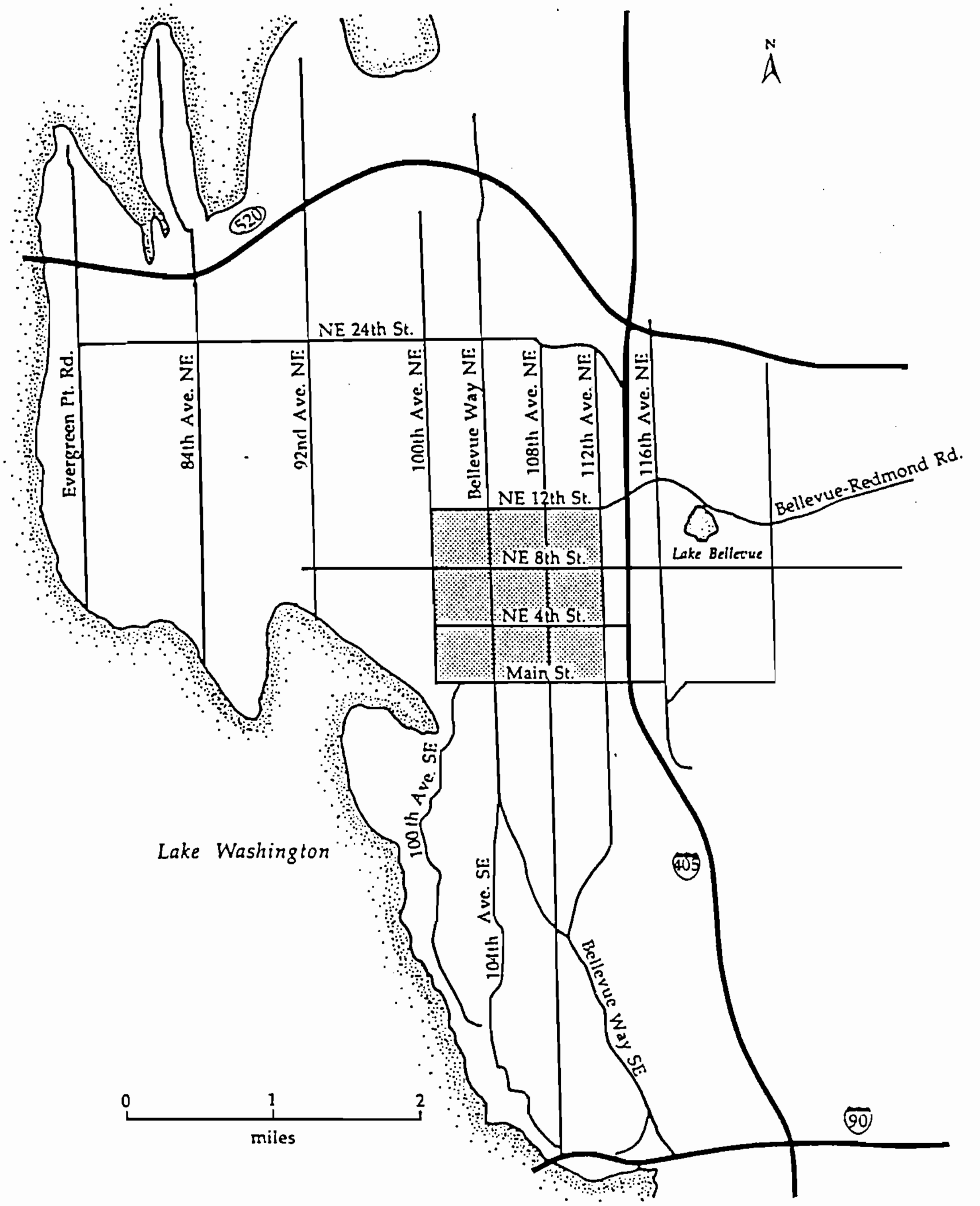
Downtown Bellevue encompasses a 330-acre zone west of Interstate 405, a major north-south facility serving the Seattle area (Map 4.6). This area presently contains around 16.1 million square feet of office and commercial floorspace and supports a workforce numbering over 20,000. Since 1980, Bellevue transformed from Eastside's primary retail center to a major regional employment hub. Prior to 1980, the area was characterized by small retail outlets interspersed by a few office buildings and institutional uses. Most businesses provided over five parking spaces for every 1,000 square feet of floor space. In general, central Bellevue was not distinguishable from other suburban communities of the 1960s and 1970s.

One of the major catalysts behind Bellevue's transformation was the upgrading of Bellevue Square from a suburban community shopping center to a regional super-mall. An overhaul of the downtown master plan in 1981 soon led to higher densities and parking reductions. By the mid-1980s, many of Bellevue's one- to two-story office and retail buildings were replaced by high-rise office towers set atop underground parking podiums. Most office additions have ranged from 10 to 25 stories in height, with floor area ratios in the city core between 6 and 8, comparable to the downtown densities of many medium-sized cities (Photo 4.9). Development has slowed down considerably since the late 1980s, however; Redmond (around four miles to the east) has generally become the "favored quarter" for what new construction has occurred in recent years, with most development taking the form of large-company headquarters on private estates, such as the Microsoft corporate complex (Leinberger, 1993).

Building a Transit-Oriented Downtown

The 1981 Downtown Plan was a watershed in Bellevue's transformation. The central idea was to convert downtown from a place for mainly automobiles to a place for people. Downtown was rezoned to allow a "wedding cake" pattern of densities, with FARs tapering away from the core. Setback requirements were also eliminated so that structures could be built closer together.

One of the obstacles faced in creating a pedestrian environment was the layout of much of downtown Bellevue on a superblock grid. The response was to create several pedestrian spines with first-floor retail and civic spaces. N.W. 6^{th} Street, which links Bellevue Square with high-rise office buildings to the east, became the principle pedestrian spine. An ordinance was passed that



Map 4.6

Central Bellevue

Photo 4.9

Downtown Bellevue: High-Rise Office Towers

required all buildings along these spines to have ground-level retail, including office structures. A system of "edge conditions" was also introduced governing the orientation of buildings to sidewalks and the massing of abutting structures. Through the design review process, local planners pressed for distinguishable features at the ground level of all new buildings, such as arcades, artwork, and architectural recesses. In combination, these measures created a unified series of pedestrianways that made walking through downtown Bellevue's large superblocks more attractive.

Besides these design features, a number of other initiatives were taken to make downtown Bellevue more transit-supportive:

- *Density bonuses.* Referred to as the "FAR Amenity Incentive System," this enabled developers to increase building densities between 10 and 25 percent in return for including such features as open plazas and public sculptures, childcare facilities, and affordable housing units in their projects. Bellevue Place, a massive 25-story mixed-use complex, took advantage of this provision to increase the square footage of the office and hotel components. Another policy tool used to promote higher densities was a novel agreement entered into between the city of Bellevue and Seattle Metro that pegged service levels to average densities. The agreement, entered into in the early 1980s, outlined a schedule of Metro transit service increases indexed to increases in employment densities and lowering of parking ratios over time. By 1984, Bellevue had earned nearly 4,000 annual hours of additional bus service. This agreement was discontinued in 1990, however, since it was clear by then that the city was not going to get much denser.

- *Parking Policies.* In 1987, the city changed its parking code to a maximum of 2.7 spaces per 1,000 net square feet of office space, far below that found in most suburban work settings. The city also allowed up to a 20 percent reduction in required parking for developments in mixed-use complexes to allow for shared parking. Bellevue officials also introduced zoning incentives to encourage the placement of new facilities underground —every two square feet of parking built below surface allows an additional square foot of office space to be provided. Because of high land values, parking fees have also become fairly common in downtown Bellevue, averaging around $75 per month for office workers (Hooper, 1989; Gilmore Research, 1991).

- *Transit and TDM Programs.* A centerpiece of downtown Bellevue is the new transit center, which is the largest terminal-transfer point for the Metro system outside of downtown Seattle. Designed with six bus bays, an overhead canopy, benches, information kiosks, and a sheltered waiting area, the center is served by 17 transit routes, most of which operate on 10-20 minute headways during the peak. Also, as a condition to project approval, most developments opened since the mid-1980s introduced transportation demand management programs. These have normally involved hiring a full-time rideshare coordinator, introducing mandatory parking charges, subsidizing transit passes, and offering preferential parking for vans and other HOVs.

Impacts on Transit and Non-SOV Travel

Table 4.3 presents some evidence that downtown Bellevue's densest and most mixed-use sites have the highest shares of non-SOV commuting. First, downtown Bellevue's share of workers

Table 4.3

Comparison of Non-SOV Modal Splits Among Activity Centers and Sites in the Eastside Area of the Seattle Region

		Density		Parking Supply		Parking Fees ($/mo.)			
	Built Environment	Average Commercial FAR	Employees/ 1,000 GSF	Per Employee	Per 1,000 GSF	SOV	HOV-2	HOV-3+	Non-SOV Percent of Work Trips
Activity Centers:									
Downtown Bellevue	Dense, mixed use	2.3	2.81	1.05	3.20	$50-$75	$10-$75	$10-$75	19.4% (1990)
Non-Downtown Bellevue	Predominantly residential; some commercial	0.3	2.14	1.20	4.00	0	0	0	12.0% (1990)
I-90/Eastgate	Shopping centers, office parks, & strip commercial	0.4	2.33	1.25	4.25	0	0	0	7.8% (1990)
Redmond/Microsoft Complex	Corporate estates & office parks	0.2	2.60	1.20	4.00	0	0	0	15.9% (1992)
Sites:									
Bellevue Place	Mixed office, retail, hotel	4.8	n/a	n/a	1.43	$75	$75	$75	18.0% (1992)
Koll Center	Office, ground-floor retail	6.3	2.42	n/a	2.29	$75	$75	$75	19.2% (1990)
One Bellevue Center									
Puget Power	Office	7.1	3.20	0.76	2.40	$21	0	0	40.9% (1988)
Other Tenants	Mainly offices, small retail	7.1	2.75	0.95	2.70	$75	$20	$10	21.2% (1988) 32.0% (1990)
Security Pacific Plaza	Office, ground-floor retail	7.7	2.94	0.79	1.92	$75	$15	$10	29.8% (1988) 25.9% (1990)
Skyline Tower	Office, ground-floor retail	6.0	2.57	1.15	2.07	$75	$35	$25	13.7% (1988)
U.S. West	Corporate headquarters	2.8	2.60	0.35	0.91	$75	$45	0	50.0% (1988) 70.0% (1990)

Sources: Hooper (1989), Gilmore Research Group (1991), Seattle Metro (1989), U.S. Bureau of Census, STF-3A, Bellevue Dept. of Public Works, and City of Redmond

who commute by non-SOV modes is 7.4 percentage points higher than for workers in the remainder of the city. Compared to the nearby I-90 Eastgate commercial strip, central Bellevue averages around three times as many bus users, ridesharers, walkers, and cyclists. Workers in central Bellevue are also more likely to commute by bus, van, or carpool than their counterparts four miles to the east in Redmond, which is dotted with low-density, campus-style office parks and corporate headquarters.[35] Thus, at an activity center level of analysis, it seems that in the Seattle area at least, denser, more mixed-use suburban places average considerably higher levels of transit usage and ridesharing than nearby work settings with lower average densities and more segregated land uses.

Table 4.3 also reveals a strong relationship at the individual site level. The six buildings shown in the table average the highest share of transit, walking, and ridesharing commuting in downtown Bellevue. They also tend to be taller, denser, and have more varied on-site activities than other buildings. However, these six sites also tend to have more restricted parking and an assortment of ridesharing incentives in place. For four of the six buildings, in fact, conditions required the developer and large employers to introduce such TDM measures as transit vouchers, ridematching services, and mandatory parking charges. USWest has introduced some of the strongest transit and rideshare incentives anywhere. Presently, it provides 402 parking spaces for 1,150 workers, more than half of which are reserved for carpools and vanpools. USWest charges $4 per day to park or $75 per month for single drivers, $45 per month for two-person carpools, and free parking for vehicles with 3 or more occupants. Presently, 30 percent of USWest's workers commute alone, 52 percent carpool (in part because of aggressive carpool promotion), and 12 percent bus to work. A block away lies another office building that is surrounded by 730 car spaces available free of charge to the 650 workers; none of the spaces are reserved for carpools. Commuting habits in this building are strikingly different —85 percent drive alone and only 8 percent carpool or vanpool.

It is difficult to decipher the degree to which land-use and site characteristics versus parking restraints and TDM measures have shaped the commuting behavior of Bellevue's workers. Most likely, the latter have had far greater influence than the former. In the absence of restraints of automobile usage and ridesharing/transit incentives, it is unlikely that features like on-site retail, pedestrian connections, and taller buildings will have much bearing on modal splits. Of course, both factors mutually reinforce and benefit from one another.

Other factors have also had some bearing on modal splits. One is company size. The odds of matching workers into carpools or vanpools increase with company size, as do the resources committed to TDM. From the 1990 downtown survey, 27.6 percent of workers for companies with over 900 employees commuted via non-SOV modes; for companies with fewer than 100 workers, the share was just 13.8 percent. Second, level of management commitment has also had an impact. Puget Power, for instance, is not a conditioned building, yet because of parking shortages and a corporate culture that promotes energy conservation, management has actively encouraged workers to commute together. They have also put up the money to underwrite vanpool services, transit vouchers, and an on-site coordinator, all voluntarily. Lastly, in the case of USWest, over half of all employees previously worked in downtown Seattle and were familiar with riding transit. They were also the most inclined to continue ridesharing or patronizing transit, especially given the steep parking charges levied against solo-commuters. Old habits can be hard to break, even in the suburbs.

Using data from the 1988 JHK survey of eleven office buildings in downtown Bellevue (Hooper, 1989), it was possible to further sort through the relative importance of land use versus TDM factors in shaping commuting choices. The correlation between shares of work trips by non-SOV modes and indicators of density and on-site retail were very weak— in the 0.01 to 0.02 range.[36] Parking policies, on the other, were strongly associated with modal splits. Table 4.4 shows that each additional parking space per worker tended to reduce transit work trip shares by around five percentage points. Parking's influence on non-SOV commuting was even stronger (Table 4.5). Over the range of 0.25 to 1.50 spaces per worker, non-SOV commuting fell exponentially with relative parking supply; because one of the buildings with a large retail component (and thus a large supply of spaces per worker) had a relatively high non-SOV share, a quadratic curve fit the data most closely (Figure 4.18). Overall, Bellevue's experiences suggest that land-use and site design measures may be important in inducing non-SOV commuting, but are not sufficient. They clearly must be matched by auto-retraint and TDM measures.[37]

6.3. Other Notable Transit-Supportive Projects

Three other projects in various stages of development in the Seattle region are notable for their transit-sensitive designs:

- *Carillon Point:* A mixed-use project on a 17-acre site overlooking Lake Washington in Kirkland. The project contains around one-half-million square feet of office space, restaurants, retail shops, a 100-room hotel, and around 25 condominiums. Garden apartments surround the site. Besides providing on-site bus amenities, pathways, and bike racks, the developer reduced parking below suburban standards and built a pay-parking structure ($35/month, with 25 percent discounts to ridesharers). The developer also built and operates a Commuter Information Center in each building occupied by 250 or more workers and operates a no-cost trolley bus between downtown Kirkland, Carillon Point, and park-and-ride locations.

Table 4.4

Factors Explaining Percent of Work Trips by Transit for Eleven Sites in Downtown Bellevue, 1988

	Coefficient	Standard Error	Probability
Parking Spaces/Employee	-5.57	2.49	.055
Retail Activity[1]	4.34	2.51	.121
Constant	10.41	3.21	.012

Summary Statistics:
R^2 = .477
F = 3.65
prob. (F) = .075
N = 11

[1] 1 = If retail activity (not including company cafeteria) in the building; 0 = otherwise.

Table 4.5

Factors Explaining Percent of Work Trips by Non-SOV Modes for Eleven Sites in Downtown Bellevue, 1988

	Coefficient	Standard Error	Probability
Parking Spaces/Employee	27.87	3.45	.0005
$(\text{Parking Spaces/Employee})^2$	-94.10	10.18	.000
Parking Cost/Month	0.12	8.23	.130
Constant	84.25	8.23	.000

Summary Statistics:
R^2 = .952
F = 45.9
prob. (F) = .000
N = 11

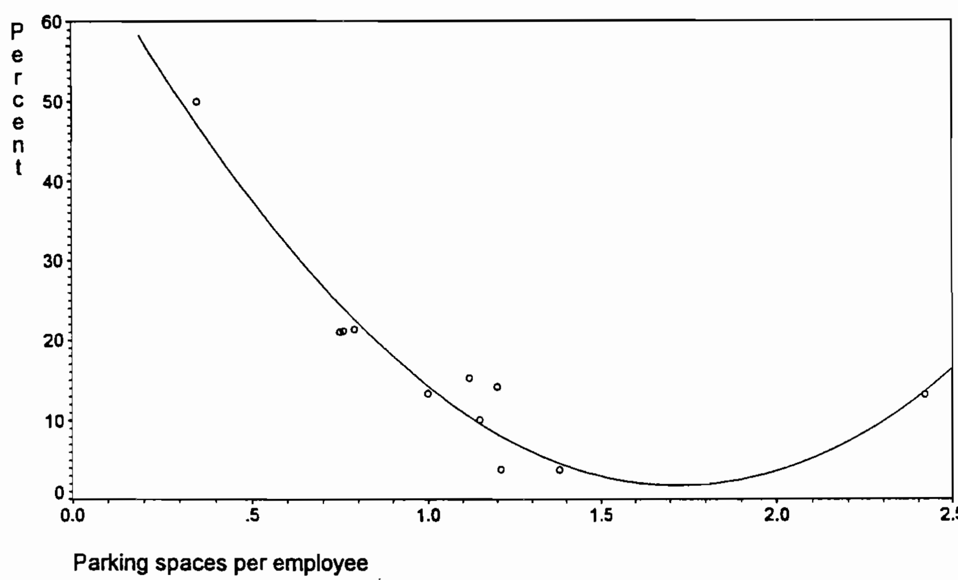
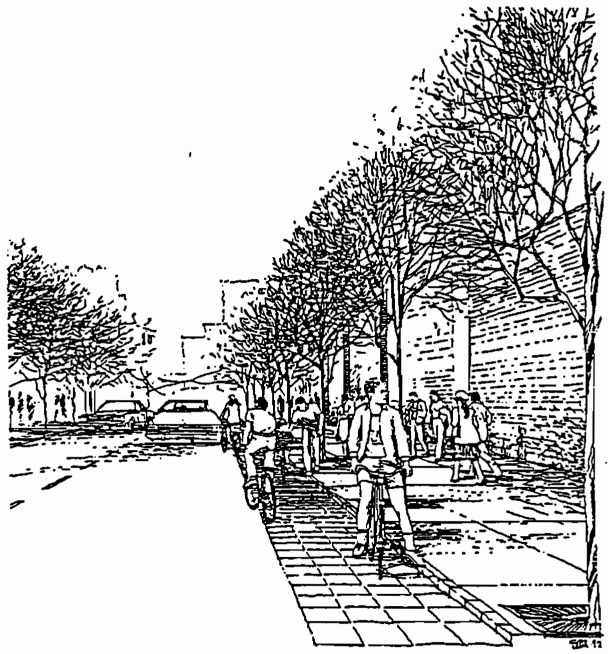


Figure 4.18

Relationship Between Parking Supply and Non-SOV Commuting in Central Bellevue, 1988

- *Klahanie Village:* A 860-acre planned development recently built about two miles north of Issaquah in eastern King County. Klahanie has 1,600 homes; a commercial center is currently under construction as well. A stated intent in the adopted master plan was to . . . "encourage the use of alternative modes of transportation, including transit, carpool, bicycle, pedestrian, and equestrian trail facilities." These criteria set the stage for many of the design features since incorporated into the Klahanie community, including an extensive trailpath network and bus pull-outs and shelters along the developments major boulevard. The developer has also complemented these site features with the provision of park-and-ride lots, a comprehensive ride-sharing program, and the provision of free bus passes to new homebuyers.

- *Seattle Commons:* Plans are underway to improve and revitalize the 47-acre business and residential neighborhood between downtown Seattle and Lake Union. Among the design elements are "green streets" that separate cars, bicycles, and pedestrians, reduced surface parking (and the elimination of parking requirements), and increased transit provisions like bus shelters. The green streets would place pedestrians on the sidewalk, protected from traffic and bicycles by a row of trees and the curb, and also provide dedicated curb-lanes for bicycles (Figure 4.19).



Green Street

Source: Committee for Seattle Commons (1993).

Figure 4.19

Proposed Green Streets in Seattle Commons

6.4. Case Summary

The Seattle region is a national leader in promoting transit-friendly development. SNO-TRAN and others have raised the region's consciousness about the benefits of designing buildings and neighborhoods that invite transit riding, walking, and cycling. Unfortunately, at the time this movement built a considerable head of steam, the real estate market began to slow down significantly. To date, these promotional efforts have had their biggest impact on local and state policy-makers.

As one of the densest, mixed-use suburban centers in the U.S., central Bellevue averages two to three times as many non-SOV trips as other nearby office-commercial centers. Part of this is due to the built environment; however, Bellevue's successful TDM programs deserve most of the credit. Clearly, TDM initiatives need to accompany land use measures if meaningful reductions in SOV commuting are to be achieved.

7. Washington, D.C./Maryland Area Case Study

The greater Washington/Baltimore region is home to two areas that have been at the forefront of promoting transit-supportive development. One is Montgomery County, located northwest of Washington, D.C. The second is suburban Baltimore. Both areas have experienced a suburban building boom. During the 1980s, suburban population and employment grew, respectively, by 37 and 45 percent in metropolitan Washington, D.C., and 19 and 31 percent in the Baltimore region. In both areas, a number of recently built projects have incorporated transit-sensitive physical designs, albeit in many cases only modestly so. Furthermore, the stage has been set for future transit-supportive projects due to the pro-active stance taken by local and county authorities in the region.

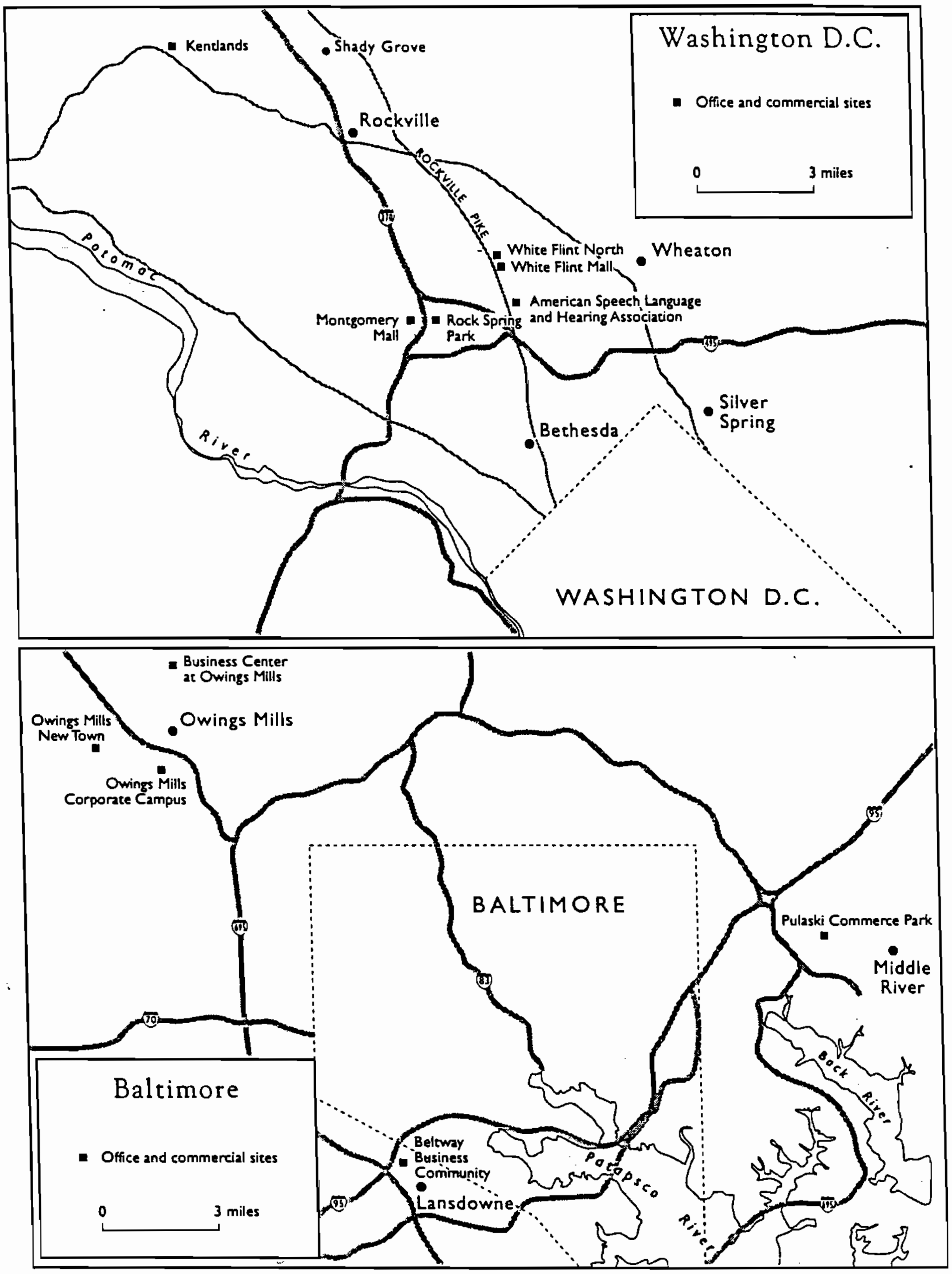
7.1. Montgomery County: Setting the Stage

A number of institutional factors have encouraged transit-supportive development in Montgomery County. The county has an adequate public facilities ordinance (APFO) stipulating that there must be sufficient transportation system capacity before a new development is approved. If the roads leading to a project are at capacity during peak periods, then developers must mitigate the impact of all new trips. Frequently transit plays a role in this mitigation in the form of developers designing in transit facilities and amenities. The county has also actively promoted development near Metrorail stations as well as alternatives to auto commuting. An example of this is the Silver Spring Transportation Management District, which was created in 1987. A major goal of this agency is to promote transit and ridesharing, while limiting parking and the use of single-occupant vehicles. Transit and land-use planners in the region encourage transit-supportive design practices whenever possible and many regularly refer to the design guidelines published by the Maryland Transit Administration (MTA).

Transit-Friendly Malls

These efforts have produced many transit-supportive projects, though the vast majority are in the rail-based urban centers of Bethesda and Silver Spring. Commercial projects not served by Metrorail tend to be auto dominated. One notable exception, however, is the Montgomery Mall (see Map 4.7 for location of all sites).

The Montgomery Mall was built many years ago, but it recently was remodeled and expanded. The developer, Center Mark, was required to pay traffic impact fees as a precondition to receiving a building permit. An agreement was reached allowing the developer to use part of the fee to build a transit center to replace a bus stop location eliminated by a new parking structure (Photo 4.10).[38] The transit center is connected to a major mall entrance by a short pedestrian crossing and a well-shaded sidewalk. It has a separate bus entrance. The separation of vehicles and pedestrians increases safety while also reducing road wear and bus travel times. This is in



Map 4.7

Washington, D.C./Baltimore Area Case Study

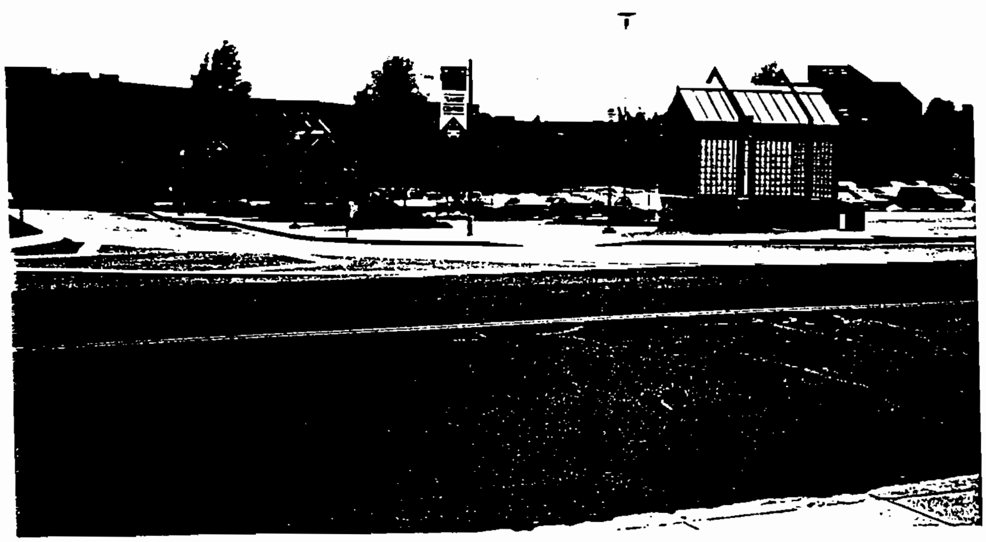


Photo 4.10

The Montgomery Mall Transit Center: Creating a "Transit-Friendly" Retail Environment

contrast to most malls, where buses are either relegated to the fringe, leaving the riders with long walks or brought "to the door" only to be left to contend with circular routing, narrow mall roads, and slow-moving traffic. The transit center has also been combined with an existing park-and-ride facility on the same portion of the mall site.

Recent surveys show that the number of local bus passengers arriving at and departing from the mall went up approximately 3 percent after the transit center was opened. The fact that ridership on an express route serving the transit center declined during this same period suggests that the transit center has had at least a slightly positive impact on ridership.[39]

Another mall in the area, White Flint Mall, has a tree shaded walkway leading from a bus stop on a nearby arterial to a major mall entrance (Photo 4.11). Although this mall shows few other physical signs of support for transit, this one provision reveals how landscaping and design can at least begin to alter the auto-orientation of standard retail projects.[40] This walkway is used not only by transit riders but also by pedestrians accessing the mall from nearby office buildings.

Transit-Supportive Office Projects

A recent transit-supportive addition to Montgomery County's office inventory is White Flint North (Phase I), home to the Nuclear Regulatory Commission (NRC). Completed in 1988, this com-

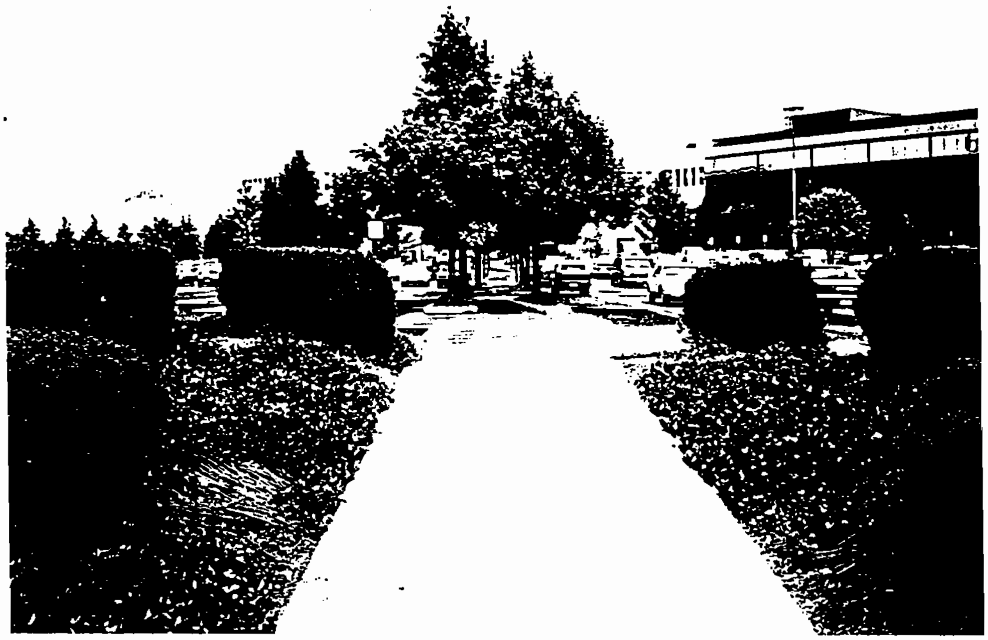


Photo 4.11

A Tree-Shaded Walkway at the White Flint Mall: Providing an Attractive Pedestrian Link for Bus Patrons

plex is near the White Flint Metro Station and across from a bus transfer center. It has convenient pedestrian access to both rail and bus services. The site is attractively landscaped and laid out to encourage on-site walking. The Phase II building is planned to contain such uses as a daycare facility, gym, and ground-floor retail. On the rear portion of the White Flint North parcel, a residential development with 200 apartment units, at a density of over 25 units per acre, is set for construction in 1994. Other factors encouraging workers to leave their cars at home include short walking distances to shopping plazas and residential areas, an on-site parking ratio of only 0.26 spaces per employee, parking rates of $60 per month on-site and $30 per month off-site, FARs of 3.0 for Phase I and 3.6 for Phase II, and a comprehensive TDM program (Table 4.6). Many of these provisions are the direct result of the county's APFO, which required the developer to mitigate all new peak hour trips over the 465 allowed for the entire 12.25-acre site.

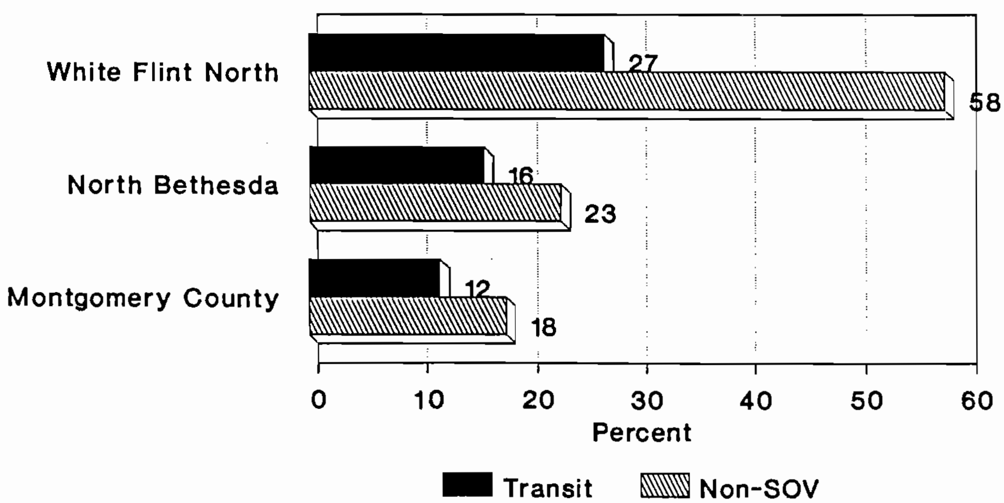
In 1988, approximately 58 percent of all NRC staff used non-SOV modes of travel to work. This compares to a 9 percent average non-SOV modal share for three other suburban office buildings in the county, all of which are within a quarter mile of a Metrorail/bus transfer station.[41] The 1988 transit and non-SOV modal shares for White Flint North employees also compared favorably to those of employed residents living in North Bethesda and Montgomery County at large (Figure 4.20).[42] Currently, around 28 percent of all White Flint workers commute by rail each day, 4 percent ride buses, and another 26 percent share rides (Figure 4.21).

Table 4.6

Characteristics of Three Office Projects in the North Bethesda Region of Montgomery County

	White Flint North (Phase I)	ASLHA	Rock Spring Park
Employees per 1,000 GSF	4.5	2.2	2.2
Average FAR	3.0	0.1	0.40 to 0.50
Parking Ratio (per employee)	0.26 (on-site)	0.81	1.6
Parking Rates (per month)	$30-$60	FREE	FREE
Mixture of Uses on or Near Site	YES	NO	MINIMAL
Conditional Buildings	YES	YES	SOME
TDM Program	YES	YES	YES
Percent Transit*	32	16.7	2
Percent non-SOV*	59	24.2	9

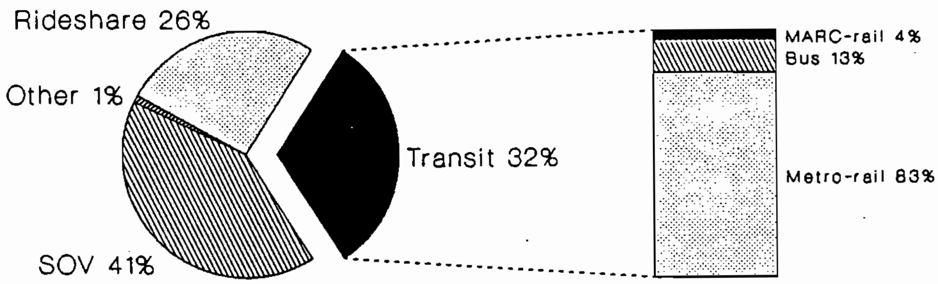
*Data sources: 1991 White Flint Employee survey, 1992 ASLHA survey, 1987 Rock Spring Park survey



Source: 1988 White Flint North Employee Survey, 1987 Census Update Survey
Note: Census Data for Resident-Workers

Figure 4.20

Work Trip Modal Shares for White Flint North Employees and the Surrounding Region and County, 1987/88



Source: 1991 White Flint North Employee Survey

Figure 4.21

Modal Share Breakdown for all White Flint North Employees, 1991 Work Trips

Quite likely, White Flint North's high non-SOV modal shares are due less to physical features and more to the site's excellent transit service and aggressive transportation demand management program. Another reason is that the NRC employees were moved from downtown Bethesda, Silver Spring, and Washington D.C., where transit use was already common among the employees; in 1987, before the initial consolidation, about 45 percent of the workers used non-SOV commute modes. Still, White Flint North clearly demonstrates that attractive, transit-oriented suburban development can yield important mobility dividends.

The American Speech, Language, and Hearing Association (ASLHA) building on the Rockville Pike, southeast of White Flint, is an example of a semi-rail-based[43] office building that features transit-supportive designs. At the insistence of county planners, this project incorporated bus shelters, sidewalks, preferential carpool/vanpool parking, and parking space limitations. Parking lots are located mainly behind the building, and walking distances are about the same for both auto drivers and bus transit riders. ASLHA has also introduced a TDM program, complete with a transportation coordinator, limited parking,[44] and discounted transit passes. Two things lacking on the site are transit-compatible densities and mixed uses (Table 4.6). Access from the main bus stop on Rockville Pike is very good relative to many other suburban locations (Photos 4.12 and 4.13). While this may be shrugged off as "window-dressing," such improvements are an important step toward physically integrating transit into a development where more often than not the

Photo 4.12

The ASLHA Building: A Walkway Connecting the Rockville Pike Bus Stop to the Building Enhances Bus Patron Access

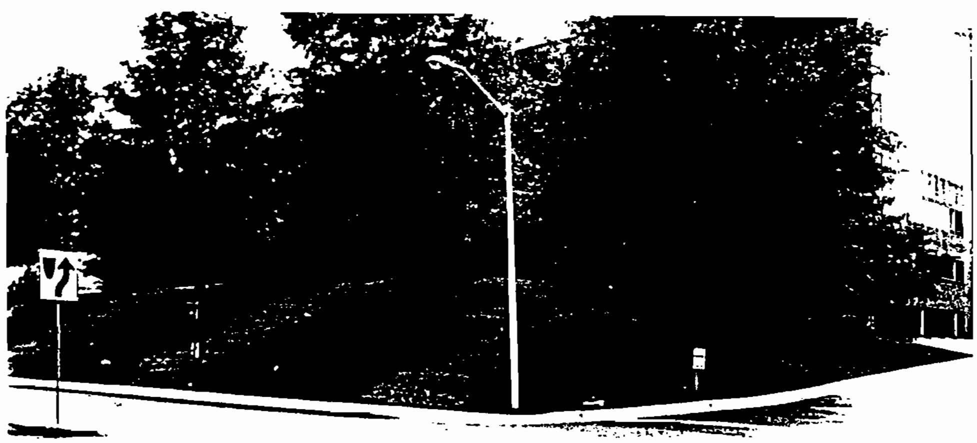
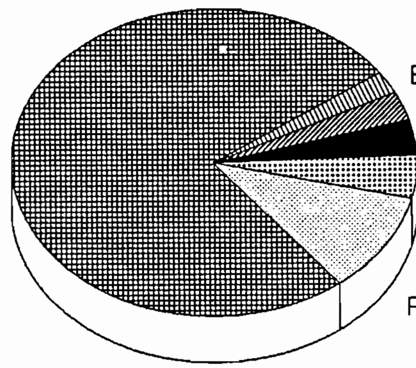


Photo 4.13

More Typical Transit Access in Montgomery County: Example of How Landscaping Can Block Direct Transit Stop Access

landscape presents a formidable barrier to transit patrons and where sidewalks to bus stops are absent or non-contiguous at best. The modal share data for ASLHA shows that the TDM program combined with a supportive design has been successful at wooing commuters out of their cars (Figure 4.22).



Source: 1992 ASLHA Employee Survey

Figure 4.22

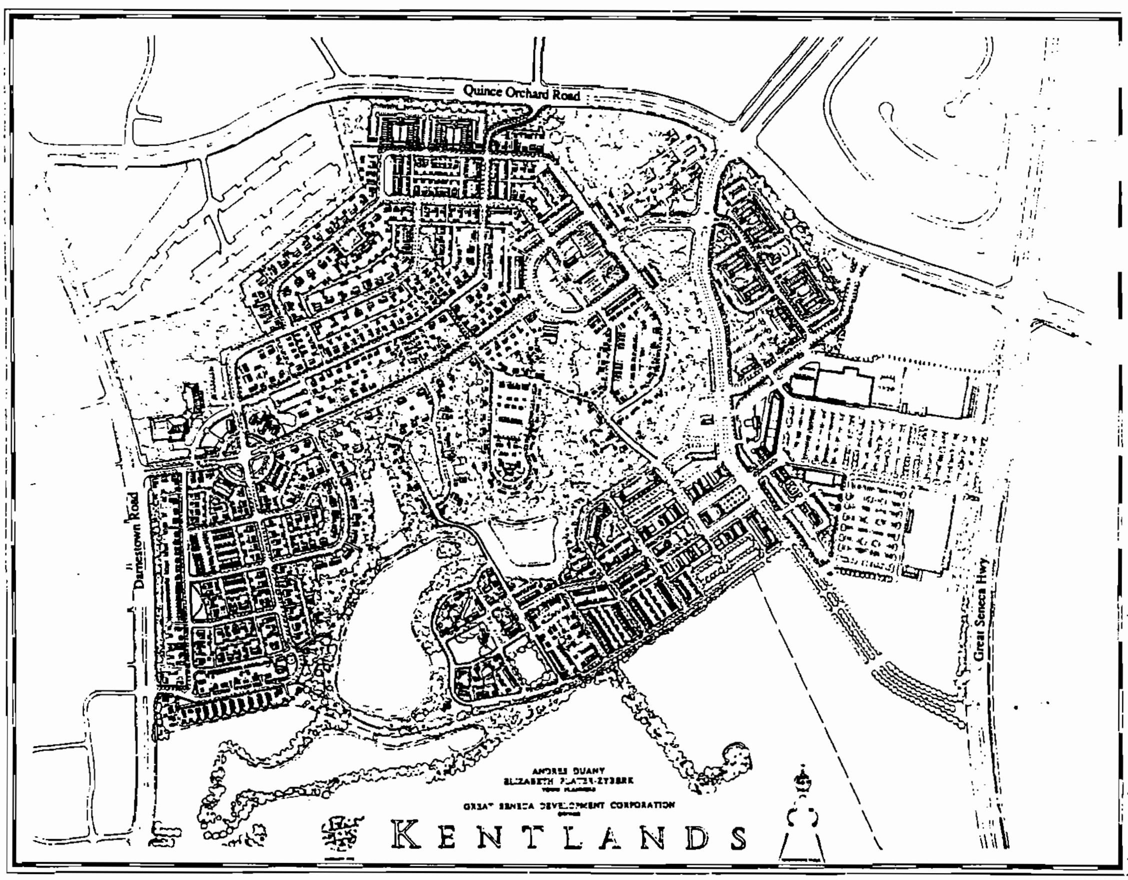
1991 Modal Share Breakdown for all ASLHA Employees

Another Montgomery County office project that was designed to invite on-site bus services is Rock Spring Park, a 247-acre campus-style office park located near the Montgomery Mall. Bus shelters and walkways are close to many buildings in the park. In at least one case, a new walkway leads from the building to the bus shelter. The office park also has other physical provisions for transit, including attractive landscaping that invites walking between buildings, staging areas for dropping off car and van pool riders, and a protected right-of-way for a possible future light rail transit line. Rock Spring Park also contains a day-care center, eateries, banks, a health club, a dry cleaners, and an office supply store. Collectively, these factors have yet to yield significant mobility benefits. Because of its very low gross FAR (0.43), abundant free parking, and modest on-site transit services, 91 percent of the park's workforce commutes alone. One problem is that the project's curvilinear street design is not conducive to efficient transit routing. A number of business tenants in the park are lobbying to have buses operate closer to their buildings; however, in most cases this would either greatly increase bus travel times or reduce the quality of service to other buildings.

Pedestrian and Transit-Friendly Mxed-Use and Residential Developments

The Kentlands has been heralded as one of the premier neotraditional mixed-use communities in the nation. Designed by Andres Duany and Elizabeth Plater-Zyberk, the 352-acre site is today over one-third built with 600 residential units fully occupied and over a hundred more under construction (Figure 4.23). A school, church, day-care center, club house, and service station are also completed. A retail center with a department store, grocery store, and 15-20 small shops will open soon on the northern portion of the site. At buildout, the Kentlands will have 1,700 dwelling units at densities ranging from 5 to 25 units to the acre. The unit mix includes single family residences, townhomes, condominiums, and apartments.

The project includes many elements that encourage pedestrian activity, such as a mix of uses in each neighborhood, narrow streets,[45] a modified grid layout, minimal building setbacks, front



Source: Duany and Plater-Zyberk, Associates.

Figure 4.23

Site Plan for The Kentlands: A Neotraditional New Community near Gaithersburg in Montgomery County, Maryland

porches, and very generous landscaping. Paths and sidewalks lace the development. On-street parking and street trees provide a protective barrier for pedestrians. A corner store, prominently located at one of the development's major focal points, is meant in part to serve as a comfortable, indoor waiting area for morning commuters to read the paper while they wait for the bus. Many garages are reached from rear alleys, and some have second units above them, increasing the density and unit mix of the community. A small amount of office development, 150,000 square feet of upscale retail, restaurants, and theaters, and a relatively dense residential component are slated for the Kentlands' midtown area.

Yet, even with all of these transit-friendly features, those in Montgomery County familiar with the project downplay the development's transit potential. Perhaps the principle reason is that its population is fairly affluent. Also, regional transit services in the area are meager, and the overall project density is too low to support frequent all day service. Still, the project is far more transit-supportive than many other recent residential additions to the county. Perhaps the Kentlands' major mobility payoff will lie with converting more neighborhood shopping and other non-work trips to foot and bicycle travel and providing an opportunity for some residents to work nearby.

Other residential transit-supportive developments in Montgomery County tend to be rail-based. Moderately dense residential concentrations are near Metrorail stations at Silver Spring, Bethesda, and White Flint. In the case of the Twin Towers and Georgian Towers apartment complexes, both situated within one-quarter-mile of the Silver Spring Metrorail station, around 35 percent of residents commute to work by rail transit (JHK Associates, 1987). Residential developments away from Metrorail have remained auto-oriented— typically in the form of PUDs with wide curvilinear roads, low densities, and poor transit access. The only notable transit amenities in such PUDs are sidewalks and bus shelters. TDM has also been mandated for a number of recent residential projects, resulting in the initiation of ridesharing programs and commute shuttle services.

Promoting Transit-Friendly Developments in Montgomery County

Montgomery County's developers are increasingly aware of the need to incorporate transit into their projects. During an interview, one local developer actually pointed out a way to improve a sample drawing found in one of the nation's "best" transit-supportive guidelines. He noted that unless a new commercial project is sited along a major highway corridor, it is important to have a meaningful physical relationship to transit to command high rents and good tenants, especially in suburban locations. But the developer downplayed the ability of buses alone to play that role. Alternatively, he credited the presence of frequent bus service at the "front door" of an apartment project with playing a small part in the successful renting of units.

In general, transit still only receives cursory attention as part of Montgomery County's project review process, although it is gaining more and more attention since passage of the county's

APFO and traffic mitigation requirements. Sidewalks are required in most new office parks and bus shelters are strongly encouraged. According to local transit planners, recently constructed buildings have been sited closer to the roadways, thus shortening walking distances and increasing exposure to transit lines.

With the Washington metropolitan area's real estate market having softened over the last few years, few new large-scale developments have broken ground as of late. This has allowed local planners to prepare for the next round of development, when they hope to be better positioned in negotiating for transit provisions in new real estate projects. It has also allowed developers to rethink how they do business. In Montgomery County, a number of plans on the drawing board draw heavily on transit-supportive design principles. One such project is the Shady Grove Plan, an amendment to the Gaithersburg Vicinity Master Plan. The Shady Grove plan covers an area that has been designated mainly as a "Research and Development (R&D) Village." The plan calls for the integration of housing, employment, services, retail uses, and public spaces all linked by transit, sidewalks, and bikeways. Other transit-friendly concepts include: locating high-intensity uses at transit stops; zoning that allows mixed use neighborhoods; clustering buildings and locating them close to the roadway; and encouraging transit serviceable residential subdivisions.[46]

Barriers to Transit-Supportive Developments in Montgomery County

A number of barriers stand in the way of transit-supportive design in Montgomery County. As in other parts of the country, many Montgomery County developers are skeptical about the marketability of transit-oriented designs in general and do not yet see a strong local demand for them. Several development community spokespersons felt that certain design features, such as back alleys, would hurt the marketability of residential units. Most were also skeptical about the wisdom of limiting the amount of parking at retail stores. In general, local developers felt that it is more difficult to make retail developments supportive of transit than residential or commercial projects.

During interviews, many development community spokespersons dwelled on financial considerations. Certain transit-supportive ideas were viewed by many as too costly relative to the anticipated benefits. For example, gridiron streets, covered walkways, and underground parking drive up development costs so far that projects become less profitable and even infeasible. Also, some transit-supportive features make project phasing difficult, therefore increasing risk and the need for more up-front financing. Interviewees also indicated that some transit-supportive designs, such as "under-parked" retail stores, are not acceptable to lenders.

Another barrier is the attitude of some developers and businesses toward transit and its clientele. In some cases, transit has been kept out of a development or removed from a project altogether. Reasons often given include the congregating of teenagers and the presence of "undesirables."

In some instances, even public officials have blocked the path toward transit-oriented designs. For example, at one site, county traffic engineers denied an attempt by the developer to create a more direct pedestrian access route from the Metrorail station. One of the main supporting reasons was that it would impede traffic circulation. Planning commissioners sometimes stand in the way of transit-supportive development by resisting lower parking requirements. Many planning boards are inclined to approve small auto-oriented developments because each individual project generates few additional trips. Yet, they may deny large transit-supportive projects in fear of the traffic congestion that might result. In one case, a large transit-oriented development was proposed adjacent to a Metrorail station, but because local roadways were already at capacity, the project was rejected. Meanwhile, the planning commission approved a small-scale auto-oriented retail plaza on a site directly across the street from the station.

7.2. *Baltimore: The Access-By-Design Program*

The Access By Design program was initiated by the Maryland Mass Transit Administration (MTA) in 1988. Its purpose was to encourage "developers and local government planners to work with the MTA to give early consideration to transit service in developing areas."[47] This led to the preparation of the *Access By Design* manual on how to incorporate transit into new real estate projects. The program and the manual both address transit service and facility requirements as well as the benefits of transit-supportive design. Some site design and land-use issues are discussed in the manual, but in general the program has struggled. This is primarily because MTA has no direct land-use authority. Another limiting factor is a lack of commitment from the transit agency, given tight budgetary times, to expand bus services in the event significant land-use changes were to occur.

The Access By Design program began with an effort to establish good working relationships with local governments. MTA planners hoped to convince public entities of the benefits of physically integrating public transit into local real estate developments. Today, many authorities in the region seek MTA input in the review of proposed projects. Baltimore County has taken the program most seriously, incorporating Access by Design principles in its Comprehensive Master Plan.

The MTA has marketed transit-supportive design in several ways. Initially, the Access By Design manual was mailed out to all developers in the region. After this mailing, at a breakfast for the developers, MTA planners discussed design concepts and their financial implications. MTA planners attempt to maintain continual contact with developers during the public review of large projects.[48] They also work closely with developers who approach them for advice on retrofitting existing developments to accommodate transit.

Access-By-Design Successes

To date, a number of Baltimore-area projects have been directly influenced by the Access by Design program (see Map 4.7). Among them are:

- *Beltway Business Community* —An office/industrial development southeast of Baltimore. A bus turnaround was added at the end of the road serving the project.
- *Pulaski Commerce Park* —An office/warehouse development. A bus turnout and stop were installed along one of the project's interior roads.
- *Owings Mills Corporate Campus* —A campus-style office park northwest of Baltimore. Two turning radii were widened and a bus layover area was built.
- *Owings Mills New Town* —A residential development northwest of Baltimore. Bus service will be introduced once the development's projected ridership level reaches 30 riders per day. All roads have been designed with turning radii and widths sufficient to accommodate buses. The development has sidewalks, a buildout density of over 11 dwelling units per acre, and future retail/office plans.

Case Summary

Transit-supportive development is steadily gaining ground in Maryland's major urban centers. In combination with TDM efforts, substantial numbers of workers at the ASLHA and White Flint North projects leave their cars at home each workday. Suburban Maryland also has a very transit- and pedestrian-friendly retail center, Montgomery Mall. On the residential side, the Kentlands is the largest neotraditional community in the nation, serving as a model of how transit-supportive densities, land-use mixes, and site features are indeed compatible with an affluent exurban setting. Baltimore's Access By Design program and the local planning efforts in Montgomery County promise to build upon these recent gains, especially when local real estate conditions begin to turn around.

8. Conclusions

Based on these five case studies, evidence on the impacts of transit-supportive site designs is admittedly thin. One problem is that every site that has transit shelters, front-door bus staging zones, mixed land uses, and other transit-supportive design features also has an active and often ambitious TDM program. Thus it is impossible to separate out the influences of physical design features from TDM initiatives. Clearly, both sets of measures complement each other extremely well and no doubt mutually benefit. However, we believe that most of the differences in modal splits between transit-supportive sites and comparison sites are due to TDM programs rather than elements of the physical design. In particular, there are numerous sites with active TDM programs that are not particularly transit- or pedestrian-friendly, yet which have relatively high non-SOV commuting shares (COMSIS Corporation, 1990). These shares tend to be as high, and in some cases higher, than transit-friendly sites examined in this chapter. Transit-supportive designs are well-intentioned and helpful, though fairly meaningless without good quality transit services and proactive measures to reduce auto-dependency.

For the most part, differences in transit ridership rates were fairly modest across sites, whether they were defined as transit-supportive or not. With the exception of several sites in the Seattle and Washington, D.C. areas, employees at transit-supportive site were generally as dependent on their cars to get to work as those working at more auto-oriented sites. Quite simply, the effects of micro-site features tend to be too "micro" to exert any fundamental influence on travel choices. It is more likely that transit-friendly design elements influence midday travel, such as the incidence of walk trips during lunch hour, than peak-period commuting. Unfortunately, most of the travel data available for this research only pertained to work trips. Had data for other trips purposes as well as for internal trips within activity centers been available, a more positive light might have been shed on the transportation benefits of transit-supportive designs.

To date, perhaps the biggest impact of the transit-supportive movement has been on local policy-making, such as the passage of Washington state's Growth Management Act and the Baltimore region's adoption of the "Access by Design" standards. Unfortunately, by the time the transit-supportive design movement gained a head of steam in the late 1980s, the real estate markets of most metropolitan areas began to cool off significantly. This mis-timing has meant that regardless how well-intentioned site design guidelines and other initiatives have been, if there is little market demand for new construction, transit-supportive designs will remain more of a concept than a reality. However, when urban real estate markets begin warming up again, a number of metropolitan areas will be well-positioned to see that whatever gets constructed is highly conducive to transit riding and walking. The challenge then will be for public agencies to mount good quality transit services and private employers to actively promote commute alternatives so as to take advantage of these supportive urban and suburban environments.

Notes

[1]In some instances, employee commuting characteristics were surveyed annually because of mandatory local trip reduction requirements or as a condition of project approval. Travel data were also available from surveys conducted by local transit agencies and planning departments as well as from the report on *Travel Characteristics of Large-Scale Suburban Activity Centers*, Hooper (1989).

[2]For three of the areas, statistics are shown for Consolidated Metropolitan Statistical Areas (CMSAs): Chicago-Gary-Lake County Illinois/Indiana; San Francisco-Oakland-San Jose California; and Washington-Baltimore D.C./Virginia/Maryland. In the case of the Washington-Baltimore CMSA, primary emphasis is given to Montgomery County, Maryland, in this chapter.

[3]Seattle has a dedicated trolley line, bus tunnel, and monorail line; however, these serve only the downtown area rather than the region at-large.

[4]In the Washington-Baltimore CMSA, ridesharing's share of commute trips fell from 22.9 percent in 1980 to 15.8 percent in 1990. Some of this loss was former ridesharers switching over to Metrorail services, though most involved new residents opting for solo-commuting and long-time residents switching from carpools/ vanpools to drive-alone commuting (Pisarski, 1992). In the Seattle MSA, ridesharing fell from 18.4 percent

of all commute trips in 1980 to 11.9 percent in 1990. Ridersharing's percentage point change in the other areas were: Chicago (-4.9 percent), San Francisco (-3.4 percent), and San Diego (-3.6 percent).

[5]Sears has entered into a contract with private bus companies to take employees to a nearby shopping mall during the lunch period. Six scheduled shuttles depart for and return from the mall between 11:30 AM and 2:30 PM, and seem to be popular among employees.

[6]The center lies 1,500 feet south of the Sears Merchandise Group headquarters building. The Transit Center includes a 1,400-square-foot passenger waiting area and transit information panel. It was designed to complement the architectural theme of the Prairie Stone development as well as to meet ADA requirements.

[7]Based on surveys of the origin-destination patterns for commute trips as well as interviews with employees, PACE designed services that they felt would complete with the private automobile in terms on ease of access and levels of comfort and convenience.

[8]No buses currently serve the site. According to PACE officials, the incidence of overtime work at this Motorola plant (which specializes in cellular infrastructure) is so high that few employees are interested in transit because of their inflexible schedules.

[9]San Diego City Council Policy #600-39, 8/4/92.

[10]The original plan called for 14.5 dwelling units an acre in each village core. The region's transit board, however, questioned whether that density was high enough to encourage transit usage. It recommended an average density of at least 18 dwelling units per acre near the transit station. Responding to others at a public hearing who feared that higher density would add to congestion, the regional transit planning director said, "we are too concerned about traffic, and not enough about the quality of the community" (Calavita, 1993: 25).

[11]While on-site light-rail costs will be covered by the developer, there are some five miles between the light-rail line and the project site.

[12]National Transit Access Center (NTRAC), University of California at Berkeley; and 1990 U.S. Census, Summary Tape File 3A.

[13]Transit service frequencies also favor Marina Village. It averages peak hour headways of 8 minutes and off-peak headways of 30 to 60 minutes, compared to 15 minute peak and 60 minute off-peak headways for Harbor Bay. Evening and weekend service is also more frequent at Marina Village.

[14]1990 Census travel data for Alameda city and county are for all employed residents and not for individuals working in the city and county, respectively. Thus, while these are not fully compatible comparisons, they provide some basis for contrasting the modal breakdowns of commute trips among workers at specific sites and the typical resident-worker in the surrounding city and county.

[15]The Harbor Bay and Marina Village employee modal share data come from surveys conducted during the winter of 1991/92 as part of the city of Alameda TDM program. The city and county modal shares are from the 1990 U.S. Census results. Data for the cities of Oakland and Berkeley were removed from the county data for our analysis because of their highly urban nature. Also, the percentage of people working at home was factored out.

[16]Those involved with Alameda's TDM program sometimes agreed and sometimes differed concerning the importance of design in promoting transit ridership. The location of the site (relative to regional transit connections) and the presence of inter-connected pedestrian and bike paths were generally thought to be important. Some felt that the transit shelters and building configurations were inconsequential. But another view was that the two developments have much higher non-SOV mode shares because of their layouts.

[17]These numbers were obtained from the Harch Investment Corporation, which manages the shopping center's TDM program. The numbers were derived from a 500-person shopper survey conducted in 1992.

[18]Both El Cerrito Plaza and Bay Fair are served by eight local bus lines, and Bay Fair has an additional three express routes.

[19]1990 Census travel data for Alameda city and county are for all employed residents and not for individuals working in the city and county, respectively.

[20]This other mall, it should be noted, lies farther out in the suburban fringes in a lower-density setting with less frequent bus transit services.

[21]The city of San Ramon incorporated in the early 1980s, changing from an almost exclusively residential suburb to a large regional employment center. As a result, estimates of employment growth are problematic.

[22]One hundred more are allowed if they are low-income units.

[23]Currently, a few commercial buildings are under construction at Hacienda, and a 52-acre moderate-density residential development (12 or less units to the acre) is slowly passing through the local review process.

[24]This is only a rough estimate as no formal BART ridership studies have been done for the business park.

[25]These provisions resulted from the developers taking a pro-active stance toward transit and working with the community to try to alleviate the project's traffic impacts. At the start of Hacienda's development process in 1978, no city or county ordinances demanded any provisions for transit. However, a development agreement was signed between the city and the developer containing many transit- and transportation-related requirements. The developers themselves even played a major role in writing the TDM ordinance now in place in Pleasanton. Today, Hacienda's owners tout high-quality transit as part of their marketing efforts.

[26]This does add to bus travel times. A better solution would be shorter building setbacks.

[27]One serves the whole development and the other serves the Pacific Bell office complex.

[28]This can be compared to the two Alameda office parks which have peak hour headways of from 8 to 15 minutes and off-peak headways of 30 to 60 minutes for buses serving the closest BART stations. The bus travel times from BART are revealing as well. Express bus travel times from BART average about 35 minutes for both Tri-Valley parks, while for the two Alameda parks the average bus access time from BART is only 14 minutes. Local bus service in Alameda is much more frequent. The evening and weekend service to the Alameda parks is also more intensive than in the Tri-Valley.

[29]1990 Census travel data for Pleasanton, San Ramon, Alameda County, and Contra Costa County are for employed residents and not for individuals working in these areas.

[30]The carpool/vanpool modal shares are high for both sites, especially for Building Complex Y. This can probably be attributed in part to the large size of Building Complex Y's tenant and its commitment to ridesharing. Past research has shown that larger firms are able to achieve higher mode shares than smaller firms (Cervero, 1989). In 1992, two large Bishop Ranch tenants, Chevron and Pacific Bell, averaged carpool and vanpool work trip shares of 26 percent or more. Also, Bishop Ranch firms with over 100 employees (not including Chevron and PacBell) averaged 17 percent carpool/vanpool shares, while those with under 100 employees averaged only 8 percent taking these modes. Thus, firm size and other non-design elements strongly influenced how people traveled to work at both of these sites, though good design definitely helped make non-auto alternatives more attractive.

[31]At a formal ceremony, the project's developers received SNO-TRAN's "1992 Transit-Friendly Development Award." In evaluating candidate projects, a committee of countywide planners visited recent developments around the county, scoring them on a number of criteria: proximity to a transit facility; density; and ease and safety of pedestrian access. The checklist used in evaluating the projects was taken from the appendix of the SNO-TRAN Guide.

[32]This estimate is based on an interview with Colby Crest's building manager.

[33]The Growth Management Act (GMA), passed in 1990, requires local governments in fast-growing and densely populated areas to adopt a comprehensive land use plan. Included in the plan must be provisions for siting major public capital facilities and developing regional transportation programs which must also address bicycle and pedestrian needs.

[34]The law (SSHB 1671) requires employers in cities in the eight counties with over 150,000 residents to adopt an ordinance that will reduce SOV trips of major employers. The law stipulates that employers with 100 or more workers must reduce SOV commute trips by 15 percent by 1995 and 35 percent by 1997.

[35]The Microsoft campus complex dominates these statistics. With 11.8 million square feet of floorspace spread over 271 acres of land, it compasses well over half of Redmond's office inventory. Because of a very active TDM program, the Microsoft campus also averages relatively high rates of non-SOV travel — according to 1992 surveys, 26.7 percent in the AM peak and 27.1 percent in the PM peak.

[36]The correlation between employees/1,000 gross square feet and Non-SOV modal split was 0.011. There was a stronger, though still not striking, correlation between transit modal shares and on-site retail (1=yes, 0=no) —0.391.

[37]Despite some of the pro-active parking initiatives in Bellevue, free parking is still fairly prevalent. The 1990 survey found that 73 percent of employees who drive to work park for free (Gilmore Research, 1992).

[38]This agreement, entered into by the county and the developer to allow impact fees to be spent on transit improvements, was very beneficial but uncommon. Normally, impact fee receipts are spent wholly on road improvements.

[39]The financial success of the Montgomery Mall is evident to everyone, especially to competing malls, one of which recently opened up a "transit store." It is likely that the project would have been successful even without the transit center, but it is the view of some that the center played at least some small role in benefiting the project through its promotional value and visual appeal.

[40]The developer for White Flint Mall and White Flint North operates a shuttle bus service with 10-minute headways that stops at 35 office buildings, the mall, and various other locations.

[41]The quarter-mile distance was a straight-line distance. The data come from the *1987 Post-Metrorail Transportation Characteristics Study* prepared by JHK and Associates for the Maryland-National Capital Park and Planning Commission.

[42]1987 Census update survey data for Montgomery County and North Bethesda are for employed residents and not for individuals working in those regions. Thus, while these are not fully compatible comparisons, they provide some basis for contrasting the modal breakdowns of commute trips among workers at specific sites and the typical resident-worker in the surrounding region.

[43]The building is about three-eighths of a mile from the Grosvenor Metrorail station, slightly beyond the one-quarter-mile limit generally applied to walk trips from a transit center.

[44]The county presently will not allow ASLHA to use 16 parking spaces in an attempt to limit the number of auto drivers to the site.

[45]Residential street right-of-ways range from 26 to 60 feet. Travel lane widths are between 9 and 11 feet, with 8-foot parking lanes. In some cases, there is one travel lane and one lane of on-street parking for a total paved width of only 17 feet. The distance from building to building across residential streets is usually 80 feet or less. Narrower streets were desired by the designers, but local public works officials would not allow them. Fire department officials also demanded wider streets.

[46]The plan lays out very clearly, with many accompanying graphics, the transit-supportive development types that are desired. It also recommends increased areawide transit service, including exclusive transitways linking much of the plan area. Plans such as this have the potential to become reality when the area's pace of development begins to pick up.

[47]Mass Transit Administration. 1988. *Access by Design: Transit's Role in Land Development: A Developer's Manual.* Baltimore, Maryland: Maryland Department of Transportation. p. iv.

[48]The program is now on hold due to a lack of personnel, but it is expected to resume soon.

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Chapter Five

Evidence on Travel Behavior of Transit-Supportive Residential Neighborhoods

1. Introduction

This chapter, like the last, examines the relationship between physical design and travel behavior in suburban settings; here, however, the analysis is at a more aggregate scale. Specifically, this chapter compares travel choices between two different types of suburban neighborhoods—older, more traditional transit-oriented areas (hereafter referred to as "Transit neighborhoods") and newer, more auto-oriented ones ("Auto neighborhoods"). Empirical investigations are conducted for these two types of neighborhoods in California's two major conurbations— the Los Angeles region and the San Francisco Bay Area.

By conducting investigations at the neighborhood scale, insights can be gained into how density, land-use mixtures, road layouts, and other basic physical characteristics of areas shape travel behavior, insights which are elusive at the micro-design level. Consequently, this chapter focuses more on neighborhoods, rather than on individual sites and buildings as in the previous chapter. Methodologically, these chapters are similar; both use paired comparisons to infer how features of the built environment influence travel behavior. A more sophisticated approach is adopted in this chapter, however, by introducing several control variables that allow the unique influences of the built environment to be better isolated. This chapter also differs from the previous one in that it focuses primarily on residential, instead of office, developments, and in that it also examines older, existing neighborhoods, not just newly built ones.

2. What We Know about Travel Behavior in Neotraditional Neighborhoods

The history of city building in the United States since World War II is largely the history of suburban development in the era of the freeway. This type of development introduced new concepts into the realm of urban building. New parts of metropolitan areas were conceived of as discrete developments; residential areas were solely residential, industrial areas solely industrial, and commercial areas given over entirely to retail activities. The only link between these areas was the hierarchically designed —and almost exclusively automobile-centric — road network. At the top of this hierarchy was the limited-access highway, made ubiquitous in the U.S. by the Interstate Highway Act of 1956. On the other end of the hierarchy was the local street, epitomized in residential neighborhoods by the cul-de-sac. If the freeway or expressway was designed to allow the highest volume of traffic to pass at the highest speeds possible, the cul-de-sac was designed to minimize traffic volume and keep it slow.

In the course of the past ten years, this form of development has increasingly come under criticism from architects, urban planners, environmentalists, and even some developers as being "unsustainable." Depending upon the viewpoint of the critic, this automobile-oriented, largely suburban development is too consumptive of land, too costly in terms of long-range infrastructure supply and maintenance, too disruptive of traditional urban and social fabric, and too limiting in the lifestyle choices it allows. One of these limited lifestyle choices that has come under increasingly close watch is travel behavior. Critics of automobile-oriented development argue that our society has become so obsessed with the production of efficiency in automobile movement that it has built transportation choices right out of the environment. For example, the cul-de-sac represents an advance in design efficiency of automobile movement— and also of protection from automobiles— but a step backwards in design efficiency for pedestrian or transit movement; pedestrians often need to walk exceedingly long distances because through-paths are cut off by cul-de-sacs, and transit vehicles cannot serve cul-de-sacs or efficiently filter through neighborhoods with curvilinear layouts or branch roads. Many modern suburbs, therefore, eliminate options in travel choice by physically designing out any but the automobile option.

As discussed in Chapter Two, a number of contemporary urban planners and designers, such as Elizabeth Plater-Zyberk, Andres Duany, and Peter Calthorpe, argue that we need to move toward building more integrated suburban neighborhoods. Undoing the rigid street hierarchy, returning to more conventional gridiron and radial street forms, narrowing street widths and allowable building setbacks, and landscaping for pedestrian scale will all serve to eliminate the dominance of the automobile in the built form and thereby reduce dependence on it. Calthorpe's Laguna West, for example, in the suburbs of Sacramento, uses radial and gridiron street patterns and minimizes (although does not eliminate entirely) the use of cul-de-sacs in an effort to focus the neighborhoods around transit stops and centers. Similarly, Duany/Plater-Zyberk's plan for the Kentlands, Maryland, provides a network of through streets which enhances both pedestrian and transit vehicle permeability. Through these and other types of neotraditional design schemes, the proponents argue, drive-alone trips and automobile dependency will be reduced.

Unfortunately for researchers trying to substantiate or refute these claims, projects which incorporate these principals are either unbuilt or too new to evaluate. It is, therefore, impossible to empirically test the assertion that neotraditional and other neighborhood types that challenge the logic of automobile-dominated suburban form actually do affect levels of transit use or pedestrian activities. In the absence of such hard-number examples, research has tended to polarize into two methodological approaches.

2.1. *Simulation Studies*

As mentioned in Chapter Two, a number of studies have attempted to use advanced transportation/land-use modeling techniques to forecast what travel behavior would look like in a hypothetical neotraditional world. Kulash (1990) used the standard UTPS travel demand models to simulate neighborhood forms, concluding that neotraditional design reduces average daily VMT by 57 percent relative to standard 1970s-style PUDs. The White Mountain Survey Company (1991) completed a similar study of Portsmouth, New Hampshire, in an effort to derive reliable trip generation rates for two neotraditional communities, which they found to be substantially below the norm.

Two larger modeling studies of transit-oriented development have recently been completed: the Middlesex Somerset Mercer Regional Council modeling project (MSM, 1992), and the Friends of Oregon modeling project (LUTRAQ, 1992). The MSM project modeled travel demand for three high-density, mixed-use center alternatives for the central New Jersey corridor between Trenton and New Brunswick, each of them incorporating neotraditional design principals. They then ran growth models for each alternative, projected to 2010, based on two scenarios,[1] and compared the projections to current trends. All alternatives and scenarios showed substantial reductions in VMT over an extrapolation of existing trends.

The Friends of Oregon's Land Use Transportation Air Quality (LUTRAQ, 1992) study similarly modeled a growth corridor to the west of Portland, Oregon, to the year 2010. The model projected growth around a proposed freeway through the corridor. The researchers then presented a number of alternatives, including both a no-build alternative and a light-rail with neotraditional development alternative. The latter, when modeled to the projection year, showed a VMT rate that was 35 percent below that of the freeway alternative. The LUTRAQ report is particularly noteworthy because it provides detailed neotraditional design recommendations for a wide variety of different neighborhood types, and accounts for those differences in its projections.

2.2. *Previous Empirical Research*

The other direction of research in the absence of hard examples of neotraditional development has been to try to extract evidence from the existing built form— that is, to use "traditional" neighborhoods as a proxy for what "neotraditional" neighborhoods might look like. Several researchers have tried to do this on a macro-scale. Newman and Kenworthy (1989), for example, have looked globally at the correlation between urban density and fuel consumption, concluding that low-density cities average four to five times more fuel consumption per capita as high-density ones with good transit services. Similarly, Holtzclaw (1991) has tried to extract evidence of the influence of residential neighborhood design on travel behavior by looking broadly at neighborhoods in the San Francisco Bay Area. Both of these endeavors, however, look at neighborhoods that are too fundamentally

neighborhoods, while controlling for confounding variables. "Transit neighborhoods" were defined as follows:[2]

- initially built along a streetcar line or around a rail station;
- primarily gridded (over 50 percent of intersections 4-way or "X" intersections);
- laid out and largely built up prior to 1945.

"Auto neighborhoods," on the other hand, were defined as:

- laid out without regard to transit, generally in areas without transit lines, either present or past;
- primarily random street patterns (over 50 percent of intersections either 3-way, "T" intersections, or cul-de-sacs);
- laid out and built up after 1945.

The first step of our research methodology was to identify candidate Transit neighborhoods for both of the metropolitan areas. This was done by comparing contemporary street maps with historical railroad and streetcar maps. Where gridiron or radial street patterns from the street map lined up with rail or street car lines from the streetcar and railroad map (and particularly where two or more of these lines crossed), we noted a potential "traditional" neighborhood. We narrowed down this list of potential neighborhoods through both windshield surveys and discussions with planners and others familiar with the neighborhoods.

Next, for each of the Transit neighborhoods, we attempted to find a matching Auto neighborhood. Two sets of criteria were used to find the matches. First, three control criteria were used—variables on which the Auto neighborhood should not vary from those of the Transit neighborhood. For each Transit neighborhood, an Auto neighborhood needed to:

- have no more than 10 percent variation of median household income from the Transit neighborhood;
- have reasonably comparable intensities and types of transit service available as in the Transit neighborhood;
- have reasonably similar topographic and other natural features as the Transit neighborhood; and
- be no more than 4 miles from the center of the Transit neighborhood.

Second, a list of differentiation criteria— those variables by which the Auto neighborhood must (by definition) differ from the Transit neighborhood— was established. The Auto neighborhood must:

- have a significantly lower percentage of 4-way, cross-intersections than the Transit neighborhood; and
- have net residential densities equal to or less than those of the Transit neighborhood.

After applying these criteria, the number of candidate neighborhood pairs in both metropolitan areas was whittled down considerably— from over 400 to just 7 in the San Francisco Bay Area, and from over 700 to just 6 in the Los Angeles-Orange County region.

3.1. Study Criteria

Since the strictness of these criteria sharply reduced the number of candidate Auto neighborhoods, it is instructive to explain in some detail the rationale for each of them.

(1) *No more than 10 percent variation of median household income from the Transit neighborhood*

It has been well established that mode choice is highly correlated with income. It is essential, then, that neighborhoods be matched in terms of median income to remove this confounding influence (Kanafani, 1983; Meyer and Gómez-Ibáñez, 1981).

(2) *Reasonably comparable levels and types of transit service available as in the Transit neighborhood*

This criterion is of utmost importance, although it is problematic in that it touches on the muddy issue of cause and effect in transit provision. We found that the Transit neighborhoods naturally had greater levels of transit service; they were, after all, laid out for transit. It is therefore difficult to assess whether these neighborhoods have more frequent transit service because they have more transit users (demand-driven) or because transit operators simply find them more efficient through which to operate (supply-driven).[3] We sought to pair neighborhoods that had less than a 50 percent difference in the transit intensity indicator, although many of the neighborhood pairs, particularly in Los Angeles, admittedly have larger differentials.[4] Where they do exceed 50 percent difference in the intensity indicator, this is noted in the neighborhood description.

(3) *Reasonably similar topographic and other natural features as the Transit neighborhood*

This criterion was based on the assumption that topographic characteristics of a neighborhood influence travel behavior independent of neighborhood design.

(4) *No more than 4-mile distance between centroids of the matched pairs*

Transit usage is most reliably compared between areas of close physical proximity. Neighborhoods that are far from each other, even if all socio-economic data match up reasonably well, are likely to experience different regional affiliations and historical contexts, which can affect mode choice in ways that are too difficult to take into account.[5]

(5) *Net residential densities equal to or less than those of the Transit neighborhood*

Critics of post-war suburban housing development have generally argued that current suburban densities are too low to support transit. Previous studies suggest that densities of 12 dwelling units to the acre are the minimum necessary to sustain basic transit of 15-minute headways or less (Pushkarev and Zupan, 1977). We assume, therefore, that transit-oriented developments will, in general, be planned with net residential densities higher than today's standards. Consequently, we looked for Transit neighborhoods with densities higher than Auto neighborhoods. In order not to overly constrain the analysis, however, threshold criteria were not set for net residential density for either the Transit- or the Auto-neighborhoods.[6]

3.2. Process of Neighborhood Elimination

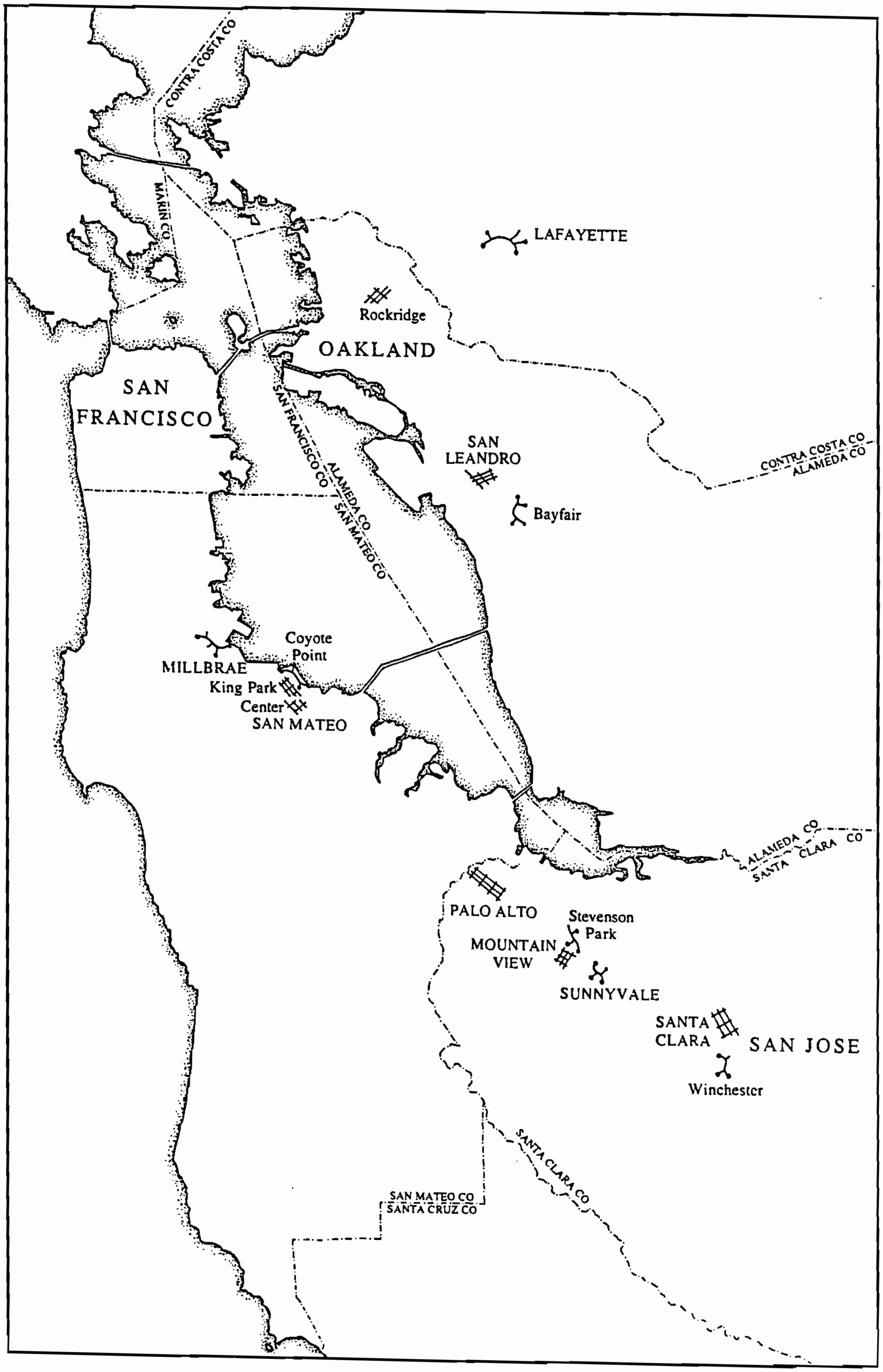
Using both the control and the differentiation criteria, matches were found through a process of elimination. Many Transit neighborhoods were eliminated from consideration because an appropriate match could not be found.[7] All of the matches met our income criterion, but some did not strictly adhere to the transit service intensity criterion. Strict adherence to this criterion would have produced practically no pairs to evaluate. Pairs that violate criteria are marked, and explanations why it is important to include them are given.[8]

4. Case Results: San Francisco

4.1. San Francisco Pair Descriptions

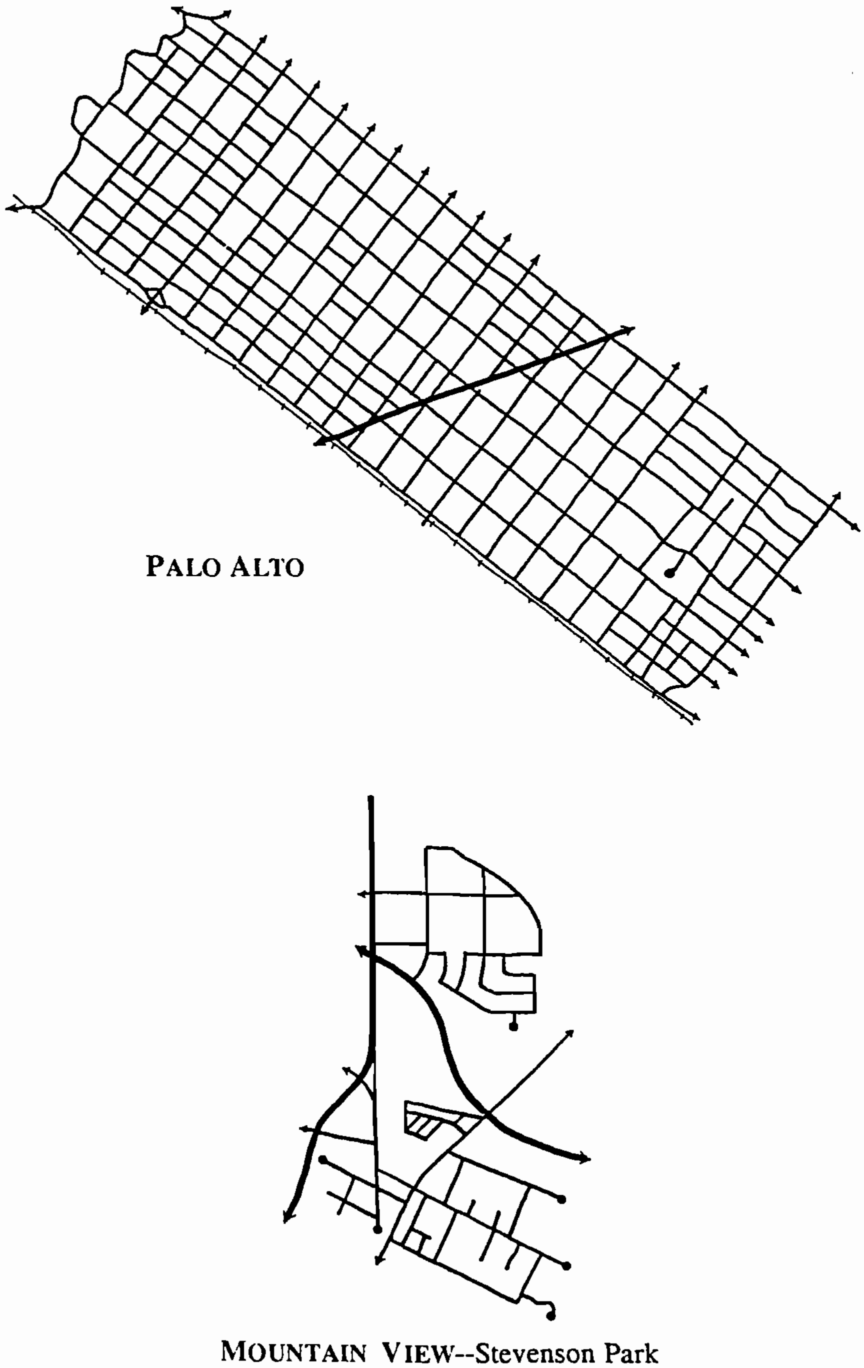
Seven matched pairs for the San Francisco Bay Area, and six for the Los Angeles area, were found. The Bay Area neighborhoods varied in geometric size from ¼ square mile to a little over 2¼ square miles. Neighborhood population ranged from 2,000 to 10,500 people living in the neighborhood. The geographic locations of the matched pairs are shown in Map 5.1.

- *Palo Alto/Stevenson Park:* Downtown Palo Alto was paired with the Stevenson School Park district of Mountain View[9] (see Map 5.2). These areas are highly comparable— there is only about a 4 percent difference in median income between them, and both have comparable levels of bus service. In addition, both have Caltrain (commuter rail) stations immediately adjacent to them.
- *Santa Clara/San Jose-Winchester:* Central Santa Clara was paired with a portion of San Jose immediately adjacent to the Winchester Mystery House[10] (see Map 5.3). Both of these neighborhoods are also highly comparable. There is only a 7 percent difference in median income, and both neighborhoods have comparable levels of bus service. Although a portion of the Santa Clara study area lies within ¼ mile of a Caltrain station while the San Jose-Winchester neighborhood does not, very little of the Santa Clara study area can be said to be within walking distance of that station. Caltrain passengers from both areas would need to arrive at the station via another mode.
- *San Mateo Center/San Mateo-Bayshore Point:* Central San Mateo was paired with the neighborhood east of the 101 Freeway just south of the San Mateo Golf Course[11] (see Map 5.4). Both areas line up well according to income, with only a 4 percent difference between them. However, there is a roughly 53 percent difference in the level of transit intensity between them.
- *Rockridge/Lafayette:* The Rockridge neighborhood of Oakland was compared with Lafayette[12] (see Map 5.5). Rockridge is actually very traditional in its feel, but, because it is built adjacent to a slope, it has as many T as cross-intersections. The two neighborhoods are roughly five miles apart, a distance which is admittedly long. It was felt, however, that it was important to have at least one pair comparing similar incomes on both sides of the Oakland hills. The Lafayette neighborhood, because of census tract demarcations, is rather large, physically. This is not problematic for purposes of comparison, however, since the bulk of the residential units in this tract are clustered in



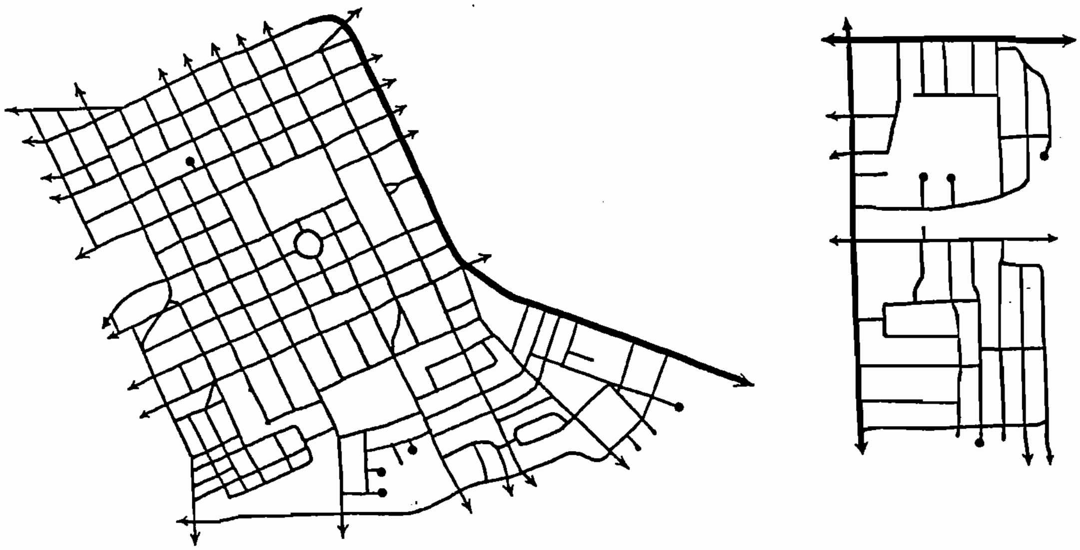
Map 5.1

Location of Paired Neighborhoods for the San Francisco Bay Area



Map 5.2

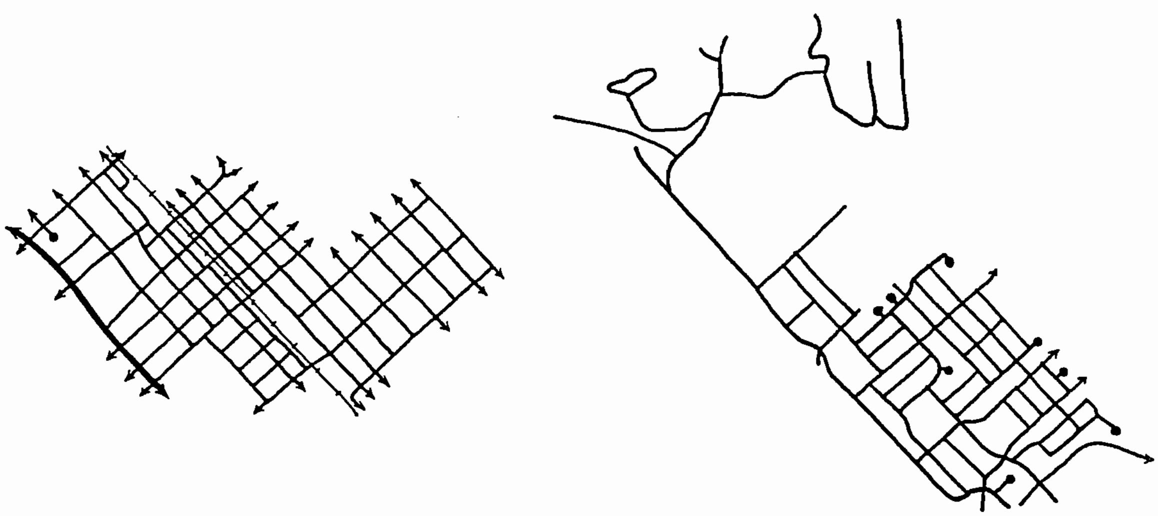
Palo Alto and Mountain View-Stevenson Park Pair



SANTA CLARA SAN JOSE--Winchester

Map 5.3

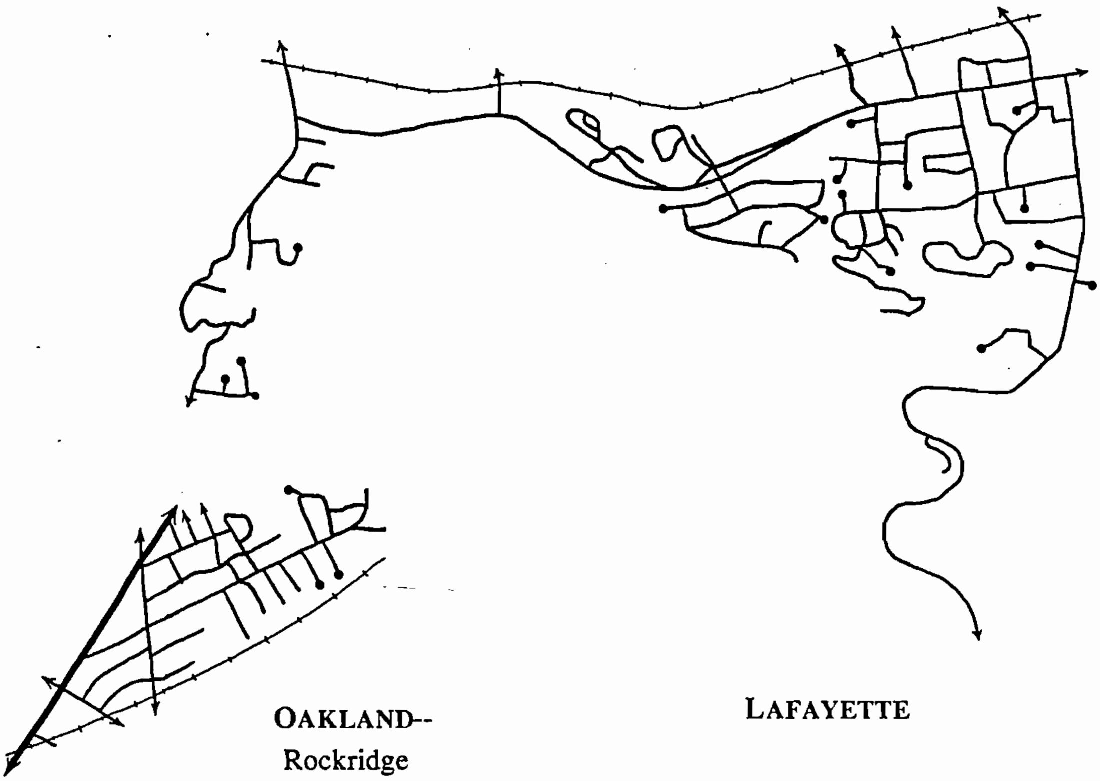
Santa Clara and San Jose-Winchester Pair



SAN MATEO--Center SAN MATEO--Coyote Point

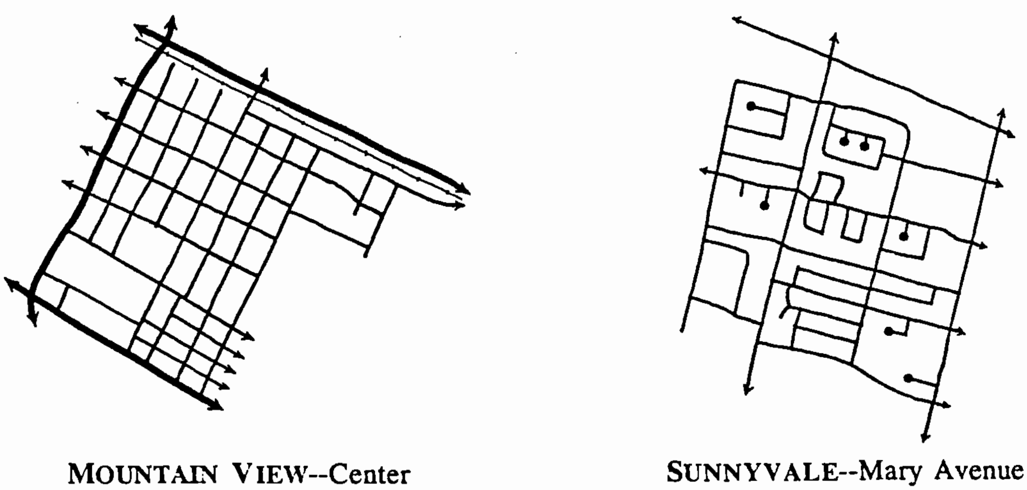
Map 5.4

San Mateo-Center and San Mateo-Coyote Point Pair



Map 5.5

Oakland-Rockridge and Lafayette Pair



Map 5.6

Mountain View-Center and Sunnyvale-Mary Avenue Pair

the quadrant of the tract near the BART station, providing a residential cluster only slightly larger than the Rockridge neighborhood.

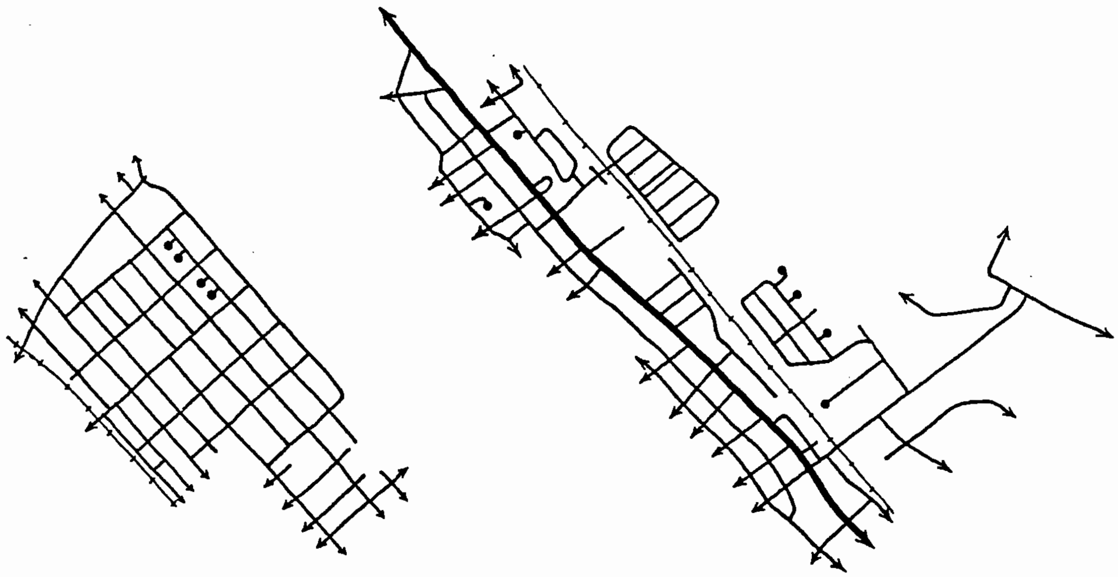
- *Mountain View (Downtown)/Sunnyvale-Mary Avenue:* The downtown area of Mountain View was paired with a neighborhood of Sunnyvale just north of Mary Avenue[13] (see Map 5.6). The areas are comparable, although the Sunnyvale neighborhood has a slightly higher net residential density than Mountain View. Also, the Sunnyvale neighborhood is not adjacent to a Caltrain station.
- *San Mateo-King Park/Millbrae:* A second neighborhood of downtown San Mateo, with a lower median income than the first, was compared with an area of Milbrae between the Caltrain station and San Francisco International Airport[14] (see Map 5.7). These two neighborhoods are highly comparable, and are served by both rail and bus.
- *San Leandro/Bayfair:* Central San Leandro was compared with the area immediately adjacent to the Bayfair BART[15] (see Map 5.8). The areas match up together in virtually all respects, including transit service intensity and type, and are therefore ideal comparisons.

4.2. San Francisco Area Results

Tables 5.1 and 5.2 summarize the control and differentiation criteria for the San Francisco Bay Area. Overall, neighborhoods match closely in terms of median incomes and transit service types, though Transit neighborhoods tend to enjoy more intensive bus services. Also, neighborhoods tend to differ sizably on differentiation criteria— Transit neighborhoods have 35-50 percent more four-way intersections and in seven of the eight pairs have higher residential densities.

The modal shares and trip generation rates for matched-pairs are presented in Tables 5.3 and 5.4, and summarized in Figures 5.1 through 5.4. All data are for 1990 work trips by place of residence. Particular attention should be paid to the Palo Alto/Mountain View, the Santa Clara/San Jose-Winchester, and the San Leandro/Bayfair matches, since these meet the study criteria in all respects.

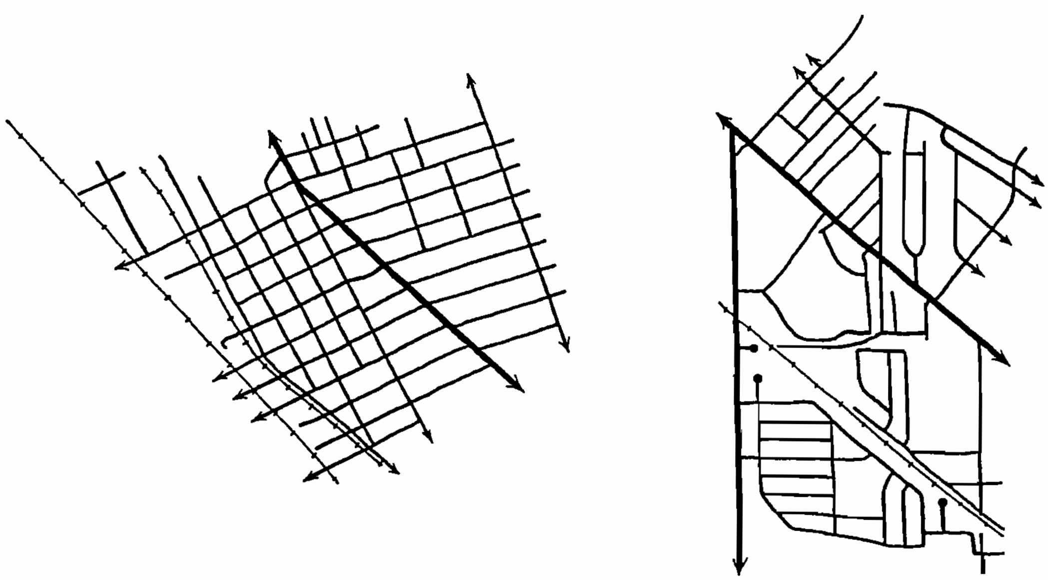
These results show significantly higher pedestrian mode shares and trip generation rates in all cases for work trips in Transit neighborhoods than in Auto neighborhoods. In addition, all Transit neighborhoods have lower automobile drive-alone modal shares and trip generation rates than Auto neighborhoods, in some cases, significantly lower. Moreover, all transit neighborhoods except Palo Alto generate more transit work trips and greater proportions of work trips made by transit than their Automobile counterparts. In all, the evidence is fairly persuasive for the selected Bay Area paired neighborhoods — controlling for income and to the extent possible, transit service levels, transit-oriented neighborhoods average far less solo-commuting than nearby auto-oriented neighborhoods.



SAN MATEO--King Park MILLBRAE

Map 5.7

San Mateo-King Park and Millbrae Pair



SAN LEANDRO BAYFAIR

Map 5.8

San Leandro and Bayfair Pair

Table 5.1

Characteristics of Bay Area Neighborhoods: Control Factors, 1990-92

Transit Neighborhood	Auto Neighborhood	Median Household Income TN	Median Household Income AN	Median Household Income % Difference	Bus Service in Daily VMT per Acre TN	Bus Service in Daily VMT per Acre AN	Bus Service in Daily VMT per Acre % Difference	Type of Transit Service TN	Type of Transit Service AN	Distance Between Centroids (in miles)
Palo Alto	Mountain View-Stevenson Park	47,500	45,486	4.2	0.27	0.23	11.8	"Bus, CR"	"Bus, CR"	3.50
Santa Clara	San Jose-Winchester	32,400	34,826	7.5	0.66	0.58	11.4	"Bus, CR"	Bus	2.00
San Mateo-Center	San Mateo-Bayshore/Point	37,159	38,873	4.6	0.47	0.22	53.3	"Bus, CR"	Bus	1.00
Oakland-Rockridge	Lafayette	46,512	43,108	7.3	1.43	0.12	91.5	"Bus, HR"	"Bus, HR"	6.00
Downtown Mountainview	Sunnyvale-Mary Ave	40,379	40,398	0.1	0.71	0.51	29.3	"Bus, CR"	Bus	1.75
San Mateo-King Park	Millbrae	32,080	31,829	0.8	0.53	0.65	23.2	"Bus, CR"	"Bus, CR"	3.50
San Leandro	Bayfair	30,115	31,282	3.9	0.87	1.00	14.3	"Bus, HR"	"Bus, HR"	2.00

Note: TN=Transit Neighborhood; AN=Auto Neighborhood; CR=Commuter Rail; HR=Heavy Rail

Data Source: 1990 United States Census, STF-3A, and data from local transit agencies.

Table 5.2

Characteristics of Bay Area Neighborhoods: Differentiation Criteria, 1990-92

Transit Neighborhood	Auto Neighborhood	% X Intersections TN	% X Intersections AN	% X Intersections % Difference[1]	% Cul-de-Sacs TN	% Cul-de-Sacs AN	% Cul-de-Sacs % Difference[1]	Net Residential Density (Dwelling Units per Acre) TN	Net Residential Density (Dwelling Units per Acre) AN	Net Residential Density (Dwelling Units per Acre) % Difference
Palo Alto	Mountain View-Stevenson Park	62.4	15.5	46.9	2.4	24.2	21.9	6.27	6.25	0.3
Santa Clara	San Jose-Winchester	63.6	28.3	35.3	3.5	18.9	15.4	6.18	4.03	53.3
San Mateo-Center	San Mateo-Bayshore/Point	67.0	19.2	47.8	3.2	20.5	17.3	6.91	5.00	38.2
Oakland-Rockridge	Lafayette	44.7	9.6	35.1	10.5	4.0	6.5	5.32	2.12	150.9
Downtown Mountainview	Sunnyvale-Mary Ave	69.8	32.1	37.7	3.2	19.6	16.4	7.08	8.31	17.4
San Mateo-King Park	Millbrae	65.9	29.0	36.9	5.5	19.6	14.1	6.89	5.09	35.4
San Leandro	Bayfair	64.5	26.1	38.4	5.4	10.2	4.8	7.34	5.94	23.6

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

[1]Percentage point difference.

Data Source: 1990 United States Census, STF-3A, and field surveys.

Table 5.3

Comparison of Work Trip Modal Splits Among Bay Area Neighborhoods, 1990

Transit Neighborhood	Auto Neighborhood	Drive Alone % TN	Drive Alone % AN	Drive Alone % Difference*	Transit % TN	Transit % AN	Transit % Difference*	Pedestrian % TN	Pedestrian % AN	Pedestrian % Difference*
Palo Alto	Mountain View-Stevenson Park	69.8	82.4	12.6	3.5	4.2	0.7	14.8	4.2	10.6
Santa Clara	San Jose-Winchester	70.1	84.3	14.2	3.7	1.4	2.3	13.4	2.9	10.5
San Mateo-Center	San Mateo-Bayshore/Point	71.9	73.9	2.0	9.5	5.1	4.4	5.3	2.1	3.2
Oakland-Rockridge	Lafayette	48.7	66.2	17.5	20.3	15.2	5.1	16.4	3.2	13.4
Downtown Mountainview	Sunnyvale-Mary Ave	78.9	82.9	4.0	4.6	1.3	3.3	7.1	2.9	4.2
San Mateo-King Park	Millbrae	57.9	73.5	15.5	12.8	7.5	5.3	9.3	8.1	1.2
San Leandro	Bayfair	70.2	73.0	2.8	13.8	10.4	3.4	6.5	2.3	4.2

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

*Percentage point difference.

Data Source: 1990 US Census, STF3-A

Table 5.4

Comparison of Work Trip Generation Rates Among Bay Area Neighborhoods, 1990

Transit Neighborhood	Auto Neighborhood	Drive-Alone Generation Rate** TN	Drive-Alone Generation Rate** AN	Drive-Alone Generation Rate** Difference	Transit Generation Data** TN	Transit Generation Data** AN	Transit Generation Data** Difference	Pedestrian Generation Rates** TN	Pedestrian Generation Rates** AN	Pedestrian Generation Rates** Difference
Palo Alto	Mountain View-Stevenson Park	783	970	186	40	50	10	100	33	67
Santa Clara	San Jose-Winchester	943	980	37	49	16	33	153	11	142
San Mateo-Center	San Mateo-Bayshore/Point	691	1,174	483	92	83	9	49	26	23
Oakland-Rockridge	Lafayette	669	855	187	278	197	81	79	32	46
Downtown Mountainview	Sunnyvale-Mary Ave	975	1,161	186	57	18	39	74	29	45
San Mateo-King Park	Millbrae	996	894	102	221	92	129	145	95	51
San Leandro	Bayfair	619	813	194	122	117	5	51	21	30

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

**per one thousand housing units

Data Source: 1990 U.S. Census, ST F3-A

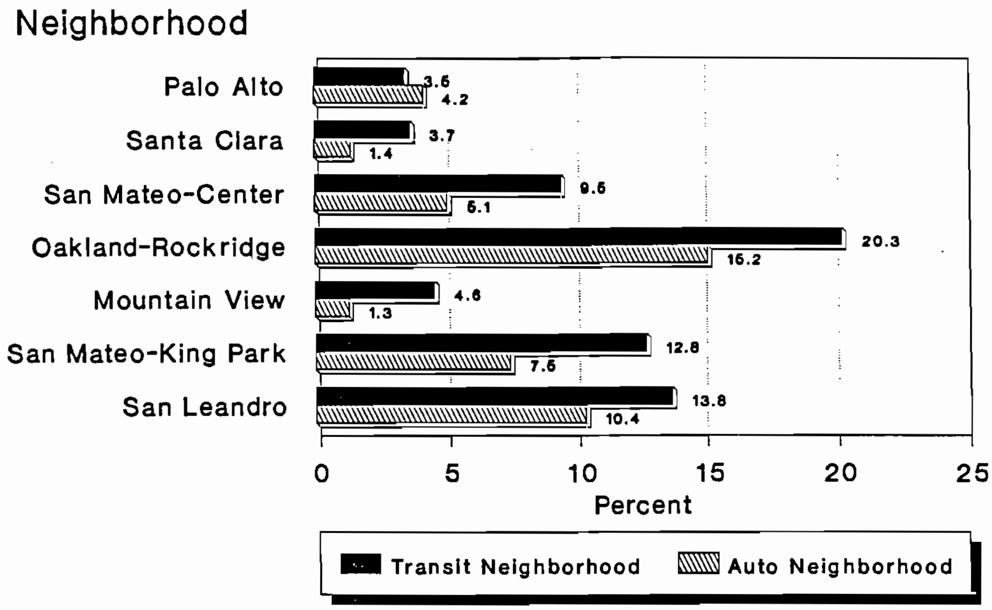


Figure 5.1

Neighborhood Comparisons of Transit Modal Splits, San Francisco Bay Area, 1990 Work Trips

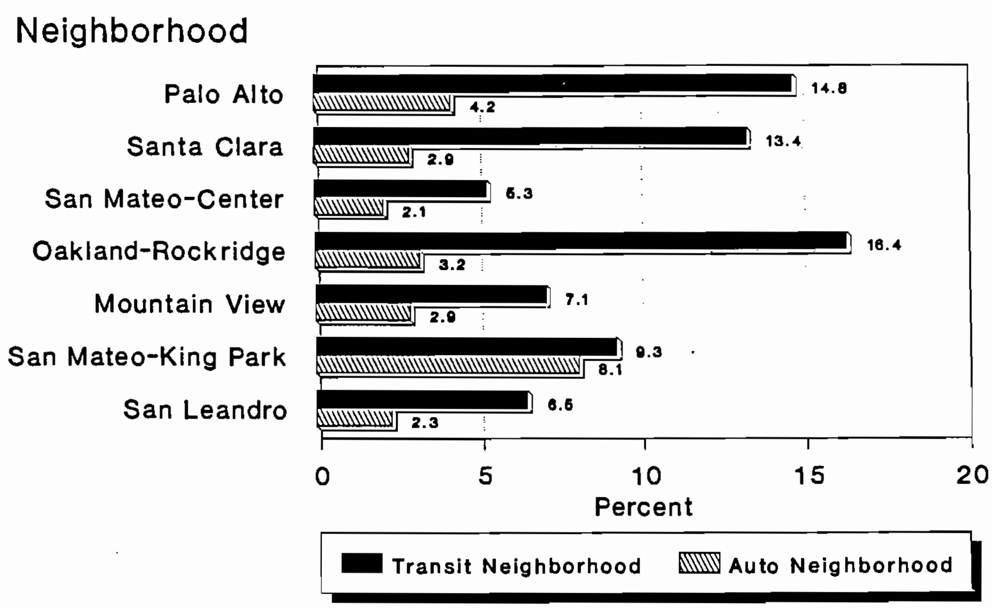
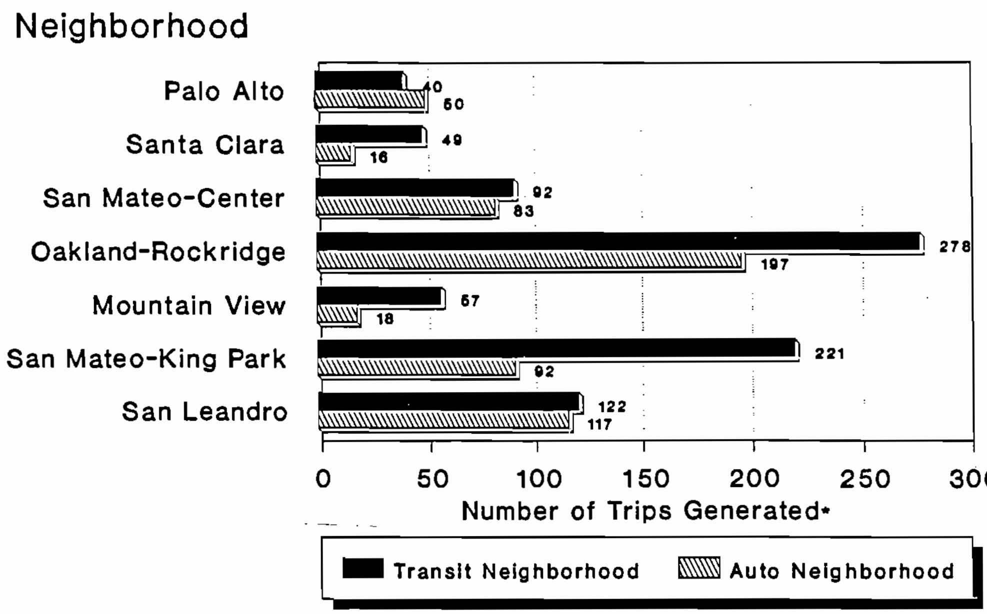


Figure 5.2

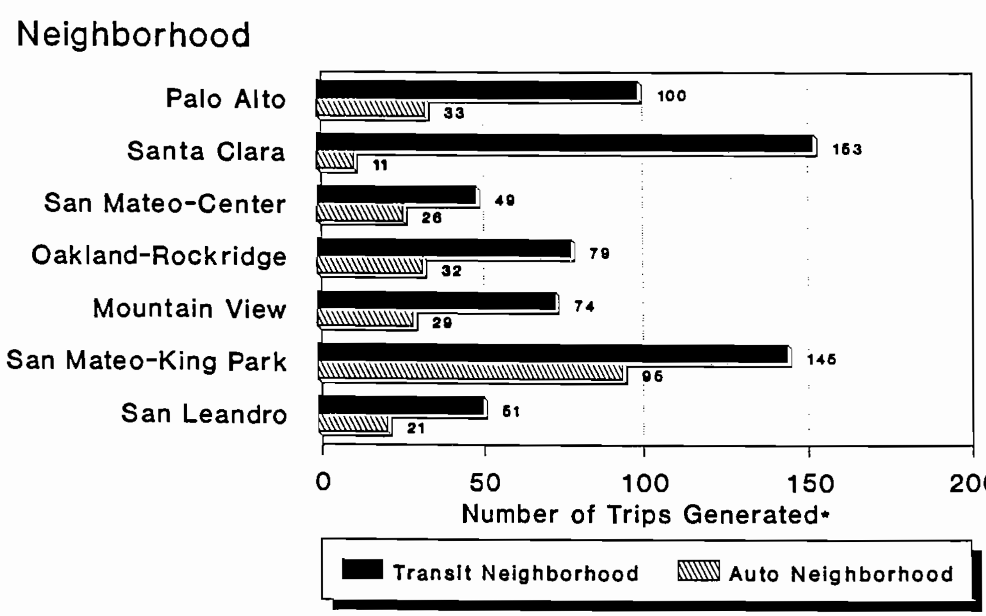
Neighborhood Comparisons of Walk and Bicycle Modal Splits, San Francisco Bay Area, 1990 Work Trips



* per 1,000 dwelling units

Figure 5.3

Neighborhood Comparisons of Transit Trip Generation Rates, San Francisco Bay Area, 1990 Work Trips



* per 1,000 dwelling units

Figure 5.4

Neighborhood Comparison of Walk/Bicycle Trip Generation Rates, San Francisco Bay Area, 1990 Work Trips

5. Case Results: Los Angeles

5.1. Los Angeles Pair Descriptions

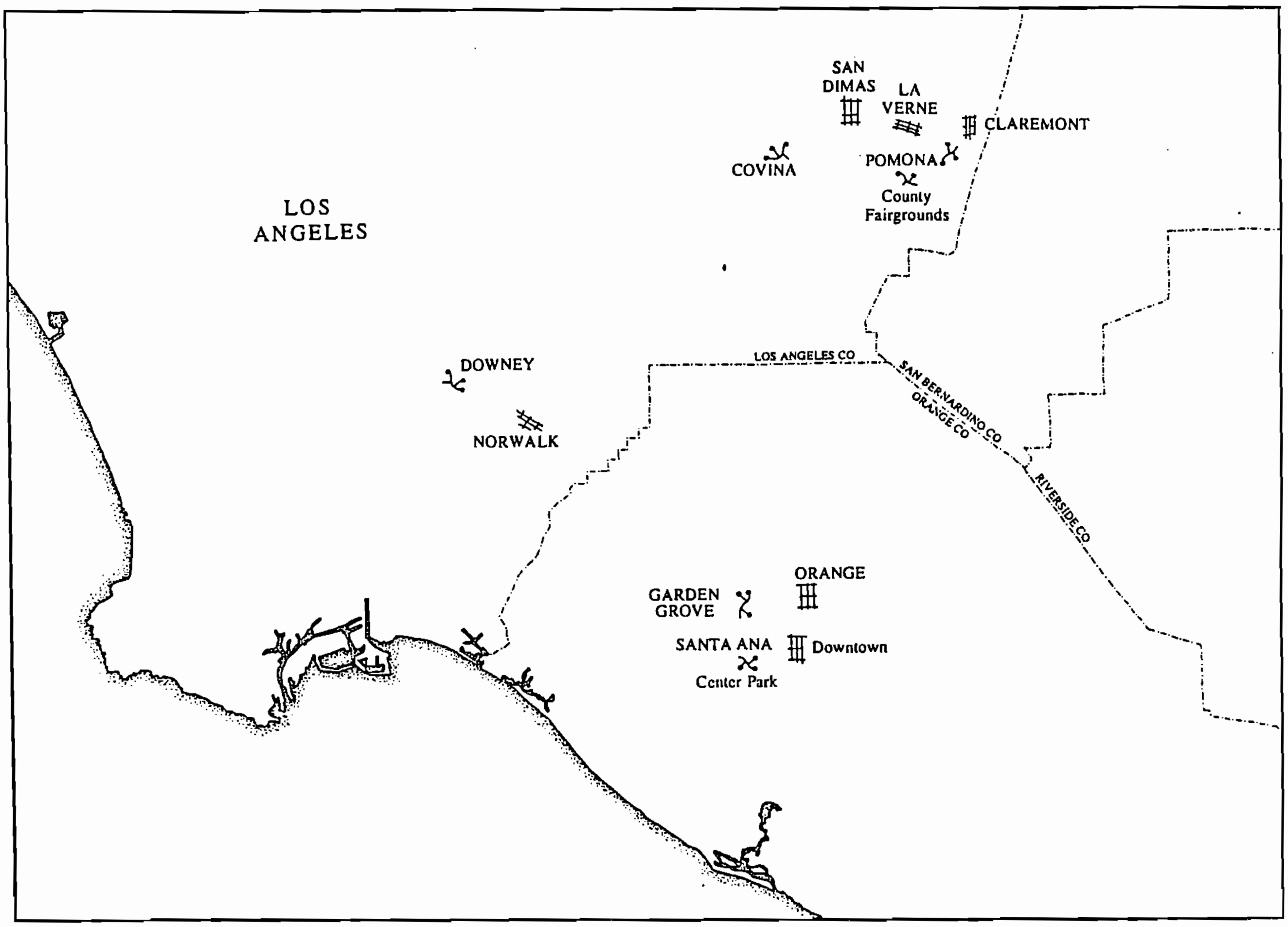
The Los Angeles neighborhoods are generally smaller than the San Francisco ones, all under a square mile in size. Neighborhood populations range from roughly 1,000 to 8,000 people. The locations of the Los Angeles pairs are shown in Map 5.9.

- *Santa Ana-Downtown/Santa Ana-Center Park:* An area adjacent to downtown Santa Ana (between downtown and the Santa Ana train station) was paired up with another Santa Ana neighborhood roughly 2¼ miles away, grouped around Center Park[16] (see Map 5.10). The areas match up well on all criteria. There is only a 1.8 percent difference in median household income, and only an 8.8 percent difference in the transit intensity indicator.
- *Orange/Garden Grove:* The center of the city of Orange was matched up with a neighborhood in Garden Grove adjacent to (but not including) "The City" shopping center, roughly 2½ miles away[17] (see Map 5.11). Again these neighborhoods match up well on all criteria. Photos 5.1 and 5.2 show residences in these two neighborhoods.
- *Norwalk/Downey:* Central Norwalk was compared with a neighborhood in Downey located adjacent to Rockwell International's Space division[18] (see Map 5.12). The neighborhoods line up well in terms of differentiation and control criteria, except that Norwalk averages 40 percent more vehicle miles of bus service per acre.
- *La Verne/Pomona-County Fairgrounds:* Downtown La Verne was paired with a neighborhood in Pomona located about one-half mile south of the Los Angeles County Fairgrounds[19] (see Map 5.13). The neighborhoods match up fairly closely on all criteria.
- *Claremont/Pomona-Palomares:* Central Claremont was compared with a neighborhood of Pomona adjacent to Pomona High School[20] (see Map 5.14). The neighborhoods pair well for all criteria except for transit service intensity, where the Transit neighborhood has 78 percent more bus service per acre than the Auto neighborhood.
- *San Dimas/Covina:* Downtown San Dimas was paired with a section of Covina near the Berkley Square shopping center[21] (see Map 5.15). Again, these areas match up well on all criteria except bus service intensity, where the Transit neighborhood averages about 50 percent more service miles per acre than the Auto neighborhood.

5.2. Los Angeles Area Results

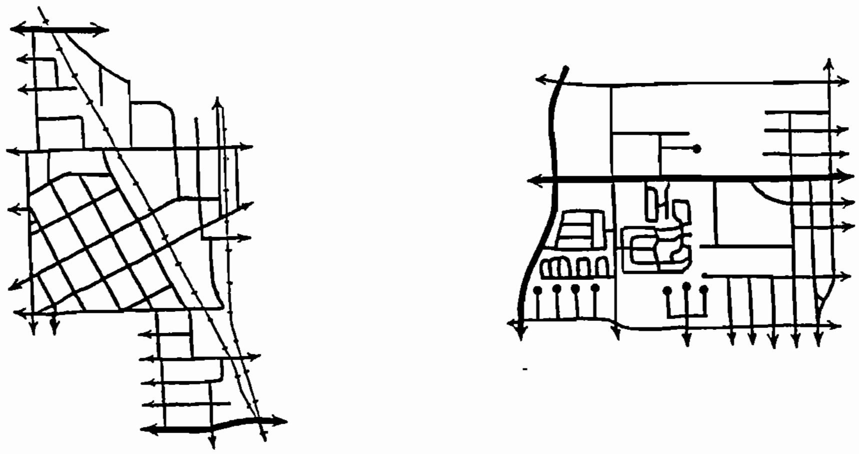
Tables 5.5 and 5.6 summarize the control and differentiation criteria for the six matched-pairs in the Los Angeles region. Overall, neighborhoods match closely on income and differ markedly in terms of road figurations. All Transit neighborhoods are denser than their Automobile peers (though in several cases only slightly). Transit service intensity again proved the most difficult factor to control.

Differences in work trip modal splits and trip generation rates are shown in Table 5.7 and 5.8, and summarized in Figures 5.5 through 5.8. These results are clearly more problematic than the San Francisco results. With the exception of La Verne, Transit neighborhoods have higher walking rates and lower drive-alone rates, for work trips, in terms of both the modal share and trip generation variables. However, impacts on transit commuting were less straightforward. Two of the Transit neighborhoods (La Verne and Claremont) had lower transit modal shares and trip generation



Map 5.9

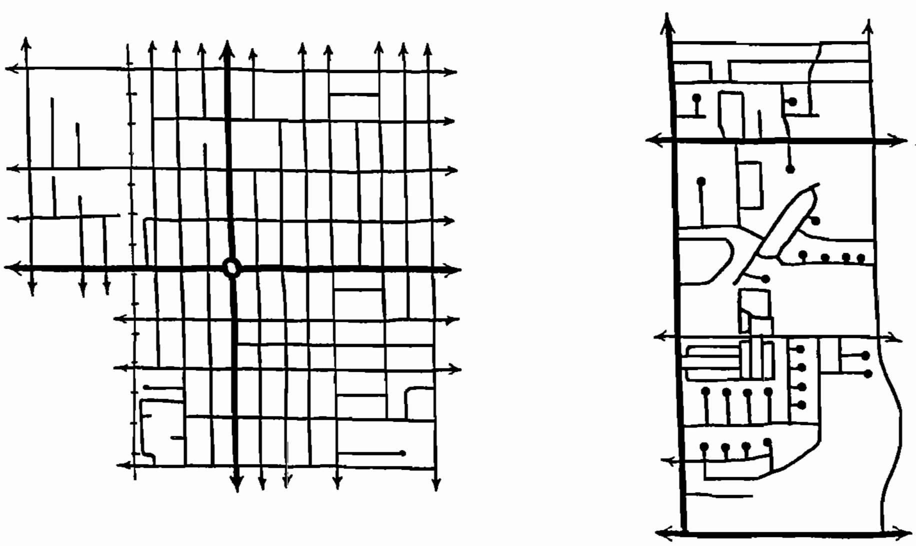
Location of Paired Neighborhoods for the Los Angeles-Orange County Area



SANTA ANA--Downtown SANTA ANA--Center Park

Map 5.10

Santa Ana-Downtown and Santa Ana-Center Park Pair



ORANGE GARDEN GROVE

Map 5.11

Orange and Garden Grove Pair

Photo 5.1

Garden Grove: Typical Automobile Residential Neighborhood in the Los Angeles Area (No Sidewalks)

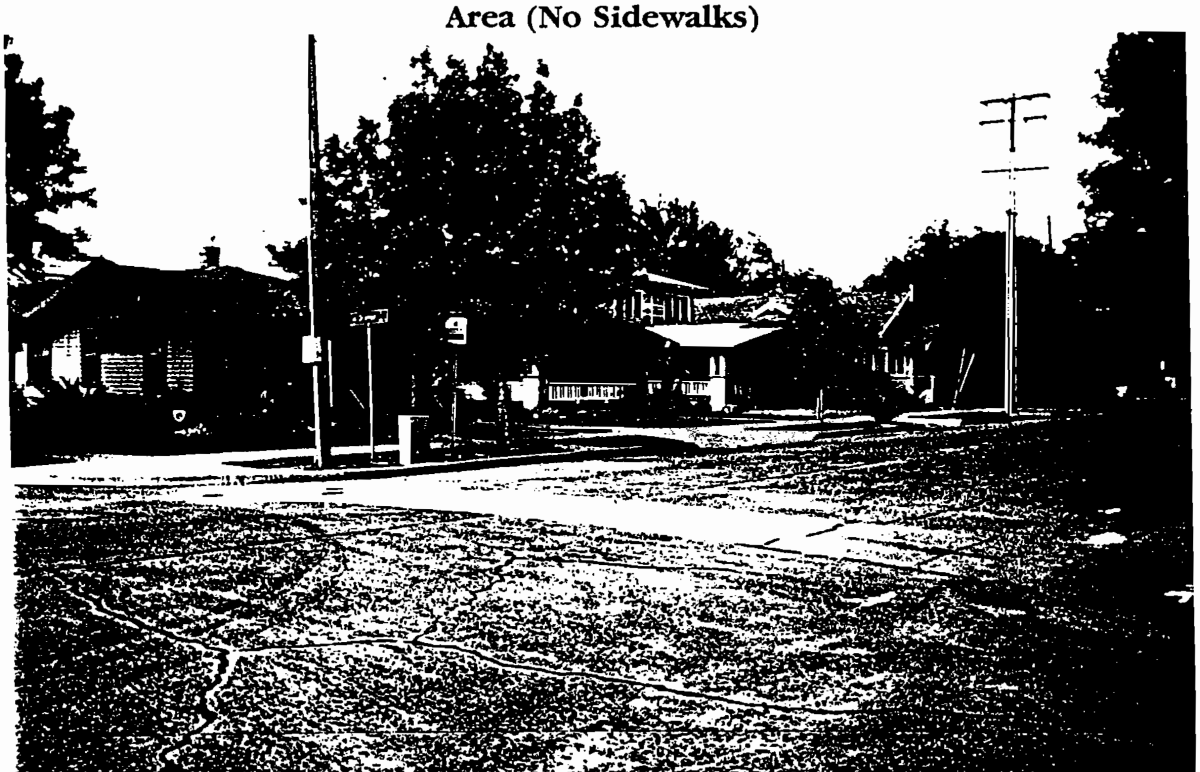
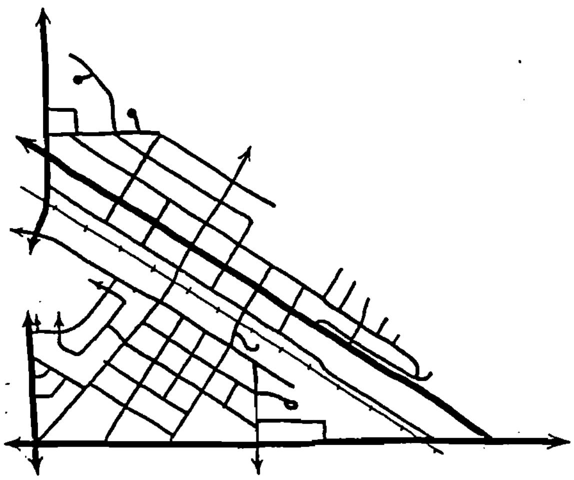
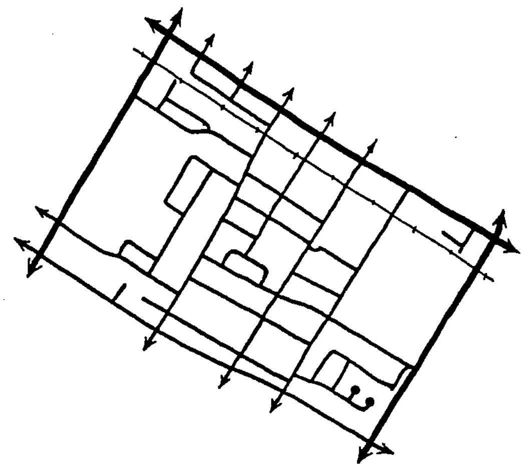


Photo 5.2

Orange City: Typical Transit Residential Neighborhood in the Los Angeles Area (Sidewalk; Transit Access)



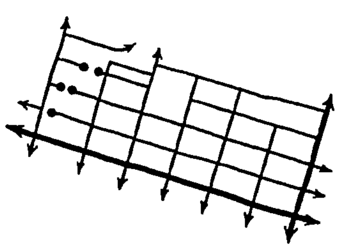
NORWALK



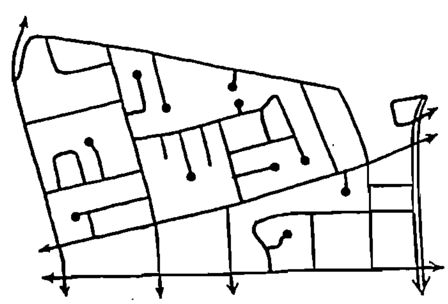
DOWNEY

Map 5.12

Norwalk and Downey View Pair



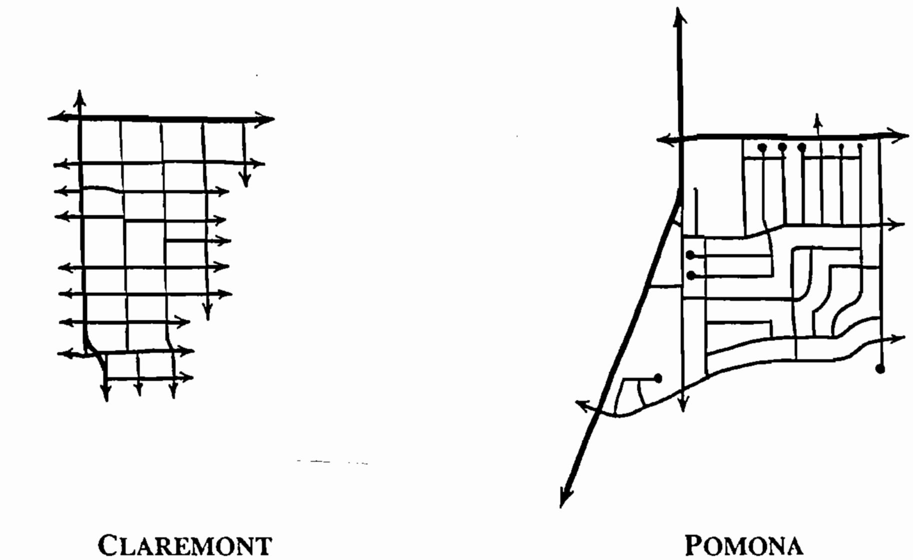
LA VERNE



POMONA--County Fairgrounds

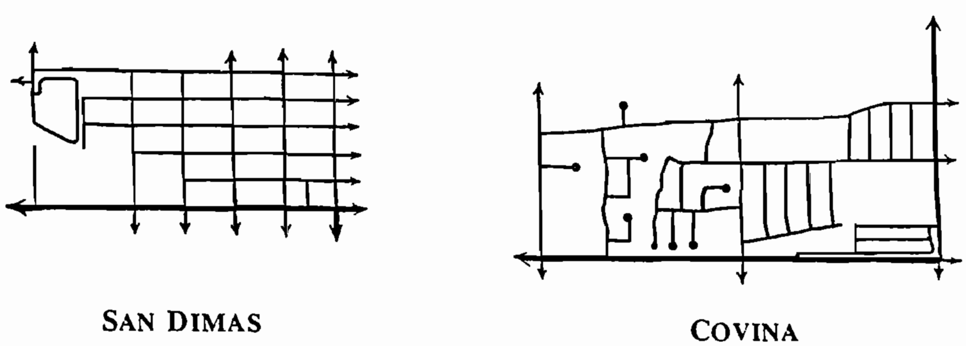
Map 5.13

La Verne and Pomona-County Fairgrounds Pair



Map 5.14

Claremont and Pomona Pair



Map 5.15

San Dimas and Covina Pair

Table 5.5

Characteristics of Los Angeles Area Neighborhoods: Control Factors, 1990-92

		Median Household Income			Bus Service in Daily VMT per Acre			Type of Transit Service		Distance Between Centroids
Transit Neighborhood	Auto Neighborhood	TN	AN	% Difference	TN	AN	% Difference	TN	AN	(in miles)
Santa Ana	Santa Ana-Center Park	25,291	25,755	1.83	0.42	0.46	8.9	Bus	Bus	2.25
Orange	Garden Grove	32,848	33,627	2.37	0.25	0.18	25.4	Bus	Bus	2.75
Norwalk	Downey	27,500	30,215	9.87	0.42	0.25	39.9	Bus	Bus	3.50
La Verne	Pomona-County Fairgrounds	28,818	29,808	3.44	0.34	0.42	23.4	Bus	Bus	2.50
Claremont	Pomona-Palomares	31,477	29,702	5.64	0.82	0.18	77.7	Bus	Bus	1.62
San Dimas	Covina	36,201	36,121	0.22	0.40	0.20	49.9	Bus	Bus	3.50

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

Sources: 1990 US Census, STF-3A, and data from local transit agencies.

Table 5.6

Characteristics of Los Angeles Area Neighborhoods: Differentiation Criteria, 1990-92

		% X Intersections			% Cul-de-Sacs			Net Residential Density (Dwelling Units per Acre)		
Transit Neighborhood	Auto Neighborhood	TN	AN	Difference[1]	TN	AN	Difference[1]	TN	AN	Difference[1]
Santa Ana	Santa Ana-Center Park	57.8	31.2	26.6	6.0	20.4	14.4	5.91	4.73	24.9
Orange	Garden Grove	72.9	13.1	59.8	5.6	25.3	19.7	7.01	6.97	5.7
Norwalk	Downey	43.9	27.8	16.1	9.2	1.0	3.3	6.56	6.03	8.8
La Verne	Pomona-County Fairgrounds	73.5	19.7	53.9	0.0	21.3	21.3	4.07	4.03	1.0
Claremont	Pomona-Palomares	7.0	23.9	46.1	0.0	21.1	21.1	4.77	4.14	15.2
San Dimas	Covina	73.3	18.8	54.5	10.0	2.0	9.8	8.24	6.38	29.2

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

[1]Percentage point difference.

Source: 1990 US Census, STF-3A, and field surveys.

Table 5.7

Comparison of Work Trip Modal Splits Among Los Angeles Area Neighborhoods, 1990

Transit Neighborhood	Auto Neighborhood	Drive Alone % TN	Drive Alone % AN	Drive Alone % Difference*	Transit % TN	Transit % AN	Transit % Difference*	Pedestrian % TN	Pedestrian % AN	Pedestrian % Difference*
Santa Ana	Santa Ana-Center Park	38.9	53.2	14.3	16.8	9.6	7.8	5.6	1.0	4.6
Orange	Garden Grove	72.2	72.8	0.6	5.8	4.6	1.2	6.8	3.6	3.2
Norwalk	Downey	71.6	81.4	9.8	3.9	2.7	1.2	4.9	3.3	1.7
La Verne	Pomona-County Fairgrounds	77.1	69.3	7.8	1.0	3.5	2.5	2.3	7.5	5.2
Claremont	Pomona-Palomares	62.5	69.6	7.1	0.1	5.0	4.9	26.4	1.9	24.6
San Dimas	Covina	79.9	78.7	1.2	4.6	2.5	2.1	3.8	1.6	2.2

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

*Percentage point difference.

Data Source: 1990 US Census, STF3-A

Table 5.8

Comparison of Work Trip Generation Rates Among Los Angeles Area Neighborhoods, 1990

Transit Neighborhood	Auto Neighborhood	Drive Alone Generation Rate** TN	Drive Alone Generation Rate** AN	Drive Alone Generation Rate** Difference	Transit Generation Rate** TN	Transit Generation Rate** AN	Transit Generation Rate** Difference	Pedestrian Generation Rate** TN	Pedestrian Generation Rate** AN	Pedestrian Generation Rate** Difference
Santa Ana	Santa Ana-Center Park	807	941	134	349	158	191	84	12	73
Orange	Garden Grove	1,003	1,045	42	80	65	15	65	34	31
Norwalk	Downey	889	976	87	49	32	16	56	33	23
La Verne	Pomona-County Fairgrounds	846	995	150	10	72	61	25	26	1
Claremont	Pomona-Palomares	704	983	279	1	50	49	251	72	179
San Dimas	Covina	846	1,040	195	10	32	22	25	17	8

**work trips per 1,000 housing units

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

Source of Data: 1990 US Census, STF3-A

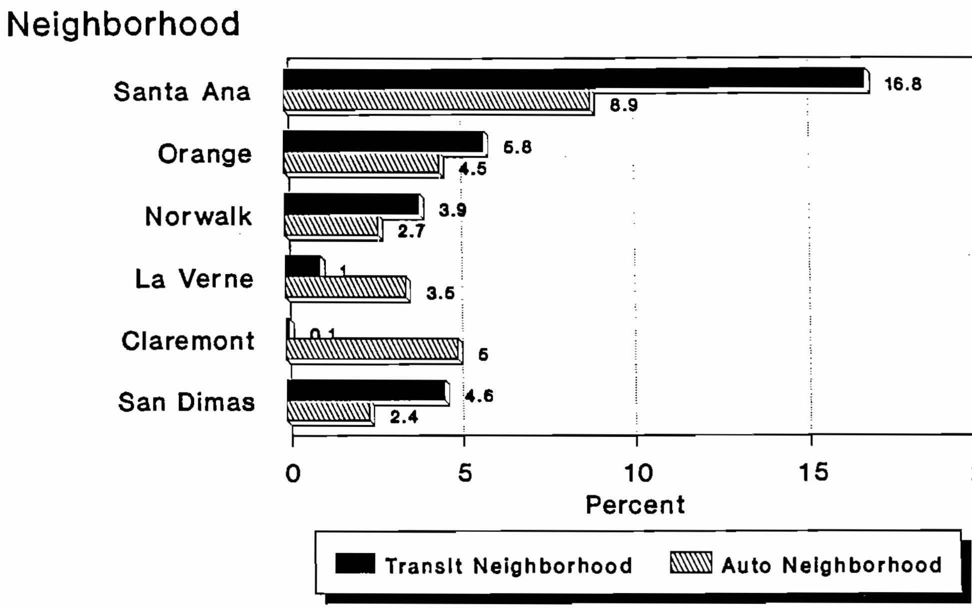


Figure 5.5

Neighborhood Comparisons of Transit Modal Splits, Los Angeles Region, 1990 Work Trips

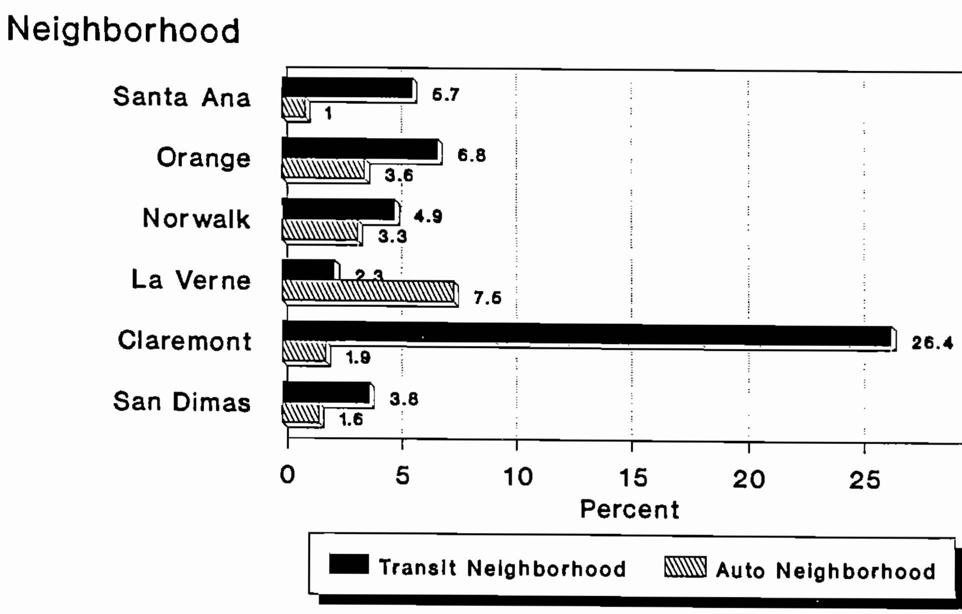
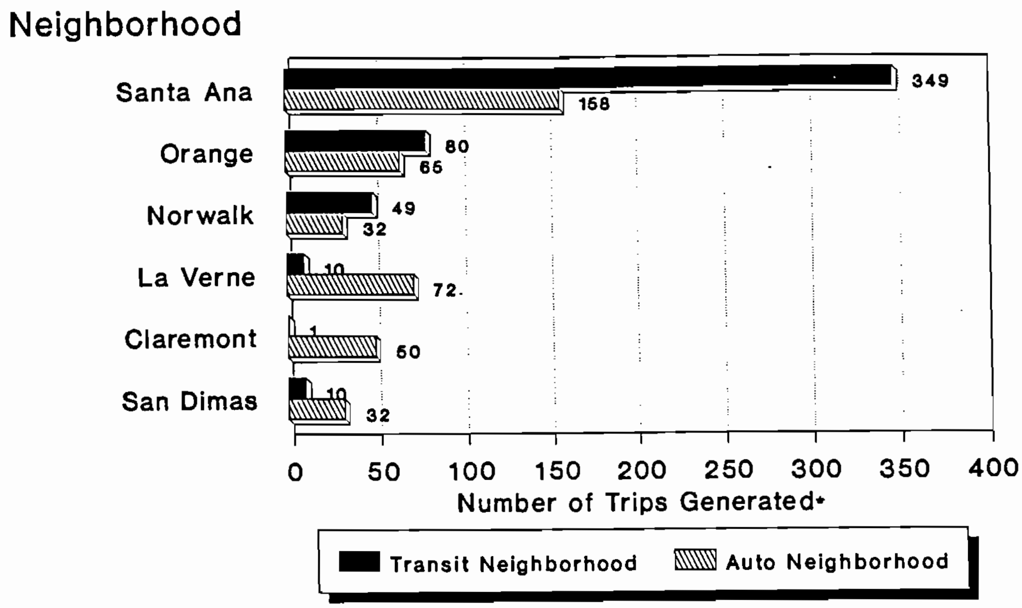


Figure 5.6

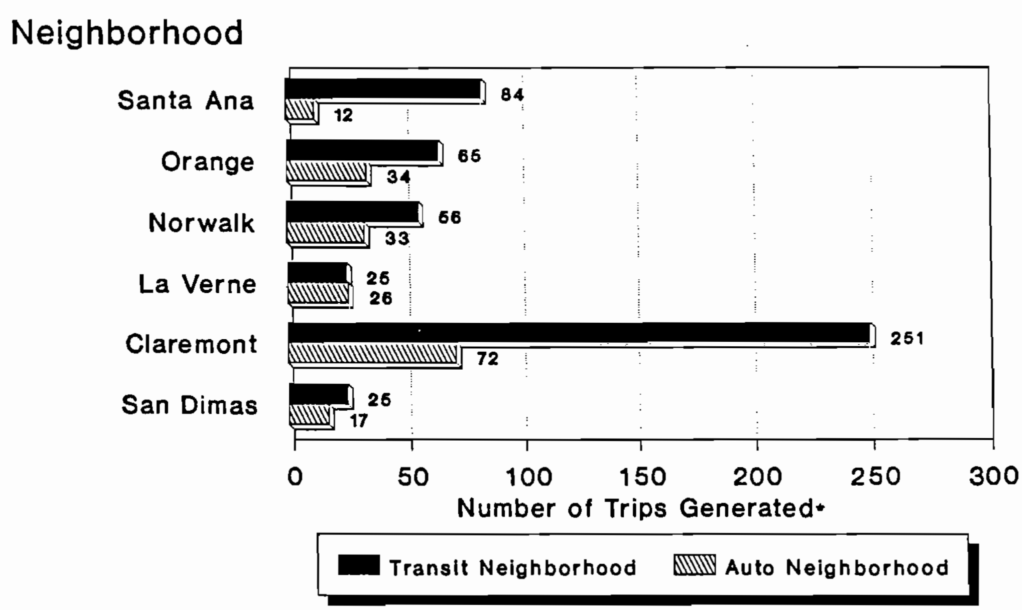
Neighborhood Comparisons of Walk and Bicycle Modal Splits, Los Angeles Region, 1990 Work Trips



* per 1,000 dwelling units

Figure 5.7

Neighborhood Comparisons of Transit Trip Generation Rates, Los Angeles Region, 1990 Work Trips



* per 1,000 dwelling units

Figure 5.8

Neighborhood Comparisons of Walk and Bicycle Trip Generation Rates, Los Angeles Region, 1990 Work Trips

rates than the paired Auto neighborhoods, and a third (San Dimas) had lower transit trip generation rates (although higher transit modal share) than its match. Ironically, two of these three have significantly higher transit service in the Transit neighborhood than in the Auto neighborhood. This would suggest that these neighborhoods are major trip attractors. In the case of Claremont, the existence of the College, as well as the very high pedestrian modal share (26 percent) bears this out to some degree; however, the explanation as to why transit performs so poorly in the other two neighborhoods is less clear.

Evidently, variables other than household income, road configurations, and residential densities account for these differences. One factor could be differences in bus service intensities, which as shown in Table 5.5 did not match up as closely as was hoped for. For example, the Transit neighborhood of La Verne averaged 23 percent less bus service miles per acre than its paired Automobile neighborhood in Pomona, and perhaps as a result only had 1 percent of its residents commuting by bus, compared to 3.5 percent in the nearby Pomona neighborhood. As already mentioned, however, two of the Transit neighborhoods with relatively low transit usage actually received more intensive services, so it is not levels-of-service alone that explain differences. One possible reason why relationships are more muddled in Southern California is that it has much more of a spread-out, auto-dependent regional form. Whereas the Bay Area has dense corridors and many transit options, in part because of its topography, Los Angeles' uniformly low-to-moderate densities could swamp any influences of transit-oriented neighborhoods. Having transit-oriented neighborhoods in a region so strongly dominated by the automobile could very well be of negligible importance.

6. Regression Analysis of Aggregate Data

Because only a small number of matched pairs were found for both metropolitan areas, regression models were run for Los Angeles County and for four Bay Area counties to further elaborate on the relationship between neighborhood type and transit modal share and generation rates.[22] Data from most census tracts in Los Angeles County and the four Bay Area counties which contained neighborhoods studied in this chapter were used in estimating these models.[23] Census tracts were assigned to one of the two categories— Transit or Auto— based on whether their road configurations were more transit- or auto-oriented and whether they were served by rail transit in the past or presently have a rail station.[24] Fairly good-fitting models were estimated for predicting transit mode share in both regions, and transit generation rates in the Los Angeles County region. Model results are shown in Tables 5.9 through 5.11.

In all three models, residential densities had a significant positive effect on transit commuting in both Transit and Auto neighborhoods— especially in Los Angeles County. Neighborhood type was also a significant predictor. For Los Angeles County, Table 5.9 shows that, holding residential densities and incomes constant, 1.4 percent more work trips are likely to be by transit in a Transit neighborhood than in an Auto neighborhood. Also for Los Angeles, Table 5.10 reveals that for every 1,000 households, 19 more transit work trips could be expected in a Transit neighborhood than in an Auto neighborhood, holding the same variables constant. And, again holding income and density

Table 5.9

Modal Split Regression Model: Percent of Work Trips by Transit, Los Angeles County, 1990

	Coefficient	Standard Error	Significance
Gross Residential Density (HHs/acre)	3.29	0.33	0.000
Natural Logarithm of Household Income	-10.24	3.64	0.000
Neighborhood Type*	1.42	0.29	0.000
Density Interaction**	2.44	0.64	0.000
Constant	111.55	3.91	0.000

Summary Statistics:

Number of cases = 1,636
R-Square = 0.55
F = 502.8
Prob. = 0.000

*1 = Transit, 0 = Automobile
**Interaction Term = (Gross Residential Density) x (Neighborhood Type)

Table 5.10

Trip Generation Regression Model: Transit Work Trips per Acre, Los Angeles County, 1990

	Coefficient	Standard Error	Significance
Gross Residential Density (HHs/acre)	3.80	0.51	0.000
Natural Logarithm of Household Income	-120.35	5.52	0.000
Neighborhood Type*	18.94	5.35	0.000
Density Interaction**	3.05	0.97	0.001
Constant	1,318.05	59.24	0.000

Summary Statistics:

Number of cases = 1,636
R-Square = 0.43
F = 304.8
Prob. = 0.000

*1 = Transit, 0 = Automobile
**Interaction Term = (Gross Residential Density) x (Neighborhood Type)

Table 5.11

Regression Model: Percent of Work Trips by Transit, Modal Split, Alameda, Contra Costa, San Mateo, and Santa Clara Counties, 1990

	Coefficient	Standard Error	Significance
Gross Residential Density (HHs/acre)	0.95	0.26	0.000
Natural Logarithm of Household Income	-4.80	0.55	0.000
Neighborhood Type*	5.14	0.91	0.000
Density Interaction**	2.75	1.17	0.019
Constant	56.70	6.06	0.000

Summary Statistics:

Number of cases = 898
R-Square = 0.46
F = 187.1
Prob. = 0.000

*1 = Transit, 0 = Automobile
**Interaction Term = (Gross Residential Density) x (Neighborhood Type)

constant, Table 5.11 estimates there will be 5.1 percent more journey-to-work trips by transit in the Bay Area's Transit neighborhoods than in its Auto neighborhoods.[25] The stronger sensitivity of transit ridership to neighborhood type in the Bay Area confirms what was found in the matched pair analyses.

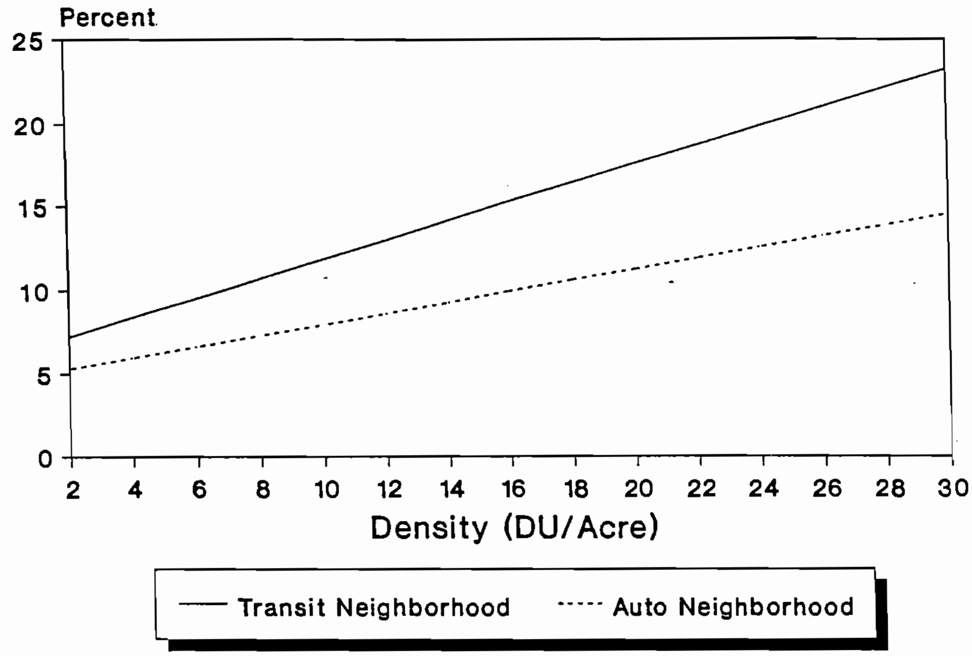
Also of interest is the fact that there was significant interaction between neighborhood type and density in both metropolitan areas. This is shown in Figures 5.9 through 5.11; all three figures plot regression lines for each neighborhood type (using median household income values for each area).[26] Interaction is revealed by differences in slopes. In the case of Los Angeles County, increases in density clearly have a stronger affect on inducing transit commuting in Transit than in Auto neighborhoods — on average, each additional dwelling unit per acre in Los Angeles' Transit neighborhoods raises the share of work trips by transit by 2-4 percentage points relative to Auto neighborhoods, all else being equal. While density had a stronger effect on transit commuting in Los Angeles County, interaction effects were stronger in the Bay Area. Figure 5.11 shows that at 10 dwelling units per acre, Transit neighborhoods averaged 8.0 percent more work trips by transit, while at 30 dwelling units per acre, they averaged 13.5 percent more transit commutes. In terms of transit trip generation rates, interactive effects were similar to what they were for transit modal splits in Los Angeles County (Figure 5.9).

7. Conclusions and Implications

The evidence presented in this chapter suggests that the distinction between traditional neighborhoods laid out originally around transit stations and more recent, automobile-centric neighborhood patterns does influence travel behavior for the commute trip. Specifically, it seems to affect the degree to which people drive alone to work, and the degree to which they walk or bicycle. Transit neighborhoods, by and large, showed lower drive-alone modal shares and trip generation rates than Automobile neighborhoods. Similarly, those we categorized as Transit neighborhoods averaged higher walking and bicycling modal shares and generation rates than their automobile counterparts.[27]

The effects of neighborhood types on transit commuting is less clear. In the Bay Area, transit ridership rates are higher in all neighborhoods classified as transit-oriented except Palo Alto. In Los Angeles, no clear pattern emerged with regards to transit commutes among neighborhood groups.[28] The regression models, however, suggest that when criteria are relaxed, stronger relationships between neighborhood type and transit modal shares and trip generation rates begin to appear. Of particular note was the finding that densities had a proportionally greater effect on inducing transit usage in transit-oriented than auto-oriented neighborhoods

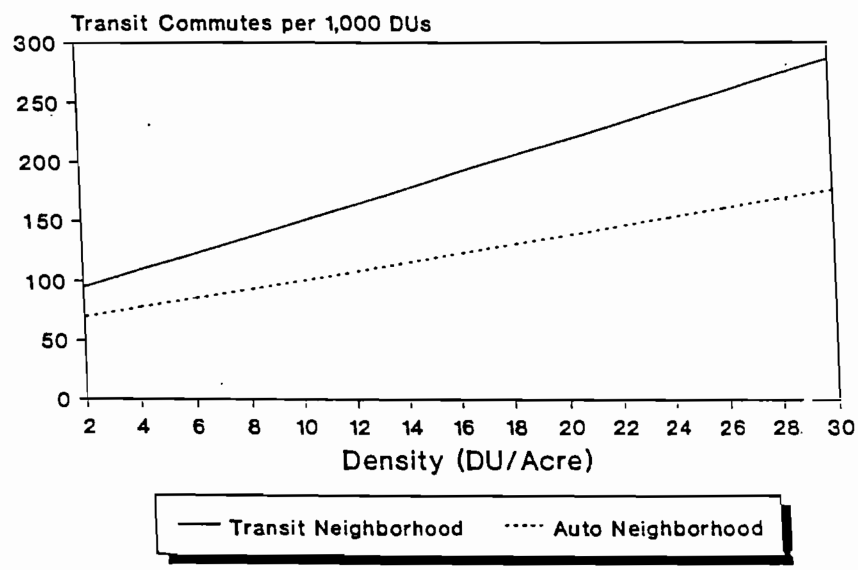
We conclude with several caveats about the endeavor to conduct matched-pair studies of neighborhoods.



For Households with Median Incomes

Figure 5.9

Interactive Effects of Density and Neighborhood Type on Percent of 1990 Work Trips by Transit, Los Angeles County



For Households with Median Incomes

Figure 5.10

Interactive Effects of Density and Neighborhood Type on 1990 Transit Work Trip Generation Rates, Los Angeles County

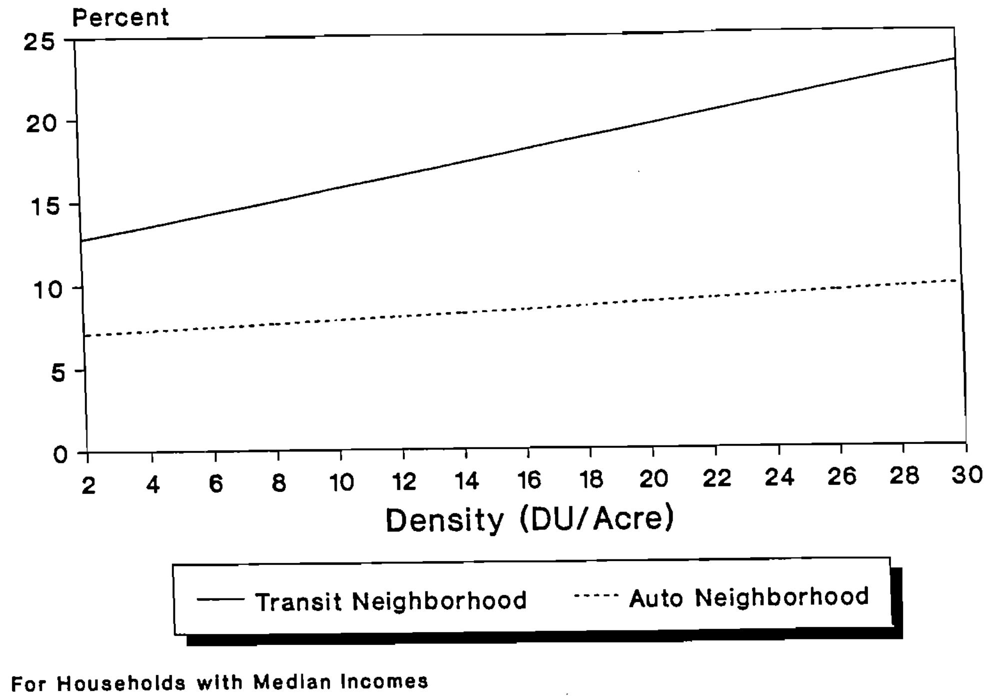


Figure 5.11

Interactive Effects of Density and Neighborhood Type on Percent of 1990 Work Trips by Transit, San Francisco Bay Area

1. One of the most persistent difficulties in our method of research was the inability to find a large number of pairs matched on the basis of income. This was probably the number one reason for deciding to eliminate a census tract. Specifically, the areas we identified as being "transit-oriented" — in other words, the older, traditional communities— almost consistently demonstrated lower median incomes than the surrounding, auto-oriented areas. This pattern held for both the San Francisco and Los Angeles regions. In many cases, this income disparity eliminated the possibility of finding matches within four miles of each other.

   Further investigation of these income disparities may provide clues about the nature of American housing and transportation patterns in general, and also about the potential obstacles that neotraditional urban development may face. For example, while much of this disparity can probably be attributed to land and housing filtration market mechanisms, it opens the question as to whether traditional neighborhood patterns (gridiron streets, shorter setback allowances, etc.) are not associated in the minds of housing consumers with lower incomes and, consequently, less desirable housing. If this is the case, it may be a tougher sell for neotraditional designers and builders in the marketplace than they previously thought.

2. The research was not particularly successful in isolating the three variables of transit service (intensity), neighborhood type, and transit usage. These three elements are so closely interwoven that, in fact, it may be virtually impossible to control for transit service levels in assessing neighborhood impacts on ridership.

3. The results for the matched pair analysis for the Los Angeles metropolitan area were not nearly as strong as those for the San Francisco area. In fact, some "transit" neighborhoods in the Los Angeles region showed weaker pedestrian and transit modal shares and generation rates than their "Auto" counterparts. Because the Los Angeles region is highly decentralized, it may be that the form of the region as a whole has as great a role, if not greater, in influencing modal choice than the design or layout of particular neighborhoods. In other words, the metropolitan form of the macro-region may be too auto-centric for the micro-pattern of any particular neighborhood to matter.

4. The analyses in this chapter were conducted on existing neighborhoods by comparing turn-of-the-century, transit-oriented communities with mid- to late-twentieth century automobile-oriented communities. These existing communities have established patterns of land settlement: established residential spatial forms, established commercial layouts and patterns, established businesses and retail operations that are already known in the community, and established employment patterns.

   These conditions undoubtedly have an effect on individual travel behavior, and consequently on aggregate modal splits. But these conditions are precisely those conditions which are not applicable to new transit-oriented developments. Businesses are *not* already located there, and employees and businesses have *not* collectively had the time or the history to "find each other," so to speak. There may be more flexibility for a household to locate within a traditional transit-oriented neighborhood— in order to take advantage, for example, of a pedestrian commute to work—than there would be for the same household to locate in a neotraditional community that has just been built, precisely because of existing firm locational decisions. Therefore, it is possible that the modal share and generation rate differentials observed in the existing communities would not be observed in new transit-oriented communities. To know for sure, however, researchers will need to wait until prototype communities are constructed, and travel behavior data compiled.

5. Some research suggests that traditional transit-oriented neighborhoods have the biggest influence on non-work trips, particularly shop trips. Holtzclaw (1990, Handy (1992), and Ewing (1993) found traditional neighborhoods averaged either fewer VMT per capita or higher shares of short walk trips than 1970s-style PUDs. Handy (1992) found, in particular, that traditional neighborhoods were conducive to internal (local access) walk and bicycle trips. However, for external (regional access) shopping trips, there was little difference in average trip length or modal splits between types of neighborhoods. Thus, people wanting to leave a traditional neighborhood were just as likely to drive their car as someone from a more auto-oriented neighborhood. Since the analysis presented in this chapter focused solely on work trips, which tend to be external to a neighborhood, the absence of any strong relationships, at least for Southern California, is totally consistent with the findings of other researchers. If the matched-pair comparisons were carried out for shop and other non-work trip purposes, differences in modal splits and trip generation rates could very well have been far more significant. This is an important area for future research.

Notes

[1]One scenario assumed absorption of the new growth areas into the regions' largest urban centers. The other assumed the new growth areas would stand alone as areas of settlement.

[2]Initially, we had included a mixture-of-use criterion, to approximate the neotraditional planning idea of having more integrated, less "magic-marker-zoning" style, land-uses. We found, however, that many potential "traditional" neighborhoods were eliminated immediately, because many of them are single-use. In addition, attempts at quantifying this mixture of use (using an entropy index) did not address the qualitative issues behind urban designers' emphasis on mixture of use: many automobile-centric neighborhoods with strip shopping streets still showed up quantitatively as "mixed-use," although they hardly exemplify contemporary standards of "mixture of use."

[3]Or, indeed, if transit operates in these neighborhoods simply because of historical precedent and inertia. When the private streetcar companies were dismantled, frequently local or county governments stepped in immediately with newly established transit agencies whose mandate was to take up the transportation service the private companies had just abandoned. Most often, this meant paralleling with buses service that had previously been provided by trains or streetcars. Subsequently, inertia or resistance to change by riders, neighborhood groups, or politicians may have insured that the routes remain in their existing alignment.

[4]Our indicator for relative level of bus transit service was calculated as total daily transit vehicle miles traveled through and within 1/4 mile of the study area, divided by the acreage of the study area (Daily Bus VMT per acre). Because of the difficulty of finding older transit maps and schedules, we calculated the transit intensity indicator based on 1993 service levels, even though the modal choice data were from 1990. We felt that 1993 schedules and routings were adequate enough to give a sense of relative intensity of transit service between the pairs, even if they are not good indicators of the actual situation at the time. Rail transit intensity was not calculated, but has been noted where present. Generally, we looked to pair neighborhoods within 1/4 mile of a rail transit stop together, but in some instances (downtown Mountain View, for example) this was not possible. The primary shortcoming of our transit intensity indicator is that it does not provide a comparative indicator of the degree to which actual transit service approximates commuter desire lines for the areas studied. Clearly, however, such an indicator is beyond the purview of this project.

[5]We did allow one exception to this rule, a comparison between Rockridge and Lafayette, which, while separated by five miles, are both located along the same segment of the BART system, yet are each excellent examples of the types of neighborhoods examined in this study. In the interest of allowing that comparison, the pairs were included in the analysis.

[6]We used a net residential density figure calculated by subtracting from the total land area (obtained from the Census) the amount of land we estimated to be used not for residential purposes (obtained by windshield surveys and clues from maps), giving us net residential acreage. The density then was calculated as dwelling units per net residential acre. We tried to obtain more accurate density information, along with information about land-uses. However, Land-Use inventories are not yet complete for the Southern California region. The Association of Bay Area Governments does have land use inventories available for the Bay Area. However, these are available only at the tract level. Since we have some areas that require Block Group-level data, we would have been unable to consistently use ABAG's inventory and density information. It was decided, therefore, to use the rougher but more consistent method of estimating net residential areas described above.

[7]As noted above, the strictness of the criteria revealed only relatively few viable matched pairs for the two metropolitan regions. The reasons for elimination of neighborhoods from scrutiny, in order of importance, were: (1) The geography of the census data was incompatible with this type of study— that is, the areas that could be defined as traditionally transit-oriented did not conform to any census boundary that made it usable (either as a census tract or a block group). We had this difficulty particularly in the North Bay region of the San Francisco area (Marin, Sonoma, and Solano counties), where census tracts and even block groups were much bigger or differently shaped than the traditional core of the city. (2) No matches could be found that met the 10 percent variation in median income criterion and still fall within our distance criterion. We encountered this difficulty particularly in the Diablo and Livermore Valleys in the San Francisco area (Alameda and Contra Costa counties), as well as in San Rafael in Marin County. We also encountered this sort of problem sporadically in the LA region. (3) Level of transit intensity did not match up. A number of areas in the Los Angeles area (Pasadena, Glendale) needed to be eliminated because of this criterion. While we did not set strict limits, we eliminated pairs

that were unreasonably different in service intensity. Because VMT per acre is likely not the only indicator of relative transit accessibility for a neighborhood, we decided to show the data for the pair even if it had noticeable differences in VMT per acre, provided they were not unreasonably excessive. (4) Some neighborhoods were eliminated from consideration for other reasons, such as unmatchable topography or excessive distance to employment centers.

[8]It should be noted that several factors likely influencing mode choice were not taken into account in our study. First and probably most important is safety. We controlled neither for relative safety between the matched pairs, nor for relative perceived safety. Perceptions of safety, both of the neighborhood and of the bus route, may play a significant role in explaining modal choice and transit usage, particularly in Los Angeles. A second group of factors not taken into account was aggregate household factors besides median income: average auto-ownership rates in the study areas, average number of working adults per household, age composition of the study areas, etc. Income, however, probably serves as a proxy for many of these additional variables.

[9]The "downtown" area of Palo Alto for the purposes of this study is the portion bounded by Alma Street, Oregon Page Mill Expressway, Middlefield Road, and San Francisquito Creek. This corresponds to Census Tracts 5113.98 and 5114.98. The Mountainview neighborhood is bounded by the Central Expressway (an extension of Alma Street), North Shoreline Boulevard, the 101 Freeway, and the 85 Freeway. This corresponds to Census Tract 5092.02.

[10]The Santa Clara area studied is bounded by Civic Center Drive, Sherman Street, Park Avenue, the San Jose border, and Pierce and University Streets. This corresponds to Census Tracts 5056 and 5057. In San Jose, the study area is bounded by Stevens Creek Boulevard, the 17 Freeway, Williams Road, and Winchester Boulevard. This corresponds to Census Tract 5064.01.

[11]The downtown area zigzags from Tilton Avenue and El Camino to 10th Avenue and the 101 Freeway. This corresponds to Census Tract 6063. The Bayshore Point study area is bounded very simply by the Golf Course on the north, the Bay on the east, Hart Clinton Drive on the south, and the 101 Freeway on the west. This corresponds to Census Tract 6061.

[12]The Rockridge neighborhood is bounded by Claremont Avenue, the BART tracks/Highway 24, Patton Street, Roanoke Road, and the Berkeley/Oakland border. This corresponds to Census Tract 4002. The Lafayette neighborhood is bounded by Acalanes Road, the Lafayette/Orinda border, the Lafayette Moraga border, Moraga Road, and the BART tracks/Highway 24. This corresponds to Census Tract 3500 (Lafayette portion only).

[13]The Mountain View neighborhood is bordered by Central Expressway, South Shoreline Boulevard, El Camino Real, Bush/Dana Streets, and Calderon Avenue. This corresponds to Census Tract 5096. The Sunnyvale neighborhood is bounded by El Camino Real, Mary Avenue, the Southern Pacific Railroad, and the Mountainview/Sunnyvale border.

[14]The San Mateo-King Park area is bordered by the 101 freeway, Poplar Avenue, the Southern Pacific Railroad, 1st Avenue, Delaware Street, and 4th Avenue. This corresponds to Census Tract 6062. The Millbrae area is bounded by San Francisco International Airport, the Millbrae/Burlingame border, Magnolia Avenue, Taylor Boulevard, Broadway, Magnolia Avenue, and the Millbrae/San Bruno border. This corresponds to Census Tract 6044.

[15]The central San Leandro neighborhood is bounded by San Leandro Creek, Bancroft Avenue, Warren Avenue/ Marina Boulevard, and the Southern Pacific Railroad. This corresponds to Census Tract 4326. The Bayfair neighborhood is bounded by Hesperian Boulevard, 150th Avenue, the I-580 freeway, 159th Avenue, 14th Street, Ashland Avenue, and the I-880 freeway. This corresponds to Census Tract 4338.

[16]The central Santa Ana neighborhood is bordered by the I-5 freeway on the northeast, the Santa Fe Railway line on the east, Pine, Garfield and 1st Streets on the south, and French Street on the west. This corresponds to Census Tract 744.05. The Center Park neighborhood is bounded by Willits Street, Fairview Street, 5th Street, and Raitt Street. This corresponds to Census Tract 748.02

[17]Central Orange is bounded by Walnut Avenue on the north, Cambridge Street on the east, La Veta Avenue on the south, and the Santa Fe Railroad/Chapman Avenue/Batavia Street on the west. This corresponds to Census Tracts 759.01 (all) and 759.02, Block Groups 1,3, and 5. The Garden Grove study area is bounded by Simmons Avenue, Lewis Street, Garden Grove Boulevard, and Haster Street. This corresponds to Census Tract 761.03.

[18]Central Norwalk is bounded by: the I-5 freeway, Pioneer Boulevard, Foster Road, Kalmor Street, Pioneer Boulevard, and Rosecrans Avenue. This corresponds to Census Tracts 5521, Block Group 2, and 5522 (all). The Downey subject area is bounded by Firestone Boulevard, Lakewood Boulevard, Steward and Gray Road, and Paramount Boulevard. This corresponds to Census Tract 5513.

[19]The La Verne study area is bounded by B Street, 8th Street, White Avenue, and Bonita Avenue. This corresponds to Census Tract 4016.02, Block Group 2. The Pomona-County Fairgrounds study area is bounded by the I-10 freeway, Dudley Street, Laurel Avenue, and Huntington Blvd. This corresponds to Census Tract 4023.01

[20]The central Claremont study area is bounded by Foothill Boulevard, Indian Hill Boulevard, 4th Street, Yale Avenue, Bonita Avenue, Harvard Avenue, 7th Street, College Avenue, 12th Street, and Dartmouth Avenue. This corresponds to Census Tract 4019.02, Block Group 1. The Pamona-Palomares neighborhood is bordered by the Atchison, Topeka, Santa Fe Railroad, Towne Avenue, the I-10 freeway, Mountain Avenue, Arrow Highway, and the Pomona/Claremont border. This corresponds to census tract 4021.01.

[21]The central San Dimas study area is bounded by San Dimas Avenue, Bonita Avenue, Amelia Avenue, and W. 5th Street. This corresponds to Census Tract 4013.11, Block Group 2. The Covina study area is bounded by Glendora Avenue, Puente Street, Barranca Avenue, and the Southern Pacific Railroad tracts. This corresponds to Census Tract 4037.22.

[22]The four Bay Area counties were those that contained the seven paired communities —Alameda, Contra Costa, San Mateo, and Santa Clara Counties.

[23]Census tracts with near-zero land area (called "sliver tracts") or zero population were eliminated from the analysis.

[24]Transit census tracts were considered to be those with percent of four-way intersections that were 25 percent above the countywide averages. Auto census tracts, on the other hand, were all remaining ones with below-average shares of four-way intersections. In the regression models, density was measured in terms of gross residential density —the number of housing units in a tract divided by the tract's gross land area in acres.

[25]These regression models, it should be noted, do not maintain the same degree of control as the matched pair analysis. First, intensity of transit service was not a variable in the regression analysis, because of the absence of county-wide indicators. Second, the density variable was based on gross, not net, residential densities. Again, this was due to the lack of adequate region-wide indicators.

[26]The 1990 median household income for Los Angeles County was $34,220. For the four Bay Area counties, it was $42,670.

[27]Although there are too few pairs here for a statistical test to be of real value, we did run a matched pair t-test for all the pairs in the sample, and found these differences to be statistically significant at a 5 percent probability level. The drive-alone modal shares showed a mean difference of .07 with a t-value of 3.30. The drive-alone trip generation mean difference was 158. This had a t-value of 4.16. The pedestrian/ bicycling modal share mean difference was .06, with a t-value of 2.97. And the pedestrian/bicycling trip generation mean difference was 52, with a t-value of 3.84.

[28]The matched pair analysis showed no significant relationship between the paired differences of observed transit modal share and generation rates, and neighborhood type.

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Chapter Six

Community Development, Land Use Patterns, and Commuting Choices

1. Introduction

This chapter ratchets the analysis up one level— to the community, or citywide, scale. Community-level analyses are obviously too coarse to address micro-design or site planning issues. Rather, they provide a context for exploring more basic relationships between overall characteristics of the built environment (e.g., degrees of community planning, densities, land-use mixtures, jobs-housing balance) and travel behavior. Thus, this chapter complements the previous two by further exploring the link between the built environments of suburban settings and travel choices, albeit at a more aggregate scale.

The first part of the chapter explores differences in commuting behavior for three classes of suburban communities: traditional towns, edge cities (large suburban centers), and planned communities. Attention is given to how 1990 work-trip modal splits varied among these different classes of suburban communities as well as relative to regional averages. The second part of the chapter explores these relationships abroad. Specifically, the link between land use and commuting characteristics is studied for a number of planned suburban communities outside of London, Paris, and Stockholm. These places were chosen since they provide perhaps the best contexts for studying what is achievable when new town and transportation planning are closely linked, at least in a modern, industrialized setting. International comparisons are also essential if public policy options for influencing suburban development and transportation outcomes are to be fully understood.

2. Traditional Communities and Commuting

Neotraditionalists Andres Duany and Elizabeth Plater-Zyberk have identified a number of older American communities that they attempt to mimic in designing new communities like Seaside, Florida, and The Kentlands, Maryland. First and foremost, these are places that are highly walkable, at least in their cores. All were laid out in a gridiron fashion, with small rectilinear blocks. Their cores contain a mix of retail, office, and institutional uses, and are accessible from nearby neighborhoods. Civic spaces, such as open plazas and inner-city parks, play a prominent role in these communities. Local streets are usually narrow, with curbside parking. Back alleys are also common. In short, these are places designed more for people than for cars.

Table 6.1 lists ten traditional American communities. With the exception of Alexandria and Savannah, all are in the 10,000 to 40,000 population range. Densities vary noticeably among these communities, as do median household incomes. Overall population and housing densities remained

Table 6.1

Physical and Income Characteristics of Ten Traditional Communities in the U.S., 1980 and 1990

1990	Land area (sq. km.)	Population	Population Density (persons/sq.km.)	Housing Density (units/acre)	Median Hhd. Income
Alexandria, VA	39.6	111,183	2,811	6.0	$41,472
Annapolis, MD	16.4	33,187	2,025	3.8	$35,516
Coral Gables, FL	30.6	40,091	1,309	2.2	$47,506
Edmonds, WA	18.9	30,744	1,626	2.8	$40,515
Folsom, CA	55.5	29,802	537	0.7	$46,726
Kingsport, TN	83.8	36,365	434	0.8	$22,750
Lake Forest, IL	42.4	17,836	420	0.6	$94,824
Princeton, NJ	4.8	12,016	2,523	3.0	$43,092
Savannah, GA	162.1	137,560	849	1.5	$22,102
Winter Park, FL	18.0	22,242	1,235	2.3	$37,080

1980	Land area (sq. km.)	Population	Population Density (persons/sq.km.)	Housing Density (units/acre)	Median Hhd. Income
Alexandria, VA	39.6	103,217	2,610	5.3	$21,016
Annapolis, MD	16.4	31,740	1,937	3.3	$17,684
Coral Gables, FL	30.6	43,241	1,412	2.3	$21,863
Edmonds, WA	18.9	27,679	1,463	2.3	$23,940
Folsom, CA	55.5	11,003	198	0.3	$16,444
Kingsport, TN	83.8	32,027	382	0.6	$14,777
Lake Forest, IL	42.4	15,245	359	0.5	$44,767
Princeton, NJ	4.8	12,035	2,527	2.9	$22,056
Savannah, GA	162.1	141,390	872	1.4	$12,483
Winter Park, FL	18.0	22,339	1,241	2.2	$17,091

Source: U.S. Bureau of the Census, 1980 and 1990

fairly constant during the 1980s in all ten communities. The least dense community, Lake Forest, Illinois, also had the highest median income. Alexandria, Virginia, was the densest, averaging six dwelling units per gross acre.

In general, residents of these traditional communities were just as car-dependent for commute trips as any resident worker. In five of the ten traditional communities, larger shares of residents solo-commuted in 1990 than did the typical resident in the respective metropolitan area (Table 6.2). In all five of these places, however, median household incomes were well above the regional average, so income itself (rather than urban characteristics) is likely the dominant factor explaining the preference for auto commuting in these places. In general, modal splits did not change much during 1980s — more or less the same relationships held at the beginning and the end of the past decade.

Table 6.2

Comparison of Work Trip Modal Splits in Traditional Communities and Their Respective Metropolitan Areas, 1980 and 1990

1990	Percent of Trips: Drove Alone	Percent of Trips: Transit	Percent of Trips: Walked	Mean Commute Time (mins.)
Alexandria, VA	59.1	17.9	3.9	25.4
Metropolitan area	*62.9*	*13.7*	*3.9*	*29.5*
Annapolis, MD	67.3	5.9	8.0	23.5
Metropolitan area	*70.9*	*7.7*	*4.0*	*26.0*
Coral Gables, FL	75.9	3.0	6.5	19.4
Metropolitan area	*72.4*	*5.9*	*2.5*	*24.8*
Edmonds, WA	77.3	5.7	1.7	25.2
Metropolitan area	*72.8*	*7.4*	*3.3*	*24.4*
Folsom, CA	82.0	1.5	2.1	25.0
Metropolitan area	*75.2*	*2.4*	*2.7*	*21.8*
Kingsport, TN	84.9	0.4	2.6	15.1
Metropolitan area	*82.3*	*0.4*	*2.1*	*19.5*
Lake Forest, IL	65.2	13.4	8.6	28.7
Metropolitan area	*66.3*	*14.6*	*4.1*	*28.5*
Princeton, NJ	32.8	5.1	47.3	16.0
Metropolitan area	*71.5*	*6.3*	*5.9*	*22.1*
Savannah, GA	70.5	6.3	4.7	18.7
Metropolitan area	*75.3*	*3.8*	*3.3*	*20.5*
Winter Park, FL	80.2	1.6	4.7	19.6
Metropolitan area	*78.1*	*1.5*	*3.5*	*22.9*

1980	Percent of Trips: Drove Alone	Percent of Trips: Transit	Percent of Trips: Walked	Mean Commute Time (mins.)
Alexandria, VA	49.4	19.7	4.7	25.9
Metropolitan area	*53.7*	*15.5*	*5.0*	*28.5*
Annapolis, MD	56.8	6.3	9.7	22.6
Metropolitan area	*59.8*	*10.3*	*5.2*	*26.5*
Coral Gables, FL	69.5	3.7	8.3	19.6
Metropolitan area	*67.4*	*6.6*	*3.5*	*23.7*
Edmonds, WA	69.6	5.1	2.3	24.7
Metropolitan area	*63.9*	*9.6*	*4.2*	*23.1*
Folsom, CA	67.8	2.6	5.1	23.3
Metropolitan area	*69.0*	*3.5*	*3.4*	*19.5*
Kingsport, TN	73.6	0.8	5.2	13.7
Metropolitan area	*69.9*	*0.7*	*3.1*	*19.6*
Lake Forest, IL	56.6	18.2	8.7	29.2
Metropolitan area	*57.6*	*18.0*	*5.8*	*28.2*
Princeton, NJ	31.6	6.9	43.7	17.2
Metropolitan area	*63.4*	*7.6*	*7.3*	*21.7*
Savannah, GA	64.6	7.7	6.1	19.8
Metropolitan area	*67.3*	*5.0*	*4.8*	*21.4*
Winter Park, FL	75.0	2.3	5.3	18.5
Metropolitan area	*69.6*	*1.7*	*4.7*	*20.7*

Source: U.S. Bureau of the Census, 1980 and 1990 change much during 1980s — more or less the same relationships held at the beginning and the end of the past decade.

Transit only played a significant role in the two traditional communities served by urban rail — Alexandria (Washington Metrorail) and Lake Forest (CTA and Metra). In six of the traditional towns, lower shares of residents commuted by transit than in their respective regions. In these places, income differences are probably again the chief reason for differences in transit modal splits. Relative to the suburbs of each metropolitan area, traditional towns did slightly better in attracting transit commuters. Figure 6.1 shows that for eight of the traditional communities for which comparison data could be obtained, larger shares of residents commuted by transit than did residents of the typical regional suburb in the majority of cases.[1] Since comparisons with surrounding suburbs are more appropriate than for the metropolitan area at large, it appears that traditional communities did have a slight edge in promoting transit commuting.

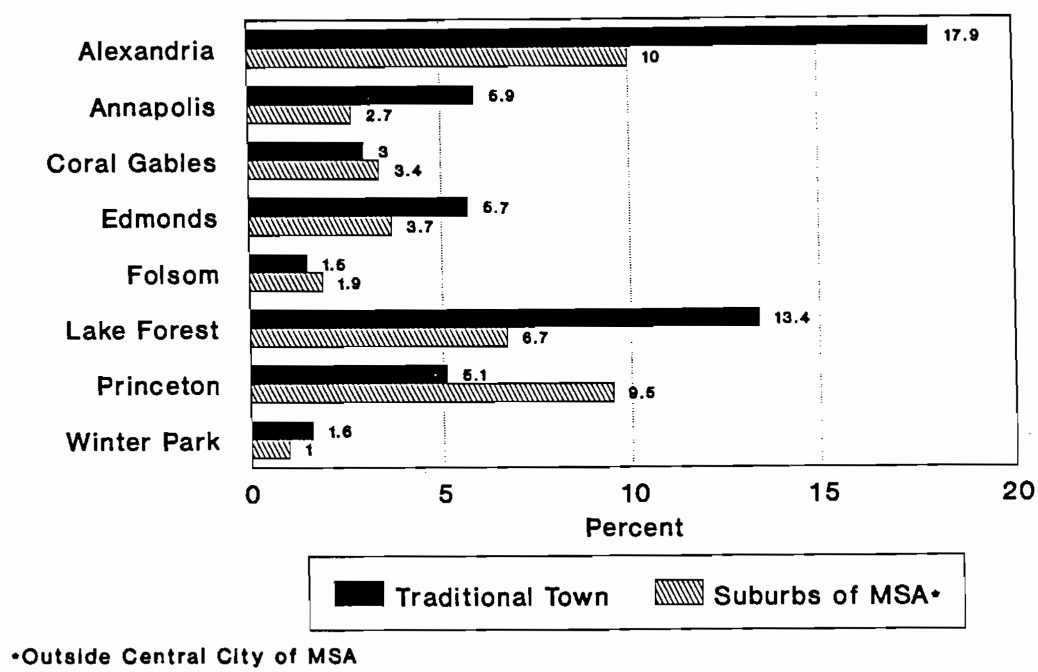


Figure 6.1

Comparison of Transit Share of Work Trips in Traditional Communities and Surrounding Suburbs, 1990

Traditional communities show their greatest advantage with respect to walk and bicycle trips. For seven of the communities, a higher percentage of residents walked or biked to work than did the typical worker in each region.[2] In Princeton, nearly one-half of those heading to work walked or cycled — no doubt, partly because Princeton is a college town with a fairly captive and autoless student population and restrictive parking but also because it is of an eminently walkable scale (under 5 square kilometers in size). Other communities which seem attractive places for walking, at least when compared to the region as a whole, are Annapolis, Lake Forest, and Coral Gables. Of course, traditional communities likely are most conducive to non-work walk trips, particularly for shopping and social-recreational purposes. If modal splits for these purposes were available, we would expect even more striking differences between community and regional averages.

Lastly, residents of traditional communities tended to enjoy shorter commutes than did the average worker in their respective metropolitan areas. This was so in seven of the ten communities shown in Table 6.2. In general, this likely reflects the tendency of residents from traditional towns to live relatively close to their workplaces and walk more often to work. Differences were less due to the use of automobiles for commuting since, as noted before, residents of traditional communities were roughly as auto-dependent as non-residents from the same region.

In summary, the study of these ten traditional communities suggests that their biggest mobility advantage lies in producing more walk and bicycle as well as shorter trips. Comparisons of non-work travel would likely be even more revealing.

3. Commuting in Edge Cities

In his 1991 book, *Edge City: Life on the New Frontier*, Joel Garreau identified some 75 Edge Cities across the U.S. — mega-concentrations of office complexes, retail malls, convention hotels, condominiums, and other enterprises, huddled in areas that only a decade or so earlier were farmland and sleepy suburbs. Most Edge Cities have densities and land-use mixtures that rival the downtowns of many medium-sized cities. Though unlike traditional downtowns that evolved gradually, many Edge Cities witnessed a tripling of commercial floorspace in a few short years during the building frenzy of the 1980s, swamping local arterials, schools, and water systems in the process. This led to suburban gridlock and grass-roots uprisings against new growth (Cervero, 1986, 1989). And unlike traditional downtowns, most Edge Cities were built primarily for automobile circulation. Many are distinctly unfriendly to walkers — laid out on a superblock scale, with squatty buildings surrounded by sprawling parking lots, and pierced by wide and busy boulevards, many of which are devoid of adjacent sidewalks.

How have transit and ridesharing fared in Edge Cities versus other places? Commute statistics gathered for 11 of them suggests it depends on the type of Edge City. Figure 6.2 shows that substantially higher shares of residents in five of six Edge Cities that had light, heavy, or commuter rail services commuted by transit in 1990 than did the typical suburbanite in each Edge City's respective metropolitan area. Nearly one-quarter of Silver Spring residents got to work by transit in 1990, compared to 10 percent of all suburban Washington, D.C. residents. Among residents of Twin Towers, a 315-unit apartment complex 900 feet from the Silver Spring Metro station, a 1989 survey by JHK & Associates found that 74 percent of residents commuted by transit each day; among those heading

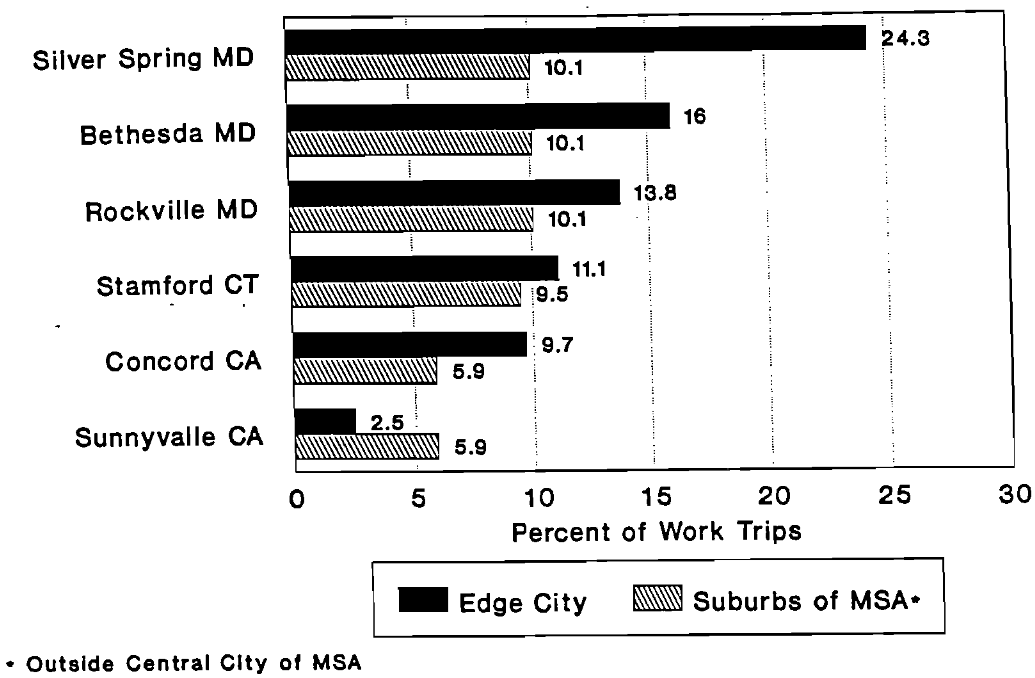


Figure 6.2

Comparison of Transit Share of Work Trips by Residents of Rail-Served Edge Cities and Surrounding Suburbs, 1990

to downtown Washington, 92 percent rode Metrorail. Those working in offices near the Silver Spring station were also prone to commute by transit— around one out of four got to work each day by rail or bus; for those workers coming from central Washington, D.C., over half commuted by Metrorail (JHK & Associates, 1989).

Among Edge Cities without rail services, transit was written off by the vast majority of commuters (Figure 6.3). Bellevue was the one exception, due in large part to the city's parking cap of 2 spaces per 1,000 square feet and mandatory parking charges imposed on several office towers built in the late 1980s as conditions of project approval. As discussed in Chapter Four, downtown Bellevue is also the Eastside's major transit hub, served by some two dozen buses operating on synchronized schedules during the weekday. While transit's market share of residents' commute trips was below the national average in the other four Edge Cities shown in Figure 6.3, in two of the four transit's share was still higher than that of surrounding suburbs. However, with regard to carpool and vanpool travel, Figure 6.4 shows that Edge Cities performed poorly compared to surrounding suburbs.

In summary, the relatively high densities and mixed land-use compositions of Edge Cities only seem to pay off if Edge Cities are served by rail transit. Where only bus services are available, roughly the same proportion of residents commute by transit, carpools, or vanpools in Edge Cities as in surrounding suburbs.

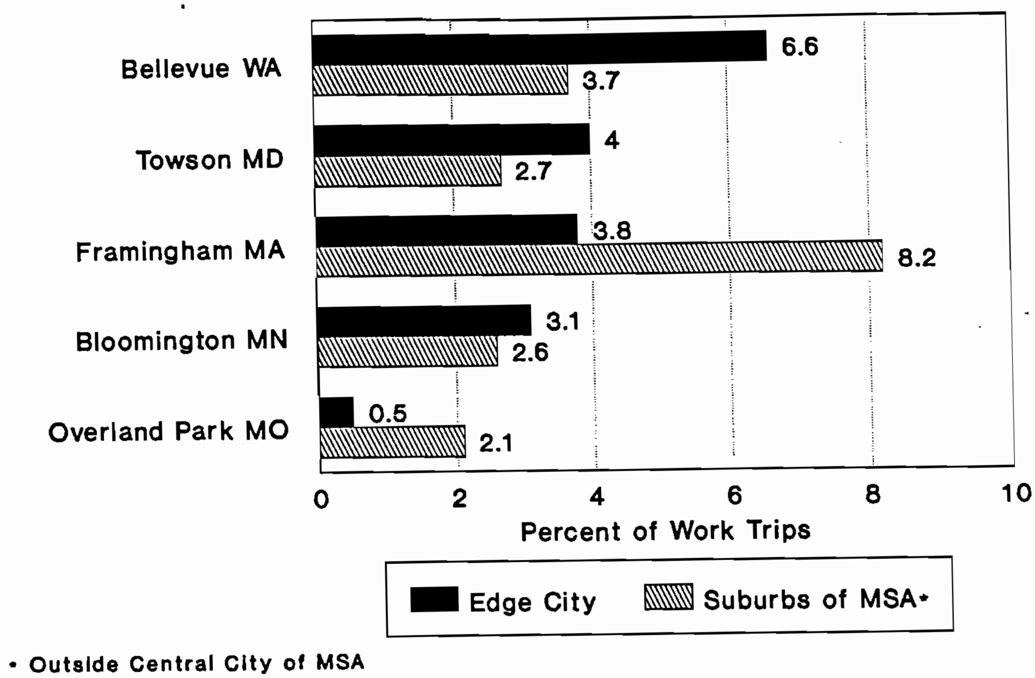


Figure 6.3

Comparison of Transit Share of Work Trips by Residents of Bus-Only Edge Cities and Surrounding Suburbs, 1990

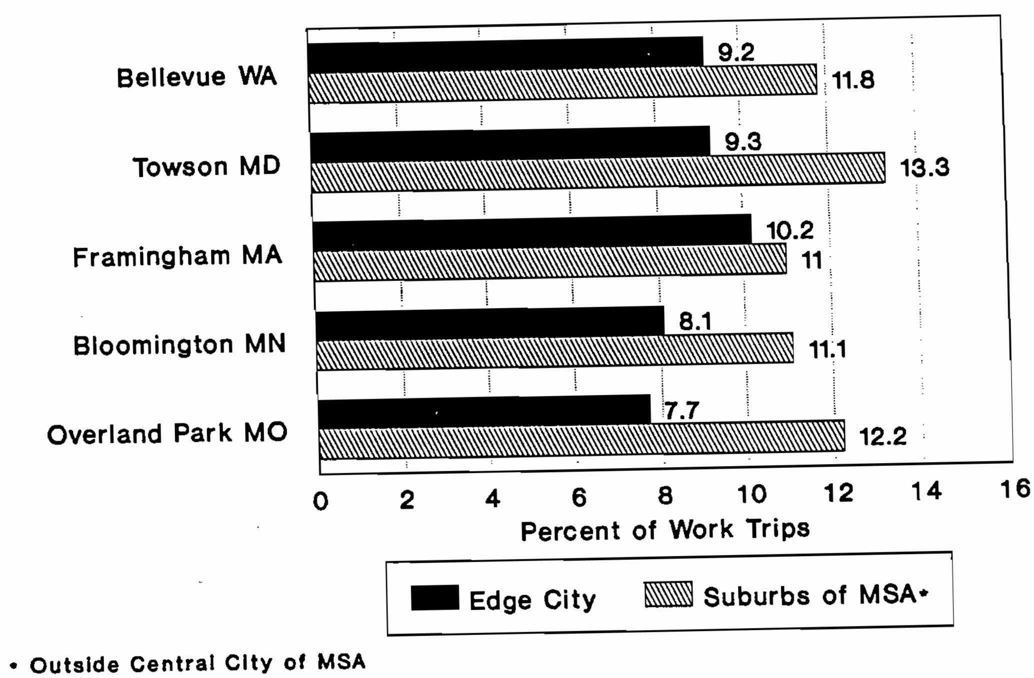


Figure 6.4

Comparison of Carpool/Vanpool Share of Work Trips by Residents of Bus-Only Edge Cities and Surrounding Suburbs, 1990

4. Commuting Characteristics of Planned Versus Conventional American Communities

Master-planned communities provide two possible mobility advantages:

(1) they are usually planned for a balance of housing, retail, and sometimes even jobs (e.g., they are more self-sufficient and self-contained), and thus give rise to shorter trips within the community, especially more trips by foot and bicycle; and

(2) since they tend to be socio-demographically homogenous, have a critical mass of resident workers, and those working outside the community often commute to similar destinations, they are particularly well-suited for establishing successful carpools, vanpools, and subscription bus services.

If the above is true, these communities should have relatively high shares of non-SOV "alternative mode" trips — more walk, bike, ridesharing, and bus trips, at least compared to surrounding suburban communities. This section explores the degree to which these propositions hold, using 1990 journey-to-work statistics. For different types of planned communities, comparisons are drawn between the commuting characteristics of planned communities and nearby communities that are "less-planned."

4.1. Planned Communities in the U.S.

Many master-planned American communities, like Columbia, Maryland, and Reston, Virginia, were modeled after the Radburn, New Jersey, plan and British garden city concepts. The plans called for the development of self-contained communities that were insulated from many of the ills of inner-city living. Each would be surrounded by a protective greenbelt, giving the community a defined edge. Plans called for a hierarchy of roads to eliminate unwanted traffic through residential areas. Most traffic is routed around superblocks of a mile or more in circumference. Local traffic is slowed by the use of cul-de-sacs penetrating the superblocks from the perimeter roads. Housing is clustered around common open space. Linear greens and internal (sometimes grade-separated) pedestrian path systems connect neighborhoods. Each neighborhood is served by an elementary school and usually a small commercial center. In short, these were planned as nice, safe places for mostly middle-class Americans to raise their families.

Planned communities are hardly passé. Contrary to conventional wisdom, new communities did not die with the ill-fated HUD program[3] of the 1970s, but rather fifty or more communities started since 1960 are still growing and expanding today, and at least fourteen new ones are in the wings (Avin, 1992; Ewing, 1991). From a survey of 58 new communities in the U.S., Ewing found that about half have populations above 10,000, and more than half are still being developed by their original master developers, a sign of financial viability.

Ewing argues that in the more difficult development climate of the 1990s, new communities will fare better than typical suburban developments, especially small-scale subdivisions, because master planning gives them an edge in terms of environmental sensitivity, fiscal self-sufficiency, and aesthetics. Specifically, they: are better able to preserve sensitive environments because of their scale and flexibility; provide more open space, recreation facilities, and amenities; produce somewhat reduced automobile travel because of their higher number of internalized trips and potentially greater transit use; have mixed uses and are large enough to support a diversity of housing; and are big enough to finance required infrastructure improvements more readily (e.g., through benefit assessment districts and bond financing) (Ewing, 1991; Avin, 1992).

Not everyone thinks so highly of the past 20 years of American new town planning. Neotraditionalists have been most vocal in their criticism. They have been particularly critical of: the use of multiple subcenters with no central focal point; large-scale subdividing of neighborhoods, interconnected by winding, curvilinear streets; strict separation of land uses, including housing types; and their insular quality, homogeneity, and "sterility."

In a recent article, Columbia's original chief architect-planner took issue with neotraditionalists' claim to be espousing something new:

> Columbia neighborhoods and villages, walkable scale, foot paths and sidewalks, narrow setbacks, generous open space, mix of uses, and strict design standards make it an early prototype for what is now being put forward as a brand-new concept in modern community design (Tennenbaum, 1990: 16.)

While new communities like Columbia and Reston do not always mix uses within neighborhoods, they certainly mix uses within villages. And while new towns tend to put pedestrians and cyclists on separate circulation paths, they clearly aim to accommodate foot and bicycle traffic nonetheless. The main difference in the neotraditional and new communities models has to do with scale and grain: neotraditional towns are built at a smaller scale, with more fine-grained (block-level) integration of uses and traffic streams, than new communities.

4.2. Earlier Studies on U.S. New Communities

Several researchers have compared master-planned communities with semi-planned, or less-planned, communities with regards to their levels of self-containment (e.g., jobs-housing balance) and transportation characteristics. Because many new communities contain both residential neighborhoods and employment centers, planners hoped they would have a relatively high proportion of persons who both live and work within the community. In a study of 13 planned communities in the U.S., Zehner (1977) found little evidence that they were any more self-contained. In fact, conventional (less-planned) communities had a slightly higher proportion of in-town workers (16 percent) than their new community counterparts (14 percent). Nonetheless, several new communities do stand out for their high levels of internalized commuting. Presently, about 40 percent of Reston's resident workers are employed in Reston; in Columbia, the share is approximately 30 percent (Avin, 1992).

Studies differ in terms of whether master-planned communities average lower rates of VMT per capita than other suburban communities. Burby and Weiss (1976) concluded that new communities reduce auto trips by at least 7.5 percent over conventional communities, due in large part to shorter auto commuting and more walk trips. Lansing et al. (1970) found no overall difference in automobile usage — total miles driven and vehicle trips per family were roughly the same in planned and semi-planned communities. The researchers did show more walking in planned communities (7 of 10 people made daily walk trips) than in conventional, semi-planned ones (5 out of 10 people). The additional walking and bicycling trips, however, did not substitute for car use. Rather, they were supplemental.

4.3. Study of Self-Containment and Commuting Patterns for Three Classes of New Communities

Using data from the 1990 census, levels of self-containment and commuting patterns were further analyzed for nine new communities in the U.S. Table 6.3 profiles each of the nine communities. These planned communities were paired with "control" communities from the same metropolitan area to assess whether they were indeed more balanced and thus had different commuting characteristics than other nearby communities of similar size.

The following pairs of communities were studied:

Master-Planned	Conventional
Clear Lake City, TX	Friendswood, TX
Columbia, MD	Aspen Hill, MD
Irvine, CA	Thousand Oaks, CA
Las Colinas, TX	Colleyville, TX
Miami Lakes, FL	Lindgren Acres, FL
Mission Viejo, CA	Newport Beach, CA
Peachtree City, GA	Snellville, GA
Reston, VA	Dale City, VA
The Woodlands, TX	Champions, TX

These communities were matched primarily on the basis of population size and median household incomes. The residential populations of five of the nine community pairs were within ten percent of each other; with one exception, median household incomes for all pairs were within eight percent of each other (Table 6.4). The median housing prices of new communities were also fairly similar to those of the control communities, and both tended to lie roughly the same distance from the regional CBD. Map 6.1 shows that all paired communities were located in the sunbelt crescent or mid-Atlantic.

Table 6.3

Profiles of Nine New Communities Studied

- *Clear Lake City, Texas,* home to roughly 40,000 persons, is one of several new communities in the Houston area planned by the Friendswood Development Company. Clear Lake City occupies a 15,000-acre site 20 miles southeast of downtown Houston. The community is adjacent to NASA's Johnson Space Center, which has spurred economic growth in high-tech fields and created a number of jobs in the area.

- *Columbia, Maryland,* is probably the most well-known new community in the U.S. Opened in 1967 by James Rouse, Columbia sought to attract a diverse population in terms of income and race. While the ethnic mix of Columbia is more varied than most new communities, it has become a solidly upper-middle-class community. The development consists of a series of neighborhood villages organized around curvilinear street plans, complemented by the Columbia Town Center, which functions as the community's downtown. Columbia has over 75,000 residents; some 43,000 people work in the community. The city lies midway between Washington, D.C., and Baltimore, Maryland, on approximately 15,000 acres of land.

- *Irvine, California,* is by far the largest new community in the survey in terms of population, jobs, and physical size. The city covers 27,000 acres about 40 miles southeast of downtown Los Angeles in rapidly growing Orange County. Initially developed by the Irvine Company on the site of a former ranch, Irvine became an incorporated city in 1971. Today, Irvine has a population of over 110,000 and in excess of 152,000 jobs. In addition to its sheer size, Irvine is notable for its well-developed network of pedestrian and cyclist pathways, which is reflected in the relatively high proportion of Irvine residents who walk to work.

- *Las Colinas, Texas,* lies on a 12,000-acre site within the city of Irving, Texas, about 15 miles northwest of downtown Dallas. The development abuts several local freeways and lies next to the bustling Dallas/Fort Worth International Airport, which has influenced the relocation of some 900 companies to the development since it opened in the mid-1970s. The number of jobs in the community, approximately 50,000 in 1990, dwarfs its residential population of about 12,000. In contrast to the other new communities in this survey, Las Colinas residents are primarily renters, perhaps because single-family housing has been targeted to upper-income families.

- *Miami Lakes, Florida,* is a 3,000-acre development in northwest Dade County, some 20 miles north of downtown Miami. The site was developed by The Graham Companies and opened to its first residents in 1962. This unincorporated community's main residential amenity is its 22 manmade lakes; its most noted commercial feature is its Town Center, a mixed-use, moderate-density sector at the center of the development which adheres to many of the design features advocated by neotraditional town planners. The community's main employment centers are its two business parks, located at the eastern and western edges of the development. Approximately 10,000 persons work in Miami Lakes.

- *Mission Viejo, California,* is a city of 73,000 persons about 50 miles southeast of downtown Los Angeles. Like nearby Irvine, the city is built on the site of a large ranch in suburban Orange County. Originally developed by a subsidiary of the Philip Morris Corporation, the community incorporated in 1988. The city estimates that nearly 17,000 people work within its borders.

- *Peachtree City, Georgia,* is located 30 miles southwest of downtown Atlanta on a 15,000-acre site developed by the Peachtree City Development Corporation and its predecessors. Peachtree City is an incorporated city and has been since 1959, fully one year before the development officially opened. Peachtree City's distance from a major freeway — 12 miles — has been a liability for attracting employers. While the city has a 2,200-acre business park, the majority of its residents are employed in downtown Atlanta or at Hartsfield International Airport. The airport, one of the nation's busiest, was the primary factor behind the city's growth through the 1980s.

- *Reston, Virginia,* occupies a 10,000-acre site in Fairfax County, Virginia, about 18 miles northwest of Washington, D.C. The development opened in 1964 and, like Columbia, was designed to accommodate a residential population of varied economic and ethnic backgrounds, a goal which has had only limited success. Like Columbia, the community is organized around a number of residential villages, which are served by a neotraditional town center currently being developed. Reston's growth was hampered in its early years due to the financial difficulties of its initial developer and its lack of access to the nearby Dulles Access Road. These problems were eventually resolved, and today the community boasts a population of about 40,000 and an employment base of approximately 31,500.

- *The Woodlands, Texas,* is an unincorporated community about 30 miles north of Houston. It was developed by local oilman George Mitchell and continues to be run by a subsidiary of the Mitchell Energy Corporation. The Woodlands, like other master-planned communities in the Houston area, enjoyed strong home sales during the 1980s' downturn in oil prices that negatively affected the region's economy. The community's high level of amenities offered reassuring stability in contrast to the neighborhoods of Houston proper, which remained unprotected by traditional zoning laws. Today, The Woodlands has a population of nearly 30,000 and is home to some 7,000 full-time jobs. Economically, it benefits from its proximity to Houston's major airport. The recent opening of a toll highway provides a fairly uncongested link to downtown Houston.

Table 6.4

Profile of Survey Communities

	Pop.	Median Hhd. Income	Median rent	Median home value	Distance from CBD (miles)
Balanced Communities					
Columbia	*75,883*	*$55,419*	*$726*	*$150,900*	*22*
Aspen Hill	45,494	$52,645	$798	$187,200	14
Reston	*48,556*	*$56,884*	*$818*	*$198,100*	*18*
Dale City	47,170	$50,940	$845	$121,600	23
Miami Lakes	*12,750*	*$45,455*	*$670*	*$137,100*	*21*
Lindgren Acres	22,290	$46,159	$817	$101,500	24
Residential Communities					
Clear Lake City	*39,601*	*$47,076*	*$595*	*$90,220*	*20*
Friendswood	22,814	$50,492	$607	$82,300	20
Mission Viejo	*72,820*	*$61,058*	*$969*	*$252,100*	*50*
Newport Beach	66,643	$60,374	$967	$500,001	45
The Woodlands	*29,205*	*$50,929*	*$531*	*$100,400*	*29*
Champions	26,262	$52,147	$486	$121,625	19
Peachtree City	*19,027*	*$53,514*	*$691*	*$118,200*	*30*
Snellville	12,084	$46,875	$616	$96,300	23
Employment Centers					
Irvine	*110,330*	*$56,307*	*$925*	*$292,600*	*36*
Thousand Oaks	104,352	$56,856	$899	$295,800	37
Las Colinas	*12,365*	*$44,733*	*$599*	*$311,233*	*12*
Colleyville	12,724	$77,530	$647	$189,300	20

Source: U.S. Bureau of the Census, 1990

Key:
- • New Communities
- ∘ Comparison Communities

Map 6.1

New and Comparison Communities

Classes of New Communities

Based on their ratios of jobs to workers, new communities were further broken into three classes: (1) Balanced Communities (Columbia, Reston, and Miami Lakes); (2) Residential Communities (Clear Lake City, Mission Viejo, The Woodlands, and Peachtree City); and (3) Employment Centers (Irvine and Las Colinas). Table 6.5 shows that the Balanced Communities had ratios of jobs-to-

Table 6.5

Density and Population-Employment Balance Characteristics of Planned Communities and Conventional Communities, 1990

	Population density (persons/sq. km.)	Housing density (units/acre)	Jobs/workers ratio	Jobs/housing ratio
Balanced Communities				
Columbia	***1,262***	***2.07***	***0.93***	***1.40***
Aspen Hill	1,679	2.57	0.23	0.37
Reston	***1,088***	***1.82***	***1.04***	***1.58***
Dale City	1,200	1.58	0.23	0.39
Miami Lakes	***1,247***	***2.40***	***1.31***	***1.66***
Lindgren Acres	2,291	3.44	0.08	0.12
Residential Communities				
Clear Lake City	***630***	***1.10***	***0.65***	***0.88***
Friendswood	425	0.61	0.21	0.31
Mission Viejo	***1,611***	***2.37***	***0.43***	***0.64***
Newport Beach	1,836	3.90	1.27	1.43
The Woodlands	***689***	***1.09***	***0.51***	***0.61***
Champions	346	0.60	0.84	1.08
Peachtree City	***315***	***0.44***	***0.35***	***0.46***
Snellville	511	0.72	0.49	0.72
Employment Centers				
Irvine	***1,007***	***1.57***	***2.47***	***3.60***
Thousand Oaks	813	1.20	0.53	0.79
Las Colinas	***423***	***0.71***	***6.08***	***10.03***
Colleyville	375	0.52	0.35	0.53

Source: U.S. Bureau of the Census, 1990

resident workers in the 0.93-1.31 range and ratios of jobs to housing units in the 1.58-1.66 range.[4] They also tend to be denser than other new communities. Part of the reason Columbia, Reston, and Miami Lakes rank as balanced communities is that they have relatively new mixed-use town centers. In Reston's case, the core was transformed over the past decade from a neighborhood commercial complex to a major regional employment and retail center, complete with a main street lined with ground-floor shops, restaurants, and even homes above businesses.

Residential Communities are just that — principally places to reside, averaging jobs-to-resident worker ratios between 0.35 and 0.65. Although each of these places contains some commercial uses, they are principally know for their residential concentrations. And the two employment centers, Irvine and Las Colinas, have jobs-to-resident worker ratios well above 2.00. These two new communities are home to many large corporations and businesses.

Table 6.6 shows that differences in ratios of jobs-to-resident workers and jobs-to-housing among the three classes of communities were statistically significant. Table 6.7 shows planned communities were also significantly more balanced, on average, than conventional ones.

Table 6.6

Mean Differences in Jobs-Housing Balance, Modal Splits, and Commute Times Between Classes of Planned U.S. Communities, 1990

	Balanced Communities	Residential Communities	Employment Communities	ANOVA Statistics F	Significance	Eta-Squared
Jobs/Resident-Workers Ratio	1.09	0.48	4.27	9.04	.015	.751
Jobs/Housing Ratio	1.54	0.64	6.80	7.70	.022	.719
Percent Commute Trips by:						
Drive-alone	80.33	82.02	82.64	0.28	.769	.085
Carpool/Vanpool	14.68	15.31	13.90	0.86	.521	.140
Transit	3.47	1.71	0.87	1.25	.350	.295
Walk/Bike	1.52	0.96	2.59	5.05	.051	.627
Commute Time (minutes)	26.24	26.98	20.83	2.44	.167	.449

Table 6.7

Matched-Pair Differences in Mean Jobs-Housing Balance, Modal Splits, and Commute Times Between Planned and Conventional U.S. Communities, 1990

	Planned Communities	Conventional Communities	Matched-Pair Test T-Statistic	Significance
Jobs/Resident-Workers Ratio	1.83	0.38	1.64	.140
Jobs/Housing Ratio	1.02	0.19	1.61	.147
Percent Commute Trips by:				
Drive-alone	81.60	80.52	0.59	.571
Carpool/Vanpool	14.88	15.50	0.60	.555
Transit	2.11	2.47	0.30	.727
Walk/Bike	1.41	1.51	0.23	.815
Commute Time (minutes)	25.32	29.23	2.04	.076

From a mobility standpoint, Balanced Communities could be expected to have relatively large shares of walking and bicycling trips, and relatively short average commutes— relative to both the "control" communities and other classes of new towns. Residential communities, on the other hand, are characterized by more out-commuting; because vanpools and subscription buses are easier to organize in these settings, it might be expected that they average relatively high rates of ridesharing and perhaps transit usage. And employment centers are places with lots of in-commuting — and perhaps also relatively high rates of ridesharing and mass transit trip-making.

Comparison of Commuting Characteristics

(A) Modal Splits

In 1990, six of the nine planned communities had higher shares of residents commuting by transit than conventional communities (Table 6.8), though differences were not statistically significant (Table 6.7). In general, Balanced Communities had the highest rate of transit commuting (Table 6.6). Only in Reston did more than 5 percent of the working population use mass transit to get to work. Next highest was The Woodlands — 4.4 percent. Both of these communities have commuter bus runs to the downtown cores of their respective metropolitan areas (Washington, D.C., and Houston, Texas). These two communities also had among the highest incidences of car-

Table 6.8

Comparison of Commuting Statistics for New Communities and Conventional Communities, 1990

	Percent of trips				Mean commute
	Drove Alone	Carpool	Transit	Walked	time (mins.)
Balanced Communities					
Columbia	***79.6***	***12.1***	***3.37***	***1.29***	***28.1***
Aspen Hill	70.1	14.7	10.90	8.13	30.4
Reston	***75.7***	***12.8***	***5.86***	***1.87***	***27.0***
Dale City	65.7	28.1	2.74	0.77	40.8
Miami Lakes	***85.7***	***9.2***	***1.19***	***1.40***	***23.5***
Lindgren Acres	84.3	8.8	2.68	1.17	29.2
Residential Communities					
Clear Lake City	***83.3***	***9.7***	***1.65***	***1.88***	***22.0***
Friendswood	85.0	9.7	0.82	0.93	30.4
Mission Viejo	***82.4***	***10.9***	***0.59***	***1.02***	***29.1***
Newport Beach	83.8	6.2	0.91	2.21	23.1
The Woodlands	***77.6***	***12.4***	***4.44***	***0.81***	***30.5***
Champions	81.8	9.3	3.49	1.51	28.2
Peachtree City	***84.7***	***9.8***	***0.16***	***0.15***	***26.1***
Snellville	87.4	9.2	0.00	0.76	30.1
Employment Centers					
Irvine	***81.9***	***9.1***	***0.60***	***3.02***	***23.2***
Thousand Oaks	80.9	11.3	0.32	1.79	26.9
Las Colinas	***83.3***	***11.0***	***1.15***	***2.16***	***18.4***
Colleyville	85.9	7.1	0.36	0.43	23.8

Source: U.S. Bureau of the Census, 1990

pooling and vanpooling among new towns, though in the case of Reston, its comparison community, Dale City, had twice the share of commuters sharing rides.

Drive-alone commuting was the dominant commuting means in all new towns— as high as 85 percent in Miami Lakes and Peachtree City. In all three Balanced New Communities, larger shares of residents solo-commuted than in the conventional communities. However, for the four Residential New Communities, the opposite held— larger shares of residents solo-commuted in the conventional communities. Thus, planned communities with a strong residential orientation were less dependent on autos, relative to their close-by "control" communities, than any other class of communities.

The only new communities with significant shares of walking and bicycling commute trips were the two Employment Center New Communities— Irvine and Las Colinas. For both communities, shares of walk and bicycle commutes were about 1.5 percentage points higher than in the comparison communities, and shares were also larger than in any of the seven other new communities studied. Thus, contrary to what might be expected, new communities with a strong employment orientation had larger proportion of residents walking to work than did balanced communities (Table 6.6). Of course, the biggest impact of self-containment probably relates more to non-work trips, such as for shopping, social-recreation, and personal business. For these purposes, balanced communities could very well have significantly higher shares of foot and bicycle travel.

In general, the same relationships existed in 1980 as well. Table 6.9 shows that Balanced Communities also had a higher rate of non-SOV travel relative to other classes of new towns in 1980, though rates were similar for the control communities. Higher shares of Balanced Community residents also walked to work in 1980 than in 1990.

(2) Trip Generation Rates

Comparable numbers of vehicle trips per acre (and per dwelling unit) were generated in planned communities and control communities, as well as across classes of new communities, for both 1980 and 1990. (See Tables A6.1 through A6.4 in the Appendix.) Trip generation rates nearly doubled in all communities studied during the 1980s, reflecting healthy rates of population and employment growth.

(3) Travel Time

The most striking relationships were in terms of mean commute times. For seven of the nine planned communities, average commute times were less than those of the control communities, in both 1980 and 1990 (Tables 6.8 and 6.9). The only exceptions in 1990 were Mission Viejo and The Woodlands, both of which are located at the extreme edge of their metropolitan areas. The average travel time to work for all new communities was 25.3 minutes; for conventional communities the average was 29.2 minutes (Table 6.7).

Table 6.9

Comparison of Commuting Statistics for New Communities and Conventional Communities, 1980

	Percent of trips				Mean Commute
	Drove Alone	Carpool	Transit	Walked	Time (mins.)
Balanced Communities					
Columbia	*64.9*	*24.7*	*5.55*	*2.19*	*29.2*
Aspen Hill	63.6	24.0	7.57	1.88	28.9
Reston	*59.6*	*23.4*	*10.50*	*3.84*	*32.6*
Dale City	49.7	42.3	4.58	1.02	37.8
Miami Lakes	*80.4*	*15.5*	*0.53*	*1.12*	*21.9*
Lindgren Acres	71.6	23.8	1.44	0.31	26.9
Residential Communities					
Clear Lake City	*72.0*	*23.1*	*0.23*	*1.59*	*23.3*
Friendswood	75.9	19.6	0.00	1.22	27.8
Mission Viejo	*77.1*	*17.0*	*1.64*	*0.74*	*27.8*
Newport Beach	80.3	9.1	1.56	3.03	23.0
The Woodlands	*76.8*	*18.1*	*0.33*	*1.44*	*30.6*
Champions	70.3	21.4	4.08	1.61	32.2
Peachtree City	*74.3*	*26.1*	*0.00*	*0.28*	*25.6*
Snellville	69.5	27.2	0.87	0.15	32.3
Employment Centers					
Irvine	*80.4*	*12.0*	*1.46*	*1.72*	*23.4*
Thousand Oaks	74.2	19.5	0.52	1.82	27.0
Las Colinas	*75.1*	*17.8*	*0.50*	*4.11*	*15.2*
Colleyville	79.3	15.5	0.34	2.49	23.4

Source: U.S. Bureau of the Census, 1980

Residents of Balanced Communities, in particular, got to work faster than those of nearby conventional communities. Columbia residents reached work, on average, about two minutes faster than their counterparts in Aspen Hill. In Reston, the average travel time to work of 27 minutes was nearly 14 minutes faster than that of workers in Dale City, who on average endured commutes of 40.8 minutes.

The shortest commutes were found in communities with a surplus of jobs. The community with the fastest average commute — 18.4 minutes — was Las Colinas, the only community in the survey where residents enjoyed an average commute under 20 minutes. (All but two of the surveyed communities averaged commutes above the 1990 national average of 22.4 minutes.) Las Colinas has the highest jobs-to-worker ratio of all the surveyed communities— over six jobs for every resident worker. The next shortest commutes were by Irvine and Miami Lakes residents, in which, like Las Colinas, the number of jobs exceeded the number of resident workers. These figures imply that residents of these communities are perhaps able to find work in close proximity to their homes and thus enjoy brief commutes. Indeed, Las Colinas had the highest proportion of in-town workers of any of the communities surveyed, approximately 38 percent. Irvine was a close second, with just over 37 percent of its employed residents working within the city.

Overall, the share of in-town workers ranged from 4.6 percent in The Woodlands to 38.5 percent in Las Colinas; in the conventional cities it ranged from 3.9 percent in Lindgren Acres to 38.9 percent in Thousand Oaks. The average share of in-town workers for the new communities, 24.9 percent, was substantially higher than the 18.7 percent figure for their conventional pairs.

Recap

New communities vary considerably with regards to ratios of jobs to housing. Regardless whether these communities have a job or housing surplus, significantly larger shares of residents of planned communities have local jobs relative to conventional communities. This gets translated into comparatively short trips. The shortest trips are in the communities with the largest job surplus. Though new communities appear to be more self-contained than most other suburban towns, commuters nonetheless seem to be as auto-reliant as in any other community. Balanced Communities had the highest shares of transit trips whereas job-surplus communities had the highest shares of walk trips. Since non-SOV modals splits tended to be higher in planned communities than conventional ones, regardless of community type, we can infer that master-planning has some positive influence on encouraging commute alternatives to the automobile.

5. Planned Communities and Commuting in Great Britain

5.1. Generations of New Towns in Great Britain

Great Britain has a long history of successful new town planning, and is thus a natural place to begin looking for comparative international insights. This section concentrates on some of the transportation and mobility implications of 23 new communities built in England since 1946 under the direction of the central government (Map 6.2).[5] The very first new towns owe much to the visionary garden-city concepts of Ebenezer Howard. Garden cities were meant as antidotes to the impoverished and filthy conditions of inner-city living in Victorian England. According to Hall (1988: 8):

> It proposed to solve, or at least to ameliorate the problem of the Victorian city by exporting a goodly proportion of its people and its jobs to new, self-contained, constellations of new towns built in open countryside, far from the slums and smoke — and, most importantly, from the overblown land values— of the giant city.

Three garden-city new towns, Letchworth, Hampstead, and Welwyn, were built in the early 1900s by private investors. Designed by two pioneering planner-architects, Raymond Unwin and Barry Parker, all three were more like garden suburbs, featuring clustered housing grouped around

Source: Watson (1991)

Map 6.2

New Towns in England: 1946-1970

communual greens and connected by pedestrian ways — nearly a quarter century before the Radburn Plan.

The depression of the 1930s and second world war stalled the British new town movement, though it pick up momentum after the war, owing to the need to replace housing in wartorn areas. Sir Patrick Abercrombie's 1944 outline plan for Greater London recommended the creation of new "satellite" towns, close enough to London to act as "overspill" areas but sufficiently removed from the capital to avoid becoming domitory towns (Watson, 1991). The New Towns Bill of 1946 followed, authorizing the establishment of Development Corporations to plan, build, and finance new towns. Between 1946 and 1950, eight new towns, referred to chronologically as Mark I towns, were built 20 to 30 miles from London, functioning as Abercrombie's recommended satellites for handling London's spillover growth.[6] Mark I towns were planned on the assumption that most people would reach their jobs on foot or bicycle and that auto ownership would be low (Dupree, 1987). Thus, all feature separate footpath and cycleways, narrow streets, and residential areas buffered from major thoroughfares. Mark I towns were segregated into functional land uses, with residential areas clustered into neighborhood units for about 10,000 people focused on retail centers. With low population densities and spatial separateness, sociologist found many inhabitants of this first-generation of British new towns were lonely and isolated, suffering from "new town blues" (Ward, 1993).

During the 1950s, enthusiasm for new towns waned in Great Britain because political priorities had shifted. Rising unemployment in central and northern England, however, led to a new generation of new town development, Mark II towns, during the 1960s. While these new communities were meant to provide for the orderly spillover of people from large cities, their primary purpose was to act as instruments for regional policy— mainly to disperse industry and population from conurbations in the Midlands and the North as well as the Southeast, and, in so doing, to spawn new centers of economic development. Thus, Mark II new towns were distinguishable from their predecessors in that they were outside of London's orbit and they tended to be much larger.[7]

From an urban design standpoint, two key factors shaped Mark II towns. One, concern over the "new town blues" syndrome of Mark I communities led to the development of larger, denser Mark II towns, to help foster "community identity." Cumernauld was the first new town designed expressly as a compact community, with a target population of 100,000. The second decisive factor was the issuance of the highly influential publication, *Traffic in Towns,* also called the Buchanan report, in 1963. This document articulated the need to plan for a distinct road hierarchy and the careful arrangement of land uses to handle the anticipated explosive growth in motorization (Potter, 1984). This led to plans for Redditch, Runcorn, and Washington that emphasized segregation of pedestrians and fast-moving traffic and the dispersal of land uses with high traffic generation to ensure balanced peak hour flows.

The last generation of British new town development occurred in the late 1960s and early 1970s with the construction of six Mark III towns.[8] All were built well beyond the periphery of London, and were targeted as sub-regional centers with populations of at least 150,000. Two of the towns, Peterborough and Northamption, were already well-established centers, while Milton Keynes was created in an area with relatively little previous development. Mark III new towns carried on the tradition of building highway infrastructure necessary to accommodate the exploding car population, though more to an extreme. Milton Keynes is unabashedly an auto-oriented community, criss-crossed by a grid of four-lane thoroughfares that are grade-separated at major junctures. The largest and last of the English new towns, Milton Keynes was designed with generous amounts of open space and highway capacity, a testament to the population and automobile growth that was envisaged.

In the past few years, British new town development has ground to a halt as policy interest has shifted to regeneration of inner cities. The wind-up of the Telford Development Corporation in 1991 and the Milton Keynes Development Corporation in 1992 brought a major chapter in the planning of urban development in England to a close. In the next several sections, lessons that might be drawn on the transportation implications of British new town development are drawn.

5.2. British New Towns, Self-Containment, and Commuting

According to Thomas (1968, p. 338), all British new towns were designed with the idea that they should be "self-contained and balanced communities for living and work."[9] Three groups of researchers, Thomas (1968), Cresswell and Thomas (1972), and Breheny (1990), have tested this proposition, and their collective findings are summarized in Table 6.10.[10]

Table 6.10 shows the "Independence Index" values of each new town over the 1951-1981 period — a measure, created by Thomas (1968), of internal work trips divided by the sum of in and out (external) work trips. The higher the index value, the higher share of all work trips that are internal and lower the share that cross community boundaries— i.e., the more self-contained the community.

The most self-sufficient British new towns are clearly those most recently built— Mark III towns. Rather curiously, then, the British new towns with the greatest provisions for automobility are the ones with the largest share of commuters traveling within their borders. This is likely partly explained by the relative isolation of many Mark III towns (e.g., surrounded by greenfields) and the emphasis placed on regional economic development (wherein housing priority was given to those working within the community).

Table 6.10 shows that the planned overspill communities around London (Mark I) became increasingly self-contained over their first 10 to 20 year of existence, though by the 1970s their residents were increasingly dependent on the hinterland for jobs and their businesses imported more and more workers. By 1966, five out of eight London orbital new towns were net importers of labor (Thomas, 1968). The 1961-66 peak period of self-containment was also when these early new towns began to reach their planned capacity, but before significant growth in car ownership. Thomas (1968) and Creswell and Thomas (1972) also compared independence indices between new towns and "natural," or control, towns. For 1966, they calculated an average independent index for natural towns of 1.04, substantially below that of new towns.[11] They attributed the higher level of locally residing workers to two key factors: the policy of Development Corporations to place those working within the community at the top of the waiting list for new housing, and the entry of women (who

Table 6.10

Work Trip "Independence Index" Values for British New Towns, 1951-1981

	1951	1961	1966	1971	1981
MARK I					
London's Orbit:					
Stevenage	0.92	2.29	2.03	1.63	1.14
Crawley	0.98	1.59	1.58	1.69	1.15
Hemel Hempstead	1.31	1.82	1.72	1.43	1.00
Harlow	1.42	2.04	2.05	1.92	1.44
Hatfield	0.65	0.63	0.66	0.32	0.45
Welwyn	1.12	1.09	1.12	0.97	0.68
Basildon	0.36	0.96	0.96	0.87	0.76
Bracknell	0.90	1.13	1.02	0.87	0.82
Average	0.96	1.44	1.39	1.21	0.93
Other:					
Aycliffe	0.08	0.52	0.57	0.44	0.74
Peterlee	0.34	0.20	0.36	0.41	0.34
Cwmban	0.72	0.74	0.88	0.75	0.86
Corby	1.41	1.91	2.51	0.69**	1.79
Average	0.64	0.84	1.08	0.57	0.93
MARK II					
Compact-Transit:					
Skelmersdale	*	*	*	0.67	0.87
Redditch	*	*	*	1.30	1.12
Runcorne	*	*	*	0.73	0.94
Average	*	*	*	0.90	0.98
Full Mobility:					
Washington	*	*	*	0.56	0.67
Newtown	*	*	*	1.03	1.32
Average	*	*	*	0.80	1.00
MARK III					
Milton Keynes	*	*	*	1.36	1.44
Petersborough	*	*	*	1.84	1.99
Telford	*	*	*	2.61	2.41
Northampton	*	*	*	2.88	2.43
Warrington	*	*	*	1.74	1.32
Central Lancaster	*	*	*	1.88	1.88
Average	*	*	*	2.05	1.91
MARK I NEW TOWNS***	0.85	1.24	1.29	1.00	0.95
ALL NEW TOWNS****	0.85	1.24	1.29	1.24	1.20

* Figures not reported by any of the below sources.
** Reported by Breheny (1990), though value is suspicious compared to 1966 and 1981 values.
*** Average for those 12 new towns (Mark I) for which values are available for all years.
**** For all 23 new towns, for years data are available.
Note: All averages are not weighted by population.
Sources: 1951, 1961, and 1966 figures are from Thomas (1968) and Cresswell and Thomas (1972), and also reported in Breheny (1990). 1971 and 1981 figures are from Breheny (1990).

at the time were less likely to drive) into the labor force. The authors also showed that self-containment generally increased with distance from London and town size![12]

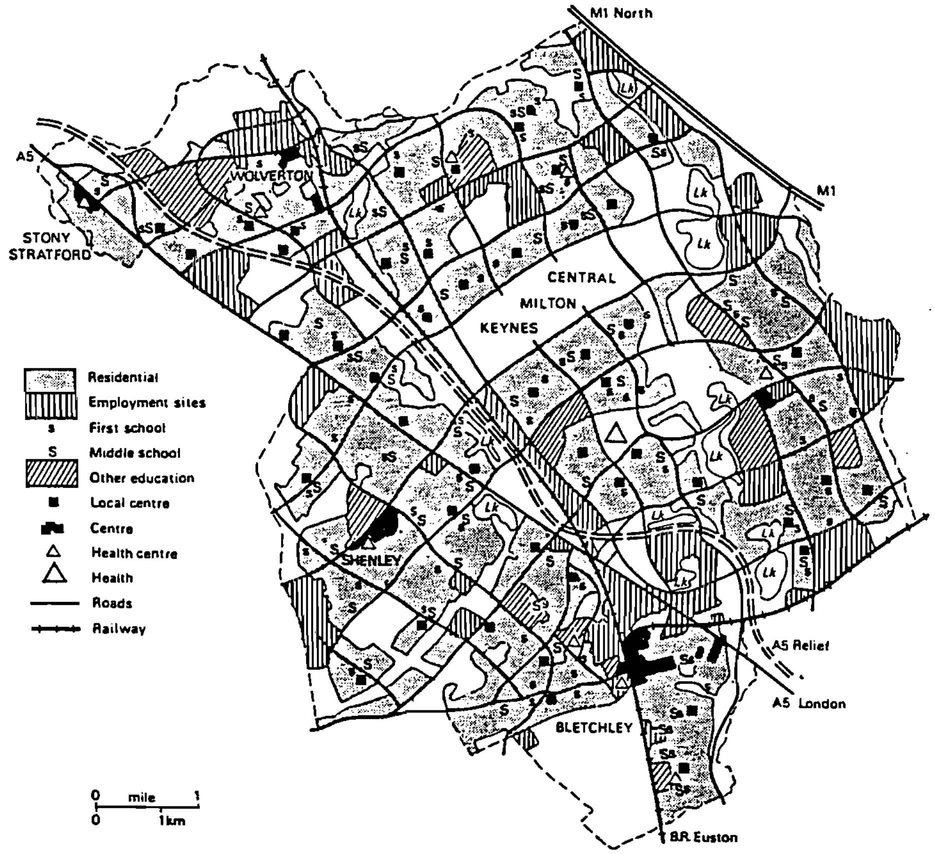
Except for Mark III towns, independence indices are fairly similar among classes of new towns. Among Mark I towns, for instance, those surrounding London appeared more self-contained than those elsewhere in Great Britain from 1951 to 1971, but by 1981 they had equal shares of external commuting. Mark I towns were slightly more self-contained than their Mark II successors in 1971, but a decade later the opposite was true. Nor does there appear to be significant differences between the earlier Mark II new towns that were compact and designed for high-quality transit and the latter full-mobility new towns (Washington and Newtown).

Breheny (1990), in updating the Cresswell and Thomas work to 1981, concludes that in both new towns and other towns, self-containment has declined and that the decline has been greater in the new towns than in the "natural towns."[13] He attributes this decline mainly to rapid increases in vehicle ownership, leading to the "breakdown of the original 'job and home' function of the new towns" (Breheny et al., 1992: 151). While perhaps true, this does not accurately portray recent trends. As noted, the latest new towns, Mark III communities, are all highly self-contained, which when averaged over the totality of the 23 new towns shown in Table 6.10 yields an average 1981 independence index which is similar to that found in 1961. More accurately, during the 1951-81 period, the trend seems to be that as they matured, Mark I new towns indeed became less self-contained, whereas the later generation of new towns maintained high levels of self-containment — Mark II actually became more balanced and Mark III new towns became the most balanced of all.

These findings probably speak less to any influences of physical design or urban planning and more to the relative location (away from England's primate city, London) of more recent new towns. Indeed, all researchers showed that levels of self-sufficiency increased with distance from London and the remoteness of the community.

5.3. Urban Form and Commuting in British New Towns

Potter (1982, 1984) has brought the impacts of auto-oriened versus transit-oriented British new towns into clear focus. Milton Keynes (Map 6.3) was purposefully designed to maximize automobility — it has low average densities (9 persons per acre) organized around a grid of four-lane thoroughfares and a random distribution of destinations to spread vehicle loading on roads over as wide an area as possible. In contrast, Runcorn, outside of Liverpool, has separate facilities for bus and car traffic. Buses operate on a figure eight track that threads its way through the center of residential neighborhoods and connects directly to the town center (Map 6.4). Runcorn's planner-designer, Arthur Ling (1967, p. 18), argued that:



Source: Potter (1982)

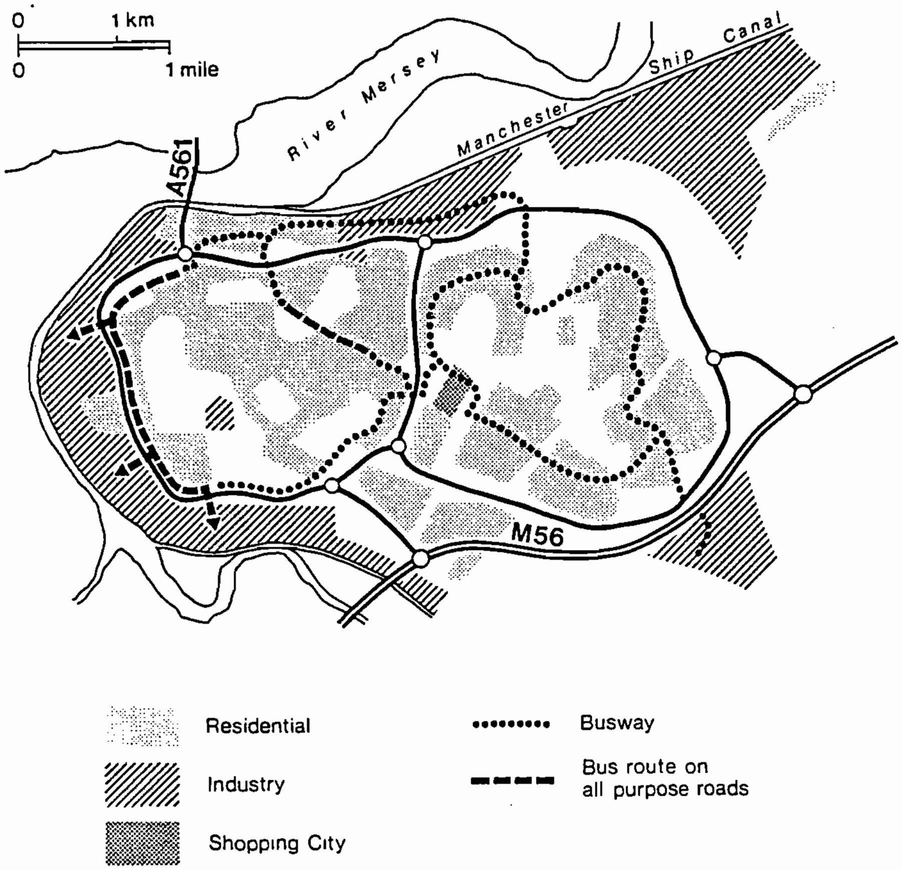
Map 6.3

Strategic Plan of Milton Keynes, 1984

> To design the town dominantly for the motor car would require maximum expenditure on highways to cater for peak-period traffic and a more extensive provision of car parking spaces at the Town Centre and in the industrial areas. In addition, public transport ... would be little used and therefore it would be uneconomic to operate a frequent service. This would cause a sense of social isolation for those without the use of a car, such as children and old people, and also members of the family to whom the car is not available at a particular time. (Quoted in Potter, 1984, p. 81).

On this basis, Ling proceeded to design Runcorn's residences at sufficient densities and in defined corridors to justify frequent bus services. This "pearls on a string" design ensured balanced two-way bus flows.

Table 6.11 summarizes Potter's comparison of Milton Keynes with Runcorn and another transit-oriented new town, Redditch.[14] Although the original Milton Keynes plan called for frequent transit service (2-5 minute headways), once the auto-dependent, low-density community was built, planners realized that frequent transit services would be prohibitively expensive.[15]



Source: Dupree (1987)

Map 6.4

Runcorn's Busway System, 1968

Table 6.11

Comparison of Physical and Transportation Characteristics of Milton Keynes, Runcorn, and Redditch, 1982

	Milton Keynes	Runcorn	Redditch
Physical Characteristics:			
Year of Designation	1967	1964	1964
Population	107,000	65,000	68,000
Planned Gross Density (persons per acre)	9	17	13
Average Number of Shops at Neighborhood Center	5	7	15
Public-Sector Development Costs per person housed (£)	10,200	7,000	4,100
Transportation Characteristics:			
Primary Road System	Grid	Linear	Linear
Average Bus Headway (minutes)	30	5	10
Cost of Weekly Bus Ticket (£)	2.40	2.50	3.50
Subsidy as Percentage of Bus Operating Cost	42	5	6

Sources: Potter (1984) and Dupree (1987)

Even with peak headways of 30 minutes, the Milton Keynes bus system required an operating subsidy of 42 percent. Potter suggests that Milton Keynes presents a "worst of both worlds" example — a town that required a £100 million outlay for high-capacity roads (much higher than any other British new town) as well as unusually high bus subsidies.

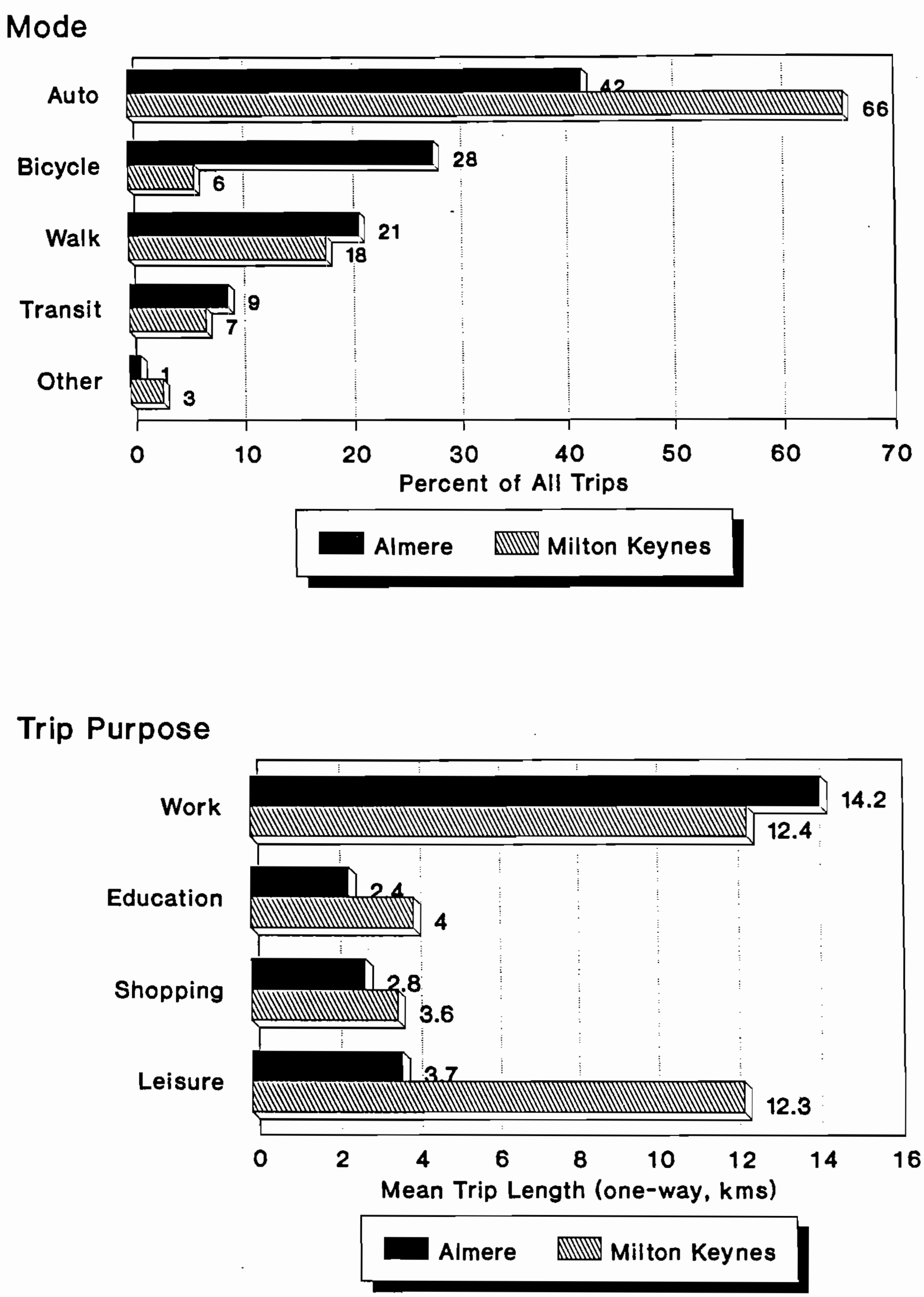
In contrast, Runcorn and Redditch were able to support bus headways of 5 to 10 minutes at a very low per rider subsidy. In 1983, Runcorn's modal split between busway use and private car trips was 53:47, slightly ahead of the master plan assumption of a 50:50 split (Dupree, 1987). In both towns, moreover, road networks have adequately handled auto traffic with no restrictions on mobility. Because they have separate foot and cycle paths and controlled crossings at grade-level intersections, both Runcorn and Redditch are also pedestrian and bicycle friendly.

Recently, Roberts and Woods (1992) have contrasted travel in Milton Keynes to Almere, a Dutch community around 30 miles east of Amsterdam. While Almere occupies a similar land area, it is slated for a similar target population (250,000), and has a similar average household income as Milton Keynes, its physical design is much different: it clusters related land uses (e.g., shopping, homes, and some jobs) and has two large subcenters and a main town center.[16] Milton Keynes averages 1.37 cars per household, compared to 0.94 in Altmere. The two communities, however, have similar counts of bicycles per inhabitant — around 0.60. Figure 6.4 shows that for all trip purposes, Milton Keynes had much higher shares of automobile trips, while Almere had higher shares of walking, transit, and especially bicycle travel. Milton Keynes also averaged much longer trips for all purposes except work (Figure 6.4).

5.4. Recap

Great Britain's new town planning experiences provide several valuable policy insights. Planned communities can achieve high levels of self-containment, though in the case of first-generation new towns, this generally eroded as motorization levels increased. Interestingly, the newest generation of new towns are the most auto-dependent yet the most self-contained. Overall, jobs-housing balance and rates of internal commuting are highest for more isolated British communities and when development corporations targetted new housing additions to local workers.

Communities designed for high-quality transit services, like Runcorn and Redditch, average high transit modal splits and low deficits per rider. Full-mobility new towns, exemplified by Milton Keynes, are relatively expensive to serve and almost as auto-dependent as many American cities. While some British scholars have questioned the sustainability of auto-dependent new towns like Milton Keynes, others note that Milton Keynes remains a prosperous community and, unlike some new towns, is experiencing healthy employment growth (Ward, 1993). The most serious liability of planned communities like Milton Keynes, some argue, lies in their relatively high levels of energy consumption per capita (Jacobs, 1991; Breheny et al., 1992; Potter, 1993).



Source: Roberts and Wood (1992)

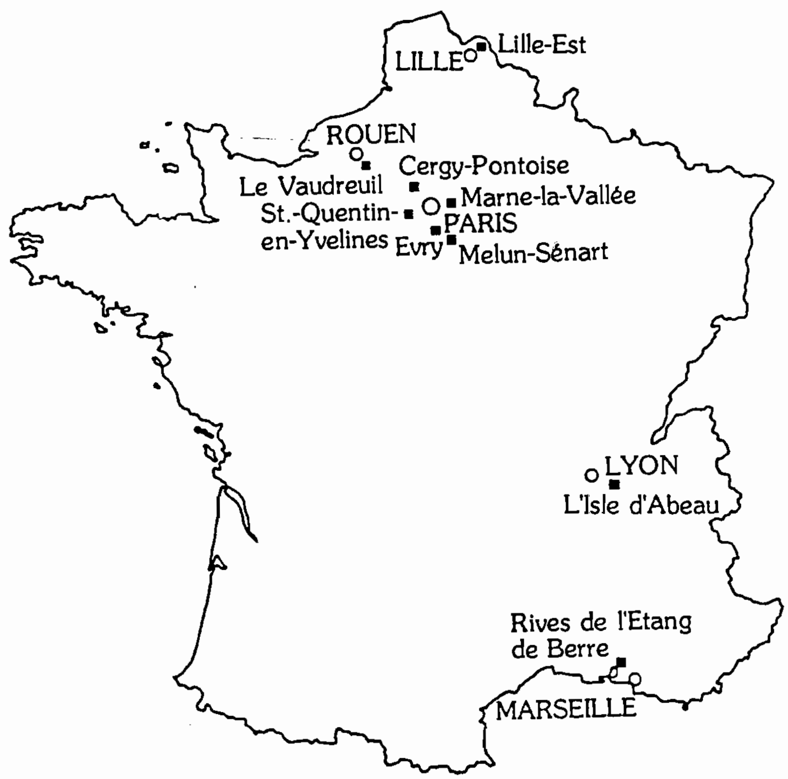
Figure 6.4

Comparison of Modal Splits and Trip Lengths Between Milton Keynes and Allmere, 1991

6. New Town Development and Commuting in France

6.1. Background on French New Town Development

France's new town experiences offer insight into jobs-housing balance issues and spatial patterns of commuting of new town residents and workers. To date, around one million inhabitants have settled into one of nine French new towns— five in the Paris region (Ile-de-France region) and four elsewhere (Map 6.5). As in Britain, planned communities ringing Paris were meant to



Source: Ploegaerts (1992)

Map 6.5

New Towns in France

relieve the national capital of extreme overcrowding after the second world war; by one French account, "the prime objective was to relax the stranglehold on the Paris region, suffocated by galopping and sprawling urbanization" (Dresch, 1993, p. 2). New towns outside of Marseille, Lyon, Rouen, and Lille, on the other hand, were planned as regional growth magnets, mainly to stimulate new industrial activities.

By the early 1960s, rapid population growth, overcrowding, and traffic congestion prompted the French government to weigh options for the Paris region. This was also a time when community services in the suburbs were under-developed and high-rise apartment blocks, hastily built to meet the acute post-war housing shortage, were under attack by the architectural community. Planned communities on the periphery of Paris were embraced by President Charles de Galle as the answer to the region's woes.

Paris's legacy of monumental construction projects is legendary, going back to Baron Haussman in the 19th century, and the new town experiments of the past twenty years carried on this tradition. The region's 1965 new town plan, Paris Schéma Directeur, was bold, visionary, and utopian:

> Nothing so grandiose was ever attempted in the history of urban civilization. The total bill to the French excheqeur was mind-boggling: the twelve-year plan...called for a total of 29 billion francs on highways and 9 billion for public transport, not to mention 140,000 new dwellings a year. Only a country...in the middle of an economic boom almost unprecedented in history, only one with a centuries-old tradition of top-down public intervention, could even have contemplated it (Hall, 1988, p. 314).

The plan rejected most other new town models of the day, including Abercrombie-style British new towns or the spatial formalism of Brasilia; instead it opted for a multi-centered metropolis organized around a regional commuter rail system, modeled after Stockholm though in a metropolis ten times Stockholm's size.

The French government seeded the initial construction of the five new towns outside of Paris. Development started in the center of new towns, grouping infrastructure and public amenities around existing or planned transit networks. Unlike in Britain, however, the French government steered away from real estate development, leaving housing, office, and factory construction to the private sector. Most French new towns segregate pedestrian and vehicle traffic in their cores, and provide easy access to various public transit systems from central areas. All residences are within easy walking distance of a transit hub, and dwelling units generally turn their backs to streets. Transit's prominence is exemplified by dedicated bus lanes and commuter railway in Evry, a regional express rail hub (RER) in Marne-la-Vallée, and the new automated underground (VAL) that terminates in Lille-Est. Additionally, French new towns take pride in their generous amounts parks and landscaping as well as architectural diversity, expressed by elaborate treatments of form, colors, and materials.

6.2. Development Characteristics of New Towns in Ile-de-France

Table 6.12 summarizes development and transportation characteristics of the Paris region's five new towns (Map 6.6). Marne-la-Vallée is the most populated and, along with Cergy-Pointoise, has grown the fastest over the past decade (Figure 6.5). Both of these new towns have the largest employment base and, along with Saint Quenten-en-Yvelines and Evry, have experienced rapid job

Table 6.12

Summary Development and Transportation Characteristics of New Towns in Ile-de-France

	St. Quentin-en Yvelines	Cergy-Pointoise	Evry	Melun-Sénart	Marne-la-Vallée
Population	128,663	159,152	74,803	80,920	210,000
Population/acre	49.4	50.4	61.5	17.1	34.6
Employment	56,778	75,586	45,846	19,550	73,600
Distance to Paris (km)*	20	25	28	30	13
Number of Regional Rail Lines (RER-SNCF)	2	3	2	2	1
Number of Rail Stations	3	3	5	4	5

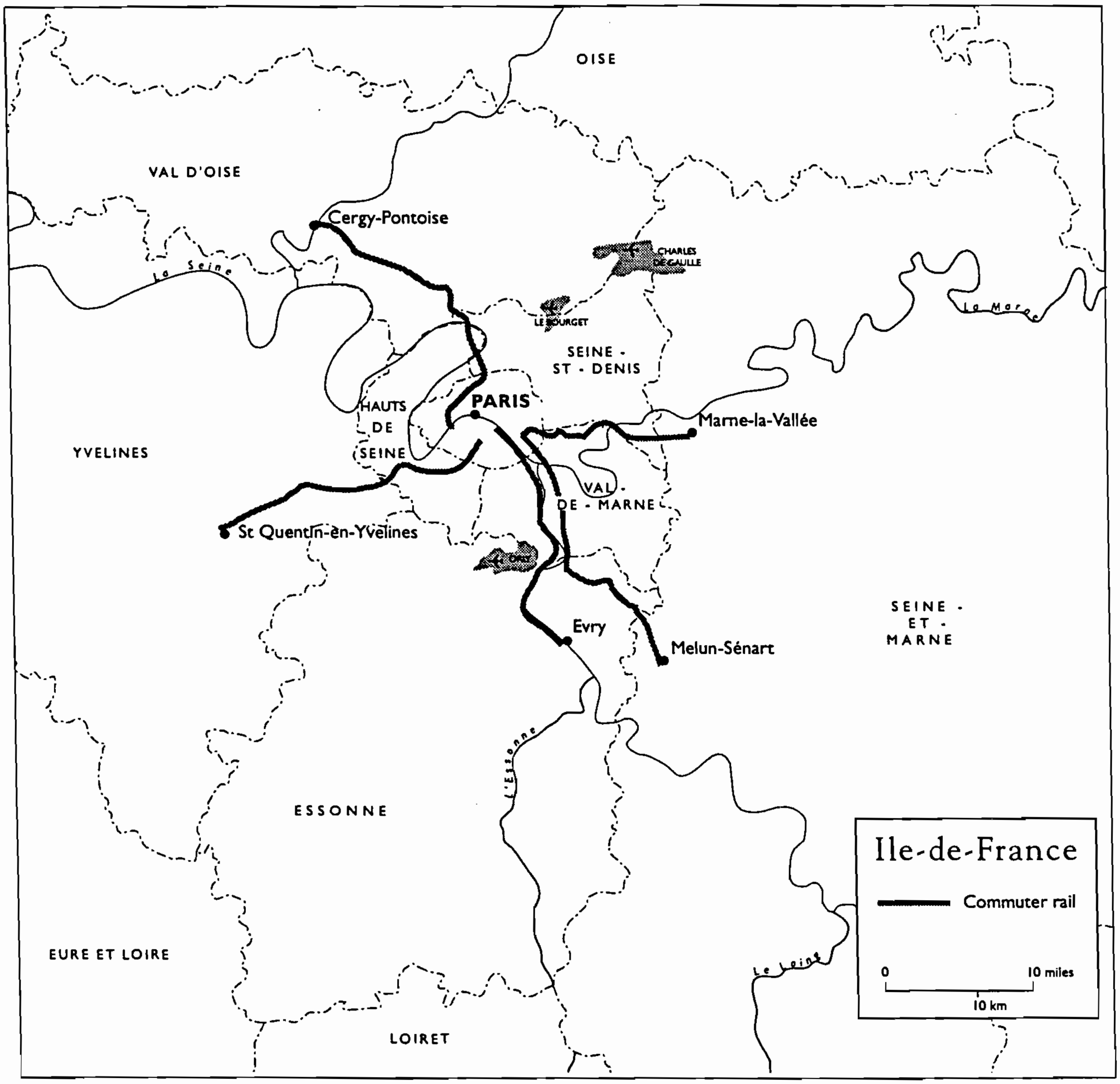
*Distance from town center to Cathedral Notre Dame.
Source: Groupe Central Des Villes Nouvelles, Ministere de L'Equipement, Des Transports et du Tourisme.

growth as well (Figure 6.6). The opening of Eurodisney has fueled much of Marne-la-Vallée's growth, principally in the service sectors. All five new towns are well served by regional commuter and express rail services.

The three towns to the west and south of Paris, Cergy-Pontoise, Saint-Quentin-en-Yvelines, and Evry, are all denser than their eastern counterparts and have prospered the most, economically, over the past decade, emerging as major centers of office, high-technology, and light manufacturing development. New towns to the east have fared less favorably, though the situation in Marne-la-Vallée has turned around with the opening of EuroDisney and the new RER express rail line. From the start, Melun-Senart lagged behind other new towns because of its mediocre transportation services; however, the construction of a new regional bypass and a TGV (high-speed rail) station, coupled with its low-cost commercial space, promises to turn this around.

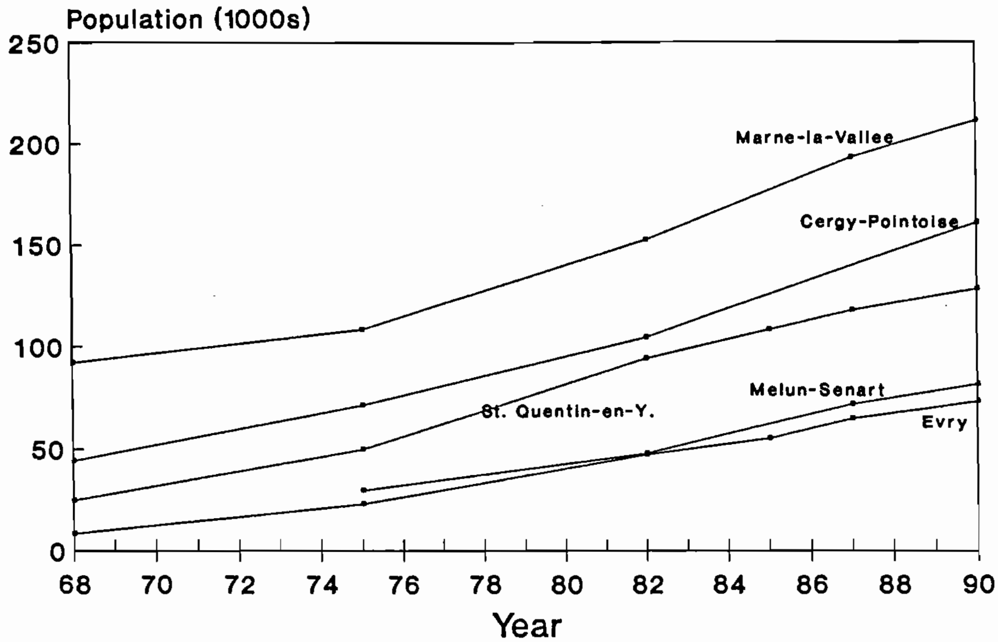
6.3. Levels of Self-Containment in New Towns of Ile-de-France

Over the past several decades, Ile-de-France's two easternmost new towns, Melun-Senart and Marne-la-Vallée, have attracted large numbers of foreign immigrants and young families in search of affordable housing. Figure 6.7 shows they have relatively low ratios of jobs-to-housing, though because of Eurodisney's opening, Marne-la-Vallée is becoming more and more balanced. The two rapidly growing westernmost new towns, Saint-Quentin-en-Yvelines and Cergy-Pointoise, are Ile-de-France's most balanced, both with jobs-to-housing ratios between 1.25 and 1.50, a range that is widely viewed as "balanced" (Cervero, 1989).[17] Evry, the technopolis 28 kilometers south of Paris, is the least balanced — averaging 80 percent more jobs than housing units.



Map 6.6

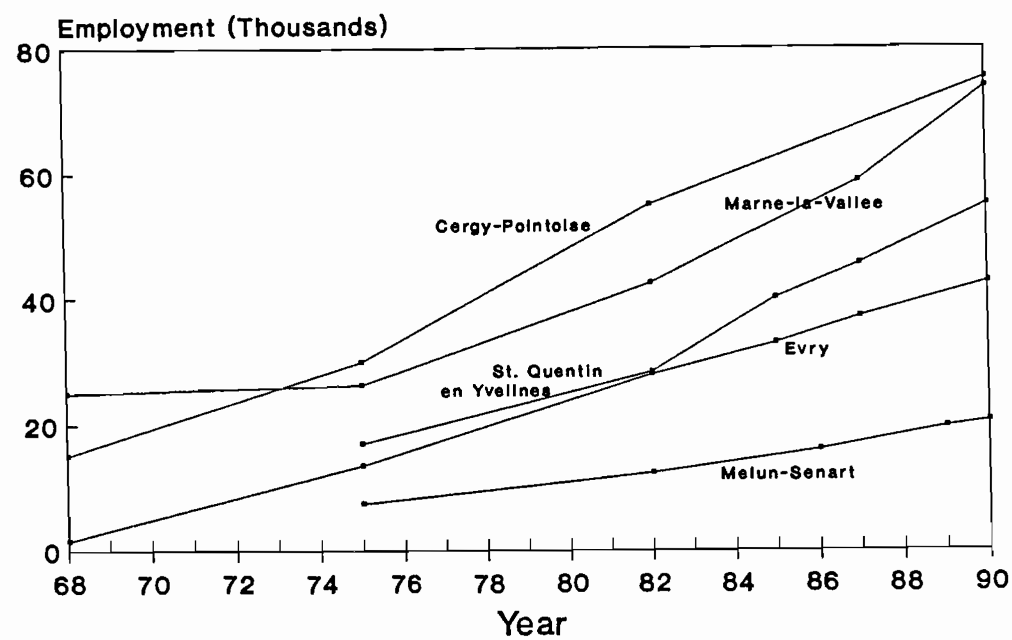
New Towns in Ile-de-France



Source: Groupe Central Des Villes Nouvelles, Ministere de L'Equipement, Des Transports et du Tourisme.

Figure 6.5

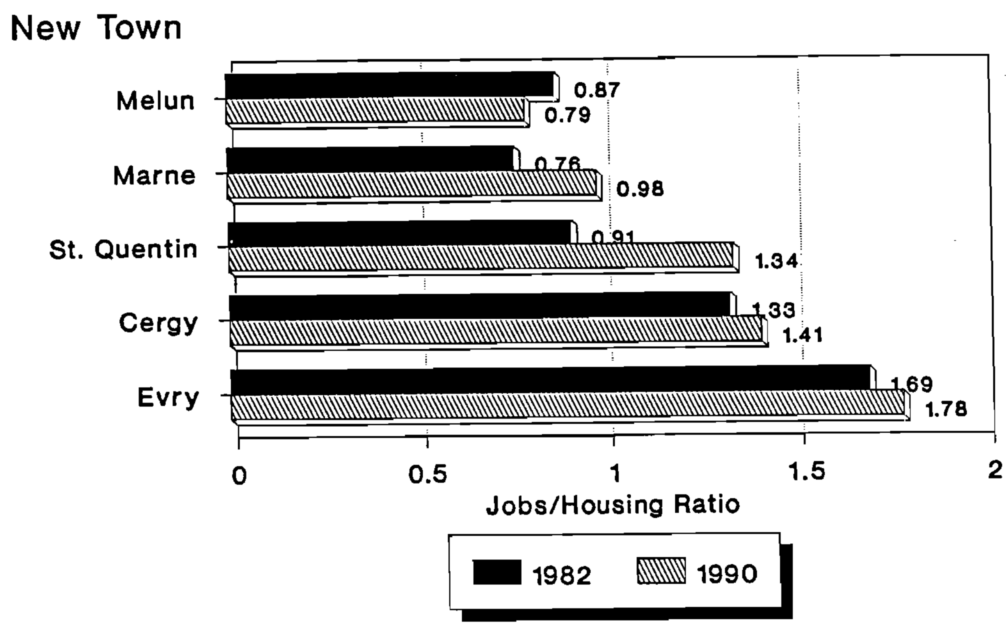
Population Trends in New Towns of Ile-de-France, 1968-90



Source: Groupe Central Des Villes Nouvelles, Ministere de L'Equipement, Des Transports et du Tourisme.

Figure 6.6

Employment Trends in New Towns of Ile-de-France, 1968-90



Source: Groupe Central Des Villes Nouvelles, Ministere de L'Equipement, Des Transports et du Tourisme.

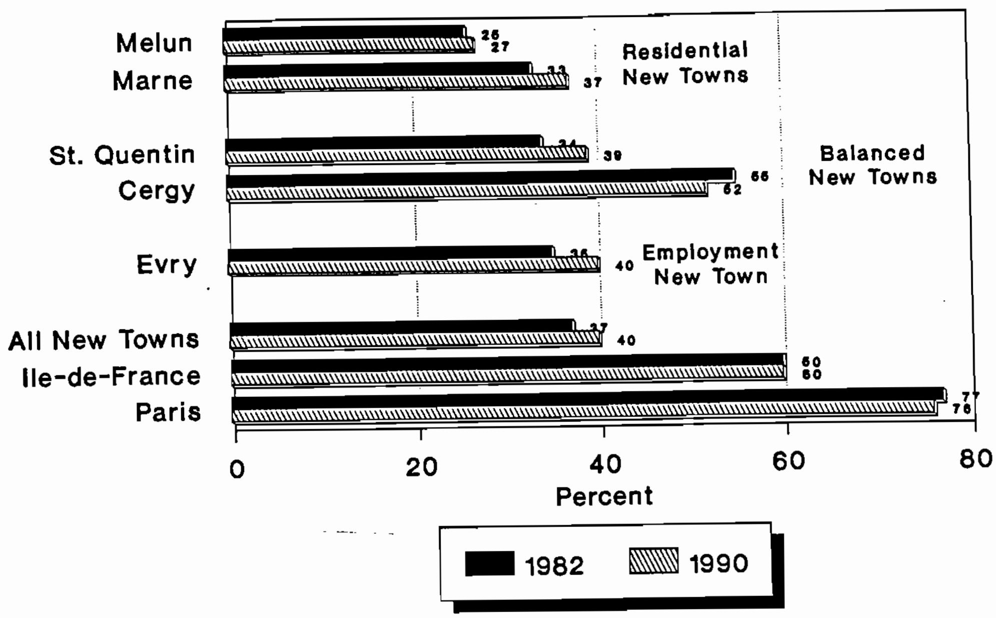
Figure 6.7

Jobs-to-Housing Ratios for New Towns of Ile-de-France, 1982 & 1990

Jobs-to-housing ratios only express the potential for balance. Whether a place is actually "balanced," or self-contained, is better revealed by the share of workers residing in a community and the share of residents working there. While community boundaries are largely political artifacts and do not always correspond to a community's commutesheds, in the case of Ile-de-France's new towns, all have distinct edges and are surrounded by greenbelts. Thus the boundaries of these five new towns are suited for distinguishing commutes that are internal (within) and external (beginning or ending outside).

Figure 6.8 shows that the two "balanced new towns" had among the highest shares of workers residing locally. In the case of Cergy-Pointoise, over half of all workers reside within the community, though the share has fallen since 1982. The "employment new town," Evry, has around 40 percent locally residing workers. In contrast, the two "residential new towns" had the lowest percentage of workers residing withing the community, especially Melun-Senart. Figure 6.8 also shows that compared to other suburban (non-master-planned) communities in Ile-de-France as well as Paris, new towns had far fewer shares of workers taking up residence within the community.

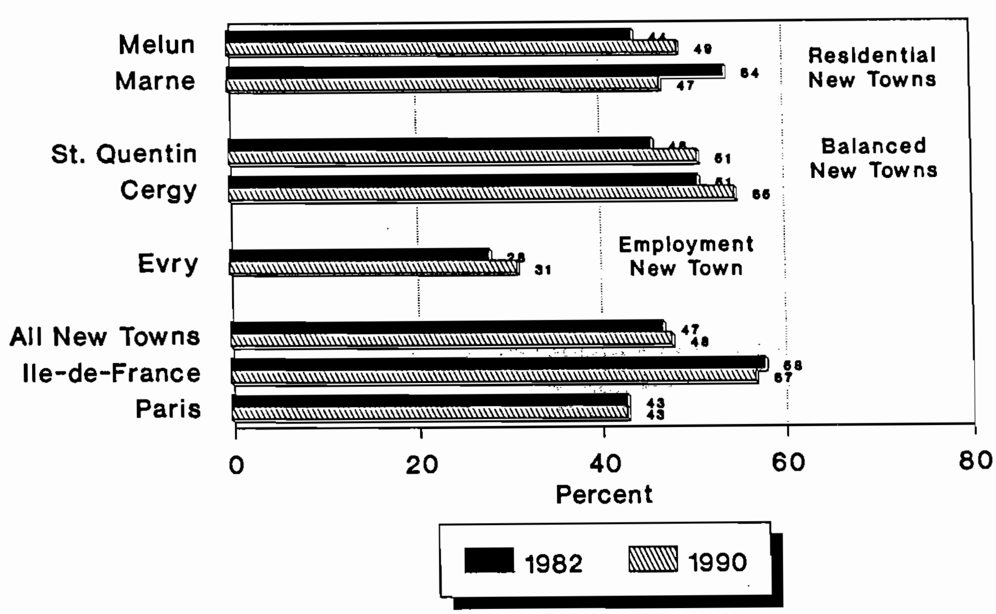
A similar relationship was found for shares of employed residents working in the community (Figure 6.9). The most balanced communities had the largest shares. The next highest shares were for residential communities. By contrast, the employment new town, Evry, had fewer than one out



Source: Groupe Central Des Villes Nouvelles, Ministere de L'Equipement, Des Transports et du Tourisme.

Figure 6.8

Percent of Workers Residing in Community, 1982 & 1990



Source: Groupe Central Des Villes Nouvelles, Ministere de L'Equipement, Des Transports et du Tourisme.

Figure 6.9

Percent of Employed Residents Working in Community, 1982 & 1990

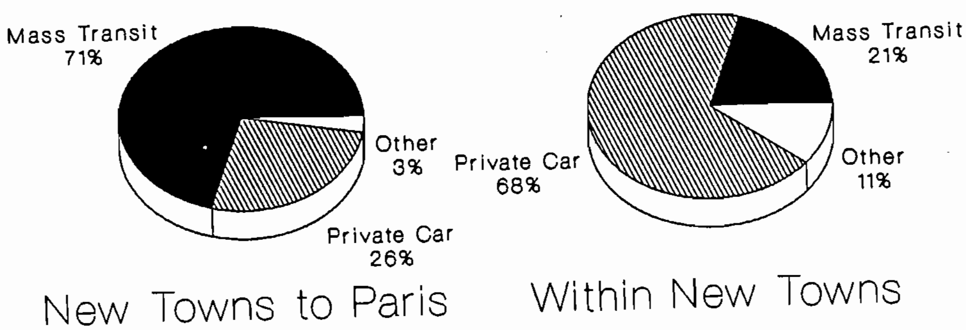
of three employed residents working locally. Again we find that other suburban communities in Ile-de-France were even more self-contained, averaging significantly larger shares of residents who worked in town. New towns, however, do have smaller shares of outbound commuters each morning than Paris.

Overall, Cergy-Pointoise is the most self-contained new town in Ile-de-France, with the majority of workers living locally and the majority of residents working in town. Like Cergy, the next most self-contained, Saint Quentin-en-Yvelines, also has a fairly balanced ratio of jobs-to-housing. The remaining new towns experience in- and out-bound commuting each day. As a massive employment concentration, Evry has relatively large shares of workers commuting within the community, though over two-thirds of residents with jobs leave Evry for work each day. Like Evry, Marne-la-Vallée averages more external than internal commuting. The least self-contained new town, Melun-Senart, has over half of its workers commuting in from elsewhere each day and around three-quarters of its residents who work commuting outbound. In sum, some numerical balance of jobs and housing units appears to be a necessary though not a sufficient condition toward self-containment in Ile-de-France's new towns.

6.4. Commuting in New Towns of Ile-de-France

While Ile-de-France's new towns are fairly self-contained and well-served by regional transit facilities, this does not necessarily translate into high transit usage for trips made within the community. Figure 6.10 shows that in 1983, the latest year for which commuting data were available, 21 percent of residents who lived in new towns commuted via transit to work. This compares to a 42.6 percent transit modal split for all work trips in Ile-de-France in 1983. (For work trips within Paris, transit carried 76.7 percent of commuters.) In general, transit's internal modal split was fairly similar across new towns. Recent survey work in Evry, however, puts the transit modal split for internal work trips at 31 percent, substantially above the 1983 average for all new towns. This difference is no doubt attributable to Evry's superior bus service that weaves through the community on a dedicated transitway, similar to that found in Runcorn, England. Other new towns, such as Cergy-Pointoise, have promoted internal transit usage in other ways, such as offering free annual passes to their first settlers.

Figure 6.10 also shows that transit's major role lies in ferrying workers in and out of Ile-de-France's new towns. For external commute trips made by new town residents, 71 percent were by transit. The vast majority of these were on the RER-SNCF commuter rail lines. These commuter rail lines recover 94 percent of their operating costs from farebox receipts (Dresch, 1993). Overall, then, we can conclude that transit usage for work trips is the highest in the least self-contained new French towns — ones with large shares of workers and residents commuting in and out of the community. This finding would seem to suggest that as long as a region is well-served by rail transit,



Sources: Groupe Central Des Villes Nouvelles, Ministere de L'Equipement, Des Transports et du Tourisme; and Conseil Regional D'Ile de France, Direction Regionale de l'Equipement.

Figure 6.10

Comparison of Modal Splits for Internal and External Work Trips for New Towns in Ile-de-France, 1983

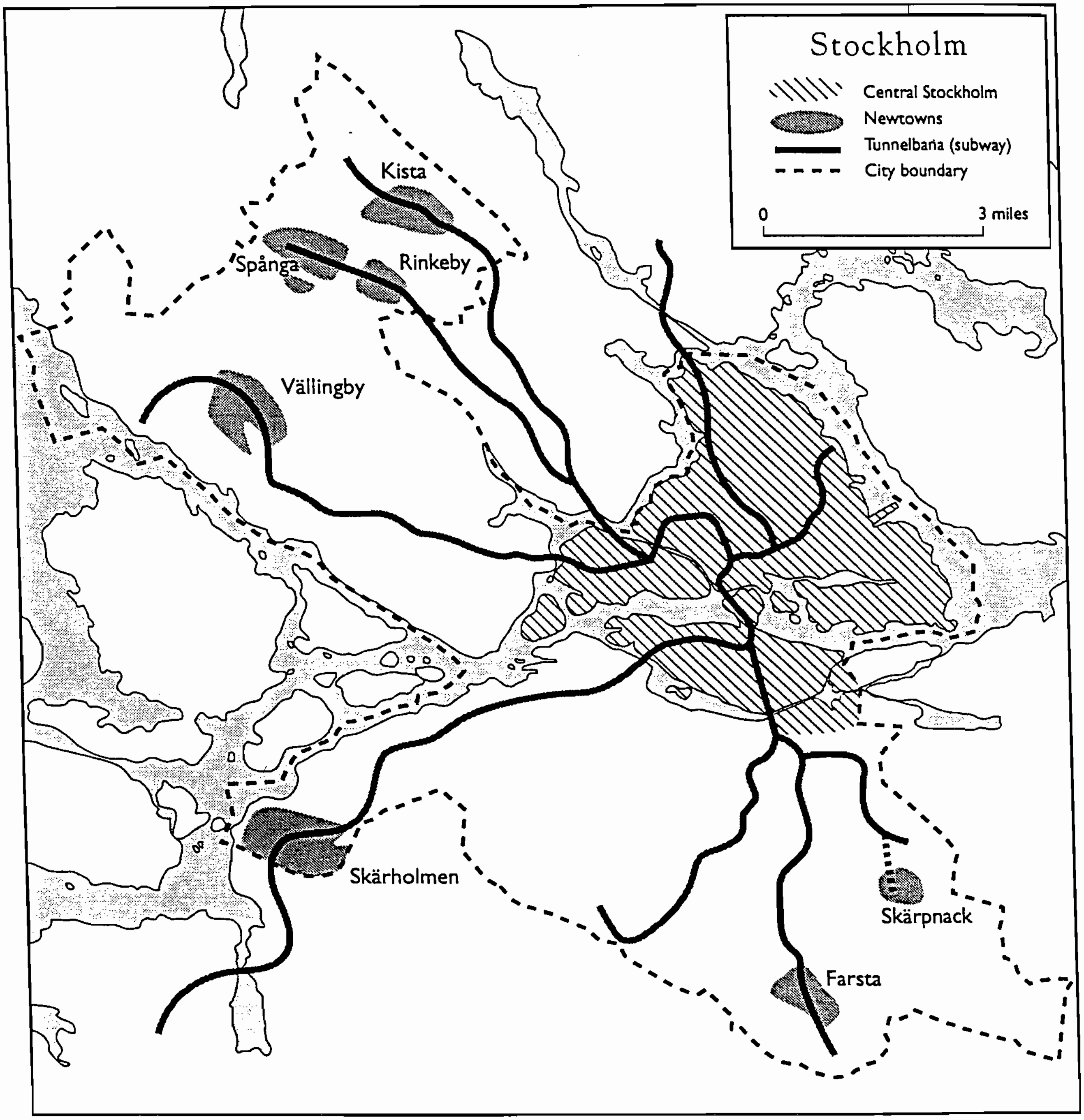
as in Ile-de-France region, levels of self-containment matter little from a mobility standpoint. In fact, the least self-contained communities can be expected to have the highest shares of transit commuting among their residents and workforces.

Where self-containment has likely made the biggest difference in commuting among Ile-de-France's new towns is with respect walk and bicycle trips. Figure 6.10 reveals there were far greater shares of "other" commutes, which comprise mainly foot and bicycle travel, for internal than external trips made by new town residents. All French new towns have superb internal walkway and trail systems, and these numbers confirm that self-containment and good pedestrian facilities can attract significant shares of internal commuters out of motorized vehicles.

7. Commuting in a Transit Metropolis: Stockholm, Sweden

7.1. Building a Transit Metropolis

Stockholm, Sweden, is arguably the best example anywhere of coordinated regional transit and land-use planning. Stockholm, Sweden's capital and largest city, is orbited by a number of planned satellite communities, most of which are served by the regional rail system (Tunnelbana) or commuter railroad (Map 6.7). This "pearls on a string" built form is the direct product of a



Map 6.7

Stockholm Region's New Towns

regional planning effort that targeted overspill growth after World War II to these planned, rail-served communities.

Today, Sweden is one of the most affluent countries in the world with a high automobile ownership rate (2.1 persons/vehicle). Because it was among the last countries in Europe to industrialize, it has experienced rapid growth, particularly in urban centers, over the postwar era. Still, most Swedish cities sit in a large forested country. The stage was set for Sweden's metropolises to easily have followed a highway-oriented development pattern. Yet Europe's most prosperous country took off on a radically different suburbanization path than in America. Why?

Two key factors deserve much of the credit. One, beginning in 1904, the Stockholm city council began purchasing land for future expansion decades in advance of need. By 1980, it owned 70 percent of land within its boundaries and over 230 square miles of land beyond the city limits. Second, after 1934 Sweden was governed for 30 years by Social Democrats, committed to improving housing. During the postwar industrial period, Sweden suffered from a serious housing shortfall, unable to adequately house new immigrants and factory workers. Quarters were cramped with few kitchens and washing facilities.[18] After World War II, the Swedish government began constructing multi-story apartments on the outskirts of metropolises. Over 90 percent of dwelling units built after 1946 — virtually all built on the city's land — enjoyed some form of state subsidy. Most were built by municipally owned housing corporations and tenant-owned cooperatives (City of Stockholm, 1989; Stockholms Stadsbygganadskontor, 1972; Hall, 1988).

The blueprint for building Stockholm's transit metropolis was Sven Markelius's General Plan of 1945-52. Markelius, an architect by training, believed that, while suburbanization was inevitable and needed to be accommodated, Stockholm's vitality and pre-eminence as the region's commercial and cultural center had to be preserved, at all cost. This was to be accomplished by building satellite new towns, connected to Stockholm by rail. Despite surveys that showed Swedes preferred low to mid-rise suburban homes, Markelius set about building fairly dense satellite centers so that most residents could be within walking distance of a rail station. He hoped that by doing so, many households would feel it unnecessary to own or use a car to reach downtown Stockholm.

In developing Stockholm's satellite new towns— Vällingby (1950-54), Farsta (1953-61), Skärholmen (1961-68), and Spånga (1964-70)— planners sought to avoid a "dormitory town environment." An overriding principle was to distribute industry and offices to satellites roughly in proportion to residential population— i.e., to achieve a jobs-housing balance. Public control of land allowed this. Tax incentives were used to lure industries to new towns and promote company-provided employee housing. New towns were also planned for a mix of housing types (single-family and multi-tenant residences) as well as uses, with offices, shops, civic buildings, and other activities in close proximity to each other.

Markelius's plan did not intend to make them complete towns, however. People were still to think of themselves as Stockholmers. Markelius proposed the rule of halves: half the working inhabitants would commute out of new towns and half of the workforce were to be drawn in from elsewhere. Thus, in contrast to Abercrombie's new towns outside of London, Stockholm's satellites were not meant to be fully "self-contained"— more like "half-contained," even though they were planned for a balance of jobs and housing units.

The regional rail system, Tunnelbana, became the device to achieve half-containment. Radial in form, Tunnelbana focused on Stockholm's redeveloped core. Satellite subcenters would function as countermagnets to the main center, leading to efficient, bi-directional traffic flows.

7.2. *First-Generation New Towns*

During 1945-57, the first Tunnelbana line was built, which allowed the first satellite town, Vällingby, to be built in parallel. The first-generation of new towns, called ABC towns (A=housing, B=jobs, and C=services), were designed using a common formula:

- Balanced communities of 80,000-100,000 people, with over 60 percent multi-family housing (at 30 to 80 people per acre);
- A hierarchy of centers — a main commercial and civic center near the rail station, flanked by neighborhood centers with schools and community facilities (within 650 yards of the main center);
- Tapering of densities — residential densities were highest closest to the main center, high around neighborhood centers, progressively lower away from these centers, so as to make most destinations, including the rail station, easily accessible by foot;[19] and
- Separation of pedestrian and bicycle paths from automobile traffic, including grade-separation at intersections.

Built on a monumental Le Corbusier-style scale, with buildings set on vast superblocks in the center of community, these first-generation new towns were later criticized by Swedish architects and sociologist as being too institutional and sterile. Regardless, repeated surveys have found that residents of these towns are quite happy with their surroundings, despite what sociologists contend (Popenoe, 1977).

Briefly, Stockholm's largest first-generation new towns are:

- *Vällingby.* Located 8 miles west of downtown Stockholm, Vällingby is dominated by several high-rise apartments at its core. Still, the community of 25,000 residents actually has a wide variety of building types, many made of brick and stucco. The elevated rail station in the core is surrounded by a large open cobblestone plaza, reflecting pools, a civic complex, and a shopping center. Elevated tracks divide the community into two districts. Vällingby's road network consists of loops encircling neighborhoods, with a secondary grade-separated pedestrian path system. The town sits in a park-like setting, surrounded by natural trees and rock outcroppings. Because Vällingby was conceived before widespread automobile ownership, it was planned with relatively little parking in its core. In most neighborhoods, cars are grouped into small clustered parking lots.
- *Farsta.* Located 14 miles outside of Stockholm, Farsta (population 42,000) is the terminus of the southernmost Tunnelbana route. Because it was built by private developers, industrialized

building methods and prefabricated concrete materials were used to construct most apartments. Very high rises surround the central open pedestrian mall, which has three times the car-parking built in Vällingby's core.[20] Residential neighborhoods are grouped into clusters of 5,000 to 7,000 dwelling units. Compared to other new towns, Farsta has a number of light industries, most located on its periphery.

- *Skärholmen.* Situated 9 miles west of central Stockholm, Skärholmen was planned as a subregional center. It has the largest commercial core of all new towns, with an enclosed pedestrian mall and numerous commercial attractions. A vast multi-story parking garage for 4,100 cars was also built, the biggest in Scandanavia. Unlike its two predecessors, Skärholmen has no high-rises; most apartments are 2-4 stories, though average densities are high. Residential neighborhoods run east-west in parallel rows, descending down the hillside.

7.3. *Later Generations of New Towns*

All three large new towns that followed — Spånga, Kista, and Skarpnäck— broke with tradition. Each was designed as a more specialized community. Accordingly, they provide a contrast for studying relationships between planning styles, land-use patterns, and travel behavior (see Table 6.13).

- *Spånga.* Built on former military grounds, Spånga has two primary cores — Tensta and Rinkeby. Spånga's development during the late 1960s coincided with the influx of many non-European immigrants to Sweden, thus more out of timing than design it attracted a concentration of low-income, industrial workers. Both Tensta and Rinkeby have rail stations in their cores. Central shopping districts are modest, though nearby farmer's markets flourish. Most apartments are 3 to 6 stories, and buildings are tightly huddled together. Pathways are at-grade, whereas most streets run below skywalks. Spånga introduced Sweden's first residential parking structures, which helped raise densities while preserving open space. Breaking from Markelius's half-containment formula, Spånga was planned as a residential community (jobs-to-housing ratio of only 0.31). It also has the lowest median incomes of Swedish new towns. Among older Swedes, it has gained a reputation as an unsafe place, in part because of press reports of youth gangs that terrorize Tunnelbana passengers.
- *Kista.* Located 10 miles northwest of downtown Stockholm, Kista has emerged as Sweden's "Silicon Valley." A few multinational electronic companies located there in the early 1980s, taking advantage of its proximity to the international airport and its location on the main auto route to the university town of Uppsala. Today over 200 companies and more than 20,000 employees have moved to Kista. With a jobs-to-housing ratio of 3.84, it could hardly be called a self-contained community (Table 6.13). Most companies are within walking distance of Tunnelbana, interconnected by a vast grade-separated pathway system (Photos 6.1 and 6.2). The centerpiece of Kista is the Electrum Complex, an indoor shopping and business mall that includes training and conference facilities. Compared to earlier new towns, Kista has a variety of housing, including some high-rise apartments, terrace garden apartments, duplexes, and single-family detached. Cul-de-sacs are used to restrict automobile access within neighborhoods.
- *Skarpnäck.* The newest new town, Skarpnäck, is just 6 miles south of central Stockholm. Designed as a neotraditional community, Skarpnäck is radically different than its predecessors. Its designers, reacting to the massive scales and the institutional "feel" of previous new towns, sought to create an urban milieu that was human-scale — 2-3 story structures, a gridiron street pattern, a fine-grained integration of uses, and ground-level retail stores and sidewalk cafes on the main street (Photo 6.3). Additionally, street crossings are at grade. Planning for Skarpnäck began almost 40 years ago, but the town only began receiving residents in the late 1980s. A mix of housing types is available, though one consistent design feature is brick facades. Apartments

Table 6.13

Population and Development Characteristics of Stockholm's New Towns

	New Towns					
	First Genera-tion[1]	Spånga[2]	Kista	Skarpnäck[3]	Täby	Central Stockholm
Population						
1980	102,500	42,225	29,081	26,237	47,105	226,405
1990	96,124	44,105	36,415	25,785	56,714	240,098
Employment						
1980	56,298	21,260	15,185	13,516	24,916	114,433
1990	50,548	21,363	18,545	13,676	32,791	324,026
Density (Dwelling Units/ Gross Acre, 1991)	8.2	14.6	4.7	5.0	1.2	8.0
Percent D.U. Multi-Family (1988)	86.1	99.5	91.4	90.8	48.3	99.9
Jobs-to-Housing Ratio (1990)	1.02	0.31	3.84	0.58	0.64	1.98
Median Household Disposable Income ($, 1988)	12,400	8,580	10,020	10,350	11,600	11,930
Percent Population Non-Swedish Origin (1988)	28.3	51.3	16.9	24.0	10.8	12.1

[1]These are statistics for Vällingby, Farstay, and Skärholmen combined.
[2]Consists of Tensta and Rinkeby.
[3]Statistics shown are for the Skärpnack district. The planned new town is a small portion of this district, and is planned for up to 3,000 dwelling units at build-out.

Source: Stockholms Läns Landsting.

Photo 6.1

Central Kista: Connection of Tunnelbana Station to Nearby Office Towers by Same-Grade Pedway

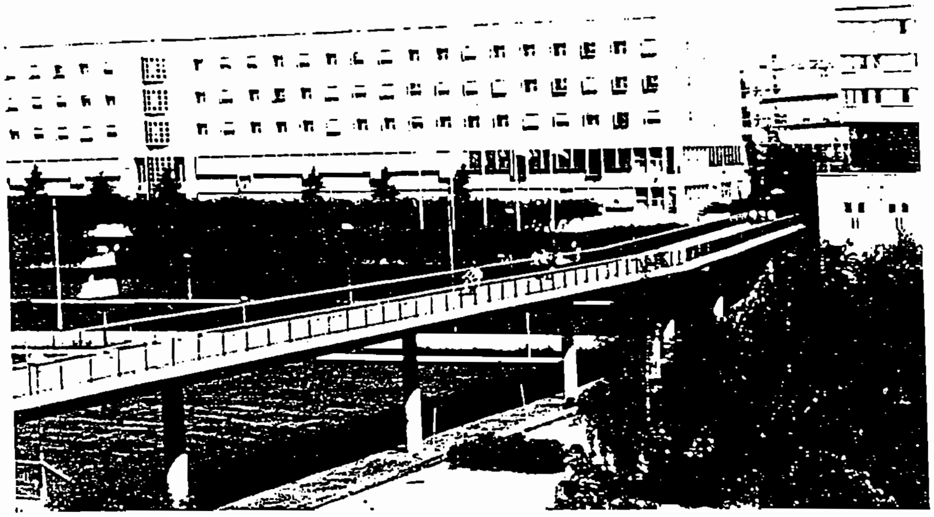


Photo 6.2

Kista: Same-Level Pedway Accommodates Pedestrians and Cyclists

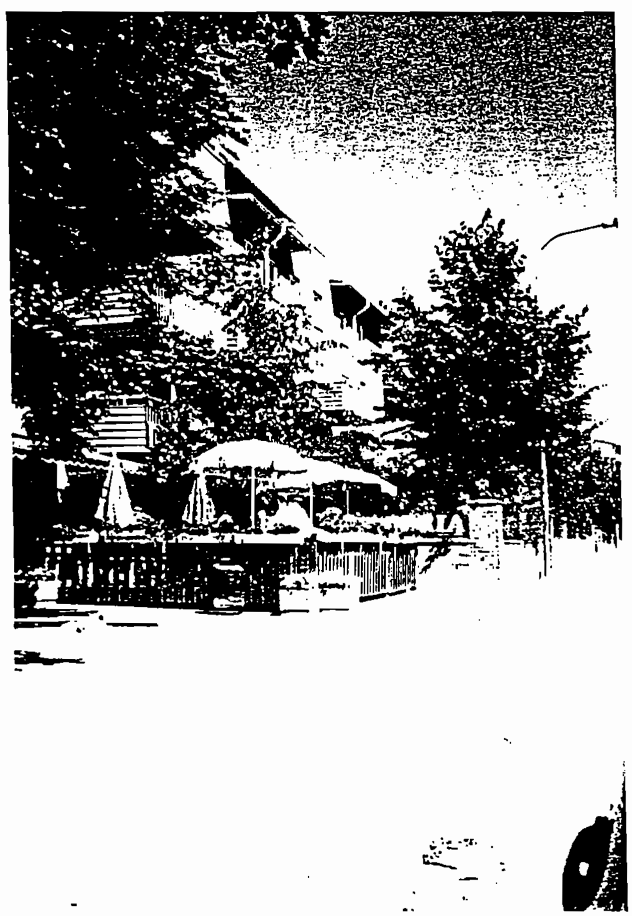


Photo 6.3

Skarpnäck: Sidewalk Cafe Surrounded by Apartments in Central Skarpnäck

are concentrated in the center with row houses and some single-family structures farther away (Photo 6.4). The majority of offices and light industries are along the perimeter of Skärpnack. Most residential and office parking is in garages. While laid out on a grid, every other street ends in a cul-de-sac to preserve enclosed courtyards. Though there are currently no rail services, a new Tunnelbana rail station will open in 1995.

In summary, the newest generation of Stockholm new towns are quite different from the first — Spånga is an ethnically mixed bedroom community, Kirsta is a technopolis, and Skärpnack is evolving as a neotraditional community in the purest sense.

Photo 6.4

Skarpnäck: Residential Cluster in Central Skarpnäck, With Commons Area, Alley Access, and Tree-Lined Buffers

7.4. Balance and Self-Containment

Stockholm's new towns have varying degrees of jobs-housing balance. Spånga has three times as many housing units as jobs. The newest planned community, Skärpnick, is also largely a residential enclave, though in striking contrast to Spånga, has a traditional urban design. The first-generation new towns, Vällingby, Farsta, and Skärholmen, are most balanced, with roughly equal numbers of jobs and housing units. And Kista, the region's technopolis, has nearly four workers for every dwelling unit.

Table 6.13 also presents statistics for a "control" suburban community, Täby, which lies roughly the same distance from downtown Stockholm as the new towns. Täby, however, is not a planned community, but rather evolved as one of the region's first market-driven suburbs, originally housing upper-income families in search of single-family living. Täby is a suitable comparison community because, besides lying a similar distance from Stockholm, it has comparable average household incomes. Its share of single-family dwellings is much higher than any of the new towns, however, producing a low average population density. It is also home to a much higher share of native Swedes. Täby is not on a Tunnelbana line, though it is served by a passenger railroad line, and, like most Swedish communities, excellent bus transit.[21] With a jobs-to-housing ratio of 0.64, Täby is predominantly a bedroom community. The other comparison community shown in Table 6.13, central Stockholm, has roughly two jobs for every dwelling unit.

Has jobs-housing balance allowed for some degree of self-containment? The answer has to be an unqualified no, regardless of how balanced a community is. Figure 6.11 shows that small shares of workers live in new towns and even smaller shares of residents work where they live. For all new towns, fewer than one out of three workers live within the community, and in the case of the technopolis, Kista, the share falls below 15 percent. Far more workers live in Stockholm and reverse commute, and even more live elsewhere in Stockholm county, either using cross-county bus transit services or their own automobiles to get to work. The non-master-planned comparison community, Täby, has a much larger share of locally residing workers, though part of this is explained by Täby's larger land area.

In all cases, fewer than one out of five new town residents with jobs are locally employed. The overwhelming majority work in Stockholm and, as we will see, commute by rail transit. It appears, then, that the region's new towns are inhabited mainly by households interested in being near a rail station so its workers can commute to Stockholm by train. Even larger shares of new town residents commute to destinations outside of Stockholm than within their own community.

These numbers suggest that Stockholm's satellites are closely tied to and economically dependent on the rest of the region. They are far from being self-contained, or even half-contained, as Sven Markelius hoped for. All have commuting independence indices (internal/external commutes) of under 0.15 (Figure 6.12). These fall well below those of the "natural" suburb, Täby, and Stockholm city. Whereas many British new towns, like Milton Keynes, are highly self-contained, with indices well above 1.0, Stockholm's new towns average a tremendous amount to inbound and outbound commuting each day. Contrary to popular accounts, the satellites of Stockholm are anything but self-contained.

7.5. Commuting Patterns of Stockholm's New Towns

With high levels of external commuting and large concentrations of housing and workplaces near rail stations, we would expect Stockholm's new towns to rank high as centers of rail commuting. Figure 6.13 shows that in the case of all new towns, over half of all workers and more than a third of residents commute via transit each day. These shares are considerably higher than those of the comparison suburb, Täby. Clearly, Stockholm's new towns have come far closer to achieving "half transit

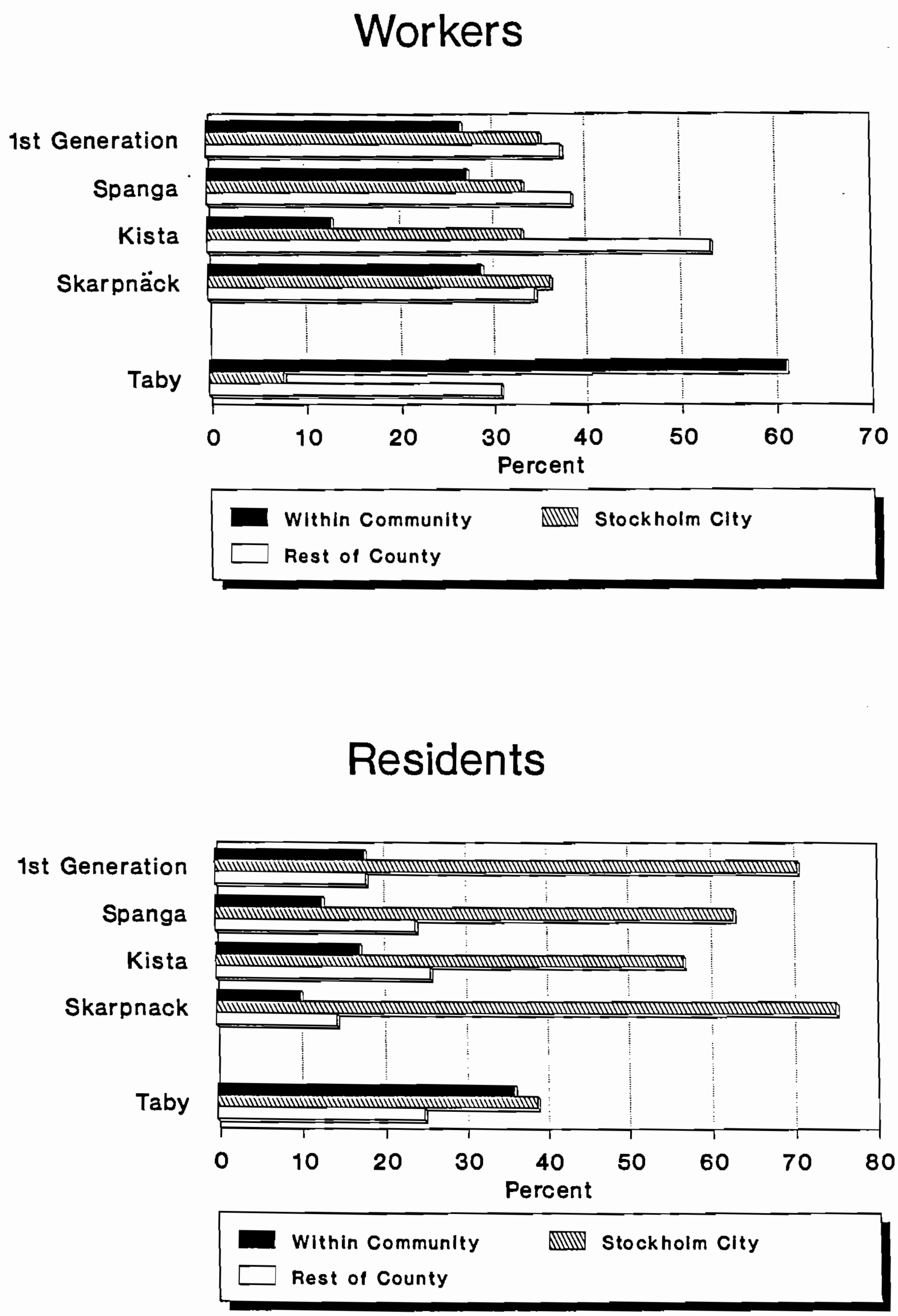
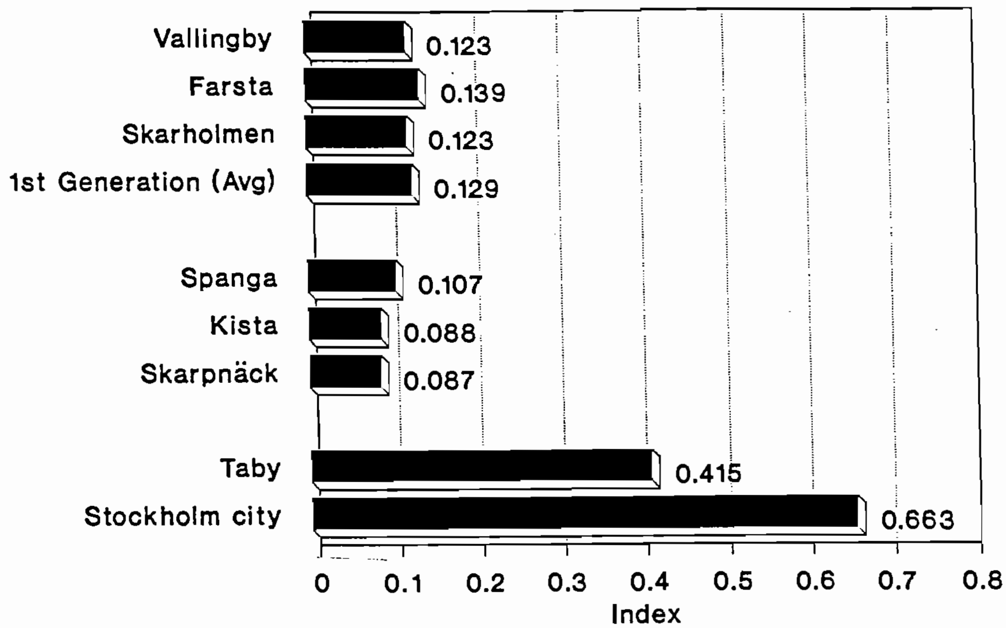


Figure 6.11

Percent of Workers Residing in and Percent of Employed Residents Working in New Towns, 1990



• Internal/External Commutes

Figure 6.12

Indices of Commuting Independence* for Stockholm's New Towns, 1990

commuting" than "half-containment." Evidently, the built form of rail-fed suburbs and outside dependency for employment has led to transit's extraordinary market share of journeys-to-work.

In the case of Kista, the technopolis, and Skärpnick, the neotraditional town, more than twice as many of their workers take transit each day as drive. While residents of new towns rely heavily on transit to reach their jobs, with the exception of Skärpnick, even larger shares travel in automobiles. Figure 6.13 shows that new town residents are more transit-dependent than residents of Täby, though far less than Stockholmers or other residents of Stockholm county. The figure also reveals that among new towns, larger shares of residents got to work by foot in Skärpnick, the "human-scale" new town without grade-separated pathways.

Transit usage was found to vary considerably depending on where commuters were coming from and going to. Figure 6.14 shows that over half of new town residents who worked locally got to work by walking or bicycle. Moreover, nearly one out of four took bus transit to work. And if new town residents worked in Stockholm, over three-quarters commuted via transit. If, on the other hand, new town workers lived in Stockholm, around 60 percent reverse-commuted on transit. These patterns held for all sets of new towns.

While having central rail facilities and good pedestrian and bus connections account for much of transit's success in new towns, other complementary factors have played a role as well. Rail fares are low. Parking fees and fuel taxes, on the other hand, are high. Sweden also has

Figure 6.13

Work Trip Modal Splits for Employees and Residents of Stockholm's New Towns, 1990

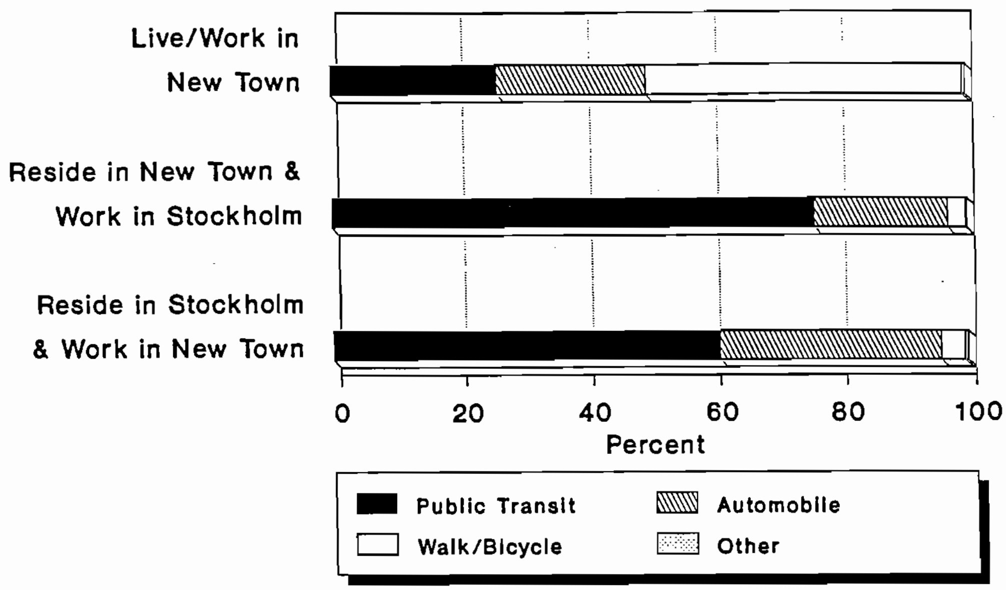


Figure 6.14

Work Trip Modal Splits for Stockholm New Towns, Spatial Markets, 1990

among the highest value-added taxes on motor vehicles and vehicle registration fee structures anywhere (McShane and Koshi, 1984; Pucher, 1988).

The importance of walking and bicycling for internal commutes by resident-workers of new towns is underscored by Figure 6.15. Compared to the "natural" suburb, Täby, much larger shares of internal trips in new towns are by foot, bicycle, and bus. Over half of all work trips made by resident-workers of neotraditional Skarpnäck are by foot and bicycle. Though data were not available, it is likely that even greater shares of internal non-work trips, such as for shopping and social visits, are by non-motorized means. Kista, the high-tech center, is the only new town with larger shares of internal work trips made by bus than by car— nearly a third of its resident-workers commuted by transit.

7.6. Recap

Over the past 50 years, greater Stockholm has transformed from a pre-war monocentric city to a planned post-war polycentric metropolis. Tunnelbana, the regional rail system, has emerged as the lifeline of this multi-centered metropolis. Like pearls on a necklace, most of the region's new towns are efficiently served and interconnected by rail transit.

The region's first-generation of new towns were consciously planned to promote rail commuting into Stockholm as well as to be somewhat self-contained. Commuting statistics reveal that they have certainly achieved the former objective but have been far off the mark of the second. More

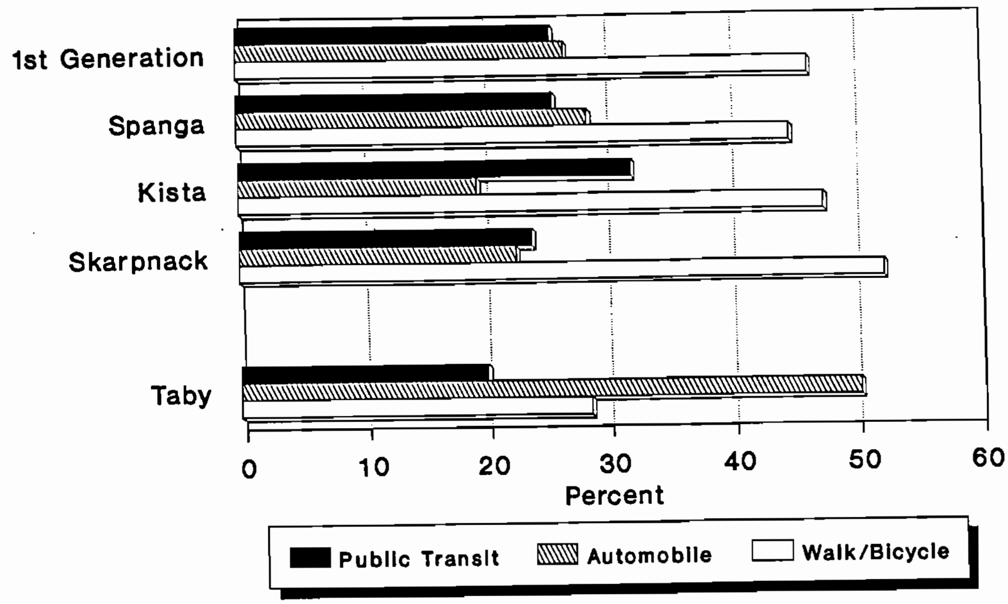


Figure 6.15

Modal Splits for Internal Commutes by Resident-Workers of Stockholm's New Towns, 1990

recent new towns broke the mold of their predecessors, becoming more specialized centers. Newer new towns are even less balanced than their predecessors and are no more self-contained.

Contrary to popular belief, all Swedish new towns have much higher levels of external than internal commuting. What external commuting does take place, however, is heavily oriented to transit, particularly for commutes into Stockholm. For internal work trips by resident-workers, foot and bicycle travel are the preferred means. Skärpnick, the region's only neotraditional new town, has the highest share of non-motorized commuters.

In summary, experiences in greater Stockholm indicate that jobs-housing balance and self-containment are not prerequisites to achieving high shares of transit and non-SOV commuting. While British new towns are far more balanced and self-contained than their Swedish counterparts, they are also more auto-dependent. Newman and Kentworthy (1989) have shown, for instance, that metropolitan Stockholm averages 3-4 times less fuel consumption per capita than comparable-size U.S. cities (with similar average incomes). Clearly, Stockholm's success stems directly from having dense, mixed-use suburbs that are superbly served by rail. This has more than compensated for any lack of jobs-housing balance and self-containment. Overall, Stockholm's success is the outcome of careful and coordinated regional planning of new towns and rail transit over the post-WWII period.

8. Conclusions and Policy Lessons

This chapter has provided a Euro-American perspective on how community form and planning principles can influence travel behavior. Neotraditionalism, Edge Cities, and planned communities, both in the U.S. and abroad, were the lenses through which fundamental relationships between land-use patterns and commuting choices were examined.

Comparisons of commuting behavior between residents of ten traditional U.S. communities revealed that their greatest advantage lies in encouraging more walk and bicycle as well as shorter trips. The study of Edge Cities suggested that densities and mixed land-use compositions paid off only if Edge Cities are served by rail transit.

American new towns were found to have relatively large shares of residents working within the community. This produced shorter average commutes in new towns, though resident-workers were generally as auto-reliant as outside workers. Balanced new towns had slightly higher shares of transit and non-SOV commuting. In general, America's new communities seem to enjoy some modest mobility benefits.

The best evidence on the link between community planning and commuting is from Europe, which has a far longer history of new town development. Britian's early new towns were designed to handle London's postwar spillover growth. Latter new towns, like Milton Keynes, became regional growth magnets. These newer, more remote, and more auto-oriented new towns also became the most self-contained. High levels of internal (and thus short-distance) commuting in fully motorized new towns partly compensate for their high per capita energy consumption. Where high-quality transit services exist, such as in Runcorn, vehicle miles of travel can be reduced even more.

Both Paris and Stockholm provide stark contrasts to Britain's new town experiences. Paris is surrounded by a mix of rail-served satellite communities — some are balanced and others are mainly residential enclaves and employment centers. The least self-contained communities, however, average the highest share of work trips by transit— mainly in the form of workers in-commuting and residents out-commuting by rail. Although planned as fairly self-contained places, Stockholm's new towns have a tremendous amount of external commuting. However, as in Paris, external commuting is predominantly in the form of rail transit trips. What internal commuting does take place tends to be by foot and bicycle. Thus, new towns outside of Paris and Stockholm are success stories from a regional mobility standpoint in spite of their lack of balance or self-containment. Indeed, there is an inverse relationship between self-containment and transit commuting. It is because of their economic interdependence with the surrounding region that so many French and Swedish new town residents and workers commute by transit.

In conclusion, findings from this chapter suggest that having good quality transit services is the key to luring commuters out of their automobiles, with such land-use considerations as density, neotraditional designs, jobs-housing balance, and self-containment of secondary significance.

Characteristics of the built environment exert their greatest influence on internal commuting— in particular, self-containment and traditional urban designs usually encourage more foot and bicycle travel. Indeed, the weight of the evidence suggests that suburban communities with strong economic linkages to a region's core and subcenters, high-quality transit services between these centers, and convenient internal pathway systems yield the greatest mobility benefits.

Notes

[1]Suburbs were defined as outside of the central city or cities of each metropolitan area. The corresponding metropolitan areas were: Alexandria — Washington, D.C. MSA; Annapolis — Baltimore MSA; Coral Gables — Miami-Ft. Lauderdale CSA; Edmonds — Seattle-Tacoma MSA; Folsom — Sacramento MSA; Lake Forest — Chicago-Gary CSA; Princeton — Newark-New Brunswick MSA; and Winter Park — Orlando MSA.

[2]In Alexandria, the same proportion of residents walked or cycled to work as the metropolitan average. So, in eight of the communities, at least as large of a share of residents walked or biked to their jobs as in their respective regions.

[3]New Communities Program (Title VII of the Urban Growth and New Community Development Act of 1970).

[4]A jobs-to-housing ratio of 1.5 signifies balance, accounting for the fact that usually around 70 percent of all households have two wage-earners and around 3 to 5 percent of units are vacant because of changes in ownership and for other transitional reasons (Cervero, 1989).

[5]Seven other new towns have been built in Wales and Scotland as well; however, since most studies on transportation impacts have concentrated on English new towns, experiences outside of England are discussed only in passing.

[6]In order of their date of designation, Mark I new towns built on the periphery of London were: Stevenage (1946), Crawley (1947), Hemel Hempstead (1947), Harlow (1947), Hatfield (1948), Welwyn Garden City (1948), Basildon (1949), and Bracknell (1949). Not all Mark I new towns orbited London, however. Two new towns, Aycliffe (1947) and Peterlee (1948), were also constructed outside of Newcastle to house industrial and mining workers and their families. Corby (1950) was designed to provide housing for steelworkers and stimulate employment growth in the area. In Scotland and Wales, the new towns of East Kilbride (1947), Glenrothes (1948), and Cwmbran (1949) were constructed mainly to house local factory workers.

[7]In order of their designation, Mark II new towns were: Skelmersdale (1961), Runcorn (1964), Redditch (1964), and Washington (1964) in England; Cumbernauld (1955), Livingston (1962), and Irvine (1966) in Scotland; and Newtown (1967) in Wales. They were planned for an initial population of 100,000 and to grow up to 200,000 to 300,000 at build-out. As Hall et al. (1976) note, however, generalization is difficult because many new towns of the 1960s were diversified, some functioning as spillover catchments and others as major regional centers.

[8]In order of designation, Mark III towns, all in England, are: Milton Keynes (1967), Peterborough (1967), Telford (1968), Northamption (1968), Warrington (1968), and Central Lancashire (1968).

[9]This is quoted from the Reith Committee, whose recommendation of the need to plan for London's overspill growth led to the passage of the 1946 New Towns Bill, which provided the basis for new town development in England over the ensuing 45 years.

[10]Thomas (1968) investigated only the eight Mark I spillover new towns around greater London. Cresswell and Thomas (1972) expanded the analysis to include several Mark II new towns as well. Breheny's (1990) study provided 1971 and 1981 statistics for all British new towns.

[11]From 1951 to 1966, the trend also favored new towns. For a number of "natural" communities in Berkshire, their average independence index fell from 1.32 in 1951 to 0.82 in 1966. Over the same period, the average

index for the eight new towns around London increased from 0.96 to 1.39. (In his original work, Thomas calculated the weighted-average index, which for the eight new towns actually rose from 0.85 to 1.33.)

[12]Several researchers have commented on the broader transportation impacts of Mark I new towns. According to Potter (1984), these communities were planned for the following work trip modal splits: car (16 percent); bus (38 percent); bicycle (38 percent); and walk (8 percent). While few travel surveys were conducted on Mark I new towns, a 1976 survey of Crawley's town center found work trip modal splits of: car (63 percent); bus (10 percent); walk (19 percent); cycle (3 percent); and other (5 percent) (Dupree, 1987). Potter (1984) notes most Mark I new towns (except Aycliffe) failed to achieve their desired pedestrian orientation because they were too small to support enough services, forcing inhabitants to travel out of town for some shopping and personal trips. Most Mark I towns also concentrated the main industrial development into one large estate, which led to heavy tidal traffic and in some caes to peak period congetion along connecting thoroughfares.

[13]From 1971 to 1981, the new town average index fell to 0.95, a 28 percent drop. This compares with the average for the other towns of 0.98, a percentage fall of only 6 percent (Breheny, 1990).

[14]Redditch adopted a similar, although much less exclusive, figure eight busway system. In Redditch, short lengths of reserved bus routes prevented regular vehicles from using the figure eight route for cross-town journeys. The city was laid out so that most homes were within eight minutes' walk of the bus stop. Dupree (1987) maintains similar results were achieved in Redditch as in Runcorn but at a substantially lower cost.

[15]Potter (1982, p. 81) notes that "tucked away in the Transportation Technical Supplement (of the Milton Keynes Plan) was the admission that 'in light of the selected land use plan, the provision of a competitive form of public transport does not make practical sense. This consideration of freedom of choice (between travel methods) has therefore been discounted' and 'the appropriateness of providing a public transport service beyond the minimum level necessary...is solely a matter of policy'." Potter (1984, p. 156) noted that the Milton Keynes Development Corporation, in a local newspaper advertisement, suggests to prospective residents that "if you haven't got a car, you might have to think about buying one."

[16]Milton Keynes' gross densities are actually around three times higher than Almere's.

[17]This range accounts for the existence of two-earner households, which today in the U.S. make up around three-quarters of all households, plus normal housing vacancies.

[18]At the end World War II, 52 percent of Stockholm's housing stock consisted of no more than one room and a kitchen.

[19]Plans placed most high-rise apartments within 500 yards of the main center, row houses and single-family dwellings within 980 yards, and factories and workplaces within 650 yards.

[20]While not initially planned for, Farsta's plan was modified to provide 2,000 mostly surface parking spaces near the core. Parking was not only for visitors and workers, but also to attract large Swedish chain stores, something the private developers felt was essential if the development was to be financially successful.

[21]Stockholm city council proposed extending a Tunnelbana line to Täby; however, local officials refused the offer, purportedly because of concerns over other population classes riding transit to their community.

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Chapter Seven

Summary and Conclusions

1. Summary

The *modus operandi* of this research was to examine the relationship between transit-supportive development and transit ridership at three grains of analysis: the site, neighborhood, and community levels. To the extent possible, community characteristics of transit-oriented and nearby auto-oriented settings were compared, matching them to control for such intervening factors as income. Emphasis was given to suburban and exurban settings served only by bus transit and other non-rail forms of travel.

Site-Level Analyses

In order to study transit-supportive designs at the site level, a national survey was conducted that elicited information from U.S. transit agencies on local real estate projects that are friendly to transit users and pedestrians. The survey also gathered useful background information on transit-supportive guidelines themselves.

In all, around one-quarter of the surveyed U.S. transit agencies had guidelines, and around one-half of the guidelines have been approved or endorsed by a local policy body. Most guidelines are devoted to some combination of three topics: transit facilities designs, site design, and land use. Around 70 percent of guidelines give at least some attention to all three topics. Levels of treatment varied greatly, however. Around 85 percent of guidelines contain illustrations and offer recommendations on the design and placement of bus stops and shelters, while only 65 percent suggest minimum densities for transit, and only 40 percent address specific land-use programs that are conducive to transit usage. Over 40 percent of guidelines set standards for transit facility designs, but only around 10 percent contain any standards for urban design or land-use planning.

From the survey, a surprisingly small number of specific real estate projects outside of rail corridors could be identified by transit officials that were genuinely transit-supportive. While not a complete list, fewer than 30 transit-supportive sites were identified nationwide; most of these, moreover, incorporated micro-design features (e.g., benches at bus stops and special staging areas for buses) rather than embracing macro design elements aimed at shaping travel behavior (e.g., dense, mixed-use developments). Overall, the national survey provided few promising leads for finding "transit-friendly" sites that could be evaluated in terms of impacts on ridership and service delivery. It did, however, provide a compendium of good transit-supportive design practices as well as good examples of guidelines themselves. Based on criteria related to clarity of text, effective use of illustrations, quality of technical information, and integration of materials, exemplary guidelines were found in eight areas: Austin, Texas; Denver, Colorado; Montreal, Quebec; Reno, Nevada; Sacramento, California; Seattle, Washington; Snohomish County, Washington; and Portland, Oregon.

More in-depth analyses were carried out on the ridership characteristics of transit-supportive sites in five metropolitan areas: Chicago, San Diego, San Francisco, Seattle, and Washington-Baltimore. Besides the fact these areas have been at the forefront of promoting transit-sensitive site planning and designs, they were chosen also because travel data were available for the tenants of several transit-supportive projects. For the most part, differences in transit ridership rates were fairly modest across sites. Wherever transit-supportive projects were clearly outperforming other nearby similar projects, there were always extenuating circumstances. In suburban Chicago, for example, around one-third of workers at the new "transit-friendly" Sears headquarters in Hoffmann Estates commute by bus or vanpool/carpool, much higher than in any other outer suburban workplace in the region; however, these shares are due more to Sears' aggressive TDM program, the size of the company, and the carryover of prior transit commuting habits among those who transferred from the Sears Tower in downtown Chicago. A number of offices and mixed-use centers in Bellevue, Washington that have densities and site features supportive of transit average substantially higher non-SOV commuting shares than in nearby campus-style developments; however, Bellevue's strict parking controls have as much to do with these outcomes as anything. Several transit-supportive retail and mixed-use projects in the Bay Area, San Diego, and greater Washington average ridership that is 8-15 percent higher than comparison sites; however, in most of these instances the projects are near rail stations. Transit-supportive designs and rail service seem fairly compatible, in part because most rail-served areas are comparatively dense; for bus-only settings, however, the relationship between transit-supportive design and ridership is more tenuous.

To date, perhaps the biggest impact of the transit-supportive movement has been on local policy-making, such as the passage of Washington state's Growth Management Act and Baltimore's Access by Design program. Once such initiatives gain a momentum of their own and once sagging real estate estate markets begin to perk up, promotional campaigns like the marketing of transit-friendly guidelines will likely begin exerting stronger influences on development practices. The challenge will then rest with the public sector to mount good quality transit services which take advantage of transit-sensitive residential, office, and mixed-use developments.

Neighborhood-Level Analyses

The next level of analysis involved a comparison of commuting characteristics of transit-oriented versus auto-oriented neighborhoods in the San Francisco Bay Area and Southern California. Transit neighborhoods averaged higher densities and had more gridded street patterns compared to their nearby automobile counterparts. Efforts were made to match neighborhoods closely in terms of median household incomes and, to the extent possible, transit service levels to control for these effects.

For both metropolitan areas, pedestrian modal shares and trip generation rates tended to be considerably higher, in some cases well over 50 percent higher, in Transit than in Auto neighborhoods. Transit neighborhoods had decidely higher rates of bus commuting only in the Bay Area; in Southern California, both groups of neighborhoods had comparable transit modal splits and trip generation rates. On the whole, however, Transit neighborhoods won over larger shares of commuters to alternative modes than their Auto counterparts — for example, even in Los Angeles, Transit neighborhoods averaged around 50 more transit work trips per 1,000 households than Auto neighborhoods, controlling for household incomes and residential densities. And higher residential densities had a proportionately greater impact on transit commuting in transit-oriented than auto-oriented communities in both Southern California and the Bay Area. That is, as densities rise, there is far greater mobility payoff in Transit than in Auto communities.

The general absence of strong and decisive relationships was no doubt due to several factors. One, finding true neighborhoods that met both differentiation and control criteria was problematic. Second, traditional transit-oriented neighborhoods probably have the biggest influence on non-work trips, particularly shop trips. Even if near-perfect matched pairs were obtained and shop travel data were available, it seems unlikely that bus transit modal splits will ever differ markedly among neighborhoods. However, when combined with pedestrian, bicycle, and carpool/vanpool travel, non-SOV shares are likely substantially higher in transit-oriented neighborhoods for many non-work trips.

Community-Level Analyses

At the more aggregate community scale, the focus shifted away from micro-design questions and more toward probing the ridership influences of structural elements of the built environment, like land-use compositions and levels of jobs-housing balance. One comparison was drawn between the commuting behavior of residents from ten traditional U.S. communities versus those of the metropolitan area at-large. Traditional communities averaged substantially higher shares of walk and bicycle travel as well as shorter trips. The study of Edge Cities found that densities and mixed land-use compositions paid off only if Edge Cities are served by rail transit.

The bulk of the community-level analyses concentrated on planned communities. America's new towns were found to be fairly self-contained, averaging relatively large shares of residents working within the community. This produced shorter average commutes in new towns. Balanced new towns had slightly higher shares of transit and non-SOV commuting. In general, America's new communities seem to enjoy only modest mobility benefits.

The best evidence on the link between community planning and commuting is from Europe. In general, an inverse relationship was found between how self-contained and balanced communities were and the share of work trips made by transit users. Britain's more recent new towns, epitomized by Milton Keynes, are highly balanced and theoretically self-contained, yet they are auto-dependent and average high levels of annual VMT per capita. In stark contrast are new towns outside of Paris and Stockholm. In both metropolises, satellite new towns are linked to the regional core by rail transit. While numerically balanced, new towns outside of Paris and Stockholm are not self-contained; rather, external commuting by residents and workers far exceeds internal commuting. Importantly, the external commuting that takes place is predominantly by rail transit, resulting in low annual VMT per capita. These results make it clear that having good quality rail or dedicated line-haul service is the key to luring new-town commuters out of their cars in substantial numbers, with such land-use considerations as density, neotraditional designs, jobs-housing balance, and self-containment of secondary significance. This is particularly so when regions have a built form similar to that of Paris or Stockholm— a strong, pre-eminent regional core orbitted by satellite centers that are radially linked to the core by fixed-guideway services. In both instances, this regional form is the direct outcome of proactive regional planning. Where regional planning is absent and development patterns are more diffuse and random-like, the opposite will result— commuting between communities will predominantly and almost unavoidably be by drive-alone automobile, even if rail services exist.

2. Conclusions and Policy Implications

Based on these research findings, we reach the following conclusions:

(1) At the site level, there is little evidence that transit-friendly design features, like front-door bus staging areas and internal pathways, have much, if any, measurable impact on transit ridership. Such micro-elements seem to be too "micro" to exert any fundamental influences on travel behavior. More macro-factors, like density and the comparative cost of transit versus automobile travel, are the principal determinants of commuting choices. Once commuters have opted for a travel mode, micro-design elements probably have some affect on secondary travel choices, such as during the midday. Thus someone commuting alone might be more inclined to walk to an on-site deli several blocks away for lunch in a transit-and pedestrian-friendly setting than in a blatantly auto-oriented environment. However, the presence of micro-design features, in and of themselves, are too weak to shape the more fundamental decision of how to arrive at work. At the extreme, an individual transit-friendly site situated in a sea of auto-oriented development will be swamped by automobile traffic and, perhaps as a result, end up being a dysfunctional site. In the bigger scheme of things, site design elements are always subsumed by influences of the macro-environment and other non-physical determinants of travel behavior.

(2) All transit-friendly environments have other programs in place, namely TDM initiatives, that make it virtually impossible to attribute any aspect of travel behavior to physical design or land uses themselves. Every office park or residential subdivision with transit shelters, front-door bus staging zones, on-site retail, internal pathways, and other transit-supportive design features also has an active, often ambitious, TDM program. Thus, determining whether the presence of subsidized vanpools and restricted parking or the layout and density of a site is reducing solo-commuting is a

futile, academic exercise. Clearly, both sets of measures complement each other extremely well and no doubt mutually benefit. However, we believe that most of the differences in modal splits between transit-supportive sites and comparison sites are due to TDM programs rather than elements of the physical design. This is partly because there are a number of employer-sponsored TDM programs across the U.S. in settings that are not particularly transit- or pedestrian-friendly, yet non-SOV commuting remains high in many of these settings. Research shows, however, that comparison sites (whether transit-friendly or not) without TDM programs average high rates of solo-commuting (COMSIS Corporation, 1990). Overall, transit-supportive designs are helpful and well-intentioned, though fairly meaningless without good quality transit and rideshare services and proactive measures that reduce auto-dependency.

(3) The economic downturn of the late 1980s and early 1990s, coupled with tight credit and overbuilt commercial markets, has hamstrung many local campaigns and initiatives aimed at promoting transit-supportive designs and developments. This largely explains why there are so few examples of transit-friendly developments in non-rail settings despite what popular accounts and press coverage might have us believe. By the time the transit-supportive and neotraditional design movements gained a head of steam in the late 1980s, largely in reaction to what was built during the boom years of the 1980s, real estate markets in most metropolitan areas began to cool off significantly. This mistiming has meant that regardless how well-intentioned site design guidelines, neotraditional campaigns, and other transit-supportive initiatives have been, if there is little market demand for new construction, America's suburban landscape will remain largely unchanged in the 1990s. However, when urban real estate markets begin warming up again, a number of metropolitan areas will be well-positioned to see that whatever gets built is highly conducive to transit riding and walking. Only then might it possible to carry out research that can demonstrate clear and measurable impacts attributable to site design and land-use patterns.

(4) In many areas, the transit-supportive design movement has so far had a bigger impact on the public than the private sector. This has mainly been in the form of convincing local planners of the importance of considering the needs of transit vehicles and pedestrians in the review of development proposals. Twenty or so communities around the country have adopted transit-related design criteria that are routinely used to evaluate and act upon development proposals. Specific plans in several suburban communities outside of Seattle and Washington-Baltimore specifically reference transit-supportive design guidelines. Even at the state level, recent land use and growth management legislation has been influenced to some degree by local movements to promote transit-oriented designs, such as Washington state's recent Growth Management Act and California's Congestion Management Act. In that many local planning authorities have already embraced transit-supportive design principles, we might expect that the second group that will be most impacted by these campaigns will be developers. Whether because of government mandates or out of a sincere belief that there is an unmet market demand, we can expect that many more developers will begin

building transit-friendly projects once regional economic conditions improve. This will then require the buy-in of a third group — transit policy-makers. Public transit agencies will either need to respond by delivering good-quality transit services to new transit-friendly sites, or existing regulations will have to be relaxed to allow private para-transit operators to respond to these new market niches. Ideally, the actions of the private sector to build more transit-friendly projects and the public sector to deliver better quality transit services will occur simultaneously.

(5) At the neighborhood level, this research demonstrated that denser communities with more traditional gridiron street patterns generally average higher levels of transit and pedestrian commuting than nearby more auto-oriented neighborhoods, controlling for income and (less successfully) transit service levels. The relationship was stronger in the San Francisco Bay Area, where the built environment is more conducive to transit riding, than in Southern California. Overall, however, differences in work trip travel were fairly modest and in no cases were differences between matched-pairs striking. Although not examined in this research, other studies suggest that differences could be greater with regards to non-work travel, particularly shop trips. Since denser, mixed-use built environments are likely to exert their greatest influences on trips internal to neighborhoods, it follows that trips to the local store or for social-recreational purposes would be most impacted. The physical characteristics of a residential neighborhood likely have far less influence on longer trips made outside the neighborhood, such as to work or a regional shopping mall.

(6) Nearly all neighborhood-scale evaluations of neotraditional and transit-oriented designs have relied on paired comparisons of older and newer (auto-oriented) areas. This is mainly because few neotraditional communities or transit-oriented developments have broken ground. Some researchers have attempted to simulate the mobility effects of neotraditional versus auto-oriented designs, though hypothetical inquiries always leave doubts in the minds of those who are considering investing in largely unproven schemes like neotraditional communities. Until more transit-oriented and neotraditional projects are built and experiences are carefully monitored and evaluated, our understanding of how such environments affect travel behavior will remain murky and conjectural.

(7) Community-level analyses provide insights into influences of more structural elements of the built environment, such as densities and jobs-housing balance, on travel behavior. Such macro-factors have a more enduring impact on fundamental travel choices, such as how to commute, than micro-design elements. Evidence suggests that U.S. communities that are denser and with more traditional designs (e.g., gridiron streets) average higher levels of walk, bicycle, and transit commuting than nearby comparison communities, controlling for income differences. America's recent master-planned communities that are balanced and self-contained also seem to offer some modest mobility benefits.

(8) Richer insights into the link between community design and commuting can be gained from European countries with advanced economies similar to America's. Experiences in some of

Europe's largest connurbations suggest that jobs-housing balance does not necessarily mean self-containment. And that self-containment and high levels of internal travel do not guarantee many residents and workers will travel by foot, bicycle, or transit. In fact, the inverse relationship seems to hold in Europe. There, planned communities that are self-contained average the highest levels of automobile travel, whereas communities with high levels of external commuting and good regional transit connections are the least auto-dependent. While not self-contained, what these planned satellite communities have are dense, mixed-use cores with good transit connections and terminuses, pleasant pathway systems, and constraints on parking at the workplace. Thus, what one finds in Europe's most transit-oriented suburbs is thousands of residents leaving for their jobs in another community each workday and thousands of workers commuting in from elsewhere, most taking some form of public transportation. Loads on the transit network are balanced and multi-directional. Behind these success stories have been both macro-level regional planning and exemplary micro-level site designs. In combination, European experiences show that good land-use and transit planning as well as careful attention to site design complement each other extremely well and indeed must co-exist if substantial headway is to be made in luring commuters out of cars and into alternative modes of travel.

3. Directions for Further Research

The inability to uncover clear, striking relationships between physical design and travel behavior in this research is by no means an indictment against this line of inquiry. At whatever scale, transportation and land use relationships are highly complex and constantly changing, often in subtle ways, and no single research endeavor can be expected to yield quantum insights into the phenomenon. This does not mean we should shy away from this topic, but does suggest that research must be carefully designed to control for as many extenuating, confounding factors as possible and should examine relationships at different grains of the urban fabric.

This project attempted to systematically control for factors beyond physical design and land uses in evaluating travel behavior. This was done through matched-pair comparisons. As a quasi-experimental technique, matched-pair analysis aims to adapt many of the research design approaches found in a scientific laboratory to eminently more difficult social laboratories like cities. Since it is next to impossible to specify and estimate a complete system of equations that adequately simulates complex transportation-land use relationships, matched-pairs provide a reasonable, second-best alternative that, if carefully applied, can provide rich and statistically reliable insights. Matched-pair analysis is more tractible and less data-hungry than other statistical tools (e.g., regression modeling), and provides the added advantage that the results are easily interpretable and thus accessible to a wide audience.

This project also examined relationships at different scales — sites, neighborhoods, and communities. Matched-pair comparisons of nearby sites allow the influences of micro-design elements to be studied and eliminate possible confounding problems related to inter-community differences. Neighborhood- and community-level comparisons offer greater insights into the impacts of density and land-use configurations; however, the ability to control for cross-community differences in other factors (e.g., quality of infrastructure and transit services) becomes more difficult the higher the scale of analysis. In combination, analyses conducted at different geographic scales can begin to build a mosaic that richly portrays the complex but intimate relationship that exists between the built environment and travel behavior. Thus, we recommend that future research in this area builds upon the model of matched-pair comparisons conducted at varying grains of analysis.

As mentioned before, we believe that some of the more significant mobility benefits of transit-oriented designs will be with respect to non-work travel, in particular shopping trips. Future research should attempt to carefully examine how mixed-use, denser physical environments can induce more non-motorized travel. The definition of mixed uses also needs to be refined. Many commercial strips contain a mixture of activities but hardly would be considered transit- or pedestrian-friendly environments. Likewise, many suburbs with shopping malls meet a strict definition of a mixed-use community (defined in terms of non-residential square footage of floorspace); however, the automobile typically reigns supreme in such settings. In Chapter Five, we were unable to include a land-use mixture variable in the analysis on the very grounds that many low-density, auto-oriented neighborhoods replete with peripheral shopping plazas had more acreage devoted to retail-commercial uses than nearby transit-oriented neighborhoods. More in-depth research into the impacts of mixed-use suburban development is clearly needed.

Lastly, if better insights are to be gained into how physical environments shape travel behavior, more experiences need to be drawn from abroad. Both Europe and Canada have many more examples of traditional transit-oriented communities than the United States. International comparisons are particularly important toward understanding how public policies, like transport pricing and taxation, interact with land-use and physical planning initiatives to effect mobility outcomes. Comparative research offers the best hope of illuminating our collective understanding of the transportation-land use nexus.

References

COMSIS Corporation. 1989. *Evaluation of Travel Demand Management to Relieve Congestion.* Washington, D.C.: Federal Highway Administration, U.S. Department of Transportation.

Appendix A

Transit Agencies That Supplied Design Guidelines

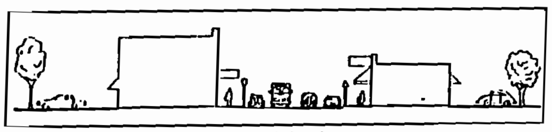
Transit Agency	Location		Title of Guidelines
Alameda-Contra Costa Transit	Oakland	CA	Guide for Including Public Transit in Land Use Planning
Capital Metro	Austin	TX	Transit Design Guidelines
Central Contra Costa Transit Authority	Concord	CA	Coordination of Property Development and Transit Improvements
Central Ohio Transit Authority	Columbus	OH	The Development of Transit Connection: A Design Manual
Chapel Hill Transit	Chapel Hill	NC	Chapel Hill Design Guidelines
City of Scottsdale	Scottsdale	AZ	Design Standards and Procedures
Denver Regional Transportation District	Denver	CO	Suburban Mobility Design Manual and Transit Facility Design Guidelines
Maryland Mass Transit Administration	Baltimore	MD	Access By Design: Transit's Role in Land Development
Orange County Transit District	Santa Ana	CA	Design Guidelines for Bus Facilities
Pace Suburban Bus Service	Arlington	IL	Development Guidelines
Washoe County Regional Transportation Commission	Reno	NV	Planning for Transit: A Guide to Community and Site Design
Riverside Transit Agency	Riverside	CA	Design Guidelines for Bus Facilities
Sacramento Regional Transit Authority	Sacramento	CA	Draft Transit and Land Use Coordination Guidelines
Seattle Metro	Seattle	WA	Encouraging Public Transportation through Effective Land Use Actions
Snohomish CountyTransportation	Lynwood	WA	A Guide to Land Use and Public Transportation
Societe de transport de la Communaute urbaine de Montreal (STCUM)	Montreal	QU	Principes et techniques d'amenagement pour les transports collectifs
Suburban Mobility Authority For Regional Transportation (SMART)	Detroit	MI	Designing for Transit: A Transit Design & Criteria Standards Manual
Tri-Cty Metropolitan Transportation District of Oregon (Tri-Met)	Portland	OR	Planning and Design for Transit
Urban Transit Authority of British Columbia	Victoria	BC	Guidelines for Public Transit in Small Communities

Appendix B

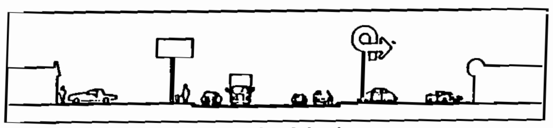
Survey Instrument

Transit, Development, and Design

A Survey of Transit Design Guidelines



Transit related development



Automobile related development

Source: Snohomish County Transportation Authority, "A Guide to Land Use and Public Transportation", 1989 from Portland "Public Sueets for Public Use", Dottemer, 1987.

Coordination between site design, public transit, and land-use, has become a topic of increased discussion in recent years among transit agency planners and professionals. Many agencies have even begun taking an active role by encouraging development patterns that are compatible with public transportation. Others are at least aware of the problems that result from projects that do not consider the needs of transit facilites and services.

This survey is an important part of a study examining the impacts of land-use and site-design on travel behavior. It is being conducted by the Institute of Urban and Regional Development at the University of California at Berkeley, and is funded through a grant from the Federal Transit Administration. Your agency's participation and cooperation in this study is of great importance and will be very much appreciated.

Please return the survey using the enclosed postage paid envelope to:

The Institute of Urban and
Regional Development
University of California
2000 Carlton St.
Berkeley, CA. 94704-9978

1. First, we would like to ask whether your agency has prepared and/or used **Design Guidelines** that encourage land developers to design and build projects that are both **more easily served by transit** and **"pedestrian-friendly"**?

______ YES ______ NO

*If you checked "NO" to this question, please skip to **question #15.***
If you answered "YES" please answer the following questions:

I. TRANSIT AGENCIES WITH DESIGN GUIDELINES

2. Please indicate the **title** and **release date** of these Design Guidelines (if possible, please include a copy when you return this survey).

TITLE: ____

DATE: ____________________

3. Who at your agency was **most responsible** for preparing the Design Guidlines?

____

(Name) (Title) (Phone #)

4. Has your agency's policy making board **formally approved and adopted** these Design Guidelines?

______ YES ______ NO

5. Check which of the following methods are used to **enforce or support** the Design Guidelines?

_____ Often required by local planning boards
_____ Often recommended by local planning boards
_____ Used in one or more review processes
_____ Legally binding on developers
_____ Unenforced
_____ Other (please explain) __________________________________
____

Appendix B (continued)

6. What were the three main reasons or motives for preparing these Design Guidelines?

1. ______________________
2. ______________________
3. ______________________

7. Please identify how much attention is given to the following items in your agencys' Design Guidelines:

Land Use	None				Considerable
Types of land uses	1	2	3	4	5
Mix of land uses	1	2	3	4	5
Density	1	2	3	4	5
Location of land uses	1	2	3	4	5
Other ________	1	2	3	4	5

Site Design					
Siting of buildings	1	2	3	4	5
Location of parking	1	2	3	4	5
Lot size/shape	1	2	3	4	5
Street layouts	1	2	3	4	5
Road width/ geometry	1	2	3	4	5
Sidewalks	1	2	3	4	5
Trails/ paths	1	2	3	4	5
Sample designs/ drawings	1	2	3	4	5
Other ________	1	2	3	4	5

Transit Facilites					
Provisions for transit expansion	1	2	3	4	5
Transit centers	1	2	3	4	5
Bus stop locations	1	2	3	4	5
Bus shelters	1	2	3	4	5
Bus turnouts	1	2	3	4	5
Pavement marking & streetscaping	1	2	3	4	5
Bike facilites	1	2	3	4	5
Other ________	1	2	3	4	5

8. Please list below any development projects in your region that were significanly influenced by or attempted to adhere to your agency's Design Guidelines.

PROJECT	DEVELOPER	PROJECT TYPE	DEVELOPMENT STAGE

9. Please rate how successful your agency's Design Guidelines have been in **influencing the designs of the following types of projects**, where 1=no influence and 10=high degree of influence

	none				moderate					high
Residential	1	2	3	4	5	6	7	8	9	10
Office Sites	1	2	3	4	5	6	7	8	9	10
Business Parks	1	2	3	4	5	6	7	8	9	10
Industrial Parks	1	2	3	4	5	6	7	8	9	10
Retail Plazas	1	2	3	4	5	6	7	8	9	10
Shopping Malls	1	2	3	4	5	6	7	8	9	10
Mixed Use Projs.	1	2	3	4	5	6	7	8	9	10
Other	1	2	3	4	5	6	7	8	9	10

(please describe)

10. How would you evaluate the **overall response** of the development community to these Design Guidelines?

very negative				no response				very positive	
1	2	3	4	5	6	7	8	9	10

11. How would you evaluate the **overall efforts** of developers in your region to incorporate the Design Guidelines into their developments?

no effort				moderate effort				tremendous effort	
1	2	3	4	5	6	7	8	9	10

Appendix B (continued)

12. For those **developers who did not successfully implement** your agency's Design Guidelines, please indicate below which factors best explain why:

___ Developers did not adequately understand the Design Guidelines
___ Physical or topological constraints prevented implementation
___ Resistance to the Guidelines by local planning boards or the community
___ Developers could not obtain financing if Guidelines were implemented
___ Developers concluded that implementation was economically unfeasible
___ Developers chose to ignore guidelines altogether
___ Other: ____________________

13. Overall, what ***impacts*** do you believe most urban and site design initiatives in your region have had on the following factors?

	None			Moderate				Significant		
Transit Ridership	1	2	3	4	5	6	7	8	9	10
Transit services and operations	1	2	3	4	5	6	7	8	9	10
Quality of walking environment	1	2	3	4	5	6	7	8	9	10
Aesthetics	1	2	3	4	5	6	7	8	9	10
Sense of community	1	2	3	4	5	6	7	8	9	10
Other ________	1	2	3	4	5	6	7	8	9	10

14. Does your agency make a "transit compatibility" checklist available to developers and local planners so that they can evaluate the transit serviceablity of proposed projects (either as part of or separate from the Guidelines)?

______ YES ______ NO

Now please skip to question #18.

II. TRANSIT AGENCIES WITHOUT DESIGN GUIDELINES

15. Has you agency ever considered drawing up a set of design guidelines for local planning agencies or the development community?

______ YES ______ NO

16. What factors have **constrained** your agency from developing Design Guidelines?

___ No interest in doing so by agency management
___ Design Guidelines have never been considered
___ Design Guidelines/ land-use issues beyond the mandate of this agency
___ Fiscal/ budget/ personnel constraints
___ Little development activity in the agency service area
___ Other: ____________________

17. Have you ever received any inquiries from developers interested in integrating transit into their projects?

______ YES ______ NO

If "YES", to what sources do you refer them? ____________________

18. Regardless of whether or not your agency has prepared formal urban or site Design Guidelines, **please identify any real estate projects in you region that stand out or are innovative** in terms of their level of **"transit-serviceability"** or **"pedestrian-friendliness".**

PROJECT	DEVELOPER	PROJECT TYPE	DEVELOPMENT STAGE

19. In order of importance, what do you feel are the **most important land use and urban design features** that are necessary in order to create a "pedestrian-friendly" and "transit-serviceable" development project?

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

Appendix B (continued)

20. Please provide any other comments or thoughts you have on the topic of transit "friendly" or serviceable urban designs.

∞∞THANK YOU FOR YOUR TIME AND ASSISTANCE∞∞

Table A6.1

1990 Work Trip Generation Rates Per Acre

	Land area (sq. km.)	Land area (acres)	Number of Commutes: Total Trips	Drove	Transit	Walk	Trip gen. rate	Car trip gen. rate	Transit trip gen. rate	Walk trip gen. rate
Balanced Communities										
Columbia	*60*	*14,787*	*45,041*	*36,892*	*1,563*	*596*	*3.05*	*2.49*	*0.11*	*0.04*
Aspen Hill	27	6,668	26,381	19,071	2,955	221	3.96	2.86	0.44	0.03
Reston	*45*	*10,984*	*29,319*	*22,865*	*1,768*	*565*	*2.67*	*2.08*	*0.16*	*0.05*
Dale City	39	9,668	25,681	17,252	721	203	2.66	1.78	0.07	0.02
Miami Lakes	*10*	*2,515*	*7,463*	*6,537*	*91*	*107*	*2.97*	*2.60*	*0.04*	*0.04*
Lindgren Acres	10	2,393	11,700	10,047	319	139	4.89	4.20	0.13	0.06
Residential Communities										
Clear Lake City	*63*	*15,462*	*22,550*	*19,198*	*379*	*434*	*1.46*	*1.24*	*0.02*	*0.03*
Friendswood	54	13,215	11,644	10,190	98	111	0.88	0.77	0.01	0.01
Mission Viejo	*45*	*11,121*	*37,600*	*32,184*	*231*	*398*	*3.38*	*2.89*	*0.02*	*0.04*
Newport Beach	36	8,929	37,238	32,901	357	868	4.17	3.68	0.04	0.10
The Woodlands	*42*	*10,423*	*13,234*	*10,632*	*609*	*111*	*1.27*	*1.02*	*0.06*	*0.01*
Champions	76	18,697	14,035	11,848	505	218	0.75	0.63	0.03	0.01
Peachtree City	*60*	*14,857*	*8,364*	*7,359*	*14*	*13*	*0.56*	*0.50*	*0.00*	*0.00*
Snellville	24	5,817	6,076	5,402	0	47	1.04	0.93	0.00	0.01
Employment Centers										
Irvine	*110*	*26,966*	*59,387*	*50,437*	*367*	*1,857*	*2.20*	*1.87*	*0.01*	*0.07*
Thousand Oaks	128	31,579	54,199	45,787	181	1,013	1.72	1.45	0.01	0.03
Las Colinas	*45*	*11,127*	*8,730*	*7,411*	*102*	*192*	*0.78*	*0.67*	*0.01*	*0.02*
Colleyville	34	8,353	6,269	5,652	24	28	0.75	0.68	0.00	0.00

Source: U.S. Bureau of the Census, 1990

Table A6.2

1980 Work Trip Generation Rates Per Acre

	Land area (sq. km.)	Land area (acres)	Number of Commutes: Total Trips	Drove	Transit	Walk	Trip gen. rate	Car trip gen. rate	Transit trip gen. rate	Walk trip gen. rate
Balanced Communities										
Columbia	***60***	***14,787***	***26,521***	***17,537***	***1,499***	***591***	***1.79***	***1.19***	***0.10***	***0.04***
Aspen Hill	27	6,668	23,984	15,504	1,847	459	3.60	2.33	0.28	0.07
Reston	***45***	***10,984***	***18,869***	***11,441***	***2,017***	***737***	***1.72***	***1.04***	***0.18***	***0.07***
Dale City	39	9,668	15,304	7,734	713	159	1.58	0.80	0.07	0.02
Miami Lakes	***10***	***2,515***	***5,536***	***4,511***	***30***	***63***	***2.20***	***1.79***	***0.01***	***0.03***
Lindgren Acres	10	2,393	6,374	4,633	93	20	2.66	1.94	0.04	0.01
Residential Communities										
Clear Lake City	***63***	***15,462***	***16,110***	***11,711***	***37***	***258***	***1.04***	***0.76***	***0.00***	***0.02***
Friendswood	54	13,215	4,808	3,736	0	60	0.36	0.28	0.00	0.00
Mission Viejo	***45***	***11,121***	***24,142***	***18,878***	***401***	***180***	***2.17***	***1.70***	***0.04***	***0.02***
Newport Beach	36	8,929	32,980	27,255	531	1,029	3.69	3.05	0.06	0.12
The Woodlands	***42***	***10,423***	***4,164***	***3,256***	***14***	***61***	***0.40***	***0.31***	***0.00***	***0.01***
Champions	76	18,697	6,773	4,846	281	111	0.36	0.26	0.02	0.01
Peachtree City	***60***	***14,857***	***2,858***	***2,149***	***667***	***8***	***0.19***	***0.14***	***0.04***	***0.00***
Snellville	24	5,817	3,978	2,804	1,099	6	0.68	0.48	0.19	0.00
Employment Centers										
Irvine	***110***	***26,966***	***32,557***	***26,595***	***483***	***569***	***1.21***	***0.99***	***0.02***	***0.02***
Thousand Oaks	128	31,579	36,635	27,626	195	679	1.16	0.87	0.01	0.02
Las Colinas	***45***	***11,127***	***5,334***	***4,090***	***27***	***224***	***0.48***	***0.37***	***0.00***	***0.02***
Colleyville	34	8,353	3,177	2,545	11	80	0.38	0.30	0.00	0.01

Source: U.S. Bureau of the Census, 1980

Table A6.3

1990 Work Trip Generation Rates Per Housing Unit

	Housing Units	Number of Commutes: Total Trips	Drove	Transit	Walk	Trip gen. rate	Car trip gen. rate	Transit trip gen. rate	Walk trip gen. rate
Balanced Communities									
Columbia	*30,651*	*45,041*	*36,892*	*1,563*	*596*	*1.47*	*1.20*	*0.05*	*0.02*
Aspen Hill	17,157	26,381	19,071	2,955	221	1.54	1.11	0.17	0.01
Reston	*19,999*	*29,319*	*22,865*	*1,768*	*565*	*1.47*	*1.14*	*0.09*	*0.03*
Dale City	15,245	25,681	17,252	721	203	1.68	1.13	0.05	0.01
Miami Lakes	*6,040*	*7,463*	*6,537*	*91*	*107*	*1.24*	*1.08*	*0.02*	*0.02*
Lindgren Acres	8,226	11,700	10,047	319	139	1.42	1.22	0.04	0.02
Residential Communities									
Clear Lake City	*17,018*	*22,550*	*19,198*	*379*	*434*	*1.33*	*1.13*	*0.02*	*0.03*
Friendswood	8,048	11,644	10190	98	111	1.45	1.27	0.01	0.01
Mission Viejo	*26,393*	*37,600*	*32,184*	*231*	*398*	*1.42*	*1.22*	*0.01*	*0.02*
Newport Beach	34,861	37,238	32,901	357	868	1.07	0.94	0.01	0.02
The Woodlands	*11,389*	*13,234*	*10,632*	*609*	*111*	*1.16*	*0.93*	*0.05*	*0.01*
Champions	11,184	14,035	11,848	505	218	0.54	0.46	0.02	0.01
Peachtree City	*6,541*	*8,364*	*7,359*	*14*	*13*	*1.28*	*1.13*	*0.00*	*0.00*
Snellville	4,185	6,076	5402	0	47	1.45	1.29	0.00	0.01
Employment Communities									
Irvine	*42,221*	*59,387*	*50,437*	*367*	*1,857*	*1.41*	*1.19*	*0.01*	*0.04*
Thousand Oaks	37,765	54,199	45,787	181	1,013	1.44	1.21	0.00	0.03
Las Colinas	*7,879*	*8,730*	*7,411*	*102*	*192*	*0.54*	*0.46*	*0.01*	*0.01*
Colleyville	4,309	6,269	5652	24	28	1.45	1.31	0.01	0.01

Source: U.S. Bureau of the Census, 1990

Table A6.4

1980 Work Trip Generation Rates Per Housing Unit

	Housing Units	Number of Commutes: Total Trips	Drove	Transit	Walk	Trip gen. rate	Car trip gen. rate	Transit trip gen. rate	Walk trip gen. rate
Balanced Communities									
Columbia	***19,116***	***26,521***	***17,537***	***1,499***	***591***	***1.39***	***0.92***	***0.08***	***0.03***
Aspen Hill	17,226	23,984	15,504	1,847	459	1.39	0.90	0.11	0.03
Reston	***13,916***	***18,869***	***11,441***	***2,017***	***737***	***1.36***	***0.82***	***0.14***	***0.05***
Dale City	9,958	15,304	7,734	713	159	1.54	0.78	0.07	0.02
Miami Lakes	***4,277***	***5,536***	***4,511***	***30***	***63***	***1.29***	***1.05***	***0.01***	***0.01***
Lindgren Acres	4,313	6,374	4,633	93	20	1.48	1.07	0.02	0.00
Residential Communities									
Clear Lake City	***12,619***	***16,110***	***11,711***	***37***	***258***	***1.28***	***0.93***	***0.00***	***0.02***
Friendswood	3,507	4,808	3,736	0	60	1.37	1.07	0.00	0.02
Mission Viejo	***17,268***	***24,142***	***18,878***	***401***	***180***	***1.40***	***1.09***	***0.02***	***0.01***
Newport Beach	31,397	32,980	27,255	531	1,029	1.05	0.87	0.02	0.03
The Woodlands	***3,408***	***4,164***	***3,256***	***14***	***61***	***1.22***	***0.96***	***0.00***	***0.02***
Champions	5,794	6,773	4,846	281	111	1.17	0.84	0.05	0.02
Peachtree City	***2,048***	***2,858***	***2,149***	***667***	***8***	***1.40***	***1.05***	***0.33***	***0.00***
Snellville	2,566	3,978	2,804	1,099	6	1.55	1.09	0.43	0.00
Employment Centers									
Irvine	***22,514***	***32,557***	***26,595***	***483***	***569***	***1.45***	***1.18***	***0.02***	***0.03***
Thousand Oaks	27,491	36,635	27,626	195	679	1.33	1.00	0.01	0.02
Las Colinas	***3,798***	***5,334***	***4,090***	***27***	***224***	***1.40***	***1.08***	***0.01***	***0.06***
Colleyville	2,128	3,177	2,545	11	80	1.49	1.20	0.01	0.04

Source: U.S. Bureau of the Census, 1980

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