Travel Characteristics of Transit-Oriented Development in California
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Executive Summary

Rapid growth in the urbanized areas of California presents many transportation and land use challenges for local and regional policy makers. Transit-oriented development (TOD) can respond to these challenges by supporting transit use and provided needed housing and other forms of development. TOD is generally considered to be moderate- to high-density mixed-use development located within an easy walk of a major transit stop.

This study provides a 2003 measurement of travel behavior in California TODs. It supports recent efforts to develop information and policy recommendations that enhance the effectiveness of TOD development. It builds upon previous studies conducted in the early 1990s, and examines a range of potential rail users—residents, office workers, hotel employees and patrons, and retail patrons. Survey sites are all located in non-CBD locations, are within walking distance of a transit station with rail service headways of 15 minutes or less, and were intentionally developed as TODs. Surveys were conducted along each of California's major urban rail systems, including the San Diego Trolley, San Diego Coaster, Los Angeles Blue and Red Lines, Los Angeles Metrolink commuter rail, San Jose VTA light rail, Caltrain commuter rail, the Bay Area Rapid Transit District, and Sacramento Light Rail.

Additionally, the study collects detailed data on site and neighborhood factors that potentially affect the likelihood of using transit and models those factors in relationship to individual and project-level travel behaviors. Comparisons are also made to the 1990-era data in order to understand how travel behavior changes occur over time, as location decisions *and* mode choice adjust to the new transit accessibility and growing roadway congestion. This broad data collection effort is intended to facilitate a more comprehensive understanding of travel decisions within TODs and to stimulate further analysis and surveys by local jurisdictions, transit agencies, and regional planning entities.

TOD Resident Findings

TOD residents have high rates of transit use for their respective communities. The rates are higher than comparable regions, cities or adjacent areas. Residents living near transit stations are around five times more likely to commute by transit as the average resident worker in the same city. This is the same ratio as found in Cervero's 1993 California TOD study. Table E-1 shows transit mode share for commute trips by station area residents, according to five station groupings.

Table E-1: Commute Trip Mode Share, TOD Residents

Percent of trips made by the following modes:	All Sites	BART: Pleas't Hill	BART: S. Alameda Cty	L.A. Metro: Long Beach	S.D. Trolley: Mission Vly	Caltrain Commuter
Vehicle	71.7	52.9	61.6	93.3	84.9	81.9
Transit	26.5	44.9	37.8	3.3	13.0	17.4
Other	4.1	2.3	0.6	0.6	2.2	0.8
N (Number of trips)	877	176	177	60	185	121

The table shows that rail use varies significantly by region and type of rail service. This is to be expected; some regions are in the midst of developing their rail networks, while others are farther along. In particular, the Bay Area's more mature rail transit system and smart-growth initiatives support higher levels of transit use among TOD residents.

The full report provides information on the station characteristics, demographics, employment characteristics, residential location, commuting costs, and transportation incentives for TOD sites. It reports on work trips, non-work trips, commuting times, trip length, and trip chaining. Rail transit shares for TOD residents are higher for the commute trip than for non-work travel. Over 90 percent of the surveyed rail commuters living near rail stations walked to the rail station.

In terms of changes over time, there is not conclusive evidence that transit mode choice increased among TOD residents in the 1992 to 2003 period. Small increases in transit trips were measured, but they were not large enough to establish a statistically valid difference. Survey results did show that transit use is positively related to length of residency.

Resident respondents indicated that housing attributes (cost or quality) were generally more important than rail transit accessibility in their decision to move to a TOD, suggesting that California's housing affordability challenges play an important role in TOD housing demand (where units tend to be smaller and less expensive than their surrounding region). Indeed, the pattern of mode change that occurs when a resident moves to a TOD is complex, because TODs provide good accessibility of all kinds, not just rail transit. Survey respondents who had changed both work location and residential location indicated a variety of mode changes; 11.5 percent switched from automobile to rail transit, but an almost equal number switched from transit to automobile.

Based on disaggregate models of transit ridership, TOD residents are more likely to use transit if there is less of a time benefit for traveling via highways (compared to transit), if there is good pedestrian connectivity at the destination, if they are allowed flexible work hours, and if they have limited vehicle availability. TOD residents are less likely to use transit if the trip involved multiple stops (or "trip chaining"), if there is good job accessibility via highways, if they can park for free at their workplace, and if their employer helps to pay vehicle expenses (such as tolls, fuel, etc.). Each of these results is consistent with travel behavior theory.

Concerning the impact that distance from the rail station might have on transit share, the analysis did not reveal a negative sloping transit share gradient. Transit share was not sensitive to distance from the station for the TODs studied (all of which were within reasonable walking distance of the station).

Physical design factors such as neighborhood design and streetscape improvements show some influence in predicting project-level differences, but have relatively minor influences on transit choice among individual station area residents. This suggests that while design elements are important, there is great variation across individuals. Within each TOD, there are likely to be some that place value on these elements while others are unlikely to be deterred, for instance, by poor landscaping or a lack of streetlighting as long as the transit is nearby.

TOD Office Worker Findings

Office workers in TOD projects also have higher rates of transit use than their surrounding areas, although the area of comparison for office workers is the region (or MSA) rather than the city since office sites are likely to draw employees from a larger area. Compared to workers in their surrounding region, TOD office workers are more than 3.5 times as likely to commute by transit, an increase from the 2.7 times ratio found in the 1993 study. Table E-2 shows transit mode share for commute trips by station area residents, according to six station groupings.

Table E-2: Primary Commute Mode, TOD Office Workers

Percent of trips made by the following modes:	All Sites	BART Berkeley	BART: Walnut Crk	LA Metro: Hollywood	SD Trolley Miss'n Vly	Sacram-ento LRT	Metrolink: Anaheim
Vehicle	77.8	50.0	81.8	88.2	96.3	66.7	92.6
Transit	18.8	38.5	17.2	7.8	2.9	29.0	6.0
Other	3.5	11.5	0.9	3.9	1.0	4.1	1.5
N (No. of trips)	853	104	110	51	210	286	67

Consistent with the findings of residents of TOD housing, there is substantial variation across TOD context and rail systems. However, in all cases, TOD transit shares for office worker commute trips significantly exceed the journey-to-work transit mode share in the surrounding region. There is also conclusive evidence that rates of transit use by office workers increased over the 1992 to 2003 period, unlike the finding for TOD residents. The rail/bus share increased from 14.3 percent in 1992 to 23.9 percent in 2003. (See full report for an explanation of this comparison).

Employers continue to subsidize parking for employees, even when located in a TOD. The Sacramento TODs had the lowest level of free parking (24.6 percent of respondents) and also had the highest level of transit use (29.0 percent), while the San Diego Mission Valley sites had the highest level of free parking (82.9 percent) and the lowest level of transit use (1.0 percent).

In spite of all sites being located within reasonable walking distance of a TOD, the distance of the TOD workplace from the transit station does have a downward sloping relationship; the farther a site was from the station, the less likely it is that an employee uses transit.

Disaggregate modeling of office worker mode choice indicates that parking policies and employer assistance with transit costs significantly influence whether those working in offices near California rail stations commute by transit. Public policy-makers can also encourage transit commuting among rail-oriented office workers by enhancing transit services: frequency of feeder bus services to stations serving offices as well as comparative travel times by transit were both significant predictors.

Retail Patrons and Hotel Sites

Transit accounts for about one-fifth of trips to retail sites in TODs. (Walking accounts for one in ten trips.) Of the three sites studied (El Cerritos Plaza-BART, Hollywood/Highland-LA Red Line, and Fashion Valley-San Diego Trolley), the Hollywood/Highland site has the highest level of rail and bus trips (32 percent of trips).

Hotel patrons in TODs use rail transit more frequently for travel during their stay than for their travel to the hotel (based on one BART and one San Diego site). Vehicles (personal or rented) are the most common modes for traveling to the hotel. Hotel employees have high levels of rail transit use for their journey to work.

Policy Implications

The research findings support continued TOD development in California. TOD can help realize the full benefits of the investment in rail transit. TODs have high transit ridership and they respond to the strong need for affordable housing. Even if some TOD transit riders self select into the TOD to gain convenient transit access, TOD development provides more opportunities for these potential riders by increasing the stock of transit-accessible land use.

In order to encourage TOD, development approval processes and local land use and housing regulations should fully recognize the reduced transportation impacts in traffic impact analyses. Possible incentives include sliding scale impact fees wherein vehicle trip generation rates are adjusted downward to reflect the higher shares of trips made by transit and other non-auto alternatives. Lender programs such as Location Efficient Mortgages (LEMs) can provide incentives on the consumer side.

Transit ridership increases as the time advantage of traveling via highways relative to transit is reduced, making improved transit travel time an important factor in TOD success: easier connections, improved transit reliability, and increased frequency and coverage of feeder bus routes.

The full transportation benefits of TOD occur when a combination of non-automobile access modes and mixed land uses are sufficient to allow households to reduce automobile ownership. Other research has shown the cascading benefits of reductions in auto ownership, including reduced building costs, occupancy costs, and trip generation.

Planners should consider transit-oriented development possibilities in station areas with large inventories of surface parking. Such projects will fulfill the need for infill development in California's regions. The question of replacing station area parking can be addressed on a station-specific level, taking into account the impacts on general ridership.

Continued streetscape and design improvements in California TODs are needed. Although these factors had only marginal impacts on transit riding, it could be the case that neighborhood amenities and enhancements make living in transit-oriented neighborhood at higher densities more attractive.

Since parking supply, pricing policy, and employer worksite policies are key influences on commuter mode choice in TODs, policy makers should consider lower parking requirements, shared parking, unbundling of parking from rent payments, parking cash-out, and/or parking charges. Design must be matched by appropriate policies. Employers and tenants should be encouraged to fully complement TOD transit advantages with appropriate policies.

In sum, while this research shows that California TODs exhibit high levels of transit ridership, transportation impacts are not the only reason for TOD. TOD should be cast in a broader, more holistic context that acknowledges other reasons for targeting development around transit stations, such as widening housing choices and providing more affordable units. Perhaps what local policy-makers can best do to promote transit riding among station area residents is to zone for sufficient housing supplies that match the taste preferences and earning levels of households wanting to live near stations. When it comes to transit-based residences, the greatest ridership pay-off comes from intensifying station area housing.

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CHAPTER 1. INTRODUCTION

The Context for Studying TOD

Rapid growth in the urbanized areas of California presents many challenges for local and regional policy makers. The capacity of transportation systems is not being expanded commensurate with growth in travel demand, and traffic congestion has reduced the capability of transportation systems to provide access and mobility. Issues of housing affordability and supply are critical in many regions. Developers and public officials face many challenges in identifying development sites that can be serviced and permitted in a cost effective manner. Finally, there are hosts of environmental issues that constrain the outward expansion of California's urbanized regions.

Transit-oriented development (TOD) promises to help with many of these challenges. Among the many TOD definitions available, the California Department of Transportation (Caltrans) uses the following:

> "…moderate to higher-density development, located within an easy walk of a major transit stop, generally with a mix of residential, employment and shopping opportunities"…it is "designed for pedestrians without excluding the auto" and can be achieved through either "new construction or redevelopment of one or more buildings whose design and orientation facilitate transit use" (Parker, McKeever, Arrington and Smith-Heimer, 2002).

TODs are intended to increase transit ridership, increase walking and biking, and decrease the share of automobile trips. The design and mixed-use features of TODs may reduce both work and non-work automobile trips. Furthermore, these potential benefits can help amortize California's multi-billion dollar investments in rail transit infrastructure.

Urban planning history provides accounts of promising ideas that did not realize their goals on implementation. TOD strategies are based on a theory that land uses near a rail transit stop will produce a different travel pattern than land uses in an automobile focused area. The best way to ensure that TODs can help solve California's urban challenges is to provide solid analytic evidence about their effectiveness. This study focuses on the levels of automobile travel, transit use, walking and bicycling in TODs, and the factors that explain difference in transit use among different TODs.

Study Purposes and Methods

The purpose of this study is to examine the travel behavior outcomes of a broad range of TODs in California. Previous studies on this subject, such as "Ridership Impacts of Transit-Focused Development in California" (Cervero, 1993) and "Transit-Based Housing in California: Profiles" (Menotti and Cervero, 1995) show that indeed there is a positive effect. These studies concluded that the average resident of a TOD was five times more likely to use transit compared to other residents in that city.

This study provides a 2003 measurement of travel behavior in TODs in California. It supports recent efforts to build profiles and data summaries concerning TODs. Compared to the previous studies, it expands the sites surveyed and addresses a broader range of trips. It adds new residential, office and hotel sites to address new questions (e.g., travel behavior of retail workers) and includes TODs built more recently. Since many of the rail systems are relatively new, many sites that are consciously designed to be part of a TOD have emerged only in the last decade. The surveys include residents, office employees, hotel employees and patrons, and retail patrons. The study also collects more detailed data on site and neighborhood factors that potentially affect the likelihood of using transit. This statewide study includes the major urban rail systems in California, including the San Diego Trolley, the San Diego Coaster, the Los Angeles Blue Line and Red Line, the Los Angeles Metrolink, the San Jose VTA light rail, Caltrain, the Bay Area Rapid Transit District, and the Sacramento Light Rail. The data were collected using mail back questionnaires, intercept surveys, fieldwork and secondary data sources. This broad data collection effort is intended to stimulate further analysis and surveys by local jurisdictions, transit agencies, and regional planning entities. Because of the scope of data collection, it is not possible to provide large samples for all systems; the intent is to provide a rich database and study method that can be supplemented by other agencies over time.

The study is designed to assess the success of TODs in enhancing transit ridership and to identify TOD design and policy features that contribute to success. We also seek to understand how these changes occur over time, as location decisions *and* travel behavior adjust to the new transit accessibility and roadway congestion. This project re-measures mode choice at a series of projects just over a decade after the original round of surveys was conducted. This ability to measure travel behavior at two points in time allows us to examine the hypothesis that transit and non-automobile travel mode shares rise as a TOD matures.

Study Outcomes

As mentioned, analytic work on the effects of TODs can improve the strategies of both transit agencies and local jurisdictions. The following provides an example of an issue where this research can support better station development strategies. Transit agencies face competing demands for land use and roadway access in their station vicinities. One approach is TOD, emphasizing proximate and clustered station development that increases walking and transit trips to the station. Yet, the percentage of total travel from station areas is rather small compared to the total patron draw of the station. Another approach emphasizes the development of parking facilities serving auto access riders from a much larger subregion. Many transit agencies in California are now deciding which strategy to pursue, and where TOD or auto-access strategies may be appropriate along their transit systems.

In order to sort out these competing priorities, transit agencies need more information on the degree to which transit focused development achieves the goal of reducing vehicle trips. They also need a better understanding of the scale of TOD that will achieve the desired mode changes. Cities need to know if they can count on transit mode share increases as they calculate traffic impacts and consider which station areas are well suited to TODs.

The project provides an information base that can enhance station area planning and access planning for existing rail systems. It will also support better route planning and station selection by providing an analytic basis for evaluating alternative station locations and supporting the refinement of TOD and joint development strategies. Better insight into how TODs really work can increase the level of partnering between transit agencies and local government on TOD. It can also support MPO and transit agency strategies. Finally, the insights on the dynamics of household travel behavior and location decisions in maturing transit systems can be used to improve predictive models.

Report Organization

The following chapters provide a review of past study findings related to travel behavior and transit-oriented development (Chapter 2), describe the research approach and rationale used in this study—including benefits and drawbacks of the study’s methodology and its connections to the 1993 baseline study (Chapter 3), provide an overview of the surveyed sites (Chapter 4), and present the results of the travel surveys, by project type, through descriptive statistics, modeling investigations, and an examination of travel behavior dynamics from the early 1990s to 2003 (Chapters 5 through 7). For the descriptive analyses, sites are clustered according to their physical setting (and by rail system); site-specific travel and other information can be found in Appendix A (Site Profiles). The report concludes with a summary of the findings, suggested research efforts, and recommendations for public policy (Chapter 8).

CHAPTER 2. LITERATURE REVIEW

Introduction

Transit-oriented development (TOD) is defined in a recent study by the California Department of Transportation (Caltrans) as "moderate to higher-density development, located within an easy walk of a major transit stop, generally with a mix of residential, employment and shopping opportunities." It is "designed for pedestrians without excluding the auto" and can be achieved through either "new construction or redevelopment of one or more buildings whose design and orientation facilitate transit use" (Parker et al., 2002). While there is no "single, all-encompassing definition that represents the TOD concept in its many forms" (Cervero, Ferrell and Murphy, 2002), most definitions do share common traits. The most notable of these traits are close proximity to a transit station, a mix of land uses, and conduciveness to transit riding, most often in the form of pedestrian and bicycle-friendly environs and nearby public spaces for riders.

After a somewhat unsuccessful era in the 1970s and 1980s, in which planners attempted to create TODs to capitalize on the construction of urban rail systems such as Bay Area Rapid Transit (BART), the 1990s and the first few years of the twenty-first century have seen a resurgence in TOD construction in the United States. This resurgence has taken advantage of demographic factors such as increased numbers of childless couples and empty nesters. The concept has "gained popularity as a means of redressing a number of urban problems, including traffic congestion, affordable housing shortages, air pollution, and incessant sprawl" (Cervero et al., 2002). According to Tumlin and Millard-Ball (2003), "even a cursory glance around the country suggests that transit-oriented development is hot," with "new TODs…on the drawing boards everywhere, from Alaska to Florida." Beginning in large urban areas such as the San Francisco Bay Area and Metropolitan Washington D.C., in which mass transit has long flourished, TODs have begun to appear throughout the nation, expanding into the suburbs and automobile-oriented regions such as Southern California.

As the popularity of transit-oriented development has increased over the past decade, so too have the number of studies examining factors that contribute to the success or failure of TOD projects, in terms of their ability to capitalize on the transit services available and increase rail transit usage. Much of this research has concentrated on TODs in California, which has been at the forefront of the most recent TOD movement. However, several trends and factors that exist at the nationwide level also provide an excellent background for the research.[1]

General Trends in Ridership: TODs versus non-TODs

Bernick and Cervero (1997) list the geographical boundaries of TOD as an area that extends roughly 1/4 to 1/3 of a mile from a transit station, a distance that can be covered on foot in roughly 5 minutes. While this distance is not invariant, and can be as much as 1/2 mile if pleasant urban spaces and corridors are created (Untermann, 1984), empirical evidence shows that just over 1/3 mile (about 2,000 feet) is the distance that "most people" would walk from transit to work (Bernick and Cervero, 1997; Cervero, Bernick and Gilbert, 1994). District boundary definitions in TOD ordinances throughout the United States range from 1/4 mile in Portland and Seattle, to 2,000 feet in San Diego, to 1/2 mile in Washington County, Oregon (Community Design + Architecture, 2001).

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[1] A more thorough review of the literature related to transit-oriented development can be found in Cervero et al.'s TCRP Research Results Digest Number 52: "Transit-Oriented Development and Joint Development in the United States: A Literature Review" (October, 2002).

When compared to ridership rates for non-TODs and cities/regions as a whole, research shows that TODs have a higher rate of patronage on heavy and light rail and other forms of mass transit. A comprehensive study of the Washington, D.C. metropolitan area conducted by JHK and Associates in 1987 and 1989–whose methodology closely resembles this study—showed that for both residential and office developments, ridership fell off steadily as distances from offices and residences to stations increased. However, the study also showed that transit usage varied depending on trip destination (for station area office workers) or origin (for station area residents), with urban workers and residents exhibiting much higher ridership rates than their suburban counterparts. A similar transit modal split for office and residential sites was found in Edmonton and Toronto, Canada, with ridership rates much higher among residents of high-density, urban residential complexes and downtown office buildings compared to similar developments in suburban areas (Stringham, 1982).

Several of the most extensive studies of the last decade have focused on TODs in California. Cervero’s 1993 report shows that residents living near transit stations were around five times more likely to commute by rail transit as the average resident worker in the same city, while those working near rail stations were about 2.7 times as likely to use rail as workers in the city as whole. This finding is similar to that of Gerston and Associates (1995), which found that residents of Santa Clara County’s light rail corridor were more than five times as likely to use transit as residents of the county as a whole.

Cervero (1993) also found that, for TOD residents, proximity to a rail station was a much stronger determinant of transit use than land-use mix or quality of the walking environment. In other words, as long as one lived near a rail station, other design factors were unlikely to deter them from using transit. The finding was similar for TOD office employees. Additionally, transit ridership significantly declined—for both residents and employees—if parking was free at their workplace (or other destination), or if they had access to a private vehicle. Transit ridership increased if a residents’ destination was located near a rail station, and if an employee lived in a “transit-friendly” region. In a later study, Cervero and Duncan (2002) found that residential self-selection was also a significant predictor of transit mode choice, accounting for approximately 40 percent of the decision to commute by rail.

Higher rates of transit ridership are expected for TODs because that form of development affects key factors that shape mode choice. TOD can lower the travel time and cost of work and non-work travel by providing convenient and low cost access to rail transit service. It can also provide neighborhood attributes and urban design features that increase the likelihood of using transit.

The higher levels of transit use in TODs are widely supported in the literature, as mentioned previously. The following sections discuss the various types of physical and policy factors that have been identified as contributors to transit ridership. Two aspects that have not been well developed, however, are the degree to which TOD induces households to shift to transit transportation patterns from auto use patterns (or whether the residents of TODs were already using transit in another location) and the relative role that personal attitudes play in mode choice decisions. These issues warrant further study.

Environmental Factors and Physical Design

Although the level of ridership in TODs is quite high when compared to traditional developments, the mere existence of transit-oriented development does not guarantee a large increase in rail transit usage. The presence (or absence) of a number of environmental factors and physical design features has been shown to significantly influence the ability of TODs to increase ridership rates. Cervero et al. (2002) list three major categories for TOD design considerations at the station level: densities needed to sustain transit investments; enriching land-use compositions that also serve to decrease auto dependence (mixed-use); and the quality of public environment, especially in the area of pedestrian accessibility. The "3 Ds," as Cervero calls them-density, diversity, and design-for the most part "embody many of the same design elements [and environmental factors] found in the neo-traditional and New Urbanist movements." In addition, the availability of free or low-cost parking in the station area is another factor that has been shown to significantly reduce rail ridership rates.

Station Area Density

According to Tom Margro, General Manager for Bay Area Rapid Transit, "from the point of view of a transit agency, density is paramount," and is a key criterion in BART's expansion policy (Tumlin and Millard-Ball, 2003). The reason for this, according to Tumlin and Millard-Ball, is that "all else being equal, the more housing and jobs within a short walk of the transit station, the greater the ridership." According to a national report by the Transit Cooperative Research Program (1996), a ten percent increase in population density around transit stations was found to increase ridership by 5 percent, while doubling density was shown to reduce vehicle travel by up to 20 percent.

In denser communities, residents are more likely to live within walking distance of retail shops and services than in traditional communities. However, in the case of California, developer, resident and consumer reservations about high-density housing, and the fact that transit has historically not competed well with the automobile under existing land use patterns have counterbalanced this seemingly attractive benefit (Cervero et al., 1994). Many communities in California face resistance to density and are seeking ways to demonstrate that higher density forms of housing can fit well with the community. Pressure for change comes from the urgent need to increase housing supply and changing demographics. These trends have begun to increase demand for high-density housing and improve the potential of TODs. In Southern California, for example, station areas were found to have 47 percent higher shares of high-density residential development and 340 percent higher shares of commercial zoning than traditional developments (Boarnet and Crane, 1998).

Many agencies and municipalities have adopted guidelines for TOD densities and design for residential and commercial development as well as employment opportunities. San Diego (CA), Metropolitan Portland (OR), and Washington County (OR) have adopted guidelines that call for a gross residential density of 18 units per acre, with densities higher in urban TODs and increasing as you move closer to the station (Community Design and Architecture, 2001). In regards to employment densities required to support light rail services, studies have found that between 50-100 workers per acre can adequately support a light rail system, even when surrounded primarily by low-density residential units (Puget Sound Regional Council, 1999; Ewing, 1999; Parsons, Brinckerhoff, Quade, and Douglas et al., 1995).

While residential density has been shown to be an important factor in increasing ridership, it does not always translate into the development of true "village-style" TODs, which would also include mixed uses and pedestrian environments. Loukaitou-Sideris and Banerjee (2000) found this to be the case along the Los Angeles Metro Blue Line in the 1990s and concluded that "formidable social, economic, and institutional barriers may continue to frustrate expectations of development around transit stations" in urban areas such as Long Beach, where problems such as fear of crime, drugs, and violence inhibit wide-scale development. Such issues often require an added emphasis on public investment and policies to counter these concerns.

Station density is also derived from preexisting land use conditions. Willson and Anderson (1996) compared TODs in Vancouver, Canada and San Diego and found that Vancouver's higher cost, elevated system allowed transit planners to place stations in optimal locations in communities and achieved further development synergies by those station locations. Furthermore, they found that in the Vancouver case, government and quasi-governmental agencies played a major role in supporting TODs through direct investment in office and cultural facilities.

Diversity of Land Uses

Recent literature suggests that the aforementioned higher densities are most beneficial to transit ridership when they result in a mix of residential, commercial, and office uses. Cervero et al. (2002) state that most successful TODs "feature land-use arrangements that produce all-day and all-week trips, such as entertainment complexes, restaurants, and other mixed uses." This "squeez[es] out efficiencies in the deployment of costly rail services" and fills up underutilized capacity that might exist without a diversity of land uses.

A survey of successful TODs illustrates the importance of a variety of land uses. Orenco Station, located in Hillsboro, Oregon on Metropolitan Portland's MAX light rail system, offers not only a wide variety of housing types, but also a neighborhood retail district and an attractive promenade (Arrington, 2000), resulting in low vacancy rates and increasing property values. The city of Mountain View (Santa Clara County) won an award from the American Planning Association for best "Integrated Transit-Oriented Development" for its station along the Caltrain commuter line in the Bay Area. One project in the Mountain View TOD—*The Crossings*—features a row of neighborhood stores that face the station (Thompson, 2002). Even seemingly successful TODs are being renovated to include a greater mix of uses, such as BART's Pleasant Hill station, which—following 6 months of community input—is now slated to increase the amount of housing, office space, and community retail in close proximity to the station (Cervero et al., 2002).

Pedestrian Accessibility

While a wide spectrum of land uses is desirable for TODs, transit stations and TODs must also have good pedestrian accessibility both within and surrounding the station area if residents, employees, and customers are to walk. According to 2002 Caltrans report, stations "often have poor pedestrian access and are not well integrated into the surrounding local community" (Parker et al., 2002). The concept of pedestrian accessibility, derived from the principles of New Urbanism, seeks to create communities and neighborhoods that take advantage of the accompanying compact mix of land uses by implementing a number of design principles that encourage local trips to be made by foot or bicycle.

The definition of transit-oriented development included in the first paragraph of this chapter noted that TODs should be designed for pedestrians, but not at the expense of excluding the automobile. The appropriate balance between pedestrian and automobile access depends to a great deal on the characteristics of the station and TOD. The key to encouraging local pedestrian trips without discouraging automobile traffic lies in creating a network of streets that allows pedestrians, bicyclists, and automobiles to interact safely efficiently. The way in which the automobile is accommodated has an important effect on ridership. For example, underground or structure parking is more pedestrian friendly than surface parking, and a network of moderately sized streets is more pedestrian friendly than wide streets.

Support for the link between pedestrian-friendly design and land use factors and increased pedestrian travel has been established in a number of studies. Some of the most commonly identified factors include human-scale streetscapes with adequate pedestrian amenities (Handy 1992 and 1996, Moudon, Hess, Snyder and Stanilov, 1996), access to shopping and other amenities (Frank and Pivo, 1995; Lund, 2003; Handy, 1992 and 1996, Kitamura et al., 1997; Shriver, 1996), and higher densities (Frank and Pivo, 1995; Kitamura et al. 1997). As Kitamura et al. (1997) and Lund (2003) find, however, a person's attitude toward walking can be even more significant than the physical environment. This was also found to be true in the case of rail ridership (Cervero and Duncan, 2002). The role of attitudes in determining mode choice is an area deserving of more research.

Station Area Parking

Balancing the notions of pedestrian accessibility and dense, mixed-use communities with the need for station area parking is often a difficult task. According to Parson, Brinckerhoff, Quade and Douglas, Inc. (2001), as summarized by Cervero et al. (2002), this is because “the long term goal of ‘community building’ and the essential short-term goal of maximizing ridership are often put in conflict with each other.” While providing station area parking provides an important ridership base, too much station area parking can inhibit TODs by taking up land close to the transit station that could otherwise be used for retail, office, or residential units. This results in “a transit station platform surrounded by a sea of parking” (Cervero et al., 2002) and the potential to undermine regional land-use benefits (Cervero and Landis, 1997). Poorly designed surface parking can undermine the potential for development that is actually transit oriented.

If the amount of station area parking is too low (both for station area residents and commuters), what often results is a spillover effect into surrounding neighborhoods, which can cause anger and contention towards future TOD projects (Isaacs, 2002). In addition, if a station is serving a large, automobile-oriented commuter shed, insufficient parking could mean that the rail system will not reach its ridership potential.

One common approach to solving these problems has been to replace surface lots for commuters with multistory parking structures. Doing so typically allows commuters to continue to park within close walking distance to station and thus not discourage from riding mass transit, while allowing for new infill developments that add a more compact, pedestrian feel to the TOD. The planned renovation of the aforementioned Pleasant Hill BART station TOD will include adding many such infill projects on land that is currently a large surface parking lot. A similar effort is underway at the Owings Mill station outside of Baltimore, with a transit village envisioned in the current home of a large surface parking lot.

Policies

While certain environmental and design factors have proven important in contributing to the success of TOD projects, many can only be implemented with the assistance and cooperation of government agencies and the presence of adequate policies to address these issues. According to Cervero et al. (2002), “experience shows that, if they are to have much of a chance of success, TODs must be proactively championed by the public sector.” This is most effective is both transit agencies and local land use agencies partner in promoting TOD.

Public sector involvement and support of transit-oriented development has long been discouraged by, among other things, community opposition to high-density developments; the location disadvantage of many transit lines, in that they often pass through unattractive and heavily industrial neighborhoods; and a “fixation on automobile-oriented design” (Porter, 1997). However, the last few decades have seen a number of new state, metropolitan and local policies, and the introduction of new legislation, that aim to support existing and encourage future TODs.

Conclusion

The conclusion to Caltrans’ 2002 statewide TOD study found that while California has been a leader in pursuing transit oriented development, and many projects have been successful in adopting appropriate environmental and design factors, transit-oriented development is still challenged by a lack of public and private financing and adequate policies and legislation to encourage TOD construction. While little has likely changed in the past year, there is evidence that suggest that TODs will be better financed and incorporated into mainstream development in the future. Large, high density, multi-use projects have appeared throughout the Bay Area, Los Angeles, and San Diego, with additional projects in the works. A housing crisis in many parts of the state puts more attention on infill development possibilities such as TOD (e.g., the Mobility 21 Initiative of the Los Angeles County Metropolitan Transportation Authority and the Los Angeles Chamber of Commerce). The need for well-designed, transit accessible higher-density development is highlighted by the anticipated California population increase of almost 10 million over the next twenty years. Developers and public officials face a promising opportunity to make TOD part of the solution to California's growth, transportation, and environmental challenges.

CHAPTER 3. RESEARCH DESIGN

Scope of Work

This report presents findings from a statewide data collection effort that surveyed patrons of forty TODs[1]—26 residential buildings, 9 office buildings, 3 hotels, and 2 retail complexes—during the spring and early summer of 2003. Sites were selected along a combination of light, heavy and commuter rail lines in four California regions—the Bay Area and Sacramento in northern California and Los Angeles and San Diego in southern California; between the four regions, each type of rail system is represented in both northern and southern California. The heavy rail lines included in this study are BART (Bay Area Rapid Transit) and the Los Angeles Metro Red Line; light rail lines include the Los Angeles Metro Blue Line, San Jose VTA (Valley Transportation Authority), Sacramento Light Rail and San Diego Trolley; and commuter rail lines include Caltrain (with service between San Francisco, San Jose and Gilroy), San Diego Coaster (with service between San Diego and Oceanside), and Metrolink (with service throughout the Los Angeles region).

Research Goals

The research design was guided by three primary goals:

1. To provide a comprehensive understanding of travel behaviors and their influences within select TODs along California rail systems;
2. To provide practical guidance for transit planning and rail station development; and
3. To continue the rail station travel behavior research from the early 1990s and, as a result, improve our understanding of longitudinal changes in travel behavior within TODs.

Goal 1, to provide a comprehensive understanding of travel and its influences, was met by utilizing a case-study approach in the selection and analysis of TODs. This enabled the study to survey a wider range of potential rail users, to focus on "best case models" of TOD, and to incorporate a wider range of potential influences on travel behavior.

Goal 2, to provide practical guidance for future transit and station area development, was met by including the participation of a technical advisory board and by focusing on suburban and in-fill development sites rather than those in long-established urban areas, such as downtown San Francisco, which are unlikely to be replicated in future rail station development. Also contributing to this goal was the decision to examine a variety of rail types (light, heavy and commuter) from regions throughout the state, so that planners in one region are not relying on data from another region with, for instance, different land use patterns, rail technologies, and levels of investment in transit-oriented development.

Goal 3, to build upon the research from the early 1990s, was met by re-surveying many of the sites included in the 1993 and 1995 studies and by maintaining as much consistency as possible with the original survey instruments. This enabled the research team to make direct comparisons between the early 1990s and 2003 findings (where data from the earlier studies were available) and created a strong base for future time comparison studies.

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[1] Note that from this point on, "TOD" is used to describe single projects located near rail stations; these projects may or may not be part of a comprehensive (e.g., mixed-use, high density) station area development. While the earlier studies referred to these projects as "transit-*focused* developments," we chose to use the term TOD because it is more widely accepted and recognized within the field.

Distribution of Surveyed Sites

As described above, a combination of residential, office, retail and hotel sites were selected from light, heavy and commuter rail systems throughout the state of California. The largest concentration of sites was located along the BART system. The purpose of this concentration was two-fold: first, it provided a larger sample size for examining changes over time, as most of the earlier study sites were also located along BART; and second, as there are more rail lines and station areas on the BART system relative to other California rail systems, it enables the study to be more representative of the statewide distribution of TODs. In terms of the surveyed population groups, the largest numbers of surveys were conducted with station area residents and office employees. This also reflects the focus of the earlier studies, and is consistent with the dominant types of projects (residential and office) occurring in station area development.

Research Questions

In accordance with the goals outlined above, separate research questions were developed for each surveyed population: residents living within rail station areas; office employees working within rail station areas; and patrons and employees of retail and hotel sites within rail station areas.

The primary research question for **people living near California rail transit stations** is:

1. Does residential location in a TOD increase the probability of transit use in work and non-work trips, as compared to transit mode share in the surrounding city? To what degree does location in a TOD bring about a change in travel behavior (versus relocation of prior transit users)?

Related questions, also addressed in this report, are:

a. What is the influence of the following factors in predicting the probability of transit use among residents in TODs?

   - Transportation service qualities of competing modes (transit service, traffic congestion) that influence travel time, convenience, and safety.
   - Costs of competing modes such as auto use costs and transit costs.
   - Demographic characteristics—personal characteristics of the trip maker and household factors (income, occupation, children in household, etc.)
   - Policy features— e.g., employer commute policies, property management policies, parking supplies, etc.
   - Neighborhood attributes, e.g., physical characteristics of the TOD and the trip destination that influence travel time, convenience, and safety.
   - Regional characteristics regarding density, jobs/housing mix, housing demand, etc.

b. Factors influencing residential location in a TOD. How did travel behavior differ from the previous residence to the current one?

c. Trend in transit mode choice among residents (increase, decrease, or stay the same) as a TOD area matures. What factors explain different responses?

The primary research question for **office employees working near California rail stations** is:

2. Do office locations in a TOD increase the probability of transit use for the commute trip, as compared to commute mode shares in the surrounding region?

As with residents, we are also interested in the following:

a. What is the influence of the following factors in predicting the probability of transit use among office workers in TODs?
   - Transportation service qualities of competing modes (transit service, traffic congestion) that influence travel time, convenience, and safety.
   - Costs of competing modes such as auto use costs, and transit costs.
   - Demographic characteristics—personal characteristics of the trip maker and household factors (income, occupation, children in household, etc.)
   - Policy features, e.g., employer commute policies, property management policies, parking supplies, etc.
   - Neighborhood attributes, e.g., physical characteristics of the TOD and the trip destination that influence travel time, convenience, and safety.
   - Regional characteristics regarding density, jobs/housing mix, housing demand.

b. Factors influencing employment location in a TOD. How did travel behavior differ from the previous workplace to the current one?

c. Trends in transit mode choice among office workers (increase, decrease or stay the same) as a TOD area matures. What factors explain different responses?

The increasing diversity in TOD development leads to our third main research question:

3. Do other land uses in a TOD (retail, hotel) contribute to transit ridership, compared to transit use among the more common TOD uses (residential, office) and in the surrounding area?

Site Selection

The first task in selecting sites for this study was to create a list of the study sites from the 1993 and 1995 reports. Including a large share of these sites was important for assessing changes in travel behavior and in policy responses to rail transit over time. To improve our representation of California transit lines and TODs, the list of potential sites was expanded to include strong examples of TOD along both new and existing rail lines throughout California. These sites were identified using a recent statewide report TODs and through conversations with local transportation planners and transit agencies.

The list of sites was then narrowed down using the following criteria:

a. Sites should be located in suburban areas that are being intentionally developed as TODs (in some cases, transit-oriented in-fill development were also included);

b. Sites should be located in station areas with service headways of 15 minutes or less (except in the case of commuter rail, where headways range from 20 to 50 minutes);

c. Sites should have at least 50 residential units or 100 employees;

d. All sites should be located within walking distance of the transit station (ideally this distance was no more than 1/4 to 1/3 of a mile, but could be up to 1/2 mile if the walking route to station was determined to be pedestrian-friendly).

Additionally, it was important that the selected sites maintain representation of (1) all types of rail transit (light, heavy and commuter); (2) all northern and southern California regions with rail service; and (3) all primary land uses (residential, office and retail/hotel). The final deciding factor in the selection of sites was the willingness of building owners or agents to participate in the survey. This was an important feature of the earlier studies, helping to gain access to information about the site and to increase survey response rates, and was maintained whenever possible in this study. An overview of the selected sites is provided in Chapter 4.

Data Collection

To collect individual travel and related data, a variety of survey methods were used: in-depth questionnaires were mailed to residents and delivered to employees at the selected residential and office sites; intercept surveys were conducted at three large rail-focused retail complexes; and brief surveys were distributed to both the employees and patrons of two hotels located along major rail lines. Site-specific data were also collected through a variety of means: property managers and/or agents provided information on parking supply and property management policies; site visits and Census data were used to assess pedestrian routes between sites and rail stations; and transit agencies provided data on rail and feeder transit service. Control data were compiled from Census data for the surrounding Census Tract(s).

An important methodological concern for this study was to enable direct comparisons to the research conducted just over a decade ago (Cervero, 1993; Menotti and Cervero, 1995). The data from these studies are referred to from this point on as “the 1992 data” since the majority of data were collected during this year. The 2003 study expanded on this earlier research in a number of ways—such as extending the study to new and expanded rail systems (particularly in southern California), including stronger examples of TOD, and increasing the focus on patrons of retail and hotel sites—but also maintains many consistencies with the survey instruments and methodological framework used in 1992. A number of the residential, office and retail sites selected for this study were also surveyed in the earlier studies.

Travel Behavior Surveys

Surveys were conducted, during May through August of 2003, with four distinct population groups found within walking distance of rail stations: residents of high-density housing developments; employees of office buildings and hotels; shoppers and other patrons at major retail complexes; and guests and employees of nearby hotels. For the residential and office developments, the sampling unit was the building. For most sites, surveys were sent to 100 percent of the building occupants or office employees (in some cases, the percentage fell just short of 100%, primarily attributed to the employer’s willingness to distribute surveys). To maintain consistency with the 1992 data, questions included in the resident, office employee and retail surveys were kept comparable to those developed for the earlier study; where necessary, however, modifications were made to account for current issues (such as rising gasoline prices) and changes in travel options (such as telecommuting). Questionnaires were also designed to reflect respondents’ local regions (in the Bay Area, for instance, all rail references referred specifically to BART; in Los Angeles, these references were altered to Metro Rail), and where necessary and feasible were conducted in both English and Spanish. To allow for geocoding, all self-administered surveys were printed with unique identifier codes. The following sections describe the instruments in more detail. Survey instruments are included in Appendix B.

Resident Surveys

Resident surveys were four pages, printed as a booklet, and collected information on the respondents’ household and personal characteristics, workplace, weekday travel choices and behaviors, commute-specific travel behavior and costs, employers’ work policies, residential location, and past residential location and commuting behaviors. To improve response rates, pre-paid/pre-addressed envelopes and letters of support from the property manager or owner (if provided) were included in each of the mailings, and survey respondents were entered in regional raffle drawings valued around $400. Follow-up surveys were sent to all non-respondents. The final response rate for residential surveys was 13 percent. (Unfortunately, resources did not allow the residential or office worker surveys to be conducted in non-English languages; this produces a bias toward English-speaking residents and employees and, as discussed under research limitations, may have negatively affected response rates).

The survey instrument asks for information on three main trips made by the survey respondent that day. Unlike the surveys conducted in the early 1990s, the 2003 survey did not ask about trips made by other household members. The research team wanted to enhance response rates from the mail questionnaire, and it was felt that restricting the trip information to the respondent would make it easier to respond to the survey. We do not expect any systematic bias to result from this difference; in fact, we expect that the accuracy of the trip responses will be greater because the respondent has to provide only his or her actual travel behavior. The survey cover letter did request that the survey "be filled out by the primary wage-earner in your household (OR the person who commutes to work on the most regular basis)" in order to capture the greatest amount of commute-related travel.

Office Employee Surveys

Office employee surveys were similar in length and content to the resident surveys, but focused solely on work-related trips. The survey instrument included questions about the employees' household and personal characteristics, their commute trip (including costs), trips made *during* the workday, and past workplace locations and commuting behaviors. Surveys were distributed, by employers, to all employees at each site. Pre-paid/pre-addressed envelopes were included with each survey, and employees were periodically reminded by their employer to complete and return the surveys no later than June 30, 2003. The final response rate for office employees was 20 percent.

Retail Patron Surveys

Surveys of retail patrons (including shoppers, employees and others) were conducted through an intercept method. Respondents were asked approximately 10 questions related to the purpose of their trip and their travel to and from the site; surveyors also estimated and recorded the respondents' age and race. To maintain consistency in the data collected across the retail centers, surveys were conducted on the same days (and times) at all three sites. Bilingual (English-Spanish) interviewers were employed at both southern California sites. Between the three sites, a total of 1,237 surveys were completed: 495 at the Hollywood/Highland Complex in Los Angeles (along the Red Line); 436 at El Cerrito Plaza in the Bay Area (along BART); and 306 at San Diego's Fashion Valley Complex (along the Trolley).

Hotel Guest and Employee Surveys

To gain new information about the travel behaviors of hotel patrons staying near rail transit stations, brief (1-page) surveys were used to collect information on hotel guests' activities and travel decisions during their stay at the hotel. With the cooperation of the hotel managers, the surveys were distributed to every hotel patron at check-in over a period of 10 days, and were returned at checkout (either to the front desk or in their "express" check-outs). Forty-four hotel guest surveys were returned.

Surveys were also distributed to hotel employees. An abbreviated (2-page) version of the office employee survey was used, in order to increase response rates while enabling comparison to the office employees. Questions were limited to employees' household and personal characteristics, their commute trip characteristics (including costs), and past commuting behaviors. The survey did not ask about mid-day trips. To accommodate the large share of Hispanic employees within the service-sector, particularly in southern California, hotel employee surveys were provided in both English and Spanish. Surveys were distributed and collected by the hotel employer; fifty-nine completed surveys were returned.

Site Data and Evaluations

To examine the influences on travel behavior among residents and office employees, a variety of data were collected for the surveyed sites and their surrounding station area. These data were compiled (to the best of our ability) from property managers, transit agencies, site visits and the 2000 U.S. Census, and include the following:

Residential Site Characteristics

- Parking supply (spaces per unit)
- Cost of parking per month (and payment structure)
- Number of housing units
- Average cost of rent/mortgage
- Dwelling units per acre
- Distance to nearest rail station[2]

Office Site Characteristics

- Parking supply (spaces per employee)
- Parking cost
- Number of employees
- Employees per acre
- Distance to nearest rail station[1]

Rail and Station Characteristics

- Parking supply and price
- Frequency and capacity of feeder transit service[3]
- Frequency and capacity of rail transit service[3]

Station Area Characteristics

- Land use mix[4]
- Quality of walking route between site and nearest rail station[5]
- Average block size
- Street connectivity (percent of 4- and 5-or-more-way intersections)

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[2] Measurement based on shortest walking route from entrance to project site (or central point of project if more appropriate) to the nearest ticket station at the nearest rail station.

[3] Measures were replicated from the Local Index of Transit Availability (LITA) manual developed for the Local Government Commission (see Appendix E); data used to calculate service measurements were collected from the serving transit agencies.

[4] Land-use, density, and street network characteristics were collected for the 1-mile radius around each trip origin and destination using 2000 Census and TIGER-Line data

[5] "Quality of walking route" evaluations were conducted during site visits and include measures of connectivity, safety, comfort and aesthetics (see Appendix D for evaluation worksheet).

- Residential and employment densities
- Travel times by vehicle (along highway network) versus transit
- Regional job accessibility via highways and transit (number of jobs that can be reached via highway/transit within 60 minutes during peak travel time)

Strengths and Limitations of Research Design

The primary strength of this research design is its ability to compare the 2003 travel surveys to those conducted in the 1990s. This type of long-term analysis is rare, and enables the study to address a number of currently unexplored questions about how responses to rail access change over time. The data also provide a strong base for even longer longitudinal studies in the future. The time frame for development responses to TOD policy initiatives is long, as is the process of land use and activity adjustment to rail accessibility. Therefore, we hope that studies of these same sites would be completed in 2013 and beyond.

A second strength lies in the organizational structure of this study. The participation of a technical advisory committee (TAC) helped to ensure that the data being collected are of use to planning and development practitioners and policy-makers. The TAC was also instrumental in identifying appropriate and interesting study sites.

A third strength is the comprehensive scope of the data collection. In providing broad statewide coverage for different land uses, it is possible for city and transit system planners to make comparisons between similar transportation technologies and land use contexts. In general, the study favored lower costs data collection techniques (mail questionnaire about three trips versus full travel diaries) to achieve that broader coverage. The study is intended to stimulate transit operators and cities to conduct more detailed follow up studies.

A fourth strength of the study is documentation of more detailed characteristics of the development, the pedestrian environment linking to the station, and other sites factors than is usually available. This information can help planners assess the role of those features in supporting transit use.

As with any study, however, there are always additional things that could have been accomplished with more time or resources. For instance, a number of tasks were removed from the initial scope of work in order to allow sufficient time and resources for the primary research goals. These eliminations were decided upon jointly by the researchers and the TAC, and included: (1) the use of matched-pair control sites, as opposed to relying on Census data for controls; (2) the collection of driveway trip generation counts, to substantiate the collected survey data; and (3) the interviewing of property owners, building managers and employers, to gain a deeper understanding of their responses to rail access.

The most notable weakness of the study, however, was low response rates, particularly among residential sites along the Los Angeles Metro Red Line. Since an identical approach was used in recruiting participants from each of the selected sites[6], this variation is most likely attributed to some characteristic of the sites themselves. Looking more closely at these sites, each appears more likely to be in an area of lower-income and/or minority populations compared to sites with higher response rates. Response rates are often low among both of these populations due to language barriers (even if the respondent speaks English, they may not be comfortable completing a four-page travel survey in their non-native language) and greater pressures on their time (especially if working multiple jobs, caring for children, etc). Response rates may thus be

[6] Refer back to Data Collection for description of survey methods.

increased in future studies by (1) providing all surveys (rather than just hotel and retail) in multiple languages, and (2) providing individual incentives for completed surveys. Both of these strategies were discussed in the early stages of the study, but eliminated due to lack of resources.

To account for low response rates at select sites, surveyed office and residential sites are grouped according to project setting. These settings are then used to present the descriptive analyses and to examine changes in travel characteristics over time. In some cases, the project settings represent an entire rail system; where enough sites exist, however, rail systems were divided into sub-areas in order to reflect differences in development type and/or location. Project settings do not combine sites from different rail systems. In addition, to determine the extent to which we can draw conclusions from the survey data, margins of error[7] were calculated for each project setting. Where margins of error are too large, survey findings for that project setting are not presented separately. Survey data from these sites are included only in the "all site" summaries, and in the modeling analyses, which are conducted at the individual level and thus treat each response equally. More information on the project settings and margins of error are provided in the site overview and findings chapters.

[7] Margins of error for each project setting are calculated at the 95 percent confidence level assuming the most conservative population proportion (0.5). This population proportion maximizes the assumed standard error. For the purposes of this study, it was determined that a 10% margin of error is acceptable. A 10% margin of error means that if the survey were to be repeated, survey responses would lie +/-10% of the initial survey responses 95 percent of the time, for each survey question. Or, we can be 95 percent confident that the actual values are +/- 10% of the reported values. Project settings with a margin of error less than 15% are included in the following descriptive analyses, but should be viewed with caution.

CHAPTER 4. OVERVIEW OF SURVEYED SITES

Surveys were conducted at a total of 26 residential sites, ranging in size from 52 to 854 occupied units, and 10 office sites, ranging in size from 150 to 800 employees. Of these, twenty-one total sites (15 residential, 6 office) were selected from rail station areas in the Bay Area and Sacramento, and fifteen sites (11 residential, 4 office) were selected from the Los Angeles and San Diego regions of Southern California. On account of the time and resource demands, a total of five retail and hotel sites were selected: three retail complexes, one each in the Bay Area, Los Angeles and San Diego; and two hotels, one in the Bay Area and one in San Diego. The selected sites were those of greatest interest to local planners and transit agencies. Nineteen of these sites were surveyed in the earlier studies. Sites and their associated rail systems, station areas and select characteristics are presented in Table 4-1; site locations are mapped (by region) in Figures 4-1 through 4-4. This chapter describes the evaluations conducted at each residential and office site and then presents the primary project settings and their associated sites in more detail.

Site Evaluations

While quantitative assessments of accessibility and route directness for the one- and three-mile rings around each site are incorporated into the modeling analyses for this report (see Chapter 3), a number of pedestrian factors—such as safety and aesthetics—can only be assessed through site evaluations. Recognizing the perceived importance of these factors in determining local travel behavior, data on the quality of the walking path from each site to its nearest rail station were collected through structured site visits (see Appendix D for evaluation worksheets). Although each of the selected sites is amenable to non-automobile travel (as a result of focusing on "best case" examples of rail-oriented development), there is still a notable range of pedestrian environments and transit opportunities across the sites.

Factors considered in the evaluations can be broken into three areas—pedestrian safety, utility, and comfort and aesthetics. A "safe" route is one with street lighting, short street crossings, , marked or signalized intersections, and a complete sidewalk network. A route is high in "utility" if it is in close proximity of the rail station, near shops and other amenities, and has short intersection wait times (or no intersections to cross). A comfortable and aesthetically-pleasing route has street trees and street furniture, narrow street widths, retail shops facing the walk path, and moderate to heavy landscaping. Also contributing to comfort levels is the presence of street medians (increasing comfort) and/or "blank walls" (reducing comfort). Summaries of the pedestrian evaluations for each site are presented in the site profiles (Appendix A). On average, residents and office workers walk 1,089 feet to the nearest station, cross 1.4 intersections, wait at these intersections for 29.4 seconds, and pass 1.7 retail shops, 6.7 street trees, 3.8 street lights and 1.1 pieces of street furniture on their way to the station. Additional factors taken into consideration include densities (which average 12.9 persons and 14.2 employees per acre around office sites and 12.5 persons and 8.0 employees per acre around residential sites) and the parking supply at the station (averaging 606 spaces per station with a range of 0 to 2557) and the sites (averaging 1.4 spaces per unit or employee).

Based on these evaluations, plus assessments of the regional and local transit service and the availability and placement of station area parking, each site was assigned a single "quality of walking route to station" rating of fair, good or excellent (see Table 4-1). The resulting data are also incorporated into the modeling analyses. Interestingly, the sites with the most pedestrian-friendly transit access (which tended to be those with direct, unimpeded routes to the nearest rail station) are not heavily clustered; they can be found in both residential and office sites, in each region, and across different rail types (light, heavy, commuter).

Table 4-1. Surveyed Sites, by Rail System and Station Area

Rail Station	Site	Type of Use	Distance to Station[1]	Quality of Walking Route to Station[2]	Peak Rail Headway	Parking Supplies		Surrounding Density[3]	
						On Site (Ratio)	At Station (Spaces)	Residents per acre	Jobs per acre
BART									
Berkeley Station:	Great Western Building*	Office	137 ft	Excellent	10-15 min	1.6/emp	0	23.65	20.64
El Cerrito Del Norte Station:	Del Norte Place*	Residential	955 ft	Fair	10-15 min	1.7/unit	2,060	12.23	3.55
El Cerrito Plaza Station:	El Cerrito Plaza*	Retail			10-15 min				
Fremont Station:	Mission Wells*	Residential	2,367 ft	Fair	10-15 min	1.3/unit	940	9.68	5.32
	Fremont Office Center*	Office	915 ft	Excellent	10-15 min	2.1/emp	2,026	13.57	8.04
Hayward Station:	Atherton Place Condos	Residential	534 ft	Good	10-15 min	2.0/unit	1,439	14.08	7.42
Pleasant Hill Station:	Coggins Square	Residential	1,014 ft	Fair	10-15 min	1.0/unit	2,557	9.13	5.19
	Embassy Suites	Hotel			10-15 min		2,557		
	Iron Horse Lofts	Residential	1,441 ft	Fair	10-15 min	1.9/unit	2,557	9.16	5.15
	Park Regency*	Residential	1,319 ft	Good	10-15 min	1.0/unit	2,557	9.26	5.07
	Wayside Plaza*	Residential	1,640 ft	Good	10-15 min	N/A	2,557	9.14	5.17
South Hayward Station:	Archstone Barrington Hill*	Residential	592 ft	Good	10-15 min	1.1/unit	1,220	10.91	2.61
Union City Station:	Verandas Apts*	Residential	930 ft	Good	10-15 min	1.0/unit	1,196	10.24	3.53
Walnut Creek Station:	California Plaza*	Office	1,318 ft	Fair	10-15 min	0.7/emp	1,989	8.13	10.73

* This site was surveyed in either 1992 or 1994

[1] Distance of most direct walking path from entrance of site building (or central point of development) to nearest ticket machine at nearest station; as a reference, 660 feet = 1/8 mile; 1,320 feet = 1/4 mile; and 2,640 feet = 1/2 mile

[2] Based on evaluation of pedestrian safety, utility, and comfort/aesthetics along walking path (see Appendix D for evaluation tool)

[3] Surrounding densities are calculated for the one-mile radius from the site (not the rail station); this explains why two sites within the same station area may have different "surrounding density" figures

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Table 4-1. Surveyed Sites, by Rail System and Station Area (continued)

Rail Station	Site	Type of Use	Distance to Station[1]	Quality of Walking Route to Station	Peak Rail Headway	Parking Supplies		Surrounding Density[2]	
						On Site (Ratio)	At Station (Spaces)	Residents per acre	Jobs per acre
San Jose VTA									
Baypointe Station:	SS8 Networks	Office	560 ft	Good	15 min	1.4/emp	0	3.70	10.16
Ohlone Chynoweth Station:	Ohlone Commons	Residential	804 ft	Excellent	15 min	2.1/units	1,172	10.53	4.64
Sacramento LRT									
8th and K Street Station:	Dept of Conservation*	Office	165 ft	Excellent	15 min	2.6/emp	0	9.04	37.62
Butterfield Station:	Windsor Ridge Apts*	Residential	1,325 ft	Fair	15 min	2.0/unit	387	5.97	4.83
Power Inn Station:	Woodlake Close Apts*	Residential	1,517 ft	Good	15 min	1.0/unit	0	5.56	8.18
Watt/Manlove Station:	California Center	Office	1,042 ft	Good	15 min	1.6/emp		8.22	3.50
L.A. Metro Blue Line									
Long Beach Transit Mall:	Pacific Court Apts*	Residential	620 ft	Good	10 min	1.2/unit	0	23.89	19.10
Pacific at 5th St. Station:	Bellamar Apts*	Residential	605 ft	Excellent	10 min	1.3/unit	0	23.45	18.90
L.A. Metro Red Line									
Hollywood/Highland Station:	Hollywood/Highland Plaza	Retail	0 feet		10 min		0		
	TV Guide Hollywood Centr	Office	710 ft	Good	10 min	1.7/emp	0	24.05	15.69
Hollywood/Vine Station:	Wilcox Apts	Residential	1,780 ft	Good	10 min	1.2/unit	0	29.14	21.16
Hollywood/Western Station:	Western Carlton Apts	Residential	450 ft	Excellent	10 min	1.0/unit	0	37.09	13.48
	5161 Lankershim	Office	1,730 ft	Fair	10 min	1.1/emp	0	20.63	6.03
North Hollywood Station:	Studio Village	Residential	2,800 ft	Fair	10 min	0.5/unit	1,100	19.58	6.16

* This site was surveyed in either 1992 or 1994

[1] Distance of most direct walking path from entrance of site building (or central point of development) to nearest ticket machine at nearest station; as a reference, 660 feet = 1/8 mile; 1,320 feet = 1/4 mile; and 2,640 feet = 1/2 mile

[2] Surrounding densities are calculated for the one-mile radius from the site (not the rail station); this explains why two sites within the same station area may have different "surrounding density" figures.

Table 4-1. Surveyed Sites, by Rail System and Station Area (continued)

Rail Station	Site	Type of Use	Distance to Station[2]	Quality of Walking Route to Station	Peak Rail Headway	Parking Supplies		Surrounding Density[2]	
						On Site (Ratio)	At Station (Spaces)	Residents per acre	Jobs per acre
San Diego Trolley									
Amaya Drive Station:	Villages of La Mesa*	Residential	840 ft	Fair	15 min	1.2/unit	239	7.61	3.92
Barrio Logan Station:	Mercado Apts*	Residential	930 ft	Fair	15 min	1.5/unit	0	12.47	8.63
Fashion Valley Station:	Fashion Valley Plaza	Retail			15 min				
Fenton Parkway Station:	Archstone Mission Valley	Residential	80 ft	Excellent	15 min	1.9/unit	0	4.10	5.51
Hazard Center Station:	Doubletree-Mission Valley	Hotel		N/A	15 min		1,000		
	Mission Valley Heights	Office	2,440 ft	Fair	15 min	1.1/emp	1,000	8.18	7.99
	Union Square Condos	Residential	150 ft	Excellent	15 min	2.5/unit	1,000	7.19	10.90
Caltrain Commuter Rail									
Broadway Station:	Northpark Apts*	Residential	1,194 ft	Fair	15 min	.96/unit	100	7.02	9.52
San Antonio Station:	Crossings	Residential	1,066 ft	Excellent	15 min	N/A	199	14.70	9.69
Palo Alto Station:	Palo Alto Condos*	Residential	1,791 ft	Good	15 min	1.0/unit	388	8.47	11.44
Metrolink Commuter Rail									
Anaheim Station:	Stadium Towers	Office	2,700 ft	Good	20-25 min	1.6/emp	400	2.91	16.75
Fullerton Station:	Wilshire Promenade	Residential	1,540 ft	Good	25 min	1.5/unit	250	11.13	7.99
Coaster Commuter Rail									
Carlsbad Poinsettia Station:	Poinsettia Station Apts	Residential	920 ft	Good	30-35 min	2.3/unit	305	3.45	1.87

* This site was surveyed in either 1992 or 1994

[1] Distance of most direct walking path from entrance of site building (or central point of development) to nearest ticket machine at nearest station; as a reference, 660 feet = 1/8 mile; 1320 feet = 1/4 mile; and 2640 feet = 1/2 mile

[2] Surrounding densities are calculated for the one-mile radius from the site (not the rail station); this explains why two sites within the same station area may have different "surrounding density" figures.

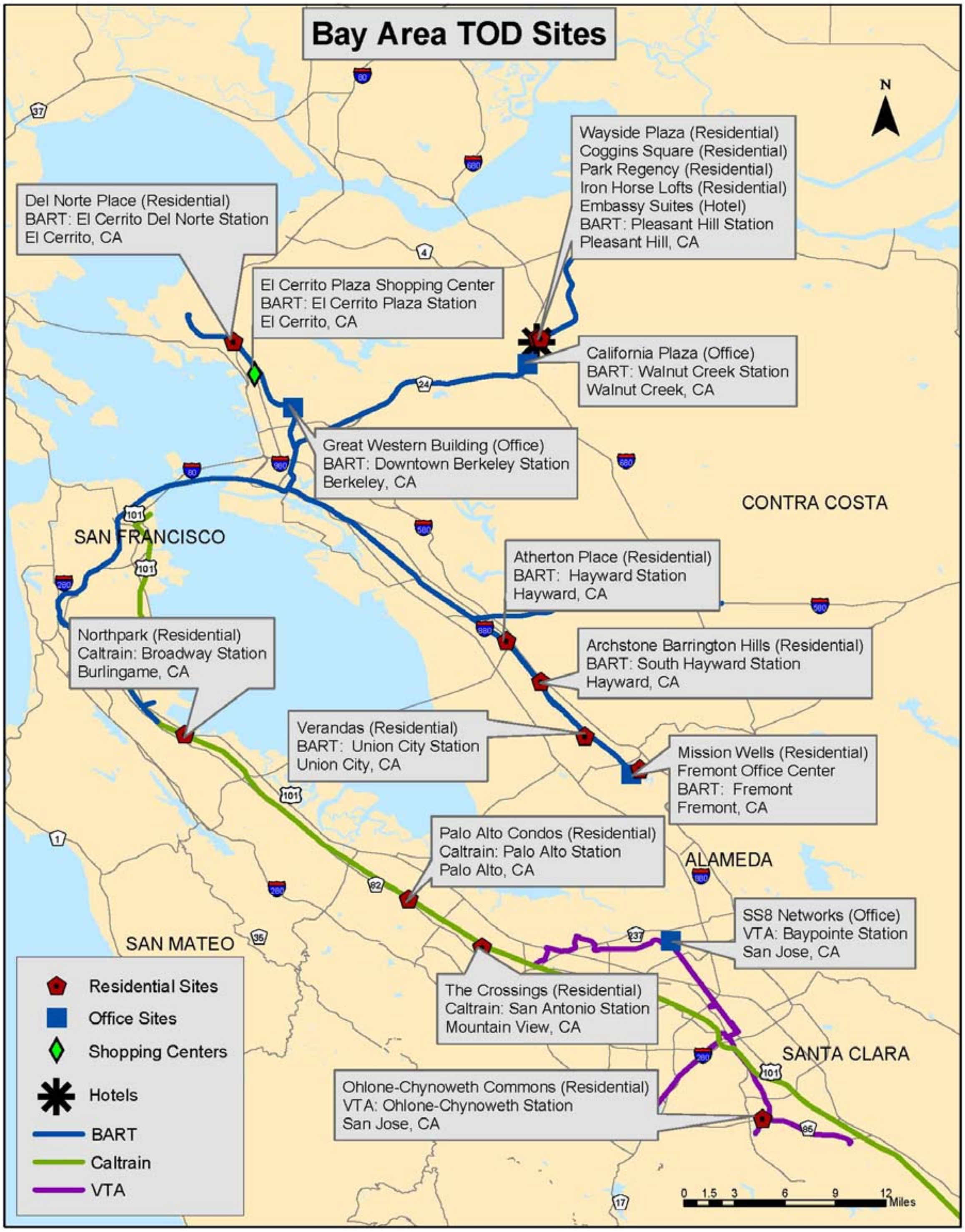

Figure 4-1. Surveyed Sites along Bay Area Rail Systems

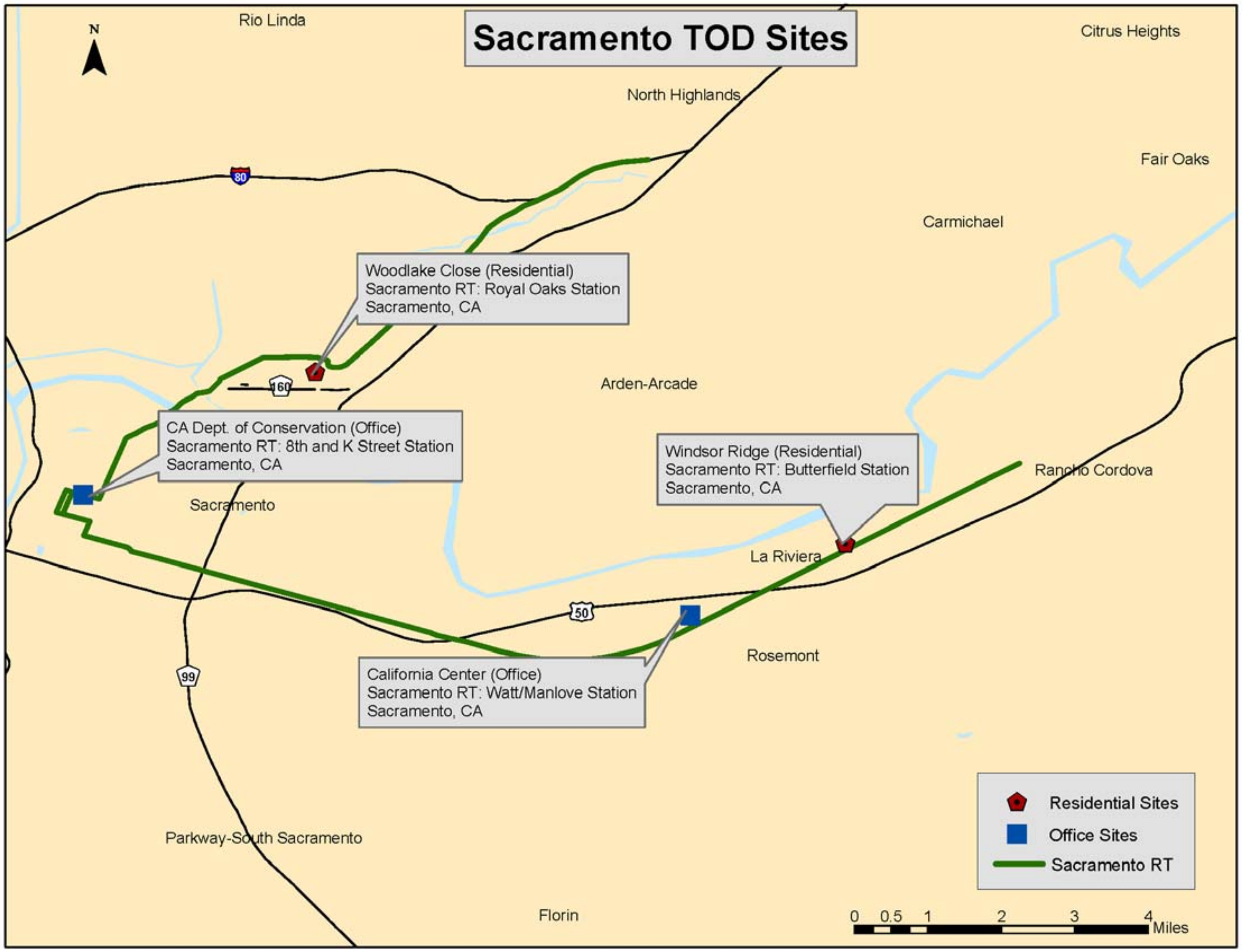

Figure 4-2. Surveyed Sites along Sacramento Light Rail Transit (LRT)

Figure 4-3. Surveyed Sites along Los Angeles Rail Systems

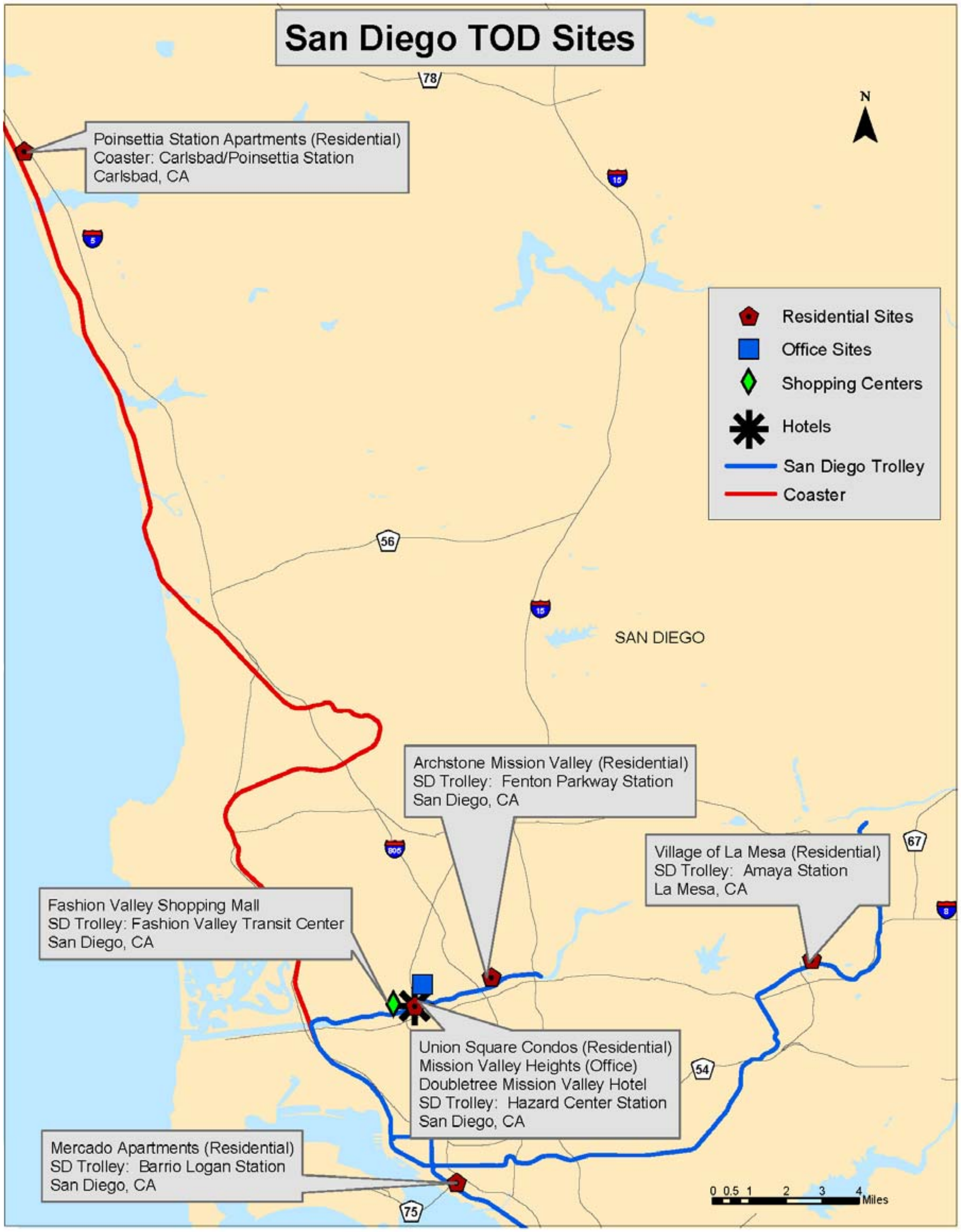

Figure 4-4. Surveyed Sites along San Diego Rail Systems

Surveyed Sites by Project Setting

As described in Chapter 3, survey findings are presented according to project setting. As sites were grouped into settings—to the extent possible—according to their common surroundings, it makes sense then to understand the nature of these surroundings. The following descriptions focus on the physical variations across project settings—e.g. walking route qualities, transit accessibility, parking supply. Demographics, workplace transportation programs, and other non-physical features are presented in the findings chapters.

Heavy Rail Systems

BART: Berkeley

The Berkeley project setting consists of the Berkeley station area on the BART system, and includes one surveyed site—the Great Western office building. The site is nearly adjacent to the station, with a pleasant walking environment. Rail commuters have no streets to cross on their way to the office building and are in close proximity to shops and other amenities (see Figure 4-5). The path is also well lit, with abundant street furniture. There are no parking spaces available at the station but the site provides 1.6 parking spaces per employee on average. Densities in the area are high: 20.6 employees per acre and 23.7 residents per acre. Overall, the site-to-station walking route at this project setting was rated "excellent." Transit service is also strong: peak rail headways range from 10 to 15 minutes, and the station is served by 8 "feeder" bus lines and one express line, for a total feeder capacity of 20,764 seats per day[1]. The total daily seat capacity for rail is 17,219.

Figure 4-5. Berkeley Station

BART: El Cerrito Del Norte

The El Cerrito Del Norte project setting consists of one site—Del Norte Place apartments—located near BART's El Cerrito Del Norte station. Overall, this site-to-station route was rated "fair." The site is less than one-quarter mile of the rail station, but the path and its two intersection crossings are oriented more toward the automobile than the pedestrian (see photos in Figure 4-6). The path has numerous streetlights—an important safety factor, but other amenities are scarce.

Other factors also contribute to an automobile-oriented environment. Parking supplies at the station and site are high: there are 2,060 public parking spaces at the rail station, and an average of 1.7 spaces per unit at Del Norte Place. The population density in the surrounding area is moderate (12.2 persons per acre), but employment density is quite low (3.6 employees per acre). Transit service at the station, however, is high: 12 feeder bus lines (regular and express service) provide a total capacity of 18,094 seats per day, and peak rail headways range from 10 to 15 minutes, with a total daily seat capacity of 17,219.

Figure 4-6. Walking Route, Del Norte Place to El Cerrito Del Norte Station

BART: Pleasant Hill

This project setting consists of four residential buildings and one retail site within Walnut Creek's Pleasant Hill station area[1]. The architects for two of the sites describe their projects as "transit-oriented high-density market rate suburban housing" (Iron Horse Lofts) and "affordable family apartments" (Coggins Square)[2]. Across the four residential sites—Wayside Plaza, Coggins Square, Iron Horse Lofts and Park Regency—walking path evaluations range from fair to good. Each site is located approximately one-quarter mile from the station (plus or minus 300 feet). All routes include at least one intersection, including one (crossed by three of the four paths) with an 86-foot crossing and no walk signal. Only one path is faced by a shop, and street furniture and trees are present but scarce. One path takes the pedestrian past a 42-foot long blank wall. Two of the paths, however, are moderately to heavily landscaped—an important aesthetic factor for pedestrians.

Figure 4-7. Walking Routes, Walnut Creek Pleasant Hill Station Area

For the sites where information was available, parking ratios range from 1 space per unit at Coggins Square and Park Regency to nearly 2 spaces per unit at Iron Horse Lofts. Densities in the surrounding one-mile rings are low: just over nine persons and five jobs per acre. The need to thus attract riders from a larger area may explain why this station has the highest number of public parking spaces—2,557 total—across the surveyed stations areas. The Pleasant Hill BART station is served by seven regular-service bus lines and three express bus lines, with a total feeder capacity of 11,417 seats per day. Total rail capacity is 11,792 seats per day.

BART: South Alameda County

This project setting consists of four residential projects—Atherton Place, Archstone Barrington Hills, Verandas and Mission Wells—and one office building—the Fremont Office Center—in a string of station areas along BART's South Alameda County line. The station areas include (from northwest to southeast) Hayward, South Hayward, Union City, and Fremont. Most walking routes were rated "good," while the Fremont routes rated at the two extremes—fair and excellent. The primary difference between the Fremont routes, however, was in terms of pedestrian utility—

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[1] The Pleasant Hill station area is located in unincorporated Contra Costa County, but is under the "sphere of influence" of the City of Walnut Creek. For this purposes of this study, Pleasant Hill is considered part of Walnut Creek given the policy orientation of the research.

[2] David Baker and Partners Architects (http://www.dbarchitect.com/)

Mission Wells residents walk about 2 ½ times further than Fremont Office Center employees and cross an 86-foot intersection (Fremont Office employees have no crossings). Across all routes, street lights and pedestrian amenities are generally scarce and only one is faced by any retail, but outside of Mission Wells, all sites are within one-quarter mile of a rail station, with minimal or no crossings.

Figure 4-8. Walking Routes, South Alameda County Station Areas

Residential densities around all sites are moderate, ranging from 9.7 to 14.1 persons per acre; employment densities are moderate near the Fremont and Hayward sites, but very low near South Hayward and Union City (2.6 and 3.5 employees per acre respectively). Rail capacity is consistent across all stations: 17,085 seats per day. Feeder bus capacities (for regular and express service) vary however—from 10,065 total seats per day serving the Union City station to over 15,300 seats per day at Fremont.

LA Metro Red Line: Hollywood

The Hollywood area of the Los Angeles Metro Red Line includes three residential sites, two office sites and the Hollywood/Highland Retail Plaza, spread across four rail stations—Hollywood/Highland, Hollywood/Vine, Hollywood/Western and North Hollywood. Walking distances, from sites to the nearest rail stations, range from zero feet (the Red Line stops directly underneath the Hollywood/Highland Plaza) to less than one-eighth of a mile to nearly one-half mile. Interestingly, the site that is furthest from a rail station (Studio Village) also has the lowest on-site parking ratio: half a space per unit. The remaining residential sites provide approximately one space per unit, and the office sites provide 1 and 1.7 spaces per employee. Only one of the stations—North Hollywood, at the northern-most extent of the rail line—provides any public parking.

Figure 4-9. Hollywood Station Areas

Rail transit runs every 10 minutes during peak periods, and bus service at the best-served station includes 10 feeder lines and a daily capacity of over 21,000 riders. Surrounding population densities are quite high, ranging from 19.6 to 37.1 persons per acre; employment densities are more varied, from 6 to 21 employees per acre. Walking routes are also varied. From Wilcox Apartments, for instance, one walks approximately one-third of a mile, crosses four intersections (with a maximum distance of 81 feet), and passes 100 feet of blank wall and no landscaping. Balancing out these unappealing factors, however, are high levels of retail activity—29 retail shops along the length of the route, moderate-to-heavy landscaping (including 30 street trees), and fully signalized and marked crossings. The 5161 Lankershim project is similar, but with fewer retail shops and street trees. T.V. Guide Hollywood Center, on the other hand, has no landscaping and few streetlights but is a much shorter route with only one street to cross. All sites, however, are in diverse urban areas and have greater access to shops and amenities compared to the suburban TODs. Feeder bus service to the Hollywood stations is high: 14,120 seats per day at Hollywood West; 21,160 at Hollywood Highland; 23,520 at Hollywood and Vine; and 15,400 at North Hollywood.

Light Rail Systems

LA Metro Blue Line: Long Beach

This project setting consists of two residential sites located in the revitalizing downtown area of Long Beach, along the Los Angeles Blue Line. As with the Hollywood TODs, these sites are located in diverse urban areas, although the number and range of shops and amenities is more limited. The sites are both within easy walking distance (one-eighth of a mile) of the station and received walking route ratings of good and excellent. There are no parking spaces available at the rail stations, and just over one space per unit at the residential sites. Surrounding population and employment densities are both high, with over 23 persons and roughly 19 employees per acre. Rail service runs every 10 minutes during peak periods, with a daily seat capacity of 15,960. The Transit Mall is served by 27 regular-service feeder bus lines, with a total daily seat capacity of 6,765, and one express line. The Blue Line provides direct access to downtown Los Angeles and the Red Line.

Figure 4-10. Long Beach Station Areas

San Diego Trolley: Mission Valley

The Mission Valley setting consists of two residential, one office, and one hotel site near the Hazard Center and Fenton Parkway stations of the San Diego Trolley. The Hazard Center provides 1,000 public parking spaces and has a peak period rail headway of 15 minutes. Fenton Parkway has the same rail headway but provides no public parking. Densities are consistent with the suburban setting. Both residential sites have high parking ratios (1.9 and 2.5 spaces per unit) and the Mission Valley Heights office building provides 1.1 spaces per employee on average. Two of the three evaluated walking routes (hotels were not evaluated) received an “excellent” rating due to their nearly adjacent proximity to the rail stations and the strong landscaping near the station. Mission Valley Heights in Hazard Center, however, is nearly one-half a mile from the station, had nearly three minutes of “wait time” at intersections, and draws pedestrians past 80 linear feet of blank wall, the parking lots of nearby shopping centers, and along two major arterials. The only positive feature of the route, aside from access to shopping centers, appeared to be its moderate landscaping. The San Diego Trolley provides a daily capacity of 9,216 seats.

San Diego: Barrio Logan/La Mesa

The Barrio Logan and La Mesa sites include two residential buildings: Villages of La Mesa near the Amaya Drive station in La Mesa, and Mercado Apartments near the Barrio Logan station in San Diego. Both are located along the San Diego Trolley line, which provides a peak period headway of 15 minutes. Both sites are about 1/6 of a mile from the rail station but the quality of the walking routes (from the site to the station) received only “fair” ratings. Based on other factors, however, Barrio Logan appears more favorable to pedestrian travel and transit ridership. The Barrio Logan station provides no public parking (compared to 239 spaces at Amaya Drive) and has surrounding densities of 12.5 persons per acre and 8.6 jobs per acre (compared to 7.6 residents and 3.9 jobs per acre around the Amaya Drive station). Both sites provide an average of more than one, but less than two, parking spaces per housing unit.

San Jose VTA

Two sites were surveyed along the San Jose VTA light rail line: one residential site near the Ohlone Chynoweth station and one office site near the Baypointe station. Both sites are around 1/8 of a mile from the rail station and both received good or excellent ratings. Station area parking supplies vary greatly however, with no spaces available at Baypointe and nearly 1,200 available at Ohlone Chynoweth. The residential building at Ohlone Chynoweth also has a high parking ratio, with more than 2 parking spaces per unit on average. The surrounding densities also vary, although not in a surprising way. The office site is in an area with moderate employment densities (and very low population densities) and the residential site is in an area with moderate population densities and very low employment densities. Daily feeder seat capacities are low: around 3,800 seats serving the Baypointe station and 1,200 seats serving Ohlone Chynoweth.

Figure 4-11. San Jose VTA Walking Routes ***(top: Ohlone Commons; bottom: SS8 Networks)***

Sacramento LRT

Two residential and two office sites, in four separate station areas, comprise the Sacramento Light Rail Transit setting. Walking distances to the stations range from 165 feet (at the Department of Conservation, located on a new “transit mall”) to just over one-quarter of a mile. Landscaping is moderate, but with the exception of the Department of Conservation, streetlights and other pedestrian amenities are limited, and pedestrians are typically crossing wide streets.

Aside from an extremely high employment density of 37.6 jobs per acre near the 8th and K Street Station, the densities are fairly low—from 5.6 to 9.0 persons per acre and from 3.5 to 8.2 jobs per acre. Parking at the surveyed sites varies. One residential site provides just one space per unit on average while the other provides two per unit; the office sites provide 1.6 and 2.6 spaces per employee. Interestingly, the site that is adjacent to the rail station (Department of Conservation) provides the greatest number of parking spaces to its employees of all surveyed office sites. Parking supply at the stations is limited, ranging from zero spaces to less than 400. Daily seat capacity on the Sacramento LRT is 8,576. The daily capacity of feeder routes to the rail stations range from fewer than 700 seats per day (to the Butterfield station) to nearly 17,500 in downtown Sacramento.

Figure 4-12. Sacramento LRT Stations and Walking Routes

Commuter Rail Systems

Caltrain

Three residential buildings were surveyed along the Bay Area's Caltrain commuter rail system: one each in the Broadway, San Antonio and Palo Alto station areas. Walking distances from each building to its nearest rail station are around one-quarter mile, and the quality of those routes ranges from fair (in Broadway) to excellent (in Crossings). Residential and employment densities in the surrounding 1-mile radii are moderate, ranging from about 7 to 15 persons per acre and about 9.5 to 11.5 jobs per acre. Residential densities are highest around the Crossings site, and employment densities highest around the Palo Alto site. Parking supplies at the sites and the rail stations are relatively low. Two of the three stations provide 200 or fewer spaces; the third, Palo Alto, provides less than 400. On-site parking ratios are generally one space or fewer per unit. The

Figure 4-13. Caltrain Commuter Rail Walking Routes

rail headway during peak hours is 15 minutes, with an average daily seat capacity of around 40,000 seats. Feeder service capacities to the three stations range from 6,730 seats per day (to the San Antonio station) to 21,684 (to Palo Alto).

Metrolink and Coaster

Three commuter rail sites were surveyed in southern California: two along the Metrolink commuter rail in the Los Angeles region (one office site in Anaheim and one residential site in Fullerton), and one residential site along San Diego's Coaster commuter rail (near the Carlsbad Poinsettia station). Residents of the Metrolink sites walk around 1/3 to 1/2 a mile to their rail station; residents of the Coaster site walk just 920 feet. All three walking routes were rated as "good" in terms of comfort, safety and utility. The Carlsbad site is located in an area with very low densities (3.5 persons and 1.9 jobs per acre). Densities around the Metrolink sites are generally higher, but still moderate: nearly 17 jobs per acre in the 1-mile radii around the Anaheim site (but only 3 persons per acre), 11 persons per acre around the Fullerton site. Compared to Caltrain, parking supplies at the rail stations are similar (250 to 400 spaces), but the ratio of parking spaces to housing units at the surveyed sites is noticeably higher, ranging from 1.5 to 2.3 spaces per unit. Rail headways during peak period travel range from 20 to 25 minutes along Metrolink to 30 to 35 minutes along the Coaster. Feeder service capacities to the studied Metrolink stations range from to 5,816 seats per day into the Anaheim station to 12,736 seats per day into Fullerton.

Figure 4-14. Metrolink's Fullerton Station Area

CHAPTER 5. FINDINGS RELATED TO STATION AREA RESIDENTS

Overview of Surveyed Station Area Residents

A total of 4,785 surveys were successfully delivered to station area residents; those living near BART received the most surveys (1,841), followed by the San Diego Trolley (974), Caltrain (901), and Los Angeles Metro (522). Housing near BART received the most surveys because there were more sites to study and more sites surveyed in the earlier studies. A total of 624 residential survey responses were received, for a 13 percent response rate overall. At the transit system level, response rates ranged from 8 percent for San Jose VTA to 16 percent for the San Diego Trolley. BART, with the largest share of surveys, had a response rate of 14 percent.

As described in Chapter 3, sites are grouped according to project setting in order to accommodate low response rates (particularly in the Hollywood area of Los Angeles, along the Metro Red Line). In some cases, the project settings represent an entire rail system; where enough sites exist, however, rail systems were divided into sub-areas in order to reflect differences in development type and/or location. Project settings do not combine sites from different rail systems. Table 5-1 provides a full inventory of sites studied, organized by project setting, and the response rates for each site and project setting. Where margins of error[1] for the project settings are too large to draw reliable inferences about the data, survey findings are not presented separately. Survey data from these sites are included only in the "all site" summaries, and in the modeling analyses presented later in the chapter. Project settings with sufficient sample sizes to be presented individually include two located on heavy rail (Pleasant Hill, South Alameda County), two on light rail (Long Beach, Mission Valley), and the Caltrain commuter rail system.

Table 5-1. Resident Survey Response Rates

Surveyed Site, by Rail System and Project Setting	Station	# Distributed (Undeliverable)	# Completed Surveys	% Completed Surveys[2]
HEAVY RAIL				
BART: Pleasant Hill				
Coggins Square	Pleasant Hill	87 (4)	12	14.5%
Iron Horse Lofts	Pleasant Hill	52 (2)	19	38.0%
Park Regency	Pleasant Hill	854 (72)	82	10.5%
Wayside Plaza	Pleasant Hill	59 (0)	12	20.3%
		1052 (78)	125	12.8%**
BART: South Alameda County				
Archstone Barrington Hills	South Hayward	190 (21)	17	10.1%
Atherton Place	Hayward	75 (0)	18	24.0%
Mission Wells	Fremont	391 (2)	42	10.8%
Verandas Apts	Union City	139 (22)	35	29.9%
		795 (45)	112	14.9%**

[1] Margins of error for each project setting are calculated at the 95 percent confidence level assuming the most conservative population proportion (0.5). This population proportion maximizes the assumed standard error. For the purposes of this study, it was determined that a 10% margin of error is acceptable. A 10% margin of error means that if the survey were to be repeated, survey responses would lie +/-10% of the initial survey responses 95 percent of the time, for each survey question. Or, we can be 95 percent confident that the actual values are +/- 10% of the reported values. Project settings with a margin of error less than 15% are included in the following descriptive analyses, but should be viewed with caution.

Table 5-1. Resident Survey Response Rates (continued)

Surveyed Site	Station	# Distributed (Undeliverable)	# Completed Surveys	% Completed Surveys[2]
BART: El Cerrito				
Del Norte Place	El Cerrito del Norte	129 (12)	18	15.4%
		129 (12)	18	15.4%‡
L.A. Metro (Red): Hollywood				
Studio Village	North Hollywood	170 (52)	11	9.3%
Western Carlton Apts	Hollywood/Western	59 (16)	2	4.7%
Wilcox Apts	Hollywood/Vine	101 (16)	3	3.5%
		330 (84)	16	6.5%‡
LIGHT RAIL				
L.A. Metro (Blue): Long Beach				
Pacific Court Apts	LB Transit Mall	141 (18)	18	14.6%
Bellamar Apts	Pacific at 5th St.	159 (6)	25	16.3%
		300 (24)	43	15.6%*
S.D. Trolley: Mission Valley				
Archstone Mission Valley	Fenton Parkway	734 (146)	107	18.2%
Union Square Condos	Hazard Center	110 (6)	23	22.1%
		844 (152)	130	18.8%**
S.D. Trolley: Barrio Logan/La Mesa				
Villages of La Mesa Apts	Amaya Drive	167 (26)	16	11.3%
Mercado Apts	Barrio Logan	143 (2)	14	9.9%
		310 (28)	30	10.6%‡
San Jose VTA: Ohlone Chynoweth				
Ohlone Commons	Ohlone-Chynoweth	182 (10)	18	10.5%
		182 (10)	18	10.5%‡
Sacramento LRT				
Windsor Ridge Apts	Butterfield	94 (4)	6	7.7%
Woodlake Close Apts	Power Inn	75 (10)	12	18.5%
		169 (14)	18	11.6%‡
COMMUTER RAIL				
Caltrain (Bay Area)				
Caltrain, Northpark Apts	Broadway	515 (66)	30	6.7%
Caltrain, Crossings	Mountain View	357 (6)	46	13.1%
Caltrain, Palo Alto Condos	Palo Alto	101 (0)	13	12.9%
		973 (72)	89	9.9%**
Other Commuter (Southern CA)				
Metrolink, Wilshire Promenade	Fullerton	129 (0)	10	7.8%
Coaster, Poinsettia Station Apts	Carlsbad Poinsettia	91 (0)	15	16.5%
		220	25	11.4%‡
GRAND TOTALS		**5,304 (519)**	**624**	**13.0%****

[2] Does not include undeliverable surveys
** Margin of error is less than 10% (at the 95% confidence level); findings can be generalized to the project setting
*Margin of error is between 10 and 15% (at the 95% confidence level); findings should be viewed with caution
‡ Margin of error exceeds 15% (at the 95% confidence level); findings *cannot be generalized* to the project setting

Personal and Household Attributes

The following figures and tables present the individual and household characteristics of survey respondents and their respective cities[2] for all sites combined, and for project settings with acceptable sample sizes. In most cases, with the exception of L.A. Metro (Long Beach) and Caltrain, the percentage of female respondents is greater than the percentage of females in the city population, with an overall difference of about 5 percent. Median age shows variation across the systems studied. Figure 5-1 shows the age distribution of adults in each project setting and overall. The age structure of station area residents is younger than the surrounding city. South Alameda County (BART) and Mission Valley (S.D. Trolley) residents have the youngest age profiles. The age differences are partly a reflection of the greater share of rental housing in station areas. It is interesting to note that these station areas do not appear to have captured a large share of older residents, even though TODs offer potential accessibility advantages for older residents who might have restrictions on driving or preferences to drive less.

[1] City percentages will not add up to 100 since populations under 18 are not included in chart

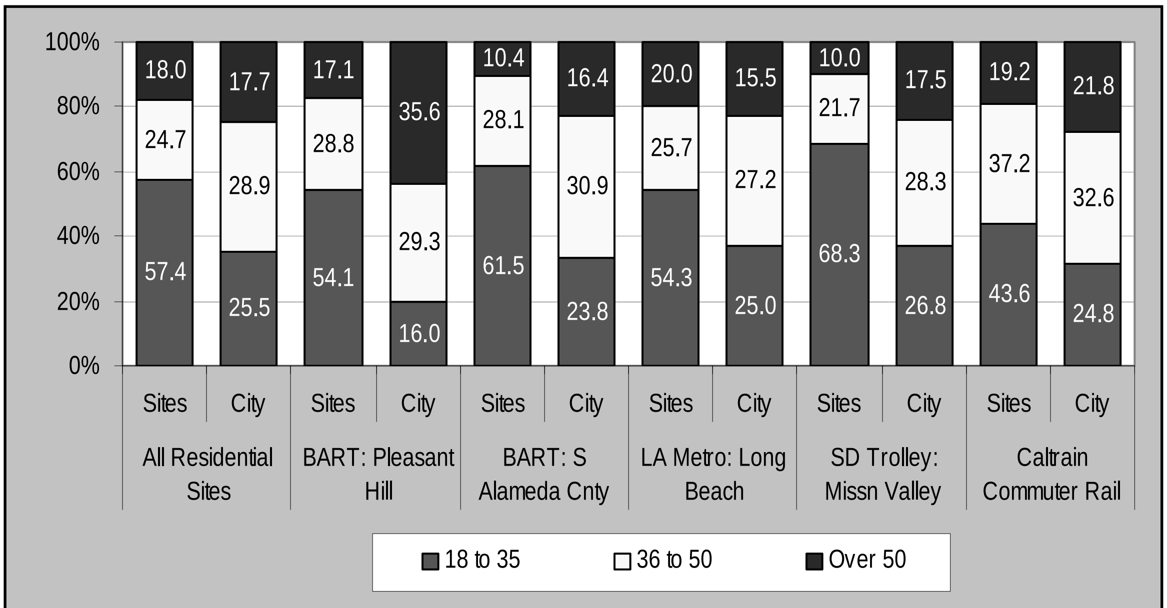

Figure 5-1. Age Distribution (Adults Only)[1], Surveyed Station Area Residents & Surrounding City

In terms of ethnicity, the compositions vary across project settings, but TOD respondents generally have higher representation of one or more racial or ethnic groups compared to the surrounding city. This is likely related to specific housing and neighborhood characteristics found within the TODs. In Long Beach and Mission Valley, for instance, there are higher shares of white residents compared to the surrounding cities; and Asian ethnicities are more frequent among the Bay Area TODs. Among all project settings, Hispanic ethnicities are less represented in TODs than in the surrounding populations. There also tend to be fewer African Americans among TOD residents than citywide averages, in every case except for BART's Pleasant Hill and South Alameda County TODs.

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[2] Collected from the 2000 U.S. Census. The cities used for city-project setting comparisons—throughout this report—are Walnut Creek (Pleasant Hill), Hayward/Union City/Fremont (South Alameda County), Long Beach (Long Beach), San Diego (Mission Valley), Burlingame/Palo Alto/Mountain View (Caltrain)

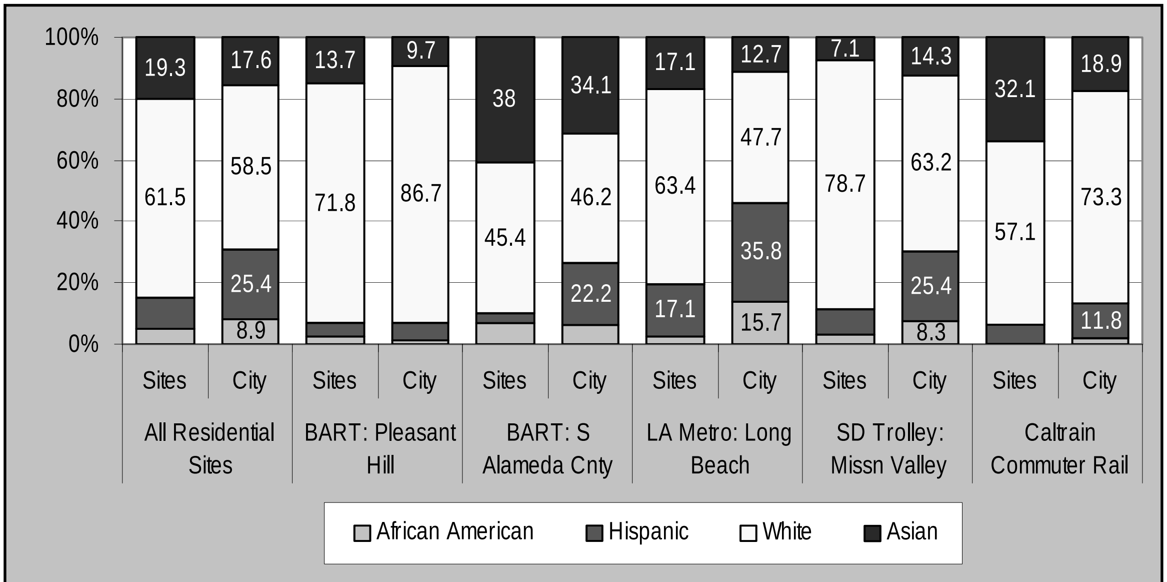

Figure 5-2. Race/Ethnic Composition, Surveyed Station Area Residents & Surrounding City[1]

[1] City percentages will exceed 100 percent since ethnicity and race were asked in separate Census questions

Occupational distributions are less varied; in every case, TOD residents are more likely to have office/professional occupations (Figure 5-3). This may relate to the particular housing characteristics and the fact that rail systems tend to serve office employment clusters better than industrial and service clusters. It might also be that these groups are more attracted to the amenities provided in TODs. Interestingly, survey respondents were more likely to be unemployed, particularly in the Caltrain and Pleasant Hill TODs. This may relate to the more affordable housing options available, making one-worker households more feasible. At least part of this difference, however, is likely attributed to the economic decline, and resulting unemployment, that occurred between 2000 (when city-level data were collected) and 2003.

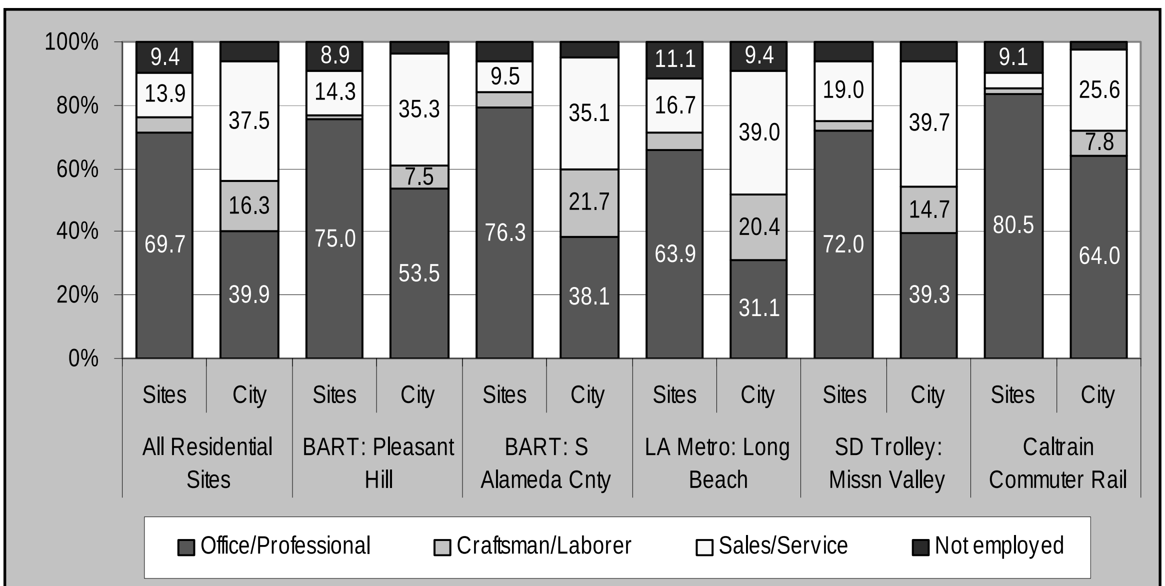

Figure 5-3. Distribution of Occupations, Surveyed Station Area Residents & Surrounding City

In terms of household structures, surveyed respondents tend to live in smaller households than citywide averages (see Figure 5-4). With the exception of Caltrain respondents, the TOD areas have a much greater share of 1-2 person households than the surrounding city. This is to be expected, as TOD housing is more likely to consist of smaller, multi-family units, especially in the case of light and heavy rail systems. In Pleasant Hill and Long Beach, the share of surveyed 1-2 person households exceeds 90 percent. Among the surveyed TOD sites, Caltrain had the highest share of three or more person households, indicating the presence of families with children. The measure of automobile availability (number of vehicles per driver) is similar across the systems surveyed, with most households having one vehicle per driver. Overall, more than one quarter of surveyed households indicate that less than one car per driver is available, indicating some pressure for transit use; this share is highest (31%) among South Alameda County TODs.

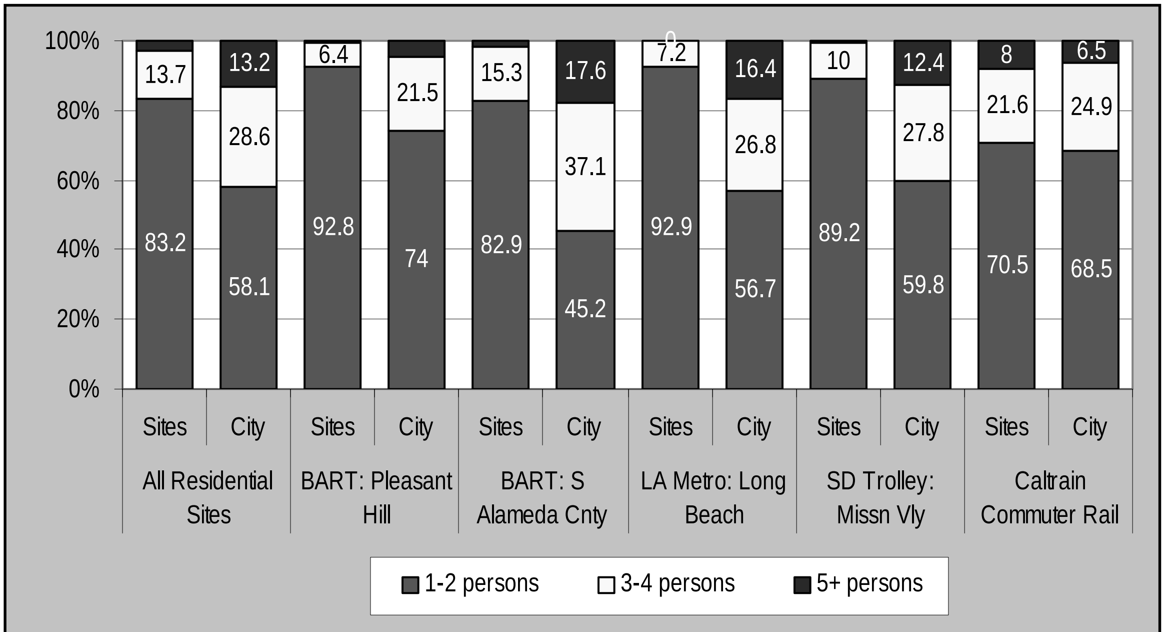

Figure 5-4. Household Size Distribution, Surveyed Station Area Residents & Surrounding City

Figure 5-5 shows that TOD sites serve a varied set of income groups. In most cases, station area residents are less likely to have household incomes of $30,000 or less compared to the surrounding city; the exception to this is Pleasant Hill (BART), where one of the surveyed sites (Coggins Square) was built as an affordable housing complex. At the higher end of the income range, households in most station areas are less likely to have incomes of $60,000 or more; the exceptions to this are Caltrain and—to a slight degree—Long Beach. This variation in income distributions suggests that while some sites may be providing more affordable housing relative to the rest of the region, particularly in regions with high housing costs, the newer residential units and amenities found in TODs are also attracting residents who have many other residential location choices.

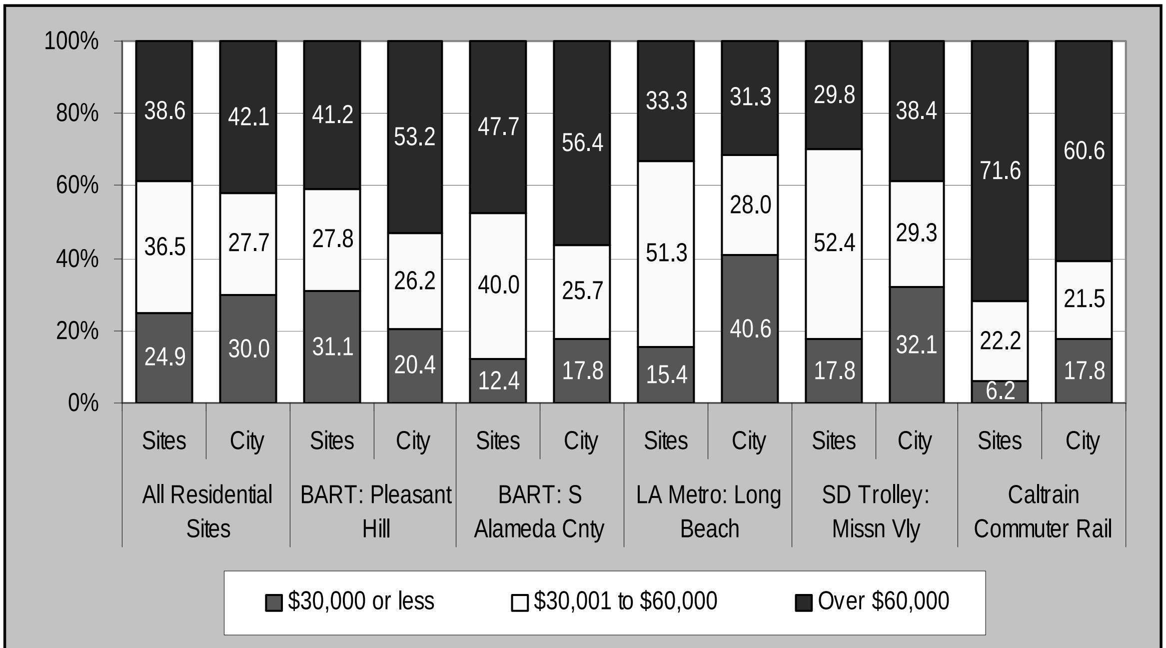

Figure 5-5. Income Distribution, Surveyed Station Area Residents & Surrounding City

An examination of residential location factors (Table 5-3) shows that TOD respondents are newer to their current location than the city populations. This is to be expected because most of the surveyed sites are recently developed, and contain rental rather than ownership units. Between 1 and 8 percent of station area residents lived in their current locations before 1995, as opposed to approximately 40-50 percent in the surrounding cities. When asked to identify the top three factors that influenced why they moved to their current address, transit access was the most common response only for BART respondents (approximately 65 percent in both Pleasant Hill and South Alameda County).

Although transportation access and transit use are very prominent expectations in the development of TODs, most surveys reveal that transportation accessibility is one of many factors influencing residential location, and usually not at the top of the list. Therefore, it was not surprising to learn that cost of housing and housing quality were the primary reasons in the other (non-BART) regions, suggesting that TODs may be attractive to many Californians on account of the new housing options that they provide. Among Caltrain respondents, for instance, over one-half noted cost of housing as a primary reason for moving to the location, likely related to the high cost of housing in that subregion. This issue is explored further in the following section.

Table 5-2. Individual Characteristics of Surveyed Station Area Residents and Surrounding Cities

	All Residential Sites		BART: Pleasant Hill		BART: S Alameda Cnty		LA Metro: Long Beach		SD Trolley: Missn Valley		Caltrain Commuter Rail	
	Surveys[1]	*City*[1]	*Surveys*	*City*	*Surveys*	*City*	*Surveys*	*City*	*Surveys*	*City*	*Surveys*	*City*
Female (%)	55.9	50.1	56.8	53.8	52.7	50.0	46.3	50.9	58.9	49.6	46.0	50.1
Over 50 yrs (%)[2]	18.0	17.7	17.1	35.6	10.4	16.4	20.0	15.5	10.0	17.5	19.2	21.8
36 to 50 (%)	24.7	28.9	28.8	29.3	28.1	30.9	25.7	27.2	21.7	28.3	37.2	32.6
18 to 35 (%)	57.4	25.5	54.1	16.0	61.5	23.8	54.3	25.0	68.3	26.8	43.6	24.8
Under 18	--	28.0	--	19.0	--	29.0	--	32.3	--	27.4	--	20.8
Median Age	33	36	32	45	32	33	34	31	29	33	39	38
Race (%)[3]*:*												
African American	4.8	8.9	2.4	1.1	6.5	6.8	2.4	15.7	3.1	8.3	0.0	2.2
White	61.5	58.5	71.8	86.7	45.4	46.2	63.4	47.7	78.7	63.2	57.1	73.3
Asian	19.3	17.6	13.7	9.7	38.0	34.1	17.1	12.7	7.1	14.3	32.1	18.9
Other	5.1	15.0	8.1	2.5	7.3	12.8	0.0	23.9	3.2	14.2	4.8	5.7
Hispanic origin (%)	9.3	25.4	4.0	6.0	2.8	22.2	17.1	35.8	7.9	25.4	6.0	11.8
Occupation (%):												
Office/Professional	69.7	39.9	75.0	53.5	76.3	38.1	63.9	31.1	72.0	39.3	80.5	64.0
Craftsman/Laborer	4.5	16.3	0.9	7.5	4.8	21.7	5.6	20.4	3.0	14.7	1.3	7.8
Sales/Service	13.9	37.5	14.3	35.3	9.5	35.1	16.7	39.0	19.0	39.7	5.2	25.6
Not employed	9.4	6.1	8.9	3.6	5.7	4.9	11.1	9.4	6.0	6.1	9.1	2.4
Other	2.4	0.2	0.9	0.1	3.8	0.1	2.8	0.1	0.0	0.2	3.9	0.1
Workplace[4] *(%):*												
Away from home	94.7%	96.4	93.0	94.3	97.1	97.7	92.1	97.1	94.9	96.0	89.6	96.2
Work at Home	5.3	3.6	7.0	5.7	2.9	2.3	7.9	2.9	5.1	4.0	10.4	3.8

[1] "Surveys" = Survey data collected from station area residents; "City" = 2000 Census data for city or cities in which the project setting is located

[2] Survey-City age comparisons are not exact; Census age categories are "under 20," "20 to 34," "35 to 54," and "55 and over"

[3] "American Indian" and "Pacific Islander" categories were also included on the survey, but are combined here with "Other" due to low responses; Survey data does not add up to 100% because "race" and "Hispanic origin" were not asked as separate questions

[4] Employed populations only

Table 5-3. Household Characteristics of Surveyed Station Area Residents and Surrounding Cities

	All Residential Sites		BART: Pleasant Hill		BART: S Alameda Cnty		LA Metro: Long Beach		SD Trolley: Missn Vly		Caltrain Commuter Rail	
	Surveys	*City*	*Surveys*	*City*	*Surveys*	*City*	*Surveys*	*City*	*Surveys*	*City*	*Surveys*	*City*
No. of people in HH (%)												
1-2 persons	83.2	58.1	92.8	74.0	82.9	45.2	92.9	56.7	89.2	59.8	70.5	68.5
3-4 persons	13.7	28.6	6.4	21.5	15.3	37.1	7.2	26.8	10.0	27.8	21.6	24.9
5+ persons	3.0	13.2	0.8	4.5	1.8	17.6	0.0	16.4	0.8	12.4	8.0	6.5
Ratio of drivers to vehicles (%):												
<1 vehicle/driver	26.4		24.0		30.6		16.7		21.5		21.6	
1 vehicle/driver	62.8		64.0		56.8		76.2		68.5		64.8	
>1 vehicle/driver	10.8		12.0		12.6		7.1		10.0		13.6	
Approximate Income[1] (%):												
$15,000 or less	9.8	13.5	8.4	7.5	7.6	7.5	5.1	20.1	10.5	14.0	0.0	8.0
$15,001 - $30,000	15.1	16.5	22.7	12.9	4.8	10.3	10.3	20.5	7.3	18.1	6.2	9.8
$30,001 - $45,000	16.9	15.2	11.8	13.9	19.0	12.4	23.1	16.4	21.8	16.4	9.9	11.0
$45,001 - $60,000	19.6	12.5	16.0	12.3	21.0	13.3	28.2	11.6	30.6	12.9	12.3	10.5
$60,001 - $100,000	25.0	23.4	26.9	26.2	37.2	30.1	28.2	19.3	21.8	22.8	33.3	23.8
$100,001 - $150,000	10.7	11.1	10.1	14.1	9.5	16.7	5.1	7.6	5.6	9.6	28.4	17.5
$150,000 and over	2.9	7.6	4.2	12.9	1.0	9.6	0.0	4.4	2.4	6.0	9.9	19.3
Residential Location												
Moved in prior to 1995	5.1	42.4	6.5	51.8	3.7	47.7	7.1	39.0	1.5	40.7	8.0	46.5
Primary reason for moving to site (survey respondents only)[3]	Housing quality (reported by 60%)[4]		Transit access (reported by 64%)		Transit access (reported by 67%)		Housing quality (reported by 60%)[5]		Housing quality (reported by 78%)		Cost of housing (reported by 55%)[6]	

[1] Approximate household income after taxes (as reported by respondent)
[2] "Surveys" = Survey data collected from station area residents; "City" = 2000 Census data for city or cities in which the project setting is located
[3] Respondents were asked to mark their *top 3 reasons for moving to current location*; the most commonly reported reason is reported here
[4] Followed closely by "cost of housing" (53%)
[5] Followed closely by "access to shops and services" (57%)
[6] Followed closely by "quality of neighborhood (52%)

Motivations for Moving to Station Area

Table 5-4 provides more information about respondents' reasons for moving into a TOD. The table reports the responses to a question that asked for the "top three" reasons for moving to the current residence, and displays the data according to the length of residency. The "Overall Shift" column indicates the change in the percentage of reasons given between the "before 1995" respondents and those who moved to the station area between 2000 and 2003. Supporting other research on residential location, the responses show that transportation accessibility is one of many factors that affect location decisions. If the responses are grouped into categories of housing attributes, neighborhood attributes and transportation access (rail and highway), transportation access ranks third. This is not to say that transportation access is not important, but is rather balanced with other factors, such as providing potentially attractive living environments. Schools are often a much more important reason for residential location decisions than is indicated by respondents. This difference may relate to the fewer number of children living in the surveyed housing units.

Examining the location decisions by length of residency (Table 5-4) reveals more interesting patterns. The newer a resident is to the surveyed TODs, the *less* likely they are to report transit access (or other neighborhood characteristics) as a "top 3" reason for moving to their current address, and the *more* likely they are to report housing cost or quality. This again supports the notion that TODs are providing improved housing options and that this benefit may currently be more attractive to potential residents than the transit access. Although this might seem to undermine the achievement of the transit goals of TOD, it suggests that another goal—providing attractive housing options—is being met.

Residential choice must also be viewed in context of the continuing housing affordability problems in most California communities. The fact that cost of housing is cited as a primary reason for moving to the TOD means that in many instances, the greater density possible in TODs is permitting efficient use of land and reasonable rental costs. These factors bode well for the market potential of affordable TODs. Finally, it is also important to note that newer TOD residents are more likely to report highway access as a primary reason for moving to their current address. This may reflect that fact that TOD locations provide good transportation access for all modes, as they are often also close to freeway and major arterial streets.

Table 5-4. Most Commonly Reported Reasons for Moving to Survey Site, by Length of Residency

Reported as one of "3 top reasons" for moving:	Residents who Moved into Station Area: *before 1995*	*from 1995 to 1997*	*from 1998 to 2000*	*from 2000 to 2003*	*Overall Shift in Distribution*
Cost of Housing	14.3%	19.4%	19.6%	17.2%	+2.9%
Type or Quality of Housing	18.7%	15.6%	19.9%	20.8%	+2.1%
Quality of Local Schools	2.2%	5.0%	4.7%	1.3%	-0.9%
Quality of Neighborhood	17.6%	11.9%	16.4%	14.8%	-2.8%
Access to Shops, Services	14.3%	13.1%	10.5%	12.5%	-1.8%
Access to Transit	20.9%	18.8%	15.8%	14.3%	-6.6%
Access to highway	6.6%	9.4%	7.9%	10.4%	+3.8%
Recreational opportunities	2.2%	3.1%	1.5%	3.5%	+1.3%
Other	1.1%	1.9%	0.3%	1.4%	+0.3%
N (Number of responses)	91	160	342	1236	

Out-of-Pocket Commute Costs

Table 5-5 provides the self-reported daily out-of-pocket commute costs for all modes. The average reported cost for the round trip is $5.04 per person. The average reported expenditure on public transit is $5.65. For those who incur toll and parking costs, the automobile cost is much greater than the transit cost. Surveyed BART commuters report the highest costs in most categories, with parking costs being especially high. Pleasant Hill respondents, for instance, report parking costs more than three times the study average. These higher parking costs are a major factor in mode choice decisions, and likely explain part of the higher rail mode shares found on the BART system. Since respondents were asked to report their parking costs, not parking price, the difference may relate to two factors: higher market prices for parking and/or lower levels of employer subsidization of parking. In addition, respondents who receive full parking subsidies would report no parking costs—responses of zero are not included in the calculation of the average.

Users of commuter rail report the next highest transit costs; this is likely related to the longer commute trips associated with commuter rail. The lack of public transit costs among Long Beach TOD respondents are not a reflection of the L.A. Metro transit fares but rather the very low level of transit ridership among these respondents.

Table 5-5. Daily Out-of-Pocket Commute Costs[1] (To and From Work) for Station Area Residents

Mean $ spent on:	All Residential Sites	BART: Pleasant Hill	BART: S. Alameda Cnty	LA Metro: Long Beach	SD Trolley: Mission Valley	Caltrain Commuter
Public Transit	5.65	6.26	6.56	--	2.92	4.25
Tolls	2.00	2.00	2.00	--	--	2.00
Parking	3.14	10.00	4.00	--	2.56	2.00
Fuel	3.86	4.97	3.81	4.32	4.12	2.73
Other[2]	3.17	1.50	4.33	2.67	1.17	0.50
TOTAL MEAN $	5.04	6.12	5.57	4.73	4.20	3.76
N (No. respondents)	372	78	86	22	81	50

[1] "Based solely on respondents who reported commute costs; Blank responses and zero values were not included in calculations
[2] "Other" responses include: vanpool/carpool costs and insurance, maintenance and "wear and tear" on car

Transportation Options Available at Place of Work

Table 5-6 summarizes transportation policies at residents' workplaces, according to programs that are either transit supportive or automobile supportive. These workplace transportation policies shape commute mode choice. For example, parking subsidies encourage drive-alone commuting, while providing a car for use during the day enables transit use and carpooling for some workers. The model results presented later in this chapter subject these propositions to empirical tests. Among the transit supportive policies, flexible work hours are common. Such programs have two possible effects, allowing carpool formation across employers, but also enabling drive-alone commuters to avoid peak hour congestion. Smaller numbers of respondents report work at home options, transit subsidies, and provisions for car use during the day.

Among the automobile supportive policies, 65 percent of respondents report that their employers provide free parking. This is a disincentive to transit use, since frequently those who do not drive and park cannot receive the cash value of the parking subsidy. Transit does not compete on a level playing field in those instances. Free parking at the workplace is most prevalent among TOD residents in Long Beach (97%) and Caltrain (75%) and least common among BART respondents.

Table 5-6. Transportation Options Available at Residents' Place of Work

	My employer (%):[1]	All Residential Sites	BART: Pleasant Hill	BART: S. Alameda Cnty	LA Metro: Long Beach	SD Trolley: Mission Valley	Caltrain Commuter
Transit-supportive	Allows flexible hours	53.7	60.6	51.2	34.5	53.2	60.8
	Lets me work at home	17.2	19.7	18.3	6.9	15.6	23.5
	Provides a car for use during day	3.9	4.5	1.2	3.4	7.8	2.0
	Helps pay for transit	16.1	19.7	17.1	13.8	13.0	19.6
Auto-supportive	Provides free parking	64.5	51.5	54.9	96.6	68.8	74.5
	Helps pay tolls, fuel, & other commute costs	7.5	10.6	6.1	10.3	11.7	2.0
N (No. of respondents)		361	66	82	29	77	51

[1] Values will not add up to 100%; Percent calculations are based on # of respondents, not # of responses (each respondent was asked to report all transportation options available at their place of work)

Travel Characteristics by Station Area Residents

Commute Trip Characteristics

The tables that follow summarize the commute characteristics of station area residents. As mentioned previously, the survey instrument asked respondents to report the three main trips they made on a pre-assigned weekday. Eight-four percent of residents work outside their home, either on a full- or part-time basis. This section addresses only the *reported commute trips* for this segment of the surveyed population. For those who commute to work, respondents were asked additional questions about their general use of transit (bus and rail) for commuting.

General Transit Usage for Commuting

Among the surveyed residents who commute by transit (n=162), over three-quarters typically use rail transit. Over fifteen percent use rail and bus equally. On average, over one-quarter of respondents report commuting by transit every day, and nearly 10 percent commute by transit between once a month and 2-3 times per week (see Table 5-7). Approximately one-half never use transit for their commute trip. This distribution varies widely across the project settings, however, with BART showing the highest level of daily transit use for commute travel (49 percent in the Pleasant Hill TODs and 38 percent in South Alameda County), followed by Caltrain commuter rail (21%).

Surveyed TOD residents in Long Beach (L.A. Metro) and Mission Valley (San Diego Trolley) are least likely to commute by transit on a daily basis, and most likely to *never* commute by transit. This may not be surprising given that most residents in these southern California TOD sites were more likely to report the housing—and not the opportunity for transit access—as their primary reason for moving near the rail station.

Finally, over 10 percent of the entire surveyed population commutes by transit "rarely," most likely as a backup to their conventional commute mode. Even though this level of use, along with those who commute by transit on a monthly or weekly basis, may not contribute significantly to a reduction in regional automobile *use*, it does underscore the role of TODs in reducing automobile *dependency*.

Table 5-7. Frequency of Transit Ridership for Commuting by Station Area Residents

I use transit for commuting:	All Residential Sites	BART: Pleasant Hill	BART: S. Alameda Cnty	LA Metro: Long Beach	SD Trolley: Mission Valley	Caltrain Commuter
Every day	29.3	48.9	37.5	6.3	12.4	21.4
2-3 times per week	3.5	5.6	2.1	0.0	3.4	7.1
Once a week	3.3	3.3	3.1	0.0	4.5	3.6
Once a month	2.1	4.4	2.1	0.0	2.2	1.8
Rarely	10.3	8.9	10.4	15.6	4.5	19.6
Never	51.4	28.9	44.8	78.1	73.0	46.4
N (No. of respondents)	426	90	96	43	89	56

Commute Trip Mode Shares

Commute mode shares for the assigned day of travel (Table 5-8) show that over one-quarter of commute trips by surveyed TOD residents are made by transit, with rail capturing the large majority (24.3%) of those trips. Bicycle and walk modes represent just 2 percent of commute trips, suggesting that TODs are not yet facilitating live-work conditions. Among the reported project settings, BART has the highest rail transit shares, followed by Caltrain and Mission Valley. The Long Beach respondents reported no rail use for commute trips, but the highest—although still modest—levels of bus use (3.3%) and walking (3.3%). Note that Long Beach is the only project setting (with a large enough sample size to be presented here) that includes in-fill projects within a downtown area. Although the Long Beach downtown area is not as fully developed as larger downtowns such as San Francisco or San Diego, it does provide a wider range of amenities within walking distance compared to the suburban project settings.

Table 5-8. Mode Shares for Commute Trips by Station Area Residents

Percent of trips made by the following modes:	All Residential Sites	BART: Pleasant Hill	BART: S. Alameda Cnty	LA Metro: Long Beach	SD Trolley: Mission Valley	Caltrain Commuter
Drove Vehicle, Alone	66.4	48.9	56.5	88.3	81.1	76.9
Drove Vehicle, Carpool	4.3	3.4	4.0	5.0	2.7	5.0
Rode in Vehicle	1.0	0.6	1.1	0.0	1.1	0.0
Rail Transit	24.3	44.3	36.7	0.0	10.8	15.7
Bus	2.2	0.6	1.1	3.3	2.2	1.7
Bicycle	0.6	0.0	0.6	0.0	1.1	0.0
Walk	1.3	2.3	0.0	3.3	1.1	0.8
Taxi	0.0	0.0	0.0	0.0	0.0	0.0
N (Number of trips)	877	176	177	60	185	121

Comparing to their respective cities (based on data from the 2000 Census), the surveyed TOD residents are *more likely* to commute by transit (Figure 5-6) and *less likely* to commute by vehicle (Figure 5-7). The one exception is again Long Beach, where survey respondents report only a moderate level of bus ridership and no rail use. This may suggest that commuters in the surrounding city of Long Beach, where transit usage is nearly 7 percent, are more likely to rely on local bus routes, which are dispersed throughout the city and more likely to be accessible to TOD and non-TOD residents alike.

Overall, however, surveyed TOD residents are nearly five times more likely to commute by transit compared to residents in the surrounding city—similar to the 1993 finding. Across the project settings, the transit commute share among TOD residents is more than 3 times higher than the city average for Pleasant Hill (BART) and Mission Valley (S.D. Trolley), nearly 4 times higher for Caltrain, and more than 6 times higher for South Alameda County's TODs.

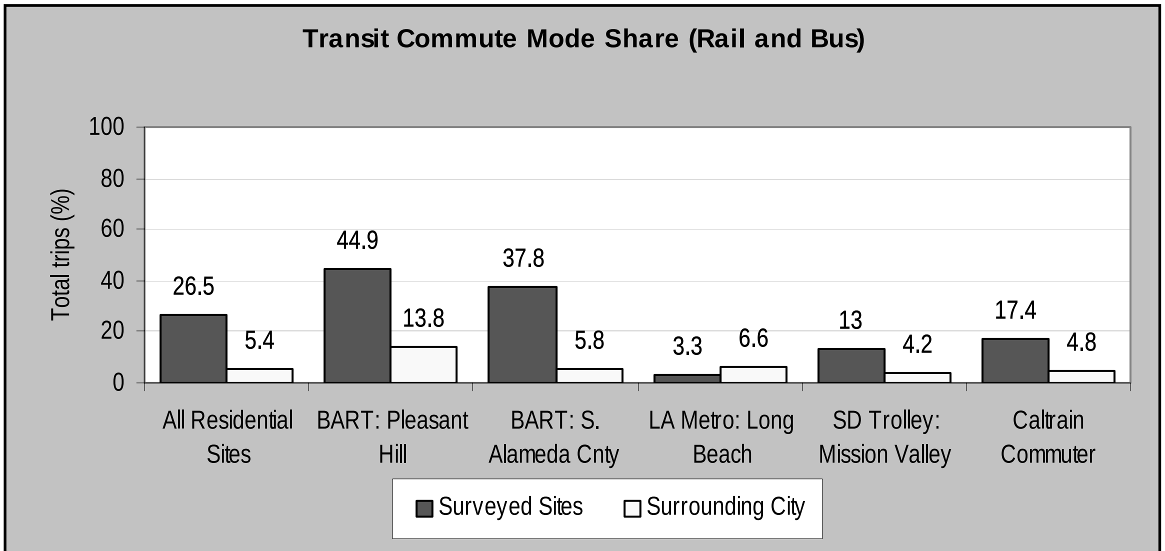

Figure 5-6. Transit Commute Mode Shares, Surveyed Station Area Residents & Surrounding City[1]

[1] Data source: 2000 U.S. Census, STF3

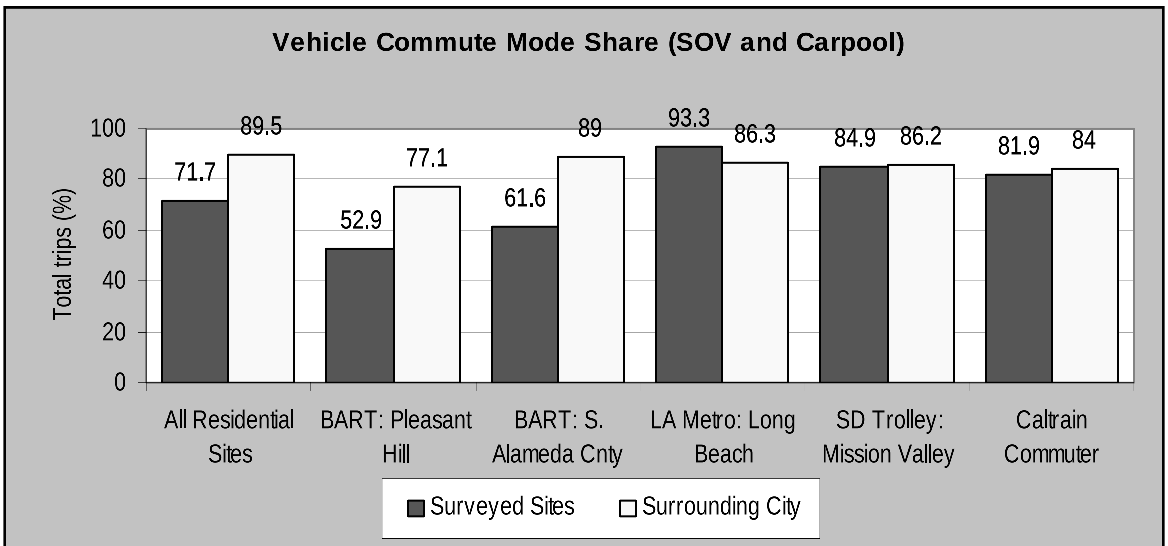

Figure 5-7. Vehicle Commute Mode Shares, Surveyed Station Area Residents & Surrounding City[1]

[1] Data source: 2000 U.S. Census, STF3

Station Access by Rail Commuters

Over 90 percent of the surveyed rail commuters walk to rail stations; the mean travel time for this segment of the trip (for all modes) is 7.2 minutes, with a high of 9.6 minutes among the South Alameda County sites. Given that sites were selected based on their close proximity to a rail station, the fact that people most likely to walk to the station is not surprising; the fact that walking is part of the commute trip, however, is of growing importance to those with a policy interest in promoting increased physical activity. In South Alameda County (BART), all of the surveyed rail commuters walk to rail stations; in Pleasant Hill, over 96 percent walk. Mission Valley (S.D. Trolley) has the lowest share of walk access trips (84.2%), but the remainder is divided between bicycling and bus transit; no Mission Valley residents report the use of a vehicle in accessing the station. (Note that the Long Beach project setting is not discussed separately here due to its low number of rail commuters.)

Figure 5-8 and Table 5-9 show that there is more variation in modes used at the other end of the rail commute, to get from the departure station to work; this is also to be expected since workplaces are not necessarily located near the rail line. Walking is still the predominant mode for completing the work trip, suggesting that station area residents are most likely to commute by rail if their workplace is also within walking distance of a rail station. Of the remaining rail commuters, bus is the predominant mode used to access the rail station. Across the project settings, rail commuters from Caltrain sites are least likely to walk to their workplace and most likely to ride the bus, and in the reverse, those from South Alameda County are most likely to walk and least likely to ride the bus. By definition, the longer station spacing of commuter rail (such as Caltrain) does not bring commuters as close to their destination, making walking a less likely alternative. In addition, the terminal station for Caltrain (in San Francisco) is located 1 to 1.5 miles from Market Street, requiring patrons to transfer to Muni. This is probably the principle explanation for the large share of bus egress among Caltrain commuters.

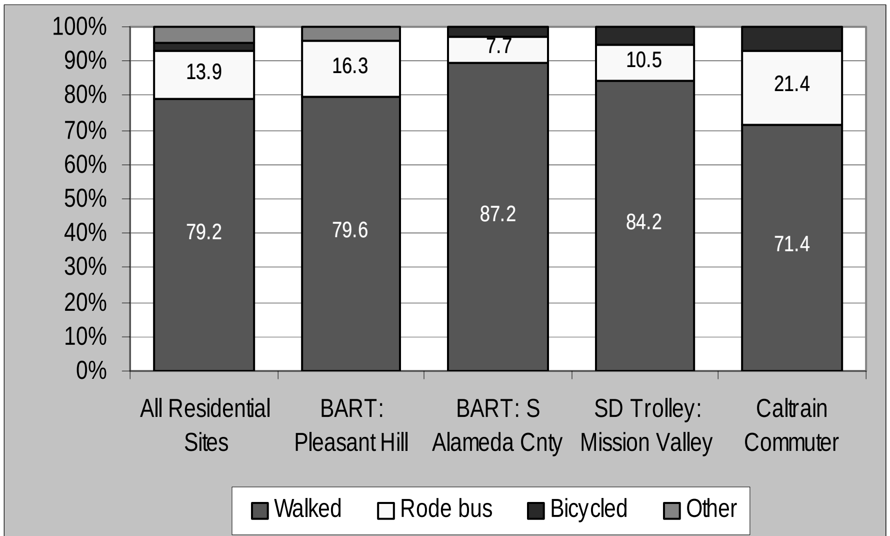

Figure 5-8. Mode used from Rail Station to Workplace

The overall results for the linking trips at both ends of the rail trip show the challenge faced by rail transit providers. On average, rail users spend a total of 24.6 minutes on average making connecting trips, not counting waiting and in-vehicle travel time for the main rail trip. Over the long term, of course, the TOD development is intended to reduce the length of these linking trips.

Table 5-9. Characteristics of Trip from Rail Station to Workplace, Residents who Commuted by Rail

	All Residential Sites	BART: Pleasant Hill	BART: S Alameda Cnty	SD Trolley: Mission Valley	Caltrain Commuter
Percent of trips made by:					
Walked	79.2	79.6	87.2	84.2	71.4
Drove vehicle	0.7	0.0	0.0	0.0	0.0
Rode as passenger	1.4	2.0	0.0	0.0	0.0
Rode bus	13.9	16.3	7.7	10.5	21.4
Bicycled	2.1	0.0	2.6	5.3	7.1
Other	2.8	2.0	0.0	0.0	0.0
Length of egress trip:					
Mean Length (minutes)	20.2	16.2	20.8	18.9	19.5
Standard Deviation	21.4	20.6	22.0	20.5	23.8
N (Number of trips)	178	57	45	22	19

Trip Chaining during Commute

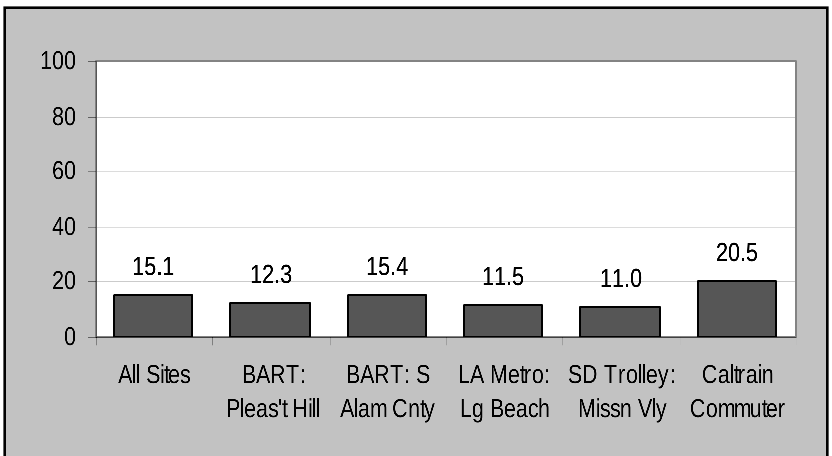

Figure 5-9. Commute Trips (All Modes) that Include Additional Stops

The survey instrument also asked commuters about trip chaining during the work trip. Trip chaining is the linking of other trip purposes to the work trip, and is a phenomenon of increasing interest with two worker and single parent households. If transit or walking modes cannot provide for the multiple trip purposes, transit becomes a less viable commute mode for those who have complex trip chains. Figure 5-9 shows that 15.1 percent of commute trips made by surveyed TOD residents involve additional stops. This level of trip chaining is quite consistent across the systems studied, with the highest level being reported by the TOD residents near the Caltrain commuter rail. Note that respondents were asked to report additional stops made (for any purpose) during *each main trip*. Unlike non-work trips, which are likely under-reported as a result of the “three main trip” survey structure, the levels of trip chaining are more accurately reflected—especially since residents who work outside their workplace were asked to report at least one direction of their commute trip as a main trip.

The most important trip purposes for those additional trips are, in rank order, meal or snack (24%), shopping (21%), and transporting children (16%). TOD development has the potential to address the need for these trips if a walkable, mixed use land use pattern with a full range of land uses is available at either the trip origin *or* the trip destination.

Commute Lengths and Times

Table 5-10 summarizes the commute trip times and speeds for station area residents; Figure 5-10 compares the mean commute lengths to those for the surrounding cities (based on data from the 2000 Census). The average commute time for station area residents is 55 minutes, with a standard deviation of 40 minutes. The variation in trip times is consistent with the size of the region and the type of rail service—the longest commutes are in the Los Angeles region and the Bay Area. Compared to their respective cities, however, station area residents spend twice as long commuting to work. It is likely that much of this is attributed to transit wait times; times reported by survey respondents reflect "door-to-door" travel; census journey-to-work data is for travel time only.

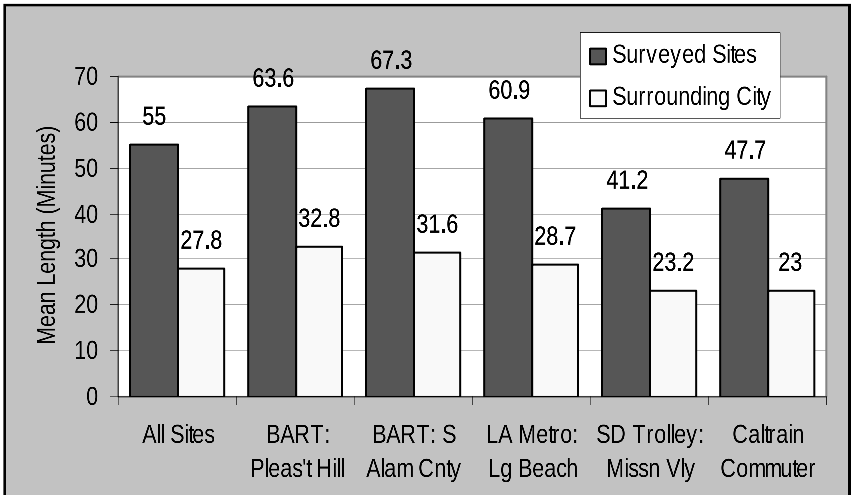

Figure 5-10. Mean Commute Times, Surveyed Residents & City

Table 5-10. Time and Length of Commute Trips (to Work only) for Station Area Residents

	All Residential Sites	BART: Pleasant Hill	BART: S. Alameda Cnty	LA Metro: Long Beach	SD Trolley: Mission Valley	Caltrain Commuter
Departed for work (%)						
Before 6:00am	4.2	4.9	4.8	1.8	5.3	2.6
6:00am-9:00am	44.9	47.6	45.2	45.6	45.0	43.1
After 9:00am	50.9	47.6	50.0	52.6	49.7	54.3
Commute lengths (%)						
Less than ½ hour	35.4	29.3	15.7	27.3	53.4	48.6
½ hour to 59 minutes	21.6	22.3	26.1	20.0	17.8	13.5
1 hour to 89 minutes	22.6	17.8	32.0	27.3	17.8	24.3
More than 1 ½ hours	20.4	30.6	26.1	25.5	11.0	13.5
Avg commute lengths						
Mean length (min.'s)	55.0	63.6	67.3	60.9	41.2	47.7
Standard deviation	39.9	45.1	35.2	38.3	33.8	40.6
N (Number of trips)	811	164	166	57	169	116

Non-Work Trip Characteristics

Non-work travel accounts for an increasing share of total trips. Many non-work trips occur during the peak period. The goals of TOD are not only to increase transit ridership for work and non-work travel, but also to increase the use of walking and bicycling by bringing shops, jobs, and other amenities within walking distance of TOD housing. Since people have more flexibility when choosing a place to shop than they do in selecting their job location, it seems that TODs greatest potential for capturing walk and bike travel lies in the non-work trips. In asking respondents to report three main trips, the survey collected information on 486 non-work trips (note that the focus on main trips, however, likely under-represents the total non-work travel).

Non-Work Mode Shares

Table 5-11 shows that the automobile dominates as the mode of choice for non-work trips among station area residents, accounting for about 87 percent of trips for all the systems. In order of importance, the non-automobile modes are rail (5.3%), walk (3.9%), bus (2.9%), and bicycle and taxi (tied at 0.4%). Given that the trip lengths of many non-work trips are shorter, it makes sense that walking, bus transit, bicycling, and taxis would be used for this type of travel. However, these results show that these modes are not yet being utilized to the extent desirable in TOD and there is a long way to go before non-automobile modes capture a large share of non-work trips.

Among automobile trips, there is a higher level of carpooling than for work trips, possibly because non-work trips are more likely to be made with family members. Figure 5-11 (next page) provides a graphic representation of the difference in mode share between work and non-work trips, showing the greater frequency of solo driving on work trips, but an approximately equal level of overall automobile use (including carpools). Rail is much less important for non-work trips.

Table 5-11. Mode Shares for Non-Work Trips by Station Area Residents

% of Trips by:	All Residential Sites	BART: Pleasant Hill	BART: S. Alameda Cty	LA Metro: Long Beach	SD Trolley: Missn Valley	Caltrain Commuter
Drove Alone	61.3	70.9	53.1	63.3	68.1	72.0
Drove Carpool	20.0	7.0	20.3	20.0	19.3	17.3
Rode in Vehicle	5.8	3.5	6.3	3.3	5.9	1.3
Rail Transit	5.3	9.3	7.8	0.0	3.0	5.3
Bus	2.9	5.8	6.3	0.0	1.5	0.0
Bicycle	0.4	1.2	0.0	0.0	0.7	0.0
Walk	3.9	2.3	6.3	13.3	0.0	4.0
Taxi	0.4	0.0	0.0	0.0	1.3	0.0
N (Number of trips)	486	86	64	30	135	75

Looking at the systems separately, the highest level of non-automobile trips is among the BART sites—particularly in terms of transit use. Long Beach reported no use of rail or bus for non-work trips, but it does capture the highest share of walk trips—3.5 times higher than the overall walk mode share. Shifts to non-automobile modes among non-work travel depend to a great degree on the maturation of the TOD in terms of density, variety in land use, mixed use, and the scale of the development. This seems to also be the case here—among BART sites, where the transit network and supporting land uses are well developed, we find higher levels of transit use for non-work travel. Among Long Beach sites, where amenities are clustered in and around the downtown area (near the surveyed sites) rather than at adjoining stations, we find higher levels of walking.

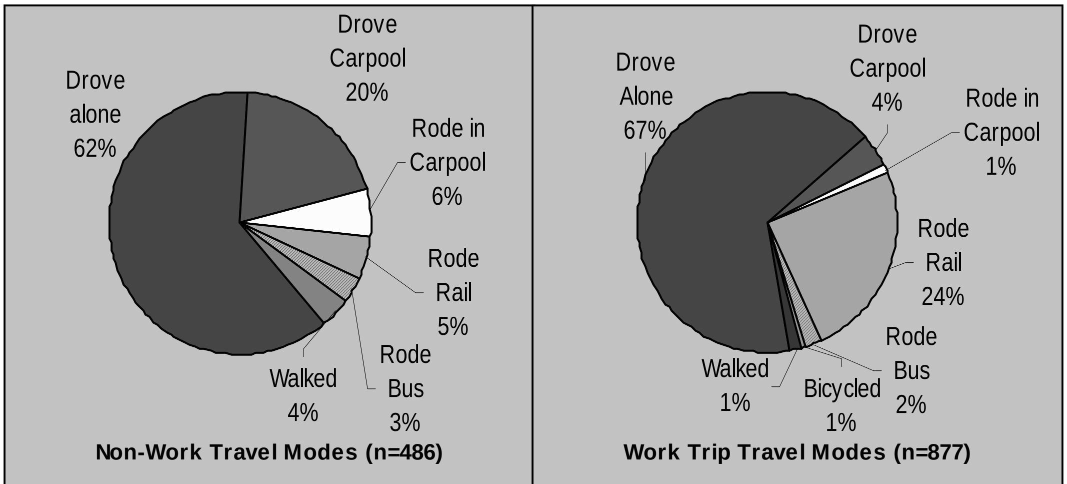

Figure 5-11. Comparison of Non-Work and Work Mode Shares, Station Area Residents

Non-Work Trip Purposes

Figure 5-12 summarizes the trip purposes for non-work trips. In rank order, the most frequent trip types are social/recreational, shopping, meal or snack and other errands (tied), and transporting children.

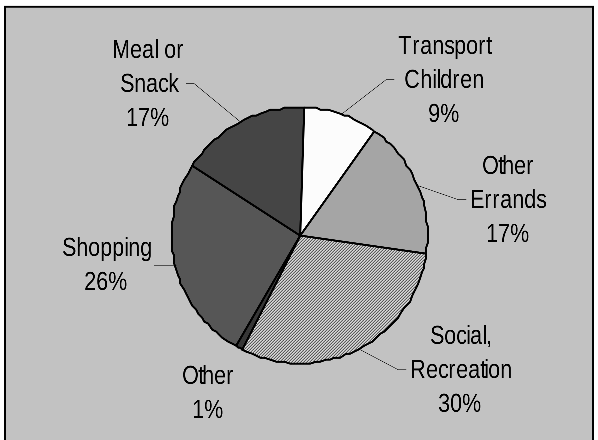

Figure 5-12. Trip Purpose for Non-Work Trips by Station Area Residents

Table 5-12 (next page) shows the mode share for each trip purpose (not including "other"). Rail is most likely to be used for social and recreation trips (10%), followed by shopping (4%) and travel for meals or snacks (3%). Social recreation trips tend to be longer, and therefore most appropriate for rail transit. The highest share of bus use is for picking up or dropping off children (7%). Walking is a significant mode for shopping (8%) and meals or snacks (4%). The high level of carpooling reported for pick up/drop off trips for children suggests that respondents may be counting children as carpooling passengers.

Table 5-12. Non-Work Mode Shares by Trip Purpose for Station Area Residents (All Sites)

% of trips made by:	Shopping	Meal or Snack	Pick up, Drop off Children	Other Errands	Social, Recreational
Drove (alone)	55.6	55.6	58.3	72.8	62.6
Drove (carpool)	22.5	25.9	31.7	16.7	14.1
Rode in vehicle	6.5	7.4	0.0	6.1	4.5
Rode rail transit	4.1	2.8	0.0	1.8	10.1
Rode bus	3.6	3.7	6.7	0.9	2.5
Bicycled	0.0	0.9	0.0	0.0	1.5
Walked	7.7	3.7	3.3	1.8	2.5
Took taxi	0.0	0.0	0.0	0.0	2.0
N (No. of trips)	169	108	60	114	198

Trip Chaining during Non-Work Trips

Figure 5-13 shows a higher level of trip chaining for non-work trips compared to work trips (25 versus 15 percent). Although there is variation in the *level* of trip chaining, this observation holds true across project settings. Sites located near BART's Pleasant Hill station have the highest level of non-work trip chaining, perhaps indicating that the more dense and mixed-use land patterns of the Bay Area enable more efficient trip chaining.

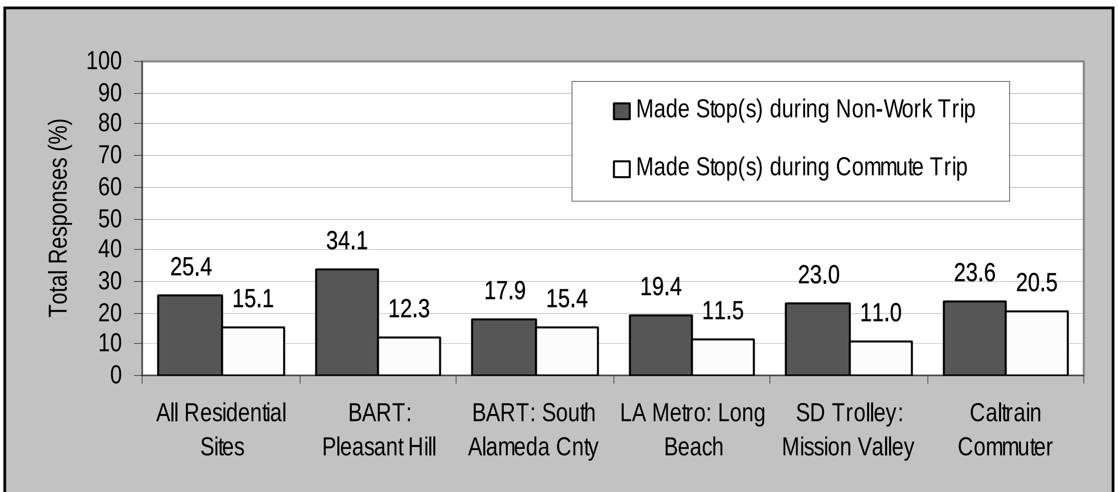

Figure 5-13. Share of Station Area Residents Making Additional Stops During Non-Work Trips (Compared to Stops made During Commute Trips)

Travel Trends (1990s to 2003) for Station Area Residents

One of the motivations for this study is to examine the dynamics of travel patterns in rail-focused TODs over an extended period. Most TOD studies provide a snapshot of travel behavior, but little insight into how travel behavior changes as a TOD matures. The availability of early 1990s mode choice surveys from California TODs made it possible to survey a series of identical sites in 2003. As mentioned in previous chapters, the 2003 survey was designed to provide comparability with the previous survey instruments and methods.

The decade interval provides time for property owners, residents and commuters to adjust marketing approaches, activity patterns, and travel mode choices to take best advantage of the rail transit accessibility. With two exceptions, the projects compared in this section were built in the late 1980s or early 1990s. The early surveys, therefore, were completed when many of these projects had their initial tenants and when some tenants were still assessing travel options for the new transit accessible location.

The primary research questions addressed in this section are the following: Does transit mode choice among residents increase, decrease, or stay the same over time as a TOD matures? What factors explain the different responses? A trend of increasing transit use will boost the benefits of implementing TODs and help to amortize the public and private investment in rail transit service and TODs.

General Trends in Travel Modes

Any change in TOD transit ridership must be placed in context of general ridership trends. During the late 1990s, the regions studied experienced increasing traffic congestion, associated with population growth and an expanding economy. This improved the competitiveness of rail transit in terms of travel time. However, the California economy was in decline at the time of the 2003 survey, which reduced employment, as well as congestion pressure and parking costs. This economic decline had an effect on transit ridership. For example, BART lost 40,000 riders between its peak ridership (slightly over 340,000 per day in September 2000 to just under 300,000 per day in early 2003). The loss of riders is partly attributable to less work trips, but also it reflects that automobile commuting was more convenient and less costly at the time that the surveys were conducted.

Table 5-13 provides journey-to-work mode choice data from the 1990 and 2000 U.S. Censuses for each of the four regions in which the surveyed sites are located; the data shows modest increases in rail use, albeit on very small percentage bases. Rail trips in the Bay Area increased from 3.3 to 3.9 percent of commute trips. There was no change in Sacramento, while both Los Angeles and San Diego show increases, but rail is still less than 0.5 percent of commute trips in those regions. Both the Los Angeles and San Diego regions experienced significant additions to rail transit systems during this period.

The comparison period shows increases in work at home across all regions, and declines in walk/bike in Sacramento and San Diego. Overall, the level of car/vehicle use in all regions is stable, the only exception being an increase in car/vehicle use in San Diego. This means that increases (or decreases) found in any of the TOD sites reported here are largely attributable to conditions in the TOD and rail transit system, rather than being a part of a region wide increase or decrease in transit use.

Table 5-13. Commute Mode Shares by Residents of Metropolitan Statistical Areas, 1990 & 2000[1]

	San Fran/San Jose		Sacramento		Los Angeles		San Diego	
% of Trips by:	1990	2000	1990	2000	1990	2000	1990	2000
Car/Vehicle	81.3	81.0	88.9	88.9	87.8	87.6	84.7	86.9
Rail	3.3	3.9	0.5	0.5	0.1	0.4	0.2	0.4
Bus	5.8	5.3	1.8	2.2	4.5	4.2	3.0	2.9
Walk/Bike	4.7	4.4	4.5	3.6	3.6	3.2	5.4	4.0
Other	1.4	1.3	1.1	0.9	1.3	1.0	1.8	1.4
Work at Home	3.5	4.1	3.1	4.0	2.7	3.6	5.0	4.4
N (employed persons over 16)	3,200,833	3,432,157	685,945	799,989	6,809,043	6,767,619	1,230,446	1,299,503

[1] Source: 2000 U.S. Census, STF 3 (San Fran/San Jose = San Francisco-Oakland-San Jose, CA Consolidated Metropolitan Statistical Area (CMSA); Sacramento = Sacramento, CA MSA; Los Angeles = Los Angeles-Anaheim-Riverside, CA CMSA; San Diego = San Diego, CA MSA)

Shifts in mode share should also be considered in terms of trends in demographics, household circumstances, and activity patterns of TOD residents. Table 5-14 summarizes demographic characteristics of surveyed residents in the 1992 and 2003 studies. For all systems, the demographic characteristics are quite similar. There was a decrease in mean vehicle per household from 1.2 to 1.1. The most notable difference in the transit system data is the decrease in mean household size and mean vehicles per household among the San Diego Trolley respondents, and the decrease in mean age and increase in mean household size among the Caltrain respondents. Any changes in mode share between 1992 and 2003 then are generally not attributable to large-scale changes in respondents' demographic characteristics.

Table 5-14. Demographic Characteristics of Surveyed Station Area Residents[1], 1992 & 2003

	All Systems		BART		S.D. Trolley		Caltrain	
	1992	2003	1992	2003	1992	2003	1992	2003
% Female	49.2	49.5	51.9	50.0	51.4	50.8	44.3	47.8
Age (Mean)	35.7	35.1	33.3	34.7	32.5	32.6	41.3	38.1
Age (Std Dev)	12.1	12.4	12.0	12.5	12.4	13.4	12.0	11.2
Mean HH Size	1.8	1.8	1.6	1.5	2.5	2.2	1.2	1.6
Mean Vehicles/HH	1.2	1.1	1.2	1.2	1.3	1.0	1.1	1.2
N (No. of Respondents)	371	294	198	207	114	37	59	50

[1] These data only include sites that were surveyed in both 1992 (or 1994) and 2003
[2] Source: Cervero, Robert (1993) *Ridership Impacts of Transit-Focused Development in California*, UC Berkeley.

Changes in Mode Share

The table that follows shows the mode shares of all reported main trips in 1992 and 2003, including work and non-work trips. (Respondents were asked to report the first three "main" trips they took on their reported day of travel). For both cases, the number of respondents, rather than number of trips, is used to produce weighted averages of the individual study sites to maintain comparability with the 1992 data reporting method.

It is important to note that many of 2003 survey respondents did not live in the development in the early 1990s; the results do not necessarily indicate changes in travel by the *same* residents. Rather, they indicate how the travel patterns of the building occupants have changed. These aggregate results, accounting for all shifts in residents and their travel behavior, are a critical question for policy makers concerned with the long-term trend in TOD trip patterns. Table 5-15 summarizes mode shares for all "main" trips and work trips by station area residents.

Table 5-15. Mode Shares by Station area Residents, 1992 & 2003[1]

	All Main Trips		Work Trips	
% of Trips by:	1992[2]	2003	1992[2]	2003
Car/Vehicle	71.4	72.5	70.3	69.8
Rail	21.2	21.8	24.4	25.4
Bus	2.0	2.3	1.2	2.0
Walk/Bike	4.6	3.4	3.9	2.9
Other	0.8	0.0	0.3	0.0
N (Respondents)	497	325	497	325

[1] These data only include sites that were surveyed in both 1992 and 2003, and are based on weighted averages of the resurveyed sites.
[2] Source: Cervero, Robert (1993) *Ridership Impacts of Transit-Focused Development in California*, UC Berkeley.

The "main trip" mode shares include both work and non-work trips. Those data show increases in rail and bus mode shares and decreases in walk/bike share for both "main trips" and "work trips." However, the differences are small and the margin of error at a 95 percent confidence interval is +/- 5 percent. Difference in proportions tests applied to the 1992 and 2003 results indicate that there is not a statistically significant difference between the 1992 and 2003 results for any of the modes listed. Therefore, we cannot conclude that the share of rail transit increased as TODs matured in either classification of trips.

Two project groupings offered sufficient sample sizes to be reported separately (margins of error are less than 10 percent at a 95 percent confidence interval)—the BART Pleasant Hill station area and the grouping of stations on the BART South Alameda line. Table 5-16 summarizes the results for all main trips and work trips.

Table 5-16. Mode Shares for Station Groupings, All Trips and Work Trips, 1992 & 2003

	Pleasant Hill				**South Alameda County**			
	All Main Trips		Work Trips Only		All Main Trips		Work Trips Only	
% of trips by:	*1992[2]*	*2003*	*1992*	*2003*	*1992*	*2003*	*1992*	*2003*
Car/Vehicle	55.6	65.3	49.5	60.4	73.3	69.1	69.4	67.6
Rail	39.8	31.1	47.3	36.5	21.8	25.6	26.2	28.8
Bus	2.0	1.6	0.7	0.6	1.6	2.9	1.2	1.8
Walk/Bike	2.6	2.1	2.4	2.5	2.1	2.4	2.0	1.8
Other	0.0	0.0	0.0	0.0	1.3	0.0	1.2	0.0
N (Respondents)	103	91	103	91	115	93	115	93

[1] These data only include sites that were surveyed in both 1992 and 2003, and are based on weighted averages of the resurveyed sites
[2] Source: Cervero, Robert (1993) *Ridership Impacts of Transit-Focused Development in California*, UC Berkeley

The Pleasant Hill results show a lower share of transit trips in 2003. However, there is only one measure of difference that is statistically significant. At a 90 percent confidence level, and assuming maximal standard error, there is a statistically significant difference in combined rail/bus mode share for work trips between 1992 and 2003. Transit share for work trips declined over time in Pleasant Hill, despite the fact that there is more development, mixed uses, and pedestrian amenities today than a decade ago. It may also be true that employment location shifts in the Bay Area partially explain this phenomenon. For example, there was substantial job growth in the I-680 corridor near the Pleasant Hill station area in the late 1990s—Hacienda Business Park, Bishop Ranch, Pleasant Hill BART, Walnut Creek—most of which was not accessible to direct BART service.

The South Alameda project grouping shows higher rates of rail transit use for all trips and work trips alone. However, these differences are not enough to establish statistical significance. Therefore, we cannot conclude that there has been a change in transit mode share for the South Alameda project grouping.

The absence of statistically significant increases in transit mode share in the two project groups is surprising. BART is the most mature and extensive transit system of those studied. There has been more time for the transit accessibility to influence development patterns, location choices, and travel behavior.

A number of transportation and land use-related factors may have influenced the trends previously described. Future studies might investigate these factors in greater detail. Examples include:

- Level of familiarity with transit service;
- Changes in transit system performance, service connectivity, or fare structure;
- Expansion of TOD development within the station area of residence or other TODs along the rail line (e.g. increase in shopping opportunities and other daily amenities);
- Changes in performance of the automobile alternative, such as increases in travel time (e.g., congestion) and higher travel costs (e.g., out of pocket automobile and parking costs); and
- Adjustment of work locations and other trip destinations; or
- The TOD transit access advantage is overwhelmed by another factor, such as strong demand for multi-family housing, housing quality, affordability, or even convenient highway access.

The level of transit ridership in a TOD is also affected by the characteristics of tenants and property owners attracted to the TOD. Examples include:

- Filtering effects among TOD residents. For example, those who use rail transit may stay in place and have longer residencies; those not using transit may be more likely to leave (especially if they are paying a rent premium for the transit accessibility); and new residents are attracted to the TOD because of a predisposition to use transit;
- Property owner marketing programs and lease provisions (e.g., parking cash out) that draw attention to the transit accessibility advantages and encourage residents to take advantage of transit; or
- A novelty effect, where commuters initially use transit but as they gain experience, they find that other modes are more versatile.

The following comments provide possible reasons why increases were not observed in this particular instance. First, the surveys were taken at a time (Spring 2003) when the California economy was in a downturn. This downturn lessoned traffic congestion and parking prices in many areas. Some TOD residents may have switched from transit to automobile commuting to take advantage of the automobile accessibility window offered by the weakened economy. It is also acknowledged that there was weakness in the California economy in the early 1990s, although that recession affected southern California more strongly. The effects were also concentrated in the aerospace sector, which was not directly related to the surveyed projects.

The other possibility in understanding the lack of increase in transit commuting in TOD is that mode shifts that significantly affect automobile ownership and use may take longer than the time interval being studied because of the need for regional-scale development of transit-friendly destinations as well as the completion of comprehensive TODs. The Pleasant Hill station area, for example, is just completing a second round of planning for TOD and will be experiencing further development in the coming years. It may take another wave of economic growth and TOD development before increases in transit use are realized in these TODs. Future increases in traffic congestion may provide an impetus to rail use and a comparative advantage to rail station proximity. However, the fact that the 2003 Pleasant Hill results show less transit use with a greater level of transit-oriented development suggests caution in making broad predictions of how transit share will change over time.

One site provided a large enough sample size to examine at a case level. The margin of error for Verandas Apartments is 13.8 percent using a 95 percent confidence interval—larger than the 10% standard used throughout this study, but allowed for here so that a single project could be examined. The Verandas Apartments are located at the Union City Station on East Bay Fremont BART line. The project is fifteen years old, so there has been a substantial period for project occupancy and marketing approach to be tailored to take advantage of rail transit. The density of the station area is 10.2 residents per acre and the quality of the walking route to the station is rated as good. Pedestrian pathways are of adequate width and tree-lined. As shown on Table 5-17, the main demographic trends, 1992 to 2003, are an increase in mean household size and a decrease in mean vehicles per household. Otherwise, it is a typical project. The parking ratio of 1.0 spaces per unit is lower than most of the sites studied. The project site is gated, which gives a project a suburban sense of separation from the street and a private internal environment.

Table 5-17. Site and Station Area Characteristics, Verandas Apts, 1992 & 2003

Year Opened: 1988
Nearest Rail System: BART
Nearest Station: Union City, Union City

Physical Features:		**Demographic Features:**	1992	2003
Number of Units	380	% Female	50.0	45.7
Unit Type	Apts.	Age (Mean)	30.7	32.6
Density (du/a)	36	Age (Std Dev)	9.1	9.6
Station Distance (ft.)	930	Mean HH Size	1.54	1.71
Census Tract (1990)	4403.09	Mean Vehicles/HH	1.22	1.06

Table 5-18 summarizes mode shares in the two time periods. A difference of proportions test indicates that there is a statistically significant difference between the 1992 and 2003 work trip rail shares (at a 90% level). BART use did increase over time at this site. The decline in car/vehicle use is also significant at the 90 percent level. About one-quarter of work trips (based on the 1992 surveys) are destined for San Francisco or Oakland.

Table 5-18. Travel Characteristics, Verandas Apts, 1992 & 2003

All Trips	1992	2003	Change	Work Trips Only:	1992	2003	Change
Mode (%):				*Mode (%):*			
Car/Vehicle	69.1	54.1	-15.0%	Car/Vehicle	64.6	49.1	-15.5%
Rail	25.8	39.2	+13.4%	Rail	31.3	50.9	+19.6%
Bus	1.0	2.7	+1.7%	Bus	0.0	0.0	--
Walk/Bike	4.1	4.1	--	Walk/Bike	4.2	0.0	-4.2%
N (Respondents)	37	35		N (Respondents)	37	35	

Long-Term versus Newer Residents

The question of whether transit use increases as a TOD matures is linked to the relationship between length of residency and transit use. We hypothesize that longer-term residents will use transit more often than will those with shorter residencies. This is expected because long-term residents have more familiarity with transit service and more opportunity to adjust workplace location and other travel patterns to take advantage of their home-based transit access. In addition, as units are re-leased in an apartment complex, those taking advantage of the transit accessibility are more likely to stay, leading to a filtering effect in which long-term residents are more likely to be those who use transit.

Table 5-19 shows the mode share for main trips for four lengths of residency, ranging from more than 10 years to less than six months. Longer residencies are associated with higher rates of transit use. The major increase is at the five-year residency level. It is interesting to note that the “drive vehicle, alone” share is similar among different lengths of residency. New residents are more likely to use carpool, walk, or bike modes, balancing out their lower level of transit use. They may have been less attracted to transit accessibility compared to the initial residents, responding instead to the quality of the housing units and the broader notions of accessibility. In addition, they may have discovered a high level of accessibility for many travel modes upon moving in to the TOD, leading to a broader range of travel choices.

Table 5-19. Mode Share for Main Trips (Work and Non-Work) by Length of Residency

% of trips made by the following modes:	Moved into the Station Area: 1992 or earlier (over 10 yrs ago)	1993 to 1997 (about 6-10 yrs ago)	1998 to 2002 (about 1-5 yrs ago)	2003 (within last 6 mos.)
Drove Vehicle, Alone	62.5	66.7	65.4	62.2
Drove Vehicle, Carpool	0.0	2.8	10.2	13.9
Rode in Vehicle	4.2	0.7	3.0	2.6
Rail Transit	29.2	24.8	16.7	15.7
Bus	4.2	2.8	2.2	1.3
Bicycle	0.0	0.0	0.5	0.4
Walk	0.0	2.1	1.8	3.9
Taxi	0.0	0.0	0.2	0.0
N (Number of trips)	24	141	953	230

Table 5-20 shows the same information for work trips only. Again, a pattern of increased transit use appears for those in the 6-10 year residency group, and even more for those having a length of residency longer than 10 years. As shown in the previous table, new residents are more likely to carpool or walk to work than longer-term residents.

Table 5-20. Mode Share for Work Trips Only by Length of Residency

% of trips made by the following modes:	Moved into the Station Area: 1992 or earlier (over 10 yrs ago)	1993 to 1997 (about 6-10 yrs ago)	1998 to 2002 (about 1-5 yrs ago)	2003 (within last 6 mos.)
Drove Vehicle, Alone	45.5	61.4	68.6	63.6
Drove Vehicle, Carpool	0.0	0.0	4.0	7.7
Rode in Vehicle	0.0	1.2	1.3	0.0
Rail Transit	45.5	36.1	22.5	23.8
Bus	9.1	1.2	1.9	2.1
Bicycle	0.0	0.0	0.6	0.0
Walk	0.0	0.0	1.1	2.8
Taxi	0.0	0.0	0.0	0.0
N (Number of trips)	11	83	627	143

Figure 5-14 summarizes the data shown in the two previous tables by combining rail and bus mode shares for each length of residency. It shows that longer residencies among these respondents lead to a greater likelihood of using transit. This suggests that length of residency should be a variable in mode choice modeling for TODs. It also suggests that there is promise for greater transit use as TODs mature if the residential population tends to stay in place. The higher level of walk trips among recent residents may be a sign of the success of the TOD in providing walkable trip destinations and a broader set of non-automobile travel choices.

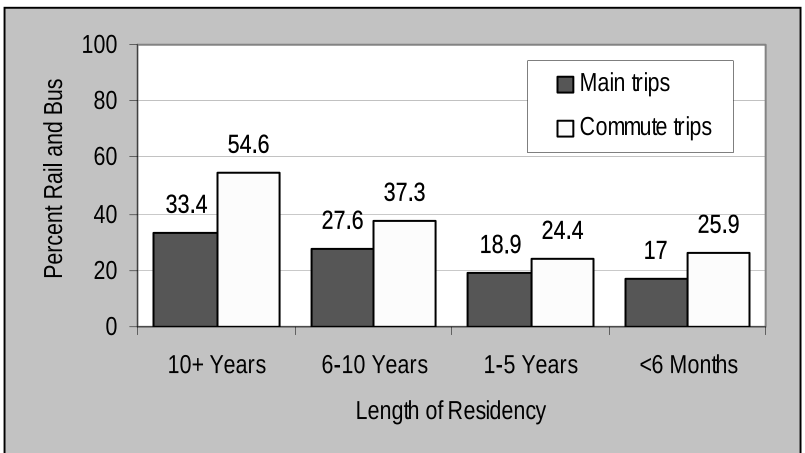

Figure 5-14. Transit Use and Length of Residency

Prior Travel Behavior

A key question in understanding the commute patterns of TOD residents over time is how new residents change (or do not change) commute modes when they move into a TOD. This is also an important question in determining if there are regional benefits of TODs. If TODs attract only residents who already use transit, for example, the regional share of transit trips may not increase even though TOD transit ridership would be high. On the other hand, if residents switch from driving alone to transit, the full measure of VMT and other benefits can be attributed to the TOD development. Table 5-21 reveals a complex pattern of changes in travel behavior, some of which are considered encouraging trends for transit use while others are not.

To address this issue, respondents who had changed *both their residential location and their place of work* were asked questions about their prior and current commute modes. It can be assumed that this subgroup of respondents has a high degree of mobility in both their residential and workplace locations. However, we are not able to discern the reasons for the workplace location change. We also cannot infer changes in mode share exclusively to relocation in a TOD since some respondents may have moved to more auto-oriented work locations.

Table 5-21. Comparison of Commute Mode at Previous Residence and Workplace to Commute Mode at Current Residence and Workplace[1]

	% of residents who shifted:	All Systems	BART	S.D. Trolley
Encouraging trends	From automobile[2] to rail transit	11.5	17.9	10.3
	From automobile[2] to bus transit	0.0	0.0	0.0
	From automobile[2] to walking or biking	1.3	1.1	3.4
	From driving alone to carpooling	1.8	0.4	0.4
	No shift: Still taking transit (bus or rail)	6.6	10.5	0.0
	Total of "encouraging" mode shifts	*21.2*	*29.9*	*14.1*
Non-encouraging trends	From rail transit to automobile[2]	5.3	7.4	5.2
	From bus transit to automobile[2]	4.4	6.3	1.7
	From walking or biking to auto[2]	4.8	3.2	6.9
	From carpooling to driving alone	3.1	0.9	1.3
	No shift: Still driving alone	55.8	41.1	60.3
	Total of "non-encouraging" mode shifts	*68.5*	*57.6*	*73.7*
	Other shifts	*10.3*	*12.5*	*12.2*
N (Number of respondents)		226	95	58

[1] Previous commute mode is based on "typical mode used"; Current commute mode is based on actual mode used to commute to work on day of reported travel
[2] Alone, with passengers, or as a passenger

The survey responses show a mixed pattern. Among this group of respondents, 14.6 of respondents switched from automobile to rail, bus or carpooling, and 6.6 percent of respondents continued to use transit. However, other respondents shifted from transit, walk/bike and carpooling modes back to driving on the combined event of moving into the surveyed TOD site and changing workplace locations. Comparing this complex set of mode changes, the share of respondents shifting out of transit, walk/bike, or carpooling (17.6%) exceeds the share that shifted from automobile commuting to transit, walk/bike, or carpooling (14.6%). Again, if the general trend was to automobile-oriented workplaces, then part of the reason for the lack of increase is not related to the existence of a TOD residential location. Among the studied sites, respondents who moved to a TOD while also changing work location did not exhibit a net decrease in automobile use.

The table includes data for two systems where response rates justified disaggregating the data. BART TOD residents report a net shift toward transit, walk/bike, and carpooling. There are a number of factors that might help explain this phenomenon, including the greater maturity of the transit system in the Bay Area, a greater share of workplace destinations accessible to transit, higher parking charges and the frequent employer subsidies. These results are from the subset of all BART respondents who changed work and residential location, so the results are not directly comparable to the Pleasant Hill and South Alameda station groups discussed previously. Shifts toward and away from transit were balanced in the San Diego Trolley responses.

Individual-Level Modeling of Travel by Station area Residents

This section presents best-fitting models that explain travel choice among individual residents. Travel behavior is primarily modeled for individuals, not projects. Factors that are thought to shape travel choice, such as workplace transportation options and urban designs, are examined one at a time. Based on these results, a logit model is estimated that predicts the probability that station area residents opt to take transit. Analyses are conducted for work trips as well as all trips combined. Sensitivity tests reveal how the decision to use transit responds to key policy variables, such as parking provisions at the workplace. Lastly, analyses are conducted on factors related to station access by walking or bicycling.

Factors Influencing Mode Choice among Station area Residents

This subsection examines simple bivariate relationships between the choice to take transit (for all trips) and various attributes thought to influence travel behavior. The relationships shed light on the variables that are likely to enter a mode choice model. Factors that explain travel choices are divided into the following groups:

- Travel times
- Accessibility levels of transit versus auto-highway
- Transportation-related options at workplace
- Trip destination
- Land use patterns and urban design: neighborhood attributes
- Urban design: shortest route attributes
- Station parking provisions and costs
- Socio-demographic characteristics of travelers
- Others: attitudes and trip-chaining

Simple correlations are used to gauge the relative influence of each factor on whether a trip was made by transit. Transit usage is expressed in simple binary terms: 1 = rode transit and 0 = did not ride transit. While the correlations cannot provide conclusive evidence due to the possibility of spurious relationships, bivariate associations are easy to understand and form the building blocks for the estimation of more complex multivariate models. Pearson product-moment correlations can range from -1 to + 1, with a minus sign denoting an inverse relationship and a plus sign indicating a positive relationship. The closer a correlation is to one, regardless of sign, the stronger the relationship between the two variables.

Travel Times

Travel demand theory holds that individuals choose among competing modes based on the relative benefits derived. Among the attributes that travelers seek are short travel times and low costs. Given the origin (O) and destination (D) of each trip, geocoded to Traffic Analysis Zone (TAZ), the expected peak-period travel time over the year-2000 auto-highway and transit networks are estimated. Travel-time data for each O-D pair were obtained from the MPOs of each region: MTC in the San Francisco Bay Area; SCAG in Southern California; SANDAG in San Diego; and SACOG in metropolitan Sacramento.

Comparative travel times have a strong bearing on transit choice among station area residents. The simple correlation between transit usage (coded 0-1) and the travel time ratio of auto to transit (i.e., peak travel time over highway network divided by peak travel time over transit network) is *0.587***.** For residents who *do not* ride transit, the mean travel time by vehicle (for all trip purposes) is 41.7 minutes faster than traveling by transit. For those who *do* ride transit, travel by vehicle is, on average, 23.0 minutes faster.

Accessibility Levels

Accessibility reflects not only the speed of travel networks but also the proximity of origins and destinations. This study examines the relative accessibility of getting from point A to point B via transit versus highway. Isochronic measures of accessibility to employment over both the highway and transit networks are examined for four travel-time periods—15 minutes, 30 minutes, 45 minutes and 60 minutes. Accessibility is measured by taking year 2000 place-of-employment data[1] and tabulating the total number of jobs that could be reached for each time band over the respective highway and transit networks.

The strongest association with transit usage is for the 30-minute travel-time isochrones. The simple correlation between transit usage (0-1) and the accessibility ratio (i.e., number of jobs that can be reached over the transit network within 30 minutes of origin divided by number of jobs that can be reached over the highway network within 30 minutes of origin) is *0.290*. That is, *the more accessible an origin is to job activities by transit (versus vehicle), the more likely a trip is to be made by transit*. The association was even higher for work trips.

Another dimension of accessibility that was examined was incidences of trip chaining. Overall, destinations are less accessible via transit if trip chaining is involved. Among the surveyed station area residents, transit ridership is lower if the traveler makes multiple stops en route (correlation is *–0.135*). Stated another way, there is a 24.5 percent likelihood that a station area resident will use transit if the trip is not chained; for a chained trip, there is just a 4.2 percent probability of transit use.

Transportation Options at the Workplace

Transportation-related programs at the workplace, such as parking provisions and schedule flexibility, are important variables to consider in explaining mode choice because they can be influenced by public policies. Several workplace practices are strongly associated with transit usage. These include the ability to "flex" one's work time (*0.462* correlation[2]*)*, the availability of free parking (-*0.346* correlation value), and employer assistance with paying commute costs. If an employer helps with transit-related costs, there is a positive correlation with transit use (*0.158*); if the employer helps with vehicle-related costs, however, there is a negative correlation (*–0.421*). Other policies, such as the ability to work at home or having access to a company vehicle during the workday, are weakly related.

Below are further elaborations on these important relationships.

- *Flextime (0.462 correlation value).* Somewhat surprisingly, the presence of flextime standards is the workplace variable most strongly associated with transit commuting. The ability to adjust one's work schedule according to transit schedules and service levels (e.g., the ability to arrive early so as to guarantee a seat) appears to influence the decision on whether to commute via transit among the surveyed station area residents. Figure 5-15 shows that *if flextime is available, half of work trips made by station area residents are by transit; if not available, transit use for commuting is just 2.8 percent*.

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[1] Place-of-employment data obtained from MPOs of the respective metropolitan areas based on employment estimates for TAZs used for long-range forecasting

[2] Transit use and the availability of a particular option are both coded 0-1, with 0 = no transit or no option and 1 = transit used or option available

- *Free Parking (-0.346 correlation value).* Almost as influential—in the opposite direction—is the availability of free parking at the workplace. Fewer than one out of twenty station area residents take transit to work *if they can park for free at work*; if free parking is *not* available, the transit-commuting share jumps to nearly 45 percent.
- *Help with Transit Costs* (*0.158 correlation value).* An employer-sponsored transit pass promotes transit commuting among station area residents – a 40 percent likelihood if they have access to an employer-sponsored transit pass versus less than 25 percent likelihood if they do not.
- *Help with Vehicle Costs (-0.421 correlation value)*. Employers helping workers cover costs for tolls, fuel, and other vehicle expenses deters transit commuting – just 1.3 percent of surveyed station area residents commuted via transit if they received this perk from their company.

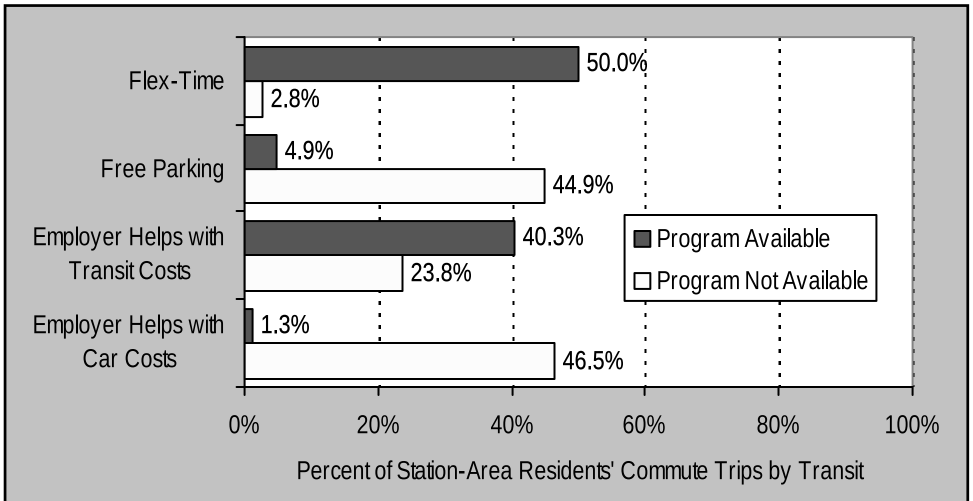

Figure 5-15. Influence of Employer Policies on Transit Commuting among Surveyed Station Area Residents

Trip Destination

The destination of a trip also has a bearing on station area residents' decision to commute by transit. (Note, however, that trip destinations among the surveyed population may be closely related to factors such as workplace transportation options and quality of transit service). The two destinations significantly associated with transit riding are San Francisco and Oakland/Berkeley. If a station area resident works in the city of San Francisco, they have a 54 percent likelihood of taking transit to work. (For all trip purposes, the likelihood that a station area resident takes transit to a San Francisco destination is 43 percent.) For station area residents heading to jobs in Oakland or Berkeley, the likelihood of transit commuting is 26 percent. No other city destinations (e.g., San Diego, San Jose, Los Angeles, Sacramento, Long Beach) are significant explainers of transit commuting among station area residents.

Neighborhood Land-Use and Urban Design Patterns

An important element of this research is to examine how the design of neighborhoods around California's rail stations influences the likelihood that station area residents patronize transit. Increasingly, the "3 D's" (density, diversity, and design) of built environments are understood as potentially powerful determinants of transit-mode choice. Programs like MTC's Transportation for Livable Communities (TLC) and Housing Incentive Program (HIP) target grants to neighborhoods around transit stations for the very purpose of promoting pedestrian-friendly designs and streetscapes.

Two sets of land-use and urban design variables were available for the analysis. One set was derived using 2000 TIGER files and other Census data to calculate metrics of density, street connectivity, and block size for one-mile radii around trip origins. In most cases, the trip origin was the survey respondent's residence. The second set compiled information, such as the number of street trees and presence of sidewalks, along the shortest path between each surveyed project and the closest rail station entrance. In order to gauge the relative density of pedestrian-friendly design features, the cumulative counts were divided by the lineal feet along the shortest route to obtain a metric of number of features per 1,000 feet of walking distance along the shortest route. Given that travel-diary data were compiled for 25 housing projects, there were 25 sets of scores for this variable.[3]

Another variable related to local transportation provisions is the supply and price of parking at the nearest transit station of each surveyed residential project. To gauge the relative availability of parking spaces, the number of spaces was divided by the number of housing units[4] within a one-mile radius to gauge the amount of station parking per housing unit (within the one-mile radius).

Two metrics of neighborhood design and density—average block size and street connectivity at the destination—are significantly correlated with transit ridership. Residential density and connectivity at the origin are weakly or counter-intuitively associated with transit use. The following points summarize these relationships.

- *Average Block Size*. There is a modest negative correlation between transit ridership and the average block size (in acres) within one-mile of either the home-end or non-home-end of a trip (*-0.127* and *-0.118*, respectively). The negative sign means that as blocks increase in size, there is a decrease in the likelihood that a station area resident rides transit.
- *Street Connectivity.* Geographic information system (GIS) tools were used to count the number of dead-end streets within a one-mile radius of the origins and destinations, as well as the number of 3-way, 4-way or 5-or-more-way intersections. Large counts of dead-end streets and 3-way (or T-intersections) suggest a disjointed street network (i.e., "loops-and-lollipops") such as found in many auto-oriented subdivisions. Large counts of 4-way and 5-way (or more) intersections generally correspond to a highly connected grid system, which is more conducive to walking (such as to the nearby train station) and other non-automobile modes. The index of street connectivity used in this study was the proportion of total intersections (including one-way end points) that have four, five, or more ways.

  At the non-home end of the trip, there was a moderately positive correlation between high street connectivity and transit travel (*0.373* correlation value, with transit travel coded 0-1). In other words, the more connected the street system is at the trip destination, the more likely it is that a station area resident will take transit to that destination. Surprisingly, the correlation for the home-end was negative (-*0.212*). The negative association is counter-intuitive, and must therefore reflect some idiosyncratic characteristics of the neighborhoods surveyed. (Or suggest that for residents living within walking distance of a rail station, lack of street connectivity in the surrounding one-mile is not a deterrent from transit use.) Clearly,

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[3] Because there is relatively little variation in this set of variables, there is potentially less ability of these variables to correlate with variation in mode choice. This could compromise the ability of these variables to enter best-fitting predictive models.

[4] Housing unit data were collected from the 2000 U.S. Census

however, for the home-end of the trip this variable does not pass the “reasonableness” test for entry into a mode-choice model.

- *Residential Density*. The relationship between residential density (dwelling units per acre within a one-mile radius of a surveyed transit-based housing project) and transit usage (coded 0-1) is insignificant, with a correlation value of *-0.025*. This is not to suggest that density is not important for promoting transit ridership, but is rather a function of the research design. Since the surveys were limited to those already living within ½ mile of a transit station, it is likely that the density of the area surrounding their home is irrelevant to their decision to use transit. From a mobility standpoint, the main benefit of higher densities is to make origins and destinations closer to each other. Given that, by definition, station area residents are close to stations, the density in and around one’s neighborhood has little bearing on mode choice.
- *Shortest Path Design Attributes*[5]. Attributes of the shortest path between surveyed projects and station portals—such as the number of street crossings and the presence of amenities like street trees and furniture—could sway some station area residents to opt for transit. While past research has generally shown micro-design features to exert modest influences on mode choice, features like the presence of sidewalks and street trees nonetheless are in a position to increase transit mode shares by a few percent. Below, the correlations between transit riding and design features along the shortest path between the site and the rail station are summarized.
  - *Number of Block Faces.* Controlling for length of route, the correlation between the numbers of blocks per 1,000 feet of walking distance and transit ridership is *-0.110*. The negative sign suggests that as the relative number of “conflict points” (i.e., street crossings) increase, getting to transit by foot becomes less attractive. This finding is not surprising. Note also that the correlation between transit ridership and the *absolute* measure of number of block faces (without controlling for route length) is positive and weak (*0.091*). This suggests that the relative measure is preferred to the absolute measure of number of blocks (whose positive sign is counter-intuitive).
  - *Sidewalks along Shortest Route*. Controlling for walking distance, there is a positive association between the presence of sidewalks on one or both sides of the street (along the shortest route to the station) and the use of transit. The correlations between transit usage and number of one- and two-side sidewalks per 1,000 feet of walking distance are *0.171* and *0.150,* respectively.
  - *Street Trees*. It is widely accepted that street trees provide shade and aesthetics, and can improve sense of safety by buffering pedestrians from moving vehicle traffic. Mature tree canopies can also add “green” to a walking corridor, something that many pedestrians appreciate on bright sunny days. For station area residents, however, there is only a weak positive association (*0.079*) between the total number of street trees along the shortest route and transit use. When controlling for walking distance, the association between transit use and street tree *density* is actually negative – a counter-intuitive result.
  - *Street Lights*. The presence of overhead illumination can encourage station area residents to take transit. Lighting is particularly important in winter months when workers often return home in the dark. Streetlights enhance both pedestrian safety and security. There is a modest positive correlation (*0.178*) between transit riding by station area residents and

[5] For more information on the shortest route evaluations, refer to Chapter 3: Research Design (Site Data and Evaluations), and Appendix D: Pedestrian Evaluation Sheets.

the total number of streetlights along the shortest route. Interestingly, this is higher than the correlation between transit riding and streetlight density (*0.106*).

- *Street Furniture*. Benches, bus shelters, and other enhancements to the sidewalk environment can improve the walking experience. The correlation between transit riding for station area residents and the amount of street furniture along the shortest path is *0.137*. On a "per 1,000 feet of walking distance" basis, the association was slightly negative *(-0.043*), against expectations.
- *Other Attributes*. The other attributes of the shortest path, such as width of the widest crossing, number of intersections, and even the subjective landscaping ranking (with a score of 1 to 5), are either insignificantly related to transit riding or produce counter-intuitive correlations. These variables are thus unlikely candidates for entry into a best-fitting mode-choice model.

Station Parking

In addition to the land-use and design characteristics of neighborhoods near rail stations, the amount and price of parking at the station itself is thought to have a bearing on transit riding, even among those living within walking distance.

- *Parking Supplies*. Simple correlations suggest that the amount of station parking influence transit usage, even among Californians residing near rail stations. The correlation between the amount of parking at a station and transit riding among station area residents (coded 0-1) is a respectable *0.331*. Controlling for population within one-mile of a residence, the correlation between parking supply (per 1,000 dwelling units within a one-mile radius) and transit riding is about the same: *0.338*.
- *Parking Price.* Having to pay for parking at a station also seems to deter transit riding among station area residents, although the relationship is not strong. The simple association between the average parking price at a station and transit riding is -*0.051*.

Summary of Neighborhood Urban Design, Land Use, and Station Parking Attributes

Like workplace programs, the neighborhood design, land-use, and station parking attributes reviewed above are amenable to public-policy influence. Figure 5-16 (next page) summarizes the measured correlations between transit riding (coded 0-1) and the various attributes of neighborhoods and station parking. Correlations are presented in absolute terms (i.e., ignoring sign) and only for variables where significant correlations met *a priori* expectations.

Street connectivity at the non-home end of a trip is the strongest predictor among urban-design variables for transit ridership by station area residents. Station parking supplies are the second strongest predictor, positively associated with transit riding (even though the surveyed residents all live within walking distance of the station). What might be called “pedestrian amenities”—street lighting as well as the presence of sidewalks and street furniture—have moderate influence on transit riding. Block characteristics like average size and relative frequency along the shortest route have weaker influences.

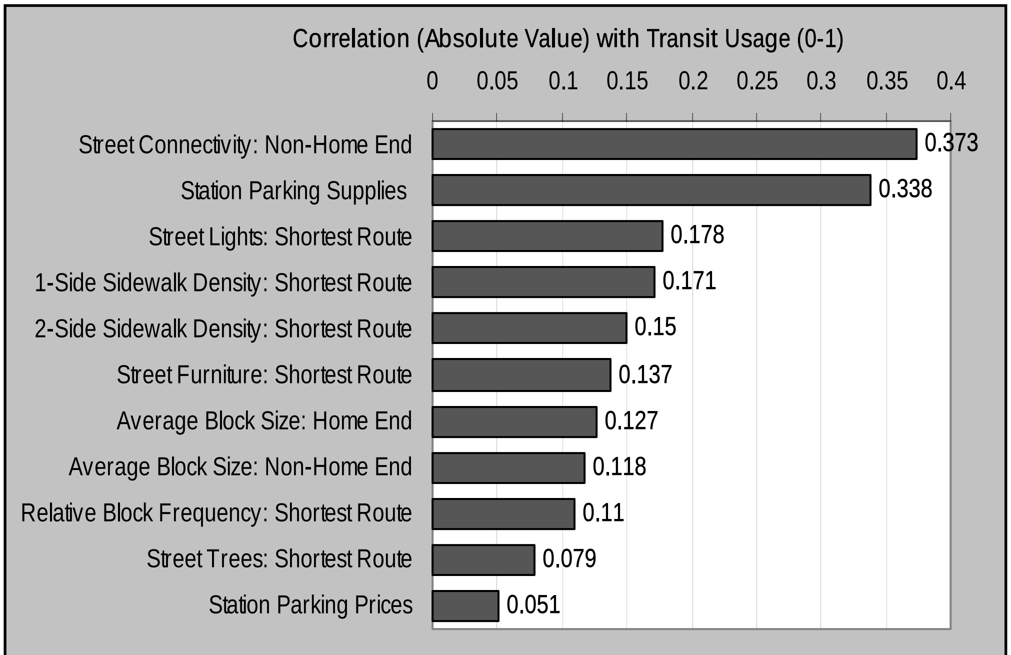

Figure 5-16. Rank-Order of Simple Correlations (in Absolute Terms) Between Neighborhood/Station Attribute and Transit Riding

Socio-demographic characteristics: Survey respondents and neighborhoods

It is important to include socio-demographic characteristics as statistical control variables in a mode-choice analysis, in order to account for the association between these characteristics and transit riding. Those living in households with numerous motor vehicles, for example, might be less inclined to patronize transit. It is also important, however, to understand the nature of these relationships. Two types of socio-demographic characteristics are included in this study: those of surveyed respondents and their households (using self-reported survey data), and of the neighborhoods in which station area residents live (using 2000 Census data for one-mile rings around surveyed sites).

The strongest socio-demographic associations with transit travel are total number of household vehicles (correlation of *-0.215*) and having an occupation in the professional/managerial/financial field (correlation of *0.085*). As noted previously, the association with white-collar occupation reflects the fact that California's rail networks focus on serving Central Business Districts (CBDs), where office jobs tend to be concentrated.

Figure 5-17 (next page) presents these data in terms of percentages. For station area residents with no vehicle available in their household, 79 percent of trips are by transit; on the other hand, if there are two or more vehicles in the household, then only about one in ten trips are by transit. Figure 5-17 further reveals a difference—around 5 percentage points—in transit usage between station area residents with white-collar office jobs versus those working in other fields, with white collar workers more likely to use transit.

No meaningful associations were found between transit riding and other socio-demographic characteristics of survey respondents, including household income, or the person's race, gender, or age. White respondents are slightly less likely to ride transit (correlation value of *–0.071*, with both variables coded as 0-1); other simple correlations are even smaller.

Little association was also found between the socio-demographic characteristics of station area residents' surrounding neighborhoods and levels of transit use. A weak positive association exists between transit riding (coded 0-1) and the median income (from the 2000 Census) of all households within one-mile radii of surveyed sites (correlation of *0.087*). There is also a weak association between transit riding and the share of residents within the one-mile radii who are Asian (correlation of *0.109*) and African-American (correlation of *0.087*). Given that African-American households generally have below-average incomes, these results seem to conflict. In general, socio-demographic attributes of the surrounding neighborhood are weak predictors of transit usage and therefore fail to enter the best predictor models.

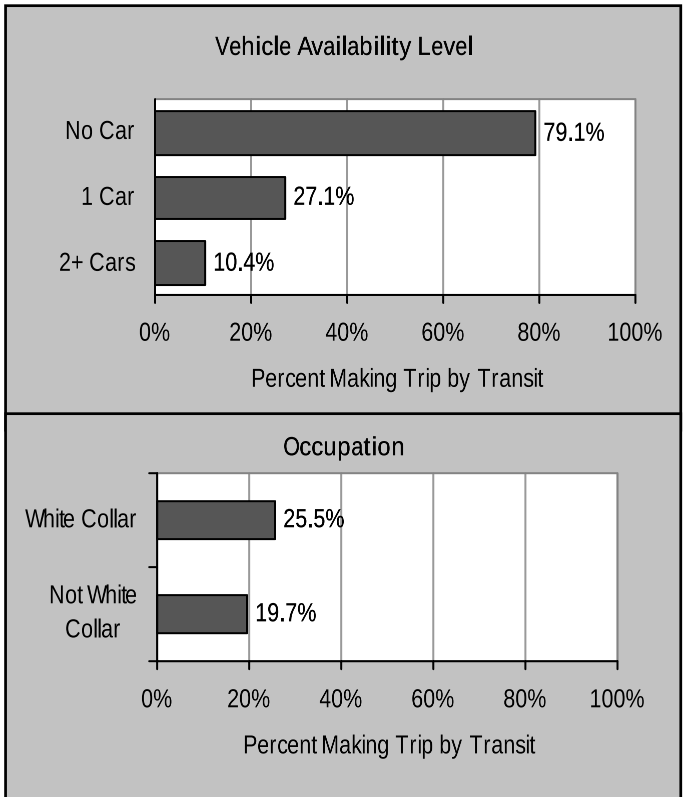

Figure 5-17. Share of Surveyed Residents Using Transit

Others: Reasons for Moving and Trip-Chaining

Two other personal variables—reasons for moving to the station area and trip-chaining behaviors—were available for the analysis. Some observers claim that higher ridership levels among those living near transit reflect a lifestyle preference—i.e., a desire to reduce stress, or to be "environmentally friendly," by taking transit rather than driving to work. The theory is that access to transit is an important factor in the choice of one's residential location, thus high ridership levels simply reflect individuals acting upon their lifestyle preference. Trip chaining is believed to deter transit usage because of the inherent flexibility advantages of a private vehicle; this theory was supported earlier in the chapter. It is also understood that those living in households with dependents are particularly likely to make trip chains, such as working mothers who balance child-rearing responsibilities with their professional careers.

Data on both variables are collected through the survey instrument. One question asked respondents to mark the top three factors considered when moving to their current residence (in the TOD), with "access to transit" being one of possible responses. This variable was coded 0-1, with a value of one indicating that living near transit was important in their residential location. With regard to trip chaining, respondents were asked—for each of their main trips—if the trip involved additional stops (or "multiple legs"). This variable was also coded 0-1, with one denoting a multi-legged trip.

Figure 5-18 shows that the expected relationships exist. Just over half of all trips made by those who said transit access was an important factor in choosing their residence are by transit. Among those who did not consider proximity to transit as one of their primary reasons for moving, only one out of 20 trips are by transit. Moreover, if a trip is chained, the likelihood that a station area resident will use transit for that trip is only about 10 percent. If the trip is not chained, the odds increase to one out of four.

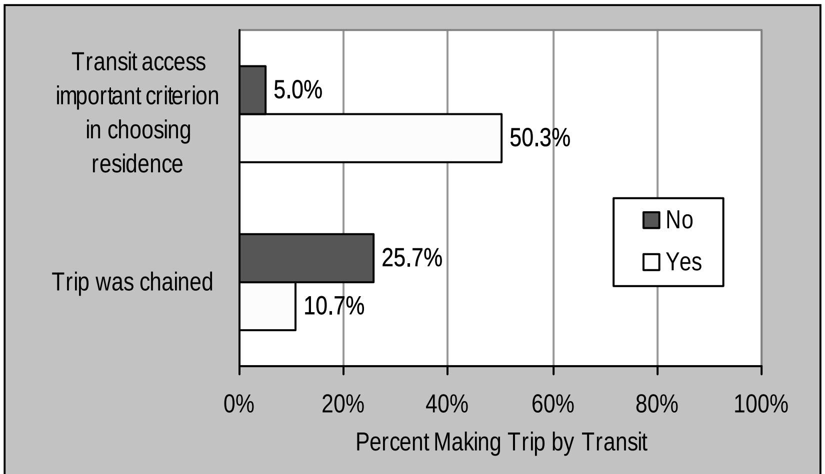

Figure 5-18. Influences of Attitudes to Transit Access and Trip Chaining on Transit Usage

Mode Choice Predictive Models

This section presents models that predict mode choice among residents of surveyed housing projects. These results build upon the simple correlations between transit choice and various attributes of travelers, competing modes, and station area neighborhoods; however, when variables are considered in combination, their marginal contributions, controlling for the influences of predictors already in the equation, can be portrayed. A fuller model specification using multiple explanatory variables provides a more accurate picture of the relative importance of predictors while also reducing the chances of spurious inferences. The models incorporate normative measures of utility found in traditional mode choice models, plus various measures of station area environments. In this sense, the models improve upon the specifications of the 1993 Cervero study.

A best-fitting binomial logit model is first estimated that predicts the likelihood that a station area resident will choose transit (rail or bus) for a trip, regardless of purpose. Many, though not all, of the variables outlined in the previous sections that were strongly correlated with transit riding entered this best-fitting model. Variables entered only if they were statistically significant and yielded intuitive and reasonable results. Some variables, particularly related to urban design, did not enter into the best-fitting model because they were highly inter-correlated with variables already in the equation. The results of this model are presented in Table 5-22 (next page). Rho-squared statistics are in the 0.83 to 0.85 range. All variables are statistically significant at the 5 percent (alpha) level, with one exception, and most are significant at the 1 percent (alpha) level. Signs are consistent with expectations.[6] In contrast to the simple correlations reviewed previously, these models show the marginal contributions of each variable controlling for the influences of others.

Using the same variables, binomial models are also shown for predicting the likelihood that a station area resident will choose transit (rail or bus) for their *commute* trip, and for predicting rail use only (not including bus) for *any* trip purpose. Results for the three models—transit (all trips),

[6] The one exception was the connectivity level variable for the work-trip model. Presumably, workers are less sensitive to street design in and around their workplace when making a commute mode choice.

transit (work trips), and rail (all trips)—are quite similar, however, thus the following discussion focuses mainly on the best-fitting one: transit (all trips).

Table 5-22. Best-Fitting Binomial Logit Models for Predicting Transit Choice

	Transit Model (Rail and Bus)				Rail Model (Rail Only)	
	All Trips		Work Trips		All Trips	
	Coef.	*Wald*	*Coef.*	*Wald*	*Coef.*	*Wald*
Travel Time and Patterns						
Comparative Times: [(travel time via highway network)/(travel time via transit network)]	5.082	36.86	3.180	9.70	5.783	44.88
Chained trip (1=yes; 0=no)	-1.475	9.83	-2.147	11.15	-0.095	4.42
Regional Accessibility						
Job Accessibility via Highways: No. of jobs (in 100,000s) that can be reached via highway network within 60 minutes peak travel time	-0.042	6.83	-0.040	3.86	-0.069	13.80
Transportation Options at Workplace						
Flex-time (1=yes; 0=no)	2.839	60.66	4.194	54.66	2.439	45.30
Free parking (1=yes; 0=no)	-1.159	8.62	-2.370	22.12	-1.031	6.58
Employer helps with vehicle expenses (1=yes; 0=no)	-2.705	15.47	-3.618	19.17	-2.352	11.21
Neighborhood Design						
Connectivity levels at destination: proportion of intersections that are 4-wayor more	4.137	16.81	2.021	2.52	3.344	11.50
Socio-demographic and Attitudinal Controls						
Auto ownership levels: No. of motorized vehicles per household member 16 yrs. or older	-2.380	29.93	-2.976	27.13	-0.987	6.24
Transit lifestyle preference: access to transit a top factor in choosing residential location (0-1)	1.602	18.46	1.471	10.42	1.545	16.41
Constant	-3.817	30.92	-1.994	5.55	-4.540	42.73
Summary Statistics						
No. of cases	967		726		967	
Chi-Square (sig.)	663.4 (.000)		585.9 (.000)		604.30 (.000)	
Rho-Squared (McFadden) = 1 – L(B)/ L (C)	.843		.852		.835	

[1] Wald Statistic equals t-statistic squared

Table 5-22 reveals that a number of policy-related variables have significant influence on mode choice, even when controlling for influential "utility" factors—most notably, comparative travel times by vehicle versus transit, accessibility levels by auto, and the need to chain trip ends.[7] Among the variables within the sphere of policy influence, workplace variables are generally the most influential, particularly the availability of flextime (a transit inducement), and employer-provided free parking and vehicle allowances (both are transit deterrents).

In contrast, neighborhood design factors have limited influences once other variables were controlled. In fact, the only neighborhood-design variable that provides significant explanatory power is the level of street connectivity at the destination. No home-end urban-design variables—

[7] These control variables had signs that matched expectations. The positive sign on the "comparative times" variable indicates that as travel time over the highway network increases relative to travel times by transit, the likelihood of taking transit increases, holding the influences of all other variables constant. On the other hand, trip chaining lowers the probability of taking transit at the margin. High accessibility to destinations (as reflected by numbers of jobs in TAZs) via highways implicitly reduces the attractiveness of taking transit, thus further lowering probability estimates.

whether measured within a one-mile ring of residences or attributes along the shortest walking path—enter as significant predictors. The only urban-design variable for the home-end of a trip with predictive promise was the amount of street furniture along the shortest route. However, this variable had a probability (alpha) value of 0.15 and its inclusion reduced the adjusted rho-squared statistic. It was thus omitted from the final best-fitting models.

Model results for each of the variable sets are summarized below:

- *Travel Time and Travel Patterns*. The most common utility-based measure of mode choice—comparative travel times—entered the model as an important and significant control. As travel-time via highways relative to transit increased, the probability of taking transit also rose. Trip-chaining marginally reduced the likelihood of transit riding, particularly for work trips.
- *Regional Accessibility*. The more accessible jobs were within a 60-minute peak travel time over the highway network, the less likely it is that station area residents will commute by transit, particularly rail transit. Job accessibility over regional highway networks is a much stronger predictor than job accessibility over regional transit networks.
- *Transportation Options at Workplace*. The most influential single variable (based on the size of the Wald T-statistics) for all three models is the availability of flextime at the workplace. There was some concern that this variable might have served as a proxy for some other workplace variable, like parking policy or help with vehicle-commuting costs, however these variables were explicitly accounted for in the model. The most significant workplace *deterrent* to transit riding is employer assistance with paying vehicle-related costs, such as tolls and fuel. Free parking also reduces the likelihood that a station area resident will commute by transit. This finding is similar to that of the 1993 Cervero study.
- *Neighborhood Design*. As noted, the only neighborhood design variable that provides significant explanatory power when other factors are controlled is the level of street connectivity at the destination end of a trip. Evidently, when deciding whether to use transit, it is important to station area residents that there be a more walkable grid-like street pattern with high connectivity at the trip destination—more important than having a high level of connectivity near their home (or other trip origin).
- *Socio-demographic and Attitudinal Controls*. Consistent with expectations, the presence of large numbers of motorized vehicles (relative to the number of household members 16 years of age or older) reduces transit usage among station area residents. Resident who reportedly moved to the TOD for the improved transit access are more likely to use the transit, suggesting that self-selection—where it exists—significantly influences mode choice.

It bears noting that some variables of particular interest from a policy standpoint, such as neighborhood density and urban design, did not enter the best-fitting equations. Another important policy variable—amount of parking per dwelling unit for surveyed projects—was also entered as a predictor of mode choice, but yielded counter-intuitive results.[8] Parking supply is

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[8] When this variable was included in the logit models, it had a positive sign, indicating the odds of transit riding increases as parking supplies per dwelling unit rises for a station area housing project. The simple correlation between "parking spaces per unit" and transit riding (coded 0-1) was weakly negative (-0.07), which matches expectations. A simple comparison of means reveals the following shares of surveyed station area residents who took transit (for all trip purposes) based on parking supplies at their projects: < 1.05 spaces per unit (30.0% took transit); 1.05 to 1.35 spaces per unit (9.9% took transit); 1.35 to 1.70 spaces (32.1% took transit); 1.70 to 1.90 spaces (60.6% took transit); and > 1.90 spaces (12.8% took transit). Except for the highest category (low transit shares among those living in projects with 1.9 spaces or more per unit), there was no clear pattern between project parking supplies and transit riding.

unlikely to be a significant predictor, however, if there are no shortages of parking and/or the cost of parking bundled with the rent for the unit (as it is in all cases in this study). Further studies of parking occupancy in these units are needed to fully understand this phenomenon.

Overall, the model results suggest that policy-makers should pursue initiatives that encourage employers to promote transit (e.g., through helping cover the cost of transit passes) and discourage vehicle commuting (e.g., by eliminating free parking). Both "workplace policy" variables were significant predictors of transit mode choice. At the local level, governments can require these provisions through development agreements. If transit-oriented development is occurring in redevelopment areas, cities have more options for requiring transit-friendly building management practices. This point is expanded on in the policy recommendations of the concluding chapter.

Sensitivity Test

For purposes of examining the sensitivity of transit choice to changes in policy variables, several sensitivity tests are conducted. This involves inputting variables in the logit models (from Table 5-22) to estimate probabilities for the "typical" person, and then changing selected inputs while holding all other variables constant. The first sensitivity test examines how changes in two workplace transportation programs—flextime and parking costs—influence the probability of choosing transit over a range of values for a key covariate: comparative travel times by auto versus transit. The "typical situation" involved inputting mean or modal (i.e., most frequently occurring) values for predictor variables of the logit model and perturbing values for the three variables examined in the sensitivity tests. The typical values are: no trip chaining; regional access to 2.2 million jobs within 60 minutes via the peak-period highway network; no employer assistance with vehicle expenses; a moderate level of connectivity at the destination (connectivity index = .34); one vehicle per household member 16 years or above; and transit access not being a factor in residential location choice.[9]

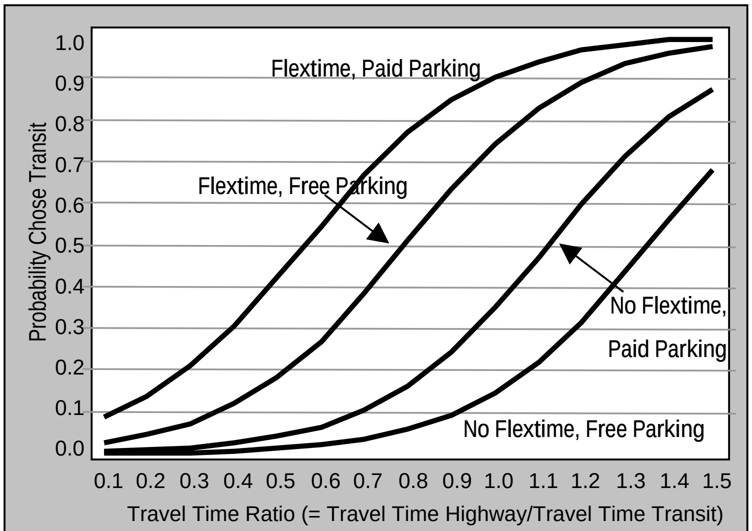

Figure 5-19. Sensitivity & Paid Parking Over Range of Travel Time Ratios, for "Typical" Trip by Station Area Residents

Sensitivity Test: Influences of Flextime and Parking Costs

Figure 5-19 plots the sensitivity results for predicting transit (rail and bus) choice for work trips. At a travel time ratio where it takes 30 percent longer to go by transit than automobile during peak hours (i.e., 0.7), there is only a 5 percent chance a station area resident will take transit if parking is free and flex-time is not available. All else equal, charging for parking increases the

[9] The share of trips that were chained was 17.5%. The shares for which employers provided help with car costs was 40.5%; the share of respondents indicating that transit access was a top-three factor in making a residential location choice was 39.7%.

probability of transit use up to around 10 percent. Introducing flextime, but retaining free parking, catapults the likelihood of transit commuting to 40 percent. Combining flextime with paid parking increases the likelihood of transit riding by nearly 70 percent. This likelihood is increased even further when the relative speed advantages of transit versus vehicle travel are considered. *When transit offers a 20 percent or more travel time savings relative to the vehicle during peak hours, the likelihood of a station area resident with flextime taking transit to get to work is well over 90 percent. Combining paid parking at the workplace brings up the probability of transit commuting to around 99 percent.* Clearly, quality-of-transit services and transportation options at the workplace are important to California's station area residents.

Sensitivity Test: Influences of Vehicle Ownership and Street Connectivity

Figure 5-20 presents the results of testing how sensitive transit ridership (for all trip purposes) is to automobile ownership levels, using the one significant urban-design variable—the street connectivity index at the non-home end of the trip—as the covariate.[10] If half of the intersections within a mile radius of a trip destination are 4-way or more, there is around a 48 percent probability that a station area resident will take transit if he or she lives in a zero-vehicle household. If there is one vehicle per person (16 years or above), the probability drops under 10 percent and if there are two vehicles per person (16 or above), it plummets to near zero. If the street network at the destination is a grid and there are no vehicles in a station area residents' household, the likelihood of transit riding is nearly 90 percent. Clearly, vehicle ownership levels are an important determinant of transit riding among California's station area residents. Policies like flexible parking standards, unbundled parking charges (which provide lower rent by separating charges for parking from occupancy) and location efficient mortgages can thus encourage transit riding to the degree they attract zero-vehicle households to station areas. Programs like carsharing (that further relieve the need for vehicle ownership among station area residents) could also translate into increased ridership.

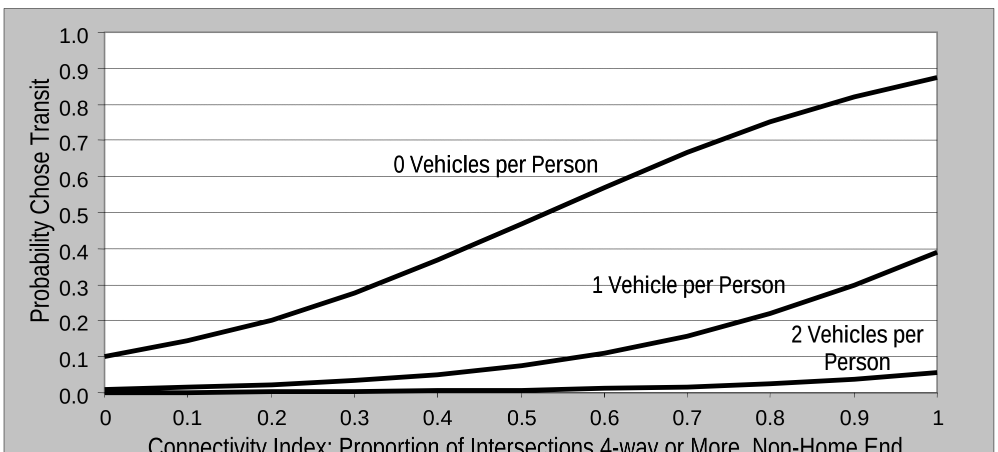

Figure 5-20. Sensitivity Test Two: Influences of Motorized Vehicles per Persons 16 years or older, Over a Range of Street Connectivity Levels (at Non-Home End of Trip), for "Typical" Trip by Station area Residents

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[10] In this test, all values for the "typical" trip are the same as before (except for variables used in the test). Values for flex-time and free-parking are set to 0, reflecting the typical situation where station area residents do not have flex-time (54.3% do not) and do not receive free parking at their workplace (59% do not).

Factors Influencing Non-Motorized Access to Rail Stations

For rail trips made by station area residents, a choice model was estimated to predict whether they accessed stations by foot or bicycle—i.e., by non-motorized transport (NMT). Given that the surveyed housing projects were within a half-mile of stations, an eminently walkable distance, reasonable shares of rail travelers might be expected to arrive by foot or bicycle. Indeed, over 85 percent of access trips to rail stops by surveyed station area residents were by NMT (predominantly walking). Given the limited variation in access mode choice, a choice model with limited explanatory variables and power was expected. This was the case.

Table 5-23 shows that high vehicle ownership levels deters walking/biking access. Transit riders with higher incomes are generally more likely to walk or bike to a station, even after controlling for vehicle ownership levels; this possibly represents the greater health consciousness of upper-income transit users. It was expected that some of the many neighborhood design variables collected for this study—e.g., street connectivity indices, retail shops, residential densities, presence of street trees and furniture—would have influenced the willingness of station area residents to walk or bike to stations. Somewhat surprisingly, only one urban-design variable entered the equation, and it had modest predictive powers. Bright lights evidently sway some station area residents to walk or bike. Good illumination is particularly valued in the evening after work. In general, the access choice model is as notable for variables that did not enter the equation (notably the absence of neighborhood design variables) as for those that did.

Table 5-23. Best-Fitting Binomial Logit Model for Predicting Non-Motorized Access to Rail Stations by Station area Residents; All Trips

	Coef.	Wald
Socio-demographic Variables		
Auto ownership levels: No. of motorized vehicles per household member 16 yrs. or older	-2.523	5.51
Higher income: Annual Household income $75,000 or more (0-1)	1.117	2.356
Neighborhood Design		
Street lighting density: Number of street lights per 1000 feet of shortest walking distance from residence to nearest station	0.146	3.328
Constant	2.394	3.743
Summary Statistics		
No. of cases	90	
Chi-Square (sig.)	12.5 (.000)	
Rho-Squared (McFadden)	.245	

Project Level Analysis: Ridership Gradients and Models

This section carries out mode choice analyses at the aggregate level, using each of the 25 surveyed residential TOD projects as a case observation. This is in contrast to the analyses presented in the previous section wherein each case was an individual trip made by a station area resident. The analysis is aggregate in that trip data for each housing project are pooled and presented collectively.

Initially, transit modal shares for surveyed projects are plotted as a function of project distance to the nearest station. This identified the degree to which a ridership gradient exists. This is followed by the presentation of a predictive ridership model. Next, transit modal shares among surveyed projects are compared to those of surrounding neighborhoods that lie beyond ½ mile of a rail station. Lastly, a model is presented that identifies factors explaining comparative transit shares of surveyed projects and surrounding areas.

Ridership Gradient

All 25 of the surveyed housing projects were situated within a half-mile of a California rail station. Figure 5-21 shows the plot of the share of trips by residents of each project as a function of distance of the project to the nearest station. There was a slight negative slope, however the ridership gradient was quite flat.[11] Compared to the 1993 Cervero study, the gradient is much flatter. These latest results suggest the presence of an "indifference zone": station area residents appear to be generally indifferent to distance as long as they are more or less within a five-to-eight minute walk, which was the case for projects surveyed. This supports the notion that urban design features exert modest influences on ridership among those who live within walkable distance of rail stations.

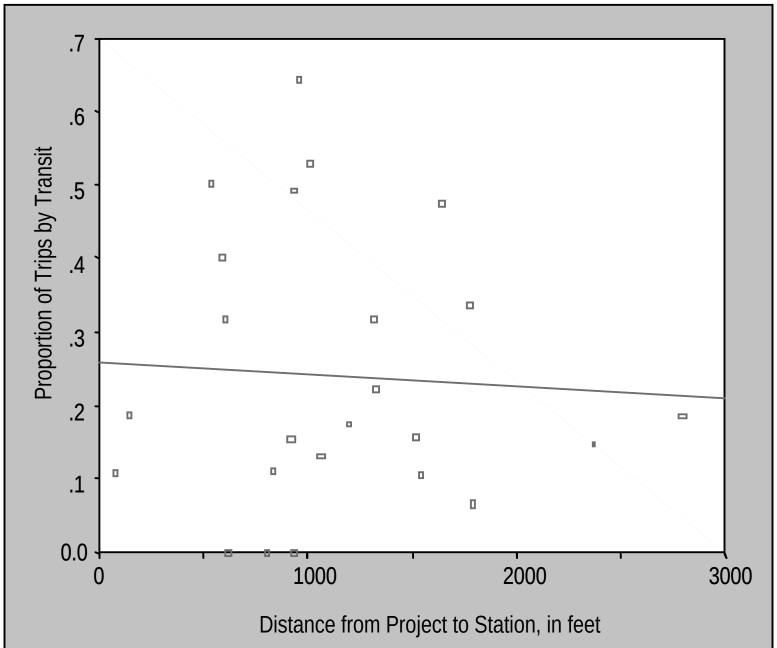

Figure 5-21. Ridership Gradient: Transit Share as a Function of Distance

Ridership Share Predictive Model

Using each of the surveyed projects as a data case, an aggregate model predicts the proportion of total trips made by residents via public transit. Ordinary least-squares regression estimation is used. Compared to the discrete-choice (logit) model presented previously, this analysis focuses on the relative influence of site and neighborhood characteristics on transit riding.

Data were not available for all projects, thus the sample size for estimating the best-fitting regression equation is 22. Table 5-24 presents the best-fitting model. All variables are significant at the .10 probability (alpha) level and most are significant at the .05 level. The model explains 81 percent of the variation in transit modal shares (for all trips) across the 22 housing projects.

The model reveals these factors to be significant predictors of project-level ridership shares:

- *Regional Accessibility*. If transit provides accessibility advantages in reaching jobs relative to highway travel, transit use by station area residents increases. Every 10 percent increase in transit's relative job accessibility over highway travel increases the share of trips by transit, on average, 13 percentage points.

[11] A simple regression of the scatterplot produced an r-squared statistic of less than 0.01.

- *Neighborhood Design and Station Attributes*. While design variables are weakly associated with mode choice, they emerge as significant predictors in the aggregate study of patterns across housing projects. Adjusting for the distance between a project and nearest station, the share of trips by transit generally increased with the density of street trees, street furniture, and pedestrian crosswalks. This suggests that creating an attractive, comfortable, and safe walking environment can induce transit riding among station area residents. One must be cautious, however, not to read too much into these results since none of these variables emerged as significant predictors in the discrete-choice model, based on considerably more observations and the proper "ecological unit" for studying mode choice. Still, these regression findings suggest built environments may be important in some transit-accessible neighborhoods and thus should be considered when planning for transit-oriented development (TOD). In addition, those neighborhood design attributes are basic elements of good community planning and support many other community objectives. The model also suggests that the ridership shares rise with relative numbers of station parking spaces. Since surveyed projects lie within a walkable distance of stations, this is not necessarily a desirable finding; nevertheless, these results suggest that parking provisions could be an inducement to transit riding even among those living fairly close to stations.
- *Socio-demographic control*. A single socio-demographic entered the equation as a statistical control: mean number of motorized vehicles per resident 16 years of age or older. (This is comparable to the average number of vehicles per household member 16 and above in a project.) Recall this was also a significant control in the discrete-choice analysis. The model suggests that every additional vehicle per household member (16 or more) decreases transit's modal share by 23.3%, all else being equal.

Table 5-24. Multiple Regression Model for Predicting Proportion of All Trips by Transit for 22 Rail-Based Housing Projects

	Dependent Variable = proportion of all trips by transit (rail and bus)		
	Coefficient	*T-Statistic*	*Sig.*
Regional Accessibility			
Relative Job Accessibility: [No. of jobs that can be reached via transit network within 60 minutes peak travel time / No. of jobs that can be reached via highway network within 60 minutes peak travel time]	1.306	2.317	.034
Neighborhood Design/Station Provisions			
Relative Parking Supply: No. parking spaces at nearest station per 100 dwelling units within 1 mile of station	0.011	4.855	.000
Street Tree Density: No. street trees along shortest route from project to station per 1000 feet walking distance	0.012	2.803	.013
Street Furniture Density: No. street furniture items along shortest route from project to station per 1000 feet walking distance	0.016	2.972	.009
Crosswalk Density: No. pedestrian crosswalks along shortest route from project to station per 1000 ft walking distance	0.023	2.776	.014
Socio-demographic Control			
Auto ownership levels: Mean No. of motorized vehicles per household member 16 yrs. or older	-0.233	-1.763	.097
Constant	-0.079	-0.446	.662
Summary Statistics			
No. of cases		22	
F Statistic (sig.)		11.46 (.000)	
R-Squared		0.811	

Attempts were made to enter other variables with potentially great policy relevance into the best-fitting model, however none of these variables is statistically significant. For example, parking supply at the residential sites (average spaces per dwelling unit) is negatively associated with transit modal shares, however the marginal contribution of this variable is highly insignificant. Since none of the parking is charged separately from rents, current parking policy creates no incentive to lower automobile ownership and rely more heavily on transit.

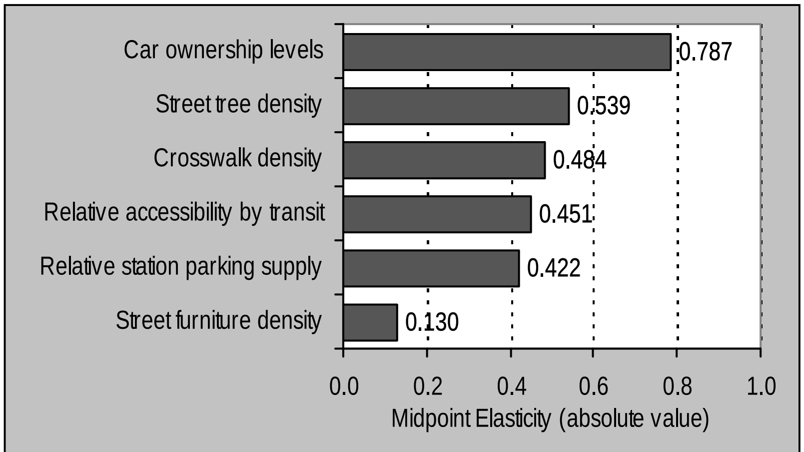

Figure 5-22. Rank Order of Midpoint Elasticities for Predicting Proportion of Trips by Transit across 22 TOD Housing Projects

A good way to summarize the relative predictive powers of variables that entered into the best-fitting regression model is to compare elasticities.[12] Midpoint elasticities of the explanatory variables (in absolute terms—i.e., ignoring signs) are rank-ordered in Figure 5-22. Vehicle ownership levels are the most powerful determinants of transit modal shares across the 22 surveyed projects. Street trees and crosswalks exert a moderately strong influence on modal shares based on the aggregate model results. Street furniture has a more modest effect.

Project Level Analysis: Comparison of Transit Modal Shares with Other Residents in Area

This section compares transit mode shares of the surveyed projects with those of residents who live beyond walking distance (but within three miles) of a station. Since sufficient data for other residents are only available from the Census, comparisons are for *work trips* only. The analysis contrasts transit commute shares between residents of surveyed projects (living within a half-mile of stations) to those who live within a ½-to-three mile radius of a project's station. This involved using GIS tools to identify a "donut" around each station (see Figure 5-23), and then extracting 2000 Census data to compare commute shares.

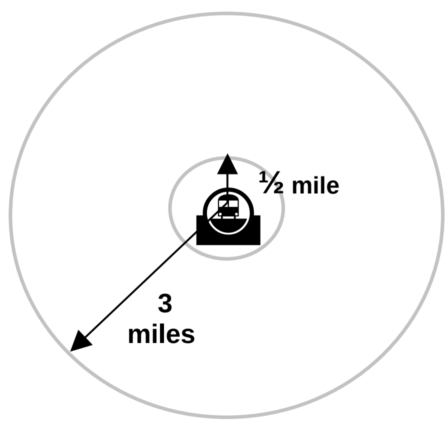

Figure 5-23. Donut for Defining Residents Within ½ to 3 miles of Rail Station

The results of the comparison are presented in Table 5-23. Results are again summarized by project setting (to ensure adequate sample sizes in each group). The differentials for BART stations are much greater than for other project

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[12] Elasticities represent the percentage change in the proportion of trips by transit given a one-percent increase in each of the explanatory variables, holding the influences of the other explanatory variables constant. Mid-point elasticities compute the relative change at the mid-point of the demand surface, using mean values for all variables: $E = (\partial Y/\partial X)(X'/Y')$ where E = elasticity, Y = dependent variable (proportion of trips by transit), X = explanatory variable, Y' = mean of dependent variable, X' = mean of explanatory variable, and ∂ = partial derivative.

settings. Residential TODs in the Pleasant Hill BART station area, as well as those near the Hayward, South Hayward, and Union City stations, have transit commute shares that are 36 percentage points above those living in the ½ to 3 mile donuts around the respective stations. In relative terms, transit's market shares in southern Alameda County are 19 times higher. The sources of these differentials can only be speculated, although factors such as self-selection, and BART's maturity as a regional transit system (relative to the other systems studied), are likely important factors. The only negative differential is found in the case of Long Beach, where the surveyed residents are *less likely* to commute by transit compared to the surrounding "donut" area. This could relate to the fact that Long Beach TOD residents were more likely to choose their residential location based on housing cost and quality as opposed to transit access. It might also be attributed to differences in the surrounding areas—whereas most of the surveyed projects (in other regions) are located in the midst of more suburban settings, the Long Beach TOD sites are both "in-fill" projects within the downtown area of Long Beach, meaning that the surrounding "donut" areas are also quite transit-friendly.

Overall, more than a quarter of work trips made by residents living in the surveyed TODs are by transit, compared to just 7 percent for those living in the "donuts," producing a 20-percentage point differential—or a 3.9 times greater likelihood that residents living near the rail station will commute by transit.

Table 5-25. Comparison of Transit Commute Shares between Surveyed Sites (by Project Setting) and Dwelling Units within a ½ to Three Mile "Donut" of Nearest Rail Station

	Transit Commute Mode Share for Those Living in[1]:			
	Project		½ to 3 Mile "Donuts" around Rail Station	% Point Difference
	Mode Share	N		
BART: Pleasant Hill	45%	176	13%	+32%
BART: S. Alameda County	38%	177	2%	+36%
LA Metro: Long Beach	3%	60	11%	-8%
SD Trolley: Mission Valley	13%	185	6%	+7%
Caltrain Commuter Rail	17%	121	5%	+12%
Weighted Average	27%	719	7%	25%

[1] Percentages for dwelling units within donut of rail stations from 2000 Census; weighted average, based on project size, is applied to both project and dwelling units within the station donuts.

Factors Influencing Comparative Project Level Analysis

A final predictive model examines variables that might explain differences in work-trip mode splits between residents of surveyed projects and those living in the "donut." Table 5-26 (next page) presents the best-fitting regression model that predicted this ratio:

$$\text{Ratio} = \frac{\text{(Proportion of project's work trips by transit)}}{\text{(Proportion of work trips in project station's "donut" by transit)}}$$

The model shows that service characteristics of a rail station—namely, peak headways and relative parking supplies—are significant in explaining differentials. Those living within walking distance evidently value frequent train services and convenient station access relative to those living within the ½ to three mile "donut." High vehicle ownership levels within a surveyed project lower the likelihood of rail commuting relative to those living in the "donut." None of the neighborhood design variables is significant in explaining differentials. The model has moderately good predictive powers, explaining around 44 percent of the variation in ratios of transit modal splits between surveyed projects and those living in "donuts."

Table 5-26. Multiple Regression Model for Predicting Ratio of Share of Work Trips by Transit for Surveyed Sites to "Donut"

	Dependent Variable = (proportion of project's work trips by transit)/ (proportion of work trips by transit for station "donut")		
	Coefficient	*T-Statistic*	*Sig.*
Rail Service Characteristics			
Rail Headway: Average peak-period minutes between train pass through project's station	0.251	2.426	.024
Relative Parking Supply: No. parking spaces at nearest station per 100 dwelling units within 1 mile of station	0.134	2.688	.014
Socio-demographic Control			
Auto ownership levels: No. of motorized vehicles per household member 16 yrs. or older in surveyed project	-5.197	-1.855	.078
Constant	3.310	1.104	.282
Summary Statistics			
No. of cases		22	
F Statistic (sig.)		7.63 (.000)	
R-Squared		0.441	

Summary of Findings Related to Station Area Residents

The residential TODs surveyed in this study seem to be attracting young professionals or, in the case of commuter rail, small families. In most cases, these households are moving to the TODs for the housing stock rather than the transit access; the exception to this is the BART system, where residents are most likely to report "access to transit" as their primary reason for moving. These priorities are also reflected in residents' reported travel patterns: transit use is much higher among residents living near BART stations.

Overall, the share of commute trips made by public transit is five times higher among TOD residents than that found in the surrounding cities, and four times higher than residents in the ½ to 3 mile "donuts" around the respective rail station. Rail is also used more frequently for commuting than for non-work purposes. These commute patterns (for TOD residents) have not shifted over the past decade; among the sites surveyed in both the 1992 and 2003 periods, there was not a significant increase or decrease in transit mode choice for commuting.

Factors that relate positively to rail use among TOD residents (at the individual level) are: comparative travel time between highway and transit, having a "flextime" option at work, pedestrian connectivity at the trip destination, and the desire to live near transit. Factors that work against the use of rail transit are: trip chaining, job accessibility via highways, free parking at the worksite, employer subsidies for vehicle expenses, and auto ownership. Design elements help explain project-level variations in transit use but are generally not significant in predicting individual mode choice behaviors.

CHAPTER 6. FINDINGS RELATED TO STATION AREA OFFICE WORKERS

Overview of Surveyed Station Area Office Workers

Response Rates by Site and Rail System

A total of 4,380 surveys were delivered to office managers and/or employers for distribution to office workers at the selected station area office sites. Employees working near BART stations received the most surveys (1,115), followed by those near Sacramento LRT stations (965) and the Los Angeles Metro Red Line (900). BART received the most surveys because there are more sites to study and more sites in the 1992/94 surveys. A total of 877 completed office surveys were returned, for a 20 percent response rate overall. The lowest response rates (6% overall) were from L.A. Metro sites; the highest (32% overall) were from Sacramento LRT sites. BART, with the largest share of surveys, had a response rate of 19 percent. Among the office sites, the highest response rates were provided by Sacramento LRT's Department of Conservation (46%) and BART's California Plaza (31%).

As with the residential sites, office sites are grouped according to project setting in order to account for low response rates at select sites. In some cases, the project settings represent an entire rail system; where enough sites exist, however, rail systems are divided into sub-areas in order to reflect differences in development type and/or location. Project settings do not combine sites from different rail systems. Table 6-1 provides a full inventory of sites studied, organized by project setting, and the response rates for each site and project setting. As in the previous chapter, margins of error[1] were calculated for each project setting, but in this case, only one project setting—San Jose VTA—has too large of a margin of error to be presented separately. Survey data from the San Jose site are included only in the "all site" summaries and in the modeling analyses presented later in the chapter.

Of those project settings that are presented, conclusions can be most accurately drawn from the Berkeley (BART), Walnut Creek/Fremont (BART), Mission Valley (San Diego Trolley), and Sacramento LRT settings. Two settings—Hollywood (L.A. Metro) and Anaheim (Metrolink)—have margins of error that are close, but not quite within the range deemed acceptable for this study; these data are presented but should be viewed with caution.

[1] Margins of error for each project setting are calculated at the 95 percent confidence level assuming the most conservative population proportion (0.5). This population proportion maximizes the assumed standard error. For the purposes of this study, it was determined that a 10% margin of error is acceptable. A 10% margin of error means that if the survey were to be repeated, survey responses would lie +/-10% of the initial survey responses 95 percent of the time, for each survey question. Or, we can be 95 percent confident that the actual values are +/- 10% of the reported values. Project settings with a margin of error less than 15% are included in the following descriptive analyses, but should be viewed with caution.

Table 6-1. Response Rates, Surveyed Office Sites

Site, by Rail Systems	Station	Surveys Distributed[1]	Completed Surveys (#)	Completed Surveys (%)
HEAVY RAIL				
BART: Berkeley				
Great Western Building	Berkeley	430	104	24.2%
		430	104	24.2%**
BART: Walnut Creek/Fremont				
Fremont Office Center	Fremont	300	39	13.0%
California Plaza	Walnut Creek	235	72	30.6%
		535	111	20.75%**
L.A. Metro (Red): Hollywood				
TV Guide Hollywood Center	Hollywood/Highland	300	36	12.0%
5161 Lankershim	Hollywood/Western	600	15	2.5%
		900	51	5.7%*
LIGHT RAIL				
San Diego Trolley				
Mission Valley Heights Office	Hazard Center	800	210	26.3%
		800	210	26.3%**
San Jose VTA: Baypointe				
SS8 Networks	Baypointe	150	23	15.3%
		150	23	15.3%‡
Sacramento LRT				
Dept of Conservation	8th and K Street	465	212	45.6%
California Center	Watt/Manlove	500	97	19.4%
		965	309	32.0%**
COMMUTER RAIL				
Metrolink Commuter Rail				
Stadium Towers	Anaheim	600	67	11.2%
		600	67	11.2%*
TOTALS		4380	877	20.0%**

[1] Office surveys were distributed to employees by employer/office manager; "surveys distributed" equals the number of surveys provided to each employer/office manager for distribution
** Margin of error is less than 10% (at the 95% confidence level); findings can be generalized to the survey site
*Margin of error is between 10 and 15% (at the 95% confidence level); findings should be viewed with caution
‡ Margin of error exceeds 15% (at the 95% confidence level); findings *cannot be generalized* to the survey site

Personal and Household Attributes

In the case of office workers, demographic and other comparisons are made to the surrounding region rather than the surrounding cities (the control group used for the residential analyses), as station area employees are more likely to draw from a larger population base. The following figures and tables summarize the individual and household characteristics of station area office workers, for all office sites combined and project settings with acceptable response rates, and their respective metropolitan statistical areas (MSAs). Station area data differ from regional averages and distributions because the survey respondents are employed persons—more specifically, employed persons in office occupations—as opposed to the total adult population.

Among the surveyed workers, the percentages of women at the Hollywood and Sacramento sites are similar to the regional populations. In all other settings, surveyed workers are more likely to be women, on the order of 10 to 20 percent. The age structure of survey respondents is reflective of the office worker population, with a disproportionate share of respondents in the working years of 18 to 50; median ages for surveyed station area workers range from 33 and 47.

Figure 6-1 shows that, overall, surveyed office workers have less ethnic diversity than their respective regional populations. The exception is Mission Valley (San Diego), which is more representative of the surrounding region. Comparing the diversity of TOD office workers with that of residents (refer back to Table 5-2) shows that TOD residents are *more* diverse than TOD office workers, again in all systems except San Diego's Mission Valley. This may be because office worker commuters are drawn to TOD workplace locations from a large commuting shed that includes less diverse suburban areas. In terms of occupation, TOD respondent are predominately office/professional workers (83 to 96 percent of respondents), as would be expected given the survey focus on office buildings. Pleasant Hill and Caltrain sites have the highest levels of sales/service employees.

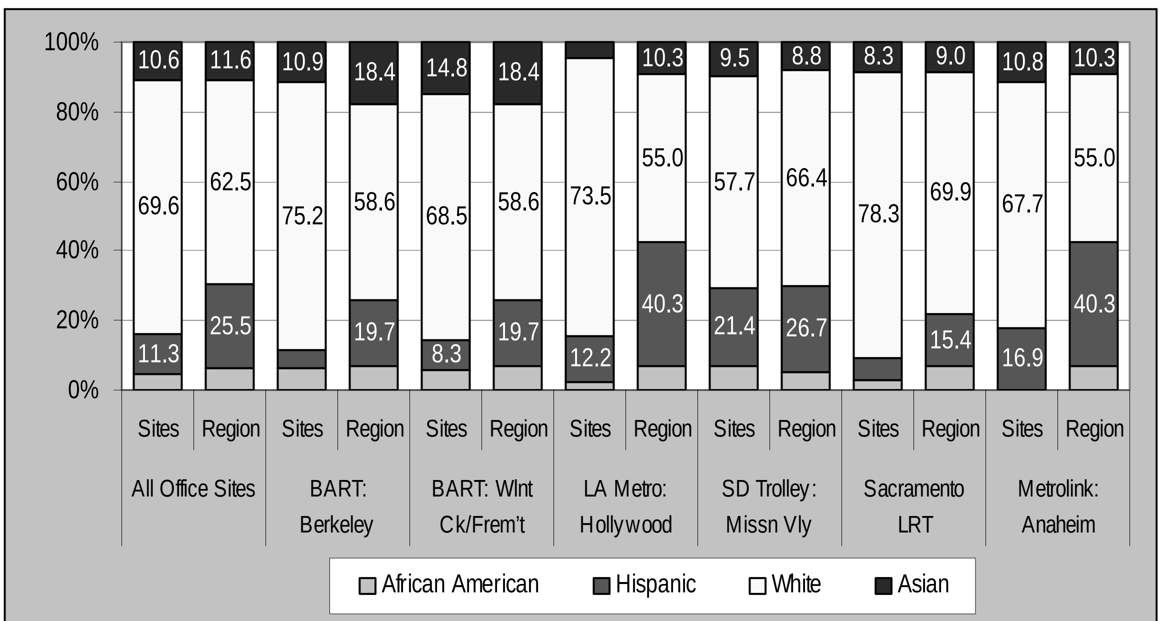

Figure 6-1. Race/Ethnic Composition, Surveyed Office Workers & Surrounding MSAs[1]

[1] MSA percentages will exceed 100 percent since ethnicity and race were asked in separate Census questions; as a result, some Hispanic persons may be double-counted

Households of the surveyed worker populations differ from the general population because the focus on office workers narrows the range of ages and life cycle stages among the surveyed population. Office workers are more likely to be single young professionals, or married with few or no children. Figure 6-2 shows that surveyed populations are more likely to live in 1-2 and 3-4 person households compared to the surrounding region and less likely to be in families of five or more. Since retirees with smaller household sizes are by definition excluded from the sample, these differences must be attributed to the younger populations. This pattern of smaller household sizes is similar to that found in the surveys of TOD residents, although residents were even more likely to be in 1-2 person households and less likely to be in 3-4 person households, reflecting the fact that multifamily housing in TODs is less able to accommodate families with children.

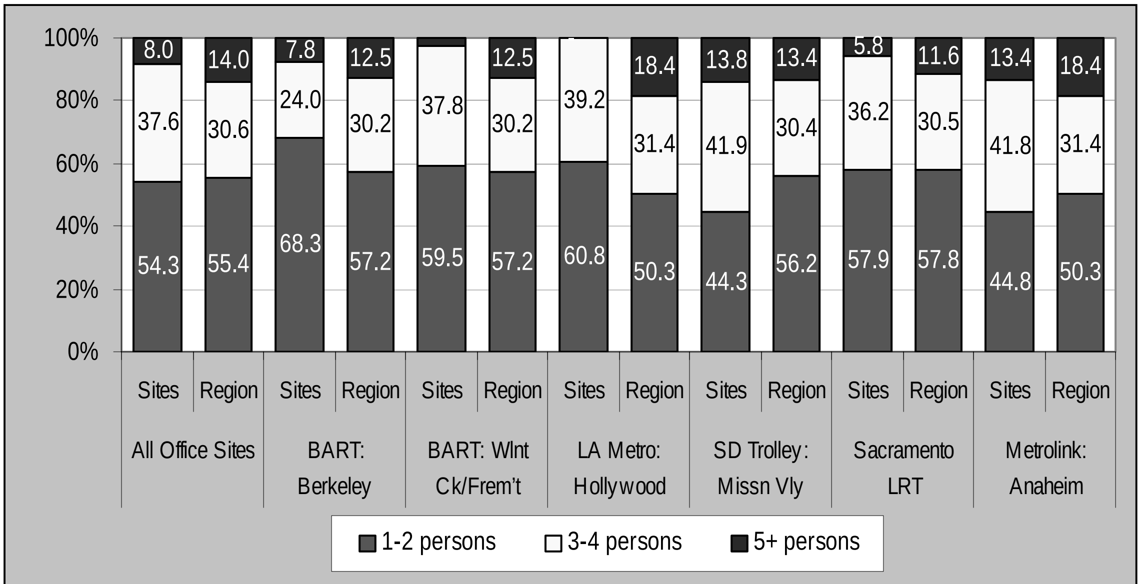

Figure 6-2. Household Size Distribution, Surveyed Office Workers & Surrounding City

Regarding automobile availability, office workers' survey responses indicate substantial variation. Of the BART respondents, around one-quarter report less than one vehicle per driver in the household (22% in South Alameda County, 28% in Pleasant Hill); responses on other systems range from 8 to 15 percent. The percent of households with less than one vehicle per driver is somewhat lower than that found in the residential surveys. Selection of a residential location with rail transit access may be a more important factor for households with lower automobile availability. The lower automobile availability on the BART system—among both residents and office workers—can be seen as both a possible explanation and a result of higher levels of transit use in the Bay Area.

Finally, Table 6-3 summarizes the income distribution of respondents. Since these are employed respondents, one would expect fewer respondents in the under $30,000 income range than found in the respective region. This is true for each project setting and overall. In addition, more respondents report incomes in the $60,000 to $100,000 range than the respective regional populations. Therefore, employees in these TOD are in higher income categories (although not necessarily the highest categories—those over $100,000), reflecting salaries in office work occupational categories and the ability of firms hiring those workers to capture desirable TOD locations. This is in contrast to the surveys of TOD residents, where residents are less likely to report incomes over $60,000 compared to the general population.

Table 6-2. Individual Characteristics of Surveyed Office Employees Compared to Surrounding Regions

	All Office Sites		BART: Berkeley		BART: Wlnt Ck/Frem't		LA Metro: Hollywood		SD Trolley: Missn Vly		Sacramento LRT		Metrolink: Anaheim	
	Surveys[1]	*Reg. Avg*	*Surveys*	*Region*	*Surveys*	*Region*	*Surveys*	*Region*	*Surveys*	*Region*	*Surveys*	*Region*	*Surveys*	*Region*
Female (%)	61.3	50.2	68.3	49.8	62.2	49.8	48.0	49.6	73.1	50.3	52.8	51.0	63.6	49.6
Over 50 yrs (%)	26.2	24.8	17.5	26.2	21.4	26.2	6.8	22.9	36.8	24.2	26.6	25.7	32.1	22.9
36 to 50 (%)	41.8	23.6	30.9	24.8	40.8	24.8	31.8	22.7	43.8	23.0	46.8	23.7	32.1	22.7
18 to 35 (%)	32.0	25.5	51.5	25.3	37.9	25.3	61.4	25.9	19.5	27.1	26.6	23.5	35.7	25.9
Under 18 yrs (%)	--	26.2	--	23.6	--	23.6	--	28.5	--	25.7	--	27.1	--	28.5
Median Age	43	33.9	35	35.6	40	35.6	33	32.3	47	33.2	44	34.6	42	32.3
Ethnicity (%)[2]:														
African American	4.2	6.8	5.9	7.2	5.6	7.2	2.0	7.5	6.5	5.6	2.8	7.0	0.0	7.5
White	69.6	62.5	75.2	58.6	68.5	58.6	73.5	55.0	57.7	66.4	78.3	69.9	67.7	55.0
Asian	10.6	11.6	10.9	18.4	14.8	18.4	4.1	10.3	9.5	8.8	8.3	9.0	10.8	10.3
Other	4.3	13.9	3.0	10.6	2.8	10.6	8.2	22.3	4.9	14.2	4.4	8.6	4.6	22.3
Hispanic origin (%)	11.3	25.5	5.0	19.7	8.3	19.7	12.2	40.3	21.4	26.7	6.2	15.4	16.9	40.3
Occupation (%):														
Office/Professional	92.1	35.2	88.5	41.5	85.6	41.5	94.0	31.3	95.9	33.2	95.3	34.9	83.1	31.3
Craftsman/Laborer	1.1	18.0	0.0	16.6	1.9	16.6	2.0	21.3	1.0	16.4	1.5	17.5	0.0	21.3
Sales/Service	5.6	38.6	11.5	36.6	9.6	36.6	4.0	39.1	2.1	38.2	2.1	40.5	15.4	39.1
Other	1.1	2.3	0.0	0.8	2.9	0.8	0.0	0.8	1.0	6.7	1.1	0.9	1.5	0.8

[1] "Surveys" = Survey data collected from station area residents; "Region" = 2000 Census data for Metropolitan Statistical Area (MSA) in which the project setting is located

[2] "American Indian" and "Pacific Islander" categories were also included on the survey, but are combined here with "Other" due to low responses; Survey data does not add up to 100% because "race" and "Hispanic origin" were not asked as separate questions

Table 6-3. Household Characteristics of Surveyed Office Employees Compared to Surrounding Regions

	All Office Sites		BART: Berkeley		BART: Wlnt Ck/Frem't		LA Metro: Hollywood		SD Trolley: Missn Vly		Sacramento LRT		Metrolink: Anaheim	
	Surveys[1]	*Reg. Avg*	*Surveys*	*Region*	*Surveys*	*Region*	*Surveys*	*Region*	*Surveys*	*Region*	*Surveys*	*Region*	*Surveys*	*Region*
No. of people in HH (%):														
1-2 persons	54.3	55.4	68.3	57.2	59.5	57.2	60.8	50.3	44.3	56.2	57.9	57.8	44.8	50.3
3-4 persons	37.6	30.6	24.0	30.2	37.8	30.2	39.2	31.4	41.9	30.4	36.2	30.5	41.8	31.4
5+ persons	8.0	14.0	7.8	12.5	2.7	12.5	0.0	18.4	13.8	13.4	5.8	11.6	13.4	18.4
Ratio of drivers in HH to available vehicles:														
<1 vehicle/driver	15.3	--	27.9	--	21.6	--	7.8	--	11.4	--	13.6	--	14.9	--
1 vehicle/driver	61.7	--	60.6	--	55.9	--	74.5	--	60.0	--	63.1	--	56.7	--
>1 vehicle/driver	23.0	--	11.5	--	22.5	--	17.6	--	28.6	--	23.3	--	28.4	--
Approx. Income[2] (%):														
$15,000 or less	1.6	12.7	3.0	10.0	0.0	10.0	4.5	14.9	1.0	12.5	1.4	13.5	1.6	14.9
$15,001 - $30,000	7.0	16.3	7.1	12.0	10.8	12.0	6.8	17.7	7.6	18.0	5.8	17.5	4.9	17.7
$30,001 - $45,000	15.5	16.3	19.2	13.5	11.8	13.5	22.7	16.5	14.6	17.3	15.1	17.8	21.3	16.5
$45,001 - $60,000	20.0	13.4	17.2	12.4	14.7	12.4	11.4	13.1	23.7	13.9	21.9	14.3	23.0	13.1
$60,001 - $100,000	36.4	23.1	37.3	25.3	36.2	25.3	29.5	21.6	35.4	22.6	38.5	22.9	31.2	21.6
$100,001 - $150,000	13.8	11.0	10.1	15.0	18.6	15.0	9.1	9.8	14.1	9.8	14.4	9.4	4.9	9.8
$150,001 and over	5.6	7.2	6.1	11.7	7.8	11.7	15.9	6.4	3.5	5.9	2.9	4.6	13.1	6.4

[1] "Surveys" = Survey data collected from station area residents; "Region" = 2000 Census data for Metropolitan Statistical Area (MSA) in which the project setting is located
[2] Approximate household income after taxes (as reported by respondent)

Out-of-Pocket Commute Costs

Table 6-4 provides the self-reported daily out-of-pocket commute costs for station area office workers. The average round trip cost is $5.16 per person. Public transit costs average $4.72 per person. For those who incur toll and parking costs, the automobile cost is much greater than the transit cost. For those who receive parking subsidies, the out-of-pocket costs are more comparable. The per-person amount for office workers is very similar to the cost reported by station area residents ($5.04).

Commute costs are higher than the survey average for office workers in Berkeley (BART), Hollywood (L.A. Metro Red Line) and Anaheim (Metrolink commuter rail). Parking costs range from free (at the Anaheim site) to nearly $5 per day at the Berkeley site. Station area office workers pay nearly $1.50 more per day to park at their workplace than do station area residents. Public transit costs are highest for Los Angeles Metro and Metrolink commuter rail riders. This reflects the generally longer commute trips by those respondents. Mission Valley (San Diego) and Berkeley respondents report below-average transit costs. In the case of Mission Valley, this is similar to the station area respondents; in the case of Berkeley, however, this is lower than all other BART commuters. Note that since the question asked for dollars spent by the commuter, the full costs may be reduced by employer subsidies of commute expenses.

Table 6-4. Daily Out-of-Pocket Commute Costs[1] (To and From Work), Station Area Office Workers

Mean $ spent on:	All Office Sites	BART: Berkeley	BART: Wlnt Crk/Fremont	LA Red Line: Hollywood	S.D. Trolley: Missn Valley	Sacramento LRT	Metrolink: Anaheim
Public Transit	4.72	3.67	5.55	6.67	4.00	5.24	6.50
Tolls	2.60	2.20	2.00	3.00	4.00	3.00	4.67
Parking	4.51	4.94	2.50	3.33	3.00	4.71	0.0
Fuel	3.63	4.09	3.77	3.32	3.82	3.24	4.02
Other[2]	4.72	3.50	2.50	0.0	6.45	3.92	0.0
TOTAL MEAN $	5.16	6.58	4.58	5.93	4.32	5.41	5.92
N (No. of workers)	604	65	83	42	160	189	49

[1] "Based solely on respondents who reported commute costs; Blank responses and zero values were not included in calculations
[2] "Other" responses include: insurance, maintenance and "wear and tear"; and vanpool/carpool costs

Transportation Options Available at Place of Work

Table 6-5 summarizes transportation policies at respondent's station area workplaces, according to programs that are either transit supportive (such as allowing flexible hours or providing a vehicle for use during the day) or automobile supportive (such as providing free parking). Flexible work hours are the most common transit-supportive program, available to two thirds of the respondents. About one third of respondents' employers help pay for transit, while smaller numbers are allowed to work at home and have a vehicle for use during the day. These workplace transportation policies can encourage transit use, carpooling, and other non-automobile modes.

These policies are counteracted however by subsidies to driving, especially the provision of free parking. Over half (56.6%) of the surveyed employees have free parking available to them, although this varies widely across the project settings—from 33 percent among Berkeley workers, to over 80 percent in Hollywood, Anaheim and Mission Valley. Given the cost of parking in many of these station areas, this policy is a major incentive for driving that works against transit ridership goals.

Transit ridership is highest when transit and carpool incentives are matched with driving disincentives. This is the case in Sacramento. In the following section, Table 6-6 shows that 29 percent of Sacramento station area workers use transit—a higher level than that found among BART's station area office workers. Influencing this result are employer policies: 61 percent of Sacramento respondents receive transit fare subsidies, the highest level of the systems studied, and only 25 percent have free parking. Working against transit ridership is the incentive/disincentive combination in San Diego Mission Valley station areas: only 17 percent of surveyed workers receive transit subsidies while 83 percent have free parking. The resulting transit commute share is just 2.9 percent.

Comparing the transportation options reported by station area residents and office workers (Table 5-6), it appears that the transportation incentives provided by TOD employers take only moderate advantage of the presence of rail transit. The surveyed TOD employers are more likely to help pay for transit (33% versus 16% at the residents' workplaces) and to provide a vehicle for use during the day (10% versus 4%). They are also less likely to provide free parking (57% versus 65%) and to pay for other automobile costs (6% versus 8%). With the exception of transit subsidies, however, each of these differences is less than 10 percent. Given the influence of employer policies on mode choice, especially concerning parking, more station area employers should be encouraged to move to the Sacramento employers' approach.

Table 6-5. Transportation Options Available at Office Workers' Place of Work

	My employer (%):[1]	All Office Sites	BART: Berkeley	BART: Wlnt Crk/Frem't	LA Metro: Hollywood	SD Trolley: Missn Vly	Sacramento LRT	Metrolink: Anaheim
Transit-supportive	Allows flexible hours	66.7	80.6	56.1	21.6	75.9	68.8	46.7
	Allows me to work at home	19.1	32.3	20.4	0.0	19.1	17.6	15.0
	Provides a vehicle for use during day	9.5	7.5	0.0	0.0	20.1	9.9	0.0
	Helps pay for transit	32.7	38.7	9.2	18.9	16.6	61.0	8.3
Auto-supportive	Provides free parking	56.6	33.3	76.5	89.2	82.9	24.6	86.7
	Helps pay tolls, fuel, & other commute costs	6.1	2.2	7.1	5.4	10.1	4.0	10.0
N (No. of cases)		780	93	98	37	199	272	60

[1] Values will not add up to 100%; Percent calculations are based on # of respondents, not # of responses (each respondent was asked to report all transportation options available at their place of work)

Travel Characteristics by Station Area Office Workers

Commute Trip Characteristics

Commute Trip Mode Shares

Transit (rail and bus) is the primary commute mode for 19 percent of reported commute trips by station area office workers (see Table 6-6). Most of these trips are made by rail, although bus transit is also well used—primarily among the Berkeley and Sacramento LRT workers. Just over three percent of surveyed workers bicycle or walk to work. The highest walk shares were at office sites on the Los Angeles Metro Red Line (3.9%) and BART's Berkeley station (3.8%), reflecting the density and employment sector characteristics in these areas.

Berkeley and Sacramento LRT workers report the highest overall transit shares (39% and 29% respectively), followed by the Walnut Creek/Fremont sites (27%). Berkeley and Sacramento also have the smallest share of workers who drive alone to work (45.2% and 51.7% respectively). Subsequent sections analyze this phenomenon further. Looking solely at rail use, Berkeley workers are most likely to commute by rail (25%); workers in San Diego's Mission Valley TODs are least likely. Workers at the Los Angeles sites (along the Red Line and Metrolink) are more likely to commute by rail compared to Mission Valley workers, but shares are still modest.

Table 6-6. Primary Commute Mode, Station Area Office Workers

% of work trips made by these primary modes:	All Office Sites	BART: Berkeley	BART: Wlnt Crk/Fremont	LA Red Line: Hollywood	S.D. Trolley: Missn Valley	Sacramento LRT	Metrolink: Anaheim
Drove Alone	68.0	45.2	79.1	84.3	84.8	51.7	85.1
Drove Carpool	6.0	1.9	2.7	3.9	6.7	8.7	7.5
Rode in Vehicle	3.8	2.9	0.0	0.0	4.8	6.3	0.0
Rail Transit	11.5	25.0	13.6	7.8	1.9	15.0	4.5
Bus	7.3	13.5	3.6	0.0	1.0	14.0	1.5
Bicycle	2.3	7.7	0.9	0.0	1.0	2.8	1.5
Walk	1.1	3.8	0.0	3.9	0.0	1.0	0.0
Taxi	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.1	0.0	0.0	0.0	0.0	0.3	0.0
N (No. of trips)	853	104	110	51	210	286	67

Compared to the journey-to-work characteristics for their surrounding regions (see Figure 6-3, next page), the surveyed office sites have an overall transit commute mode share that is over 3.5 times the regional average. The project settings with the greatest disparity between the TOD sites and their surrounding regions are the Berkeley sites (along BART) and the Sacramento LRT sites. Berkeley's transit mode share for TOD office workers is more than 4 times the regional average (note that the regional average is already quite high); and the transit mode share for Sacramento TOD office workers is *nearly 11 times greater* than that of the surrounding region.

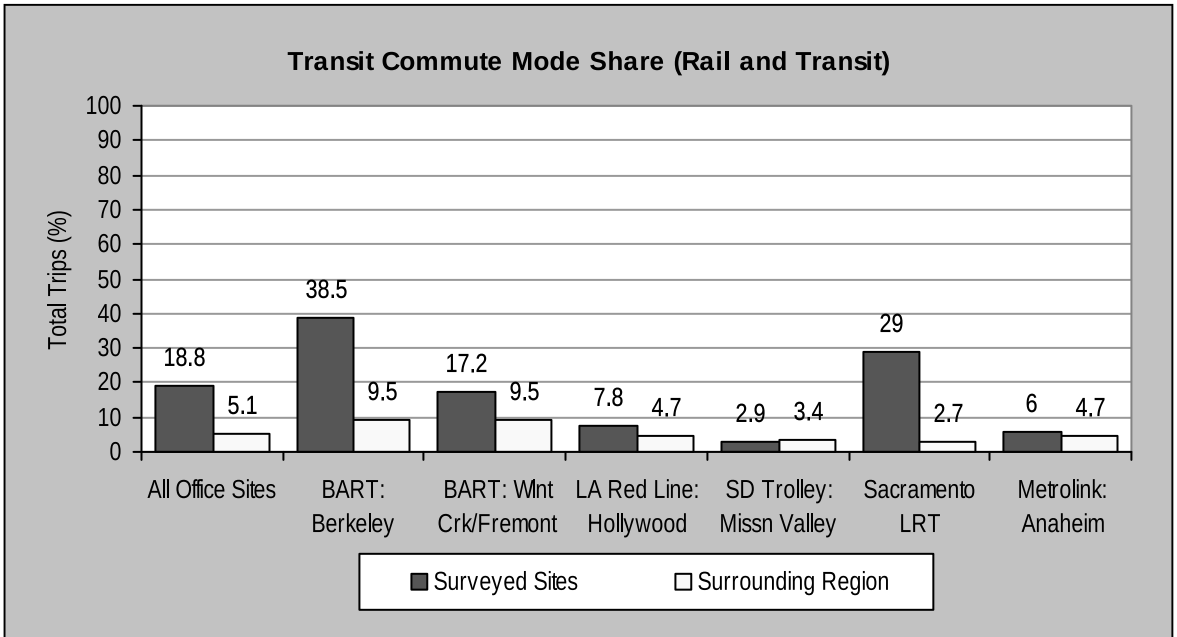

Figure 6-3. Transit as Primary Commute Mode, Surveyed Office Workers & Surrounding Region[1]

[1] Data Source: 2000 U.S. Census, STF3; collected at the MSA/CMSA level

Additional modes used during the commute trip, in combination with any primary mode, are presented in Table 6-7. Driving alone was most common (18.5% of surveyed workers), possibly for accessing park and rides or driving to carpools, followed by walking (7.2%). Bus, rail transit, and carpool were seldom reported as an additional mode. (Also note that while the next section focuses specifically on rail station access modes, these access modes may also be reported here as the "additional mode" of travel.) Berkeley and Sacramento LRT station area workers were most likely to report an additional mode, suggesting more complex travel patterns for these workers. This is likely connected to the higher use of transit at these office sites, which requires the use of an additional mode for accessing the stations. This is explored further in the following section.

Table 6-7. Additional Commute Mode, Station Area Office Workers

% of work trips using these additional modes:	All Office Sites	BART: Berkeley	BART: Wlnt Crk/Fremont	LA Red Line: Hollywood	S.D. Trolley: Missn Valley	Sacramento LRT	Metrolink: Anaheim
Drove Alone	18.5	26.9	11.7	7.8	8.6	24.9	14.9
Carpooled	2.3	6.7	0.9	0.0	0.0	2.9	4.5
Rail Transit	2.5	7.7	1.8	0.0	0.5	2.9	0.0
Bus	2.1	3.8	1.8	2.0	0.5	2.6	3.0
Bicycle	0.3	0.0	0.9	0.0	0.0	0.3	1.0
Walk	7.2	13.5	6.3	3.0	2.9	10.7	0.0
Taxi	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.1	0.0	0.0	0.0	0.0	0.3	0.0
No additional mode	67.0	41.3	76.6	84.3	87.6	55.3	76.1
N (No. Of trips)	853	104	110	51	210	286	67

Station Access by Rail Commuters

Among the surveyed workers who commuted by rail, most (51%) drove from their home to the station and one-third walked. Across the project settings with a reasonable level of rail use, walking to the station is most common among workers at BART's Berkeley and Walnut Creek/Fremont sites; driving is most common at the Sacramento sites. Such frequent walk access among BART commuters suggests success in achieving the densities and design qualities conducive to walking. Bus was also a significant access mode for BART office workers, especially among the Walnut Creek/Fremont sites. Table 6-8 summarizes the results.

As one would expect, the connection from the station to the workplace is most commonly accomplished by walking (78% of responses). This share is similar across each project setting. Overall, as was the case among station area residents, it appears that rail transit is not likely to be feasible if it requires lengthy or complicated mode changes at both ends of the commute trip.

Table 6-8. Rail Station Access Mode during Commute Trip, Station Area Office Workers

How office workers got from their home to the station (%):	All Office Sites	BART: Berkeley	BART: Walnut Crk/Fremont	Sacramento LRT
Walked	33.2	45.8	42.1	26.0
Drove vehicle	50.8	31.3	21.1	67.0
Rode as passenger	6.4	10.4	10.5	3.0
Rode bus	7.5	10.4	21.1	3.0
Bicycled	2.1	2.1	5.3	1.0
Other	0.0	0.0	0.0	0.0
N (Number of cases)	187	48	19	100

[1] Includes only those respondents who commuted by rail on the recorded day of travel; Hollywood (LA Metro Red Line), Mission Valley (SD Trolley), San Jose VTA, and Anaheim (Metrolink) project settings are not presented due to low response rates for this question

Trip Chaining during Commute Trips

Figure 6-4 shows that station area office workers frequently make additional stops during their commute trip (35.2%). The highest level of additional stops is on the San Diego Trolley, while the lowest level is on the Los Angeles Metro. Station area employees are about two times more likely to make an additional trip during the commute than are station area residents (see Figure 5-9).

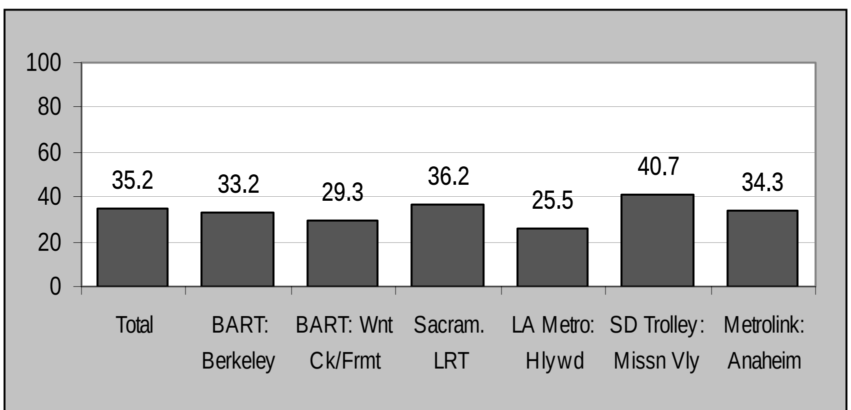

Figure 6-4. Share of Workers Who Made Stops During Commute

Figure 6-5 shows that the purposes of additional stops made during the trip are varied, and include transporting children, shopping trips, other errands, trips for meals or snacks, and other trip purposes. Under “other” trips, the most commonly reported purposes are to park at a train station or bus station and to pick up/drop off passengers. Because many of the station area office workers use the automobile as a primary or secondary additional travel mode, more automobile-oriented trips chains are possible, such as dropping children at schools.

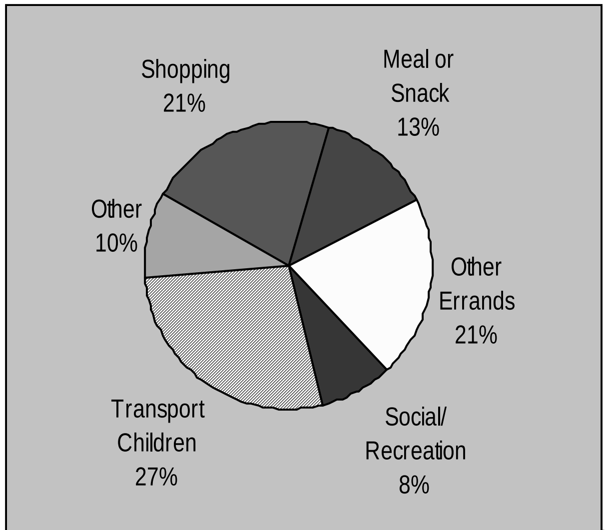

Figure 6-5. Purpose of Additional Stops

Time and Length of Travel to Work

Table 6-9 shows the characteristics of employees’ commute travel to work. Given that these data represent commute patterns of office employees, which typically operate during “normal” business hours, it is not surprising that the large majority of trips begin during the peak periods of 6:00 to 9:00 a.m. The distribution of trip lengths is fairly even, with approximately one-quarter of trips falling into each of four half-hour time intervals. Compared to the commute times of station area residents (Table 5-10), station area office workers have somewhat longer commutes (69 minutes versus 55 minutes), suggesting that workers in station area office buildings are drawn from a large commuter shed. It is also interesting to note that among the surveyed office workers, over half are commuting more than one hour *in each direction*; this does not vary significantly across the regions.

Table 6-9. Time and Length of Commute Trips to Work, Station Area Office Employees

	All Office Sites	BART: Berkeley	BART: Wlnt Crk/Fremont	LA Red Line: Hollywood	S.D. Trolley: Missn Valley	Sacramento LRT	Metrolink: Anaheim
Departed for work (%)							
Before 6:00am	9.1	5.9	8.3	0.0	15.0	7.9	6.0
6:00am-9:00am	86.9	83.2	81.7	96.0	83.1	90.5	91.0
After 9:00am	4.1	10.9	10.1	4.0	1.9	1.6	3.0
Commute lengths (%)							
Less than ½ hour	24.1	25.0	25.7	16.7	27.1	24.0	22.7
½ hour to 59 minutes	20.5	20.0	23.9	27.1	19.7	20.0	18.2
1 hour to 89 minutes	29.6	25.0	22.9	31.3	34.5	29.3	24.2
More than 1 ½ hours	25.8	30.0	27.5	25.0	18.7	26.7	34.8
Avg commute lengths							
Mean length (min.’s)	68.8	68.5	66.4	70.2	67.6	68.1	72.5
Standard deviation	54.9	50.3	52.7	55.8	66.1	49.6	51.5
N (Number of trips)	861	101	109	50	207	304	67

Mid-Day Trip Characteristics

Table 6-10 summarizes the modes used by office workers for mid-day trips (trips made during the work day which begin and end at the workplace). The predominant mode is walking, representing 56.7 percent of all trips across all the systems; Berkeley has the highest level of walking (87%), followed by Sacramento LRT (63.3%); while Metrolink has by far the lowest level (2.7%). The remaining project settings (Walnut Creek/Fremont, Hollywood and Mission Valley) fall around the 50 percent mark. The next most frequent mode is vehicle, at 39.5 percent for all systems, with a high of 97 percent for Metrolink. Rail, bus, bike, and "other" modes are not well used.

Table 6-10. Mode Share for Midday Trips[1], Station Area Office Workers

% of trips by:	All Office Sites	BART: Berkeley	BART: Wlnt Crk/Fremont	LA Red Line: Hollywood	S.D. Trolley: Missn Valley	Sacramento LRT	Metrolink: Anaheim
Vehicle	39.5	8.4	46.7	50.0	49.3	30.7	97.3
Rail	1.7	2.4	3.3	0.0	0.0	2.8	0.0
Bus	1.0	0.0	0.0	0.0	0.7	2.3	0.0
Bike	0.2	1.2	0.0	0.0	0.0	0.0	0.0
Walk	56.7	86.7	50.0	50.0	48.6	63.3	2.7
Other	0.9	1.2	0.0	0.0	1.4	0.9	0.0
N (No. of trips)	580	83	60	34	140	218	37

[1] Mid-day trips were calculated as round trips; one trip equals travel from and back to work

Table 6-11 shows the relationship between mid-day mode and length of trip, showing that walk trips clearly dominate trips of less than one-quarter mile, and accounting for a substantial portion of trips up to one mile in length. The automobile is the clear preference for trips over one mile. In most cases, that means that transit users are not able to reach trip destinations of greater than one mile unless they have a vehicle available at work.

Table 6-11. Midday Mode by Length of Trip, Station Area Office Workers

	Length of Midday Trip (Miles)				
Percent of trips by:	Less than ¼	¼ to 1	1 to 5	5 to 10	10 or more
Vehicle	3.2	22.6	82.9	94.8	87.5
Rail	0.4	2.0	3.1	1.7	5.0
Bus	--	1.0	1.6	1.7	5.0
Bike	--	1.0	--	--	--
Walk	96.4	73.5	10.1	--	--
Other	--	--	2.3	1.7	2.5
N (No. of midday trips)[2]	250	102	129	58	40

Figure 6-6 summarizes the purposes for office workers' mid-day trips, indicating that trips for meals and snacks are most common, most likely representing lunch hour trips, followed by business-related travel and shopping. These trip purposes, combined with the number of mid-day trips being made and the fact that nearly all trips within walking distance of the office are made by foot, suggests that locating shops, restaurants and other amenities near offices (in TODs or other settings) holds great potential for increasing pedestrian travel. This is significant not only for reducing automobile trips, but for increasing physical activity among office workers.

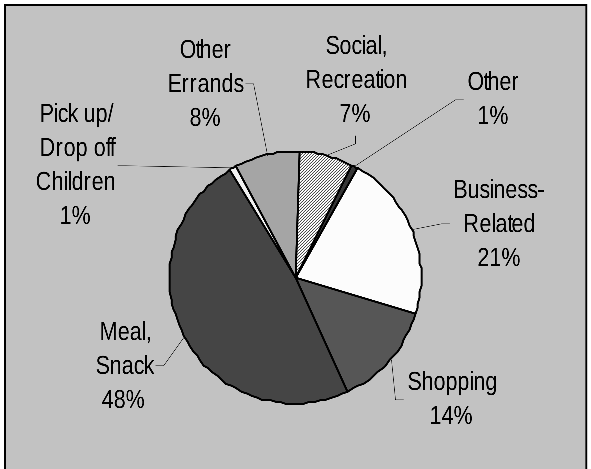

Figure 6-6. Midday Trip Purposes, Surveyed Office Workers (n=568)

Travel Trends (1990s to 2003) for Station Area Office Workers

This section examines the question of whether transit use among office employees increases, decreases, or stays the same as a TOD area matures. Factors that might lead to an increase in transit ridership include:

- Greater employee familiarity with transit service.
- Increases in transit connectivity associated with expansions of transit service.
- Residential location adjustments by employees to enable use of the transit system.
- Attraction of employers having a transit-oriented employee base to TOD locations.
- Property owner marketing programs seeking to draw attention to the transit accessibility advantages, or changes in property manager/employer transportation policy (e.g., parking "cash out").
- Synergy between mixed uses in larger TODs (e.g., mid-day trips can be accomplished on foot in the TOD, allowing the employee to use transit for the commute trip).

Transit share might decline over time if any of the trends above are reversed. For example, a decline in transit connectivity (either rail transit or feeder buses) or an influx of tenants whose employee base is not likely to use transit could lead to a downward trend in transit ridership.

As mentioned in the discussion of residential surveys, the regions in this study experienced increasing traffic congestion and an expanding economy during the 1992 to 2000 period. Such congestion improved the competitiveness of rail transit in terms of travel time. However, the California economy was in decline at the time of the 2003 survey, reducing congestion pressure and parking costs, and making it easier for employers to cut back on their transportation benefits.

Project level data are not available from the 1992 survey, and there is not an exact correspondence of projects between 1992 and 2003. The comparison is made between published results from the 1992 survey and resurveyed projects from the 2003 survey.

Table 6-12 shows that 23.9 percent of workers in the 2003 comparison group used transit. A significant share of this transit use (9.9 percent) is by bus. (Note that this is a different level of overall transit use than reported in Table 6-6 because this is a subset of the 2003 sample—it includes only those sites that were surveyed in both 1992 and 2003.) This level of transit use is slightly less than that reported for the full population of surveyed TOD residents for 2003 (27.4 percent of work trips, as reported in Table 5-15).

Comparing the 2003 TOD office worker transit share of 23.9 percent to the level identified in 1992 (14.3 percent) shows an increase of the time period. This increase is statistically significant for rail and bus use at a 99 percent confidence level. There is also a statistically significant decline in car/vehicle use. These data suggest that TOD workplaces experienced an increase in transit share over the last decade. It appears that a TOD work destination increased in desirability more than a TOD origin over the same period. Because many of these rail systems provide parking at suburban stations, a TOD work destination can attract transit riders from a very broad commuting shed when there is increasing automobile congestion, which may explain the greater increase than observed in the residential sample. Said another way, while a TOD residential location makes all employment destinations at other transit station more easily accessible, a TOD work destination makes almost any residential location in the respective region transit accessible.

There are many implications for local planners. First, developing employment opportunities in TOD offers the possibility of gains in transit use over time. In the past, there has been concern that too much commercial development has occurred at early TODs (as opposed to residential development) but there are clear transit ridership benefits from TOD employment locations. If these patterns are widely replicated, then TODs may be able to increase employment density over time, relying on a fixed roadway capacity and parking supply because more workers choose transit.

Table 6-12. Mode Shares for Commute Trips by Station Area Office Workers[1], 1992 & 2003

Percent of trips by:	All Systems (Avg.) 1992[2]	All Systems (Avg.) 2003
Car/vehicle	82.5	72.3
Rail	8.9	14.0
Bus	5.4	9.9
Walk/Bike	2.6	3.7
Other	0.6	0.0
N (No. of respondents)	1079	637

[1] 2003 data includes only sites that were also surveyed in 1992; the 1992 data, however, was not available at the site level and includes all sites surveyed in 1992 (even if not resurveyed in 2003)
[2] Source: Cervero, Robert (1993) *Ridership Impacts of Transit-Focused Development in California*, UC Berkeley.

Mode Changes on Moving a Work Location to a TOD

Table 6-13 displays the mode shifts of 102 office workers from the 2003 survey who changed work location in the last three years. One would expect that a new work location in a TOD would result in more frequent transit use. Similar to the results for the TOD residents, shown in Table 5-21, there is a complex pattern of shifting between travel modes. However, in the case of station area workers, there appears to be a net shift toward transit, carpooling, and other non-automobile modes. The respondents shifting into and out of driving modes are within approximately one percentage point of each other—13.8 percent reported a shift from automobile to other modes; 14.7 percent reported a shift from non-automobile to automobile modes. Within automobile modes, there was a slight net increase in carpooling, with 5.9 percent shifting from SOV to carpools and only 3.9 percent shifting from carpools to SOV. The largest share of these office workers, however, drove to work (alone) before they changed work location and continue to do so in their new work location.

Table 6-13. Comparison of Prior and Current Commute Modes[1], for Station Area Workers who have Changed Work Location in Past 3 Years

Percent of office workers who shifted:					
Encouraging trends	From automobile[2] to rail transit	7.9	*Non-Encouraging trends*	From rail transit to automobile[2]	3.9
	From automobile[2] to bus transit	2.9		From bus transit to automobile[2]	4.9
	From automobile[2] to walking or biking	3.0		From walking or biking to auto[2]	5.9
	From driving alone to carpooling	5.9		From carpooling to driving alone	3.9
	No shift: Still taking transit (bus or rail)	7.8		No shift: Still driving alone	**47.1**
	Other shifts (%)	6.8			
	N (No. of cases)	102			

[1] Prior commute mode is based on "typical mode used"; Current commute mode is based on actual mode used to commute to work on day of reported travel
[2] Alone, with passengers, or as a passenger

Individual-Level Modeling of Travel by Station area Office Workers

Similar to Chapter 5, this section of the chapter focuses on identifying factors that explain the transit mode shares presented above. Both individual-level and project-level models are presented for office employees working in the surveyed California TODs, in addition to sensitivity tests and other summary findings.

Factors Influencing Mode Choice among Station Area Office Workers

This section examines relationships between the choice to take transit to work and the most strongly correlated explanatory variables. Following a brief discussion of these correlations, a logit model is presented that predicts mode choice among station area workers.

Figure 6-7 presents simple correlations between employee transit commuting (coded 0-1) and the most significant explanatory variables. Correlations are shown in absolute terms (i.e., ignoring signs) and only for relationships with correlations over 0.20. Neighborhood attributes (such as retail shops, street connectivity, and street trees) are for the work-end of the commute only. As in the residential analyses, urban design variables expressed as "density" represent the tabulation of design elements per 1,000 feet distance along the shortest route between the surveyed office building and the nearest rail station. The "retail shop density" variable, for instance, denotes the number of retail shops per 1,000 feet for the shortest route between office buildings and the nearest rail station.

The following findings are of note:

- *Employer-Provided Transit Pass*. Compared to the analysis of station area residents, transportation options at the workplace are not strongly associated with commute choices of surveyed office workers. The one policy variable that moderately contributes to transit commuting is if the employer provides a transit pass or other fare assistance (correlation value of *0.305*). If an employer does *not* help pay the cost of transit, the likelihood that the office worker will commute by transit is just 4.7 percent; if the employer *does* help with the cost of transit, the share increases to 25.4 percent.

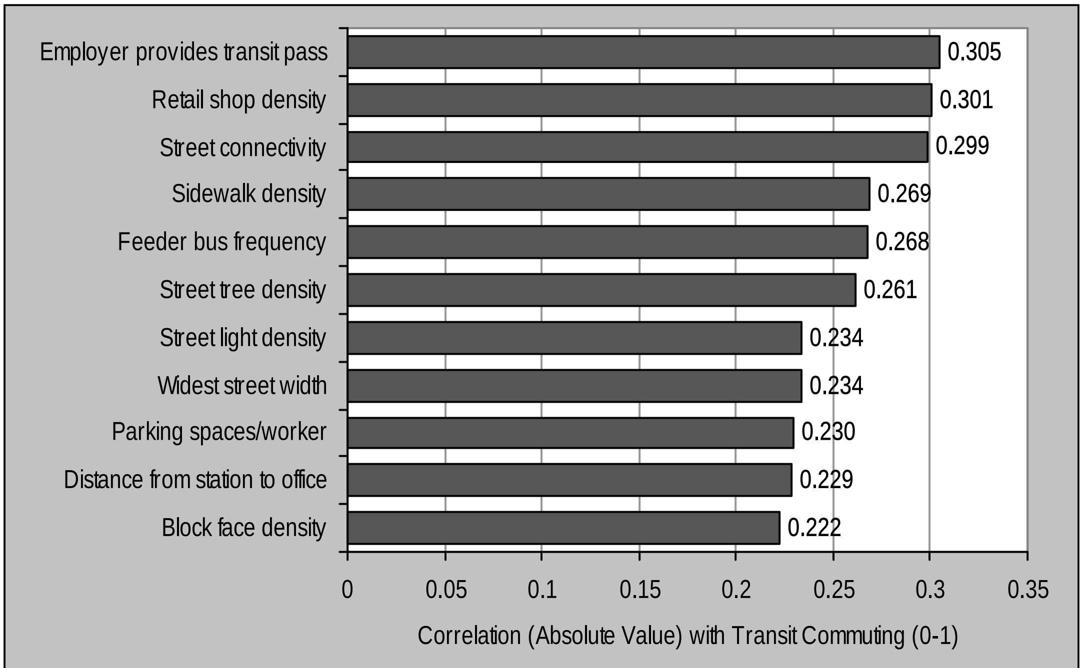

Figure 6-7. Rank-Order of Simple Correlations (in Absolute Terms) Between Attributes of Neighborhoods and Stations near Office Sites and Transit Commuting

- *Urban Design Variables*. Six attributes of the shortest path between a surveyed office building and its nearest station are moderately associated with transit commuting among surveyed office workers. These include densities of retail shops, sidewalks (on one side of the street), street trees, streetlights, and block faces (reflecting relative frequency of blocks), as well as the width of the widest street crossed (with a *-0.234* correlation value). In addition, the street connectivity index for the one-mile radii around surveyed office buildings is moderately correlated with transit commuting. In general, urban design variables are stronger correlates of transit use for station area office workers than for station area residents.
- *Feeder Bus Frequency*. The frequencies of buses serving the rail stations closest to surveyed office sites were positively associated with transit commuting. For those facing long walks from a station to their office, or those who prefer to take feeder bus in bad weather, having intensive feeder bus services are important in the decision to commute by rail. More intensive feeder bus service increases the likelihood that the employee can get from the station to their workplace via transit.
- *Parking Spaces per Worker*. Higher supplies of parking per worker generally reduce transit commuting among the surveyed office workers (correlation value of *-0.230*). Figure 6-8 shows that for offices with less than one parking space for every two workers, three out of ten

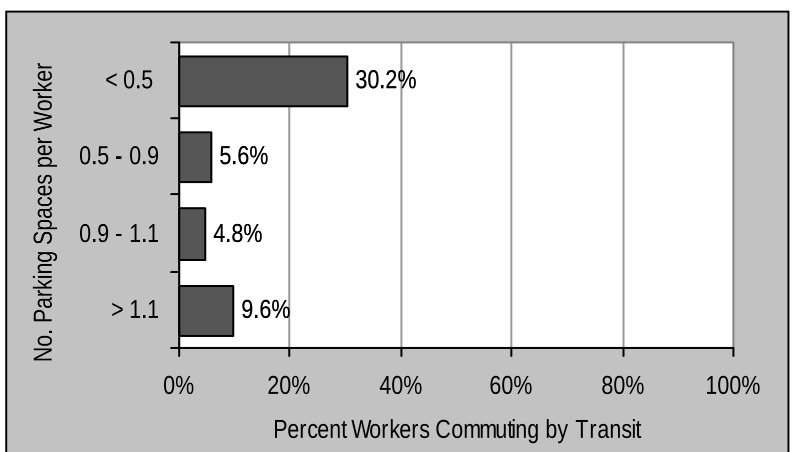

Figure 6-8. Transit Modal Splits by Number of Parking Spaces per Worker at Surveyed Office Sites

employees commute by transit. Where more than one space per two workers are provided, the share of workers commuting by transit drops to fewer than one in ten employees.

- *Distance from Station to Office*. Although all sites were located within walking distance of the rail station, there is a significant negative association between transit ridership and distance from the nearest station to their workplace (correlation of -*0.229*). In other words, transit ridership by station area office workers erodes as the distance from a station increases. Interestingly, this is different from the finding for station area residents, where distance from the station was *not* a significant predictor of mode choice.

Commute Mode Choice: Predictive Model

This section builds upon the correlation results by presenting a best-fitting model that predicts whether surveyed office workers commuted by transit. A best-fitting binomial logit model is estimated using many of the variables outlined in the previous section. Variables entered if theory suggests they belong in the model (e.g., travel time) or if they were statistically significant and yielded intuitive and reasonable results. Some variables, notably those related to socio-demographic attributes of workers and urban design of workplace areas, did not enter into the best-fitting model because of high inter-correlation with variables already in the equation.

Table 6-14 presents the best-fitting logit model of transit commute choice among station area office workers. Longer travel times over the highway network increase the likelihood of taking transit to work, as does more frequent feeder bus service at the stations closest to the surveyed office sites. Consistent with expectations, higher vehicle ownership levels reduce the odds that a station area office worker will commute by transit.

The two model variables most easily subject to change pertain to employer parking and workplace transportation options. The probability of office workers commuting by transit fell as the supply of parking relative to workforce size increased. Employer assistance in covering the cost of transit travel, such as the provision of Eco-passes, significantly increased the odds of transit commuting. It follows that flexing parking standards and providing tax or impact-fee credits to businesses near transit sites that help their employees with transit costs can promote transit commuting.

Table 6-14. Best-Fitting Binomial Logit Model for Predicting Transit Commute Choice among Surveyed Office Workers

	Coef.	*Wald*[1]	*Sig.*
Travel Time and Transit Service			
Automobile Travel Times: Peak-period travel time on highway network	0.007	1.496	.221
Frequency of feeder bus services at work-end station, in buses per day	0.002	13.826	.000
Workplace Parking and Policies			
No. parking spaces per worker	-0.749	8.503	.004
Employer helps with transit costs (1=yes; 0=no)	1.178	15.633	.000
Socio-demographic and Attitudinal Controls			
Auto ownership levels: No. of motorized vehicles per household member 16 yrs. or older	-1.736	16.210	.000
Constant	-1.068	3.061	.080
Summary Statistics			
No. of cases		744	
Chi-Square (sig.)		106.9 (.000)	
Rho-Squared (McFadden) = 1 – L(B)/ L (C)		0.23	

[1] Wald Statistic equals t-statistic squared

Sensitivity Test

As with the analysis of station area residents, a sensitivity test was conducted using the best-fitting logit model from Table 6-14 and assuming inputs for predictor variables. The sensitivity results, shown in Figure 6-9, are for the typical worker situation, assuming an average commute by vehicle of 30 minutes and one vehicle per household member 16 years of age or more. The figure shows the estimated probability of a surveyed office worker commuting by transit given changes in three variables: frequency of feeder bus services (the covariate on the horizontal axis); whether employers help with transit costs (shown by the solid lines); and parking supplies per worker (shown by the dashed lines). With 25 feeder buses per day, a workplace with 50 percent more parking spaces than workers, and no employer help with transit costs, the model predicts that just 8 percent of office workers near a rail station will commute by transit. At the other extreme, for a worker heading to a station with 400 daily feeder buses, an employer that provides transit-pass assistance and just one parking space for every two workers, the likelihood he or she will commute by transit is 50 percent. Over the range of feeder bus frequencies, the differential in transit commuting probabilities is 30 percent to 40 percent depending on the degree to which employers are promoting transit (i.e., by providing minimal parking and helping with transit costs) or accommodating the automobile (i.e., by providing ample parking and no help with transit costs).

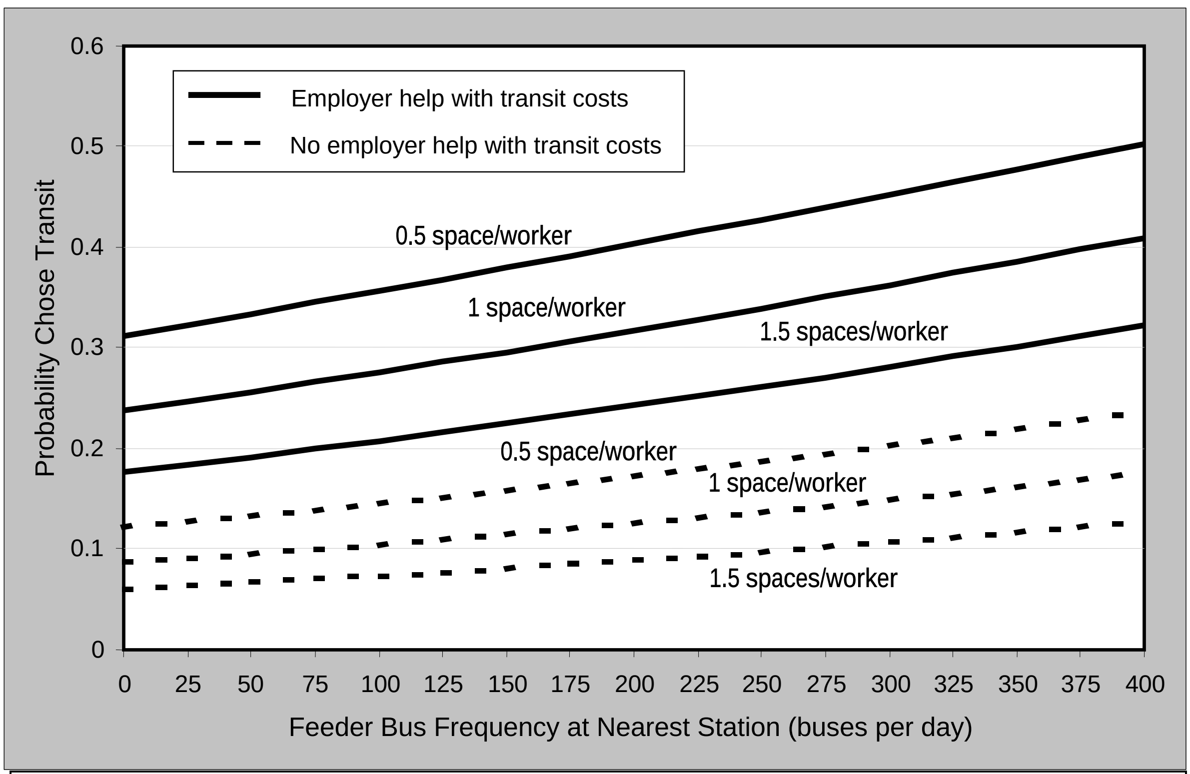

Figure 6-9. Sensitivity Test: Influences of Parking Supply at Office Site, Employer Transit Cost Policies and Feeder Bus Frequencies on Probability of Transit Commuting among Office Workers

Predictive Model: Midday Walk Choice

Given that over half of the reported midday trips (those which begin and end at the workplace) made by surveyed office workers are by foot, a choice model is estimated for predicting trips by walking instead of mass transit. Transit, in fact, plays a minor role for non-commute workday trips among surveyed workers, serving only 2.4 percent of midday trips. Because most midday trips occur within close proximity to the workplace, variables related to regional travel times and residential land-use patterns are not considered in the analysis. A limited set of variables pertaining to travel distance and purpose of midday trips as well as street connectivity near the workplace enter the best-fitting model.

Table 6-15 presents the best-fitting logit model for predicting midday mode choice. All variables in the model are highly significant and the model itself has moderately good predictive powers. The table shows that the probability of walking for midday trips is higher if the journey is one mile or less. If the trip is job-related, the odds of walking for that trip also increase. Evidently, most out-of-office job-related activities are to nearby destinations, reachable by foot. Lastly, the most relevant policy variable is the level of street connectivity in and around the office site. As the level of street connectivity increases (measured as the share of 4-way or more intersections within a mile of the office), the odds of walking also increase. This provides support for the grid street patterns promoted in New Urbanist designs. Another factor to consider is that workers are more likely to commute by transit if they are able to get around during the workday without the need of a vehicle. If they have to drive to reach their midday destinations, odds are they will drive to work so that they have a vehicle on-site. This supports the increased development of mixed uses in close proximity to office employment, both within and outside of TODs.

Table 6-15. Best-Fitting Binomial Logit Model for Predicting Walk Choice for Midday Trips by Office Workers

	Coef.	*Wald*[1]	*Sig.*
Midday Travel Characteristics			
Distance: midday trips under 1 mile (0=no; 1=yes)	5.924	254.15	.000
Purpose: business-related (0=no; 1=yes)	1.334	6.41	.011
Neighborhood Design			
Street Connectivity: proportion of intersections that are 4-way or more within 1 mile of office site	3.451	22.37	.000
Constant	-5.000	220.72	.000
Summary Statistics No. of cases = 828 Chi-Square (sig.) = 735.7 (.000) Rho-Squared (McFadden) = 1 – L(B)/ L (C) = .45			

[1] Wald Statistic equals t-statistic squared

Project Level Analysis: Ridership Gradient

This section summarizes modal characteristics for the 10 surveyed office projects in the aggregate. The small sample size (10 cases) prevents any predictive models from being estimated. As shown in Figure 6-10, work trip transit shares fall in an exponential manner as the distance of an office site to its nearest station increases.[1] While the small sample size of this simple plot cautions against drawing strong inferences, the presence of a relatively steep non-linear slope suggests considerable ridership benefits would accrue from clustering employment growth around California rail stations. Because the ridership gradient for station area office workers is considerably steeper than that for station area residents, these results suggest that priority should be given to concentrating employment growth immediately around rail stations.

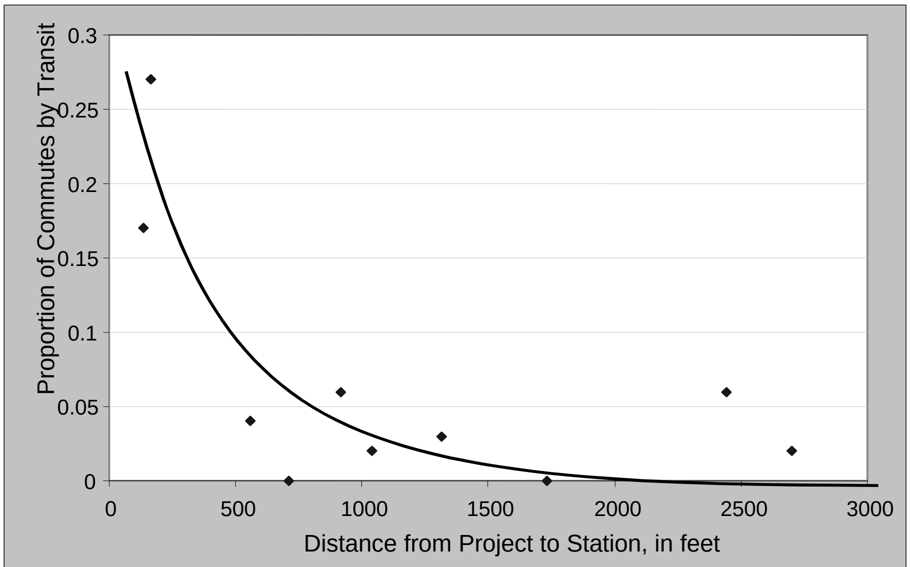

Figure 6-10. Ridership Gradient: Transit Share as a Function of Distance of Office Site to Nearest Station

Ridership Factors

Among the 10 office sites surveyed, the "outlier" case is the state Department of Conservation building in downtown Sacramento. The share of workers commuting by transit at this site was far higher (27 percent) than the other projects. The office site with the second highest share of transit commuters (17 percent) is the Great Western Building in downtown Berkeley, served by BART and AC Transit. No other office TOD sites reported a transit ridership share higher than 6 percent of surveyed workers.

What distinguishes these two sites from the others? Regression analyses are not needed here; simple comparisons will suffice. First, both the Department of Conservation and Great Western Buildings are in dense, mixed-use downtowns. The employment densities of the two buildings—

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[1] The best-fitting simple regression equation was of the following inverse logarithmic form: Proportion of commutes by transit = 0.523 – 0.067 log (distance), R = 678.

37.6 workers per acre for the Department of Conservation and 20.6 per acre for Great Western—are much higher compared to the other eight projects. High densities in downtown settings translate into high parking costs. This is the case for both projects relative to other sites: both charge over $100 per month to park, with the Department of Conservation charging $130 per month for a reserved space. Moreover, there is no parking at the nearest rail stations of either office building. Lastly, both buildings are closer to rail stops than any of the other office sites: Great Western is 137 feet from the nearest BART portal and the Department of Conservation building is just 165 feet away from the 8th and K Street light-rail stop in downtown Sacramento. High densities, high parking costs, and convenient access to the transit platform are clearly the formula for ridership success for any office building reasonably close to transit.

Summary of Findings Related to Station Area Office Workers

Surveyed TOD office workers are less likely to commute by rail than the surveyed TOD residents, but much more likely to commute by rail compared to the surrounding region. Unlike TOD residents, the rail mode share for commute trips by TOD office workers did experience an increase (among the re-surveyed sites) between the 1992 and 2003 periods.

Rail use among office workers relates significantly to workplace transportation policies, particularly the availability of free parking and employer assistance with transit costs, as well as the frequency of feeder bus services to nearby rail stations, and comparative travel times between highway and transit.

CHAPTER 7. FINDINGS RELATED TO HOTEL PATRONS AND EMPLOYEES AND RETAIL PATRONS

Overview of Surveyed Hotel Patrons and Employees and Retail Patrons

Response Rates by Site and Rail System

Patrons and employees of major hotel and retail sites within rail station areas were surveyed using three separate surveys. Hotel guests at two sites—one in the Bay Area and one in San Diego—were surveyed about their travel to the hotel and during their stay using a self-administered questionnaire. Hotel employees at these same sites were surveyed using an abbreviated version of the office worker survey (also self-administered). Retail patrons (including shoppers, workers and other users) at three sites—one each in Los Angeles, the Bay Area, and San Diego—were surveyed using an intercept survey method. In order to increase response rates, each of these surveys was brief. Survey completion rates at each site and for each population group are summarized in Table 7-1. The travel and other behaviors for each population group are presented in the following sections.

Table 7-1. Completed Surveys, Surveyed Hotel and Retail Sites

Site, by Rail System	Station	Patron Surveys[1]	Employee Surveys	Total Surveys
BART				
El Cerrito Plaza Retail Center	El Cerrito Plaza	452	N/A	
Embassy Suites Hotel	Pleasant Hill	21	44	65
L.A. Metro Red Line				
Hollywood/Highland Retail Center	Hollywood/Highland	507	N/A	
San Diego Trolley				
Fashion Valley Retail Center	Fashion Valley	305	N/A	
Doubletree Hotel	Hazard Center	23	15	38

[1] Patrons of retail sites were surveyed through an intercept method; at hotel sites, patrons of hotel sites completed self-administered questionnaires, which were distributed and collected by hotel staff.

Survey Respondents

Hotel Employees and Patrons

Surveys of hotel employees and patrons were conducted at two sites located within walking distance of a rail station: the Embassy Suites hotel (Pleasant Hill Station, BART) and the Doubletree Hotel (Hazard Center San Diego Trolley). As described previously, hotel surveys were conducted over the period of approximately one week, with both the employee and patron surveys being distributed and collected by hotel staff. Employee surveys were re-sent toward the end of August, with a shorter version of the questionnaire, due to low initial response rates. Both surveys were provided in English and Spanish.

Fifty-nine completed surveys were returned by hotel employees—15 from Doubletree and 44 from Embassy Suites. Over one-third of the total were conducted in Spanish. In terms of demographics, most of the hotel employees (62.7%) come from larger households of 3 to 5 persons; 30.5 percent live in households of 1-2 persons. Over half (53.3%) live in households with limited vehicle availability—less than one vehicle per person of driving age—and over half are Hispanic. As with the resident and office worker surveys, most hotel employee respondents are female. Most employees reported household incomes of $30,000 or less; only one-quarter earn more than $30,000 per year. Overall, the surveyed hotel employees are typical of the populations most likely to take advantage of transit access.

Forty-four hotel patron surveys were completed and returned, approximately half from each site (23 from Doubletree and 21 from Embassy Suites). Hotel patrons were not asked to report demographic information, but were asked to describe the nature of their visit. Among the surveyed patrons, 46 percent were at the hotels on business and 48 percent were there on pleasure travel; the remainder was at the hotel on "other" business. *Lengths* of stay range from one to eight nights, with most trips on the shorter side: nearly half of the patrons (43%) stayed at the hotel for just 1 night; 31 percent for two to three nights; 21 percent for four to five nights; and just 5 percent stayed more than five nights.

Retail Patrons

As described previously, shoppers and other retail patrons were surveyed (by trained surveyors) through an intercept method at three major transit-focused shopping centers. Surveys were conducted in both Spanish and English at the two southern California sites. Between the three sites, a total of 1,237 surveys were completed: 495 at the Hollywood/Highland Complex in Los Angeles (along the Red Line); 436 at El Cerrito Plaza in the Bay Area (along BART); and 306 at San Diego's Fashion Valley Complex (along the Trolley). These responses provide a strong sample size for generalizing about travel to these TOD retail centers.

Surveyed retail patrons are slightly more likely to be female (54%); this is higher than the share found in the surrounding regions by approximately 5-10 percent but consistent with all other population groups surveyed. Genders do not vary noticeably across retail sites. Age groups are also well represented across each of the sites. Overall, the largest share of retail patrons (30%) are 31 to 45, followed by age groups 18 to 24 (23%), 25 to 30 (19%), and 46 to 60 (18%).

In terms of ethnicity, however, there is notable variation. At El Cerrito Plaza in the Bay Area, retail patrons are most likely to be white (54%), followed by a nearly equal distribution of Black, Asian and Hispanic patrons (18, 16 and 11 percent respectively). In comparison, the largest ethnic group among surveyed patrons in southern California is Hispanic, with 53 percent at Hollywood Highland and 41 percent at Fashion Valley. Black and Asian patrons comprise a much smaller share (less than 10 percent each) at the southern California retail sites. These distributions roughly correspond with the surrounding regions (Los Angeles and San Diego), which also have higher Hispanic and lower Asian and Black populations compared to the Bay Area. It does appear overall, however, that so-called "minority" groups are over-represented at the TOD retail sites compared to their surrounding regions.

Travel Characteristics by Hotel Employees

Mode Share for Commuting to Hotel

The primary commute mode used by surveyed hotel employees varies significantly across the two sites. Over 90 percent commute by rail at the Doubletree-Mission Valley hotel near San Diego Trolley's Hazard Center station; even with just 27 reported trips, this share is notable. At Embassy Suites, near BART's Pleasant Hill station, only one-quarter of employees reportedly commute by rail; two-thirds of commute trips are made by single-occupancy vehicle. Additional modes used during the commute consist of bus (52 percent overall) and walking (29 percent).

Table 7-2. Primary Commute Mode, Surveyed Hotel Employees

% of trips made by:	Combined Hotel Sites	Embassy Suites (BART)	Doubletree (SD Trolley)
Drive alone	50.5	66.7	0.0
Carpool	0.9	1.2	0.0
Bus	6.3	7.1	3.7
Rail	41.4	25.0	92.6
Bike	0.0	0.0	0.0
Walk	0.9	0.0	3.7
N (No. of trips)	111.0	84.0	27.0

Station Access during Commute to Hotel

Among those who commuted by rail (n=30), walking is the predominant mode for accessing the rail stations, at both ends of the trip. Just over one-half (53.3%) walked from their home to the rail station at the start of their commute; over three-quarters (76.2%) walked from the station to the hotel site. The second most common access mode was bus—40 percent traveled from home to the rail station via bus and 24 percent used bus to travel from the rail station to the hotel site. With the exception of one rail commuter who rode to the rail station as a passenger, no automobile modes were used to access rail at either end of the trip.

Trip Chaining during Commute to Hotel

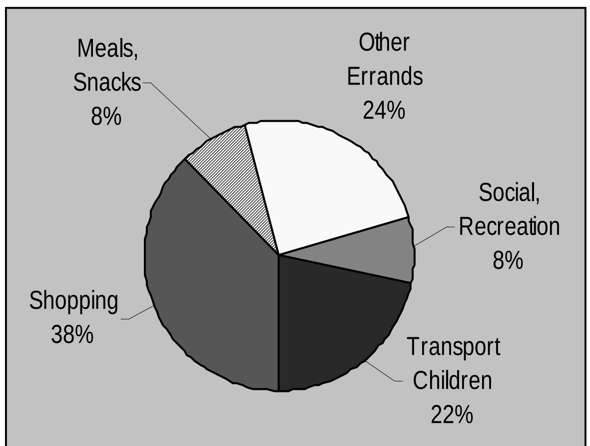

Figure 7-1. Purposes of Stops Made during Commute to Hotel

Out of 107 commute trips reported by hotel employees, approximately one-quarter involved additional stops. This was consistent across both hotel sites—25.3 percent at Embassy Suites and 25.0 percent at Doubletree. Figure 7-1 shows the purposes of these trips. Trip chaining is most common for shopping trips (38%), followed by other errands (24%), and transporting children (22%). Looking at the sites separately (see Table 7-3), it appears that employees at the San Diego site are more likely to stop for social and recreational purposes or to run errands other than shopping on their way to and from work. Employees at the Bay Area site are more likely to stop for shopping purposes or to transport children. This may help to explain, or result from, the dominant commute modes at each site. For instance, driving would make it easier to pick up and drop off children on your way to and from work; it would also provide more shopping opportunities, especially for larger shopping trips. Social and recreational opportunities, on the other hand, may be more conducive to rail transit (as was also revealed in the surveys of station area residents). Note, however, that trip purposes are based on just 37 trips involving additional stops.

Table 7-3. Purposes of Additional Stops Made during Commute, by Hotel Site

% of trips made by:	Combined Hotel Sites	Embassy Suites (BART)	Doubletree (SD Trolley)
Shopping	37.8	45.8	23.1
Meals, Snacks	8.1	8.3	7.7
Other Errands	24.3	16.7	38.5
Social, Recreation	8.1	0.0	23.1
Transport Children	21.6	29.2	7.7
N (No. of trips)	37	24	13

Travel Characteristics by Hotel Patrons

Travel to Hotel by Hotel Patrons

Less than one-quarter of the surveyed hotel patrons (23.8%) arrived from the nearest airport. The majority (45%) arrived from another location outside of the region and the remainder (31%) arrived from another location (other than the nearest airport) within the region of the hotel. If traveling from the nearest airport, hotel patrons are most likely to use a rental vehicle to get to the hotel (see Table 7-4). If traveling from locations other than the nearest airport, most patrons arrive at the hotel in a personal vehicle. Only 2.4 percent of all travel to the hotels was made by transit.

Table 7-4. Mode of Travel to Hotel Site, by Trip Origin

Mode of travel to hotel:	*Origin of initial trip to hotel:* Nearest airport	Other location within region	Other location outside of region	*All origins*
Rental vehicle	70.0%	23.1%	15.8%	*31.0%*
Personal vehicle	10.0%	69.2%	68.4%	*54.8%*
Hotel shuttle	20.0%	0.0%	5.3%	*7.1%*
Taxi	0.0%	7.7%	5.3%	*4.8%*
Bus transit	0.0%	0.0%	5.3%	*2.4%*
N (Number of trips)	10	13	19	*42*

Travel during Stay at Hotel

As shown in Table 7-5, hotel patrons are more likely to take advantage of the nearby rail access if their stay is limited to one night. It appears that while over half of hotel patrons use rail transit at some point during their stay, most are not willing (or able) to rely on rail transit during extended stays. Interestingly, this seems to hold true for both business and pleasure travelers; among both populations, about one-quarter reported rail transit as their usual mode of travel during their visit. Both are also about equally likely to rely on a vehicle as their usual mode of travel, except that business travelers are more likely to be using a *rental* vehicle and pleasure travelers are more likely to be using a *personal* vehicle.

Table 7-5. Usual Mode of Travel during Hotel Stay, by Length of Stay

Usual modes of travel during stay[1]:	*Length of stay at hotel:* 1 night	2-3 nights	4-5 nights	5-8 nights	*All Trip Lengths*
Rental vehicle	50.0%	37.5%	10.0%	25.0%	*25.5%*
Personal vehicle	62.5%	37.5%	40.0%	0.0%	*31.9%*
Taxi	0.0%	0.0%	0.0%	50.0%	*4.3%*
Bus transit	0.0%	6.3%	10.0%	0.0%	*4.3%*
Rail transit	75.0%	18.8%	40.0%	25.0%	*29.8%*
Other	25.0%	0.0%	0.0%	0.0%	*4.3%*
N (# of responses)	17	16	10	4	*47*

[1] Some respondents reported more than one "usual" mode; percentages are based on total responses

Table 7-6. Usual Mode of Travel during Hotel Stay, by Purpose of Hotel Visit

Usual modes of travel during stay[1]:	*Purpose of hotel visit:* Business	Pleasure	Other	*All Trip Purposes*
Rental vehicle	38.5%	17.4%	0.0%	*26.9%*
Personal vehicle	19.2%	39.1%	66.7%	*30.8%*
Taxi	3.8%	4.3%	0.0%	*3.8%*
Bus transit	3.8%	4.3%	0.0%	*3.8%*
Rail transit	23.1%	30.4%	33.3%	*26.9%*
Other	3.8%	0.0%	0.0%	*1.9%*
N (# of responses)	26	23	3	*52*

[1] Some respondents reported more than one "usual" mode; percentages are based on total responses

Use and Awareness of Rail Transit among Hotel Patrons

As shown in Figure 7-2, just over one-half of hotel patrons used rail transit at some point during their hotel stay. Among those who did use rail, the purpose of those rail trips is nearly divided between business, shopping and errands, and entertainment. Among those who did *not* use rail at any point during their stay, only 10 percent were unaware of the rail service. Forty-five percent (approximately one-quarter of the total surveyed population) said they were aware of the service but had "no interest in using rail transit." The remainder knew that there was rail access nearby, but the service was not convenient for them (30%) or they did not know enough about the service to use it (15%).

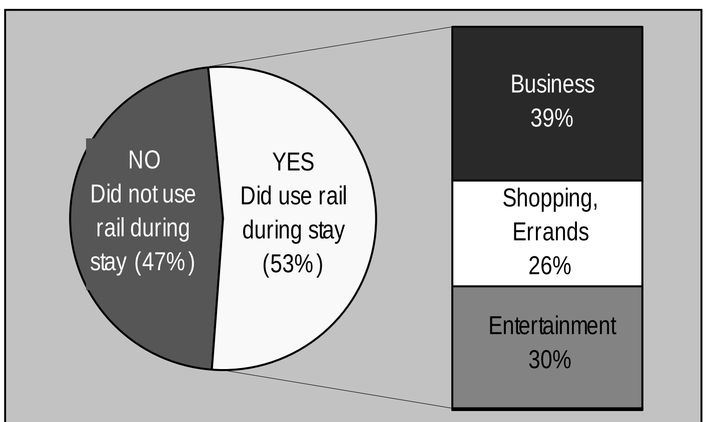

Figure 7-2. Share of Hotel Patrons that Used Rail Transit During Stay, and Purpose of Rail Trips

Travel Characteristics by Retail Patrons

Purpose of Trip to Retail Center

Not surprisingly, the large majority of surveyed retail patrons (62%) were at the site to shop (see Figure 7-3). A notable number of patrons, however, were there for the primary purpose of eating (12.3%), working (11.2%), or other purposes (12%).

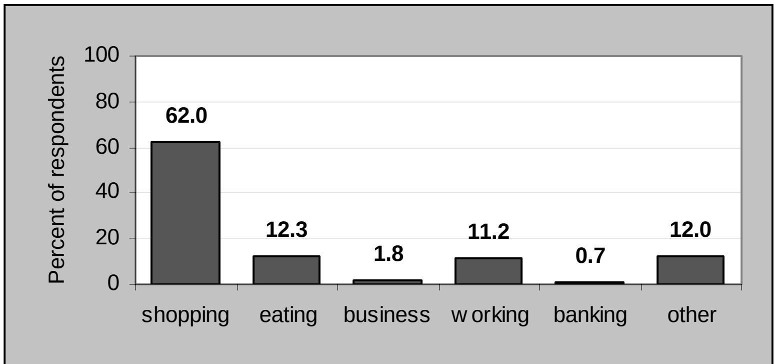

Figure 7-3. Mode of Travel to Retail Center

Table 7-7 (next page) shows the primary modes used to access each retail site by all retail patrons (including shoppers, workers and others). Overall, nearly 13 percent arrived by rail; the highest rail share (16.6%) was at Hollywood/Highland along the L.A. Metro Red Line, and the lowest was at Fashion Valley (7.2%). Sixty-one percent of the surveyed patrons who traveled to the site on rail transit did not have a vehicle available to them for that trip, suggesting that vehicle availability is a significant factor and may help to explain the higher rail share in the Hollywood area. Further analysis also reveals that patrons utilizing rail for this trip are likely to use rail on a regular basis. Within this group, 44 percent use rail five or more days a week, 17 percent use rail 3-4 days a week, and only 26 percent use rail on less than a weekly basis. These shares are much higher compared to all surveyed retail patrons combined (see Figure 7-4). Some of this "regular" rail usage may be explained by retail employees: in addition to having the highest rail mode shares compared to other patrons, retail site workers are more likely than other patrons to use rail five or more days a week (which may correspond with the number of days they work at the site).

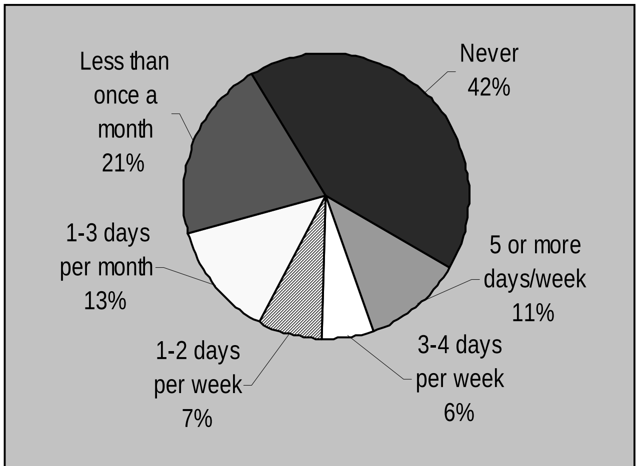

Figure 7-4. Frequency of Rail Transit Use by Retail Patrons (Any Trip Purpose)

Looking at mode share by site, it appears that patrons are less likely to use a vehicle and more likely to use rail or bus to access the Hollywood retail site compared to the other two sites. This contradicts the stereotype of Los Angeles travelers and is likely connected to the high-density, mixed-use nature of central Los Angeles (particularly along the Red Line) and the strong rail orientation of this particular site. The availability and/or cost of parking, as well as surface street congestion, may also be significant factors.

Table 7-7. Mode of Travel to Retail Center

How did you get here today?	All Sites	El Cerrito Plaza (BART)	Hollywood/Highland (L.A. Metro)	Fashion Valley (S.D. Trolley)
Vehicle: Drove	53.8%	49.3%	50.9%	65.2%
Vehicle: Rode as passenger	11.7%	16.8%	4.3%	16.4%
Vehicle: Dropped off	2.8%	2.9%	2.4%	3.6%
Walked	9.8%	14.8%	10.3%	1.6%
Rode rail transit	12.6%	11.7%	16.6%	7.2%
Rode bus	8.3%	2.2%	15.4%	5.6%
Bicycled	0.7%	2.0%	0.0%	0.0%
Other	0.2%	0.2%	0.2%	0.3%
N (No. of respondents)	1259	452	507	305

Origin of Trip to Retail Center

The most common origin for trips to the retail sites is one's own home (see Table 7-8). A large share of retail trips, however, appears to be the continuation of a trip chain, with patrons coming directly from work (11.5 percent overall) or from another errand (16.6 percent overall). It is important to note, however, that just because the retail trip is home-based does not exclude it from being part of a trip chain; it may simply be the patron's first stop after leaving home. The Hollywood Highland and Fashion Valley sites also appear to be drawing patrons from nearby hotels (in the case of Hollywood Highland, a large hotel is located on the same site as the retail complex).

Table 7-8. Type of Place where Trip to Retail Center Originated

Place of origin for trip to retail center (%):	All Sites	El Cerrito Plaza (BART)	Hollywood/Highland (L.A. Metro)	Fashion Valley (S.D. Trolley)
Office	11.5	17.1	9.5	6.7
School	1.7	1.5	3.0	0.0
Home	44.6	51.0	40.8	41.5
Friend's Home	7.1	7.2	7.4	6.7
Shopping or other errands	16.6	19.5	17.0	11.7
Hotel	8.4	0.5	13.9	11.0
Other	10.2	3.2	8.3	22.4
N (No. of respondents)	1134	404	431	299

CHAPTER 8. SUMMARY AND CONCLUSION

This study provides a broad data collection and analysis effort for transit-oriented developments in California. It is part of a series of efforts to understand the travel implications of TOD. Given the urgent transportation and housing challenges in California's urban regions, it is vital to understand the transportation implications of this form of infill development. This chapter summarizes key conclusions, recommends follow up research, and identifies policy issues for consideration.

Key Conclusions

The following represents the key conclusions of this research. In terms of the overall level of transit ridership among the surveyed populations, the study found that:

- TOD projects have much higher rates of transit use than comparable regions, cities or adjacent areas, for both residents and office workers. For office workers, there is conclusive evidence that rates of transit use increased over the 1992 to 2003 period.
- The Bay Area's more mature rail transit system and pro-active smart-growth initiatives support higher levels of transit use among TOD residents and workers.
- Transit accounts for about one-fifth of trips to retail sites in TODs. (Walking accounts for one in ten trips.)
- Hotel patrons in TOD use rail transit more frequently for travel during their stay than for their travel to the hotel (based on one BART and one San Diego site).

More detailed analyses of the travel behaviors of **people living in TODs** revealed that:

- Transit use by TOD residents varies across transit system and station area characteristics, but in all cases exceeds comparison areas. On average, transit shares for TOD residents exceed the surrounding city by a factor of 4.9. Transit shares for TOD residents are higher for the commute trip than for non-work travel.
- There is not conclusive evidence that transit mode choice increased among TOD residents in the 1992 to 2003 period. However, transit use is positively related to length of residency.
- The pattern of mode change upon moving to a TOD is complex. TODs provide good accessibility for all travel modes; some commuters switch to transit when they move to a TOD, while other switch from transit to automobile use. The impact of TOD in inducing a net commuting change toward transit use (as compared to the person's previous location) is modest. This finding is based on responses by residents who changed both home and work locations.
- Disaggregate models indicate that TOD residents are *more likely* to use transit if there is less of a time benefit for traveling via highways (compared to transit), if there is good pedestrian connectivity at the destination, if they are allowed flexible work hours, and if they have limited vehicle availability. TOD residents are *less likely* to use transit if the trip involved multiple stops (or "trip chaining"), if there is good job accessibility via highways, if they can park for free at their workplace, and if their employer helps to pay vehicle expenses (such as tolls, fuel, etc.). Each of these results is consistent with travel behavior theory.
- Neighborhood design and streetscape improvements are generally only important in predicting project-level differences; they have relatively minor influences on transit choice among individual station area residents. This suggests variation across individuals—within each TOD there are likely to be some that place value on these elements while others are

unlikely to be deterred, for instance, by poor landscaping or a lack of street lighting as long as the transit is nearby.

More detailed analyses of travel by **people working in TOD office buildings** reveals that:

- Transit use by TOD office workers is less than that of residents, but is much higher than the surrounding MSA. On average, transit shares for TOD office workers exceed the surrounding city by a factor of 3.7. The number of transit trips per acre for office projects may exceed that for residential projects due to their generally higher density.
- Consistent with the findings concerning TOD residents, individual-level modeling indicates that parking policies and employer assistance with transit costs significantly influence transit mode share. Public policy-makers can also encourage transit commuting by enhancing transit services: frequency of feeder bus services to stations serving offices as well as comparative travel times by transit were both significant predictors.

Finally, it is also important to note that the timing of the surveys (Spring 2003) may have affected the results because the surveys were implemented before California had emerged from an economic downturn. This downturn likely made automobile commuting relatively less costly and reduced the number of people commuting to work, thereby reducing transit ridership. The expected recovery and associated traffic congestion may well increase transit ridership over the next decade.

Research Recommendations

This research adds to the body of knowledge on California TODs, as developed by Caltrans, other universities, and public agencies. This data collection effort is intended to stimulate further analyses and surveys by local jurisdictions, transit agencies, and regional planning entities. Because of the scope of data collection, it was not possible to provide large samples for all systems. A primary research recommendation is to encourage other transit systems and land use authorities to commission more detailed surveys of sites included in this study and new TODs as they come on line. TOD represents a break from conventional development processes in many ways. Given the long time frame for changes in transportation and activity systems, it would be useful to conduct evaluations of California TODs once a decade.

Suggestions for further research include the following:

- Surveys of trip generation and parking occupancy in TODs. This information is needed for trip generation calculations, parking requirements and impact fee determinations. Furthermore, project trip generation can be correlated with the mode choice measurements conducted in this study.
- Surveys of property owners and managers concerning management practices, leasing policies, and marketing approaches.
- Additional travel behavior surveying, to increase response rates at individual sites and to include new sites as they come on line.
- Surveys of employers and merchants concerning their approaches to getting the most from the transit accessibility.
- Additional surveying of hotels, especially for systems where airport access has recently been expanded (e.g., BART SFO Extension).

- Analysis of real and perceived crime levels within station areas and their relative influence on TOD travel behavior. Perceptions of bus and rail systems (in terms of safety and other factors) should also be analyzed in relationship to transit ridership.
- Analysis of the impact that locating car-sharing programs and improved bicycle facilities (such as the Long Beach Commuter Bike Station) near rail stations have on reducing travel by and dependency on the automobile.
- Tracking changes in the spatial distribution of housing and employment to determine how the potential of rail to serve home-to-work trips is changing over time.

Policy Issues for Consideration

The study team has identified the following policy recommendations:

- Support continued TOD in California. In addition to providing transportation benefits, these developments provide attractive and affordable multi-family housing units that are needed to respond to housing shortages. They also broaden housing choices for California residents and provide desirable urban design and pedestrian features.
- Recognize the greater use of transit in TOD approval processes, local land use plans, and housing regulations. This study, along with many others, shows that there is a greater transit share in TODs. This transit use reduces requirements for roadway widening over conventional development. Possible incentives include sliding scale impact fees based on adjusted vehicle trip generation rates. This would lower the development cost of TOD projects and make housing more affordable. In addition, proponents of Location Efficient Mortgages (LEMs) contend that such a program, currently being pilot-tested in Los Angeles and the San Francisco Bay Area, can promote TOD by making it easier to qualify for a mortgage in settings where people ride transit more and drive less.
- Continue to improve transit travel times by making connections easier, improving transit reliability, and increasing the frequency and coverage of feeder bus routes. Transit ridership increases as the time advantage of traveling via highways relative to transit is reduced.
- Tailor TOD designs to local site characteristics. Transit use varies between heavy rail, light rail, and commuter rail systems, and it differs by project land use setting. Projects should be designed with recognition of those differences.
- Realize the full transportation benefits of TOD with a combination of non-automobile access modes and mixed land uses sufficient to allow households to reduce automobile ownership. Other research shows cascading benefits of reductions in auto ownership, including reduced household expenses, building costs, occupancy costs, and trip generation.
- Consider TOD possibilities in station areas with large inventories of surface parking. Such projects will fulfill the need for infill development in California's regions. The question of replacing station area parking should be addressed on a station-specific level, taking into account the impacts on general ridership.
- Support continued streetscape and design improvements in California TOD. Although these factors had only marginal impacts on transit riding, it could be the case that neighborhood amenities and enhancements make living in higher-density transit-oriented neighborhoods more attractive. They may therefore be critical to encouraging more Californians to sort themselves into TOD locations, which in turn corresponds with higher rates of transit usage.
- If transit ridership is the primary goal of TOD, it is important to increase the number of TOD residents who value transit access. Increasing housing supplies near stations will allow more

Californians to self-select into transit locations and this, more than neighborhood enhancements, will translate into higher ridership.

- Re-emphasize the role of parking supply, pricing policy, and employer worksite policies as key influences on commuter mode choice in TODs. Develop policy instruments that allow lower parking requirements, shared parking, and unbundling of parking from rent payments. Introduce initiatives that encourage employers to promote transit (e.g., through providing incentives for flextime programs or helping to cover the cost of transit passes) and discourage vehicle commuting (e.g., by eliminating free parking).

In sum, while increasing ridership is an important objective of TOD, it is not the only one. In California, TOD should be cast in a broader, more holistic context that acknowledges other reasons for targeting development around transit stations, such as widening housing choices and providing more affordable units. California has considerable precedence of regional initiatives aimed at reducing automobile dependence—the "Employer Commute Options" initiatives mandated by Federal and State clean-air legislation in the 1990s; today, such employer-based policies are largely voluntary.

Perhaps what local policy-makers can best do is to zone for sufficient housing supplies that match the taste preferences and earning levels of households wanting to live near stations. That is, market-responsive zoning, along with incentives like expediting the permit process for TOD projects and preparing specific station area plans, can allow developers to build housing more quickly (and thus at a lower cost) which in turns facilitates the process of residential sorting (i.e., households self-selecting to reside in station areas).

Streetscape improvements, parking supply, and other physical-design elements might influence the attractiveness of station area housing among prospective tenants, but such factors appear to exert minimal influences on whether station area residents opt for transit or not. Survey results suggest that housing supplies, not station area designs and parking levels, most strongly affect ridership. However, the practice of bundling parking with rents in most projects in this study means that residents had no incentive to reduce car ownership. In addition, since parking levels affect project economics, cities should carefully assess the amount of parking they require of residential projects. Conventional minimum requirements can drive up the cost of the project and result in an oversupply of parking.

Greater maturity of California's transit systems, along with mixed land use patterns, provides the type of connectivity to spur increases in mode share. This pull, combined with high future automobile commuting costs, will create an incentive/disincentive structure that we expect will support greater rail use in the future. Public policy can support this trend. For example, the Bay Area has been progressive in promoting smart-growth planning around stations, through MTC's Housing Incentive Production (HIP) and Transportation for Livable Communities (TLC) initiatives. Expanding transit services and leveraging development through smart growth are long-term propositions, however, that extend well beyond the ten-year scope of this comparison.

REFERENCES

Arrington, G.B. 2000. Reinventing the American Dream of a Livable Community: Light Rail and Smart Growth in Portland. Paper presented at the 8th Joint Conference on Light Rail Transit Investment for the Future, Transportation Research Board: Washington, D.C.

Bernick, M. and R. Cervero. 1997. *Transit Villages for the 21st Century*. New York: McGraw-Hill.

Boarnet, M. and R. Crane. 1998. Public Finance and Transit-Oriented Planning: New Evidence from southern California. *Journal of Planning Education and Research*, 17 (3): 206-219.

Cervero, R. 1993. Ridership Impacts of Transit-Focused Development in California. Monograph 45, Institute of Urban and Regional Development, University of California: Berkeley, CA.

Cervero, R. 1994. Transit-Based Housing in California: Evidence on Ridership Impacts. *Transport Policy*. 3: 174-183.

Cervero, R., M. Bernick and G. Gilbert. 1994. Market Opportunities and Barriers to Transit-Based Development in California. Working Paper 621, Institute of Urban and Regional Development, University of California: Berkeley, CA.

Cervero, R. and M. Duncan. 2002. Residential Self-Selection and Rail Commuting: A Nested Logit Analysis. Working Paper, Institute of Urban and Regional Development, University of California: Berkeley, CA.

Cervero, R., C. Ferrell and S. Murphy. 2002. Transit-Oriented Development and Joint Development in the United States: A Literature Review. TCRP Research Results Digest Number 52, National Research Council: Washington, D.C.

Cervero, R. and J. Landis. 1997. Twenty Years of the Bay Area Rapid Transit System: Land Use and Development Impacts. *Transportation Research A*, 31(4): 309-333.

Community Design + Architecture. 2001. Model Transit-Oriented District Overlay Zoning Ordinance. Report prepared by Valley Connections: Oakland, CA.

Ewing, R. 1999. Pedestrian and Transit-Friendly Design: A Primer for Smart Growth. Smart Growth Network.

Frank, L. and G. Pivo. 1995. Impacts of Mixed Use and Density on Utilization of Three Modes of Travel: Single-Occupant Vehicle, Transit, and Walking. *Transportation Research Record 1466*: 44-52.

Gerston and Associates. 1995. *Transit-Based Housing*. San Jose: Prepared for the Santa Clara County Transportation Agency and the Santa Clara Valley Manufacturing Group.

Handy, S. 1992. Regional versus Local Accessibility: Neo-Traditional Development and its Implications for Non-Work Travel. *Built Environment* 18(4): 253-267.

Handy, S. 1996. Understanding the Link between Urban Form and Nonwork Travel Behavior. *Journal of Planning Education and Research* 15: 183-198.

Hess, P., A. Moudon, M. Snyder and K. Stanilov. 1999. Neighborhood Site Design and Pedestrian Travel. *Transportation Research Record*, 1674:9-19.

Isaacs, Linsday. 2001. Development on the Line. *American City and County*. February 1, 2001.

JHK and Associates. 1987. *Development-Related Survey I*. Washington, DC: Washington Metropolitan Area Transit Authority.

JHK and Associates. 1989. *Development-Related Survey II*. Washington, DC: Washington Metropolitan Area Transit Authority.

Kitamura, R., P. Mokhtarian, and L. Laidet. 1997. A Micro-Analysis of Land Use and Travel in Five Neighborhoods in the San Francisco Bay Area. *Transportation* 24: 125-158.

Lund, H. 2003. Testing the Claims of New Urbanism: Local Access, Pedestrian Travel and Neighboring. *Journal of the American Planning Association,* 69(4): 414-429.

Menotti, V. and R. Cervero. 1995. *Transit-Based Housing in California: Profiles.* Working Paper 639, Institute of Urban and Regional Development, University of California: Berkeley, CA.

Moudon, A., P. Hess, C. Snyder and K. Stanilov. 1996. Effects of Site Design on Pedestrian Travel in Mixed-Use, Medium-Density Environments. *Transportation Research Record 1578*: 48-55.

Parker, T., M. McKeever, G.B. Arrington and J. Smith-Heimer. 2002. *Statewide Transit-Oriented Development Study: Factors for Success in California*. Business, Transportation and Housing Agency, California Department of Transportation: Sacramento, CA.

Parson, Brinckerhoff, Quade, and Douglas, Inc., R. Cervero, Howard/Stein-Hudson Associates, and J. Zupan. 1995. *Regional Transit Corridors: The Land Use Connection.* TCRP H-1 Project, National Research Council: Washington, D.C.

Parsons, Brinckerhoff, Quade and Douglas. 2001. Transit-Oriented Development in California. Working Paper, California Department of Transportation Statewide TOD Study: Sacramento, CA.

Porter, D. 1997. Transit-Focused Development. TCRP Synthesis 20, Transit Cooperative Research Program, National Research Council: Washington, D.C.

Puget Sound Regional Council. 1999. Creating Transit Station Communities in the Central Puget Sound Region: A Transit-Oriented Development Workbook.

Shriver, K. 1996. Influence of Environmental Design in Pedestrian Travel Behavior in Four Austin Neighborhoods. *Transportation Research Record 1578*: 64-75.

Stringham, M. 1982. Travel Behavior Associated with Land Uses Adjacent to Rapid Transit Sections. *ITE Journal,* 52(1): 18-22.

Thompson, Laura. 2002. Integrated Transit-Oriented Development: Mountain View. *Planning* (March 2002): 10-11.

Tumlin, Jeffrey and Adam Millard-Ball. 2003. How to Make Transit-Oriented Development Work. *Planning,* (May 2003): 14-19.

Untermann, R. 1984. Accommodating the Pedestrian: Adopting Towns and Neighborhoods for Walking and Bicycling. New York: Van Nostrand Reinhold.