7. IMPLEMENTATION MECHANISMS FOR TRANSPORTATION-RELATED LAND USE STRATEGIES

This chapter explains how jurisdictions can implement the recommended transportation-related land use strategies. This chapter focuses on seven topics, each of which is in an individual section.

- Policies that jurisdictions can adopt to implement the recommended transportation-related land use strategies.
- Policy documents that can be updated or created to implement the strategies.
- Administrative actions that jurisdictions can take to implement strategies.
- Organizational tools available to local governments to assist in implementing the strategies.
- Resources available to finance strategy implementation.
- Barriers and uncertainties associated with the implementation tools, and ways to minimize or resolve these problems.
- Monitoring mechanisms to track results of implementation.

Table 7-1 indicates which implementation tools are appropriate for each of the individual strategies.

Many of the policies and actions recommended in this report are compatible with the existing planning programs and goals of California's communities. For example, some of the actions listed can help cities and counties meet existing goals and requirements in the areas of housing provision, air quality improvement and congestion management. Higher-density housing near transit stations can help meet housing goals. Requiring pedestrian and transit access in site plans and zoning for mixed use can help increase walking, reduce vehicle trips, and improve air quality. Providing more thorough connections in the street network can help reduce traffic congestion on arterial streets. The actions described, therefore, not only help to meet the need to minimize vehicle emissions; they can also help to meet other local and regional priorities as well.

Table 7-1
TOOLS THAT CAN BE USED TO IMPLEMENT RECOMMENDED STRATEGIES

IMPLEMENTATION TOOLS	PROVIDE PEDESTRIAN FACILITIES	INCREASE DENSITY NEAR TRANSIT CORRIDORS	INCREASE DENSITY NEAR TRANSIT STATIONS	ENCOURAGE MIXED-USE DEVELOPMENT	ENCOURAGE INFILL AND DENSIFICATION	DEVELOP CONCENTRATED ACTIVITY CENTERS	STRENGTHEN DOWNTOWNS	DEVELOP INTER-CONNECTED STREET NETWORK	PROVIDE STRATEGIC PARKING FACILITIES
Policies That Can Be Created or Changed									
Top Priority Policies									
1. Set densities		✓	✓			✓	✓		
2. Create mixed-use zones				✓		✓	✓		
3. Award density bonuses		✓	✓	✓		✓	✓		
4. Focus growth within urban areas		✓	✓		✓	✓	✓		
5. Revise street standards	✓	✓				✓		✓	
Other Policies									
6. Allow transfer of development rights		✓	✓		✓	✓	✓		
7. Reduce requirements for setbacks and lots		✓	✓		✓	✓			
8. Require pedestrian and transit access in site plans	✓					✓			
9. Require signs to be at pedestrian scale	✓					✓	✓		
10. Revise parking standards	✓	✓	✓	✓		✓			✓
Policy Documents in Which to Create or Change Policies									
Top Priority Documents									
1. General Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Zoning Ordinance	✓	✓	✓	✓		✓	✓		✓
3. Subdivision Regulations	✓					✓		✓	
4. Design Guidelines	✓	✓	✓			✓	✓		
5. Master EIRs	✓	✓	✓	✓		✓	✓	✓	✓
Other Documents									
6. Specific Plans	✓	✓	✓	✓		✓	✓	✓	✓
7. Redevelopment Plans	✓	✓	✓	✓	✓		✓		
8. Trip Reduction Ordinance	✓								✓
9. Capital Improvement Program	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 7-1 *continued*
TOOLS THAT CAN BE USED TO IMPLEMENT STRATEGIES

IMPLEMENTATION TOOLS	PROVIDE PEDESTRIAN FACILITIES	INCREASE DENSITY NEAR TRANSIT CORRIDORS	INCREASE DENSITY NEAR TRANSIT STATIONS	ENCOURAGE MIXED-USE DEVELOPMENT	ENCOURAGE INFILL AND DENSIFICATION	DEVELOP CONCENTRATED ACTIVITY CENTERS	STRENGTHEN DOWNTOWNS	DEVELOP INTER-CONNECTED STREET NETWORK	PROVIDE STRATEGIC PARKING FACILITIES
Administrative Actions									
Top Priority Action									
1. Streamline permit process	✓	✓	✓	✓		✓	✓	✓	✓
Other Actions									
2. Negotiate development agreements	✓	✓	✓	✓		✓	✓	✓	✓
3. Modify fees and exactions	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Attract employers		✓	✓			✓	✓		
5. Establish enterprise zones			✓		✓		✓		
Organizational Tools									
1. Combine land use and transportation planning	✓	✓	✓	✓		✓	✓	✓	✓
2. Involve service providers	✓	✓	✓	✓	✓	✓	✓	✓	
3. Work with transit agency	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Involve business and community groups				✓	✓		✓		
5. Enter agreements with neighboring jurisdictions		✓	✓		✓	✓	✓	✓	
6. Establish a Joint Powers Authority	✓					✓			
7. Use the Congestion Management Agency	✓	✓	✓	✓					✓
Resource Tools									
1. ISTEA	✓	✓	✓			✓	✓	✓	
2. Housing and community development funds		✓	✓	✓	✓		✓		
3. Main Street Program	✓						✓		
4. Historic preservation tax credits							✓		
5. Motor vehicle registration fee surcharge funds	✓	✓	✓			✓	✓	✓	
6. Redevelopment Area	✓	✓	✓	✓	✓		✓		

Table 7-1 *continued*
TOOLS THAT CAN BE USED TO IMPLEMENT STRATEGIES

IMPLEMENTATION TOOLS	PROVIDE PEDESTRIAN FACILITIES	INCREASE DENSITY NEAR TRANSIT CORRIDORS	INCREASE DENSITY NEAR TRANSIT STATIONS	ENCOURAGE MIXED-USE DEVELOPMENT	ENCOURAGE INFILL AND DENSIFICATION	DEVELOP CONCENTRATED ACTIVITY CENTERS	STRENGTHEN DOWNTOWNS	DEVELOP INTER-CONNECTED STREET NETWORK	PROVIDE STRATEGIC PARKING FACILITIES
7. Public/private partnerships			✓	✓			✓		
8. Public and tax delinquent land		✓		✓	✓		✓		
9. Assessment districts	✓						✓		
10. Mello-Roos districts	✓					✓	✓		
11. General fund	✓	✓	✓	✓	✓	✓	✓	✓	
12. Bonds	✓		✓		✓	✓	✓		
Problems and Solutions									
1. Public opposition; Education and improvements	✓	✓	✓	✓	✓	✓		✓	✓
2. Capital reluctance; Education, guarantees, local funding	✓		✓	✓			✓	✓	✓
3. Uncertain market; Market studies and marketing	✓	✓	✓	✓	✓		✓	✓	✓
4. Developers building elsewhere; Multi-jurisdictional cooperation	✓								
Monitoring Methods									
1. Track new development projects in jurisdiction	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Track new development projects outside jurisdiction	✓								
3. Evaluate the capital improvements program	✓	✓	✓			✓	✓	✓	
4. Conduct ridership and path use surveys	✓	✓	✓	✓		✓	✓		

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7.1 POLICIES THAT CAN BE CREATED OR CHANGED

This section examines the policies that cities and counties could adopt to implement the transportation-related land use strategies. A policy is a regulation in a plan ordinance adopted by a City Council or County Board of Supervisors. Table 7-1 indicates which policies are directly related to each of the ten strategies. The table indicates that a number of policies support several of the strategies.

Of particular importance are five policies listed as "Top Priority" in the first part of this section. Implementing these policies in a way that reflects local conditions is the most effective first step toward minimizing automobile trips and motor vehicle emissions.

Top Priority Policies

If a city or county wants to begin moving in the direction of providing multiple transportation options, it may not know where to begin. These top priority items reverse the direction of most existing policy documents or common practice, and apply to a city or county as a whole. These items would therefore be the most effective actions a county or city can take to begin moving in the direction of supporting a variety of transportation options.

Policy #1: Set Densities to Reflect Proximity to Transit and Activity

Traditionally, local land use policy has focused on the maximum density of development that can occur in an area. Because development patterns that reduce automobile dependence require relatively high densities, land use polices that also emphasize higher densities near transit stations and corridors and around activity areas will reduce vehicular trips.

> Minimum Densities. The most effective way to encourage density is to set *minimum densities* for residential, retail and employment generating uses in central areas and around transit. Santa Cruz County, for instance, requires development within the zoning density range.
>
> "No Net Loss" Policy. For residential developments, another approach is to require that no new development result in the loss of housing units. For example, the Sacramento General Plan requires "no net loss" of housing units.
>
> Wording of Density Requirements. For all densities, stating densities as a number of square feet of land per dwelling unit, rather than a minimum lot size, indicates an openness to clustering as a matter of course. The Santa Cruz County General Plan and Zoning Ordinance use this phrasing.

Policy #2: Create Mixed-Use Zones

Mixing commercial and residential uses makes it easier for people to walk from their homes to the places where they work, shop and participate in civic life. Building housing downtown can make the downtown livelier. Unfortunately, many general plans and zoning ordinances prohibit mixed use. This requirement stems partly from the rise of noisy, polluting industrial plants next to residential areas in the late 1800's and the first part of this century. This prohibition is no longer necessary in most cases, because most modern employment-generating uses are compatible with residential uses.

Allowing Mixed Use. A city or county can begin by ensuring that mixed use is allowed in its central and transit-oriented development areas. In San Jose, for example, properties along the new light rail corridor are designated "Transit Corridor High-Density Residential." This zone allows some commercial uses.

Requiring Mixed Use. A jurisdiction can go a step further by requiring mixed uses with a certain percentage of housing, public and commercial uses in a district in target areas. The Sacramento and San Diego transit-oriented development guidelines take this approach. Policy documents can also specify how uses are arranged in a mixed-use district. For example, many mixed-use areas require retail or other uses that attract foot traffic on the ground floor, with offices or residences above.

Special Districts. Jurisdictions can create special land use and zoning districts with mixed land uses where transit availability or activity makes them desirable. An area containing several historic buildings and places can be declared a historic district. Development within the district can be required to be consistent with the historic character of the area. Historic buildings within the Historic District are eligible for federal Historic Preservation Tax Credits, which are described in the Resources section of this report. Larkspur's downtown Historic District has become a key component of the Downtown Specific Plan, which emphasizes pedestrian and bicycle access and pedestrian-oriented design.[1]

Fine-Grained Use Zones. A variation on mixed-use policy is fine-grained land use designation and zoning. For example, the West Berkeley Specific Plan replaced a large industrial district with a mosaic of zones. Light industrial and retail zones were used to buffer residential zones from heavy industrial uses. The zones are small enough that residential zones are within walking distance of heavy industrial zones.

Mixed-Use Overlay Zones. Overlay land use and zoning districts are a method for adding a second use to an area that is primarily in one use. San Jose uses a General Commercial overlay in residential areas where some commercial use is desired, such as arterial streets that serve as major bus corridors.[2] Portland, Oregon and Hartford, Connecticut use residential overlays in commercial zones to require housing as a part of commercial development projects.

Conflict Resolution through Performance Standards. Performance standards are rules limiting environmental impacts, such as traffic, noise, visual effects and air pollutant emissions. Performance standards minimize the impacts of industrial and commercial uses on adjacent residences. This makes it possible for cities and counties to zone for commercial uses near residential uses. To reduce noise impacts, Santa Cruz County sets noise limits at the adjacent property line, for example.

Exceptions. Of course, some uses cannot be sited in mixed-use settings because they are unattractive, noisy or even dangerous. For example, State law requires residences, child care centers, hospitals and schools to be located at least 2,000 feet from properties where significant disposal of hazardous waste has occurred, or where hazardous waste is transferred, stored or treated.[3] This law makes it impossible to locate such facilities within walking distance of residences.

Policy #3: Award Density Bonuses for Projects Furthering Jurisdiction Goals

Allowed densities can be increased, and other incentives given, for projects that provide transit- or pedestrian-oriented amenities such as housing and child care near commercial uses and pedestrian-oriented design. California's Density Bonus Law already requires local governments to grant 25-percent density bonuses plus other incentives (such as reduced parking requirements) for low-income, very-low-income, and senior housing.[4] State law also allows jurisdictions to grant a 25-percent density bonus for developers of housing within a half mile of transit stations.[5] A third state law allows cities and counties to give floor area ratio bonuses for commercial and industrial uses that provide child care facilities.[6] New York City increases the floor area ratio for new projects with direct connections to transit stations. Near the Bellevue, Washington station, a developer may build an extra four square feet of office space for each square foot of residential space provided in an office complex. Near the Ballston station in Arlington County, Virginia, the office floor area ratio is doubled if ten percent of the floor space is residential.[7] All of these methods are effective at enticing developers to build high density, mixed-use projects near transit and activity centers. In addition, the Second Unit Law allows second unit development to be promoted as an infill development strategy.[8]

Policy #4: Focus Growth Within Urban Areas

All of the recommended strategies are oriented towards concentrating higher density development near transportation and activity centers. This overall approach is supported if communities create incentives that increase appropriate development density within existing urban areas.

Communities can create conditions and incentives that make urban development and infill near transportation and activity centers more attractive and profitable. For example, local redevelopment agency activities and incentives to attract development to existing urban areas can focus on infill and redevelopment projects that are served by transit and easily accessible to pedestrians.

Infrastructure to serve infill and redevelopment projects (such as water, sewer, streets, etc.) is often already in place in existing urban areas, thus reducing the costs to local governments and utility companies of providing such services. However, if infrastructure is not available or of sufficient capacity, this constraint may significantly increase the cost of infill and redevelopment projects and reduce their economic feasibility. In comparison, new development in outlying areas often requires new infrastructure and services that can increase total costs to local governments, transportation agencies, and public utilities.

Policy #5. Revise Street Standards To Make Streets Pedestrian-Friendly

Many jurisdictions' street standards require wide streets and wide turning radii, which are designed to accommodate high volumes of automobile traffic. The high traffic speeds and volumes that wide streets allow are not compatible with pedestrian activity. Wide streets also cover large areas of land, so they limit the density that can be attained in a given area. Many local streets built today are also designed as cul-de-sacs, with limited access for pedestrians and bicycles to surrounding facilities.

To answer these problems, cities and counties can revise their street standards to require connected, narrower streets with trees and sidewalks, and bicycle lanes and bus stops on larger streets. Traffic calming devices could be required or at least allowed in residential and commercial areas that would promote pedestrian and bicycle activity and transit use. Traffic calming devices can include: narrower streets, tighter curb turning radii, textured paving at crossings, frequent intersections with pedestrian-activated traffic signals, traffic circles or "roundabouts," and landscaping within designated parkways. Rancho Cucamonga requires street trees, sidewalks, and a bicycle lane if the new street is in a location designated for a bicycle lane.[9]

Other Policies

Policy #6: Allow Transfer of Development Rights Within or To Target Areas

Transfer of development rights is used to preserve existing open space, agriculture, and other low-density uses and increase densities in areas where this is desired. When the allowable density on the land is reduced, a set of credits can be set up based on the potential use of the land. Developers in the area where the jurisdiction wishes to increase density can buy the credits, which become density bonuses for them.[10]

> Use in Central Districts. Within and near downtown, a jurisdiction may wish to preserve residential or historic buildings that are less dense than the allowed density on their sites. The city or county can allow the owners to sell un-used development rights to developers within the same or other target areas. In Seattle, the owner of land with low-density housing may sell development rights to the owner of another parcel downtown. The Seattle Housing Resources Group sold unused development rights above an apartment building to the developer of another building downtown, and used the proceeds to renovate the apartment building.[11]
>
> Use in Peripheral Areas. Transfer of development rights is also used to preserve agricultural land and privately held open space at the periphery, thus funneling growth into developed areas. When the amount of allowed development is reduced in fringe areas, the owner receives development credits for the difference between the original development rights and the new reduced rights. The owner may not use these credits on his or her land, but may sell them to a developer in an area targeted for increased density. The buyer can use the credits to build at a higher density than the zoning code would otherwise allow. The Land Conservancy of San Luis Obispo County, for instance, administers a Transfer of Development Rights program to avoid development on steep slopes with Monterey pines east of the developed areas.[12]

Policy #7: Reduce Requirements for Setbacks, Lot Sizes and Lot Shapes

Large setbacks tend to separate buildings from pedestrian life. Setback requirements can be reduced, or maximum setbacks can be established, to create a stronger connection between buildings and sidewalks.

Large minimum lot sizes and dimensions and prohibition of certain lot shapes can prevent the attainment of specified densities. They also make it difficult to cluster buildings and to provide a greenway and pedestrian and bicycle facilities. One of the purposes of lot regulations is to prevent the creation of unbuildable lots; however, the regulations may go beyond what is required to achieve this.

Setback, lot size and lot shape requirements can be reduced in the zoning code, or on a case-by-case basis during negotiation of development agreements. Rancho Cucamonga reduces these requirements in exchange for open space and pedestrian amenities provided by developers.

Policy #8: Require Pedestrian, Bicycle and Transit Access in Site Plans

Cities and counties can require developers to provide such amenities as pedestrian and bicycle pathways, bicycle parking, showers, bus shelters, and parks. A jurisdiction must compile a quantitative report on the relationship between development and the need for these facilities, and ensure that the requirements imposed on each project are proportional to the size of the project, as stated in the recent court case, Dolan v. City of Tigard.[13]

Policy #9: Require Signs To Be at Pedestrian Scale in Pedestrian Areas

Signs that are designed to be viewed by high-speed traffic at some distance are inconsistent with the human scale that defines pedestrian areas. The sign ordinance can require pedestrian-scaled signs in transit station areas, transit corridors and pedestrian-oriented activity centers. For example, Huntington Beach requires pedestrian-scale signs in its downtown.[14]

Policy #10: Revise Parking Standards to Reward Design for Alternative Modes

In some areas, parking standards require more parking than is normally used. These standards can lead to the construction of parking lots that interfere with transit and pedestrian access, and reduce the density of land use that can be achieved within a certain building height. Parking requirements can be lower in downtowns and other transit hubs, parking minimums can be reduced for projects that provide features encouraging alternate travel modes, parking maximums can be set in transit- and pedestrian-oriented areas, and preferential parking for car pools can be required. Shared parking reduces the number of spaces needed per square feet of commercial space or residential unit, especially if uses are mixed. The parking standards can reflect this by requiring fewer spaces for shared parking and for mixed uses. Mountain View's downtown parking standards are generally 90 percent of city-wide standards. The standards for retail and restaurant uses were reduced as part of the 1992 Downtown Precise Plan, and standards are lower for businesses in a shared parking assessment district.

7.2 POLICY DOCUMENTS IN WHICH TO CREATE OR CHANGE POLICIES

All of the policies discussed above can be implemented through existing planning processes, including updates of the General Plan and the Zoning Ordinance. Some of the policies can also be expressed in other documents, and all of the policies can be expressed in Specific Plans. The documents discussed in this section are plans and ordinances that can be adopted by a City Council or County Board of Supervisors. Policies that can be incorporated into the described policy documents are illustrated in Table 7-2.

One approach a jurisdiction could take would be a "pedestrian and transit-oriented code update." This update could consist of updates to the General Plan, Zoning Ordinance and Subdivision Regulations, along with a set of Design Guidelines and a Master EIR. Making these revisions together can streamline approval of the changes and of subsequent projects. It is best to consult with the Public Works Department, the transit agency, and transportation planning organization (RTPA) on this update. It could begin by eliminating policies that lead to high vehicular emissions, such as low, uniform intersection level of service standards; low-density single-family housing designations in areas served by transit or near other uses; prohibitions against mixed-use development; and parking standards that exceed actual needs. To replace these policies, each jurisdiction can select options from the policies listed above.

Top Priority Documents

Document #1: General Plan

General Plan elements can be coordinated to provide and support more efficient multi-modal transportation facilities related to appropriate land uses, to enable people to walk, take transit or bicycle to some of their destinations. Land use, transit and public works planners should work together to develop a cohesive plan. State law requires each General Plan to include seven elements: land use, circulation, housing, conservation, open space, noise and safety. Some jurisdictions have also adopted air quality and other elements. The policies discussed in this report can be implemented through the Land Use Element, and should also be coordinated with the Circulation and Housing Elements. "Transfer of development rights" can also be included in the Conservation and Open Space Element(s), and some performance standards could be placed in the Noise Element. As part of Inglewood's General Plan update process, the city is considering a mixed-use district within a quarter-mile radius of its downtown transit hub. Within

Table 7-2
MATRIX OF POLICIES AND POLICY DOCUMENTS

Document	Set densities to reflect proximity	Create mixed use zones	Award density bonuses	Focus growth in urban areas	Revise street standards	Transfer of development rights	Reduce setback, lot requirement	Pedestrian and transit access	Signs at pedestrian scale	Revise parking standards
General Plan	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Zoning Ordinance	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Subdivision Regulations	✔		✔		✔	✔	✔	✔		
Design Guidelines		✔			✔		✔	✔	✔	✔
Master EIRs										
Specific Plans	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Redevelopment Plans	✔	✔		✔				✔		
Trip Reduction Ordinance								✔		
Capital Improvement Program		✔		✔	✔			✔		

this district, high residential densities may be allowed, and planners may have the flexibility to reduce parking requirements for shared parking.[15] Santa Ana is integrating circulation provisions into its land use, urban design and education elements.[16] Any changes to the General Plan must be reflected in the Zoning Ordinance and the Subdivision Regulations. A summary of how the General Plan Elements can support this report's recommended strategies is provided below:

> Land Use Element. A land use element sets the locations, mix and densities of land uses. It can increase densities and require mixed uses near transit stations, along transit corridors and in activity centers where transit lines converge. The Land Use Element can also incorporate policies to focus development in existing areas; civic or historic districts; performance standards to facilitate mixed use; density bonuses to help preserve historic, housing and open space uses; reduced setbacks and flexible lot standards; a requirement for pedestrian, bicycle and transit access facilities on development sites; pedestrian-oriented sign policies; and reduced parking requirements. The 1992 Pasadena Land Use Element, for example, includes a Mobility section designed to complement the Mobility Element.
>
> Circulation Element. The circulation element can include facilities for transit, bicycles and pedestrians as well as automobiles. Pedestrian trails and bicycle paths can link residential neighborhoods to activity centers. Ample sidewalks, bicycle lanes, bicycle racks and street trees can improve pedestrian and bicycle access within the activity centers. In updating circulation elements, Ontario, California has added bike ways, Rancho Cucamonga identified transit routes and options, and Thousand Oaks is developing a pedestrian master plan. The City of Davis requires all new development to provide bicycle/pedestrian paths that connect to the existing pathway system.
>
> Coordination between the locations of transportation facilities and land use mix and density is key to making a place accessible by walking, bicycling and transit. One way to support pedestrian circulation is to avoid placing major arterial streets or highways between residential areas and nearby business districts, and to provide pedestrian-activated traffic signals at appropriate locations.
>
> Housing Element. State law requires that General Plans designate land for sufficient amounts of overall housing and affordable housing to meet a jurisdiction's regional housing need allocation as identified by the regional Council of Governments. The Housing Element must set forth a plan to remove constraints to the construction of adequate housing; identify sites that could be used for housing, including high-density sites for low-income housing; and include a five-year schedule for implementation of housing programs.[17] Inclusion of high-density housing in downtowns and near transit stations and corridors can meet these requirements while also acting to reduce vehicular trips. El Monte, for example, allows downtown residential densities of up to 50 units per acre for family housing and up to 100 units per acre for senior housing.
>
> Conservation and Open Space. The conservation and open space elements (which are combined in many General Plans) define where development will and will not occur. If open space areas are designated away from transit[18] corridors, this could have the effect of directing development toward transit corridors and stations. The Conservation and Open Space Elements can also

include walking trails, street trees and small parks in pedestrian-oriented activity centers, and bicycle paths linking residential and business areas. Ontario, California's recreation element addresses bicycle and pedestrian circulation.[19] The recreation element can include policies about making recreational facilities accessible by walking, bicycling and transit.

Noise Element. State law requires the noise element to show noise contours for all listed sources of noise. The noise element is an appropriate tool for protecting residences from highway and transit noise. Performance standards protecting residents from industrial, commercial and recreational noise can be placed in this element, facilitating mixed use development. Fullerton, for example, has noise standards for stationary sources.

Safety. Policies regarding development in floodplains, geologic hazard areas and wildfire hazard areas affect the shape of the developed areas. Sometimes this element is combined with the conservation and open space elements.

An air quality element is not required, but can provide a unified strategy that includes land use, housing, transportation and recreational aspects. Glendale adopted an air quality element in 1994,[20] and Inglewood is preparing one for adoption in 1995, among other jurisdictions.

Document #2: Zoning Ordinance

The Zoning Ordinance provides the specific regulations that implement policies in the General Plan. Zoning regulates the type and intensity of land use, signs, parking, setbacks, and the location and size of buildings, lots, yards, courts and other open spaces.[21] The zoning ordinance is the code that can specify higher densities, lower parking standards, pedestrian-scale signs and mixed-use or fine-grained variations in uses near transit facilities and in activity centers. To achieve a mix of uses downtown, the Portland zoning ordinance includes residential districts and stipulates that 60 percent of the buildings in the downtown must be in residential use.

Document #3: Subdivision Regulations

Subdivision Regulations are authorized under the California Subdivision Map Act to regulate the division of land. A part of the Municipal Code, subdivision regulations set standards for the size and shapes of lots, conditions for condominium formation, and design and dedication requirements for public facilities, including streets.[22] The California Subdivision Map Act expressly allows cities and counties to require sidewalks, bicycle paths, public transit lines, bridges, easements for public access to streams, and schools.[23] The Subdivision Map Act also allows jurisdictions to require any other design changes and dedications (collectively known as exactions) necessary to bring the subdivision into conformance with the General Plan. For example, the Chula Vista Subdivision Regulations authorize the Planning Commission to require pedestrian ways where necessary for access to schools, playgrounds, shopping centers, transportation facilities, other community facilities or unusually long blocks. Subdivision regulations include street standards for streets for subdivisions. The Subdivision Regulations can be revised to relax lot shape and minimum lot sizes; increase requirements for pedestrian, bicycle and transit facilities; and reduce required street widths and turning radii in order to support transit- and pedestrian-oriented development.

Document #4: Design Guidelines

Design Guidelines set standards for building placement and orientation, facade and roof treatment, parking locations, landscaping and streetscape improvements. Design Guidelines for transit- and pedestrian-oriented development can increase the accessibility, safety and attractiveness of buildings, pedestrian paths and streets.[24] The Guidelines can specify such building parameters as garage placement, porch requirements and setbacks, and can require site amenities such as pedestrian connections, street trees, street lights, bicycle racks and bus shelters. Design Guidelines can require facilities such as showers and bicycle lockers in office buildings and other employment centers. Design Guidelines can be developed for a city or county as a whole, or different guidelines can be developed for different areas. The General Plan can refer to the Design Guidelines, and they can be a chapter of the Municipal Code (either as part of the Zoning Ordinance or separately) or a Specific Plan. Design Guidelines can be mandatory, applying equally to all development in a certain district or use, or they can give planners the flexibility to require what is needed for each project. The City of San Diego uses its "Transit Oriented Development" guidelines in negotiating developer agreements.[25]

Document #5: Master EIRs

By preparing a Master Environmental Impact Report (EIR) for a Specific Plan or for a group of policy changes (such as a set of amendments to the General Plan, Zoning Ordinance and Subdivision Regulations), a jurisdiction can streamline the development application process for developers who comply with the new plan and regulations. A Master EIR assesses the impacts of a plan, a program, or a set of policy changes, and recommends mitigation measures.[26] Once a Master EIR is prepared for a group of policy documents, any project that is allowed by right in those and other documents, and that complies with all regulations, does not require a separate environmental document.

Other Documents

Document #6: Specific Plans

A Specific Plan includes regulations similar to those of a zoning ordinance for a particular focus area. A Specific Plan sets the distribution, location and extent of land uses and infrastructure; development standards; and implementation methods (regulations, programs, pubic works and financing). A Specific Plan must be consistent with the General Plan. Plan preparation can be paid for by a development fee in the Specific Plan area. A Specific Plan could be prepared for a transit corridor, station area, downtown, business district or neighborhood. An EIR would need to be prepared for the Specific Plan; development projects that are consistent with the Specific Plan would not necessarily require discretionary approvals nor project EIRs. One example of a specific plan is the Anaheim Downtown Plan, which specifies trees in the streets and other design features to slow traffic and encourage pedestrian uses of streets. Several San Jose specific plans overlap residential and commercial uses. Sacramento County has developed a number of specific plans for transit-oriented areas.

Document #7: Redevelopment and Housing Production Plan

A Redevelopment Agency must have a Redevelopment Area Plan and a Housing Production Plan. These plans can focus businesses and housing near transit stations and corridors. Redevelopment and housing production plans are especially appropriate tools for stimulating development of downtowns and activity centers, and for encouraging mixed-use and infill projects. (Redevelopment is also discussed as "Resource Tool #6" in Section 7.5 of this chapter.)

Document #8: Trip Reduction Ordinance

Many trip reduction ordinances contain only the provisions required by state law and air district regulations. These ordinances could include measures that private builders and employers must implement, and could include incentives as well as penalties. LaVerne's 1989 Trip Reduction Ordinance, for example, requires employers of over 100 people to provide van pools, subsidized bus passes, flex time, staggered hours and bicycle facilities. Commercial and industrial buildings in LaVerne with more than 75,000 square feet must provide an internal jitney, bus or taxi shelter.

Document #9: Capital Improvement Program

Priorities within the Capital Improvement Program can be ordered to emphasize transportation, lighting and landscaping projects that support alternate means of transportation; civic and cultural projects located in areas that are targeted for increased pedestrian activity; infrastructure upgrades for areas near transit, business centers; and projects that would improve the mixture of uses. For example, Glendale's capital improvement program includes funding for a shuttle system and an intermodal transfer facility. Federal law requires a Major Investment Study for any major metropolitan transportation investment that uses federal funds and affects existing or planned housing.[27] Relocation and replacement housing can be located near transit, employment, civic uses, shopping and services.

7.3 ADMINISTRATIVE ACTIONS

Administrative actions are processes, operations or negotiations that city or county agencies can initiate. The agencies taking action could include the planning, public works, community development or economic development departments or the redevelopment agency.

How a jurisdiction implements planning documents and manages the development and redevelopment processes on a daily basis determines to what extent actual land uses will support alternative modes of travel. Streamlining the permit process for projects that promote walking, cycling and riding transit is the most important administrative action a city or county can take in this direction. A municipality can take these steps in guiding public economic development efforts as well as private development proposals.

Top Priority Action

Action #1: Streamline the Permit Process for Desired Projects

Currently, the permit process in many jurisdictions is simpler for a single-use, automobile-oriented project that covers an entire parcel with private lots than it is for a clustered or mixed-use project. For example, a mixed-use or clustered project may require a master plan and a hearing, while single-family residential projects may be allowed by right. (The California Environmental Quality Act requires an Environmental Impact Report for any discretionary action that could have a significant adverse effect on the environment. In many cities and counties a hearing is held regarding the EIR, but the law does not require it.) The permit process could be changed to reward mixed-use, transit-oriented projects and projects in target areas. For example, approval criteria could enable staff to approve pedestrian-friendly or target-area projects up to a certain size without a hearing, while a hearing could be required for projects that do not meet transit-oriented or pedestrian-friendly design criteria. In Washington, D.C., for example, the Pennsylvania Avenue Development Corporation centralized the permit process for its redevelopment area and in some cases cut permitting time in half.[28]

Other Actions

Action #2: Negotiate Development Agreements

State law allows cities and counties to negotiate developer agreements for proposed projects that require use permits or changes to adopted policy documents.[29] (Projects that are within the use and density allowed by the zoning code and comply with the other elements of the Municipal Code do not require such approvals.) The law specifies that the agreement must include the use, density, height and size of buildings and land dedications. A development agreement can specify a mix of uses, grant density bonuses (pursuant to ordinance), and require land for pedestrian, bicycle and transit facilities.

A developer and a local government decide many of the design features of a project while negotiating the development agreement. Design features that make high-density and mixed use projects enjoyable can be incorporated at this point. One example is a development in downtown Mountain View which features buildings that look like townhouses, with porches fronting on streets, and with underground parking.

Action #3: Modify Impact Fees and Exactions

Many cities and counties require developers to pay impact fees or provide in-kind provision of land, facilities, or services to meet the needs generated by a project. Infill projects may actually generate higher fees to support infrastructure needs even though the actual infrastructure costs may be lower than outlying development. Where this occurs, a community may consider exempting certain fees to attract development to areas near transit, downtowns, and activity centers.

Alternatively, there may be instances where infrastructure fees may be calculated to be higher for an outlying development than a more centralized development. Where this is the case, there would be an incentive for new development to occur closer to existing developed areas. Any development fee or exaction should be adopted only after thorough documentation to support findings of the proportional relationship between the amount of the fee and the cost of impact that is directly attributable to the development on which the fee is imposed.

> Fees. Many jurisdictions assess the development fees for transportation improvements necessitated by project traffic. If a project is oriented and designed to reduce vehicular traffic, these fees likely will be reduced. Transportation impact fees could also be reduced if appropriate housing is provided near an employment use.
>
> Exactions. In-kind exactions may include transit and pedestrian facilities such as bus turnouts, sidewalks, bike racks, bike lanes, pedestrian connections to transit stations, and provision of transit information to home buyers. Exactions may be a trade-off for reduced requirements. For example, Santa Ana requires bike racks to reduce parking requirements.

Action #4: Attract Employers to Areas Near Transit and Housing

As a part of its economic development efforts, local governments can work to attract employers to areas close to transit corridors and stations, to downtowns and other activity centers, and to neighborhoods that house potential employees. Companies that employ a relatively large number of people per given area and require minimal truck access to highways are good candidates for location in transit corridors. For example, in Rancho Cucamonga, a food processing company is building a 300,000-square-foot facility near a new commuter rail station. The company has stated that proximity to transit was a major consideration in its choice of location.

Action #5: Establish Enterprise Zones in Older Activity Centers

An enterprise zone provides tax breaks and infrastructure upgrades for employers locating in the zone. A local government can apply to the U.S. Department of Housing and Urban Development to have an economically depressed area designated as a federal Enterprize Zone. Or a local government can create its own enterprize zone, giving local tax breaks to businesses in the zone. An enterprise zone can help to increase the density of business areas where there is not presently a strong real estate market. If the goal is to create a central area that can attract a large enough number of workers to support a rapid transit system, the type of jobs created is unimportant. If, however, the goal is to locate jobs near existing housing, it is important to specify that the subsidized uses would employ the types of workers who reside nearby. For example, Richmond has a federal Enterprise Zone. San Bernardino established its own Enterprise Zone, placing tax incentives in its Municipal Code. The incentives are available to new and expanding businesses in the zone, and for housing rehabilitation and infill housing construction.

7.4 ORGANIZATIONAL TOOLS

An organizational tool is a way to set up relationships among agencies and community groups to pursue common goals. This section addresses the question of who implements the policies, planning documents and administrative systems discussed above, and how these groups of people can most effectively work together. Increasing travel options will require increasing coordination among the City Council or Board of Supervisors, the Planning Department, the Public Works Department, the Metropolitan Planning Organization or Council of Governments, and some service providers within a municipal government. It will also require counties and cities to cooperate with service districts, transit agencies, local commercial and neighborhood organizations and other jurisdictions.

Organizational Tool #1: Combine Land Use and Transportation Planning

Transportation and land use planners have traditionally worked in isolation from each other in many municipalities. Many transportation planners work in the Public Works Department, while land use planners work in the Planning and Building or Community Development Department. Their training, goals, methods and language differ, making communication difficult. However, transportation and land use planners in many jurisdictions are learning to "speak the same language." The two departments working together can restore transit-and pedestrian-oriented communities, recommending land use changes that could improve transit, pedestrian and bicycle access and designing streets for play, social interaction and various forms of transportation. The two groups can cooperate to strengthen central business districts and other activity centers.

In many California cities and counties, transportation and land use planners are working together. In Thousand Oaks, the planning and public works departments work closely on development proposals.[30] In Glendale, the two departments are working together on the Circulation Element update. In Santa Ana, the two departments are working together on congestion management and bike ways. In Torrance and Berkeley, transportation planners are located in the planning department. The County of Sacramento coordinated extensively with the Regional Transit Agency in creating a transit-oriented General Plan.[31]

Organizational Tool #2: Involve Service Providers

Fire, police, sanitation and school agencies are concerned about a variety of issues associated with pedestrian- and transit-friendly design. It is important for land use and transportation planners to meet with these departments and agencies early in the planning process.

California jurisdictions have varying ways of involving service departments in the planning process. Santa Ana circulates plans as well as proposals to all city agencies. In Inglewood, the EIR process includes multi-agency review.

Safety. Police departments and sheriff's offices have concerns such as lighting and visibility of paths and entrances. Their input can be valuable in devising design criteria for a safe pedestrian and transit environment and bicycle parking.

Vehicular Access. Service providers who use large vehicles may be concerned about access. One way to meet this concern is to demonstrate that clearances would be adequate under the proposed standards. For example, developers of Laguna West in Sacramento County created a mock-up street and invited the sanitation and fire districts to try maneuvering their largest vehicles on the street; after the demonstration the service providers withdrew their opposition to the narrower residential streets.

Schools. School districts are currently in a quandary because Proposition 13 requires a 2/3 majority vote to raise school facilities funds through taxation, and state legislation sets developer fees based on the amount of area built for each residence or commercial project. The smaller residences that would be provided in denser developments generate lower school fees per dwelling unit than larger residences built under this formula. A school district objected to a Specific Plan prepared by the San Jose Planning Department for increasing residential density in a transit corridor for this reason. Some of the tools discussed in the Resource Tools section of this report could be used to address this problem.

Organizational Tool #3: Work with the Transit Agency

Most transit authorities are separate from city and county governments. To increase transit use, it is critical to involve them in planning for land use, street and path design.

Design Guidelines. A transit agency can provide design guidelines for bus stops and other transit connections in all areas, and for transit-oriented development. San Diego's Metropolitan Transit Development Board and the Sacramento Regional Transit District have published manuals on land use design for transit.

Corridor Selection. Transit agencies, counties and cities can work together to select corridors for transit improvements along with supportive land use strategies such as increased density and mixed use. The transit agency can also identify areas where through street connections and transit ways would be most useful. The transit agency could locate stations near employment uses and housing rather than (or in addition to) peripheral industrial areas where rail lines already exist.

Joint Development. A transit authority may undertake transit joint development: sharing costs with private developers to improve transit station areas and provide direct connections between the developments and the transit stations. A city or county can support transit joint development by giving density bonuses to developers who connect to transit stations, allowing transfer of air rights from above the stations to adjacent parcels, changing the zoning and parking requirements around the stations, giving high priority to infrastructure and civic projects near stations, and streamlining permit applications.[32] The San Francisco Bay Area Rapid Transit District (BART) sold development rights to adjacent land owners for development near the Pleasant Hill BART station in Contra Costa County, allowing for higher-density development near the station than could otherwise occur.[33] The transit agency can market air rights, coordinate with developers on the design of stations and buildings, assemble land and guarantee loans.[34]

Negotiating with Developers. Local governments and transit agencies can negotiate together with developers to include transit features in projects. For example, AC Transit and the Cities of Emeryville and Oakland in the East Bay recently negotiated with Catellus Development Co. for a transit center in the proposed East Baybridge retail and housing development.

Organizational Tool #4: Involve Business and Community Groups

Non-profit organizations, chambers of commerce, universities, insurers, neighborhood organizations, community development corporations, and small business development centers can play a role in improving, densifying and balancing neighborhoods in central areas and transit corridors. For example, the Milwaukee Redevelopment Corporation, a private non-profit corporation funded by membership dues, contributed to the development of several commercial, residential and mixed use projects downtown. In Orlando, the Downtown Development Board, which included private and publicly appointed members, worked with the Orlando Redevelopment Agency to plan and complete public projects. The Redevelopment Agency purchased land and leased it to the Neighborhood Improvement Corporation for 50 years. In addition to city funds, loans from the state and local banks were used.[35]

Organizational Tool #5: Enter Into Agreements with Neighboring Jurisdictions

Adjoining jurisdictions may wish to enter agreements to create or improve alternative transportation facilities, to create economies of scale when purchasing clean-fuel vehicles, or to preserve open space. Cities in the South Bay Cities Association south of Los Angeles are pursuing all three of these goals together. Cities and counties have made agreements to preserve undeveloped areas that overlap the boundaries of several jurisdictions. Such agreements can serve to funnel some growth into the developed portions of the cities (although some goes to other areas). Agreements could be made to increase the density, mix of uses and streetscape along a transit corridor, or to connect streets and paths. An agreement could be made to distribute funds among jurisdictions, even if only one directly benefits from development.

Organizational Tool #6: Establish a Joint Powers Authority

A Joint Powers Authority (JPA) is an entity formed by member jurisdictions to develop a plan, facility or program benefitting all of the jurisdictions. Each jurisdiction contributes opinions, time and money to the plan, project or program and shares in the use of it. Where a focus area overlaps jurisdictions, a JPA can be formed to prepare and implement a plan for an area, fund transportation improvements, develop a housing project or employment center, or build a civic facility. The cities of Orange and Santa Ana have a JPA for transportation improvements to serve mixed-use development at an activity center near the border between the two cities.

Organizational Tool #7: Use the Congestion Management Agency as a Forum

State legislation requires a county-wide effort to develop and implement a Congestion Management Program (CMP) in each urbanized county. The law requires each urbanized county to set up a Congestion Management Agency (CMA) with representatives from all of the cities in the county. Local jurisdictions must inform the CMA of major land use decisions, so that the agency can project traffic increases. "Deficiency plans" are required for areas where congestion reaches certain levels. Deficiency plans can include any measures that will reduce traffic congestion, including transit, bicycle and pedestrian improvements, land use changes, and parking management as well as roadway improvements for vehicular traffic. The CMA provides a setting for coordinated efforts through meetings, information sharing and development of deficiency plans.

Some CMAs are developing area and county-wide deficiency plans. Los Angeles County's 1993 CMP includes a county-wide deficiency plan. The deficiency plan includes a list of strategies from which local jurisdictions may choose. The list includes land use, transit service, transportation demand management, transportation systems management, and capital strategies.[36] Local governments are assigned "debits" when they issue building permits, based on the automobile trips that the buildings would generate. Cities and counties receive credit for implementing strategies in the deficiency plan, based on the number of person-miles of travel demand accommodated or reduced on a typical weekday. The jurisdictions must implement enough measures from the "toolbox" in the deficiency plan so that their credits equal their debits.

7.5 RESOURCE TOOLS

A resource tool is a source of funding, service, or land. Funds are available for developing and implementing policies and programs, and for designing and building facilities, in support of the recommended strategies. Many of the sources can fund multi-purpose projects and programs, such as those designed to strengthen downtowns and other activity centers.

Resource Tool #1: Apply Through Your MPO for ISTEA Funding

Regional transportation commissions, known by federal transportation agencies as metropolitan planning organizations (MPOs), apply for federal funding under the Intermodal Surface Transportation Efficiency Act (ISTEA). Some ISTEA highway funds can be spent on facilities for travel modes other than automobiles. ISTEA also includes funding for scenic byways, recreational trails, and transportation planning. Funding for vehicular transportation projects includes a ten percent set-aside for transportation enhancements: bicycle-pedestrian facilities, acquisition of scenic easements and sites; enhancement of scenic and historic areas near highways; landscaping on transportation corridors (not just roads); historic preservation; and preservation of rail corridors for rail and/or pedestrian-bicycle use.[37] Funds are available for planning and implementing bicycle and pedestrian circulation systems. Tuolumne County and the cities of Modesto, Livermore, Lathrop and Manteca are embarking on bicycle planning projects using ISTEA funds. Scenic easements, landscaping and billboard control can help to implement pedestrian-friendly design.

ISTEA Congestion Mitigation/Air Quality (CMAQ) funds are intended to help local governments implement the federal Clean Air Act Amendments of 1990. The Clean Air Act Amendments mandate the preparation of State Implementation Plans, which in turn are implemented through regional Clean Air Plans. Regional Clean Air Plans include land use provisions. For example, the Bay Area Clean Air Plan includes indirect source review, high-density zoning at transit stations and General Plan air quality elements. A jurisdiction could use CMAQ funds to implement any of these programs, ordinances or plans.

Resource Tool #2: Use Housing and Community Development Funds

The California Department of Housing and Community Development (HCD) administers state and federal housing assistance programs. Prevalent financing programs available to local governments from the U.S. Department of Housing and Urban Development (HUD) and HCD include the federal Community Development Block Grant (CDBG) and Home Investment Partnership (HOME) programs, Housing Opportunities for People with AIDS (HOPWA), and Emergency Shelter Grants (ESG). To apply for these funds, a city or county must submit a Consolidated Plan to HUD. This plan must address housing and community issues in a coordinated way, and is part of a combined application for all four funding programs.[38] These four types of grants can fund staff and other expenses to increase densities in transit corridors and around stations, improve central business districts, and promote infill projects. Rancho Cucamonga is using HCD funds for building rehabilitation, sidewalks and street lights.

Federal housing and community development funds are administered locally or by HCD, depending on whether a jurisdiction is an "entitlement entity." CDBG's primary uses are infrastructure, community facilities and building rehabilitation. El Monte, for instance, is using CDGB funds for downtown facade restoration. Another major source of housing funds is the state and federal Low Income Tax Credit Program, which gives tax credits for investments in housing construction. Information about funding sources for housing is available from HCD's Clearinghouse for Affordable Housing Finance in Sacramento.[39]

Resource Tool #3: Establish a Main Street Program

The National Trust for Historic Preservation initiated the Main Street Program in 1986, and states are responsible for implementing it. Main Street programs are used to revitalize the downtowns of small cities (3,500 to 50,000 people) through economic restructuring, pedestrian-oriented design and improvements, promotion, and organization.[40] The California Main Street Program is operated by the State Department of Commerce Office of Local Development in Sacramento. It includes demonstration cities and maintains a lending library. To be a demonstration community, a community must hire a full-time coordinator for the program; thus, the program has a matching requirement. Even if a community does not become a demonstration city, it can use Program videotapes and literature for help in revitalizing its downtown. A Main Street Program can help to revive a downtown so it functions more effectively as a transit hub and activity center. El Monte has used the Main Street Program to revitalize its downtown. Ontario has used it to rehabilitate commercial structures and improve facades.

Resource Tool #4: Apply for Historic Preservation Tax Credits

A city or county can designate an area that has historic significance as a Historic District. Once this is done, building owners can receive Historic Preservation Tax Credits for renovation of historic buildings. The jurisdiction can use these tax credits to revitalize older areas that have a pedestrian environment and to strengthen downtowns. The City of Pomona, for example, established a mixed use Historic District as part of its Downtown Pomona Specific Plan.

Resource Tool #5: Motor Vehicle Registration Fee Surcharge Funds

In September of 1990, Assembly Bill 2766 was signed into law.[41] This legislation authorizes regional air quality management districts to impose an additional four dollars on local annual motor vehicle registration fees. The proceeds may be used to implement programs to reduce air pollution from mobile sources, pursuant to air quality management plans and the California Clean Air Act. The air quality management districts distribute a portion of the funds to cities and counties. Local governments can use these funds for programs in the regional or state air quality plan, including local planning efforts.

Resource Tool #6: Establish A Redevelopment Area

A redevelopment area uses tax increment financing. To establish a redevelopment area, a city or county must make certain findings to declare the area blighted. The jurisdiction then makes improvements in the area, which are intended to increase the economic activity in the area and thereby increase property values. The Redevelopment Agency uses the tax increment to pay for the investments made in the area. Tax increment funds can fund infrastructure, public pedestrian amenities and services as well as land assembly and joint development. Portland, Oregon, has redeveloped much of its central city, using tax-increment financing for low-interest loans, limited property tax abatements, revenue bonds and land write-downs for housing.[42] Pasadena's redevelopment program has significantly increased the downtown's prosperity. San Jose is having mixed financial results after large cash infusions into its downtown, although most of the public facilities attract users.[43] The Redevelopment Agency can assemble parcels near transit stations and pursue joint development with developers.[44] A Redevelopment Agency could be used to revitalize a declining area that is rich in transit connections, or a single-use area with mixed-use potential. When the Bay Area Rapid Transit system, BART, was built, San Francisco established a redevelopment area, and the tax increment financing was used for plantings and other beautification efforts along Market Street.

State law requires each redevelopment agency to set aside 20 percent of its tax-increment revenue for moderate, lower and very low income housing. Many cities and counties use this Housing Fund in conjunction with other funds (described under Resource Tool #2) and in conjunction with the Housing Authority. Funded projects can be located near transit, work places, shopping and services. Market rate housing can attract professionals who work in downtown offices, possibly reducing automotive commuting into the central business district from the suburbs. The Southside Park Co-Housing Project in downtown Sacramento, an infill project including six moderate-income and 14 market-rate housing units, was built with partial financing from the Sacramento Housing and Redevelopment Agency on Agency property. All of the units were sold to Co-Housing Group members.[45]

Resource Tool #7: Set Up a Public-Private Partnership

Many redevelopment projects in central business districts are funded by multiple organizations. For example, funding sources for the renovation of the downtown Denver Dry Goods Building for mixed uses included developer equity and union pension funds, as well as state multi-family housing bond issues, city loans, a federal grant, sales of low-income housing units and historic tax credits. Other organizations that could provide financial or technical assistance include local businesses, insurers, community development corporations, Small Business Development Centers (one in each county), the California Conservation Corps (which trains youths in urban ecological restoration) and the Trust for Public Lands' urban gardens program. Oakland's City Center, an office-commercial complex including a plaza with a fountain and sculptures at the entrance to a BART station, was developed by a private corporation in conjunction with City redevelopment efforts.

Resource Tool #8: Build on Public and Tax-Delinquent Land

Jurisdictions can use surplus property or sites that have been acquired through non-payment of taxes to develop transit stations and infill projects. Infill projects can locate jobs and housing near each other and increase density near transit service and in central business districts. For example, a mixed-use project near Caltrain in downtown Mountain View was developed on an old school site. Many tax-delinquent sites are abandoned, but many also have toxic contamination. A profitable new business use or a redevelopment project could help pay for cleanup.

Resource Tool #9: Establish Special Assessment Districts

A special assessment district is used to fund public improvements in an area of a city or county. It requires property owners to pay according to the benefit they receive, which is not necessarily the same for each property owner. State law expressly authorizes several types of assessment districts. One of these is a Lighting and Landscaping District, which could be used to make transit, pedestrian and bicycle facilities safer and more attractive. Downtown merchants sometimes use assessment districts to fund amenities designed to attract customers to the downtown. The City of Pasadena established a special assessment district comprised of the facades of shops on Colorado Boulevard in the downtown historic district. In Tulsa, Oklahoma, the Downtown Improvement District, a special assessment district, funded property development. Assessment funds complemented contributions from the Downtown Tulsa Unlimited, Inc., a membership organization funded by dues, city contracts and parking fees.

Resource Tool #10: Establish Mello-Roos Special Tax Districts

A law enabling cities and counties to set up Mello-Roos districts was passed in response to Proposition 13, which requires a two-thirds vote for most tax increases but only a simple majority for special, single-purpose taxes. A Mello-Roos district sets up a special tax to pay for a single-purpose set of improvements, and must be approved by a majority of the residents of the district. If projects in the district have not yet been built, the developer constitutes the majority of owners and the tax is passed on to future residents who buy land from the developer. The district can sell tax-exempt bonds to fund the public improvements. In a Mello-Roos district, each parcel owner pays the same tax, and the payments may be used for operations and maintenance costs as well as capital improvements. A Mello-Roos district could be used to pay for transit, pedestrian and bicycle improvements or for infrastructure, civic buildings or beautification intended to draw people into an area. Long Beach is using a Mello-Roos District to revive Pine Avenue downtown, one block from the Blue Line light rail transit. The City is also working to establish a theater complex, restaurants and shops in this area.[46]

Resource Tool #11: Use the General Fund

If money is available in the General Fund, and a planning or capital project is expected to result in changes that will increase revenues in the long run, it could be worthwhile to allocate money from the General Fund for plan preparation and implementation. General funds are used for day-to-day in-house planning work and for most General Plan update projects.

Resource Tool #12: Issue Bonds

There are two types of bonds: general obligation bonds and revenue bonds. General obligation bonds are sold to pay for capital improvements that do not generate income, such as schools. These bonds must be paid back from the General Fund; therefore, issuing general obligation bonds generally requires a tax increase. Under Proposition 13, a tax increase requires a two-thirds majority vote of the people. If a proposed effort is popular enough to garner a two-thirds vote, this could be an option.

Revenue bonds are issued to fund projects that will generate income such as civic centers, utilities and housing. The federal Tax Reform Act of 1986 severely limits the issuance of revenue bonds; however, if the local government can secure a portion of the state's small allocation, it can issue revenue bonds. For example, mortgage revenue bonds issued locally or by the California Housing Finance Agency are still a major source of financing for affordable housing in California.[47]

7.6 PROBLEMS AND SOLUTIONS

Local jurisdictions are likely to encounter a number of local barriers and difficulties in implementing transportation-related land use strategies. This section outlines some of these potential problems, and it briefly suggests solutions to them. The problems referred to in this section are generally related to caution on the part of institutions and citizens who are not certain that transit- and pedestrian-oriented development will be profitable or desirable. Solutions include education and guarantees designed to increase the sense of security to those who are in a position to take risks regarding the form of development.

Of course, cities and counties also work within the context of state and federal policy, and policies at these upper levels of government could have a bearing on local implementation of transportation-related land use strategies. For example, the lack of regional governance, the structure of property taxes, the fiscal effects of Proposition 13, and the State's environmental laws all have some effect on local land use and development decisions. Similarly, federal policies such as income tax credits for historic renovation and multi-family housing, loan guarantees and transportation funding requirements can also influence local policy and development. These state and federal issues are not the topic of this report, since local governments can do very little about them directly. Instead, this section looks at the local issues and concerns that can arise when transportation-related land use strategies are implemented, and it suggests solutions to these local problems.

Most of these problems are based on people's perception that there may not be a strong market demand for pedestrian- and transit-friendly development. Some residents oppose higher densities nearby, most lenders are reluctant to fund mixed-use projects, and many retail corporations demand large parking lots. There is, in fact, a demand for pedestrian- and transit-friendly design, but many groups have not yet been convinced of this. Local governments can overcome some of this reluctance by providing information about this demand.

Problem and Solution #1: Public Opposition; Education and Public Improvements

Residential neighbors of land proposed for change may oppose that change. They may believe that the changes will ruin the appearance of their communities. For example, to many people, higher densities means high-rise apartment buildings surrounded by parking lots. Planning with the residents is the key to successful change. One method is a visual preference survey. At a public meeting, planners can show slides of various places in the town or other towns and have residents rate the slides as to which places they prefer. These preferences can then be incorporated into the new plans. Often residents see that the places they prefer are well-designed, pedestrian-friendly, mixed-use, and even higher density environments.

Citizens may also believe that high-density residential projects will reduce their property values or increase crime. The Cities of Fremont and San Jose and the County of Santa Cruz have prepared presentations to show neighbors the design and population characteristics of affordable housing, along with statistics on adjacent property values. Some available resources that showcase high-quality, higher-density development are a video from the American Institute of Architects and a slide show from BRIDGE housing corporation. Also, the Local Government Commission maintains a video library including these and other videos.

Residents may oppose high-density commercial or residential development because of anticipated increased traffic and associated noise and air pollution. Site-specific impacts can be mitigated to some extent or compensated for with public improvements, such as those listed above.[48] Residents and merchants may oppose removal of parking to make way for bicycle lanes; replacement parking may have to be developed to compensate for this loss. The public may object to the cost of alternative transportation facilities; publicizing the high cost of building and maintaining vehicular roadways can counter this objection. Objections to the cost of improvements in commercial areas can be overcome by a unified effort to improve the area. In Denver, a group of civic, neighborhood, business and government leaders campaigned for a bond issue for downtown infrastructure improvements. The bond measure passed and the downtown prospered.

Problem and Solution #2: Capital Reluctance; Education, Loan Guarantees and Local Funding

Banks and other financial institutions that make construction loans tend to be very conservative. Their loan policies are based on "tried and true" developments, and may lead to denied loans or higher interest rates for "experimental" projects. There is information about dense, mixed-use, and limited-parking projects that have been financially successful, which the lenders may not have. For types of projects where this is the case, educating the lenders can at least lead them to make a loan, even if it is at a higher rate than "conventional" project. For pioneering projects, a loan guarantee from a local agency or entity could be the only way to induce institutions to finance a project. Local lenders may be more likely to support local renewal efforts than larger institutions whose central offices are outside the area, because they benefit from local renewal. In Shelby, North Carolina, the local banks formed a tax exempt loan pool for Uptown renovation.

The California Home Energy Efficiency Rating System, Inc. (CHEERS) encourages Energy Efficient Mortgage Programs. Under energy efficient mortgages, utility savings on energy efficient homes are subtracted from the principal, interest, and taxes in calculating the amount a homebuyer can borrow. A recent study[49] quantifies how neighborhood characteristics can reduce vehicle use and associated household costs. The neighborhood characteristics are residential density, transit and pedestrian accessibility, and neighborhood shopping. CHEERS is considering factoring these characteristics into the mortgage qualification formula for Energy Efficient Mortgage programs.

Problem and Solution #3: Uncertain Market; Market Studies and Marketing

Developers may be concerned as to whether there is a market for infill, mixed uses or pedestrian-oriented design. They may also be uncertain about the market for projects in central cities and near transit stations. Density incentives only elicit development if there is a market for higher density projects.

Market Studies. Each area is in a unique market position. Its location, existing uses, surrounding uses, and access all help determine what type of development and transportation tools would attract people to that location. It is important to conduct a market study before embarking on improvements to an area or a transportation system. A market study can not only help to determine whether there is a demand for the type of development and transportation facilities a jurisdiction is considering, but can also identify what types of uses and facilities are likely to draw people.

Marketing. A marketing program developed along with improvements in an area can inform potential residents, businesses, customers, walkers and riders about the improvements. A marketing coordinator can also advise businesses in targeted activity centers on how to improve their marketing.

Market Experience. Because many downtown, pedestrian-oriented, transit-oriented and mixed-use development projects are just being completed, the market evidence is anecdotal. Computer firms have located in downtown San Jose and at Laguna West, a pedestrian-oriented development near Sacramento. In a joint development project on land owned by the San Diego Metropolitan Transit Development Board, 100 apartments and a day care center built next to a suburban light rail station are full. A new residential project near a BART station in El Cerrito in the East Bay is drawing residential renters. The ground floor retail, however, is half empty after two years. This station is not in a pedestrian-friendly area; in this situation the small shops do not draw from foot traffic, even to the BART station. San Rafael's experience with retail in its commuter bus terminal suggests that more than 3,000 boardings per day are required to support retail in a transit terminal.[50] Residents of new traditional neighborhoods, where most houses have front porches and are within a five- to-ten-minute walk of a commercial-office center, reported high satisfaction; 84 percent preferred this type of community in a 1992 survey.[51]

Outreach to Developers. Luring developers to a downtown can take a concerted effort. The City of Columbus, Ohio, directed an educational effort toward the development community regarding the market for high-density housing downtown. After conducting a market study, the City identified 350 suitable parcels, mailed a survey to owners, and provided technical assistance in assessing the feasibility of potential projects and in cutting costs. A conference held downtown attracted 150 developers, lenders, architects, builders and realtors. Market data, a computer to run pro formas, and sessions on adaptive reuse, design and construction techniques, financing and marketing strategies, mixed use development and moderate-income housing were available at the conference. The City has continued to update development community members through a newsletter. These efforts, together with one-stop permitting for downtown housing, longer inspector hours, federally assisted loans, tax deferral, and capital improvements resulted in a fourfold increase in developer interest. The 321 residential units that were built between 1987 and 1992 may not seem like a high number for all that effort, but they have appreciated 190 percent.[52]

Problem and Solution #4: Developers Building Elsewhere; Multi-Jurisdictional Cooperation

If a jurisdiction places substantial requirements and restrictions on developers and employers, and these requirements are not offset by the advantages of locating within the jurisdiction's boundaries, developers may locate outside the boundary. A multi-jurisdictional area may have unique assets, such as a labor pool with unusual skills or a natural feature. If all the jurisdictions within the area adopt the same ordinance, most firms will not base their location decisions based on the ordinance's requirements. The Golden Triangle trip reduction ordinance, which was a forerunner of Congestion Management Programs, is an example of this kind of cooperation.

7.7 MONITORING METHODS

Monitoring refers to methods of ascertaining whether or not actions and changes are having the desired effect and moving the jurisdiction toward its goal. The monitoring methods described below are ways to measure the effectiveness of policies, planning documents and administrative actions in achieving the recommended strategies. This section address the question of how a jurisdiction can know whether land use, infrastructure and travel patterns are changing in the desired directions. Most of these methods simply mean checking for another set of changes when performing monitoring tasks that many cities and counties already carry out. (Monitoring of travel indicators is addressed in Appendix I).

Monitoring Method #1: Track New Development Projects in a Jurisdiction

As a local jurisdiction's Current Planning office receives development project applications, it can enter them into a geographic information system (GIS) or a computer database. Each entry could state the type of use or mix of uses; the number of square feet or dwelling units; a score for transit, pedestrian and bicycle-oriented design; interior street type; number of parking spaces; and location. If the project is approved, staff would enter the approval date and any project changes. At the end of each quarter or year, a report could be printed showing how many development applications were located in the targeted areas and how many incorporated desired design options. Development can also be tracked on GIS for congestion management purposes, as it is in Long Beach.

To monitor the effect of policies on urban form, a jurisdiction could compare maps of the uses, densities and street forms of new developments before and after the policies are implemented. GIS are an efficient way to do this; although setup and learning take time, the long-term usefulness and savings can make it worthwhile. Councils of Governments, such as the Association of Bay Area Governments (ABAG), map land uses by parcel. Street maps would show whether connecting street patterns have been used in the new developments. A more difficult, but worthwhile, task is to map densities (dwelling units or commercial square feet per acre) before and after implementation of the new policies. This can indicate whether the policies are having the intended effect of increasing densities in certain areas.

Monitoring Method #2: Track New Development Projects Outside a Jurisdiction

If a city or county is concerned that requirements or limitations placed on developers might lead developers to locate projects outside the jurisdiction limits, staff could track new developments in neighboring jurisdictions. If this appears to be occurring, the county or city could coordinate with the neighboring jurisdictions, especially within the same air basin, to make requirements uniform. If this is not possible, the jurisdiction could adjust its regulations.

Monitoring Method #3: Evaluate the Capital Improvement Program

A city or county could review the Capital Improvement Program in terms of the ratio of public infrastructure and transportation projects supporting private automobiles to projects supporting other modes, denser development near transit hubs, downtown revitalization, infill and development of activity centers.

Monitoring Method #4: Conduct Ridership and Path Use Surveys

To measure the effect of land use and public improvements on transit ridership and use of pedestrian and bicycle facilities, a city or county could conduct surveys. Transit agencies do not normally track ridership by location of boarding and debarking, because drivers are occupied with driving and collecting fares. Survey workers could ride the routes in questions or stand at relevant transit stops and stations. Thousand Oaks has conducted surveys on its transit system. Similarly, survey workers could count or interview pedestrians and cyclists on sidewalks, bike lanes and paths. This information is important for developing short- and long-range transit plans and evaluating methods of improving the efficiency and effectiveness of the transportation system.

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8.0 RECOMMENDATIONS FOR FUTURE RESEARCH

This is one of the first research efforts to develop recommendations for packages of transportation-related land use strategies that are based on quantitative assessments of the strategies. The findings are intended to assist local jurisdictions, air quality districts, developers and other interested parties in their efforts to use land use planning to help in achieving air quality attainment and congestion relief. Through the course of this research, the JHK team, ARB staff, and Advisory Committee members identified a number of areas that would benefit from further research and study. These areas are listed below.

- Expand the number of case study communities (as in the Holtzclaw study) to add to the database.
- Collect data for exurban communities to serve as case studies.
- Implement demonstration projects for transportation-related land use strategies and track changes in travel behavior associated with them.
- Develop baseline data for local jurisdictions in California that are comparable to the performance goals suggested in this report.
- Develop level-of-service standards for pedestrians, bicycles, and transit; similar to those for intersections and streets.
- Evaluate the impact of traffic level-of-service standards on development densities.
- Perform additional analyses to further isolate the causality of a number of factors that influence travel behavior: density, lifestyle, income, availability of modes, attitudes, etc.
- Examine relationships between parking use, parking supply, parking costs, and parking requirements.
- Examine the relationship between quality of life characteristics such as crime, income, and density.
- Collect land-use-specific vehicle trip generation rates in California and evaluate how they are impacted by factors such as density, mixture of uses, location within metropolitan areas, and transit availability.

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GLOSSARY

Activity Centers: Any site that attracts a large number of trips. Activity centers can include major employment centers, commercial districts or malls, transportation hubs, and educational institutions.

Air Quality Attainment Plan: The plan for attainment of state air quality standards, as required by the California Clean Air Act of 1988.

Air Quality Districts: Regional agencies that are responsible for air quality issues.

Alternative Modes: Means of travel other than as the driver of a single-occupant vehicle. Alternative modes include transit, carpools, vanpools, bicycling, and walking.

ARB (California Air Resources Board): The statewide agency in California that is responsible for air quality issues.

Arterial: Multiple lane roadway that carries significant volumes of regional traffic.

Attainment: Characteristic of an area that has met specific air quality standards mandated by legislation (e.g, the Clean Air Act Amendments).

BART (Bay Area Rapid Transit): The heavy-rail transit system in the San Francisco Bay Area.

BURDEN: One of several computer programs used by ARB to estimate on-road vehicle emissions for counties and air basins in California.

CAC (Concentrated Activity Center): An activity center, often for employment, developed at relatively high densities.

Caltrans (California Department of Transportation): The state agency responsible for the safe operation and maintenance of the state highway system.

CDBG (Community Development Block Grant) Program: Federal housing financing program available to assist local governments.

CHEERS (California Home Energy Efficiency Rating System): Program by which homebuyers can more easily qualify for a mortgage by purchasing energy efficient homes and subtracting the savings from the calculated monthly mortgage costs.

Clean Air Act Amendments of 1990: Federal mandate that requires nonattainment areas to prepare plans for attaining air quality standards.

CMA (Congestion Management Agency): The countywide agency responsible for developing the Congestion Management Program and coordinating and monitoring its implementation.

CMAQ (Congestion Mitigation/Air Quality): An ISTEA funding program that is available to Metropolitan areas that are not in attainment of the national ambient air quality standards.

CMP (Congestion Management Program): A multi-jurisdictional program to reduce traffic congestion, required of every county in California with an urbanized area as defined by the Census Bureau (at least 50,000 people).

Cul-de-sac: A street that dead-ends into a court; generally in residential areas.

Densification: The practice of developing properties at higher densities than existing properties.

Density: Population or housing units as a function of area (usually per acre or square mile).

DMV (Department of Motor Vehicles): The California state agency with responsibility for licensing drivers.

DU (Dwelling Unit): A residence (e.g., single family home, townhouse, or apartment) for one or more people.

EIR (Environmental Impact Report): A required document for new or improved developments or facilities that assesses environmental impacts and recommends mitigation measures.

ESG (Emergency Shelter Grants): Federal and state housing financing program available to assist local governments.

Exurban: (also Rural) A descriptor of a community with a limited range of uses. In rural areas, agriculture, extractive industries, and open space are predominant; in exurban areas, recreational, retirement, and part-time residential uses are a growing aspect of the local economy. Exurban or rural areas often are scattered settlements with a population less than 2,500, or a population of less than 50,000 in the contiguous area.

FAR (Floor-Area Ratio): The ratio of the total floor area of a building (the total square footage of each floor) to the area of the lot in which the building is located.

GIS (Geographic Information System): Computer-based system for mapping and geographic analysis that is often used for planning applications.

Gridded Street Pattern: A network of streets and roads that are primarily organized in parallel and perpendicular, so the resulting network map has a grid pattern. Cul-de-sacs and dead-end streets are very uncommon or nonexistent in a gridded street pattern.

HCD (California Department of Housing and Community Development): Agency that administers state and federal housing assistance programs in California.

HH (Household): A group of people, generally members of a family, living in a single dwelling unit.

HOME (Home Investment Partnership) Program: Federal housing financing program available to assist local governments.

HOPWA (Housing Opportunities for People with AIDS): Federal housing financing program available to assist local governments.

HOV (High Occupancy Vehicle): An automobile or other vehicle with at least one passenger other than the driver.

HPMS (Highway Performance Monitoring System): A data collection system developed by the U.S. Department of Transportation to bring together data, at a national level, to assess the status of the nation's highways.

HUD (U.S. Department of Housing and Urban Development): Federal agency that administers financing programs for housing and community development funds.

Indirect Sources: A facility, building, structure, installation, or real property that attracts, or may attract, mobile sources of pollution (e.g., vehicles).

Infill: The practice of developing on open land that is surrounded by urban development.

ISTEA (Intermodal Surface Transportation Efficiency Act of 1991): Federal legislation to fund the national highway system and give state and local governments more flexibility in determining transportation solutions. It requires states and MPOs to cooperate in long-range transportation planning.

Jobs/Housing Balance: A community has a jobs housing/balance if the number of jobs and the number of residents is balanced. The ratio of employment to residences for balanced communities is arbitrary, but ratios of around 1.5 are commonly considered balanced.

JPA (Joint Powers Authority): An entity formed by member jurisdictions to develop a plan, facility, or program benefitting all of the jurisdictions.

LUTRAQ (Land Use, Transportation, Air Quality Connection): Portland (OR) demonstration project to develop methodologies for creating and evaluating alternative suburban land use patterns and design standards.

Mixed-Use Development: A design approach that fosters integration of compatible land uses, such as shops, offices, and housing and encourages them to locate closer together, or within the same building, to decrease travel distances between them.

Mode: A means of travel (e.g., automobile, transit, or bicycle).

Mode Share: The percentage of people using a particular mode for a given trip or set of trips.

MPO (Metropolitan Planning Organization): An organization in a urbanized area chartered to coordinate transportation planning activities.

Net Commercial Acre: Land designated and/or used for commercial development, exclusive of streets, open spaces, and residential uses.

Net Residential Acre: Land designated and/or used for residential development, exclusive of streets, open spaces, and commercial uses.

Pedestrian-Oriented Design: A design approach for residential and commercial areas that locates services and/or residences within walking distance of each other and provides adequate pedestrian facilities.

POD (Pedestrian-Oriented Development): A development with a pedestrian-oriented design.

Preferential Parking: The practice or policy of reserving parking spaces close to buildings for carpool and vanpool vehicles.

Rural: (also Exurban) A descriptor of a community with a limited range of uses. In rural areas, agriculture, extractive industries, and open space are predominant; in exurban areas, recreational, retirement, and part-time residential uses are a growing aspect of the local economy. Exurban or rural areas often are scattered settlements with a population less than 2,500, or a population of less than 50,000 in the contiguous area.

SOV (Single Occupant Vehicle): An automobile or other vehicle with the driver as the only passenger.

Suburban: A descriptor of a community where residential uses are predominant and most retail and public land uses serve local needs. Some region-serving retail and employment may be present. Suburban jurisdictions often have a population of under 50,000 (or a population of 50,000 to 200,000 in the contiguous area), and density is usually less than 10 dwelling units/net residential acre.

TDM (Transportation Demand Management): Demand-based strategies for reducing traffic congestion, such as ridesharing programs and flexible work schedules.

TND (Traditional Neighborhood Design): A design approach that emphasizes pedestrian accessibility and the orientation of houses towards narrower, tree-lined, grid-pattern, or otherwise interconnected streets. It combines, on a relatively small, neighborhood scale, mixed uses and integrated street patterns to create a land use pattern that makes it easier for residents to walk between their jobs, houses, and commercial services.

TOD (Transit-Oriented Design): A design approach that includes relatively high densities and a mixture of uses, located within walking distance of transit station.

Traffic Calming: Any of a collection of strategies designed to reduce vehicle speeds, usually on neighborhood streets. Common traffic calming approaches include street narrowing, vehicle diverters, pavement treatments, speed humps or bumps, and stop signs.

Transit Corridor: A development pattern centered near a transit line.

Transit Station: A transit stop or transit center that is served by numerous bus or rail lines. A bus stop for single routes is not considered a transit station.

Trip: A one-way movement of a person or vehicle between two points.

Urban: A descriptor of a community serving a full-range of uses, especially region-serving "high-order" functions in business and government with complex social and political life. Urban areas are found in primary and secondary central cities with a population of at least 50,000 in the central city, or 200,000 in the contiguous metropolitan area.

VMT (vehicle miles traveled): The product of the number of vehicles at any given location or throughout a roadway network multiplied by the number of miles each vehicle travels between its origin and destination. VMT is often calculated on an annual basis for a specific vehicle (accounting for all the trips a vehicle is used for in a given year) or a set of vehicles (e.g., in a metropolitan area).

VT (vehicle trip): A one-way movement of a vehicle between two points.

ZEV (Zero Emissions Vehicle): A class of vehicles, primarily electric, that emit no pollutant emissions.

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APPENDIX A

Characteristics of Transportation-Related Land Use Strategies

Table A-1
TRANSPORTATION-RELATED CHARACTERISTICS OF STRATEGIES EXAMINED

STRATEGY	NECESSARY TRANSPORTATION SERVICES	IMPACT BY MODE			REDUCTION IN VMT	REDUCTION IN VEHICLE TRIPS
		AUTO (SOV)	CAR/ VANPOOL	TRANSIT, BICYCLE, AND WALKING		
1. **Transit-Oriented Design**	- Transit services - Routes for feeder buses - Sidewalks/pedestrian facilities - Bike lanes/facilities	Decrease	Decrease (shift to transit)	Increase	High	High
2. **Density Near Transit Stations**	- Sidewalks/pedestrian facilities - Frequent transit service - Rail or express bus service	Decrease	Decrease (shift to transit)	Increase	Medium	Medium
3. **Density Near Transit Corridors**	- Sidewalks/pedestrian facilities - Frequent transit services - Bus service or streetcars	Decrease	Decrease (shift to transit)	Increase	Medium	Medium
4. **Mixed-Use Development**	- Sidewalks/pedestrian facilities - Bike lanes/facilities - Parking (quantity and location)	Decrease	If residential included, decreases. If nonresidential area, addition of services near jobs may increase ridesharing	Increase	Medium	Medium
5. **Infill and Densification**	- Sidewalks/pedestrian facilities - Transit - Parking (quantity and location)	Decrease	Same use as existing - increase Different use from existing - decrease	Increase	High	Medium/ High
6. **Concentrated Activity Centers**	- Sidewalks/pedestrian facilities - Transit hub - Bike lanes/facilities	Decrease	Increase	Increase	High	Medium
7. **Strong Downtowns**	- Sidewalks/pedestrian facilities - Transit hub - Bike lanes/facilities	Decrease	Increase	Increase	High	Medium

Table A-1 (continued)
TRANSPORTATION-RELATED CHARACTERISTICS OF STRATEGIES EXAMINED

STRATEGY	NECESSARY TRANSPORTATION SERVICES	IMPACT BY MODE			REDUCTION IN VMT	REDUCTION IN VEHICLE TRIPS
		AUTO (SOV)	CAR/ VANPOOL	TRANSIT, BICYCLE, AND WALKING		
8. Pedestrian Facilities	- Sidewalks/pedestrian facilities - Parking (quantity and location)	Decrease	No impact	Increase	Medium	Medium
9. Interconnected Street Networks	- Sidewalks/pedestrian facilities - Transit - Bike lanes/facilities	Decrease	No impact	Increase	High at Neighborhood Scale	Low
10. Strategic Parking Facilities	- Sidewalks/pedestrian facilities - Transit - No alternative parking supply nearby - HOV lanes beneficial	Decrease	Increase	Increase	Medium	High

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Table A-2
OTHER CHARACTERISTICS OF POTENTIAL STRATEGIES

STRATEGY	IMPACT ON EMISSIONS	LIMITATIONS AND CONSTRAINTS	IMPLEMENTATION BARRIERS	OTHER POTENTIAL BENEFITS	OTHER ISSUES
1. Transit-Oriented Design	Reduce cold starts Reduce running emissions Reduce hot soaks	- Only applicable to newly developing/ redeveloping areas with current or imminent high capacity transit	- General Plan and zoning restrictions - Financing	- More revenue for transit operators - More efficient use of infrastructure - Increased mobility for non-drivers - Increased housing diversity and affordability	
2. Density Near Transit Stations	Reduce cold starts Reduce running emissions Reduce hot soaks	- Only applicable to areas with transit stations (existing or planned)	- Public opposition to increased density	- More revenue for transit operators - More efficient use of infrastructure - Increased mobility for non-drivers - Increased housing diversity and affordability	Absolute volume of autos may increase even though per capita use declines
3. Density Near Transit Corridors	Reduce cold starts Reduce running emissions Reduce hot soaks	- Only applicable to areas with transit corridors (existing or planned)	- Public opposition to increased density and noise pollution, if transit service increases	- More revenue for transit operators - More efficient use of infrastructure - Increased mobility for non-drivers - Increased housing diversity and affordability	Absolute volume of autos may increase even though per capita use declines
4. Mixed-Use Development	Reduce cold starts Reduce running emissions Reduce hot soaks	- Not applicable for all combinations of uses	- Cannot locate polluting industries near certain areas (e.g., schools) - Financing	- Provides convenient services for local population - More efficient use of infrastructure	Quality, quantity and pricing of goods and services must match needs and desires of local population
5. Infill and Densification	Reduce cold starts Reduce running emissions Reduce hot soaks	- Not applicable to areas with purposely undeveloped land such as wetland, historical and natural preserves	- Public opposition to increased density - Potential conflict over types of development	- Utilizes available infrastructure - Maintains/revives urban neighborhoods and urban tax base	Community opposition strongest when existing property values appear threatened

Table A-2 (continued)
OTHER CHARACTERISTICS OF POTENTIAL STRATEGIES

STRATEGY	IMPACT ON EMISSIONS	LIMITATIONS AND CONSTRAINTS	IMPLEMENTATION BARRIERS	OTHER POTENTIAL BENEFITS	OTHER ISSUES
6. Concentrated Activity Centers	Reduce cold starts Reduce running emissions Reduce hot soaks	- Space and sufficient demand to develop new activity centers	- General Plan and zoning restrictions - Timing of development (if new center)	- Maximizes efficient use of infrastructure - Creates vital social/cultural centers	May become so large that walking between uses is difficult
7. Strong Downtowns	Reduce cold starts Reduce running emissions Reduce hot soaks	- Crime rate - Deteriorated infrastructure	- Public opposition to increased density - Potential conflict over types of development	- Improved economic vitality of a CBD - Maximizes efficient use of infrastructure - Enhances social/cultural centers	Larger CBDs may require a shuttle service
8. Pedestrian Facilities	Reduce cold starts Reduce running emissions Reduce hot soaks	- Mainly applicable to newly developing or redeveloping areas	- Public opposition to high pedestrian traffic near their properties	- Sense of community - Increases mobility for non-drivers - Increased housing diversity and affordability - Can be first step toward attracting viable transit.	Climate or topography may influence POD (ex. rain, snow, uphill, etc.)
9. Interconnected Street Networks	Reduce cold starts (possibly) Reduce running emissions Reduce hot soaks (possibly)	- Mainly applicable to areas with proper topography	- General Plan and zoning restrictions - Public opposition to vehicle traffic near properties	- Sense of community - Emergency vehicle access improved - Accommodates pedestrians and bike travel (more direct routings)	Cold start and hot soak reductions contingent upon effective deterrents to auto use
10. Strategic Parking Facilities	In the short run - running emissions may increase In the long run - Reduce cold starts Reduce running emissions Reduce hot soaks	- Mostly applicable to new developments, though built-up areas could reduce supply - Most effective if SOVs pay for parking	- Existing minimums in parking code - Financing - Opposition from large retailers, nearby residents	- Reduces cost of and need for parking infrastructure - Enhances aesthetics, sense of community	Spillover potential must be addressed to counter nearby residents' concerns

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APPENDIX B

Summary of Transportation-Related Land Use Strategy Literature and Annotated Bibliography

Table B-1
SUMMARY OF THE LITERATURE

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Promote Transit-Oriented Design						
Bacon, et.al., 1993	San Francisco Bay Area (Lafayette, and Rockridge area of Oakland BART station neighborhoods)	Urban, Suburban	Analysis of commute and shopping mode for Lafayette and Rockridge. Trip generation studies of 3 supermarkets in distinct settings: - Low-density single-family ½ mile from transit station (Lafayette) - Moderate density mixed-use 300 feet from rail transit station (Rockridge) - Moderate density mixed use ⅓ mile rail transit station (Rockridge)	Commute trips Supermarket trips	BART mode split for work trips 20% in both neighborhoods but Rockridge had - 20% lower drive-alone - 15% less use of auto for BART access Vehicular trip generation at supermarket near rail station 20% lower than ITE (low-density neighborhood) and 40% lower than ITE in moderate density/mixed use neighborhood next to rail station	Similar per capita income between neighborhoods Unclear why Lafayette site has 20% lower trip generation since BART mode split only 3.3% and walk/bike 0%.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Cervero, 1993	San Francisco and Los Angeles regions	Suburban	Matched-pair analyses of pre-1945 neighborhoods (transit-oriented) and post-1945 (auto-oriented)	Commute	Controlling for income and density, transit-oriented neighborhoods have 1.4% higher transit mode split in LA and 5.1% higher in the Bay Area. Furthermore, transit neighborhoods, by and large, showed lower drive-alone modal shares and trip generation rates than automobile neighborhoods and averaged higher walking and bicycling modal shares and generation rates than their automobile counterparts. (Mode shares 3.3% higher in L.A., 6.6% higher in Bay Area).	Only work trips studied. Study attempts to control (with limited success) the level of transit service, so that land use and street patterns are primary independent variables.
Friedman, et.al., 1992	San Francisco Bay Area	Urban, Suburban	Comparison of trip generation and mode split data between Pre-World War II and Post-World War II commuter using 1981 MTC survey data.	All purposes	Pre-war neighborhoods exhibit 20% fewer total trips per household and 25% fewer auto driver trips. (No data presented on VMT)	No control for HH size, auto ownership, or income (income 23% less in older neighborhoods) Cannot isolate effect of different TOD components.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Cambridge Systematics, et. al., 1992	Portland, OR	Suburban, Urban	Sophisticated model-based forecast based on 1985 travel survey and other information. Focuses on impact of TOD type development at regional and subregional scale.	All purposes	Regionally, TOD - LUTRAQ alternative reduces VT by 7.7% and VMT by 13.6% Within TODs: - 22% fewer home-based car trips. - >20% transit mode split compared to <10% in standard suburb .	
Middlesex-Somerset Mercer Regional Council, 1992	Central New Jersey	Urban, Suburban	Modeling study of Transit and Walking "Constructs." Modeling parameters based on literature review and survey data.	All trip purposes -Daily -Peak -Off-peak	12% reduction in regional growth of VMT, 18% reduction in growth of vehicle trips. Transit construct (mixed use centered on a major rail or bus stop with a jobs/housing ratio of 2.18 or more) reduces per capita vehicle use by approximately 28% and 32% peak and 25% off-peak compared to standard suburban.	NCHRP #323 (JHK, 1989) used to develop trip reduction factors

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Increase Density Near Transit Stations						
Cervero, 1993	California Rail Transit Stations (Bay Area, Sacramento, San Diego)	Suburban, Urban	Survey of residents at developments with at least 75 D.U. located less than ⅔ mile (most less than ⅓ mile) of a transit station.	Major Trips (3 most important trips on the survey day, as defined by the respondents)	For all systems taken together: 15% of major trips by rail transit, 12% by other non-auto mode. Near BART 35.6% of trips are non-auto. This compares to 14% non-auto in California in 1991.	A very comprehensive and recent study. Includes summary analysis of rail station access in Washington DC and Canada. Parking charges at destination and greatly increase probability of rail use (Fig. 5.1 p. 93) Both Cervero and the JHK studies (see below) results indicate that proximity of both residence employment to rail stations are key.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
JHK, 1987 and 1989	Washington, D.C.	Urban, Suburban centers	Surveys of residents and office workers near WMATA rail stations. Large projects (at least 75 DU) within one-third mile of station.	Work trips	Within 1,000 feet of a rail station, transit mode splits (bus and rail) are approximately: - 50% for residents - 50% for downtown workers - 20% suburban workers (Rosslyn, Crystal City) Transit mode share declines by 0.65% for every 100 feet for residences and 0.75% for every 100 feet for offices.	
Santa Clara County Manufacturing Group, 1993	Santa Clara County	Suburban, Urban	Survey of housing preferences of 500+ high tech workers in Silicon Valley. Included several questions on commute preferences.	Commute	65% of respondents stated they would use rail transit if located within ½ mile of both home and job.	
Stringham M., 1982	Toronto and Edmonton Canada	Urban	Study of 2,000 people living and working near rail transit stations.	Work and school	30-60 percent of all trips within 3,000 feet of station used rail transit. High-density residents 30% more likely to use rail at same distance.	

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Increase Density in Transit Corridors						
Barton-Aschman Associates, 1990	Raleigh-Durham NC	Urban, Suburban	Projective analysis of a proposed rail system based in part on Pushkarev and Zupan.	Rail transit		New rail transit requires 43 DU/acre within ⅛ mile and 10 DU/acre within the next ⅛ mile.
Pushkarev and Zupan, 1977	Nationwide with detailed data from the New York City region	Urban, Suburban	Empirical study of relationship between urban form and transit use. Two key variables identified: corridor residential density and activity center employment.	Transit trips (all purposes)	Between 7 and 30 DU/residential acre, transit usage triples for each doubling in density (Assumes at least one activity center with 5-10 million SF non-residential uses.	7 DU/acre is min. threshold for 40 buses/day. 15 DU/acre is the threshold for 120 buses/day.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Encourage Mixed-Use Development						
Colorado/Wyoming ITE, 1987	3 Colorado cities	Suburban	Empirical study of mixed-use developments (newer auto-oriented) (double-check)	Shopping, personal business, work	8% actual trip reduction found at mixed-use centers compared to 25% predicted on basis of interviews. Article concludes that other additional trips would not have been made.	Although mixed use reduced daily trips less than expected at site, users of mixed-use centers can accomplish more with one trip, and may reduce their total travel on a weekly/monthly basis.
Ewing, Haliyur and Page, 1994	Suburban (Palm Beach County Florida)	Suburban	Six suburban communities. Travel behavior analyzed with respect to: - Trip frequency - Mode choice - Trip chaining - Trip length - Vehicle hours of travel Database is a 16,000 record database for Palm Beach County. (Sample size for communities not given).	All	Vehicle mode splits not dramatic across communities. Vehicle hours of travel (VHT) do appear to be affected. Four auto oriented suburbs had an unweighted average of VHT/capita of 3.42 West Palm Beach (traditional neighborhood) had 2.28 VHT/capita (-33%) while partly gridded and master-planned 1920's community had 2.8 VHT/capita (-18%)	Study concludes that communities "internalize as many facilities and services as possible". Promoting efficient auto-trips and auto tours (multi-stage chained auto trips) is important "where the auto reigns supreme".

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
JHK & Associates, 1989	Nationwide	6 office and regional shopping centers, including Bellevue, WA (Regional center with 4.7 million ft office, 2 million ft retail/ commercial, 1000 hotel rooms)	Development of a database of travel characteristics for large-scale, multi-use suburban activity centers.	Commute Mid-day	Primary trip purpose is shopping for midday trips (46-84%) and P.M. peak trips. Relatively high transit share at Bellevue attributable to "extensive radial bus system" (17 bus route and transit center) The larger the center, the greater the percentage of internal trips (31-47% evening and midday). The more office space at a center, the greater the number of office-origin trips to the center. Automobile is the dominant mode, even for internal trips. Bellevue, with good transit service and design for pedestrians, had significantly higher shares of transit (7% versus 1%) and midday walk trips (25% versus 16%) than the other SACs.	Study concludes midday non-auto use and office proximity highly related. Trip generation rates tended to be lower than ITE estimates for all uses. For office, rates per square foot were lower than ITE rates, but rates per employee were higher, suggesting that employee densities are lower in SACs.
Urban Land Institute, 1983	Nationwide survey of 161 sites: 122 "suburban" 39 "CBD"	Suburban, Urban, CBD	Survey of employees regarding use of nearby facilities and services. Cross-sectional comparison of single-use vs. mixed-use sites.	Work, midday work-based trips	Mixing of uses increased the number of employees using nearby facilities from 19% to 28% in suburban areas and from 29% to 61% in CBD.	Study is a decade old but database is large (28,000 total questionnaires including non-employee user of sites.)

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Frank, 1994	Seattle, WA Metropolitan area.	Urban, Suburban	Analyses of database based on a transportation panel (survey). Census, employment and parcel-level land use data. Controlled for non-land use variables.	Work and shop trips by 3 modes. Single occupant vehicle (SOV), transit and walking.	Employment density reduces SOV and increases transit and walking, for both work and shop trips: population density increases walk trips (work and shop) and transit trips (shop). Major decreases in SOV: occur. - At employment densities above 75/acre. - At residential densities above 15 persons/acre (gross density).	A comprehensive study. Not all analysis is reported in this paper.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Encourage Infill/Densification						
Middleton, 1990	Portland, OR	Urban, especially downtown	Summary descriptions of the effects of LRT and land use developments since 1970's.		Number of autos entering downtown unchanged despite 30,000 new jobs. 43% work, 26% all day transit mode split in downtown (no "before" data).	
Dunphy and Fisher, 1994	Nationwide	Urban, Suburban, Rural.	Analysis of 1990 NPTS by residential density categories	Person Trips Vehicle Trip VMT	Generally confirms Holtzclaw's findings, except density increases at lowest levels (from 1,300 to 2,700 persons/sq. mi.) had no effect.	Authors note that density is associated with other factors (e.g. auto ownership, good transit)
Frank, 1994	Seattle, WA Metropolitan area.	Urban, Suburban	Analyses of database based on a transportation panel (survey) Census, employment and parcel-level land use data. Controlled for non-land use variables.	Work and shop trips by 3 modes. Single occupant vehicle (SOV), transit and walking.	Employment density reduces SOV and increases transit and walking, for both work and shop trips: population density increases walk trips (Work and shop) and transit trips (shop). Major decreases in SOV: occur. - At employment densities above 75/acre. - At residential densities above 15 persons/acre (gross density).	A comprehensive study. Not all analysis is reported in this paper.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Holtzclaw, 1990	San Francisco Bay Area	Urban, Suburban	Empirical analysis of neighborhoods in San Francisco, Oakland (Rockridge) Walnut Creek and Danville, using CA DMV smog check mileage readings.	Total VMT (no trip data)	Doubling density results in per capital VMT reductions of 20-30%.	Author sites similar studies in Toronto, Chicago and elsewhere which support basic relatively of a 20-30% reduction in VMT for each doubling in density.
Middlesex Somerset Mercer Regional Council, 1992	Central New Jersey	Urban, Suburban	Modeling study of Transit and Walking "Constructs." Modeling parameters based on literature review and survey data.	All trip purposes -Daily -Peak -Off-peak	Major urban growth in employment and households, combined with the suburban constructs, **reduces the growth in total trips by nearly 20 percent.** Without that type of urban growth -- meaning it is absorbed into the suburban constructs -- the overall growth in regional trips is reduced by only 10 percent. Similar differences occur for VMT.	

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Develop Concentrated Activity Centers/Strengthen Downtowns						
Colorado/Wyoming ITE, 1987	3 Colorado cities	Suburban	Empirical study of mixed-use developments	Shopping, personal business, work	8% actual trip reduction found at mixed-use centers compared to 25% predicted on basis of interviews. Article concludes that other additional trips would not have been made.	Although mixed use reduced daily trips less than expected at site, users of mixed-use centers can accomplish more with one trip, and may reduce their total travel on a weekly/monthly basis.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
JHK & Associates, 1989	Nationwide	6 office and regional shopping centers, including Bellevue, WA (Regional center with 4.7 million ft office, 2 million ft retail/ commercial, 1000 hotel rooms)	Development of a database of travel characteristics for large-scale, multi-use suburban activity centers.	Commute Mid-day	Primary trip purpose is shopping for midday trips (46-84%) and P.M. peak trips. Relatively high transit share at one center attributable to "extensive radial bus system" (17 bus route and transit center) The larger the center, the greater the percentage of internal trips (31-47% evening and midday). The more office space at a center, the greater the number of office-origin trips to the center. Automobile is the dominant mode, even for internal trips. Bellevue, with good transit service and design for pedestrians, had significantly higher shares of transit (7% versus 1%) and midday walk trips (25% versus 16%) than the other SACs.	Study concludes midday non-auto use and office proximity highly related. Trip generation rates tended to be lower than ITE estimates for all uses. For office, rates per square foot were lower than ITE rates, but rates per employee were higher, suggesting that employee densities are lower in SACs.
Markovitz in Gilbert, 1974	New York City Region	Urban, Suburban	Empirical study of trip generation rates. (Cross-sectional comparison of areas with clustered and unclustered land uses).	All	Residential trip generation reduced by 65% due to clustering. Non-residential trip generation reduced by 45%.	No VMT data

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Middlesex Somerset Mercer Regional Council, 1992	Central New Jersey	Urban, Suburban	Modeling study of Transit and Walking "Constructs." Modeling parameters based on literature review and local survey data.	All trip purposes: - Daily - Peak - Off-peak	Major urban growth in employment and households, combined with the suburban constructs, **reduces the growth in total trips by nearly 20 percent.** Without that type of urban growth -- meaning that it is absorbed into the suburban constructs -- the overall growth in regional trips is reduced by only 10 percent. Similar differences occur for VMT.	This study suggests that urban infill is twice as efficient in trip and VMT reduction as well-designed new suburban centers, but also notes scarcity of data on urban trip making.
Urban Land Institute, 1983	Nationwide survey of 161 sites; 122 "suburban" 39 "CBD"	Suburban, Urban, CBD	Survey of employees regarding use of nearby facilities and services. Cross-sectional comparison of single-use vs. mixed-use sites.	Work, midday work-based trips	Mixing of uses increased the number of employees using nearby facilities from 19% to 28% in suburban areas and from 29% to 61% in CBD.	Study is a decade old but database is large (28,000 total questionnaires including non-employee user of sites), no information on whether or not trips would have been made elsewhere if no nearby destinations.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Encourage Jobs/Housing Balance						
Cervero, 1988	Nationwide	Suburban	Empirical analyses of 57 large centers. Effects of density and other land use also considered.	Commute and mid-day travel	3 to 5% more trips by walking, cycling and transit. Jobs/housing balance creates shorter commutes discourage ride-sharing and transit (if service is infrequent)	Cites other studies by Giuliano (1991) and Downs (1992) that simple jobs-housing balances do not translate directly into mobility benefits.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Promote Pedestrian-Oriented Design						
Bacon, et.al., 1993	San Francisco Bay Area (Lafayette, and Rockridge area of Oakland BART station neighborhoods)	Urban, Suburban	Analysis of commute mode spent for Lafayette and Rockridge. Trip generation studies of 3 supermarkets in distinct settings: - Low-density single-family ½ mile from transit station (Lafayette) - Moderate density mixed-use 300 feet from rail transit station (Rockridge) - Moderate density mixed use ⅓ mile rail transit station (Rockridge)	Commute trips Supermarket trips Commute (work) trips	BART mode split for work trips 20% in both neighborhoods but Rockridge had - 20% lower drive-alone - 15% less use of auto for BART access Walk mode split at Rockridge supermarkets: 11.1% - 12.5% (Bike: 0 - 2.5%)	Similar per capita income between neighborhoods Unclear why Lafayette site has 20% lower trip generation since BART mode split only 3.3% and walk/bike 0%
Ewing, Haliyur and Page, 1994	Suburban (Palm Beach County Florida)	Suburban	Six suburban communities travel behavior analyzed with respect to: - Trip frequency - Mode choice - Trip Chaining - Trip length - Vehicle hours of travel Database is a 16,000 record database for Palm Beach County. (Sample size for communities not given.	All	Vehicle mode splits not dramatic across communities. Vehicle hours of travel (VHT) do appear to be affected. Four auto-oriented suburbs had an unweighted average of VHT/capita of 3.42 West Palm Beach (traditional neighborhood) had 2.28 VHT/capita (-33%) while partly gridded and master-planned 1920's community had 2.8 VHT/capita (-18%)	Study concludes that communities "internalize" as many facilities and services as possible promoting efficient auto-trips and auto tours (multi-stage chained auto trips) is important "where the auto reigns supreme".

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Middlesex Somerset Mercer Regional Council, 1992	Central New Jersey	Urban, Suburban	Modeling study of Transit and Walking "Constructs." Modeling parameters based on literature review and survey data.	All	"Walking Construct" modeled in this study showed an 18% reduction in Daily VT. (more in peak, less in off-peak)	Walking construct features some bus transit and a low jobs/housing balance (0.14).
Untermann, 1984	U.S.	All	Empirical studies of American walking behavior	All	Proportion of Americans willing to walk: 500' most (70%) 1,000' 40% 2,600' 10% (longer for work and other "crucial" trips)	Pleasant/interesting environment can perhaps double distance willingly walkers. Walkers tend to be young and female.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Integrated Street Networks						
Friedman, et.al., 1992	San Francisco Bay Area	Urban, Suburban	Comparison of trip generation and mode split data between Pre-World War II and Post-World War II commuter using 1981 MTC survey data.	All purposes	Pre-war neighborhoods exhibit 20% fewer total trips per household and 25% fewer auto driver trips. (No data presented on VMT). Also, pre-war had 12% walk trips and 4% bike (versus 8% and 2% in post-war areas).	No control for HH size auto ownership or income (HH income 23% less in older neighborhoods) Cannot isolate effect of different TOD components.
Kulash, 1990	Florida	Suburban	Modeling study of grid vs cul-de-sac dominated street networks.	All	43% reduction in VMT at community scale due to more direct routes.	Trips that go beyond community less affected.
White Mountain Survey, 1991	Portsmouth, New Hampshire	Suburban, Urban	Trip generation study	All	Study found the average daily traffic (ADT) generated by these neighborhoods to be about 50 percent lower than the ADT predicted by the *ITE Trip Generation Manual*.	No control for income, HH size, vehicle ownership.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Parking Management						
Aarts and Hamm, 1984	King County	Suburban	Testing whether ridesharing decreases the demand for parking.	Work	Findings show that it may be the limited parking supply that leads to ridesharing rather than ridesharing decreases demand for parking.	The result of this study is consistent with other studies.
Dowling, 1991	San Francisco	Urban	Study of mode share at San Francisco Hospitals as related (by regression) to parking pricing and supply.	Work	Pricing explains most variations in mode share (elasticity of about 1 at 50-55 dollars per month), but supply off-site is also important. About 1/3 as "strong" as price according to a regression.	Parking supply appears to be important even independent of pricing.
Gentvoort, 1984	Netherlands	Urban		Work	When a parking lot closed, SOVs dropped by 16% while transit increased by 17.5%. Carpooling increased by 3%, and there was no impact on bicycle trips.	The survey was given before and after the lot was closed. In the short run emissions and VMT were high because of SOV driving around looking for parking.
Golob, 1988	Irvine, CA (UCI)	Urban	Parking fees were increased for both student and faculty of the University of California, Irvine.	School/ (Univ) Work	A 10% reduction of students' permits might mean a reduction in VT/VMT and emissions.	Students were more price sensitive than faculty to the increase in parking fees.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Gross, W.P., et.al.	Massachusetts	Suburban	Parking fees were increased on and around campus, and parking supply was decreased.	School/Work	The actual impact came from the reduction of parking spaces rather than parking prices.	Since 79% of the survey respondents still chose lots based on convenience rather than pricing (while supply was somewhat limited) VMT and VT were not reduced much.
Higgins, 1982	Calgary, Sacramento, Davis, Montgomery County, Phoenix, Palo Alto, Bellevue, Portland, Seattle.	Urban	Study of parking code policies allowing reductions in required parking in return for developer TOM action or in-lieu fees.	Work	Few developers opt for reduced minimums.	"Flexible" parking requirements are not a reliable planning option to encourage less parking supply.
Keyani and Putnam, 1976	Pittsburgh	Urban (CBD)	A 3 day strike of parking garage operators closed 80% of Pittsburgh parking lots.	Work/Work Related	Transit ridership was up to 75% and peak period CBD traffic declined by 25%.	
Kulash, 1974	San Francisco	Urban	An increase of parking charges by 10-25%, at the same time an increase in transit services.	Work Shopping	Work related elasticity: An overall price elasticity on the basis of # of automobiles is about -0.3 (i.e. level of demand for parking is inelastic.)	Commuters were more likely than shoppers to shift to new travel modes to avoid increased parking fees.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Mehranian, et. al., 1987	Los Angeles	Urban	The study examined parking management of two downtown LA companies. Company A provides only subsidy for parking while Company B has incentive and rideshare programs.	Work	Company B had a higher percent of carpool/vanpool than Company A. However, SOV was almost the same : Firm A / Firm B SOV 49% 48% Carpool/Van 20% 34% Transit 31% 18%	The authors noted that Firm B has a lower transit share due to the fact that Firm B's incentive programs may be shifting transit users into carpools rather than shifting SOV's to other modes.
Miller and Everett, 1982	Washington, D.C.	11 Urban sites 4 Suburban	A "before and after" study of federal and private employees who were charged additional parking fees for commute trips.	Work	Urban: - SOV decreased by 2-5% - Transit increased by 1-3% while carpooling decreased Suburban: - SOV decreased by 2% - No change in carpooling & transit - A 3% increase in "other modes" (walking, biking, etc.)	Overall, the largest shifts were among lower income groups. Note that transit increased as a result of decrease in carpool. Usually the reverse is true.
Miller and Higgins, 1983	San Francisco, CA; Washington, DC; Ottawa, Can; Seattle, WA; Santa Cruz, CA.	Mostly Urban	Study of parking taxes, rate increases, surcharges, and carpool discounts across several cities.	Walk	Parking tax brings uneven results, but overall long term parking price hike increases short term parking in Chicago; peak period surcharge shifts parkers among parking facilities in Madison. Auto usage decreased 20% in Ottawa after free parking ended for government employees.	Pricing can reduce auto use, but also can increase short term parking and shift parker locations.

Table B-1
SUMMARY OF THE LITERATURE
(continued)

SOURCE	LOCATION	AREA TYPE	DESCRIPTION	TRAVEL TYPE	IMPACTS	COMMENTS
Olsson and Miller, 1978	Seattle, WA	Urban	Free parking was given to employees using HOVs in Seattle, WA.	Work	22% of respondents had driven alone prior to using the lots. 40% had used transit and 38% carpooled.	The monetary incentive was not the main reason for changing their mode, since most of the employees already had highly subsidized parking.
Pickrell and Shoup, 1980	Los Angeles UCLA	Urban	When parking permits were denied to students, they found alternatives to SOVs. However, as soon as they were offered parking permits they switched from rideshare to SOV.	School (University)		Although SOV students did not park on campus, they were still likely to drive alone and park away from campus.
Transport Canada Report #291, 1978	Ottawa	Urban	When parking fees were levied on federal employees, transit ridership increased up to 7.3%.	Work	This study suggests that parking supply, has a greater impact on rideshare mode than pricing.	
Willson, 1992	Los Angeles	Urban	Analysis of reduced or removed parking subsidy effects, including both case studies and model projections.	Work	Based on Los Angeles data, elasticity of demand for solo driving relates to parking price is about -0.2 to -0.3 at average daily costs of 3 to 4 dollars.	
Zarka and Krail, 1987	Seattle	Urban	Survey of 12 downtown buildings as to correlation between price and supply and mode share.	Work	While higher priced parking is associated with more transit use, tighter supply also appears to encourage additional transit use.	Study based on very limited number of cases and is cross-sectional, not time series.

(#31009/SOURCE.TBL)

ANNOTATED BIBLIOGRAPHY

1. Aarts, Jan Alexandra and Jeffrey Hamm,"Effects of Ridesharing Programs on Suburban Employment Center Parking Demands", *Transportation Research Record 1980*, Transportation Research Board, 1984.

Summary: Testing whether ridesharing decreases the demand for parking. Study comparing sites with and without ridesharing programs found sites with ridesharing programs and limited parking supply (28 percent less than comparison sites) had 20 percent less parking demand. Concludes, "Limited parking may be acting as the agent motivating the employees to rideshare."

Quantification: Parking demand

Area Types: Suburban

2. Alonso, William, *Location and Land Use*, Cambridge: Harvard University Press, 1964.

Summary: Synthesis of modern location theory and presentation of Alonso's model of how varying site rents - a product of the trade-off between transportation cost and the benefits of proximity for residential, commercial, and agricultural land uses - determines land use and urban form in a metropolis. Alonso's model represents a meticulous elaboration of Von Thunen's nineteenth century theory which explained agricultural site-rent as inversely proportional to transportation costs.

Quantification: Extensive theoretical economic analysis, but limited "real-world" applications; no data on tripmaking, or VMT.

Area Types: Urban/Metropolitan, especially monocentric urban areas

3. Altshuler, Alan, with James P. Womack and John R. Pucher, *The Urban Transportation System*, Cambridge, MA and London, England, MIT Press, 1981.

Summary: A broad summary of the political, cultural, economic, and technological factors that affect the urban transportation system in the United States. Analysis suggests that dominance of the auto is unlikely to diminish significantly. Includes a critique of the *Costs of Sprawl.*

Quantification: At national and metropolitan level

Area Types: Urban, Suburban

4. Bacon, Vinton, Carolyn Radisch, Tom Wieczorek, *Trip Reduction Potential of "Transit Village" Development Pattern*, Prepared for Professor Robert Cervero and Dan Solomon, University of California at Berkeley, City Planning 218 / Architecture 201, December 6, 1993.

Summary: Development patterns in the study areas do not result in higher levels of BART ridership for work trips, although the drive alone share of work trips was 20% lower in the more pedestrian oriented environment.

Mode of access to transit stations is significantly influenced by the built environment immediately surrounding a transit station, the driving modes (park and ride, kiss and ride) were found to occupy a 20% lower share within the pedestrian oriented environment.

Shopping trips appear to be significantly influenced by mixed use and pedestrian oriented development patterns. Reductions of more than 30% in automobile trips were found in a mixed use setting with high levels of transit service.

Quantification: Yes

Area Types: Urban, Suburban

5. Barton-Aschman Associates, Inc. with Hammer, Siley George Associates, *Research Triangle Regional Transit/Land-Use Study*, prepared for North Carolina Department of Transportation, 1990.

Summary: Examined land use requirement for a successful rail system in the Research Triangle area. Analysis of the proposed rail system was based in part on Pushkarev and Zupan. Land use requirements were expressed in terms of dwelling units per acre and proximity to the rail stations.

Quantification: Densities

Area Types: Urban, Suburban

6. Beimborn, Edward, Rabinowitz, Harvey, Mrotek, Charles, Gugliotta, Peter, Yan, Shuming, "Transit-Based Approach to Land Use Design", *Transportation Research Record,* 1349, 1992.

Summary: Guidelines for encouraging transit use by providing adequate densities, transit priority, mixed uses, short walk distances to buildings, other strategies.

Quantification: None

Area Types: Urban, Suburban

7. Beimborn, Edward, Rabinowitz, Harvey et al, *Guidelines for Transit Sensitive Suburban Land Use Design,* Urban Mass Transportation Administration, U.S. Department of Transportation, Final Report, July 1991.

Summary: This report was developed by a team at the University of Wisconsin, Milwaukee with expertise in engineering, architecture, planning real estate and geography. An excellent compendia of transit supportive urban design Sets out guidelines for density, mixing of uses and parking. Presents several pro-typical transit-oriented community plan. Appendix sets forth relative compatibility between different suburban land uses and transit service.

Quantification: Design principles, not traffic or travel impacts

Area Types: Suburban

8. Bourne, Robert T., Peter M. Schauer, *Case Study in Land Use and Parking Regulations in Support of Campus Transit Services, The Development of CY-Ride, Ames Iowa,* Paper No. 890523 presented at the 69th Annual meeting of the Transportation Research Board, Washington D.C., January 1990.

Summary: This paper examines how land-use and parking regulations were used in Ames Iowa to support, expand and improve bus service on the Iowa State University campus. The paper focuses on the "creation of innovative parking policies as the operational key to a strong transit service. Aggressive land use and innovative parking policies are only partial factors in building a strong transit service. Actual management and approach in operations are final links in a successful campus transit service."

"The continued successful provision of fixed route and demand responsive transit service on the Iowa State University campus and throughout the City of Ames has been the result of cooperation between the City of Ames, the University administration and the University students. These three groups have recognized the relationship between land use, parking and transit. In 1981 when CY-RIDE was in its formative stage, they set a course of action agreed to by consensus of reducing available parking and increasing available transit services."

Quantification: Parking and transit

Area Types: Urban - campus and neighborhood

9. Breheny, Michael, Tim Gent, David Lock, *Alternative Development Patterns: New Settlements*, University of Reading and David Lock Associates, Department of the Environment (United Kingdom) Research Report, Final Report, February 1992.

Summary: One area of consensus that emerges from this study's review of four approaches to understanding the relationship between transport, energy consumption, pollution and urban form in the United Kingdom is that forms of "decentralized concentration" are relatively efficient. However, even here there are uncertainties about the potential energy advantages of this form of development. When alternative development patterns are modelled and ranked according to energy efficiency, the results tend to be sensitive to assumptions about future lifestyles and the way in which people value mobility and choice. They suggest that if rising energy costs or policy restraints restrict mobility a pattern of "decentralized concentration" will be energy efficient because people will use the jobs and services which are close to them. If travel costs pose only a minimum deterrent, such a pattern may be more energy-intensive than centralization, because of the potentially large amounts of cross-commuting and other travel. In practice it is the latter situation that seems to have prevailed in the United Kingdom.

All of this implies that an energy-efficient form of urban development cannot be defined without qualifications, though there is some consensus that peripheral or ex-urban residential development unrelated to jobs and services is an energy-intensive pattern. In this sense dormitory urban extensions and new settlements do not perform well on the criterion of sustainability. Both centralization, or urban infill, and "decentralization concentration", possibly in the form of urban extensions with strong centers, are likely to be more energy efficient, but involve different sets of costs. A relatively robust form involves development in centers large enough to provide access to a good range of jobs and services without the need for long journeys, and with good public transport links to offer a viable alternative to the private car.

Under prevailing conditions of mobility, even quite large mixed developments are unlikely to be self contained unless they are quite isolated. This would suggest that energy efficiency would best be promoted by remote new settlements or integrated development within towns and cities. It cannot be claimed that new settlements are inherently energy efficient because they include provision for some employment and services. But, such provision is preferable to housing-only dormitory developments. (Summary drawn from pp. 41-45 of report).

Quantification: British Trip, VMT and Mode Share Data

Area Types: Urban, Suburban

10. Breheny, Michael, *Sustainable Development and Urban Form: The Contradictions of the Compact City*, Paper presented at the Joint ACSP/AESOP Conference, Oxford, England, July 1991.

Summary: Argues that compact urban development is not a simple good nor universally desirable. Compact and balanced mixed-use development does not always reduce environmental impacts. Notes that in the 1970's and 1980's the London New Towns' relative commuting independence of London was lost due to engulfment by the London conurbation.

Quantification: Commute data (Internal vs. External) for planned new comminuted near London.

Area Types: Suburban, Exurban

11. Cabell, Lee, Kimley Horn and Associates, "Neo-Traditional Neighborhood Design," *Westernite*, Official publication of District 6 of the Institute of Transportation Engineers, July - August 1993, Volume 47 No. 4.

Summary: This article is intended to provide a brief overview of suburban development and its problems, the basic

NTND concept along with the main characteristics that distinguish it from the modern suburb, the goal of NTND, transportation and traffic issues associated with NTND potential problems and areas of concern regarding NTND, and NTND applications.

Quantification: None

Area Types: Suburban

12. California Department of Transportation, *1991 Statewide Travel Survey*, November 1992.

Summary: Comprehensive travel survey for the State of California, the first conducted since the 1970s. Data is presented by region, but not by individual city/suburb. The size of the samples used generally precludes extraction of reliable community-scale data.

Quantification: Trip and mode share data (statewide and by region); no VMT data.

Area Types: Metropolitan (Urban and Suburban combined), Rural

13. California Department of Transportation (Caltrans), State of California, *Commuter Computer School Program Evaluation*, December 1982.

Summary: Dated but informative source on trip patterns to/from schools. Provides data on mode share and VMT for elementary, high school and college trips in the San Diego region. Also indicates the effectiveness of rideshare promotions and matching services with respect to these trips.

Quantification: Mode share, trips, VMT for school trips

Area Types: Urban, Suburban

14. Calthorpe, Peter, with Mark Mack, *Pedestrian Pockets*, San Francisco, 1988.

Summary: Outlines the simple but alluring idea of restructuring suburbs to slightly higher densities with a much finer-grain mixture of uses, enabling residents to access basic services and some employment without an automobile, while still accommodating motor vehicles.

Quantification: None of traffic/emissions data

Area Types: Suburban

15. Cambridge Systematics Inc., Calthorpe Associates with Parson Brinkerhoff Quade Douglas Inc., *The LUTRAQ Alternative Interim Report*, 1000 Friends of Oregon, October 1992.

Summary: The LUTRAQ alternative is a comprehensive solution, integrating land use and transportation policies, for managing projected growth in Washington County, Oregon.

The Metro (Metropolitan Service District) transportation modeling system was used to conduct simulations of the LUTRAQ alternatives and a No Build alternative. The results of this analysis show that the LUTRAQ alternatives, as compared to the Bypass alternatives for the year 2010 would:

- Increase the share of trips from home to work made by transit by 45%

- Increase the proportion of all trips made either on foot or be bicycle by 22%

- Reduce the number of households who will own 2-3 automobiles by 5.6%

- Reduce the number of vehicle trips per household by 7.7% and

- Reduce peak hour vehicle miles traveled by 13.6%.

The analysis also shows that residents living in TODs would enjoy the following advantages in the year 2010:

- over 35% would choose to own only one car, and over 9% would choose not to own a car at all;

- the average TOD household would make 22% fewer home-based car trips per day than the average household in the area under the Bypass alternative;

- over 20% of the workers living in TODs would choose to take transit to work, over twice as much as under the Bypass alternative; and

- the children living in TODs would be more than twice as likely to walk or bike to school from their homes than would children elsewhere in the study area, under any alternatives.

These statistics represent the results forecast developed for an early version of the LUTRAQ alternative. Since the completion of that version, reviews by national and local technical committees have led to modification of the alternative.

This latter version of the LUTRAQ alternative will be modeled using the same forecasting system applied to the early version of the alternative. In addition, the LUTRAQ study will be modeling the transportation impacts of the alternative not only to the year 2010, but through the year 2040, using an interactive land use model installed at Metro as part of the LUTRAQ project. Impacts on vehicle emission, energy consumption, system and user costs, and quality of life measures will be assessed.

Quantification: Trips and VMT

Area Types: Urban, Suburban

16. Cambridge Systematics, Inc., *Downtown Economic Study*, for the City of Sacramento, June 1989.

Summary: Evidence of parkers moving cars to avoid escalating hourly fees, probably with adverse consequences for air quality. Also data on mode share for office and shoppers. Spending patterns of shoppers and commuters also explored. Pivot point model used to predict effect of parking price increase, by type of parker (commuter, shopper), with the conclusion price increase will divert away some drivers (bigger spenders), but new demand will replace diverted in a few months.

Quantification: Mode share, parking turnover, shopper versus commuter parking and mode data, spending data but no VMT, trip or emissions data.

Area Types: Urban

17. Canadian Urban Transit Association, *The Implications of Demographic and Socioeconomic Trends for Urban Transit in Canada*, December 1991.

Summary: Contains 1987 travel survey data for metropolitan Toronto. Used to determine a vehicle trip per capita for a "best case" city. Body of report discusses how rising crime, a reduction in number of transit dependents and suburbanization are challenging transit in Canada.

Quantification: Yes

Area Types: Urban

18. Cervero, Robert, Robert Fraizier, Roger Gorham, Lisa Madigan, and Edward Stewart, *Transit-Supportive Development in the United States: Experiences and Prospects,* Prepared for Federal Transit Administration, U.S. Department of Transportation, October 1993.

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

Quantification: Yes

Area Types: Urban, Suburban

19. Cervero, Robert, *Ridership Impacts of Transit-Focused Development in California*, National Transit Access Center (NTrac), University of California at Berkeley, October 1993.

Summary: An in-depth report on the current realities and potentialities of concentrating more housing and workplaces around rail stations. Existing large-scale developments near stations of five California rail transit operations (BART, the Peninsula CalTrain, Sacramento Regional Transit, and San Diego Transit) are described. Ridership patterns are identified, stratified for housing office/workplace and retail developments. The study is based to a large extent on a survey of the "main trips" by 900 station area residents, 1,430 station area workers and 900 station area shopping center patrons. The research includes a literature review of similar studies in the Toronto and Washington, D.C. metropolitan areas.

For this study, surveys were conducted of developments near California rail stations that met these criteria: (1) Maximum distance: sites had to lie within two-thirds of a mile from stations, and ideally within the more walkable distance of one-third mile; and (2) minimum size: the following thresholds had to be met - residential (75 dwellings units); office (10,000 square feet or 100 employees); and retail (400,000 square feet). Candidate sites were screened for the following five California rail systems: BART; CalTrain ; and Santa Clara County Transit (SCCTA);Sacramento Transit (ST); and San Diego Transit (SDT). These systems represent a mix of rail technologies: BART-heavy rail; CalTrain-commuter rail; and SCCTA, ST, and SDT-light rail. In all, 27 residential projects located near 20 different rail stations were surveyed. Surveys were mailed to all households at these sites, eliciting data on "main" weekday trips made by persons 16 years and above. The response rate was 18.4 percent, providing data on over 2,500 trips among nearly 900 individuals.

For transit-focused offices, surveys were conducted at the workplace with the approval of office management. In all, data were compiled from 1,430 workers at 18 transit-focused offices in California, representing a 22.7 percent response rate. Lastly, pedestrians intercept surveys were carried out to gather travel data for shoppers and others at retail centers near BART stations, producing around 900 survey responses.

The following results were found for the 27 survey residential sites.

- The average rail modal split for all trips was 15 percent, with significant variation. Rail shares as high as 79 percent and as low as 2.0 percent were found among residential projects. Housing around BART averaged the highest rail splits (26.8 percent), while housing around SCCTA averaged the lowest (6.7 percent). Overall, those residing near California rail stations are fairly auto-dependent - over 75 percent relied on a car, either as a driver or a passenger, for their primary trips.

- Rail captured 19 percent of work trips made by stations-area residents, and in the case of BART, 33 percent. This is much higher that the three BART-served counties' rail modal split of 5 percent for work trips in 1990. It is also considerably higher than the 1990 average of 17.8 percent for all Bay Area residents living within one-half mile of BART station. For each Bay Area city served by BART, residents living near rail stations were around five times as likely to commute by rail transit as the average resident-worker in the same city.

- The strongest predictors of whether station-area residents commuted by rail was whether their destination was near a rail station and whether they could park free at their destination. Other significant predictors were vehicle ownership levels and the availability of employer-paid transit allowances. If station-area residents work in San Francisco for an employer who charges for parking and they receive a transit voucher, there is over a 95 percent chance they will commute by BART. If the same conditions hold and they work in Oakland, the probability falls to 64 percent; and for most other BART-served destinations, the odds are in the 10 to 15 percent range. And if they work at a destination beyond normal walking distance from BART and receive free parking, there is only around a 2 percent chance they will commute by rail. Clearly, if transit-based housing is to produce meaningful mobility and environmental benefits, there must also be a transit-focused employment centers.

Key findings: Although station area residents are several times more likely to use rail transit than non-station area residents, the rail system will attract a substantial proportion of work trips only if both home and work sites are within walking distance of rail transit, and parking charges exist at the work site.

Quantification: Trips, mode shares, VMT and speeds

Area Types: Suburban, Urban (Rail station areas)

20. Cervero, Robert, "Jobs-Housing Balancing and Regional Mobility", *APA Journal,* Spring 1989.

Summary: Despite the steady migration of jobs to the suburbs over the past decade, many suburban residents commute farther than ever. In this article the widening separation of suburban workplaces and the residences of suburban workers is attributed to several factors: fiscal and exclusionary zoning that results in an undersupply of housing; rents and housing costs that price many service workers out of the local residential market; and several demographic trends, including the growth in dual wage-earner households and career shifts. Case studies of metropolitan Chicago and San Francisco confirm the displacing effects of high housing costs and housing shortages. In addition, data from over 40 major suburban employment centers in the United States show that suburban workplaces with severe jobs-housing imbalances tend to have low shares of workers making walking and cycling trips and high levels of congestion on connecting freeways. Inclusionary zoning, tax-base sharing, fair-sharing housing programs, and a number of incentive-base programs could reduce jobs-housing mismatches and go a long way toward safeguarding regional mobility for years to come.

Quantification: Yes

Area Types: Urban, Suburban

21. Cervero, Robert, *America's Suburban Centers, A Study of the Land Use - Transportation Link*, University of California, Berkeley, Prepared for Urban Mass Transportation Administration, January 1988.

Summary: Very comprehensive study of suburban employment centers as to employment, density, land use, mixed use, job housing measures, commuting and traffic conditions. Fifty-seven large suburban centers are surveyed. ("Centers" all had at least 1 million square feet of office floor space, 2000 or more workers, and at least 5 miles from the CBD, as of 1987). The relationship between solo commuting and land use variables is explored and quantified by regression.

Among the findings: high density centers show higher use of alternative modes and relatively lower levels of parking supply, but they also the slowest commute times and worst traffic levels of service on nearby arterial streets; single-use office is associated with more solo commuting; accessible retail near such offices seems to enhance ridesharing; centers with a more "even" jobs housing balance have higher walk and bike shares, but lower ridesharing. Influences on speeds and travel times also are examined.

The study is empirical, i.e., based on real travel data collected from a national cross-section of suburban centers. It investigates the extent to which suburban congestion problems and declining mobility are linked to the emerging land use environment of suburban employment areas, which induce most employees to drive alone. In addition to the land use environment (low density, single use, non-integrated), jobs/housing imbalances and certain policies (free parking, inadequate roads, meager transit service) contribute to the problem.

The study concludes that high density, large size, and high degree of mixed use development are necessary, but not sufficient prerequisites for significant levels of ridesharing, walking, and transit. Another conclusion is that single-use office settings (higher percent of total floorspace in office) induce drive alone commuting, while varied work environments (higher percent retail plus lower on-site jobs/housing ratio) encourage ridesharing. For individual workers, the shared-ride percent increases if they work at larger, single-tenant sites, and as distance from the job site increases.

Other conclusions: the benefit of balancing jobs and housing is in shorter work trips, not in mode shift, since transit and ridesharing are reduced. (With a higher ratio of jobs to housing in the area there is less balance); average speed on nearby freeways decreases as the jobs/housing ratio increases and as employees per acre increases.

Cervero's overall recommendation for suburban areas is the creation of workplaces with high density and "rich mixtures" of land uses, i.e. "small downtowns", with nearby affordable housing. (Summary based in part on SLH)

Quantification: Mode share, travel time, parking supply, land use characteristics and regression correlations given; however, no explicit VMT or pollution quantification, thought these might be derived from data given.

Area Types: Suburban (Large Activity Centers)

22. Chambers, Clifford and A.J. Zissler, *Survey Implications for Suburban Mobility Strategies*, Report submitted to Sacramento Area Council of Governments, Menlo Park California, Crain and Associates, November 20, 1991.

Summary: This report discusses the results of a survey to study the travel characteristics of employees and visitors at two Sacramento activity centers: Arden Fair/Point West and Sunrise/White Rock. The study provided the following information:

- People living within a five mile radius of the center are more likely to visit the center than those living over ten miles away. A regional shopping center draws from a wider geographical area.

- Where bus and/or rail service to the center was minimal, many people perceived that it was not even possible to get to the center using transit.

- The distance from home to the center was not considered to be a factor in determining whether to carpool.

- Sunrise attracts more repeat visitors than does Arden Fair. Trips to Sunrise are short in length and parking is plentiful.

- Improved bicycle access for short trips may reduce auto trips.

- Visitors would consider using fixed-route service to the center if it was easily accessible or if the center was close to downtown. Arden Fair had 10% non-auto trips and it is partly because of its proximity to urban Sacramento.

- Low population density and dispersed travel patterns make fixed-route transit service difficult. According to TRB guidelines, a successful transit system typically requires 4000 persons/square miles for densely spaced routed and 2000 persons/square miles for widely spaced routes.

- Survey results indicate that the three services most likely to alter commuters' driving alone to the center are free home delivery, direct regional transit service and shuttle service with a fare no greater than two dollars.

- Survey respondents ranked the "single strategy" that would most likely influence them to a non-auto mode instead of driving to a shopping center in the following order: free home delivery (15%), direct transit from neighborhood to center (13%), shuttle group ride from home to center @ two dollars each way (13%), reserved parking for two or more (11%), free token for the bus (9%), more frequent service (7%).

Quantification: Yes

Area Types: Suburban

23. Chang-Hee, Christine Bae, "Air Quality and Travel Behavior Untying The Knot", *Journal of the American Planning Association*, Vol. 59, No. 1, Winter 1993.

Summary: This paper examines the contributions made by transportation and land use measures (especially alternative work schedules, mode shift strategies, and growth management) to achieving the air pollution emission reduction targets of the 1991 Air Quality Management Plan in the Los Angeles Basin. It asserts that contrary to popular belief, the measures aimed at reducing vehicle miles traveled have only a modest impact on reducing air pollution. The article argues that technological solutions to the automobile emissions problem are much more important and that more transit use, ridesharing, and telecommunicating are not needed to achieve clean air objectives. The author regards this as an optimistic conclusion since radical changes in travel behavior are difficult to achieve.

Quantification: Emissions, VMT

Area Types: Urban, Suburban

24. Charles River Associates, Inc. with Urban Mass Transportation Administration, *Characteristics of Urban Transportation Demand, An Update*, July 1988, DOT-T-88-18.

Summary: This report presents a selection of updated data on a wide variety of statistics pertaining to urban travel demand. The information supplements earlier data contained in the 1978 UMTA handbook, *Characteristics of Urban Transportation Demand - A Handbook for Transit Planners*. The report is designed to be used by transportation analysts as a source of data to check the validity and reasonability of local forecasts developed from traditional planning studies, or as a cross-check on the similarity of travel statistics from one locality to another. Certain data also may be used as default values for modeling purposes, when such information is not available locally or would require new or extensive data collection efforts. Much of the information presented was obtained from reports, documents, and memoranda produced by or for each study area contacted. A main criterion of the study was that the information collected be based on surveys, measurements, counts and so forth, and not be synthesized results from analytical modeling efforts. Many source documents have not been circulated widely, adding to the usefulness of the data contained in this report. One particularly interesting set of data is a summary of total and per person VMT for approximately 20 urban areas in the U.S. (Table C-4). The data indicate that California's major metropolitan areas ranges from 16.5 to 19.1 VMT per person. The data vary widely from one urban area to another, suggesting that the method collecting VMT data explains part of the variation.

Quantification: Trips and VMT, transit data

Area Types: Urban, Suburban

25. Chellman, Chester E. P.E., *A Discussion of Street Geometry and Design Criteria for Traditional Neighborhood Development*, September 25, 1989.

Summary: Street design for encouraging pedestrian use in neighborhoods, curb design related to vehicle speed, street widths for slowing auto speeds.

Quantification: No VMT, mode share, trip length, but quantification of design standards.

Area Types: Urban, Suburban

26. Cheslow, Melvyn D. and J. Kevin Neels, *The Effect of Urban Development Patterns on Transportation Energy Use*, Presented at the 59th Annual meeting of the Transportation Research Board, January 1980.

Summary: This meticulous cross-sectional study of numerous cities investigates how characteristics of urban form influence travel patterns and energy use. Three characteristics of urban form were defined: metropolitan population, separation between activities, and neighborhood density. Distance-to-CBD was used as a surrogate for the separation between activities. The data set consisted of a pooled sample of neighborhoods drawn from home interview surveys conducted between 1966 and 1971 for 8 U.S. cities of a variety of sizes in a variety of regions. Cross-sectional regression analysis is analyzed at the level of the neighborhood, where individual survey responses were aggregated to neighborhood. Several transportation characteristics were examined, including auto ownership, vehicle trips per household, percent transit, auto occupancy, average auto trip length, and auto VMT.

The authors acknowledge the difficulty of determining direction of causality as well as the importance of considering the feasibility of the changes in urban form evaluated. The use of three geographic levels of detail to measure urban form to describe urban form more thoroughly than most other studies.

Key findings:

- Neighborhood density has a strong negative effect on vehicle trip frequency, presumably because of the substitution of walking trips for vehicle trips at higher densities. The effects of density on trip lengths are about one-third as important, in their influence on VMT, as the impacts of trip frequency.

- Neighborhood proximity to the central business district has a very strong negative effect on auto VMT, through its effect on trip length. As distance from the CBD increases, trip lengths increase.

- "A simultaneous shift of one standard deviation in both urban development characteristics has the effect of reducing average household VMT by approximately one-third -- a substantial impact on urban auto travel."

- "For many of the variables, there are greater variations between cities than between neighborhoods within the cities. Large scale activity separation is apparently more important than the localized land use measures."

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

27. Colorado/Wyoming Section Technical Committee, "Trip Generation for Mixed-Use Developments," *ITE Journal*, February 1987, pp. 27-32.

Summary: Trip generation analysis of a cross-section of mixed-use centers. Twenty-four hour drive-way traffic counts at mixed-use developments in three Colorado cities in 1986 were taken, in addition to interviews to check for multi-purpose trips. Machine counts were then compared to estimates based on ITE trip generation rates, and the statistical significance of the difference was tested.

Findings:
- Based on interviews with tripmakers, a 25% reduction in trip generation for individual uses might be predicted, since 16% of trips were found to involve two uses and 7% three or more uses. But only an 8% difference between total actual trips and the predicted number of trips based on ITE rates was found - not a statistically significant difference. Thus it seems that secondary trips would not occur or would occur at a much lower rate when land uses were not mixed.

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

28. Commuter Transportation Services, *State of the Commute*, Los Angeles, California, 1992.

Summary: Provides results of a telephone survey of LA commuters, including travel mode, travel distance, travel time, arrival and departure time, carpool occupancy, bus rider trip characteristics, use of day care, stops during trips, shopping trip purpose, vehicles per household, and income. Also assessed are work destination, awareness of employer trip reduction and the regional rideshare agency phone number, attitudes about HOV lanes, and details on part time rideshare trends.

Quantification: Mode share, trip length, VMT, time of travel, but no emissions data.

Area Types: Urban, Suburban

29. Curry, David, Crain and Associates, *Case Studies of UMTA Private Sector Initiative Projects in Syracuse, Central New Jersey and Atlanta*, for the Urban Mass Transportation Administration, December 1987.

Summary: One case study of hospital (Crouse-Irving Memorial Hospital) parking management and TSM program in Syracuse shows successful park and ride lot to hospital by frequent shuttle, combined with price hike for employees at main lot. Some cost and implementation particulars also provided.

Quantification: General use factors only, no prior mode, VMT, trip reduction or emission data.

Area Types: Urban

30. Deakin, Elizabeth, *Land Use and Transportation Planning in Response to Congestion: A Review and Critique*, Paper before the Transportation Research Board Annual Meeting, January 1989.

Summary: Based on survey of localities, discusses transportation requirements imposed as condition of development approval, and general city land use policies including general plan, subdivision control and zoning revisions related to transportation. Also discussed are exactions and impact fees; TSM measures (signal improvements, ridesharing and transit subsidies and work hour programs). Pros and cons of implementation, monitoring and methodological problems are discussed.

Quantification: No explicit projections or existing data presented on VMT, trips, mode share or emissions.

Area Types: Discussion ranges over urban and suburban settings; based on survey of 62 jurisdictions.

31. DiRenzo, John F., Bart Cima, and Edward Barber, Peat Marwick and Mitchell, *Parking Management Tactics - Volume III: A Reference Guide*, for the Federal Highway Administration, 1981.

Summary: Dated but comprehensive review of parking pricing and supply strategies, including experience to date, effectiveness and implementation considerations. In the supply category, maximums, flexible minimums and overall supply caps are reviewed. Cases reveal mixed effectiveness with flexible minimums, possible (though not conclusive) effectiveness of maximums and overall caps, though implementation difficulties with all the strategies will give pause to application. Also reviewed is the vital role of enforcement to support all the strategies, including a review of ticketing, booting and speedy adjudication.

Quantification: Effectiveness of strategies in terms of reduced solo and increased transit; no VMT, trip or emissions data.

Area Types: Urban, Suburban

32. Dowling, Richard, *Factors Affecting TDM Programs Effectiveness at Six San Francisco Medical Institutions*, Paper before the TRB 70th Annual Meeting, January 1991.

Summary: Case study suggests and quantifies effect of parking pricing and supply restraint on mode share at San Francisco hospitals. On-site parking supply is not related to ride share, but off-site parking is more important. Regression with parking charge above is enough to explain ride share variation; elasticity suggests $8/month increase will get 1% ride share reduced.

Quantification: Parking price and supply effects quantified, but not VMT, trips or emissions

Area Types: Urban

33. Dunphy, Robert T., and Kimberly M. Fisher, *Transportation, Congestion, and Density: New Insights*, Transportation Research Board, 73rd Annual Meeting, January 9-13, 1994, Washington, D.C.

Summary: Part of the case for higher density development is based on the belief that compact urban forms are more efficient compared to low density development, derisively known as suburban sprawl. This paper examines some broad relationships between driving, transit use, urban form and congestion using urban area data as well as special analysis of the 1990 National Personal Transportation Survey. While some of the relationships found by other authors are confirmed, the regional data shows that there are other factors involved in explaining such differences, and the national household data presents a less robust relationship. The national data shows that there are significant differences in the household characteristics of persons living at different density levels - characteristics that are themselves important determinants of travel. Issues relating to these findings in the context of public policies on development and transportation are explored.

Quantification: Yes

Area Types: Urban, Suburban

34. Ewing, Reid, Padma Haliyur, and G. William Page, *Getting Around a Traditional City, A Suburban PUD, and Everything In-between*, Transportation Research Board, 73rd Annual Meeting, January 9-13, 1994, Washington, D.C.

Summary: Beyond some studies relating density to mode choice, VMT, or gasoline consumption, precious little is known about the relationship of location and land use to household travel patterns. Against this backdrop, a 16,000-record travel survey for Palm Beach County, Florida, was analyzed. Six communities were culled from the larger data base, and household travel data were then tested for statistically significant differences

in trip frequency, mode choice, trip chaining, trip length, and overall vehicular travel.

Households in a sprawling suburb generate almost two-thirds more vehicle hours of travel per person than comparable households in a traditional city. While travel differences are significant, they are smaller than one might expect given the more than ten-fold difference in accessibility among the communities. Sprawl dwellers compensate for poor accessibility by linking trips of household members in multipurpose tours.

Implications for land planning are more complex than simply pedestrianizing the suburbs. Communities should internalize as many facilities and services as possible. This is true even where the automobile reigns supreme. Land uses should be arranged to facilitate effieient auto trips and tours. The more sprawling the area, the more important this becomes. By concentrating activities in centers and corridors, linked accessibility to activities can be maintained even as direct accessibility falls off.

Quantification: Yes

Area Types: Urban, Suburban

35. Ewing, Reid, *TDM, Growth Management, and the Other Four Out of Five Trips,* Paper before the Transportation Research Board Conference, January 10-14, 1993.

Summary: In an analysis of TDM potential in Florida, author concludes TDM would address only 1-2% of area wide vehicle trips, and cover only 1/5 of vehicle trips. Author concludes TDM needs to address non-work trips and small work sites as well as residential and shopping trip TDM, and even freight and goods movement.

Quantification: Trip volumes and purpose in Florida, no mode share or emissions data

Area Types: Urban, Suburban

36. Ewing, Reid, "Financing New Communities", *Urban Land*, pp. 10-15, August 1990.

Summary: Surveys 52 new communities, and conducts more in-depth analysis of five (including Valencia, California) to determine factors that make for financial success for developers. Five key strategies for financial success are identified:

a. Shifting costs to special districts
b. Developing incrementally
c. Creating "phenomenal value" with amenities
d. Participating in builder profits

Quantification: None of traffic/emissions data

Area Types: Suburban, Exurban

37. Ewing, Reid, "The Evolution of New Community Planning Concepts", *Urban Land*, pp. 13-17, June 1990.

Summary: Begins with a brief historical overview of the guiding planning concepts behind new town development from the 1920's to the present. Final section contains a brief presentation of site planning issues. Seven new communities now in the "late planning/early development stages" are then characterized by the mix of design concepts incorporated. New communities examined include three Southern California projects: Ahmanson Ranch, Otay Ranch, and Rancho Santa Margarita.

Quantification: None of traffic/emissions data

Area Types: Suburban, Exurban

38. Ewing, Reid, "What Makes a New Community Tick?", *Urban Land*, pp. 2-6, April 1990.

Summary: Outlines factors that make for a successful new town or quasi-independent master-planned community. Key requisites are patient and plentiful start-up capital (i.e. a stable master developer), securing a major employer, and high population growth in adjacent metropolitan area.

Quantification: None of traffic/emissions data

Area Types: Suburban, Exurban

39. Federal Transit Administration, Private Sector Briefs, *Travel Demand Management, University of Washington U-Pass Program*, Seattle, WA., January 1993.

Summary: Case study of successful campus TSM program combining transit pass incentives, preferential carpool parking, vanpools, shuttles, bicycle facilities, parking price hikes and guaranteed ride home. Vehicle trips in the morning peak are down 15 percent, according to the evaluation.

Quantification: Mode share change, reduction in vehicle trips, increase in ridesharing and decline in solo driving all tracked; VMT and emissions data not reported.

Area Types: Urban

40. Fink, Marc, "Toward A Sunbelt Urban Design Manifesto", *Journal of the American Planning Association*, Vol. 59, No. 3, Summer 1993, American Planning Association, Chicago, IL.

Summary: Cities in the sunbelt, with their own distinct development patterns, are the most rapidly growing urban centers in the country. Government programs and American life-style preferences spurred the growth of these cities, which are characterize by low density, open landscapes, spread out land uses, and automobile dependency. Traditional models of urban form do not work for the sunbelt. The urban village concept develop by the City of Phoenix offers a new model, which practitioners are using to mitigate the urban problems in the sunbelt.

Quantification: None

Area Types: Suburban, Urban

41. Fletcher, "Master Planned Communities", *Builder*, June 1987.

Summary: Uses the broadest possible definition of "Planned Community", i.e., a Planned Unit Development, which it characterizes as clustering of development and offering shared, semi-public amenities. Emphasizes the importance of matching amenities to markets.

Quantification: None of traffic/emissions data

Area Types: Suburban, Exurban

42. Frank, Lawrence D. Ph.D., *The Impacts of Mixed Use and Density on The Utilization of Three Modes of Travel: The Single Occupant Vehicle, Transit, and Walking,* Transportation Research Board, 73rd Annual Meeting, January 9-13, 1994, Washington, D.C.

Summary: Presented in this paper are findings from an empirical analysis to test the impacts of land-use mix, population density, and employment density on the use of the single occupant vehicle (SOV), transit, and walking for both work trips and shopping trips. The hypothetical relationships tested focused on whether there is a relationship between urban form factors. Whether this relationship exists when controlling for

non-urban form and modal choice and urban form when they are measured at both trips ends as opposed to either the origin or destination. A review of literature and experiences suggested that a fair amount of information is known about the impacts of density on mode choice. However, considerable debate exists over whether density itself is actually the causal stimulus or a surrogate for other factors. To address this issue, a database was developed with a comprehensive set of variables for which density may be a proxy, e.g., demographics and level of service. This analysis employed a correlational research design in which modal choice was compared among census tracts with differing levels of density and mix. Findings from this research indicate that density and mix are both related with mode choice, even when controlling for non-urban form factors for both work trips and shopping trips. Furthermore the relationship between population and employment density and mode choice for SOV, transit, and walking is non-linear for both work and shopping trips. Transit usage and walking increase as density and land-use mix increase, while SOV usage declines. Findings from this research suggests that measuring urban form at both trip ends provides a greater ability to predict travel choices than looking at trip ends separately. Findings also suggest that increasing the level of land-use mix at the trip origins and destinations is also related with a reduction in SOV travel and an increase in transit walking.

Quantification: Yes

Area Types: Urban, Suburban

43. Frederick, Stephanie J. (Transportation Management Services) and Kenyon, Kay L. (City of Bellevue, Washington), *The Difficulty with Easy Ride: Obstacles to Voluntary Ridesharing in the Suburbs,* Paper before the TRB Annual Meeting, January 1991.

Summary: Effectiveness of parking pricing in suburban employment setting demonstrated by City Hall program; tight supply of parking at one company maybe helps ridesharing rate.

Quantification: Mode share rates documented, but no trip reduction, VMT or emission data

Area Types: Suburban

44. Friedman, Bruce, Stephen P. Gordon, John B. Peers, *The Effects of Neo-Traditional Neighborhood Design on Travel Characteristics*, Fehr & Peers Associates Inc., Lafayette, California, July 10, 1992.

Summary: This paper presents empirical evaluation of the potential effects of "Neo-Traditional Neighborhood Design" (NTND) community design on household trip rates relative to what one could expect when compared to travel characteristics of standard suburban planned unit developments. The analysis uses data from a 1981 regional travel survey of the San Francisco Bay Area households, and compares household travel characteristics of older "Traditional-design" communities to those in the newer suburban tract communities exhibiting dramatically higher drive alone rate, whereas households in traditional communities exhibited significantly higher use of alternative travel modes.

When considering the results of this paper for NTND designs, these findings must be modified somewhat, as not all mode choice factors that exist in older Traditional-design communities would be duplicated in a modern NTND. Actual travel patterns will depend on community location, demographic mix, specific design, and available travel alternatives. Thus the differences identified here should be interpreted as the maximum level of shift in the travel mode choice one could expect. Depending on the project location and specific design features, study findings indicate that on average, the daily trip generation for neo-traditional households would be 20% less than for households in Standard Suburban areas, and daily auto trip generation rates would be 24% less. The availability of these estimates could be valuable to planners, engineers, and public officials in determining the role of these projects in meeting regional public goals.

Note:
Effects of income, household size, and vehicle ownership not explicitly considered.

Quantification: Trips and mode shares

Area Types: Urban, Suburban

45. Fulton, William, "Winning Over the Street People", *Planning*, Vol. 57, No. 5, pp. 8-11, May 1991.

Summary: Peter Calthorpe, Andres Duany, et al, versus the traffic engineering establishment. References theoretical modeling studies by Walter Kulash, and reports that traditional neighborhood grid pattern streets with integrated nonresidential uses can reduce overall travel by 12 percent, even allowing for no reduction in the generation of vehicle trips.

Quantification: None of traffic/emissions data

Area Types: Suburban

46. Gantvoot, J.Th., "Effects Upon Mode Choice of a Parking Restraint Measure", *Traffic Engineering and Control, #25*, 1984.

Summary: Study of before and after effects of closing a parking lot in the Hauge (The Netherlands). A sample of lot users was tracked before and after closing.

Qualification: Mode shares

Area Types: Urban

47. Garreau, Joel, *Edge City, New York and Elsewhere*, Doubleday, 1991.

Summary: Popular exposition of large-mixed use suburban districts.

Quantification: Some data in passing

Area Types: Suburban

48. Gilbert, Gorman and Javiv S. Dajani, "Energy, Urban Form & Transportation Policy", *Transportation Research*, Vol. 8, pp. 267-276, 1974.

Summary: This review of other works examines the following experimental and empirical analyses which consider land use patterns as a variable and estimate resulting travel demands give some indication of which spatial patterns would reduce travel demands. Major findings of studies reviewed include:

Theoretical (Modeling) Studies:
- Putman: Develops models that integrate land use and transportation analysis but are not intended to minimize travel requirements.

- Hemmens: Heavy concentrations in the center of jobs and residences results in higher aggregate travel times. Transportation planning and land use planning may not be interdependent.

- Jamieson, MacKay, & Latchford: Linear forms lead to lower capital costs and average travel times. Aggregate demand was not reported.

- Vorhees: Puget Sound Regional Transportation Study: Farbey & Murchland: There is little difference in transportation demand patterns for alternative land use patterns.

- Schneider & Beck: A computer procedure was developed to search for better land use forms, using a gravity model for evaluation. The best form had a maximum balance of jobs and housing at the least central node, a minimum of activity elsewhere, and the rest of the activity in the second least central node.

Studies Based on Actual Travel Behavior
- Watt & Ayers: The effect on gas consumption of price, commuter transportation efficiency, density, area, interspersion, and urban freeway availability were tested. For a sample of 37 U.S. cities, work trips by transit explains 61% of the variation in gas consumption per capita; freeway availability is the only other significant variable.

- Markovitz: Trip generation rates for clustered and non-clustered non-residential and residential land uses were determined for the New York region. For residential, clustering reduced the number of trips by 45%; for non-residential, clustering reduced the number of trips by 65%.

- Lansing, et al: Travel demand (trips/family/day) are not appreciably altered by planning; there was more variation within than between the communities investigated.

- Weiss, Burby, & Zehner: Annual household vehicle miles increased less in new towns (Columbia, Reston) than in control communities - 17% versus 37%.

Overall, the studies produce an unclear and somewhat contradictory picture of the urban form impact on travel demands, because they use different assumptions and methodologies, and because the many dimensions to "urban form" are not used consistently.

- Nevertheless, these studies suggest that:
  a. clustering results in fewer trips
  b. clusters should not be in central locations
  c. a linear form - or some other pattern that differs from concentric - may be most efficient in terms of minimizing travel
  d. city size affects demand
  e. a sprawling pattern is not the most efficient

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

49. Golob, J., *Parking Permits and Price Changes* (unpublished study/personal communication), University of California, Irvine, 1988.

Summary: Study examines the effects of increase in the cost of parking permits at the University of California, Irvine. There was a 78 percent increase in the price of a parking permit between the 1984/85 academic year and the 1986/87 academic year.

Quantification: Number of permits issued

Area Types: Urban

50. Goodwin, P.B., "Variations in Travel Between Individuals Living in Areas of Different Population Density", *Planning and Transport Research and Computation,* July 1975.

Summary: The effect of population density on travel patterns is examined using data from the (British) National Travel Survey 1972-3. Comparisons are made between travel analysis zones. The basic unit of travel used was the "stage", i.e. a journey or part of a journey made by a single mode without interchange. Relationships were tested graphically.

Key findings:
- As population density increases, the total number of stages per person remains constant, the average stage distance is less, travel is slower, and the use of private transport decreases.

- The average time taken per stage for each mode separately and in total is approximately constant, as is the total amount of time spent on all travel per person.

Comments:
- The data refer do not refer to travel in areas of a particular density, but to travel by individuals who live in areas of a particular density.

- The relationships are presented graphically, but are not tested statistically.

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

51. Gross, W.P., P.W. Giglio, et. al., *Amherst, Massachusetts Fare Free Bus and Demonstration Project: Final Evaluation Plan,* For the U.S. Department of Transportation, UMTA, 1978.

Summary: Parking fees were increased from $5.00 to $55.00 per year in the campus core, to $21 near the center and not increased for peripheral lots. Assigned spaces in the core and edge lots were decreased and the number of peripheral spaces increased. Campus shuttle was expanded. 79% of survey respondents still choose lots based on convenience rather than price, though students were more price sensitive.

Quantification: None

Area Types: Suburban

52. Gruen + Gruen Associates, *New Town Communities: Directions for the 1990's*, A White Paper, October 1990.

Summary: Argues that New Towns are the appropriate development strategy for the 1990's particularly in California, where all urban growth must pay its own way: the case is made that in post-Proposition 13/growth-control California, developers are better off developing on cheap, marginal range land, away from current population centers. Master planning, flexible mixed-use site design, and "patient" capital are identified as important requisites of successful new town planning in the 1990's.

Quantification: None of traffic/emissions data

Area Types: Exurban

53. Handy, Susan, *How Land Use Patterns Affect Travel Patterns, A Bibliography*, Council of Planning Librarians Bibliography 279, Chicago, Illinois, Council of Planning Librarians, 1992.

Summary: An excellent recent survey of the literature, with cogent reviews of both theoretical (e.g. modeling) and empirical studies of land use, urban form and travel behavior. Served as the basis for many detailed summaries in this bibliography.

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

54. Hanson, S. and M. Schwab, "Accessibility and Intraurban Travel, Graduate School of Geography," *Environment and Planning A*, 1987, Volume 19 pp 735-748.

Summary: This paper contains an examination of the fundamental assumption underlying the use of accessibility indicators: that an individual's travel behavior is related to his or her location vis-a-vis the distribution of potential activity sites. First, the conceptual and measurement issues surrounding accessibility and its relationship to travel are reviewed; then, an access measure for individuals is formulated. Using data from the Uppsala (Sweden) Household Travel Survey and controlling for sex, automobile availability, and employment status, the authors explore the relationship between both home and work-based accessibility and five aspects of an individuals travel: mode use, trip frequencies and travel distances for discretionary purposes, trip complexity, travel in conjunction with the journey to work, and size of the active space. From the results it can be seen that although all of these travel characteristics are related to accessibility to some degree, the travel-accessibility relationship is not as strong as deductive formulation have implied. **High accessibility levels are associated with higher proportions of travel by non-motorized means, lower levels of automobile use, reduced travel distances for certain discretionary trip purposes, and smaller individual activity spaces.** Furthermore, the density of activity sites around the workplace affects the distance travelled by employed people for discretionary purposes. Overall, accessibility level has a greater impact on mode use and travel distance than it does on discretionary trip frequency. This result was unexpected in light of the strong relationships between trip generation (frequency) and accessibility posited frequently in the literature.

Quantification: Swedish data on trips, VMT and mode share

Area Types: Metropolitan (Urban and Suburban combined)

55. Higgins, Thomas, J., *Flexible Parking Requirements*, An Urban Consortium Information Bulletin, Public Technology, Inc., Washington DC, 1982.

Summary: Dated but informative review of policy to reduce minimum parking requirements in return for developer contributions to in-lieu funds or demand management actions. Suggests policy has had mixed effect and presents many implementation difficulties. Case reviews include Calgary, Sacramento, Davis, Culver City, Escondito, Montgomery County, Phoenix, Palo Alto, Bellevue, Portland, and Seattle.

Quantification: Effectiveness reported in terms of overall mode share results; no trip, VMT or emissions data.

Area Types: Urban, Suburban

56. Higgins, Thomas J., "Parking Requirements for Transit-Oriented Developments", *Transportation Research Record.*

Summary: Local transportation and land use planners are attempting increasingly to develop parking requirements (both minimum and maximum requirements) to encourage transit use and avoid excess parking supply. Planners are focusing particular attention on transit-oriented developments in proximity to transit where tight parking supply, good pedestrian access to transit, and dense development are aimed at increasing transit use. This paper presents a method for setting parking requirements for office, commercial, and industrial developments in proximity to transit stations and stops. The method presented relies on annual employee transportation surveys of the kind typically required under trip-reduction ordinances. These ordinances are now present, or soon will be, in many urban areas and are the result of air quality regulations, traffic management regulations, or both. The method of deriving parking requirements is demonstrated using employee survey data from the city of San Diego. The method derives a range of estimates for parking demand in proximity to transit stops on the basis of high and low use of transit and other alternatives to solo driving, as revealed in the employee survey data. The author draws implications for maximum and minimum parking requirements in San Diego and suggests general cautions in applying the method and areas for further research to improve results from the method.

Quantification: Yes

Area Types: Urban, Suburban

57. Holtzclaw, John, *Explaining Urban Density and Transit Impacts on Auto Use*, Presented by the National Resources Defense Council and the Sierra Club to the State of California Energy Resources Conservation and Development Commission, April 19, 1990.

Summary: An empirical study of a cross section of Bay Area communities explores the extent to which higher residential density plus neighborhood businesses plus improved transit services result in higher convenience and mobility which result in a reduction in driving, which results in savings in fuel, pollutant emissions, and auto ownership costs.

A survey of selected neighborhoods of the Bay Area was undertaken for 1988 (NE San Francisco, San Francisco as a whole, Rockridge in Oakland, Walnut Creek, and Danville-San Ramon). Data sources included U.S. Census, ABAG, MTC, and various state agencies; VMT data was derived from the California Bureau of Automotive Repair.

Key finding: a doubling of the population or residential density reduces annual auto mileage per household and per capita by 25-30%. Thus, if the population of an area is doubled by infill, VMT will increase by only 40-50%, rather than 100% at existing densities or 167-186% for half the density.

This analysis does not attempt to separate the effect of density from the effect of neighborhood services and transit services in its conclusions. A community that is twice as dense as another and has these other characteristics that the other does not will have less automobile travel; without these characteristics, the effect on auto travel would likely be diminished. Also income, household size, and auto ownership are not controlled for, though comparative values for these variables is presented.

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

58. Holtzclaw, John, *Using Residential Patterns and Transit to Decrease Auto Dependence and Costs*, National Resources Defense Council, June 1994.

Summary: The paper presents an attempt to assess automobile usage and personal transportation costs based on the effects of four "neighborhood descriptors": residential density, transit accessibility, neighborhood shopping, and pedestrian accessibility. The best statistical correlations are based only on the density and transit accessibility variables. The author proposes an approach, based on these finds, for determining an average annual transportation cost savings for a particular house or neighborhood that could be applied to mortgage qualification calculations.

Quantification: VMT, personal transportation costs

Area Types: Urban, Suburban

59. Institutional and Municipal Parking Congress, "Parking May Be A Problem," *The Parking Professional*, October 1992.

Summary: Article suggests Mall of America, a giant new shopping mall in Minneapolis, has far less parking on-site than needed and has had to resort to park and ride shuttles and leased parking in outlying lots. Parking supply is 4.5 spaces per 1,000 square feet of leasable area.

Quantification: Parking demand and supply only

Area Types: Suburban fringe of urban area

60. Jackson, Kenneth T., *Crabgrass Frontier*, 1987.

Summary: A modern classic on the history of suburbia

Quantification: None of trips, VMT, or emissions

Area Types: Suburban

61. JHK & Associates, *Evaluation of the Impacts of Small-Area Land Use Design on Travel and Air Quality*, March 2, 1994.

Summary: Description of development and use of a modeling methodology to analyze land use strategies at three suburban sites in San Bernardino County. The areas were between 140 and 765 acres with varying amounts of development and redevelopment potential. Relatively minor increases in density and mixed use are found to have very minor trip and VMT impacts (from one to five percent) because of the rather small increment of new development (insufficient for a critical mass of pedestrian-oriented uses) and the fact that interspersed parking at the sites made auto access easier than walking. Moreover, the lack of transit access to the sites results in the trips with origin and destinations outside the study area being made almost exclusively by auto, and no incentives for carpooling were assumed.

Quantification: Trips and VMT for seven scenarios at three sites.

Area Types: Suburban

62. JHK & Associates, *Analysis of Indirect Source Trip Activity at Regional Shopping Centers*, Prepared for the California Air Resources Board, ARB Contract #A132-094, 1993.

Summary: This research project was undertaken to provide a better understanding of the travel characteristics for regional shopping centers, one category of indirect sources, and to develop a methodology for evaluating travel reductions measures at regional shopping centers. To attain the study objectives, a number of tasks were identified, including a review of the literature related to shopping centers and travel reduction measures, the development of a database of shopper survey responses, the application of the analytical methodology to five regional shopping centers that served as case study sites, and the identification of recommended areas for future research.

Two significant research findings emerge from the data collected for this study and from the application of the methodology to the five case study sites.

a. For the case study sites, the estimated impact of the individual travel reduction measures ranges from 0.1 percent to 6.2 percent. This does not include the measure parking pricing, which, if implemented only at regional shopping centers, may have a negative impact economic impact as a result of travel shifting to other locations. In combination, packages of travel reduction measures might reduce trips by five to seven percent.

b. Variation in travel mode is best explained by the level and regional coverage of public transit service and the density and proximity of the surrounding land uses. Differences in the demographic trip characteristics of travelers to each of the case study sites do not appear to explain the variation in travel mode.

The results from this research project provides guidance to local air districts in the evaluation of travel reduction measures at regional shopping centers, and provide a significant addition to the research and literature on travel to regional shopping centers and indirect sources.

Quantification: Yes

Area Types: Urban, Suburban

63. JHK and Associates, *Development-Related Ridership Survey II*, prepared for the Washington Metropolitan Area Transit Authority, December 1989.

Summary: This study is a follow-up to the 1987 study, *Development-Related Ridership Survey*. The purpose of this study was to study the travel behavior of persons travelling to and from residential and commercial developments around Metrorail stations. In this survey, 38 buildings sites were surveyed, 13 of which were repeated from the first study.

Quantification: Mode shares, travel times, site characteristics, trip generation

Area Types: Urban, Suburban

64. JHK & Associates, and Kevin G. Hooper, *Travel Characteristics at Large-Scale Suburban Activity Centers*, National Cooperative Highway Research Program Report 323, Transportation Research Board, Washington, DC, October 1989.

Summary: This study is based on a large-scale survey of six large-scale suburban activity centers (SACs), containing office, retail, hotel, and residential activity. Three centers (Bellevue; Southcoast Metro; Southdale) were "small", with relatively equal amounts of office and retail. Three centers (Parkway; Perimeter; Tysons Corner) were "large" with 2.5 to 6.5 times as much office as retail. Surveys included: person and vehicle counts; workplace travel surveys (to 38,000 employees); intercept surveys at retail and hotel sites; daily trip diaries from residents. The study was explicitly exploratory, aimed at establishing basic information about travel behavior at SACs. It does not include any statistical testing of the differences between SACs or of the relationship between the physical characteristics of the SACs and their travel characteristics.

Key findings:
- Trip generation rates tended to be lower than ITE estimates for all uses. For office, rates per square foot were lower than ITE rates, but rates per employee were higher, suggesting that employee densities are lower in SACs.

- Auto modes represent the vast majority, even for internal trips. Bellevue, with good transit service and design for pedestrians, had significantly higher shares of transit (7% versus 1%) and midday walk trips (25% versus 16%) than the other SACs.

- A significant portion of travel in the SACs was not between home and work.

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

65. JHK and Associates, *Development-Related Ridership Survey*, Final Report, prepared for the Washington Metropolitan Area Transit Authority, March 1987.

Summary: This ridership survey was conducted to study the travel behavior of persons travelling to and from residential and commercial developments around Metrorail stations. Relationships between travel characteristics and the nature of development at each site were established. The study consisted of survey of persons travelling to and from office buildings, multi-family residential buildings, retail sites and hotels near Metrorail stations. A sample of 34 building sites were survey. The results of the study document a number of significant implications of land use and transportation planning in the Washington metropolitan area.

Quantification: Mode shares, site characteristics, trip generation

Area Types: Urban, Suburban

66. Kelly, Barbara M., ed., *Suburbia Re-examined*, Contributions in Sociology, Number 78, Greenwood Press, 1989.

Summary: Collection of essays on changing nature of suburbia as uses and activity patterns duplicate more an more urban functions.

Quantification: None

Area Types: Suburban

67. Kelly, James with Task Manager, Kathleen Bradley, *National Transportation Statistics Annual Report, 1989*, August 1989 DOT-TSC-RSPA-89-1.

Summary: This report is a summary of selected national transportation statistics from a wide variety of government and private sources. Featured in the report are cost, inventory, and performance data describing passenger and cargo operations of the following modes: air carrier, general aviation, automobile, bus, truck, local transit, rail, water, oil pipeline, and natural gas pipeline. The report illustrates basic descriptions of U.S. transportation, such as operating revenues and expenses, numbers of vehicles and employees, vehicle miles and passenger miles, etc. Transportation trends in performance, safety and motor vehicle sales, production, and costs are included from 1977-1978/ 1988. Supplementary sections also include transportation and the Economy and Energy in Transportation which is divided into Energy Consumption, Energy Intensiveness, Energy Transport, and Energy Supply and Demand. In this addition the selected data cover the period 1955 through 1987/1988 (subsequently updated through 1990).

Quantification: VMT, trips, and mode share

Area Types: Aggregate national level data

68. Kenworthy, Jeff and Peter Newman, *Automobile Dependance: The Irresistible Force?*, Institute of Science and Technology Policy, Murdoch University. Commissioned and published by University of Technology, Sydney, Faculty of Design Architecture and Building, August 1993.

Summary: This paper examines the proposition by Charles Lave that the automobile is "unstoppable" and an "irresistible force" and that transit has "lost the battle" in the U.S. and is losing it in Europe. It also examines Lave's proposition that, despite this power of the automobile, car use in the U.S. will probably plateau because of saturation in car ownership, and therefore it may be possible to expand the U.S. highway network without new roads immediately filling up, as they have done until now.

The paper presents 1990-91 data on private and public transport for US, Australia, European and Asian cities, which has been collected as part of the updating process of the author's previous work "Cities and Automobile Dependance". In this book, which compares thirty-two international cities, automobile dependence was shown to be a combination of dominant transport patterns linked to infrastructure that is provided mainly for the automobile, and low density, dispersed land use where little transport other than the automobile is feasible. This update (of previous work by the authors - see below) to 1990 is, attempting to see the extent to which these patterns are continuing or changing in different cities.

The authors conclude that:
- US cities have been accelerating in their automobile use between 1980 and 1990 compared to the previous decade. The increase alone between these years are equivalent to the total per capita use of cars in London and Paris and a number of smaller European cities in 1980. There appears to be no sign yet of any leveling off of car use in US cities while automobile dependant suburbs continue to be built in seemingly endless bands of development around their urban areas.

- Authors such as Gordon and Richardson provide additional basis for Lave's optimistic view of the automobile by suggesting that US cities are beginning to minimize the car use simply through a process of self-adjustment which brings to work and other destinations closer to the houses through dispersion. However, the data here show that this is probably wishful thinking and the suburbanization of work out of central areas in a totally dispersed way, is in fact increasing the car use through decimation of transit use.

- US cities have all experienced similar increases in car use per capita between 1980 and 1990 regardless of overall differences in the urban structure of the region (eg the New York region's increase was similar to that in Los Angeles). As a result, overall differences in per capita automobile use between US cities is diminishing as a automobile dependent urban forms become pre-eminent.

- Outer areas appear to be dominating the transport patterns of US cities with uniformly large and faster growing increases in car use than in central and inner areas. Most new development in the US appears to be strongly oriented around the automobile, resulting in car use which seems to be out of control.

- Transit in US cities has obviously been unable to make much mark on the growing use of cars. However, since 1970 transit system in medium to large US cities have been slowly recovering their per capita use and service provision, after the very big declines of the 1960s. A number are now stronger than they were in 1960, so that the picture of transit is not one of outright defeat as portrayed by Lave. Even in Los Angeles, transit use is strongly linked to density, with use in some areas rising to quite high levels. An important limitation on the role of transit in the US, particularly in Los Angeles, appears to be low overall levels of service that are provided even in higher density areas.

Quantification: Transit trips, VMT

Area Types: Urban, Suburban (International)

69. Kessler John and William Schroeer, *Meeting Mobility and Air Quality Goals: Strategies that Work*, February 10, 1993.

Summary: Description of transportation service and pricing strategies and land use measures that can help reduce trips and VMT; no original data, though 1000 Friends results are quoted on Transit Oriented Development, and Shoup and Willson are quoted on Parking cash-outs ("5%" nationwide reduction possible with cash out).

Quantification: None of land use strategies, other than a citation of findings from the 1000 Friends of Oregon LUTRAQ study.

Area Types: Urban, Suburban

70. Kitamura, Ryuichi, Patricia Mokhtarian and Laura Laidet, *A Micro-Analysis of Land Use and Travel in Five Neighborhoods in the San Francisco Bay Area*, November 1994.

Summary: Analysis was performed to determine the effect of specific land-use and attitudinal characteristics on travel behavior in five diverse San Francisco Bay Area neighborhoods. The land-use factors found to be significantly correlated with trip generation and mode share were residential density, public transit accessibility, mixed land use, and the presence of sidewalks. The attitudinal variables were assessed with a survey and analyzed in eight factors (environment, transit, automobile mobility, etc.). These factors were found to have a more significant association, which the authors suggest means that "land use policies promoting higher densities and mixtures may not alter travel demand materially unless residents' attitudes are also changed."

Quantification: Trip generation, mode share

Area Types: Urban, Suburban

71. Kittelson, Wayne K. and Keith T. Lawton, "Evaluation of Shopping Center Trip Types", *ITE Journal* 57(2):

pp 35-29, February 1987.

Summary: The purpose of the article was to describe the results of recent field studies aimed at identifying the net traffic impact of commercial establishments on the surrounding street systems. A major regional center near Washington D.C. and two sites in Portland were studied and lead to several conclusions.

- Commercial developments containing between 100,000 and 200,000 gross square feet of area typically generate relatively few new vehicle trips;

- Commercial centers located on a major arterials are likely to draw a significant percentage of their total customers from the passing traffic stream; and

- The net traffic impacts of commercial activities quickly dissipates as the distance from the commercial activity is increased.

- Commercial developments of 100,000 to 200,000 square feet gross floor area experience significantly higher percentage of drop-ins than typically assumed. The location of the center affects the drop-in rate, the image of the center, the type of goods sold and name recognition of the center. (Drop-ins already exist on the roadways that provide primary access to the new center. They are the same as undiverted link trips.)

- Very few commercial centers driveway trips are new to the surrounding street system.

- Twenty-five percent of trips are drop-in, forty percent diverted and thirty-five percent are new shop trips.

- The distribution of trips throughout the day is heavier in the PM and evening.

Quantification: Yes

Area Types: Urban

72. Knack, Ruth, "Tony Nelessen's Do-It-Yourself Neo-Traditionalism", *Planning* Vol. 57, No. 12, pp. 18-22, December 1991.

Summary: Reviews the work of Rutgers University urban designer Anton Nelessen, whose "visual preference surveys" suggests that there is considerable popular (and hence, potential market) support for higher-densities and mixed-use.

Quantification: None of traffic/emissions data

Area Types: Suburban

73. Komanoff Energy Associates, Transportation Alternatives and Konheim and Ketchman, *The Environmental Benefits of Bicycling and Walking in the United States,* Paper No. 930234 presented at the 72nd Annual Meeting of the Transportation Research Board, Washington, D.C., January 1993.

Summary: In this paper the fuel and emissions savings resulting from current levels of walking and bicycling are estimated. Based on 'high' estimates of miles traveled by bicycling and walking, these combined modes displace 1.2% and 2.4% of passenger vehicle emissions of CO, NOx and VOC. additionally, bicycling and walking displace as much as 1.6% of passenger CO_2 emissions. Key findings include:

- Developed high/low projections for bicycling and walking in the U.S.

- Estimates that 26 to 32% of walk miles displace auto miles, and 38 to 56% of bicycling miles displace auto miles. The remainder of walk and bicycling trips would have been by carpool, transit or not at all.

- By the year 2000, cycling increases by a factor of 3(low estimate) or by a factor of 5 (high estimate), while walking increases by a factor of 1.5 (low estimate) or by a factor of 2.5 (high estimate).

The following table was presented in the report;

Environmental Benefits of Bicycling and Walking, 1990-1991

	Bicycling-High Estimate	Bicycling-Low Estimate	Walking-High Estimate	Walking-Low Estimate
Bicycling/Walking Miles Traveled (millions)	21,300	5,800	44,100	26,300
Passenger Vehicle Miles Displaced	12,000	2,200	16,100	5,400
Vehicle Miles Displaced by Bike/Walk Mile	.56	.38	.37	.26

The last row of the table can be interpreted as a "VMT" elasticity": every bike/walk mile encouraged by TDM strategies would result in this number of vehicle miles "displaced" or reduced.

Quantification: Theoretical analysis of VMT emissions reductions due to biking/walking.

Area Types: National level estimates

74. Kuah, Geok K., "Estimating Demand for Mixed Use Developments", *The Parking Professional*, IMPC, September 1991.

Summary: Provides methodology for calculating parking demand in shared use, mixed developments, as well as allowances for reduced demand due to TSM.

Quantification: Provides mode share for an example area (City of Alexandria) and parking demand assuming shared use and a modestly effective TSM program; no trip, VMT or emissions data.

Area Types: Urban

75. Kulash, Damian, *Parking Taxes as Roadway Prices: A Case Study of the San Francisco Experience*, Urban Institute, Paper 1212-9, March 1974.

Summary: In October 1970, San Francisco imposed a 25 percent parking tax, the largest jump in parking taxes and prices experienced to that time in the United States. It stayed in effect for 21 months before being lowered to 10 percent. This study examined the effect of the tax on parking demand and industry revenues.

Quantification: Parking Demand

Area Types: Urban

76. Kulash, Walter, *Traditional Neighborhood Development: Will the Traffic Work?* Real Estate Research Corporation, 1990.

Summary: A modeling study comparing a gridded neighborhood with one served by a conventional hierarchical suburban street network. The study kept trip generation between The grid network reduces VMT by approximately 43 percent within the community.

Quantification: VMT at the neighborhood/community level

Area Types: Suburban

77. Lader and Bayly Consulting Group, R.J. Nairn & Partners Pty Ltd, Sustainable Solutions Pty Ltd, PPK Consultants Pty Ltd. *Greenhouse Neighborhood Project, The Low Energy Suburb, Summary Report*, prepared for the Victorian Government's Department of Planning and Development Environmental Protection Authority and Energy Victoria, Australia, July 1993.

Summary: Based on modelling of alternative development patterns in the Melbourne Australia metropolitan region, this study found that substantial savings in energy requirements and greenhouse gas emissions could be achieved through changes in urban form. By comparison with conventional development practices, emission reductions of up to 42% were achieved by optimizing land use and transport-related factors to reduce car travel, and by optimizing dwelling siting and design to reduce heating and cooling-related emissions. Greater savings were possible from land use and transport-related changes than dwelling-related changes. For transport, car-related savings of up to 57% were achieved, with the two key factors being increased residential densities, and an increased proportion of local employment, retail and related land use providing higher levels of self- containment for daily activities.

Quantification: Trips, VHT and emissions

Area Types: Suburban

78. Lansing, John B., Robert W. Marans, and Robert B. Zehner, *Planned Residential Environments*, Ann Arbor Institute for Social Research, University of Michigan, 1970.

Summary: This study tests the level of planning at suburban communities and their location relative to the central city affect the travel behavior of residents, using a survey to compare different planned residential environments in terms of the travel behavior of its residents.

Ten communities were surveyed, two in each of the following groups: suburban highly planned (Columbia, Reston); suburban moderately planned (Crofton, Montpelier); suburban less planned (Norbeck, Southfield); inner city highly planned (Lafayette-Elmwood, SW Washington); and NY suburbs - older, planned (Radburn); and not-planned (Glen Rock).

Key findings:
- Residents in the suburban communities are more likely to have two or more cars, but miles per car per year does not vary as much, and does not exhibit a clear pattern. The percent transit is lower in the suburban communities.

- All communities have longer commutes than the national average, though inner city communities have shorter commutes than the others. Planned suburban communities have the longest commutes, despite the fact that they were originally planned to be "self-contained."

- The number of vehicle trips per family is lowest in the inner city communities, but does not seem to be a function of planning.

In her review of this work, Susan Handy notes that the analysis does not show the statistical significance of the apparent correlations, presenting only standard deviations of variables.

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

79. Lawley Publications, "Census Summary" and "Some Statistics Related to Auto Travel", *The Urban Transportation Monitor,* May 29, 1992.

Summary: Summary of 1980 versus 1990 census travel data showing Virginia and Maryland trends in solo, carpool and transit rates. General finding is that the solo drive rate is up, carpool and transit share is down. Mean travel time also is up slightly. Another article in the same issue shows gasoline prices as U.S. average by year from 1970 through 1991, and monthly variation from 1989 to 1992. VMT growth also displayed graphically from 1970 to 1991. Data suggests that stable (effectively falling) gasoline prices may be a major determinant of auto use.

Quantification: Mode share rates and trends, gasoline prices, mean travel time and VMT trends, but no emission data.

Area Types: All

80. Lea, Elliott, McGean & Company with Cambridge Systematics, Inc., Howard, Needles, Tammen & Bergendoff, Urban Systems Consultants, *Dallas Parkway Center Land Use and Transportation Study - Final Report,* June 1985.

Summary: Discusses land use implementation precepts including mixed use, high density residential and overall compatibility with adjacent land uses, all applicable to study area in Dallas. Various land use transportation scenarios are analyzed as to trip productions and attractions, with resultant traffic flows modeled using TMODEL. Conclusions are given about how much development can be supported with land use guidelines, roadway improvements, expanded transit and TSM actions.

Quantification: No explicit projections or existing data presented on VMT, trips, mode share or emissions, though model makes implicit assumptions about trip generation and mode share.

Area Types: Suburban

81. Levinson, Herbert S., Charles O. Pratt, "Estimating Downtown Parking Demands: A Land Use Approach," *Transportation Research Record,* No. 957, 1984.

Summary: Discusses a procedure for estimating and allocating downtown parking demand based on land use and employment data. Procedure is applied to downtown New Haven.

Quantification: No data given for trips, VMT or emissions, though cautions given about applying the method where transit shares are higher or lower than in the sample city.

Area Types: Urban

82. Levinson, Herbert S. & F. Houston Wynn, "Effects of Density on Urban Transportation Requirements," *Highway Research Record 2,* pp. 38-64, 1963.

Summary: A somewhat dated review; the analyses summarized are consistent with more recent work indicating that higher densities reduce transportation demand.

More specifically, the review of several regression models shows that:
- trip generation increases as density decreases,
- daily VMT per capita increases as density decreases,
- trip length (distance) increases as density or urban area size or population increases,
- transit rides per capita increases as density increases

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

83. Levy, Lisa, *The Importance of Non-work Trips in the SCAG Region*, March 1993

Summary: Extensive analysis of National Personal Transportation Survey SCAG Region

Quantification: Trips, and mode share detailed for the SCAG region.

Area Types: Urban, Suburban

84. Livingston, Bruce Lee, *Using Jobs/Housing Balance Indicators for Air Pollution Controls*, for EPA Region 9, May 10, 1989.

Summary: Good conceptual overview of jobs/housing balance issues, including what are appropriate indicators of J/H, methodological problems with the indicators, and recommendations for a method of applying J/H measures to development site approval. Paper also provides data for Contra Costa County showing the degree of imbalance across different income groups. An appendix summarizes alternative consumer choice models for predicting housing choice. Implementation mechanisms also reviewed (e.g. enforcement, higher density zoning, density bonuses, inclusionary zoning, residential zoning and mixed use zoning).

Quantification: Jobs/housing "imbalance" quantified for study site, but no mode, trip, VMT or emissions data.

Area Types: Urban, Suburban

85. Lorch, Brian J. and Mark J. Smith, "Pedestrian Movement and Downtown Enclosed Shopping Centers, *Journal of the American Planning Association*, Vol. 59, No. 1 Winter 1993.

Summary: Downtown enclosed shopping centers projects have been criticized for the limited extent to which the economic benefits of such schemes are transmitted to surrounding conventional shopping streets. This paper tests this assertion through a case study of a pedestrian movement of patrons of a downtown mall in Thunder Bay Ontario. Analysis of route maps and records of purchasing activity of respondents reveals a significant bias toward the indoor shopping environment. Outside pedestrian movement of mall patrons is also shown to be spatially patterned.

Despite limited spill over of mall patrons, business on conventional shopping streets remained healthy in the postmall era, suggesting that the indoor and outdoor shopping environments serve different market segments.

Quantification: None

Area Types: Urban (Downtown Retail)

86. Los Angeles County Metropolitan Transportation Authority, *1993 Congestion Management Program for Los Angeles County*, Appendix G, November 1993.

Summary: The Congestion Management Program (CMP) for L.A. County was developed in response to the state mandate to create a plan to address urban congestion problems. The CMP represents an attempt to improve planning by linking land use, transportation, and air quality decisions; developing a partnership to devise appropriate solutions; and to propose viable, useful, and cost-effective projects. One element of the CMP requires local jurisdictions to demonstrate that they have implemented a set of transportation improvement strategies to offset the congestion - worsening effects of new development. Appendix G is a toolbox of strategies and "credit factors" that must equal or exceed the accumulated points allocated from new development.

Quantification: Congestion mitigation credits

Area Types: Urban, Suburban

87. Loudon, William, Elsa Coleman, John Suhrbier, *Air Quality Offsets for Parking,* Paper before the Transportation Research Board, January 1989.

Summary: Air quality and emission trends for Portland, potential effects of TSM, TCM measures for Portland. Discussion of short term parking and its role (under one hour) in CO production, especially cold start issues. Conclusion offered that short term parker is not problem, but those parking over one hour contribute to emissions. Thus, measures which free up long term parking for short term parkers may increase emissions, if the short term parkers park long enough for the engine to cool. Model is used to predict trips reduction, VMT and the mix of hot and cold starts. Paper provides potential CO reductions from model runs for fringe parking, parking rate changes and reserved carpool parking, among other TCM measures.

Quantification: Mode share, trips, trip reduction, VMT and emission impacts all provided as model parameters or outputs.

Area Types: Urban

88. Maitland, Barry, *The New Architecture of Retail Mall,* Van Nostrand Reinhold New York, New York: 1990.

Summary: The article talks about various design considerations of retail malls. Pertaining to the ARB study, this article states that "vehicle access, servicing and parking, should be unobtrusive and should not disrupt pedestrian movement around the perimeter of the development." The author discusses how servicing areas have been moved from the basement of the centers, where they were originally located, to at-grade perimeter service points. However, the design concern with the scenario is that if the ground level is occupied with servicing points then the mall level may be elevated to upper floors. This creates dead store frontages. The remainder of the article deals with the design considerations of integrating the retail center within the urban context.

Quantification: Design features

Area Types: Suburban

89. May, Jeffrey H. and George J. Scheuernstuhl, *Land Use, Transportation and Air Quality Sensitivity Analysis,* Paper before the Transportation Research Board Conference, January 1991.

Summary: Modeling of various land use, density of development scenarios for Denver area, effect on emissions, pollution, air quality. Results suggest the complex relationship between land use strategies, mode choice and resulting emissions. Findings suggest concentrating employment growth in transit corridors may increases transit ridership and HOV use, but concentrate CO emissions in more dense downtown Denver, increase congestion and decrease highway speeds, even if peak period trips decline in length and VMT per capita is reduced. Result seems to be due to concentrating employment growth in transit corridors with no movement of existing residence. This pattern increases VMT for non-peak, non-work, trips, offsetting ride share gains. Good report for complexities.

Quantification: VMT, mode share, trips and emissions all quantified

Area Types: Suburban, Urban

90. McKeever, Christopher, Judy W. Quon, Roberta Valdez, *Market-Based Strategies for Increasing the Use of Alternate Commute Modes,* Paper No. 910291 presented at the 70th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1991.

Summary: This paper studies the results of Orange County, California commuter and rideshare matching survey implemented to study the potential diversion auto-trips to carpools, vanpools, bike trips, walk trips, and public transportation. It outline a set of demographic factors affecting the use of alternative commute modes: The paper identifies the following factors as those considered in the choice of travel mode: travel time; the need for a car before work, after work, and during the day; independence; comfort; commute costs and privacy.

Quantification: Estimates of potential trip diversions

Area Types: Suburban

91. Mehranian, Maria, Martin Wachs, Donald Shoup, Richard Platkin, *Parking Cost and Mode Choices Among Downtown Workers: A Case Study,* University of California at Los Angeles, DP8613, August 1986.

Summary: The study examined parking management of two downtown LA companies. Company A provides only subsidy for parking while Company B has incentive and rideshare programs.

Quantification: Mode shares

Area Types: Urban

92. Metropolitan Transportation Commission, Oakland, California, *Census Transportation Planning Package, The Journey to Work in the San Francisco Bay Area,* April 1993.

Summary: This MTC working paper (#5) on the 1990 Census provides a summary of 1990 Bay Area county-to-county and place-to-place (city-to-city) commute characteristics by means of transportation to work. Data from this working paper is extracted from the 1990 Census Transportation Planning Package - Statewide Element (CTPP/SE). Comparisons are made to previous census years using data from 1970 Census Urban Transportation Package (UTP) and the 1980 Census Urban Planning Package (UTTP). These three special products from the Census Bureau, the 1970 UTP, the 1980 UTTP and the 1990 CTPP- otherwise known as the "Journey-to-work Packages" - have been jointly sponsored and developed U.S. Bureau of the Census, the U.S. Department of Transportation, state departments of transportation, metropolitan planning organization, and related organizations.

Quantification: Trips, VMT and mode share - work trips only

Area Types: Urban, Suburban

93. Metropolitan Transportation Commission, *1981 Bay Area Travel Survey,* 1981

Summary: Comprehensive travel survey for the nine-county Bay Area. Tabulations of this data by DHS, Inc. at the superdistrict level are especially useful in assessing subregional differences.

Quantification: Trips, VMT and mode share detailed for the nine-county Bay Area.

Area Types: Urban, Suburban

94. Middlesex-Somerset-Mercer Regional Council (MSM), *The Impact of Various Land Use Strategies on Suburban Mobility,* FTA-NJ-08-7001-93-1, December 1992.

Summary: This is a report on a projective study of the interaction between suburban land use trends and regional traffic conditions. Three different models of high density, mixed use centers designed to fit in the Middlesex-Somerset-Mercer Region of New Jersey where developed. The three models examined-transit construct, short drive construct, and walking construct-placed residents' home closer to their working and shopping destinations. The models incorporated residential and employment growth expected in the region by 2010, but reshaped the growth into different land use configurations. The project growth was located in the cities and in a small number of newly crated suburban centers instead of in a low density developments spread throughout the region. Based on the study it is concluded that concentrating new suburban development into higher density, mixed-use centers will slow the growth of regional vehicular use, by up to 18% in terms of vehicle trips and 12% in terms of VMT.

Quantification: VMT and trips, based on modelling of Land Use Constructs; also quantifies land use within constructs.

Area Types: Suburban, Urban

95. Middleton, William D., "LRT helps reshape a city," *Railway Age*, February 1990.

Summary: Analysis of the role Portland's light rail system (MAX) has played in reinforcing the city's effort to increase the vitality of downtown while reducing auto dependence for downtown access and circulation. While focused mainly upon describing development projects along the LRT line, the article does report that Portland has witnessed an increase in downtown employment of 30,000 without an increase in the number of autos entering the downtown.

Quantification: Mostly qualitative

Area Types: Urban, Suburban

96. Miller, Gerald K., Thomas J. Higgins, *Implementing Parking Pricing Strategies*, Urban Institute Paper, August 1983.

Summary: Indicates the effectiveness of various parking pricing strategies including revenue tax, space tax, surcharges, permits, rate changes at municipal garages, and discusses in general terms effects of reduced parking supply. Case studies highlighted for San Francisco, Washington D.C. federal workers, Ottawa, ENI Company, Seattle carpool discount program, Santa Cruz on street program.

Quantification: Parking price effects

Area Types: Urban, Suburban

97. Miller, Gerald, Carol Everett, "Raising Commuter Parking Prices - An Empirical Study," *Transportation II* 1982.

Summary: A "before and after" study of federal and private employees who were charged additional parking fees for commute trips.

Quantification: Parking demand, parking location, auto usage

Area Types: Urban

98. Miller, Gerald, Maria Olosson, *Parking Discounts and Carpool Formation in Seattle*, Urban Institute Paper 55050-3-8, 1978.

Summary: Reduced and free parking program implemented for carpoolers at two city owned facilities at periphery of the CBD. The $25 per month fee was reduced to free at one lot and to $5 at other.

Quantification: Mode shares

Area Types: Urban

99. Ministry of Transportation, Ontario, Canada, *Transit-Supportive Land Use Planning Guidelines,* April 1992.

Summary: This "how to" design manual also includes a chart summarizing the relationship between transportation use and land use mixing and density. Well-written and illustrated, it contains numerous quantitative and qualitative guidelines for transit-supportive urban form.

Quantification: Site design characteristics. Also relates density and land uses as to their potential for transit orientation; no explicit traffic, travel, or emissions data.

Area Types: Suburban, Urban

100. Modesto, City of/ROMA Design Group, *Village One Specific Plan: Final Draft,* October 16, 1990.

Summary: A specific application of "pedestrian pocket/traditional neighborhood" design. Plan provides for pedestrian access to parks, schools and basic shopping, but provides no substantial auto-disincentives. Village One has been adopted as the City of Modesto's <u>only</u> urban growth area once current infill sites are exhausted in the mid-1990s.

Quantification: None of traffic/emissions data

Area Types: Suburban

101. Montgomery County, Maryland, *Trip Reduction and Affordable Housing,* January 11, 1990.

Summary: Implications of trip reduction in office developments for freeing parking space for residential development; considerations about where housing would and would not be appropriate to create in-lieu of parking space; implementation concept of "floating zone".

Quantification: Quantification of number of parking spaces which might be freed up due to trip reduction, and number of apartment units which could be added for typical development; no mode share, VMT or emissions data.

Area Types: Suburban

102. Municipality of Metropolitan Seattle, *Parking Utilization Study*, Seattle, Washington, June 1992.

Summary: Survey of parking supply and demand at 36 sites in suburban areas. Findings suggest office is 36% above average demand, 3.1 versus demand of 2.5. Code parking requirements also surveyed, with the finding the requirement is 15% in excess on average.

Quantification: Parking demand and supply, some mode share data, no trip, VMT or emissions data.

Area Types: Urban, Suburban

103. Nelessen, Anton C., *Visions for a New American Dream: Process, Principles and an Ordinance to Plan and Design Small Communities,* American Planning Association, 1994.

Summary: A "how-to" guide for implementing neo-traditional design. Contains discussion and summary of author's trademarked "Visual Preference Survey" a slide show based survey tool that has been administered to over 50,000 individuals in more than 10 states. Author concludes that a majority of people reject conventional

suburban "sprawl" and prefer traditional/neotraditional communities, which Nelessen terms the "New American Dream."

Quantification: None

Area Types: Suburban

104. Newman, Peter W.G. and Jeffrey R. Kenworthy, *Cities and Automobile Dependence, A Sourcebook,* Brookfield, IL, Gower Technical, 1989.

Summary: An ambitious empirical analysis of a cross-section international cities and their metropolitan areas. Extensive local travel data was collected for 32 cities from throughout the world for transportation demand and supply characteristics (vehicle ownership, private car use, public transit use, road supply, central city parking, average speed, vehicles per kilometer of road) and land use characteristics (population and job density overall, for the CBD, for inner and outer areas, the portion of jobs and population in the CBD or inner areas) for 1970 and 1980. Correlations, factor analysis, and cluster analysis were used to test hypotheses using 1980 data.

Key findings:

-Across cities, variations in transport patterns are closely related to variations in land use patterns. Transport patterns also reflect the provision of transportation infrastructure.

- There are strong negative relationships between gas use/private vehicle use and all density variables except CBD job density (which is characteristic of U.S. cities). This relationship is exponential, so that there a multiplicative effects of increasing density. Similarly, there are positive relationships between public transit service and use and all density variables except CBD job density.

- Five factors are negatively related to gas use: land use intensity, orientation to non-auto modes, high level of traffic restraint, high degree of centralization, and high public transport performance. The highest density cities, with the lowest gasoline use per capita (7,785 MJ/capita), were: Munich, Vienna, Singapore, Tokyo, and Hong Kong. The lowest density cities, with the highest gasoline use per capita (49,900 MJ/capita) were: Brisbane, Perth, Phoenix, Houston, Adelaide, and Denver. (Los Angeles was classified as "low density", while San Francisco and New York were classified as medium density").

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

105. Newman, Peter W.G. and Jeffrey R. Kenworthy, "Gasoline Consumption and Cities: A Comparison of U.S. Cities with a Global Survey", *Journal of the American Planning Association*, Winter, pp.24-37, 1989.

Summary: Based on the database developed in the authors' book Cities and Automobile Dependence, this article examines gasoline consumption in ten large United States cities varies by up to 40 percent, primarily because of land use and transportation planning factors, rather than price or income variations. The same patterns, though more extreme, appear in a Global sample of 32 cities. Here, average gasoline consumption in U.S. cities was nearly twice as high as in Australian cities, four times higher than in European cities and ten times higher than Asian cities. Allowing for variation in gasoline price, income, and vehicle efficiency explains only half of these differences.

The authors find that for the U.S. Cities the intensity of land use and gasoline consumption are correlated; the strongest relationship is with inner city population density. City center strength is correlated with consumption both the number of jobs and the proportion in the center. Transit use is also highly negatively correlated with gas use while provision for automobile is positively correlated. A low consumption city is

thus one with a dense form, strong center, and intensively utilized suburbs; this city has a theoretical potential fuel savings of 20-30%.

The authors suggest physical planning policies, particularly reurbanization and reorientation of transportation priorities as a means of reducing gasoline consumption and automobile dependence. While this analysis does not consider the role of subcenters, a follow-up discussion by Newman and Kenworthy (Journal of the American Planning Association, Summer 1992 JAPA) suggests that decentralization may further reduce auto dependence, if decentralization features concentrated subcenters sufficiently dense to encourage significant transit use and walking.

Quantification: Gasoline auto and transit use, but not trips and VMT

Area Types: Urban, Suburban (Aggregate at Metropolitan level)

106. Office of Policy Development, *Edge City and ISTEA-Examining the Transportation Implications of Suburban Development Patterns, Searching for Solutions*. A Policy Discussion, Series Number 7, August 13, 1992.

Summary: Proceedings of a conference on the implications of "edge cities "large-scale commercial developments overlain on previously residential/rural areas. Potential transportation measures and travel trends discussed. Henry Richmond of 1000 Friends of Oregon discusses LUTRAQ and states that urban growth boundaries or other development guiding techniques are necessary for effective trip reduction via land use measures.

Quantification: Travel statistics from 1990 discussed by Pisarski and others, but no detailed quantitative expositions.

Area Types: Suburban

107. Parker, Terry, California Air Resources Board, *The Land Use - Air Quality Linkage, How Land Use and Transportation Affect Air Quality*, 1994.

Summary: This report summarizes data currently available on the relationships between land use, transportation and air quality, and will be updated periodically. It also highlights land use strategies that can help to reduce the use of the private automobile. And, it briefly summarizes several research projects funded by the California Air Resources Board (ARB). As new data becomes available, it will be added to updated versions of this report.

Quantification: Yes

Area Types: Urban, Suburban

108. Parsons Brinckherhoff Quade and Douglas, Inc., *The Pedestrian Environment*, 1000 Friends of Oregon, Making the Land Use, Transportation, Air Quality Connection, December 1993.

Summary: This report describes a methodology for quantifying zones in the Portland (OR) regional travel demand forecasting model network according to four pedestrian factors: ease of street crossings, sidewalk continuity, local street characteristics, and topography. These parameters were combined into a "Pedestrian Environmental Factor" (PEF) that was found to be a statistically significant predictor of auto ownership, mode choice, and destination choice.

Quantification: Pedestrian environment, auto ownership, mode choice, destination choice

Area Types: Urban, Suburban

109. Pickrell, D.H., D.C. Shoup, "Employer Subsidized Parking and Work-Trip Mode Choice", *Transportation Research Record 786*, 1980.

Summary: Study of 500 students at UCLA who were denied parking permits. 40% of students denied permits indicated that they commuted in other SOVs, but when the were later offered permits, they discontinued use of alternative modes.

Quantification: Mode share

Area Types: Urban

110. Pisarski, Alan, *New Perspectives in Commuting*, U.S. Department of Transportation, July 1992.

Summary: Based on early data from the 1990 Census and the 1990 National Personal Transportation Study (NPTS). Analysis of 1980 versus 1990 census travel data for the U.S., with metropolitan summaries for Los Angeles, San Francisco and Sacramento regions, as well as other U.S. metropolitan areas. Detailed trends analysis of solo, carpool, transit and nonmotorized modal shifts. Overall finding is that the solo drive rate up, carpool and transit share down. Mean travel time up slightly nationwide.

Quantification: National and metropolitan modal trends

Area Types: Metropolitan areas

111. Pivo, Gary, Anne V. Moudon, and Franz E. Lowenherz, *A Summary of Guidelines for Coordinated Urban Design, Transportation and Land Use Planning, With Emphasis On Encouraging Alternatives To Driving Alone*, Washington State Department of Transportation, Washington State Transportation Commission, Research Project T9233, Task 6, August 1992, Land Use, Transportation, and Urban Design Problem - 1.

Summary: This report summarizes urban development guidelines that various jurisdictions, professional consultants, and experts have prepared to address the interactive relationship among transportation planning, land use planning, and urban design. The following guidelines have been compiled from the literature surveyed in this project (see references). The aim of these guidelines is to aid in the design of cities and transportation systems that will reduce the necessity of driving alone.

Research for this report include the following steps: (1) the identification of literature sources that provide guidelines related to land use, urban design, and transportation, (2) a compilation of all guidelines provided, which address specifically one or several relationships among land use, urban design, and transportation, (3) a classification of the guidelines under broad categories, and (4) the consolidation of guidelines of similar nature in each category. The broad categories into which the guidelines were divided were, therefore, derived directly from what was found in this research literature review.

These categories include "Location of Land Uses"," Site Planning and Design Standards," "Transit Station Design," "Parking Design and Management," "Site Planning and Design of Park-and-Ride Facilities," "Bicycle and Pedestrian Planning," "Standards and Procedures for Developing Review," and "Implementation Mechanisms."

Quantification: None of trips, VMT or emissions

Area Types: Urban, Suburban

112. Potter, Stephen, *Transport and New Towns*, Milton Keynes, 1984.

Summary: Analyzes the transportation planning for over a dozen of Britain post-World War II New Towns. Although the analysis does not extend past the mid-1970's. it offers very intriguing analysis of both the theory underlying the circulation plans for a wide variety of new towns, as well as actual data on travel behavior in Britain's master-planned communities through 1971.

Quantification: Commute data (internal vs. external) for planned new comminuted near London.

Area Types: Suburban, Exurban

113. Pucher, John, "Urban Travel Behavior as the Outcome of Public Policy: The Example of Modal-Split in Western Europe and North America", *Journal of American Planning Association,* Vol.54, No.4, 1988, pp 509-520.

Summary: Urban transportation systems and travel behavior vary widely, eve among countries with similar per-capita incomes, technology, and urbanization. This article compares modal-split-- how people get from place to place -- for 12 countries in Western Europe and North America. Differences in travel behavior arise largely from public policy differences, especially from differences in automobile taxation. In addition, variations in transit subsidies, land use controls, and housing programs significantly influence travel choices, although sometimes only indirectly. The success of pubic transportation depends more on supportive urban development and automobile taxation policies than on transit subsidies. The absence of such complementary policies in the U.S.- unlike the countries studied--explain the ineffectiveness of the attempt to revive American public transportation exclusively through large subsidies.

Quantification: Trips and mode share

Area Types: Aggregate national data

114. Purvis, Charles L., *Changes in Regional Travel Characteristics and Travel Time Budgets in the San Francisco Bay Area: 1960-1990,* Metropolitan Transportation Commission, July 1993.

Summary: This research is an update of a 1984 study by Kollo and Purvis. Results from the 1990 household travel survey conducted in the San Francisco Bay Area are compared to results from surveys conducted in 1965 and 1981, and to decennial census data. **The study shows a decline in trip frequency per household and per person between 1981 and 1990, which is offset by an increase in average trip duration, yielding an apparent constant travel time budget expended per person and per household.** Regularities in average travel time expanded per household vehicle are also analyzed. Changes in Bay Area demographic characteristics, 1960 to 1990, are described to provide context to the changes in aggregate travel characteristics. Changes in household trip rates, by market segment, and by trip purpose and travel mode, are also summarized. Findings show a decline in home-based non-work and non-home-based trip rate per household, and increases in home-based work trips per household. Bay Area results are compared to household travel surveys from other metropolitan areas.

Quantification: Trips and trip lengths

Area Types: Metropolitan (Urban and Suburban aggregated)

115. Pushkarev, B. and J. Zupan, *Public Transportation and Land Use Policy,* Bloomington, Indiana University Press, 1977.

Summary: This study attempts to identify and quantify the key determinants of transit ridership in urban areas. To this end it explores the role of land use density (especially residential), presence of rail transit, amount of downtown nonresidential space (a surrogate for employment), residential density, land use patterns, and other variables. Residential density influences transit share.

Increased densities are related to transit mode share by regression and correlation; patterns of work trips per worker and trip lengths are provided for various land use types and various downtown sizes. This based on data from New York and 23 downtowns. Other sources of data included 1960 and 1970 Census Journey-to-work data for U.S. metropolitan areas.

Key findings:
- Transit share increases as residential density increases, across different cities and within cities. But only

56.8% of the variation between cities is explained by density. Total downtown office floor space (CBD strength) and rapid transit service are also predictors of transit share, explaining an additional 22% of the variation.

- Transit trip-end density (population density times the number of trips per person) increases more rapidly than residential density increases, due to a compounding effect.

- Auto ownership increases as income increases and residential or destination density decreases.

- If rapid transit service is provided, auto ownership decreases at each income or density level; the impact of rapid transit service is equivalent to a ten-fold increase in residential density.

- Trip attenuation rate for different non-residential cluster groups in the New York City area is a function of total non-residential floorspace, distance to the cluster, distance to Manhattan (farther from Manhattan means more trips). Thus, the public transit pay-off of an increase in residential density is greatest if in the immediate vicinity of a non-residential cluster.

Quantification: VMT, trips, densities, mode shares quantified, but no emissions data.

Area Types: Primarily focused on suburban/urban to CBD travel.

116. Rabinowitz, Harvey et al, *The New Suburb*, Urban Mass Transportation Administration, U.S. Department of Transportation, Final Report, July 1991.

Summary: This piece of work was prepared in conjunction with Beimborn, Rabinowitz et al's, *Guidelines for Transit Sensitive Suburban Land Use Design*. It consists of site plan and summary descriptions of recent and proposed suburban communities; these designs are rated with respect to their compatibility with transit service on the basis of explicit criteria and the judgement of a panel of architects and transportation planners. Plans reviewed are largely unbuilt.

Quantification: Site design characteristics (e.g., density); also ratings as to degree of transit orientation; no explicit traffic, travel, or emissions data.

Area Types: Suburban

117. Real Estate Research Corporation, *The Costs of Sprawl*, 1974.

Summary: Detailed cost analysis of various typical forms of residential development; conclusion is that planned higher-density ("clustered") results in reduced economic costs and environmental impacts. Two basic prototypes are analyzed: the community-scale (10,000 units, 33,300 population) and the neighborhood-scale (1,000 units, 3,300 population). are analyzed in detail, utilizing fairly wooden unit-cost factors. Has an extensive bibliography.

Quantification: Extensive

Area Types: Suburban, Urban

118. Richardson, Harry W. and Peter Gordon, "Counting Nonwork Trips, The Missing Link in Transportation, Land Use, and Urban Policy", *Urban Land*, pp. 6 - 12, September 1989.

Summary: Emphasizes the growing importance of work versus non-work trips, and dispersed trip-making patterns, particularly in suburban areas and poly-nucleated cities. Authors utilize 1977 and 1982 Nationwide Personal Transportation Study (NPTS) conducted by the U.S. DOT. Authors fail to discuss the direct linkage between many work and nonwork trips (i.e., the fact that many nonwork trips form links in trip-

chains between the workplace and home. The Nationwide Personal Transportation Study was conducted again in 1990; results, published in 1992, partly undermine Richardson and Gordon's analysis, since many types of trips have become longer.

Quantification: Trips speeds, and VMT (from NPTS)

Area Types: Metropolitan (Urban and Suburban combined)

119. Robinson, Ferrol O., Jerry L. Edwards, and Carl E. Ohrn, "Strategies for Increasing levels of Walking and Bicycling for Utilitarian Purposes", *Transportation Research Record 743,* 1980.

Summary: This paper reports the results of an extensive survey of motorized and non-motorized travel. The survey was conducted in connection with a study to (a) identify problems associated with walking and bicycling. (b) identify a wide range of incentives to promote the use of walking and bicycling for utilitarian trip purposes, and (c) establish the cost-effectiveness of the incentives identified. This paper limits itself to an analysis of the survey results as they relate to the topics of (a) trip and trip-maker characteristics, (b) mode choice and preference, and (c) changes in preferences for alternative modes of travel in response to the implementation of selected scenarios. The scenarios tested were (a) provision of bicycle and pedestrian facilities, (b) fee on automobile use during peak periods, (c) compact land-settings with provision of pedestrian and bicycle facilities, and (d) increases in fuel prices. The survey responses indicate that a compact land-use arrangement, combined with the provision of pedestrian and bicycle facilities, has the greatest potential for creating a shift from the automobile to walking and bicycling. Bicycle and pedestrian facilities alone follow in importance. A fee on automobile use during peak periods has the effect of reducing automobile use; however, one-third to one-half of the trips diverted go to transit rather than nonmotorized modes. Finally, doubling the price of fuel appears to be the least effective of the strategies analyzed for increasing walking and bicycling.

Quantification: Mode share

Area Types: Urban, Suburban

120. Sacramento, City of, *Transportation Management Plan Handbook*, Planning Department, (November 1983).

Summary: Employee densities provided for land use types, ITE trip generation rates by land use type and trip reduction levels expected for several rideshare measures also provided (preferential carpool parking, vanpool and transit subsidies, shuttle buses, bicycle support measures). Also estimated are trip reductions estimated for jobs housing links (employees hired within adjacent neighborhoods).

Quantification: Employee densities, trip reduction percentages for TSM and jobs housing link

Area Types: Urban, Suburban

121. San Joaquin County, *Draft Environmental Impact Report on the San Joaquin County Comprehensive Planning Program No. 91-3,* (Revision of ER 90-6,SCH 90020018): San Joaquin County Comprehensive Planning Program, December 1991.

Summary: Outlines policies for new towns in San Joaquin county; projects and analyzes traffic impacts and air quality impacts based on projections made via a regional MINUTP model. San Joaquin was the first California county to adopt the new towns concept in its General Plan. Proposed policies require new urban area to:

- offer "a full range" of urban services, including jobs
- avoid prime agricultural land
- be developed at "urban densities"
- have comprehensive pedestrian/open space networks

- provide housing for "all segments" of the community
- maintain a close jobs/housing balance
- have multi-modal circulation systems
- be located and design to distinct from existing cities
- be fiscally self-sustaining

Quantification: Traffic emissions data quantified in traffic impacts section of EIR; new towns assumed to be additional growth in county, hence impacts are additional.

Area Types: Exurban

122. Santa Clara County Manufacturing Group, "High Tech Workers Housing Survey, Findings and Analysis", August 1993.

Summary: A survey of workers in high-tech industries in Santa Clara County, CA suggested that a sizable proportion would be willing to accept attached homes and/or homes with smaller lots if housing prices were lower or their commutes were significantly shorter.

Quantification: Housing location choice

Area Types: Urban, Suburban

123. Sawyer, Chuck, Kathy Snow, Municipality of Metropolitan Seattle, *First Hill Action Plan: A Unique Public/Private Approach to Transportation,* Paper presented before the Transportation Research Board, Washington D.C., January 7-11, 1990.

Summary: Case study of TDM at a hospital, medical center, showing parking pricing, park and ride, express service, discount transit passes, guaranteed ride home can reduce solo driving significantly.

Quantification: Prior mode of HOV uses, overall HOV ridership, but no trip or VMT or emissions data.

Area Types: Urban

124. Schneider, Jerry B., *Transit and the Polycentric City,* U.S. Department of Transportation, September 1981.

Summary: Findings from a variety of studies are used to assess the energy efficiency of the polycentric metropolis.

Findings:
- Kydes, Sanborn, Carroll: Compared to urban sprawl, comprehensive plan development result in a 28% energy savings, while growth centers development results in a slightly higher 32% energy savings. (Lowry-type land use model + transportation model, real data base for Suffolk County, New York).

- Peskin & Schofer: Compared to concentric ring and one-sided city development patterns, a polynucleated pattern results in 57% and 44% less energy use and 30% and 23% shorter average trip lengths, respectively. The conversion to a polynucleated form was also tested: the addition of one center increased energy consumption by 3% but decreased average trip length by 6%. (A Lowry-type model was used in conjunction with a travel demand model). Suggests that the impact of conversion is different from implementing a particular form from the ground up.

- Rice: A multi-centered form (CBD plus outlying centers) had the least person-hours of work trips and the shortest average work trip (29% and 22% better than the next best) compared to central, homogeneous, radial corridor, linear, and satellite forms. (Transportation model, hypothetical).

- Urban Transportation Development Corporation, Ltd.: A more transit oriented, medium density form with subcenters resulted in 24% fewer vehicle miles traveled, overall and by auto, than a continued low density form with limited transit. (Simulation Model for Ontario).

- The unanimous conclusion is that a polycentric form requires less travel than other forms investigated. The importance of transit is not clear from these studies.

Quantification: Extensive

Area Types: Urban, Suburban (city-scale and larger)

125. Sharpe, R., "Energy Efficiency and Equity of Various Urban Land Use Patterns", *Urban Ecology*, 7, pp. 1-18, 1982.

Summary: In this review of other works, the author concludes that a dominant urban center, with suburban center development is favored from an energy and equity standpoint. Concentration in the center is best, but not realistic; with some restriction on density, a subcenter pattern is best.

Quantification: Energy use

Area Types: Urban, Suburban (city-scale and larger)

126. Shaw, John, *Transportation, Land Use, and Residential Choice,* Paper presented before the Transportation Research Board Annual Meeting, January 1993.

Summary: Calls into question whether individuals will opt for higher residential or workplace densities called for by planners attempting to encourage transit use. Includes a general review of residential location preference literature.

Note that given increased problems with automobile dependence, many planners, policymakers, and others are examining the potential for alternative land use patterns in urban areas, specifically developing increased densities around existing or planned transit stations or developing new communities that would that would be served by rail transit. However, rail transit systems require certain minimum densities to be successful, at both origin and destination ends. Since there is a choice of residential locations within a metropolitan area, it is an open question whether residents will choose to live at densities necessary to support various types of transit service.

This paper examines past research that has dealt directly or indirectly with this question. Hedonic pricing studies are reviewed, and their strengths and weaknesses discussed. Residential satisfaction studies have the most to offer; these are reviewed in some detail, and key findings summarized. The paper concludes with a description of current research efforts on high density transit-based housing satisfaction.

Quantification: None, except for preference survey responses

Area Types: Urban, Suburban

127. Smith, Steven A., "Park-and-Ride at Shopping Centers: A Quantification of Modal-Shift and Economic Impacts", *Transportation Research Record 908,* 1983, 27-31.

Summary: The purpose of this research was to quantify the effects of park-and-ride facilities at shopping centers on commuter travel and shopping behavior. A survey of commuters at three shopping centers in Montgomery County, Maryland was conducted to estimate the impacts. The analysis demonstrates that there can be a significant economic benefit to shopping-center operators for allowing commuter parking to occur in their parking lots. Survey results indicate that between 25 and 45 percent of park-and-rides shop at the shopping centers on a typical day on their way to and from work. Approximately two- thirds of this shopping activity is either diverted from other shopping locations or in newly induced shopping. For the shopping centers surveyed, the average increase in sales due to the presence of park-and-ride activity is $5/park-and-

ride/day. Also, the presence of the park-and-ride facility, in itself, is responsible for 10% to 30% of the park-and-riders choosing to use transit or form a carpool.

Quantification: Diverted trips, trip linkage and mode shift.

Area Types: Suburban

128. Smith, Thomas P., *Flexible Parking Requirements*, Planning Advisory Service of the American Planning Association, August 1983.

Summary: Guidelines for applying shared parking requirements, including example calculations as per Montgomery County approach. Also discussed are fees in lieu of parking, and sample zoning code provisions. Parking demand estimates are provided for medium density housing.

Quantification: Parking demand for residential uses, but no mode share, VMT or emissions data.

Area Types: Suburban, Urban

129. Snohomish County Transit, *A Guide to Land Use and Public Transportation*, Urban Mass Transportation Administration, October 1989.

Summary: This report entails a summary discussion of recent evidence regarding compatibility of various land uses and design patterns with public transportation; includes a discussion of walking distances and the effect of pedestrian facilities and distance (750 feet is the maximum for most purposes, 1,000 feet for bus park and ride, and up to 1,800 feet for rail transit access). Contains an interesting 2-page table summarizing compatibility of various typical suburban land uses with different modes of transportation (pp. 3-8 and 3-9). Numerous charts and diagrams of transit-supportive urban form.

Quantification: Site design characteristics. Also relates density and land uses as to their potential for transit orientation; no explicit traffic, travel, or emissions data.

Area Types: Suburban

130. Sorenson, S.C., and Schramm, J., *Individual and Public Transportation: Emissions and Energy Consumption Models*, Technical University of Denmark, January 1992.

Summary: Prediction model is presented for purposes of quantifying effects of traffic regulation policies on emissions (HC, CO and NO). No indication of the policies tested, or whether land use was one of them.

Quantification: Trips, mode, speeds and emissions

Area Types: Urban, Suburban

131. Southworth, Michael and Peter M. Owens, "The Evolving Metropolis, Studies of Community, Neighborhood, and Street Form at the Urban Edge", *Journal of the American Planning Association*, Vol. 59. No. 3, Summer 1993, American Planning Association, Chicago, IL.

Summary: This paper examines the form of the evolving metropolitan fringe by means of the cooperative case studies of fringe development in the San Francisco Bay Area at three scales - the community, the neighborhood, and the street and house lot. The study identifies underlying organizing principles and spatial topologies and analyzes patterns of growth, land use, and street layouts for several periods of suburban development beginning early in the twentieth century and continuing into the 1990s. As the scale of development has grown, there has been a parallel growth of self-contained, single use developments and an erosion of the public street framework. This shift has serious implications for the character, convenience, and adaptability

of new urban environments.

Quantification: Density and urban design factors

Area Types: Suburban

132. Steiner, Ruth L., *Residential Density and Travel Patterns: A Review of the Literature and Methodological Approach,* Transportation Research Board, 73rd Annual Meeting, January 9-13, 1994, Washington, D.C.

Summary: With the increasing concern about the environmental side effects of the use of the automobile, a few researchers, real estate developers and increasingly policy makers in many states argue for the need to build infill housing, mixed land-uses and increased density especially around transit stations. In making these recommendations, they make several assumptions about the relationship between high-density residential development and transportation choices and the resultant environmental impacts. They assume that people in high density developments will make fewer and shorter trips and walk or use transit more frequently than residents of other areas. Further they often assume that people will be willing to move to high-density areas, and when they do, will change their travel patterns.

This paper explores several sets of literature to gain a better understanding of the interactions between the household in high-density residential area, the land-use characteristics of the area and the transportation choices of those households. It also presents a preliminary outline of the methodological approach to be taken in a dissertation that will explore the following question, are the differences in the travel patterns of households in high-density residential areas explained by the socioeconomic and demographic characteristics of households in the area, or, do land use and urban design characteristics result in different behavior among otherwise similar individuals and households?

Quantification: Yes

Area Types: Urban, Suburban

133. Stringham, M., "Travel Behavior Associated with Land Uses Adjacent to Rapid Transit Station," *ITE Journal*, April 1982.

Summary: A study based on surveys of 2,000 persons living and working near rail transit stations in Toronto and Edmonton, Canada. The study found that within 3,000 feet of stations 30 to 60 percent of major trips were by transit. High density (apartment) dwellers were 30 percent more likely to use transit compared to single-family dwellers at the same distance from a station.

Quantification: Trip generation near rapid transit stations

Area Types: Urban, Suburban

134. The Planning Institute, *Jobs Housing Balance and Regional Mobility Research Report,* University of Southern California, April 1990.

Summary: The conclusion from this report is that "jobs housing balance policy is not likely to be an effective means for reducing traffic congestion, and it therefore is not justified." This conclusion is supported with assertions that policy intervention is not necessary or desirable for achieving jobs housing balance, and that there is little evidence to support the assumption that there is a relationship between jobs housing balance and traffic congestion.

Quantification: None, although the theoretical impacts on traffic congestion are explored.

Area Types: Urban, Suburban

135. Transport Canada, *The Effects of the Imposition of Parking Charges on Urban Travel in Ottawa*, Summary Report TP 291, Montreal.

Summary: Increase in parking charges on federal employees in Ottawa. Prices rose from free to about 70 percent of commercial rates. Major bus improvements were included. Seven percent of federal workers changed mode, auto driver declined from about 35 percent to 28 percent. Bus transit share increase from 42 percent to 49 percent.

Quantification: Mode shares

Area Types: Urban

136. Transportation Research Board, "Campus Transportation Systems Inventory," *TR News*, July - August 1992.

Summary: Report of a data base being developed summarizing transit system characteristics and performance at 186 campuses.

Quantification: None reported, but transit data coming

Area Types: Urban, Suburban

137. Untermann, Richard, with Lynn Lewicki, *Accommodating the Pedestrian: Adapting Neighborhoods for Walking and Bicycling*, New York, 1984.

Summary: Extensive analysis of pedestrian behavior. Untermann suggests that most Americans will walk 500 feet. At one-half mile (2,640 feet) only about ten percent walk willingly. While Americans have historically been less willing to walk than other nationalities, acceptable walking distance can be increased significantly by catering to pedestrians with pleasant routes and pedestrian-oriented activities along routes.

Quantification: Of pedestrian behavior

Area Types: Urban, Suburban

138. Urban Land Institute, *ULI on the Future Land Use in Transition; Emerging Forces & Issues Shaping the Real Estate Environment*, 1993.

Summary: A strategic look at the dramatic changes taking place in American society and the issues that will determine the need for, the location of, and the type of real estate investment and development activities in the United States throughout the 1990s.

Published by the Urban Land Institute, the report is divided into three sections:

a. Forces - Examines the demographic, economic, sociological, and technical changes that are effecting the way U.S. residents live, work, shop and play.

b. Issues - Describes the strategic land use and development issues facing the real estate industry, often requiring reconciliation of competing public and private interests and opposing visions of America's future.

c. Forecasts - Looks at the implications and future real estate needs for center cities, suburbia, and exurbia. Essays on exurbia focus on second home, resort and retirement communities.

The individual essays are written by a variety of real estate experts and reviewed extensively by others, this work attempts to crystallize current development trends and issues for debate.

Quantification: Real estate market trends

Area Types: Urban, Suburban, Rural

139. Urban Land Institute, *Employment and Parking in Suburban Business Parks: A Pilot Study*, 1986.

Summary: Gruen Gruen & Associates national study showing parking supplies in suburban areas are excessive; also survey of suburban business park developers on occupancies, floor area ratios, (FAR), rents per square feet, parks offering carpool, transit encouragements (very few). Mode share estimated and employment density (square feet/employee) given by type of use (office R&D, etc.).

Quantification: Some mode share and parking supply data, also occupancy rates and FAR, but no trip reduction, emissions or VMT information

Area Types: Suburban

140. Urban Land Institute, *Shared Parking*, 1983.

Summary: A nationwide study, primarily of parking behavior associated with various land uses. The study also examines the effect of mixed use on parking and trip linkage at CBD and non-CBD mixed-use sites.

Quantification: Extensive for parking; also trip linkage

Area Types: Urban, Suburban

141. U.S. Department of Housing and Urban Development, *An Evaluation of the Federal New Communities Program*, 1984.

Summary: Concludes that the failure of the more than one dozen federally supported new communities in the 1960's and 1970's was primarily due to: poor timing; poor locations; and weak developers.

Quantification: None of traffic/emissions data

Area Types: Exurban

142. U.S. Department of Transportation, *1990 National Personal Transportation Survey, Summary of Travel Trends*, Washington, D.C., 1992.

Summary: The fourth national survey of travel behavior conducted by the U.S. DOT (prior surveys were conducted in 1969, 1977, and 1983).

Quantification: Trips, VMT and mode share detailed at national level

Area Types: All

143. Van Der Ryn and Peter Calthorpe, eds, *Sustainable Communities*, San Francisco: Sierra Club, 1986.

Summary: A compendium of essays on the history of new towns and suburbs. One particularly interesting essay is by Fred A. Reid, titled "Real Possibilities in the Transportation Myths", which outlines the feasibility for serving specialized needs via specialized vehicles, of meeting consumers desire for automobility with a diversity of vehicles and transportation services (e.g., short-term auto rental), all of which would have fewer negative environmental and social impacts of the present auto-highway system.

Quantification: None of traffic/emissions data

Summary: Brief article covering the debate over a proposed new town in Florida. Sited just beyond the edge of Orlando's urban limit line; the debate centers on whether the level of internal capture justifies extension of the urban limit line. Notes the paucity of data regarding trip capture within mixed-use areas adjacent to a metropolitan area.

Quantification: Design principles, not of traffic or travel impacts

Area Types: Suburban, Exurban

145. Walters, Gerald P.E., Fehr & Peers Associates, Inc., *Peak Hour Traffic Generation for Mixed-use Development Areas,* Paper presented before the ITE Conference, Reno, Nevada, 1987.

Summary: Surveys of mixed use traffic generation rates in Palo Alto and Sacramento show ITE generation rates too high. Articles also suggests how to reduce ITE rates.

Quantification: Traffic generation but no mode share, trip length or emissions data.

Area Types: Suburban, Urban

146. Watson, Robert K., and Veronica Kun, "Vehicle Trip Reduction Credits for Land-Use Decisions: A Proposed AQMP Compliance Tool for Local Jurisdictions," National Resources Defense Council, July 1992.

Summary: A "point table" is proposed that quantifies the impact on vehicle trips from a menu of land-use options. This table is designed to be used by local jurisdictions to assess the potential benefits of an air quality plan. The analysis focuses primarily on land-use decisions, but also includes trip reduction factors for parking.

Quantification: Vehicle trips

Area Types: Urban, Suburban

147. Wilbur Smith "Automobile Parking Trends", *Planning*, American Planning Association, June 1983.

Summary: Summary of city approaches to parking pricing and supply restraint policies, including maximums, parking caps and reduced minimums for rideshare incentives. Parking credit for mixed use also reviewed.

Quantification: Minimum and maximum policies quantified, but no trip, VMT or emissions data.

Area Types: Mostly Urban

148. Williams, Michael E., *Husky Stadium Expansion Parking Plan and Transportation Management Program,* Paper presented before the Transportation Research Board, Washington D.C., January 1989.

Summary: Case study of TDM at the University of Washington suggesting park and ride, carpool discount parking and free transit can mitigate special event traffic.

Quantification: Mode share, trips, but no VMT or emissions data.

Area Types: Urban

149. Willson, Richard, *Suburban Parking Economics and Policy: Case Studies of Office Work Sites in Southern California*, for the Federal Transit Administration, October 1992.

Summary: Parking demand and supply at ten case study sites in Riverside, Los Angeles, Orange and San Bernardino counties. Findings suggest oversupply of parking and quantifies the excess supply.

Quantification: Parking supply, requirements, floor area ratios, shared parking, gross square feet, area of parcel devoted to parking all quantified, but no mode share, trip length or emissions data.

Area Types: Suburban

150. Willson, Richard, "Estimating the Parking Demand Effects of Employer-paid Parking," *Regional Science and Urban Economics*, Vol. 22, pp. 133-145, March 1992.

Summary: Based on case studies in Southern California

Quantification: Yes

Area Types: Urban, Suburban

151. Zarker, Gary and Jesse Krail, Seattle Engineering Department, *The 1987 Evaluation of Transportation Management Programs, Final Report,* 1987.

Summary: Survey of 12 downtown buildings suggests parking supply availability may be a significant cause of mode shift. Report also demonstrates the ineffective nature of carpool discount stalls.

Quantification: Mode share, parking supply and price given for various buildings, also trip generation calculations; no VMT or emissions data.

Area Types: Urban

APPENDIX C

Development of Ratings Criteria for Sample Communities

Appendix C
DEVELOPMENT OF RATINGS CRITERIA FOR SAMPLE COMMUNITIES

The qualitative ratings criteria provided in Table 4-5 were developed by Terry Parker with the California Air Resources Board, Office of Air Quality and Transportation Planning. A summary of the rating criteria is provided below.

RATING CRITERIA	PEDESTRIAN ACCESSIBILITY FACTOR*	TRANSIT SERVICE FACTOR*
extremely low	<.1	0-1.9
very low	.1	2-4.9
low	.2	5-7.9
moderate	.3-.4	8-15.9
high	.5	16-25.9
very high	.6	26-50
extremely high	.7	>50

* Numbers are rounded to the nearest 0.1.

Additionally, an evaluation of the VMT characteristics for each of the sample communities was performed. The VMT data are presented in Chapter 5. Tables 5 and 6 from Holtzclaw are provided as Appendix D and include a summary of VMT and community characteristics.

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APPENDIX D

VMT and Community Characteristics: Summary Tables from Holtzclaw

Table 5
1990 Annual Vehicle Miles Traveled

Community	N Sample Size	Mean Annual VMT/car	Std Error of mean (mi)	Autos Capita	Autos HH	VMT Capita	VMT HH
San Francisco Area							
Nob-Rus-NoBea	177	9,855	481	.28	.56	2,759	5,519
San Francisco	3,818	10,619	112	.45	1.06	4,779	11,256
central Berkeley	246	9,737	418	.58	1.28	5,647	12,463
Daly City	667	11,128	260	.55	1.73	6,120	19,251
Alameda	461	10,765	333	.65	1.58	6,997	17,009
Rockridge	252	9,781	376	.66	1.46	6,455	14,280
Walnut Creek	499	12,175	333	.79	1.83	9,618	22,280
San Ramon	321	13,406	424	.79	2.10	10,591	28,153
Morgan Hill	228	12,809	449	.72	2.22	9,222	28,436
Lafayette	225	10,229	416	.81	2.18	8,285	22,299
Los Altos-L A H	280	10,971	378	.87	2.38	9,545	26,111
Los Angeles Area							
s Long Beach	406	11,823	343	.45	1.29	5,320	15,252
s Santa Monica	188	10,155	442	.78	1.45	7,921	14,725
sw Beverly Hills	122	8,591	534	.77	1.51	6,615	12,972
sc Pasadena	200	11,504	462	.70	1.50	8,053	17,256
Alhambra	525	12,447	312	.61	1.74	7,593	21,658
c Downey	207	11,828	486	.71	1.81	8,398	21,409
n Riverside	100	13,773	860	.58	1.72	7,988	23,690
Moreno Valley	141	13,875	716	.61	2.07	8,464	28,721
San Diego Area							
Uptown	386	11,469	361	.70	1.35	8,028	15,483
Clairemont	394	11,455	322	.78	1.98	8,935	22,681
La Costa	120	14,031	671	.80	1.95	11,225	27,360
Escondido	454	12,397	327	.60	1.75	7,438	21,695
Bos-Cr-Fl Sp-BV	378	11,424	334	.67	1.88	7,654	21,477
Sacramento Area							
Central City	172	10,710	483	.50	.94	5,355	10,067
E Sac-n Land P	323	10,082	345	.64	1.43	6,452	14,417
S Sac	402	12,016	339	.57	1.65	6,849	19,826
Merced Co.	450	13,282	558	.56	1.79	7,438	23,775
Alameda Co.	10,911	11,260	64		1.68		18,917
Contra Costa	6,257	11,838	90		1.91		22,611
San Mateo Co.	5,560	10,969	90		1.90		20,841
Santa Clara Co.	12,885	11,185	56		1.99		22,258
Los Angeles Co.	53,686	11,620	31		1.68		19,522
Riverside Co.	6,544	13,165	97		1.83		24,092
San Diego Co.	32,045	11,799	52		1.78		21,002
Sacramento Co.	7,432	11,423	79		1.73		19,762
California	346,918	12,072	17		1.78		21,488

Population, Households, Income, Autos and Acres are from the 1990 U.S. Census. Household density excludes vacant residential units.

Residential Acres excludes streets. They were measured by ABAG, SCAG, SANDAG and the Sacramento Planning Department.

$$\text{TAI} = \frac{\Sigma(\text{buses both dir/day})(\text{seats/bus})(\%\text{hh to 1/4 mi}) + \Sigma(\text{railcars both dir/day})(\text{seats/car})(\%\text{hh to 1/2 mi})}{(\text{50 seats/std bus})(\text{24 hr/day})}$$

NSI = fraction of hh within 1/4 mi of 5 key local commercial (market, restaurant, drugstore) establishments.

PAI = ((fraction of through streets)(fraction of roadway below 5% grade).33[(fraction blocks with walks, each side) + (building entry coefficient) + (fraction of streets with traffic controlled)]; Building entry coefficient = [1 if 0 - 3 ft avg. building setback from walk; 0.5 if 4 - 10 ft; 0.3 if 11 - 20 ft; 0.1 if 21 - 40 ft; 0 if > 40 ft]

VMT = Vehicle miles traveled, calculated from the California Bureau of Automotive Repair's odometer readings taken during smog-checks.

n, e, s, w, c = north, east, south, west, central

Prepared by John Holtzclaw

Table 6
1990 Community Characteristics And Auto Use

Community	Pop Density Pop/Acre	Net HH Density HH/Res Ac	Income/Capita $	Income/HH $	TAI Transit	NSI Shopping	PAI Pedestrian	Autos/Capita	Autos/HH	VMT/Capita	VMT/HH
San Francisco Area											
Nob-Rus-NoBea	49.2	100.9	21,792	42,044	90	1.00	.66	.28	.56	2,759	5,519
San Francisco	24.2	48.3	19,695	45,664	70	.76	.49	.45	1.06	4,779	11,256
central Berkeley	12.1	15.6	15,960	34,567	49	.16	.58	.58	1.28	5,647	12,463
Daly City	14.6	14.9	14,814	45,892	13	.17	.10	.55	1.73	6,120	19,251
Alameda	10.3	12.2	20,287	47,887	6.7	.22	.48	.65	1.58	6,997	17,009
Rockridge	8.2	9.6	26,116	57,208	27	.24	.13	.66	1.46	6,455	14,280
Walnut Creek	4.6	4.7	26,245	60,647	21	.10	.07	.79	1.83	9,618	22,280
San Ramon	2.4	3.2	26,493	69,975	1.0	.00	.08	.79	2.10	10,591	28,153
Morgan Hill	1.7	2.3	20,410	61,957	3.1	.13	.16	.72	2.22	9,222	28,436
Lafayette	1.8	2.2	33,557	89,101	11	.09	.02	.81	2.18	8,285	22,299
Los Altos-L A H	2.1	1.8	43,936	118,870	2.3	.12	.03	.87	2.38	9,545	26,111
Los Angeles Area											
s Long Beach	15.9	24.1	9,712	28,000	19	.57	.66	.45	1.29	5,320	15,252
s Santa Monica	15.0	15.0	25,153	46,677	20	.71	.59	.78	1.45	7,921	14,725
sw Beverly Hills	19.4	13.5	25,991	50,981	13	.65	.71	.77	1.51	6,615	12,972
sc Pasadena	13.9	10.4	20,392	43,510	5.5	.37	.42	.70	1.50	8,053	17,256
Alhambra	16.7	8.6	14,727	42,197	4.7	.24	.37	.61	1.74	7,593	21,658
c Downey	11.3	6.8	18,716	47,535	2.1	.16	.21	.71	1.81	8,398	21,409
n Riverside	5.2	5.2	11,373	33,884	0.6	.07	.13	.58	1.72	7,988	23,690
Moreno Valley	3.8	3.5	15,095	51,074	0.4	.08	.09	.61	2.07	8,464	28,721
San Diego Area											
Uptown	14.0	12.3	19,124	36,570	9.0	.50	.39	.70	1.35	8,028	15,483
Clairemont	8.8	6.2	17,558	44,210	2.4	.08	.07	.78	1.98	8,935	22,681
La Costa	2.3	4.0	26,082	63,117	.5	.03	.01	.80	1.95	11,225	27,360
Escondido	1.9	3.6	14,053	40,688	2.1	.03	.09	.60	1.75	7,438	21,695
Bos-Cr-Fl Sp-BV	2.2	2.6	13,990	38,394	.8	.04	.02	.67	1.88	7,654	21,477
Sacramento Area											
Central City	7.9	22.2	14,226	24,880	20	.17	.41	.50	.94	5,355	10,067
E Sac-n Land P	7.4	7.5	18,180	39,835	5.3	.10	.26	.64	1.43	6,452	14,417
S Sac	8.7	6.6	12,021	34,358	1.2	.13	.03	.57	1.65	6,849	19,826
Merced Co.	.1		10,606	34,197				.56	1.79	7,438	23,775

Population, Households, Income, Autos and Acres are from the 1990 U.S. Census. Household density excludes vacant residential units.

Residential Acres excludes streets. They were measured by ABAG, SCAG, SANDAG and the Sacramento Planning Department.

$$TAI = \frac{\Sigma(\text{buses both dir/day})(\text{seats/bus})(\%\text{hh to 1/4 mi}) + \Sigma(\text{railcars both dir/day})(\text{seats/car})(\%\text{hh to 1/2 mi})}{(50\ \text{seats/std bus})(24\ \text{hr/day})}$$

NSI = fraction of hh within 1/4 mi of 5 key local commercial (market, restaurant, drugstore) establishments.

PAI = (fraction of through streets)(fraction of roadway below 5% grade).33[(fraction blocks with walks, each side) + (building entry coefficient) + fraction of streets with traffic controlled)]; Building entry coefficient = [1 if 0 - 3 ft avg. building setback from walk; 0.5 if 4 - 10 ft; 0.3 if 11 - 20 ft; 0.1 if 21 - 40 ft; 0 if > 40 ft]

VMT = Vehicle miles traveled, calculated from the California Bureau of Automotive Repair's odometer readings taken during smog-checks.

n, e, s, w, c = north, east, south, west, central

Prepared by John Holtzclaw

APPENDIX E

Methodology for Conversion from Daily to Annual Travel Values

APPENDIX E
Methodology for Conversion from Daily to Annual Travel Values

ARB staff developed a methodology to convert VT and VMT per person values from daily to annual figures. A more sophisticated methodology was required because a simple multiplication by 365 days per year would not have reflected the travel differences between weekday and weekend travel. The travel data are based on weekday travel, thus, the key element of the conversion process was a method for determining comparable values for weekend travel.

Datasets on weekend and weekend travel, as reported in the *1991 Statewide Travel Survey Final Report* that was prepared by Caltrans in December 1993, were compared to each other. The variable examined was "person trips per person five years of age or older", which seemed to be the measurement most compatible with the per capita variable. There is a 16 percent difference between the statewide average number of weekday person trips (3.6) and weekend person trips (3.1). It was assumed that this relationship was similar for VMT (i.e. a 16 percent difference). This does not imply that VT and VMT are the same; it is only an assumption that VT and VMT are distributed between weekdays and weekends in the same proportion.

The overall approach developed was to multiply the daily VT (or VMT) by the sum of the number of weekdays in a year plus the number of weekend days in a year multiplied by 84 percent (taking into account the 16 percent difference described above). It was estimated that, with an average of ten holidays, there are 251 workdays in the year and the remaining 114 days can be treated as weekend days. The resulting equation for converting daily VT per person to annual VT per person is:

$$\text{VT per person per year} = \text{VT per person per day} * (251 + 114 * .84)$$

or

$$\text{VT per person per year} = \text{VT per person per day} * 347$$

This same approach was used for VMT and the equations are provided below.

VMT per person per year = VMT per person per day * (251 + 114 * .84)

or

VMT per person per year = VMT per person per day * 347

The methodology presented here can also be used by local jurisdictions to convert daily data to annual figures that can be used as a baseline for comparison to the performance goals. The methodology described in this appendix uses average, statewide values for the differences between weekday and weekend travel. It is recognized that individual jurisdictions will vary in the proportion of weekend to weekday travel from the values used in this methodology. If the proportion is known, that value can be substituted into the equations provided below to derive baseline travel figures.

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APPENDIX F

BURDEN Activity Data

1990 Baseline Average Vehicle Travel in California Counties

CALIFORNIA COUNTIES	Average VMT per Household per YEAR *	Average Vehicle TRIPS** per Household/YEAR
Alameda County	16,686	2,155
Amador County	19,228	2,830
Butte County	17,089	3,096
Calaveras County	20,249	3,294
Colusa County	56,012	4,235
Contra Costa County	16,834	2,289
Del Norte County	18,275	2,189
El Dorado County	30,083	3,240
Fresno County	20,499	2,472
Glenn County	29,758	3,952
Humboldt County	18,846	2,590
Imperial County	57,486	6,512
Inyo County	49,376	3,015
Kern County	21,171	2,531
Kings County	21,851	2,350
Lake County	15,236	2,889
Lassen County	37,225	2,583
Los Angeles County	18,678	2,624
Madera County	25,667	2,961
Marin County	17,342	2,101

** 'Vehicle Miles Traveled,' excluding heavy duty truck travel.*
*** Vehicle Trips include: automobile, pickup, RV, van and motorcycle trips.*

Source: Air Resources Board's
"BURDEN" EMFAC 7F 1.1 and
1990 US Census (persons/HH)

Terry Parker, ARB staff
February, 1995

1990 Baseline Average Vehicle Travel in California Counties

CALIFORNIA COUNTIES	Average VMT per Household per YEAR *	Average Vehicle TRIPS** per Household/YEAR
Mariposa County	31,525	3,105
Mendocino County	26,376	2,852
Merced County	29,058	2,748
Modoc County	25,970	2,506
Mono County	64,854	3,096
Monterey County	21,852	2,669
Napa County	13,161	2,290
Nevada County	23,701	3,133
Orange County	21,345	2,787
Placer County	28,927	3,690
Plumas County	10,670	3,176
Riverside County	24,132	2,273
Sacramento County	17,333	3,051
San Benito County	24,900	3,168
San Bernadino County	20,378	2,472
San Diego County	21,192	2,892
San Francisco	8,851	1,350
San Joaquin County	21,592	2,549
San Luis Obispo County	21,899	2,369
San Mateo County	17,393	2,289

** 'Vehicle Miles Traveled,' excluding heavy duty truck travel.*
*** Vehicle Trips include: automobile, pickup, RV, van and motorcycle trips.*

Source: Air Resources Board's
"BURDEN" EMFAC 7F 1.1 and
1990 US Census (persons/HH)

1990 Baseline Average Vehicle Travel in California Counties

CALIFORNIA COUNTIES	Average VMT per Household per YEAR *	Average Vehicle TRIPS** per Household/YEAR
Santa Barbara County	19,340	2,367
Santa Clara County	17,114	2,631
Santa Cruz County	18,158	2,859
Shasta County	22,077	3,579
Sierra County	53,098	3,228
Sonoma County	12,616	2,064
Stanislaus County	19,121	2,696
Sutter County	19,999	3,272
Tehama County	32,572	3,734
Trinity County	21,077	2,936
Tulare County	21,034	2,613
Tuolumne County	21,283	2,900
Ventura County	21,711	3,037
Yolo County	20,070	3,113
Yuba County	20,547	3,360

** 'Vehicle Miles Traveled,' excluding heavy duty truck travel.*
*** Vehicle Trips include: automobile, pickup, RV, van and motorcycle trips.*

Source: Air Resources Board's "BURDEN" EMFAC 7F 1.1 and 1990 US Census (persons/HH)

Terry Parker, ARB staff
February, 1995

APPENDIX G

Mode of Travel by Region

Appendix G
MODE OF TRAVEL BY REGION

Region	Mode Share of Person Trips	
	Auto Driver[1]	Other[2]
AMBAG (Monterey and Santa Cruz Counties)	69.3%	30.7%
Butte	70.6%	29.4%
Fresno	69.7%	30.3%
Kern	71.7%	28.3%
Merced	68.9%	31.1%
MTC (San Francisco Bay Area)	65.8%	34.2%
SACOG (Sacramento Region	73.0%	27.0%
San Diego	67.4%	32.6%
San Joaquin	72.9%	27.1%
San Luis Obispo	68.1%	31.9%
Santa Barbara	70.2%	29.8%
SCAG (Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties)	69.3%	30.7%
Shasta	72.3%	27.7%
Stanislaus	67.6%	32.4%
Tulare	67.6%	32.4%
Rural (All Other Counties)	69.5%	30.5%

(31009\B\APPDX-G.DF)

Source: California Department of Transportation, *1991 Statewide Travel Survey: Summary of Findings*, November 1992.

Notes:

1. Auto Drivers include single occupant vehicles and drivers of carpools and vanpools.
2. Other includes all non-motorized forms of transportation, transit riders and passengers of car/vanpools.

APPENDIX H

Calculation of Emission Performance Goals

Emission Factors for Average Fleet
Light & Medium Vehicles & Motorcycles

Year 1995	ROG	NOx	CO
Trip End Factor	3.84	2.34	60.13
VMT Factor	0.79	0.85	6.20

Year 1996	ROG	NOx	CO
Trip End Factor	3.26	1.92	64.70
VMT Factor	0.59	0.73	4.57

Year 1997	ROG	NOx	CO
Trip End Factor	3.10	1.88	60.15
VMT Factor	0.56	0.69	4.19

Year 1998	ROG	NOx	CO
Trip End Factor	2.91	1.83	55.54
VMT Factor	0.52	0.66	3.85

Year 1999	ROG	NOx	CO
Trip End Factor	2.70	1.77	50.87
VMT Factor	0.49	0.63	3.55

Year 2000	ROG	NOx	CO
Trip End Factor	2.47	1.69	46.17
VMT Factor	0.46	0.59	3.28

Documentation of emission factors:

These factors are statewide fleet averages for light duty vehicles, medium duty vehicles, and motorcycles based on EMFAC7F1.1. Summer inventories were used for ROG and NOx. Winter inventories were used for CO. Trip end factors represent cold starts plus hot starts plus soaks--all divided by total trips. VMT factors represent running exhaust/VMT plus running losses/VMT

Average Annual Vehicle Emissions per Household by Performance Goal

PERFORMANCE GOAL:		Emissions per HH per Year*	
		Emission Factors	*Less than:*
URBAN LEVEL 1	**Vehicle Trips**	*ROG g/trip:*	**pounds/yr:**
	less than:	*3.84*	**13.5**
	1,600	*NOx g/trip:*	
	Average yearly	*2.34*	**8.2**
	VTs per HH	*CO g/trip:*	
		60.13	**211.7**
	VMT	*Emission Factors*	*Less than:*
	less than:	*ROG g/mile:*	**pounds/yr:**
	10,000	*0.79*	**17.4**
	Average yearly	*NOx g/mile:*	
	VMT/year/HH	*0.85*	**18.7**
		CO g/mile:	
		6.20	**136.4**

Urban Level 1:

Annual/HH Emissions from VT & VMT (lbs.):		
ROG:	<	31
NOX:	<	27
CO:	<	348

PERFORMANCE GOAL:		*Emission Factors*	Emissons per HH per Year:	
	Vehicle Trips		*From:*	*To:*
URBAN LEVEL 2	*from:*	*ROG g/trip:*	**pounds/yr:**	**pounds/yr:**
	1,600	*3.84*	**13.5**	**17.7**
	to:	*NOx g/trip:*		
	2,100	*2.34*	**8.2**	**10.8**
	Average yearly	*CO g/trip:*		
	VTs per HH	*60.13*	**211.7**	**277.8**
	VMT	*Emission Factors*	*From:*	*To:*
	from:	*ROG g/mile:*	**pounds/yr:**	**pounds/yr:**
	10,000	*0.79*	**17.4**	**22.6**
	to:	*NOx g/mile:*		
	13,000	*0.85*	**18.7**	**24.3**
	Average yearly	*CO g/mile:*		
	VMT/year/HH	*6.20*	**136.4**	**177.3**

Urban Level 2:

Annual/HH Emissions from VT & VMT (lbs.):		
	from:	*to:*
ROG:	31	40
NOX:	27	35
CO:	348	455

PERFORMANCE GOAL:		*Emission Factors*	Emissons per HH per Year:	
	Vehicle Trips		*From:*	*To:*
URBAN LEVEL 3	*from:*	*ROG g/trip:*	**pounds/yr:**	**pounds/yr:**
	2,101	*3.84*	**17.7**	**22.0**
	to:	*NOx g/trip:*		
	2,600	*2.34*	**10.8**	**13.4**
	Average yearly	*CO g/trip:*		
	VTs per HH	*60.13*	**277.9**	**343.9**
	VMT	*Emission Factors*	*From:*	*To:*
	from:	*ROG g/mile:*	**pounds/yr:**	**pounds/yr:**
	13,001	*0.79*	**22.6**	**27.8**
	to:	*NOx g/mile:*		
	16,000	*0.85*	**24.3**	**29.9**
	Average yearly	*CO g/mile:*		
	VMT/year/HH	*6.20*	**177.3**	**218.2**

Urban Level 3:

Annual/HH Emissions from VT & VMT (lbs.):		
	from:	*to:*
ROG:	40	50
NOX:	35	43
CO:	455	562

Source of Emission Factors: ARB EMFAC7F1.1 and BURDEN 7F (see end notes)

Average Annual Vehicle Emissions per Household by Performance Goal

PERFORMANCE GOAL:		Emissions per HH per Year*	
	Vehicle Trips	*Emission Factors*	*Less than:* **pounds/yr:**
SUBURBAN LEVEL 1	*less than:* **3,200**	*ROG g/trip:* *3.84*	**27.0**
	Average yearly VTs per HH	*NOx g/trip:* *2.34*	**16.5**
		CO g/trip: *60.13*	**423.3**
	VMT	*Emission Factors*	*Less than:* **pounds/yr:**
	less than: **20,000**	*ROG g/mile:* *0.79*	**34.8**
	Average yearly VMT/year/HH	*NOx g/mile:* *0.85*	**37.4**
		CO g/mile: *6.20*	**272.8**

Suburban Level 1:

Annual/HH Emissions from VT & VMT (lbs.):		
ROG:	<	62
NOX:	<	54
CO:	<	696

PERFORMANCE GOAL:		*Emission Factors*	Emissons per HH per Year:	
	Vehicle Trips		*From:* **pounds/yr:**	*To:* **pounds/yr:**
SUBURBAN LEVEL 2	*from:* **3,200**	*ROG g/trip:* *3.84*	**27.0**	**29.6**
	to: **3,500**	*NOx g/trip:* *2.34*	**16.5**	**18.0**
	Average yearly VTs per HH	*CO g/trip:* *60.13*	**423.3**	**463.0**
	VMT	*Emission Factors*	*From:* **pounds/yr:**	*To:* **pounds/yr:**
	from: **20,000**	*ROG g/mile:* *0.79*	**34.8**	**38.2**
	to: **22,000**	*NOx g/mile:* *0.85*	**37.4**	**41.1**
	Average yearly VMT/year/HH	*CO g/mile:* *6.20*	**272.8**	**300.1**

Suburban Level 2:

Annual/HH Emissions from VT & VMT (lbs.):	*from:*	*to:*
ROG:	62	68
NOX:	54	59
CO:	696	763

PERFORMANCE GOAL:		*Emission Factors*	Emissons per HH per Year:	
	Vehicle Trips		*From:* **pounds/yr:**	*To:* **pounds/yr:**
SUBURBAN LEVEL 3	*from:* **3,501**	*ROG g/trip:* *3.84*	**29.6**	**33.8**
	to: **4,000**	*NOx g/trip:* *2.34*	**18.0**	**20.6**
	Average yearly VTs per HH	*CO g/trip:* *60.13*	**463.1**	**529.1**
	VMT	*Emission Factors*	*From:* **pounds/yr:**	*To:* **pounds/yr:**
	from: **22,001**	*ROG g/mile:* *0.79*	**38.2**	**43.5**
	to: **25,000**	*NOx g/mile:* *0.85*	**41.1**	**46.8**
	Average yearly VMT/year/HH	*CO g/mile:* *6.20*	**300.1**	**341.0**

Suburban Level 3:

Annual/HH Emissions from VT & VMT (lbs.):	*from:*	*to:*
ROG:	68	77
NOX:	59	67
CO:	763	870

Source of Emission Factors: ARB EMFAC7F1.1 and BURDEN 7F (see end notes)

Average Annual Vehicle Emissions per Household by Performance Goal

PERFORMANCE GOAL:		Emissions per HH per Year*	
	Vehicle Trips	*Emission Factors*	*Less than:*
EX-URBAN LEVEL 1	*less than:*	*ROG g/trip:*	**pounds/yr:**
	4,500	*3.84*	**38.0**
	Average yearly	*NOx g/trip:*	
	VTs per HH	*2.34*	**23.2**
		CO g/trip:	
		60.13	**595.3**
	VMT	*Emission Factors*	*Less than:*
	less than:	*ROG g/mile:*	**pounds/yr:**
	28,000	*0.79*	**48.7**
	Average yearly	*NOx g/mile:*	
	VMT/year/HH	*0.85*	**52.4**
		CO g/mile:	
		6.20	**381.9**

Ex-urban Level 1:

Annual/HH Emissions from VT & VMT (lbs.):		
ROG	<	87
NOX	<	76
CO	<	977

PERFORMANCE GOAL:		*Emission Factors*	**Emissons per HH per Year:**	
	Vehicle Trips		*From:*	*To:*
EX-URBAN LEVEL 2	*from:*	*ROG g/trip:*	**pounds/yr:**	**pounds/yr:**
	4,500	*3.84*	**38.0**	**40.6**
	to:	*NOx g/trip:*		
	4,800	*2.34*	**23.2**	**24.7**
	Average yearly	*CO g/trip:*		
	VTs per HH	*60.13*	**595.3**	**635.0**
	VMT	*Emission Factors*	*From:*	*To:*
	from:	*ROG g/mile:*	**pounds/yr:**	**pounds/yr:**
	28,000	*0.79*	**48.7**	**52.1**
	to:	*NOx g/mile:*		
	30,000	*0.85*	**52.4**	**56.1**
	Average yearly	*CO g/mile:*		
	VMT/year/HH	*6.20*	**381.9**	**409.2**

Ex-urban Level 2:

Annual/HH Emissions from VT & VMT (lbs.):	*from:*	*to:*
ROG	87	93
NOX	76	81
CO	977	1044

**** Average vehicle emissions per Household per Year.***

Terms Used:
('VMT' is Vehicle Miles of Travel; 'VT' is Vehicle Trip; HH is 'Household'; 'ROG' is reactive organic gases; 'NOx' is oxides of nitrogen; 'CO' is carbon monoxide.)

Source of emission factors:
ARB's EMFAC7F1.1 and BURDEN 7F, statewide fleet averages for light and medium duty vehicles and motorcycles for 1995.
Summer inventories were used for ROG and NOx; and Winter inventories for CO.
"Trip end" factors represent average cold starts plus hot starts plus hot soaks.
"VMT" factors represent average running exhaust plus running losses.

By ARB Staff (Terry Parker & Pamela Burmich, Transportation Strategies Group)

APPENDIX I

Monitoring Guidelines for Travel Data

APPENDIX I
Monitoring Guidelines for Travel Data

In this appendix, a methodology is presented for monitoring the effectiveness of the land use and transportation strategies in achieving the performance goals. Emissions benefits are difficult to monitor for each individual strategy; therefore, this methodology proposes methods for tracking changes in travel characteristics, including those stated in the performance goals.

A tool that can be helpful in monitoring the implementation of land use and transportation strategies is a geographic information system (GIS). With a GIS, a local jurisdiction can readily enter and track information such as density of development, type of development, and availability of transportation facilities (e.g., transit routes, rail stations, pedestrian crossings). The type of data and level of detail can be customized for each jurisdiction. Some of the data may already be in the GIS for other purposes. A GIS may also be helpful in planning and evaluating future development potential for transit stations and corridors.

Various data collection methods appropriate for use in monitoring are presented below. Included is information regarding the types of data that can be collected, any issues that should be considered when using these methods, and how to administer the method. A summary of the types of data that are collected for each of the methods described below is provided in Table H-1. This information should be used to help the implementing agencies decide which data collection methods are most appropriate and what factors to take into account when implementing them. The design of the data collection methodology would be specific to each jurisdiction.

Home Interview Surveys

Data on all types of trips, not just commute trips, may be obtained through home interview surveys. Home interview surveys, however, are costly to administer and are usually only conducted every five to ten years to support the development of a travel forecasting model for an area. Data collected might include:

- number of trips, by time of day and by trip purpose;
- mode of travel, by trip purpose;
- average trip length, by trip purpose;
- number of people in a vehicle (for automobile travel); and
- factors that affect mode choice decisions.

Because conducting a survey is costly, the questionnaires are typically very long to obtain as much information as possible. It is therefore very important to ensure that the questionnaire includes all necessary questions without being too extensive.

It is likely that a local jurisdiction would use home interview survey data, also referred to as travel survey data, to establish baseline conditions for the application of the performance goals. These data may be available from the metropolitan planning organization (MPO) for the region or a county transportation agency that has conducted a home interview survey in support of the development of a travel forecasting model. The data obtained will probably be expressed as daily values, and the performance goals are provided as annual values. The methodology for performing this conversion is described in Appendix A.

Table I-1
TYPE OF DATA COLLECTED BY INDIVIDUAL METHODS

Data Collection Methods	Number of Vehicle Trips			Average Trip Length			Total VMT	Avg. Speeds	Avg. Vehicle Occu-pancy	Mode of Travel
	Commute	Non-Commute	Total	Commute	Non-Commute	Total				
Home Interview Survey	X	X	X	X	X	X			X	X
On-Board Surveys									X	X
Windshield Surveys	X	X	X	X	X	X			X	X
License Plate Surveys[1]			X							
Origin/ Destination Survey	X	X	X							
Traffic Counts on Major Facilities			X				X[2]			
Transit Ridership Counts										X
Cordon Traffic Counts			X							
Highway Vehicle/ Passenger Counts			X						X	
Traffic Speeds on Major Facilities								X		
Odometer Checks							X			

Notes: 1. License plate surveys can also be used to identify through trips
2. Change in total VMT obtained by combining traffic counts with modeling techniques

On-Board Surveys

Surveys conducted on-board transit vehicles are useful to determine the travel characteristics of transit users, such as trip type, frequency of transit use, and mode used to access transit. In particular, the transit user can be asked if they previously used another mode of travel to determine the extent to which the land use and transportation strategies have affected transit ridership. In addition, information on distances walked from the transit stop to a destination can be collected and used to verify assumptions regarding an individual's willingness to walk. On-board surveys should be administered in conjunction with the appropriate transit agency, which may have an ongoing survey process.

Windshield Surveys

For vehicles parked within a given area, surveys placed on the windshield of the vehicles can be used to obtain site-specific information on automobile users. For example, those who park in areas that can be accessed by transit may be asked questions such as what distance they drove to the area, why they did not use transit, and whether they were able to combine a number of trips by traveling to that destination. Depending on the area targeted, efforts may be coordinated with local agencies, and permission may be needed to place items on car windshields. Some localities may prefer to use a method other than a windshield survey because of the potential litter problem.

License Plate Surveys

The movement of vehicles through an area can be identified by noting the time of day and license plate numbers of passing vehicles at key locations. The data at various locations can then be compared to determine what percentage of the total trips are regional or longer distance trips. These surveys can also be used to identify through movements, which are less likely to be impacted by land use and transportation strategies. Caltrans and many regional agencies conduct license plate surveys, and any similar efforts should be coordinated with these agencies.

Origin/Destination Surveys

Origin/destination surveys performed at a specific facility, such as a development near a transit station, identify the origins and destinations for trips currently being made. One method of administering this type of survey is to videotape license plates of the vehicles as they pass through the facility, obtaining the home addresses of owners of each vehicle from the Department of Motor Vehicles, and mailing the owners a questionnaire. For origin/destination information that is not site specific, home interview surveys should be used. Origin/destination surveys are fairly expensive to administer, and efforts should be coordinated with similar efforts being undertaken by other agencies, such as MPOs and regional transportation agencies.

Annual Non-Survey Data Collection Methods

There are a number of types of data, other than surveys, that can be collected on an annual basis to support monitoring. These are briefly described in this section. Data collection should occur at roughly the same time each year to avoid seasonal variation and should take place on a representative weekday. This will ensure consistency in the data and make the comparison to the baseline straightforward. The time of year chosen should be similar to the time of year when the data used to estimate the baseline values were collected. All counts should be made over an entire day to include both the peak and off-peak periods. A local jurisdiction should probably not try to perform all of these data collection efforts, only those needed to monitor the performance goals, given what data collection efforts may already be ongoing. In particular, data may already be available from MPOs, Caltrans, county transportation departments, or other agencies involved in transportation in the region.

Traffic Counts on Major Facilities

Traffic counts provide data on the number of vehicle trips on a given facility by time of day. In addition, traffic count data can be used in conjunction with modeling or survey estimates of trip length by area to determine vehicle miles traveled (VMT) by time period (peak and off-peak). Traffic counts do not differentiate between commute and non-commute trips. Caltrans, MPOs, counties, and cities may already collect these data.

Transit Ridership Counts

The land use and transportation strategies are intended to encourage a shift in travel mode away from drive-alone vehicles. The extent to which drive-alone trips are shifted to transit can be captured through transit ridership counts. These counts are generally conducted by transit agencies, and may be coordinated with other data collection efforts that the agencies are performing. The counts should be conducted on as many transit vehicles as possible at various times of the day.

Cordon Traffic Counts

If the strategies only affect certain areas, such as a central business district, then cordon traffic counts can be useful to determine the total number of trips into and out of the area by time of day. As with traffic counts on major facilities, cordon counts do not differentiate commute and non-commute trips. Cordon traffic counts are performed by first defining the analysis area, then identifying all access points into and out of the area. Traffic counts are made at the boundary of the area at each of these access points and summed to obtain the total traffic count into and out of the area. Government agencies such as a city, an MPO, or Caltrans may also be performing cordon traffic counts for separate studies.

Highway Vehicle/Passenger Counts

Highway vehicle/passenger counts can be very useful in verifying the average vehicle occupancy reported in home interview surveys and in providing information describing the number of vehicle trips on the highway by time of day. The counts should be made at the same locations on the various highways to ensure consistency from year to year. Coordination should occur with local governments and with Caltrans to determine whether any of these agencies are already performing highway vehicle/passenger counts.

Traffic Speeds on Major Facilities

An additional piece of data that may be of interest to monitor is average traffic speeds. Traffic speed data are collected by driving along various roadways during both the peak and off-peak periods and documenting average travel speed. These average travel speeds include wait times at traffic signals and freeway merges. Regional transportation agencies generally collect this information.

Odometer Checks

Total VMT for vehicles in the air basin can be obtained through annual or biennial vehicle odometer checks, which may be coordinated with smog inspections. A limitation of odometer checks is that they do not reveal the portion of a vehicle's total VMT that occurred in the air basin, when the VMT occurred, or whether the trip was a commute or non-commute trip.

(310099#8/APPDX-I.FIN)

APPENDIX J

Method of Setting Densities and Mix of Uses

APPENDIX J
Method of Setting Densities and Mix of Uses

This appendix, prepared by Brady and Associates, describes how the commercial and residential densities and mixed use percentages recommended in Chapter 6 were derived.

1. **Commercial Densities.** To set the commercial densities, Brady and Associates relied on data regarding both floor area ratios (FARs) and employees per 1,000 square feet of building available from sources in the literature. Table J-1 shows the sources used for FARs.

Table J-2 shows employees per square foot of building as calculated by SANDAG and Holtzclaw. As shown in this table, this background data was used to derive an average numbers of employees per 1,000 square feet of building of 3.8.

As shown in Table J-3, the FARs in Table J-1 were applied as a continuum to the eight types of community studied in this report, and were then multiplied by the average employment density of 3.8 employees per 1,000 square feet of building. This resulted in minimum employment densities per net acre, which are also shown in Table J-3.

2. **Residential Densities.** Residential densities were set for corridors and infill as a relationship to densities near stations. In doing this, we considered three sets of background information, which are summarized as a continuum in Table J-4. The data sets used were:

- John Holtzclaw's data on densities in various types of communities.
- Pushkarev and Zupan's study of what densities support what kinds of transit.
- Peter Calthorpe's book (with Shelley Poticha), which recommends residential densities for "urban" and "neighborhood" transit-oriented development, and illustrates various densities.

In addition, we considered the types of housing that can be built at various densities, which are illustrated in Table J-5. Sources for these drawings and densities included Warkentin and Van Meter/Williams/Pollack. A copy of a memo from William Warkentin, prepared for the Building Industry Association, is enclosed at the end of this Appendix. It indicates the types of housing units that can be built at various densities. For each type of community (urban, suburban, exurban; levels 1, 2 and 3) the consultant team considered which types of housing shown in Table J-5 would be appropriate.

The resulting recommended density specifications and the rationale for them are shown in Table J-6.

3. **Mix of Uses.** Brady and Associates developed target mixes based on the following three issues:

Existing Mixes in Urban, Suburban and Exurban Areas. Because rents are higher in regional business centers, there are essentially no residential uses in these centers. High-rise office buildings command these districts. As one moves toward the suburbs, one finds a higher proportion of residential uses. In exurban areas, residential and rural uses dominate; primarily local retail and services are provided in small towns. Brady and Associates developed a continuum of ratios of business and residential uses based on this relationship.

Agglomeration Benefits for Like Uses. Similar uses benefit from being close together. They draw the same customers, and they do business with each other. When Brady and Associates prepared a land use study for areas near transit stations in North Sacramento, we found that the station areas fell into four types: office center, retail/cultural center, residential area, and in-between areas with a mix of residential and commercial uses. We recommended strengthening the existing character of each type of area.

Transit-Oriented Development Mixes. Calthorpe and Poticha recommend 10 to 15 percent public uses in neighborhood TODs and 5 to 15 percent public uses in urban TODs. We used these ranges to set the proportion of public space in the target mixes of uses. We recommended the lower end of their range of public uses in Urban 1 office centers, slightly more in retail/cultural centers because these centers often include civic facilities, and their neighborhood range for residential areas where the main public use is schools. Calthorpe and Poticha's recommendations are for new communities; therefore, the mixes have a higher residential component than rents in urban office centers would allow. We use their proportion of housing for Suburban 3 commercial centers, residential areas and neighborhood centers.

Calthorpe and Poticha's mixes for Transit-Oriented Developments are shown in Table J-7. The target mixes are shown in Table J-8; they total 100 percent. The recommended minimums that might be needed to achieve these targets (which form the input to Chapter 6) are shown in Table J-9. These minimums total 50 to 60 percent, leaving 40 to 50 percent which could be assigned to any use within the mix.

References

Calthorpe, Peter with Shelley Poticha, *The Next American Metropolis: Ecology, Community and the American Dream*, New York: Princeton Architectural Press, 1993.

City and County of San Francisco, *Planning Code.*

Los Angeles County Metropolitan Transportation Authority, *Congestion Management Program for Los Angeles County*, 1993.

Pushkarev, Boris S. and Jeffrey M. Zupan, "Where Transit Works: Urban Densities for Public Transportation," in *Urban Transportation: Perspectives and Prospects*, 1982.

San Diego Association of Governments, *Traffic Generators*, 1990.

Snohomish County Transportation Authority, *Creating Transportation Choices Through Zoning: A Guide for Snohomish County Communities*, 1994.

Von Meter/Williams/Pollack, Untitled, No Date. Examples of Residential Densities.

Warkentin, William. Memorandum to Deborah Dagang, JHK & Associates, regarding residential densities, March 9, 1995.

(3100998/APPDX-J.DF)

Table J-1
BACKGROUND INFORMATION FOR FLOOR AREA RATIOS[a]

INFORMATION TYPE	SOURCE	NEAR RAIL STATIONS	NEAR TRANSIT CORRIDORS - URBAN AND SUBURBAN LEVEL 1	NEAR TRANSIT CORRIDORS - SUBURBAN LEVEL 2-3 AND EXURBAN
CALCULATIONS	FAR Calculation based on Zupan[b] and SANDAG	1.8	1.1	0.7
	Mix of uses assumed	Offices, restaurants, shopping, banks, theaters and hotels/motels	Same as station areas, but more retail, less office and hotel/motel	Same as urban corridors, but more retail, less office and hotel/motel
REFERENCES[c]	Los Angeles County Congestion Management Program FAR	2.0	2.0	--
	Snohomish County Guide FAR	--	--	Commercial Neighborhood: 1.00 Office/Industrial: 1.25
	Snohomish County Guide Employees Per Acre	75	--	50
	San Francisco Zoning Code FAR[d]	3.6	2.3	--

[a] Ratio of building area per gross acre.

[b] Based on Pushkarev and Zupan's article on square feet of building in a square-mile downtown required to support given transit modes, adjusting required FAR to compensate for lower employment densities in corridors, using SanDAG report on employees per square foot.

[c] Los Angeles County includes urban and suburban areas. Snohomish County includes urban, suburban and exurban areas, but it is largely suburban and exurban. San Francisco is an urban area.

[d] Corridor FAR from residential zones; Station FAR from C-1 and C-2 zones.

-- Not shown in the document.

Table J-2

BACKGROUND INFORMATION FOR EMPLOYEES PER 1,000 SF OF BUILDING

	SANDAG		HOLTZCLAW				
	LAND USE	WORKERS/ 1,000 SF	LAND USE	WORKERS/ NET ACRE	WORKERS/ 1,000 SF IF FAR=1	MID-POINT	ASSUMPTION USED
Land Use	Hotel	1.11					1
	Motel	1.08					
	Movie Theater	1.47					2
	Bank	3.15					3
Office	Corporate Office	3.40	Insurance, Travel, etc.	150 — 500	3.5 — 11.5	7.5	4
	Business Park	4.01					
	Office Bldg <100,000 SF	4.38					
	Office Bldg >100,000 SF	4.53					
Retail	Community Shopping Center	1.70	Community Markets	100 — 300	2.3 — 6.9	4.6	4
	Neighborhood Shopping Center	2.61	Neighborhood Retail	150 — 500	3.5 — 11.5	7.5	
Restaurant			Restaurant	100 — 200	2.3 — 4.6	3.5	4
Average							3.8

Source: San Diego Association of Governments, Traffic Generators, 1990.
John Holtzclaw, Conversation, January 1995.

Table J-3
EMPLOYMENT DENSITY CALCULATIONS

		URBAN 1	URBAN 2	URBAN 3	SUBURBAN 1	SUBURBAN 2	SUBURBAN 3	EXURBAN 1	EXURBAN 2
Average employees per 1,000 square feet of building		3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Within ¼ Mile of Major Transit Stations	Floor Area Ratio	2.2	2.1	2.0	1.8	1.6	1.4	1.2	1.0
	Average employees per 1,000 square feet of land on lot	8.4	8.0	7.6	6.8	6.0	5.3	4.6	3.8
	Average employees per net acre	364	348	331	298	265	232	199	166
	Minimum Employment Density Specification	360	340	330	290	260	230	190	160
Within ¼ Mile of Major Transit Corridors	Floor Area Ratio	2.0	1.9	1.8	1.6	1.4	1.2	1.0	0.8
	Average employees per 1,000 square feet of land on lot	7.6	7.2	6.8	6.0	5.3	4.6	3.8	3.0
	Average employees per net acre	331	315	298	265	232	199	166	131
	Minimum Employment Density Specification	330	310	290	260	230	190	160	130
Infill	Floor Area Ratio	1.8	1.7	1.6	1.4	1.2	1.0	0.8	0.6
	Average employees per 1,000 square feet of land on lot	6.8	6.4	6.0	5.3	4.6	3.8	3.0	2.3
	Average employees per net acre	298	282	265	232	199	166	131	100
	Minimum Employment Density Specification	290	280	260	230	190	160	130	90

Table J-4
RESIDENTIAL DENSITY CONTINUUM

HOLTZCLAW DENSITIES			PUSHKAREV AND ZUPAN		CALTHORPE AND POTICHA		SPECIFIED DENSITIES (TABLE 7)		
Region	Community	DU/Net Res. Acre	DU/Res Acre*	Transit Service	Neighbor-hood TOD DU/Res. Acre*	Urban TOD DU/Res. Acre*	Station DU/Net Res. Acre	Corridor DU/Net Res. Acre	Infill DU/Net Res. Acre
San Francisco	Central San Francisco	101					70 (U,S1)		
San Francisco	All of San Francisco	48					50 (U2)	50 (U1)	
							40 (U3)		
Los Angeles	South Long Beach	25.5					30 (S1)	32 (U2)	32 (U1)
Sacramento	Central Sacramento	22					20 (S2,3)	22 (U3,S1)	22 (U2)
							18 (E1)		18 (U3)
San Francisco	Central Berkeley	16.4						16 (S2,3)	16 (S1)
Los Angeles	South Santa Monica	15.9							
San Francisco	Daly City	15.5	15	Frequent Bus (every 10 minutes, 20 hours/day - 120 buses/day, ½ mile spacing over area)		Min. Average 15			
Los Angeles	Southwest Beverly Hills	14.3							
San Diego	Uptown San Diego	13.1							
San Francisco	Alameda	12.8	12	Rapid Transit (heavy rail)		Min. Project 12	12 (E2)		12 (S2)
Los Angeles	South Central Pasadena	11.0							
San Francisco	Rockridge	10.1			Min. Average 10			10 (E1,2)	10 (S3)
Los Angeles	Alhambra	9.1	9	Light Rail (street car, radial corridors)					
Sacramento	East Sacramento/N. Land Point	8.0							8 (E1)
Los Angeles	Central Downey	7.2							
Sacramento	South Sacramento	7.0	7	Intermed. Bus (½ hourly, 20 hours/day, 40 buses/day)	Min. Project 7				7 (E2)
San Diego	Clairemont	6.6							
Los Angeles	North Riverside	5.5							
San Francisco	Walnut Creek	4.9							
San Diego	La Costa	4.3	4	Minimal Bus (½ hourly, 10 hours/day or hourly, 20 buses/day)					
San Diego	Escondido	3.8							
Los Angeles	Moreno Valley	3.7							
San Francisco	San Ramon	3.4							
San Diego	Bos.Cr.Fl. Sp-Bv	2.8							
San Francisco	Morgan Hill	2.4							
San Francisco	Lafayette	2.3	2	Commuter Rail on Existing Track					
San Francisco	Los Altos	1.9							

U = Urban, S = Suburban, E = Exurban.
* These authors do not distinguish between net and gross acres in their works.

Table J-5
Character of Residential Density

5 - 7 units acre* - standard single-family

8 - 12 units/acre* - small-lot single-family

12 - 18 units/acre* - 2-story townhouses

12 - 20 units per acre* - single-family with second units

15 - 23 units/acre* - 2-story flats

15 - 23 units/acre* - 3-story townhouses on parking

30 - 70 units/acre* - 3 to 4-story flats on parking

* Dwelling units per net residential acre: housing units per acre of land in residential use, not including streets and sidewalks.

Table J-6
MINIMUM RESIDENTIAL DENSITY SPECIFICATIONS
(Dwelling Units Per Net Residential Acre)

	WITHIN ¼-MILE OF TRANSIT HIGH-VOLUME STATION	WITHIN ¼-MILE OF MAJOR TRANSIT CORRIDOR	INFILL DEVELOPMENT PROJECTS
Urban 1	70[a]	50[b]	32[c]
Urban 2	50[b]	32[c]	22[d]
Urban 3	40[b]	22[d]	18[f]
Suburban 1	30[c]	22[d]	16[f]
Suburban 2	20[e]	16[f]	12[g]
Suburban 3	20[e]	16[f]	10[h]
Exurban 1	18[f]	10[h]	8[i]
Exurban 2	12[g]	10[h]	7[j]

[a] Between Holtzclaw density of Central San Francisco and all of San Francisco. Four-story flats over parking.

[b] Similar to Holtzclaw density of for all of San Francisco. Three-story flats over parking.

[c] Between Holtzclaw density of South Long Beach and San Francisco. Three-story flats over parking.

[d] Holtzclaw density of Central Sacramento. Three-story townhouses over parking.

[e] Similar to Holtzclaw density of Central Sacramento. Single-family with second units, townhouses or two-story flats.

[f] Holtzclaw density in Central Berkeley and South Santa Monica, 1 more than Pushkarev and Zupan frequent bus service, 1 more than Calthorpe and Poticha minimum average density for urban transit-oriented development. Single-family with second units, townhouses or two-story flats.

[g] Holtzclaw density for uptown San Diego and Alameda, Pushkarev and Zupan density for rapid transit, Calthorpe and Poticha minimum project density for urban transit-oriented development. Single-family with second units or townhouses.

[h] Holtzclaw density for Rockridge and South-Central Pasadena, 1 more than Pushkarev and Zupan density for light rail, Calthorpe and Poticha minimum average density for neighborhood transit-oriented development. Small-lot single-family.

[i] Holtzclaw density for East Sacramento and Alhambra, 1 more than Pushkarev and Zupan density for intermediate bus service. Small-lot single-family.

[j] Holtzclaw density for South Sacramento and Clairemont, Pushkarev and Zupan density for intermediate bus service. Calthorpe and Poticha minimum project density for urban transit-oriented development. High end of density for standard single-family.

Table J-7
MIX OF USES FROM CALTHORPE AND POTICHA

USE	NEIGHBORHOOD TOD	URBAN TOD
Core/Employment	10-40%	30-70%
Housing	50-80%	20-60%
Public	10-15%	5-15%

Table J-8
TARGET MIX OF USES

SCENARIO	OFFICE CENTER		RETAIL/CULTURE CENTER		RESIDENTIAL AREA		NEIGHBORHOOD CENTER	
URBAN 1	Office	85	Retail	75	Residential	60	Residential	35
	Retail	10	Office	10	Retail	10	Retail	30
	Public	5	Public	10	Public	10	Public	15
	Residential	0	Residential	5	Office	10	Office	20
URBAN 2	Office	80	Retail	70	Residential	70	Residential	45
	Retail	10	Office	10	Retail	10	Retail	30
	Public	5	Public	10	Public	10	Public	15
	Residential	5	Residential	10	Office	10	Office	10
URBAN 3	Office	65	Retail	70	Residential	70	Residential	45
	Retail	20	Office	10	Retail	10	Retail	30
	Public	5	Public	10	Public	10	Public	15
	Residential	10	Residential	10	Office	10	Office	10
SUBURBAN 1	Office	70	Retail	65	Residential	70	Residential	45
	Retail	10	Office	10	Retail	10	Retail	25
	Public	10	Public	15	Public	10	Public	15
	Residential	10	Residential	10	Office	10	Office	15
SUBURBAN 2	Office	60	Retail	65	Residential	80	Residential	55
	Retail	20	Office	10	Retail	10	Retail	20
	Public	10	Public	15	Public	10	Public	15
	Residential	10	Residential	10	Office	0	Office	10
SUBURBAN 3	Office	30	Retail	55	Residential	80	Residential	60
	Retail	30	Office	10	Retail	10	Retail	15
	Public	10	Public	15	Public	10	Public	10
	Residential	20	Residential	20	Office	0	Office	5
EXURBAN 1					Residential	80	Residential	60
					Retail/Office	10	Retail	20
					Public	10	Public	10
					Agriculture	0	Office	10
EXURBAN 2					Residential	80	Residential	70
					Retail/Office	0	Retail	15
					Public	10	Public	10
					Agriculture	10	Office	5

Table J-9
MIXED USE MINIMUMS

SCENARIO	IN OR NEXT TO AN OFFICE CENTER		IN OR NEXT TO A RETAIL/CULTURE CENTER		IN OR NEXT TO A RESIDENTIAL AREA		IN OR NEXT TO A NEIGHBORHOOD CENTER	
URBAN 1	Office	45	Ret, Enter, Hotel	30	Residential	30	Residential	20
	Retail	10	Office	10	Retail	10	Retail	15
	Public	5	Public	10	Public	10	Public	15
	Residential	0	Residential	5	Office	5	Office	10
URBAN 2	Office	40	Ret, Enter, Hotel	25	Residential	35	Residential	20
	Retail	10	Office	10	Retail	10	Retail	15
	Public	5	Public	10	Public	10	Public	15
	Residential	5	Residential	10	Office	5	Office	10
URBAN 3	Office	35	Ret, Enter, Hotel	25	Residential	40	Residential	30
	Retail	10	Office	10	Retail/Office	10	Retail/Office	15
	Public	5	Public	10	Public	10	Public	15
	Residential	10	Residential	10				
SUBURBAN 1	Office	30	Ret, Enter, Hotel	20	Residential	40	Residential	30
	Retail	10	Office	10	Retail/Office	10	Retail/Office	15
	Public	10	Public	15	Public	10	Public	15
	Residential	10	Residential	10				
SUBURBAN 2	Office	25	Ret, Enter, Hotel	20	Residential	40	Residential	30
	Retail	10	Office	10	Retail/Office	10	Retail/Office	10
	Public	10	Public	15	Public	10	Public	15
	Residential	10	Residential	10				
SUBURBAN 3	Office	20	Ret, Enter, Hotel	10	Residential	40	Residential	30
	Retail	10	Office	10	Retail/Office	10	Retail/Office	10
	Public	10	Public	15	Public	10	Public	10
	Residential	15	Residential	20				
EXURBAN 1					Residential	40	Residential	30
					Retail/Office	10	Retail/Office	10
					Public	10	Public	10
EXURBAN 2					Residential	50	Residential	30
					Public	10	Retail/Office	10
							Public	10

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MEMORANDUM

DATE: 3/9/95
MEMO TO: **JHK & ASSOCIATES**
ATTN: DEBORAH DAGANG
2000 POWELL ST., SUITE 1090
EMERYVILLE , CA 94608
510.428.2550
BIASC FEDEX: 1174-51062
FROM: WILLIAM JOHN WARKENTIN, AIA
SUBJECT: DENSITY RANGES
PROJECT: INDIRECT SOURCE EMISSION MINIMIZATION STRATEGIES

HOUSING TYPE	5-7 DU/AC	8-11 DU/AC	12-13 DU/AC	16-18 DU/AC	20-23 DU/AC	30-45 DU/AC	50+ DU/AC
STD. LOT SINGLE FAMILY HOMES	1						
SMALL LOT SINGLE FAMILY HOMES	2	2	2				
CLUSTER SINGLE FAMILY HOMES	3	3	3	3			
2 STORY TOWNHOMES W/ ATTACHED PARK'G	4	4	4	4			
2 STORY STACKED FLATS W/ DETACHED PARK'G				5	5		
3 STORY TOWNHOMES W/ ATTACHED PARK'G				6	6		
3 STORY STACKED FLATS W/ STRUCT'D PARKING						7	7

NOTES:
Conventional wood framed structures are limited to 4 stories with resulting maximum densities of 70-80 for standard market units, and up to 120 du/ac for age restricted, very low parking seniors apartments.

1 STD. LOT SINGLE FAMILY HOMES: 7 du/ac is about the max. achievable with standard lots down to approx. 4500 SF in size.

2 SMALL LOT SINGLE FAMILY HOMES: Small lots homes with reduced lots and setbacks can achieve 12 du/ac with very careful planning. These lots drop down to about 2500 SF.

3 CLUSTER SINGLE FAMILY HOMES: These densities are pretty much restricted to lots that are specially configured to the precise requirements of the cluster and often

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have the "zipper" feature, which means the lot is customized to the home footprint. Typically only one footprint can be plotted on any given lot configuration.

4 2 STORY TOWNHOMES W/ ATTACHED PARKING: This prototype can be used in a wide variety of densities. At the 18 du/ac end of the range, the site plan is quite tight, the units very compact and uniform and parking is usually the driver of the achievable density.

5 2 STORY STACKED FLATS W/ DETACHED PARKING: This is the typical California garden apartment, 2 story walk up arrangement with detached carports or garages. With the use of tuck under parking, 28 du/ac can be achieved.

6 3 STORY TOWNHOMES W/ ATTACHED PARKING: This is an unusual housing type for Southern California, but with the ADA and Fair Housing access requirements, may become more common as only the "ground floor" of townhomes is required to be accessible. Typically the garage is set 50% into the earth which by building code permits the garage to be classified as a basement, not another story.

7 3 STORY STACKED FLATS OVER STRUCTURED PARKING: This is the classic elevator serviced fully accessible, urban housing type in Southern California and can reach densities of 60 to 70 du/ac. Parking structures cost approx. $20 - $25 per SF which is often built property line to property line. Fundamentally, the parking structure replaces the raw land as the building platform. Thus, the land cost is basically increased by the parking structure cost which only makes sense where land values are very high.

In special cases, senior housing for example, densities as high as 120 du/ac can be attained.

A GENERAL NOTE: As land costs rose rapidly in the '80s, architects and developers searched for higher and higher densities while maintaining some semblance of the traditional single family home. Across the board, we began to apply housing concepts that had previously been restricted to quite narrow density ranges. We now commonly plot single family small lot projects that used to be restricted to townhome designs. The point is that a narrow density range is no longer applicable to a particular housing design.

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