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MANAGING TRANSPORTATION DEMAND

In its broadest sense, transportation demand management (TDM) is any action or set of actions aimed at influencing people's travel behavior in such a way that alternative mobility options are presented and/or congestion is reduced.

TDM is most often viewed from two perspectives: strategies or actions that are implemented at specific sites (e.g., rideshare programs at an employment site) and strategies that are implemented at an areawide level (e.g., growth management policies for a state or community, or the implementation of an areawide traveler information system). In reality, many of the actions in each category can be discussed in both contexts. For example, rideshare programs can be implemented on an areawide basis as well as at a particular site. In addition, the effectiveness of areawide or comprehensive TDM programs often relies heavily on the success of TDM actions that are taken at individual locations in the area. For purposes of this Toolbox, however, TDM actions will be presented primarily from the perspective of those implemented at site-specific versus areawide contexts. It should also be noted that in some areas (e.g., Minneapolis/St. Paul), TDM programs have been implemented at the corridor level. In this case, TDM actions from both the site-specific and areawide categories can be combined to produce results.

IMPORTANT CONSIDERATIONS

There are many different types of TDM tools that can be used to affect individuals' travel behavior. In addition, there are many different types of travel markets in which these tools can be applied. Figure 5-1 shows how different types of TDM actions can be applied to markets that are defined by geographical scale (Meyer et al 1994). As is also shown in this Figure, the institutional mechanisms that are typically used to deliver TDM programs are different for each market. Therefore, the market-orientation of TDM implementation becomes a critical dimension for successfully using demand management tools from the Toolbox.

Another important consideration when discussing TDM programs is that they can focus on short-term actions designed to mitigate existing mobility/congestion problems, or they can provide a more strategic approach to avoid future congestion. TDM actions can relieve spot congestion-for example, at entrances and exits to large employment centers - but they often do not appreciably reduce traffic on freeways and major arterials that handle high volumes of traffic which are not targeted by the TDM actions. The only exception to this is the application of areawide road pricing schemes which at least in travel modeling studies seem to

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Figure 5.1: Demand Management Tools As Applied to Travel Markets

Trip Purpose	Site	Subarea/Corridor	Regional
Work	Carpools Vanpools Public/private transit Bicycling/Walking Alt. work hours Site telecommuting Parking policies	Subarea ndeshare Corridor HOV Parking policies Transit subsidies Subarea telecommute	Areawide ndeshare Transit service HOV lanes Areawide pricing Areawide telecommute Trip reduction ordinances Areawide traveler Info. system
Shop	Shuttles Transit subsidies Pedestrian access Bicycle access Urban design Teleshopping	Shuttles Park-and-nde Transit services	Teleshopping Transit subsidies Areawide transit services Areawide traveler info. system
Tourist	Shuttles parking policies Transit services	Park-and-ride lots Parkmg management Shuttles Transit services Bicycle/pedestrian amenities	Regional transit services Marketmg Park-and-ride lots Areawide traveler info. system

Example Delivery Mechanisms for TDM Programs

Site	Subarea/Corridor	Regional
Employer trans coordinators Personnel dept. Part time trans. manager Voluntary participation Negotiated traffic mitigation Site design	Transportation management associations Chambers of commerce Trans Management Districts City or MPO coordinator	Trip reduction ordinances Adequate public facilities ordinances Growth management State, MPO. or transit agency coordination

Source Meyer, et al, 1994

have a significant impact on travel behavior One should be careful therefore not to raise unrealistic public expectations as to the impact of TDM actions on areawide levels of traffic congestion.

This chapter begins by examining the types of TDM actions that can be implemented at the site level. In many ways, these actions are the building blocks for areawide applications, and should thus receive attention first.

The reader is referred to the Transportation Demand Management Glossary published in 1996 by the Institute of Transportation Engineers for an overview of the terms used in this area of mobility enhancement and congestion reduction.

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Meyer, M., S. Siwek, and W. Bennan. 1994. The State-of-the-Practice of Travel Demand Management, in TDM Innovation and Research Symposium, Transportation Research Circular 433, Transportation Research Board, Washington D.C., October.

(SITE-SPECIFIC TDM STRATEGIES)

Most TDM experience in the United States has occurred at the individual site level. It is at this level where the benefits of TDM programs can be best seen. As noted by a representative of the business community, there are 10 "business" reasons for better managing employee transportation: (Gerwig 1996)

- Increase in public (and employee) health through reduced air pollution and lower levels of stress.
- Improvement in regional mobility and thus economic health.
- Enhanced customer access.
- Possible connection of trip reduction to core business (e.g., telecommunications technologies for telecommuting).
- Reduced congestion and decreased parking demand.
- Extended hours of service through alternative work hour programs.
- Enhanced ability to recruit and retain staff.
- Opportunities for creative and flexible space planning and sharing.
- Mitigation of new development traffic impacts at a fraction of the cost for new physical improvements.
- Improved productivity (especially through telecommuting).

The important message from this perspective is that successful TDM programs result from businesses deciding for themselves that reducing the number of employee trips is good for business.

- There are three major types of demand management tools that are often used at the site level-encouraging travelers 1) to switch to alternative modes of transportation, 2) to travel in the non-peak hours, or 3) to accomplish the trip purpose by using telecommunications technologies and thus not leave the home or work site. Table 5.1 shows the types of trip reductions that have been observed at employment sites in the United States. Each of these types of TDM actions has its own set of advantages and disadvantages which will be discussed below.

The three major types of demand management tools used at the site level are"

1) to switch to alternative modes of transportation,

2) to travel in the non-peak hours,

3) to accomplish the trip purpose by using telecommunications technologies and thus not leave the home or work site.

Reference

Gerwig, K. 1996. *"Transportation Demand Management* as a Business Necessity," TDM Review, Association for Commuter Transportation, Washington D.C., Winter.

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ALTERNATIVE MODES OF TRANSPORTATION

Alternative modes of transportation imply the use of any type of mode other than the private automobile. In this section, only two major categories of alternative modes will be considered-ridesharing and bicycling/walking. Although transit services provide an important component of a TDM program, transit actions are discussed in Chapter 4 and thus will not be repeated in this chapter.

Ridesharing

Description: The term "ridesharing" came into use during the 1970s to generically denote two or more individuals sharing a vehicle for a trip. Ridesharing, which can involve "carpooling," "vanpooling," and "buspooling," is usually the backbone of most employer-based TDM programs. It can also be an important option for non-work trips.

Carpooling: Carpooling involves the use of an employee's private vehicle to carry one to five fellow employees to work, either using one car and sharing expenses, or rotating vehicle use so that no money changes hands. Carpooling is an especially attractive alternative mode in that it offers door-to-door service, and provides a level of convenience closest to the private automobile.

Vanpooling: Vanpooling generally involves the use of an 8- to E-passenger van with driving done by an employee. The fixed costs are often subsidized by employers whereas operating costs are at least partially paid by the riders through monthly fees. There are three major types of vanpool programs: company-sponsored, third-party, and owner-operated. In company-sponsored programs the company owns or leases vans and administers the program. In third-party programs, a ridesharing organization or some other agency offers a vanpool service. The third-party organization administers the vanpool program and assumes financial liability for operations. Owner-operated vans are the sole responsibility of the owner/driver. A combination of third-party and privately-owned programs is the vanpool "transition" concept used by some public agencies such as the Golden Gate Transportation District in the San Francisco Bay area. The program uses a small Vanpool fleet owned by the District to introduce commuters to vanpooling. After a trial period, commuters are encouraged to purchase or lease vans themselves. The district vans are then turned over to a new group.

Third-party vanpool programs have become increasingly popular across in the United States because they relieve the employer of the legal and financial risks involved in setting up a vanpool program. They also provide administrative, ride matching, and insurance services at no cost to the employer. In effect, the third-party organizations act as a consultant and a broker for employers and employees who wish to organize a vanpool.

Buspools: Buspools are also known as charter, club, or subscription buses. Buspools are usually initiated by employers, although neighborhood-

Table 5.1: Characteristics of Employer TDM Programs, *Source: ITE 1993*

							Employer Support Levels				*Employee Modal Split*			
Program	Vehicle Trip Reduction Travel Base	Travel Base	Type Area	Preferential Reserved Parking	Restricted Parking	Parking Charges	Transit	Carpool	Vanpool	Legal Requirement	SOV	Transit	Carpool	Vanpool
Travelers	47.90%	10,000	CBD	Yes	Yes	Yes	High	High	High	No	33%	36%	19%	8%
US West	47 1	1,150	SBD	Yes	Yes	Yes	High	High	High	Yes	26	13	60	-
NRC	41.6	1,400	ISI	Yes	Yes	Yes	Low	High	None	Yes	42	28	27	-
GEICO	38 6	2,500	SBD	Yes	Yes	Yes	Medium	Medium	None	Yes	40	31	20	8
Ch2M Hill	31.2	400	SBP	No	Yes	Yes	High	High	High	Yes	54	17	12	-
State Farm	30.4	980	SBP	No	No	No	High	High	None	Yes	66	-	31	-
Pacific Bell	27 8	6,900	SBP	Yes	Yes	Yes	None	High	Medium	Yes	63	2	22	11
Hartford Steam Boiler	26.5	1,100	CBD	No	Yes	Yes	High	High	Medium	No	40	36	21	1
Swedish Hospital	26 1	2,500	ISI	No	Yes	Yes	High	High	High	Yes	33	44	23	-
Bellevue City Hall	25.8	600	ISI	Yes	Yes	Yes	Medium	Medium	Medium	No	52	7	29	4
San Diego Trust & Savings	22 7	500	CBD	No	Yes	Yes	High	High	Medium	Yes	44	37	14	-
Pasadena City Hall	21	350	SBD	No	Yes	Yes	High	Medium	None	Yes	58	7	27	2
TransAmerica	20	2,700	CBD	Yes	Yes	Yes	Medium	High	High	Yes	45	14	21	19
ARCO	19.1	2,000	CBD	No	Yes	Yes	Medium	Medium	High	Yes	46	20	20	14
Varian	17 7	3,200	SBP	No	Yes	Yes	Medium	High	High	Yes	62	8	21	3
AT&T	13.4	3,890	SBP	Yes	Yes	Yes	Low	Low	Low	Yes	71	2	22	3
Ventura County	13	1,850	OSI	No	No	No	Medium	Medium	Medium	Yes	69	2	23	-
COMSIS	10.5	250	SBD	No	Yes	Yes	Medium	Medium	None	Yes	54	18	25	-
3M	9 7	12,700	OSI	No	No	No	Low	Low	None	No	83	2	14	8
Allergan	7	1,250	SBP	Yes	No	No	Medium	Medium	High	Yes	76	1	14	7
UCLA	5 5	18,000	ISI	No	Yes	Yes	High	Low	High	Yes	74	6	10	5
Chevron	3 7	2,300	SBP	Yes	No	No	High	Medium	High	Yes	82	1	11	5

Key
CBD = Central Business District,
SBD = Suburban Business District,
ISI = Inner Suburb, Isolated,
OSI = Outer Suburb, Isolated,
SBP = Suburban Business Park

Inner Suburb, Isolated,
OSI = Outer Suburb, Isolated,
SBP = Suburban Business Park

based buspools have also been formed under the auspices of transit agencies, homeowners associations, and private bus companies.

A basic ingredient of a ridesharing program is the capability of matching potential riders. Such a service can be provided at four levels:

1. At the regional level by a regional planning agency such as a metropolitan planning organization (MPO), a state DOT, a regional transit agency, or an organization especially created to promote and facilitate ridesharing within a region (e.g., RIDES in San Francisco, Southern California Rideshare in Los Angeles, and CARAVAN in Boston).
2. At the sub-regional level by a local unit of government (municipality or county). County-level ridesharing services are often decentralized to provide ridematching that is closely tailored to a local market.
3. At the sub-regional level by private employers . Company-sponsored ridematching services are limited to the company's own workers and often involve a more personalized approach, combined with a heavy element of marketing and promotion. In some areas, companies utilize the matching services of local or regional ridematching agencies. In addition, many metropolitan areas now have transportation management associations (TMAs), non-profit organizations that are usually created by employers and developers to provide transportation services (such as ridesharing) to sites in a particular employment area.
4. At the residential level by private developers, condominium associations, and homeowners associations. Neighborhood-based ridesharing efforts account for only a small fraction of ridesharing programs.

Benefits/Costs: Ridesharing can reduce commute costs to individual travelers, lower energy consumption per passenger, reduce highway congestion and improve air quality (if adopted by large numbers of travelers) , and decrease demand for parking. By encouraging employees to rideshare, a company can often induce better employee morale, reduce absenteeism and tardiness, develop a potentially expanded labor market, experience lower capital costs for employee parking, and develop a "good corporate citizen" image. Ridesharing programs can also help a company retain employees when an office is being relocated. One estimate of the impact of ridesharing programs in California is shown in Table 5.2.

As noted in a synthesis report on TDM, the overall impact of rideshare services varies by the context of implementation (ITE 1993). The findings of this report were as follows:

Area-wide carpool matching and promotion programs reduce work trip VMT by 0 to 3 percent. They do so by influencing a small, but significant proportion of rideshares into choosing carpooling.

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Table 5.1: Impact of California's Ridesharing Programs [FY-95-96], *Source: Caltrans 1996*

	Individuals Receiving Service	Increased HOV Use	Vehicle Miles Travel Reduced	Fewer Gallons of Fuel Consumed	Pollutants Reduced(Pounds)	Dollars Saved
Central Valley	15,336	771	3,392,400	168,776	118,734	$1,255,188
Kern Rideshare	3,500	875	3,850,000	191,542	134,750	$1,424,500
Monterey Ridesharing	2,536	964	3,922,178	195,133	137,276	$1,451,206
RIDES for Bay Area	80,297	19,352	78,046,458	3,882,908	2,731,626	$28,877,190
Sacramento Rideshare	4,875	1,452	9,263,760	460,884	324,232	$3,427,591
San Benito Ridesharing	1,445	742	3,264,800	162,428	114,268	$1,207,976
San Diego Ridelink	103,488	11,313	14,703,750	731,530	514,631	$5,440,388
San Joaquin Connection	3,816	834	3,669,600	182,567	128,436	$1,357,752
San Luis Obispo Ridesharing	8,788	690	3,036,000	151,045	106,260	$1,123,320
Santa Barbara County Traffic Solutions	11,127	1,309	5,759,600	286,547	201,586	$2,131,052
Santa Cruz Commute Soln's	2,017	550	4,235,000	210,697	148,225	$1,566,950
SCAG Southern CA Rideshare	591,861	121,923	286,070, 697	14,232,373	10,012,474	$105,846,157
Statewide Total	829,131	160,774	419,214,240	20,856,430	14,672,498	$155,109,269

Employer-based ***carpool matching and*** promotion programs have been documented with ***reducing trips by 20 percent over prevailing conditions, but these*** results are largely a result of financial ***incentives and*** parking management ***strategies. When evaluated alone, carpool promotion might*** only be expected to reduce trips a few percentage points.

Vanpooling will reduce vehicle trips and traffic levels to the extent that it draws travelers away from lower occupancy modes of travel. Table 5.3 indicates the level of impact that vanpools can have at a particular location. AVR stands for average vehicle ridership and represents the total private vehicle users divided by the total private vehicle trips at a location. Thus, an AVR of 1.05 (a typical low-density suburban area) represents a high single occupant vehicle (SOV) environment, whereas an AVR of 1.3 (a typical radial corridor into a CBD) represents an environment where transit and other higher occupancy vehicles are present. Table 5.3 indicates that for an AVR environment of 1.05 and a 10 percent market share for vanpools, one could expect a vehicle trip reduction of approximately 9.2 percent. Assuming an average vanpool trip of 20 miles/32 kms compared to an average length of commute trip of 10.9 miles/l7.5 kms, each vanpool trip would reduce vehicle miles traveled by about 16.9 percent.

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The benefits of ridesharing will accrue to three major groups: society, employers, and individual travelers. Direct societal benefits will result by reducing the need to provide additional highway capacity to those who rideshare assuming they would (and could) drive individual vehicles in the absence of a rideshare option. A study for the State of Maryland estimated that the cost of providing incremental highway capacity to support an additional single occupant vehicle trip was $6.75 per one-way trip [assumes a one-way trip of 10.5 miles/l6.9 kmsq and includes capital/operations/maintenance costs (COMSIS Corporation 1990)]. If a traveler made the same trip in a 12-passenger van, the cost per person transported would be reduced to $6.75/12 = $0.56 which represents a total **savings** per year of

Table 5.3: Estimated Impact of Vanpool Programs

AVR	Vanpool Market Share			
Commute Vehicle Trip Reduction				
1 05	0.3%	0 9%	46%	92%
1 10	0.3%	0 9%	4 5%	9 1%
115	0.3%	0 9%	45%	9 0%
1 30	0.3%	09%	4 5%	8 9%
Commute VMT Reduction				
1 05	0.6%	17%	8 5%	169%
1 10	0. 6%	17%	8.4%	16 7%
115	0.6%	17%	83%	16.5%
1 30	0.6%	1.7%	8 2%	163%

Source ITE 1993

$3,220 for every person trip made in a van. Assuming 2.5 persons per carpool, the savings for a carp001 rider would be $4.04 per one-way trip+ . These estimates do not include the benefits associated with improved air quality, reduced noise levels, and reduced accidents.

The largest ridesharing program benefits to employers are related directly to the cost savings of having reduced parking requirements. Close to 95 percent of all commuters in the United States do not pay for parking at their employment site (Shoup and Breinholt 1995). And to an employ er, these parking spaces can be expensive. A study of 160 private employers, for example, indicated that the cost of providing additional parking spaces at their work sites averaged $3,930 per space (Wegmann 1989).

Cost savings are also a persuasive argument for selling ridesharing to commuters, especially for long distance vanpools. With a typical vanpool roundtrip commute of 70 miles/l 13 kms, 13 passengers in a vanpool would each pay approximately $60 a month. Driving alone in a subcompact car on that same commute would cost each person $300 a month. In one year, the vanpool rider on the 70-mile/l13 km round trip commute can count on a $2,900 savings. Table 5.4 shows a comparative per person cost of using a single occupant vehicle versus a vanpool assuming the characteristics of an individual company's vanpool program. As indicated, the per trip and per mile costs to the individual are significantly reduced in the vanpool program.

Implementation: The successful implementation of employer-based ridesharing depends very much on employer support. Such support could mean hiring a ridesharing coordinator, providing preferential parking for ridesharers, publishing a commuter newsletter, offering subsidies, etc. Ridesharing can be implemented at nearly all worksites, although the site and employee characteristics that favor ridesharing success are considered to be: employees with consistent work hours, residential concentrations of employees, high percentage of employees with long commutes, high percentage of employees with moderate salaries, the availability of nearby HOV lanes, and a constrained parking supply. The characteristics of successful ridesharing programs include: (ITE 1993a).

- A pool of prospective commuters who might share rides
- Sound market research on targeted employees for matching and promotion
- Up-to-date information on commuter options and potential matches made in a timely manner
- A "personalized" approach to persuade employees to try ridesharing
- High-level corporate support for the program
- Financial support to assure a stable program
- Supporting programs such as marketing, financial incentives or disincentives for single occupant vehicle use, and employee information exchanges

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Table 5.4: Comparative Cost of Single Occupant Vehicle vs Vanpool

	Single Occupant Vehicle					Vanpool			
	Cost Per Mile			Cost Per Trip		Employer		3rd Party	
Round Trip Distance	Variable (cents)	Fixed (cents)	All (cents)	Variable	All	Per Mile	Per Trip	Per Mile	Per Trip
30	7 3	18.5	25 8	$2.19	$7 74	7.5	$2.25		
40	7 3	15.5	22.8	2 92	9.12	6.2	2 48		
50	7.3	13.3	20 6	3 65	10 30	5.4	2 70		
60	7.3	11.7	19 0	4 38	11 40	4.9	2 94		
70	7 3	10.4	17 7	5.11	12 39	4.5	3 15		
80	7 3	9 4	16 7	5 84	13 36	4.3	3 44	6.3	$5.00
90	7.3	8 6	15 9	6.57	14.31	4.0	3 60		
100	7 3	7.9	15 2	7.30	15.20	3.9	3.90		
110	7 3	7 3	14 6	8.03	16 06	3.7	4 07		
120	7 3	6.7	14 0	8.76	16.80	3.6	4 32		
130	7 3	6.3	13 6	9.49	17.68	3.5	4 55		
140	7.3	5.9	13 2	10 22	18.48	3.4	4 76	4 2	5 86
150	7 3	5.6	12 9	10 95	19.35	3.3	4.95		

Source: ITE 1993b

The most important characteristic of successful ride-sharing program implementation is that it must address a real and immediate site-specific problem such as constrained access, limited parking, difficult recruitment, etc.

In the absence of mandates from government, the most important characteristic of successful ridesharing program implementation is that it must address a real and immediate site-specific problem such as constrained access, limited parking, difficult recruitment, etc. No matter what the rationale for a ridesharing program, a key ingredient to successful implementation is to know the customer you are trying to serve and to target individual travel markets with services aimed at attracting these customers. Some might respond to financial incentives, others to a guaranteed ride home program (a guarantee that the traveler will not be stranded without a car if the need arises to go home). Market-oriented planning that focuses on targeted traveler markets for ridesharing is thus critical for successful program operation.

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Nonmotorized Transportation
(Bicycling/Walking)

Description: Nonmotorized transportation, primarily bicycling and walking, has for years been neglected by the transportation profession as a serious mode of transportation. However, in many communities, bicycling and walking can be an important component of a TDM program. Table 5.5 shows the characteristics of cities that have bicycle commuters. Not surprisingly, many of these communities have large universities which clearly provide a conducive market for bicycle transportation. In some cases, bicycle trips constitute a significant proportion of total trip-making. For example, the University of Colorado, Boulder has 21.3 percent of total trips on campus made by bicycle; the University of Washington, Seattle has 7 percent (9.5 percent of the faculty trips, 5.5 percent staff, and 9.8 percent students), and the University of North Carolina at Chapel Hill has 11 percent students and 8 percent of the employees riding bicycles regularly. Some private employers who actively promote bicycle commuting also achieve impressive results. Nearly 20 percent of the employees at the Xerox Corporation in Palo Alto, California commute by bicycle. At Fleetwood Enterprises in Riverside, California, 12 percent of the 600 employees commute on bicycles. The City of Glendale, Arizona gives unclaimed stolen bicycles to employees who ride to work at least three days a week. Seventy of the 1,100 employees (6.3 percent) participate in the program (Bicycle Federation of America 1993). A study of employers in Los Angeles that had over 10 percent nonmotorized tips to and from their site had the following strategies associated with their sites: (ITE 1993)

- Perception of safe movement
- Easy access to services
- Mix of land uses
- Numerous convenience-oriented services
- Financial incentives
- Assistance programs
- Flexible work schedules
- Award programs
- Bicycle/walking subsidies
- Bike racks

Even with the mode usage numbers described above, the picture of the "average" walking and bicycling activity in the U.S. is quite limited. Table 5.6 shows the rates of bicycle and walking use for major trip purposes as determined from the 1990 Nationwide Personal Transportation Study (NPTS). Not surprisingly, the private vehicle dominates all trip purposes. Walking is generally more prevalent than bicycling for all urban area sizes and trip purposes. And central city residents generally have higher bicycle/walking propensities than suburban residents.

Bicycle commuters

Nonmotonzed transportation, primarily bicycling and walking, has for years been neglected by the transportation profession as *a serious mode of transportation. However, in many communities, bicycling and walking can be an important component of* a *TDM program.*

Table 5.5: Characteristics of US. Cities With Bicycle Transportation

	Davis	Palo Alto	Boulder	Eugene	Gainesville	Orlando	Madison	Raleigh	Minneapolis	Pittsburgh
Population	55,000	56,000	80,000	106,000	140,000	166,000	190,000	212,000	358,000	370,000
Area (sq mi.)	8	25	27	35	35	71	58	91	58	55
Pop Density	6,875	2,240	2,985	3,029	4,000	2,338	3,276	2,330	6,172	6,727
Mean High Temperature	73 7	69	65 3	63 3	81 4	82 8	56 1	70 3	54 2	59 9
Days 0 1" + Precipitation	47	38	51	138	75	116	118	112	114	153
Terrain	Flat	Flat	Mostly flat	Flat + hills	Flat	Flat	Flat + hills	Mildly hilly	Flat	Rolling hills
Total Mi's Bikeway	56	42	39	60	102	5	33	50	46	20
Mi Bike Lane	31	35	14	38	75	0	13	10	6	10
Mi Bike Paths	25	7	25	22	0	5	20	40	40	10
Bike path/Bikeway Miles	0.45	0 17	0 64	0 37	0	1	0 61	0 8	0.87	0 5
Mi's Bike Street	106	N/A	280	427	400	430	587	806	1,078	800
Arterial/Collector Miles	33	N/A	116	126	125	N/A	210	N/A	306	248
Mi's Bkwy/Mi Street	0 528	N/A	0 139	0 141	0 255	0 012	0 056	0 062	0 043	0 025
Mi Bkwy per Sq. Mi.	7	1 7	1.5	1.7	2.9	0.1	0.6	0 5	0.8	0 4
Mi's Bklane/Mi Arterial	0.939	N/A	0 121	0.302	0 6	0	0.062	N/A	0.02	0.04
Average Commute	3	11	5 1	4	4	21	7 2	N/A	7	6
% Commute <5 miles	68 00%	N/A	77 00%	N/A	N/A	22 00%	56 00%	N/A	35 00%	N/A
% Bicycle Commute	25.00%	2 60%	9 30%	8 00%	10.00%	0 50%	11 00%	0.20%	2.00%	0 50%

	Tucson	Portland	Seattle	Washington	Phoenix	Dallas	San Diego	Ft. Lauderdale	Chicago	New York
Population	403,000	435,000	516,000	628,000	1,000,000	1,000,000	1,000,000	1,300,000	2,800,000	7,300,000
Area (sq mi.)	156	137	86	63	424	390	331	411	228	322
Pop. Density	2,583	3,175	6,000	9,968	2,358	2,564	3,021	3,162	12,218	22,671
Mean High Temperature	81 7	62	59.7	66 4	85	76 9	70 5	83 5	58 7	62.2
Days 0 1" + Precipitation	52	149	158	112	35	78	43	80	126	121
Terrain	Flat to rolling	Some hills	Hilly	Flat	Flat	Flat	Flat	Flat	Flat	Flat
Total Mi's Bikeway	73	76	54	44	59	42	113	33	18	94
Mi Bike Lane	67	40	15	2	59	0	93	17	0	45
Mi Bike Paths	6	36	39	42	0	42	20	16	18	49
Bike path/Bikeway Miles	0 08	0.47	0 72	0 95	0	1	0 18	0 48	1	0 52
Mi's Bike Street	1,751	2,092	1,394	1,102	3,802	6,000	2,519	3,900	3,676	5,585
Arterial/Collector Miles	509	490	477	433	977	N/A	711	834	989	2,172
Mi's. Bkwy/Mi Street	0.042	0 036	0 039	0.04	0.016	0.007	0.045	0.008	0.005	0 017
Mi Bkwy per Sq Mi	0.5	0 6	0 6	0.7	0.1	0.1	0.3	0.1	0.1	0 3
Mi's Bklane/Mi Arterial	0.132	0 082	0.031	0 005	0.06	0	0 131	0.02	0	0.021
Average Commute	10 6	6 6	9	8.5	9	N/A	10 6	8	12.6	N/A
% Commute <5 miles	32.00%	40 00%	40 00%	N/A	34 70%	N/A	32 00%	N/A	40.00%	16.00%
% Bicycle Commute	3 50%	2 00%	2.30%	0 50%	2 40%	0 20%	1 60%	0 80%	0 70%	0.20%

Source. Replogle and Parcells 1992

Table 5.6: Rates of Bicycle and Walking Use for Major Trip Purposes, Source: *Goldsmith 7993*

	Urban Areas < 1 Million		*Urban Areas > 1 Million (No Rail Transit)*		*Urban Areas > 1 Million (With Rail Transit)*	
Trip Purpose/Mode	Residence in Central City	Residence in Suburbs	Residence in Central City	Residence in Suburbs	Residence in Central City	Residence in Central City
Commuting	**19.5%**	**20.5%**	**21.1%**	**20.5%**	**22.2%**	**22.4%**
Private Vehicle	93.6%	98 6%	92 2%	96 8%	66 0%	88 7%
Transit	2 0	1.0	3 8	1.1	19 0	6 0
Walking	3.3	1 6	3 3	1 7	13.2	4 5
Bicycle	0 6	0 01	0.6	0.3	0 4	0 2
Other	0 5	0.6	0 1	0.1	1.4	0.6
Shopping	**41.6%**	**39.7%**	**42.6%**	**41.3%**	**39.1%**	**41.3%**
Private Vehicle	93 4%	97 2%	92.7%	94.8%	71.6%	92 9%
Transit	1.0	0 5	1 1	0 7	4 2	0 7
Walking	5 1	1.7	5.6	3.6	22.5	6 0
Bicycle	0.3	0 4	0 4	0 4	0 8	0 2
Other	0 2	1.2	0 2	0 5	0.9	0 2
Social/Recreate	**25.8%**	**25.1%**	**23.5%**	**25.2%**	**24.5%**	**24.8%**
Private Vehicle	86 9	90.5%	84 8%	88 6%	67.9%	87 6%
Transit	0.6	0 2	1 1	0 6	6 8	1 0
Walking	10 6	7.1	12 0	8 3	21 6	9 4
Bicycle	1.6	1 1	1 7	1 7	2 0	1 6
Other	0 3	1.1	0 4	0.8	1 7	0 4

Factors that *influence the use of nonmotorized-transportation* are:

- *Trip distance*
- Traffic *safety*
- Travel *cost*
- *Physical Environment*
- *Demographics*

There are three important ways in which bicycle and walk modes could play a greater role in a TDM program: (Goldsmith 1993)

As Primary Modes:

Using bicycles or walking as the major means of accessing a job site

As a Feeder Mode:

Using bicycles or walking to connect with other modes for longer trips (e.g., public transit)

For Circulation:

Using bicycles or walking to access other locations at an activity center

For each application, there are certain factors that have been shown to influence the use of nonmotorized transportation. These factors include:

Trip Distance: Bike commute trips can average between 5 to 6 miles/8 to 9.7 kms or about a 30 to 40 minute one-way trip. Acceptable walk trips range from 1 to 1.5 miles/1.6 to 2.4 kms. (Goldsmith 1982)

Traffic Safety: Surveys of commuters have consistently shown that perceived conflicts with motor vehicles are a major cause of deterring individuals from bicycling (Bicycling Magazine 1991).

Travel Cost: Cost of travel is not a significant incentive to use bicycles or walking. However, providing financial incentives for such commuting might be an important influence [44.5 percent of active bicyclists and 18 percent of all adults in a recent survey suggested such incentives would provide an important difference (Herman 1993)].

Physical Environment: Important environmental characteristics include terrain, climate and weather, land use patterns, access and circulation within activity centers, availability of alternative modes (if bicycling or walking was not feasible), and urban design.

Demographics: Bicycle commuting is most popular to those in their mid-twenties, with bicycle use declining rapidly after age 45. Data from surveys suggest that exercise is the top reason for bicycle commuting for all age groups.

Bicycling and walking can also be important access modes to transit facilities (see Chapter 4-Multimodal Access). Several surveys of transit users show the potential of such access: (Replogle and Parcells 1992)

- A 1992 survey in Oyster Bay, Long Island found 24 percent (418) of the respondents would bicycle rather than drive to a Long Island Railroad station if theft-proof lockers were available.
- A 1988 Chicago survey found that over 50 percent of park-and-ride users at rail stations were located within 2 miles/3.2 kms.
- A 1980 survey of New Jersey rail commuters indicated they would consider bicycle access if bicycle facilities were provided.
- A 1988 study by the Metropolitan Washington Council of Governments indicated that the major reasons why commuters did not use nonmotorized modes of access to WMATA stations were lack of suitable facilities, danger

from auto traffic, no sidewalks, and inadequate lighting.

See Chapter 2, Bicycle and Pedestrian Networks and Chapter 4, Multimodal Access for further discussion on strategies to improve nonmotorized mode access to transit facilities.

Benefits/Costs: The benefits of bicycle and pedestrian facilities relate directly to the reduction in vehicular trips and thus the decrease in concomitant costs to serve additional demand through road or parking expansion. This is true not only for line-haul capacity, but especially true for the costs associated with the storage of automobiles at intermodal connections such as park-and-ride lots. Typical construction costs for surface parking lots range from $5,000 to $8,000 per space. Structured lots can cost from $12,000 to $25,000 per space. Given that a large portion of the automobiles parked at typical park-and-ride lots have driven usually less than 3 miles/4.8 kms (within the range of a bicycle trip), converting some of these access trips to a nonmotorized mode could provide substantial savings.

Table 5.7 shows an analysis of the effect of increased mode share for nonmotorized transportation in a typical community. These results are based on percentages of commute trips by bicycle and walking, average trip length, and percentage of regional vehicle miles traveled for commuting as determined from the 1990 NPTS. As indicated in this Table, the primary benefit from a switch to nonmotorized modes would be in the reduced number of vehicle trips, not necessarily in the reduced vehicle miles traveled. This reduction in vehicle trips, however, can be important when computing the cost effectiveness of bicycle strategies for reducing emissions. With today's automobile technology, starting a vehicle with a cold engine contributes a large portion of a total trip's pollutant emissions. Thus, reducing the number of vehicle starts through the use of alternative modes can have a very positive impact on air quality (if a sufficiently large number of starts is reduced).

Table 5.7: Effect of Increased Walking/Bicycle Use

	Walk	Bicycle
Current Share of Commute Trips	4.5%	0.4%
Increase Share by 1%, New Share is:	5.5%	1 4%
Reduction in		
Commute Trips	0.5%	0.9%
Commute VMT	0 1%	0 2%
Total Trips	0 1%	0 2%
Total VMT	<0 1%	0 1%
Increase Share by 2%, New Share is:	**6.5%**	**2.4%**
Reduction in		
Commute Trips	1 4%	1.8%
Commute VMT	0 2%	0.5%
Total Trips	0 3%	0.5%
Total VMT	<0.1%	0 2%
Increase Share by 5%, New Share is:	**9.5%**	**5.4%**
Reduction in.		
Commute Trips	4 1%	4 1%
Commute VMT	0 4%	1 1%
Total Trips	0 9%	0 9%
Total VMT	0 2%	0 4%

Source: ITE 1993

Cost-Effectiveness of Various Strategies for Reducing Hydrocarbon Emissions

Strategy	Cost/Ton Hydrocarbons Avoided
Secure bicycle parking at rail stations	$311
Commuter rail carpool matching	$3,979
Express park-and-ride service	$96,415
Feeder bus service to stations	$214,959

Source: Replogle and Parcells 1992

The primary benefit from a switch to nonmotorized modes would be in the reduced number of vehicle trips, not necessarily *in the reduced vehicle miles traveled. This reduction in vehicle trips, however;* can *be Important when computing the cost effectiveness of bicycle strategies for reducing emissions.*

The cost of bicycle/walking facilities is relatively minor compared to other transportation modes. Depending on the type of facility, bicycle trails/lanes can cost about $50,000 per mile to construct. Bicycle storage lockers cost between $50 to $500 per locker. In comparison, the cost per mile of constructing an urban arterial is between $2 to $4 million. With respect to user costs, non-motorized transportation modes effectively address the issue of equity in that a large sunk cost of purchasing an expensive vehicle is not required to make use of the infrastructure facilities. This aspect of public mobility is undoubtedly an important issue in large metropolitan areas.

Implementations: The successful implementation of nonmotorized modal services or facilities is contingent upon agencies and employers recognizing the needs that the users of such services have. Guidelines for implementing nonmotorized modal options as part of a TDM program include:

- High priority should be given to providing safe and convenient access. This includes providing secure bicycle storage at transfer points and readily marked and lighted sidewalks.
- Bicycle facilities should be placed as close as possible to destinations.
- Network information should be available to those using nonmotorized transportation.
- Design of complementary facilities (e.g., roadways) should be sensitive to the needs of nonmotorized modal users.
- Supporting programs and strategies should be considered seriously as part of encouraging nonmotorized transportation e.g., showers, guaranteed rides home in the event of emergencies, and flexible parking permits for those needing to drive on rare occasions.
- Encourage developers and employers to incorporate nonmotorized mode considerations into site design.
- Monitor nonmotorized modal use and modify programs to reflect opportunities to enhance overall performance of the program.

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ALTERNATIVE HOURS OF TRAVEL

Descriptions: Given that most work trip congestion occurs during specific periods of time in the morning and afternoon, spreading the demand for travel into non-peak periods could provide a cost-effective way of utilizing existing capacity. The approach for doing this is, referred to as alternative work hours, includes three types of programs.

Staggered Hours. In a staggered work hours program, groups are assigned to begin work at different times. Spacing arrivals at specified intervals before and after conventional work hours allows workers to travel at times when traffic moves more freely and when more seats are available on transit. Such a program works well for assembly-line operations and back office operations where the beginning and end of work shifts can be easily controlled by the employer.

Flextime. Flextime allows individual employees to choose their own schedules within company-set guidelines. Most flextime arrangements allow employees to begin work as early as 7 a.m. or as late as 9:30 a.m. with workers varying their arrival times from day to day. Flextime works well for office workers who work independently and can exercise a certain amount of discretion over the scheduling of their work.

Compressed Work Week. Four-day work weeks allow employees to complete 40 hours of work in four 10-hour days, often referred to as a 4-40 program. These programs have a double impact on travel to work: one day of commuting is eliminated each week and the early arrivals and late departures built into the lo-hour day means employees travel before and after the rush hour peaks.

Benefits/Costs: The main benefit of alternative work hours programs is the reduction of traffic demand during the peak hours (thus reducing needed capacity). By adopting earlier or later hours than nearby employers, a company allows its employees to avoid the worst periods of traffic congestion and transit crowding. Large companies may also stagger work hours to alleviate on-site crowding at plant gates and exits from office parks.

One of the first large-scale demonstrations of compressed work weeks occurred with federal agencies in Denver in 1982. About 9,000 federal employees in 42 agencies arrived one hour earlier on average than before the program and departed one hour later. The maximum percentage of total arrivals in a half hour period was reduced from 56 percent to 42 percent; the reduction was from 47 percent to 34 percent for departures (Atherton 1982). In addition, there was a 15.3 percent reduction in vehicle miles traveled for those employees participating in the experiment. At Bishop Ranch, California a survey of 14,800 employees over a two-year period showed that after the implementation of a flextime program, the percentage of employees starting work before 7:00 a.m. increased from 8 to 17 percent, and those starting after 9:00 a.m. increased from 1 to 9 percent. This increase was attribut-

Three types of programs for alternative work hours are:

- Staggered *hours*
- Flextime
- *Compressed work week*

able to the implementation of a flextime program as part of a required TDM trip reduction program (Beroldo 1990). In Honolulu, 11,000 employees participated in a staggered work hours program which reportedly was the cause of a travel time savings on specific commuter routes of up to 7 minutes or an 18 percent improvement in travel time (Guiliano and Golob 1990).

The benefits of flextime accrue to the employee, the employer, and the community. The community benefits from fewer vehicles on the road during the rush hour. Flextime might also offer the scheduling flexibility needed to meet bus schedules and arrange carpooling more conveniently. In San Francisco, the regional rideshare agency found the placement rate among its rideshare applicants on flextime to be 30 percent compared to 16 percent for applicants not on flextime (Burch 1988). However, another survey in Pleasanton, California indicated that only 7.6 percent of the workers that rideshared were on flextime, compared to 11.4 percent of the entire labor force (Ott and Slavin 1980). In Seattle, a survey of employees placed on flextime showed a decrease in the percentage who drive alone from 24 percent to 14 percent. Among employees in San Francisco's financial district, the work share of those who drove alone fell from 3.5 percent to 1 percent after flextime.

The Pacific Gas & Electric Company of San Francisco *reported annual savings from flextime of $20,000 in decreased sick leave and $46,000 in decreased use of work time for personal business*

The traffic impacts of alternative work hours will vary with the specifics of the application. The most probable impact will be a flattening of peak period arrival rates. In some cases, however, there is evidence that some programs, most notably compressed work weeks, reduces vehicle miles of travel for all trip making. Case studies of compressed work week programs estimate a 15 percent reduction in vehicle miles of travel (Ho and Stewart 1992).

The costs to employers of alternative work hour programs will vary by characteristics of program implementation. Several examples of flextime programs indicate a net savings to the employers. The Pacific Gas & Electric Company of San Francisco reported annual savings from flextime of $20,000 in decreased sick leave and $46,000 in decreased use of work time for personal business. The City of Berkeley credits flextime with reducing overtime costs by $18,000 and sick leave costs by $26,000 annually (Seattle METRO 1989).

Implementation: The following questions serve as a point of departure in evaluating those factors that work for and against the adoption of work schedule changes: (Jones 1983).

- Is there a single large employer or a strong employers' association within your area? (favorable)
- Does the proposed plan concentrate on a specific work area or portion of the business district (favorable) or does it apply instead to the whole city or region? (unfavorable unless the same proportion of participants can be maintained)
- Is it likely that the public transit agency will cooperate in making any schedule changes necessary? (favorable)

- Is the target area one which has a concentration of administrative offices (favorable) or an area of offices or stores depending heavily on consumer contact? (unfavorable)
- Is the target area where offices have recently relocated such that employee travel arrangements are possibly disrupted anyway? (favorable)
- Is the proposed work schedule one which union officials will accept? (favorable-note that unions often oppose longer work days as well as four-day work weeks in which the three days off are not consecutive)

The main benefit of alternative work hours is the reduction of traffic demand during the peak hours.

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ALTERNATIVE LOCATIONS

Telecommunications

Description: The rapid adoption of computers and telecommunication technologies into all facets of our daily lives has become a defining characteristic of today's technological society. Importantly, such technologies have the potential of substituting for a trip by allowing a user to accomplish a specific activity via a telecommunications network. Table 5.8 shows the different types of telecommunications applications as they relate to travel substitution. Although the applications deal with many different types of activities, telecommuting is the application most often discussed in the context of TDM, and will thus be described here.

Most home-based telecommuting consists of time split between home and the office (U.S. DOT 1993). A study conducted in 1991 indicated that the average total time worked at home for telecommuters was 18.6 hours per week, with about 26 percent of telecommuters working at home less than 8 hours per week (LINK Resources Corporation 1991). Telecommuting can occur at the

Table 5.8: Applications of Telecommunications Substitutions for Travel

Application	Definition	Examples
Telecommuting	Work performed at a remote worksite so as to reduce the work commute	Work from home, work from a satellite office
Teleconferencing	Meeting held at multiple locations linked by audio video, or data equipment	Conference call, video conference
Teleshopping	Shopping activities performed with computer or television services	Home shopping. telemarketing
Telebanking	Banking transactions performed with computer or telephone	ATM machine
Tele-entertainment	Transmission of entertainment events to multlple locations	Cable TV movies and sporting events, videocassettes
Tele-education	Classroom Instruction transmitted to remote locations	Home instruction, college instruction at the worksite
Tele-medicine	Transmission of information between medical professonals	X-ray diagnosis, closed circuit televised operations
Tele-justice	Routine legal functions performed remotely via video *or* audio links	Remote witness testimony, depositions, arraignments

Source. Sullivan, Mahmassani, and Herman 1993

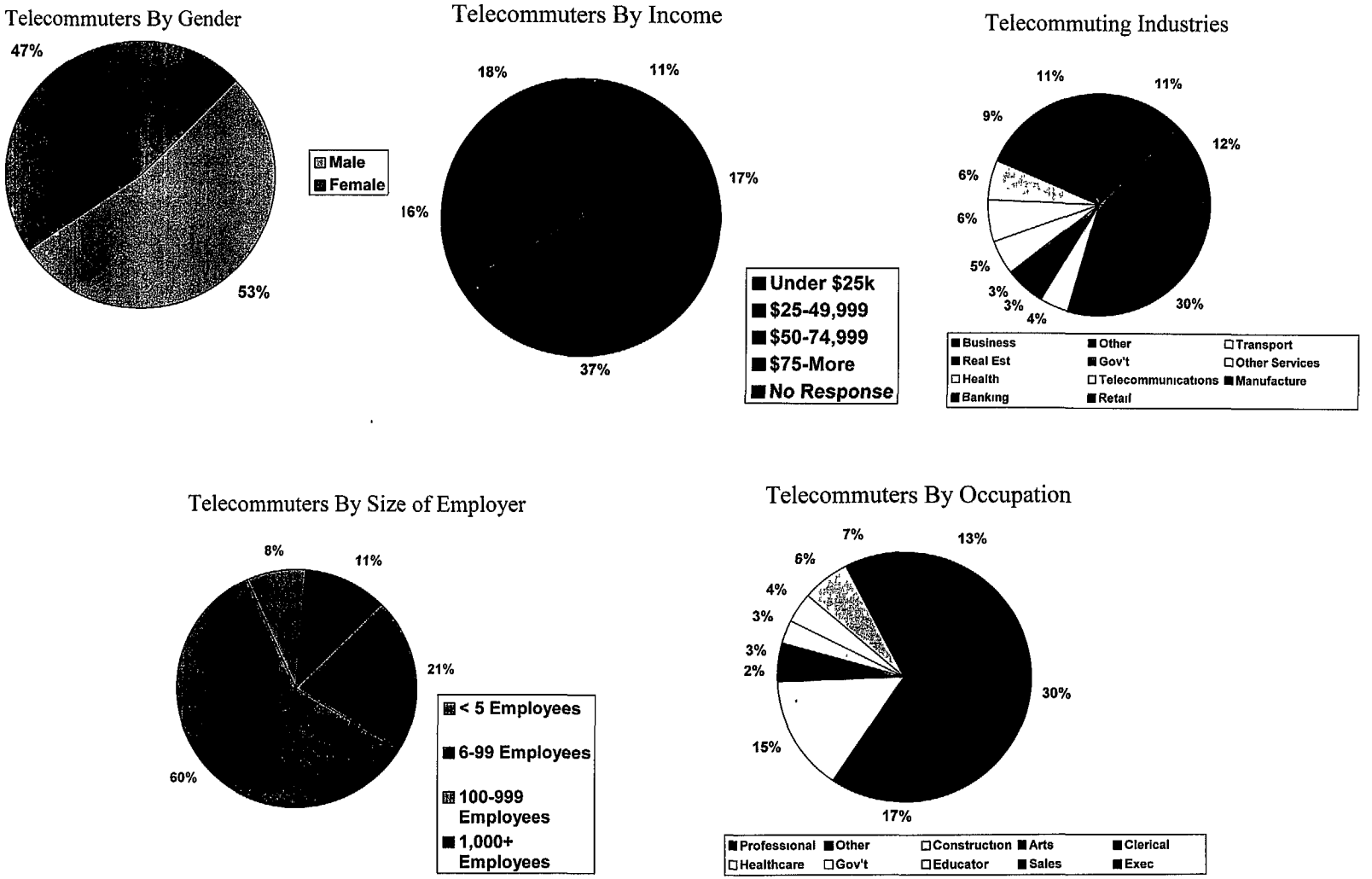
Technologies have the potent/a/ of substituting for a trip by allowing a user to accomplish a specific *activity via a telecommunications network*

home or at regional worksites owned and operated by a firm or by several organizations. These regional centers are often referred to as satellite centers. A more recent concept is a neighborhood telecommuting center where workers who live within walking or bicycling distance can accomplish assigned tasks via the Internet.

Telecommuting is appropriate for only certain types of jobs and industries. Figure 5-2 shows several important characteristics of those who have been found to telecommute. Of significant interest:

- Professional and managerial staff account for 43 percent of those telecommuting.
- Business services, relating/wholesaling, and banking/finance tend to be the leading telecommuting industries.
- By far, smaller companies constitute a large majority of those firms having telecommuters.
- A fairly even distribution of men and women are found in the telecommuter sample.
- The median income of a telecommuter is $40,000 with a substantial number of telecommuters having incomes less than $50,000.

Benefits/Costs: The travel impacts of telecommuting have both a spatial and temporal dimension. Telecommuting could have an almost immediate effect on the level of trip-making and thus on the transportation network. Over longer periods, telecommuting could affect auto ownership and land use patterns (Sullivan, Mahmassani, and Herman 1993). Many of the studies on telecommuting have often started with assumptions concerning the rate of usage among target employee groups. As noted earlier, telecommuting today tends to be associated with fairly specific employee and employer types, which means that understand-



Source: U.S. DOT 1993

Figure 5.2: Characteristics of Those Who Telecommute

Figure 5.3: Perceived Advantages to Telecommuting/Teleworking

Source Walk and Hellot 1997

ing your employee profile becomes a critical first step in assessing what level of impact can be expected. A national study, for example, estimated the following impacts based on projected future telecommuters in the labor market (U.S. DOT 1993). The number of telecommuters was expected to increase from 2 million in 1992 to between 3.1 and 6.2 million in 1997 and to between 7.5 and 15.0 million in 2002. This level of telecommuting thus represented between 5.2 and 10.4 percent of the labor force in the year 2002. The expected average number of days of telecommuting per week rose from 1 to 2 days in 1992 to 3 to 4 days in 2002.

To employees, the benefits of telecommuting will vary depending on the specific circumstances. Figure 5-3 shows the results of a survey of telecommuters in Southern California and the advantages perceived by this work group (Valk and Hellot 1997).

Some examples of telecommuting in the U.S. and of subsequent impacts include:

Southern California: The Southern California Association of governments implemented a demonstration project with 14 percent of its employ ees participating. Each telecommute saved 31 vehicle miles of travel, with average participation being once every nine days (Southern California Association of Governments 1988).

State of California: Travel diaries were used to track trip-making behavior of 400 state employees. On days they worked at home, telecommuters reduced their number of personal trips by 27 percent; their total vehicle miles traveled by 77 percent, and freeway travel by 40 percent. In addition, a study in California of the air quality impacts of telecommuting which took into account changes in average travel speeds and proportional changes in cold starts (a significant contributor to vehicle emissions) showed a 39 percent decrease in cold starts. This resulted in a reduction in Total Organic Gases (TOG) of 48 percent; a 64 percent reduction in CO; a 69 percent reduction in NOx, and a 78 percent reduction in particulate matter. However, it was also found that while the vehicle miles traveled for commutes decreased on average by 5.3 miles, the number of non-commute trips on average increased by 0.5 trips per person-day. This supports the suggestion that non-commute pollutant emission could be a negative impact of telecommuting (Koenig, Henderson and Mokhtarian

1996; Mokhtarian, Handy and Saloman 1995).

Puget Sound: When telecommuting, workers averaged 30 percent fewer trips, a 63 percent reduction in vehicle miles traveled and 44 percent fewer cold starts. These factors resulted in a 50 to 60 percent reduction in per vehicle emissions per telecommuting day (Henderson, Koenig and Mokhtarian 1996).

Hawaii: A telework facility was established approximately 20 miles/32 kms from downtown Honolulu. Travel time savings per telecommuter were 7.4 hours per week with 93 percent of the employees reporting a reduced number of work trips (Mokhtarian 1992).

The following studies illustrate the potential impact to the employer (National Research Council 1985).

Blue Cross/Blue Shield South Carolina: A comparison was made between telecommuters and in-office employees. Evaluations of individual performance for both groups showed that telecommuters were rated much better by supervisors than in-office workers.

Control Data Corporation Minnesota: Telecommuters estimated that their productivity improved 35 percent when they telecommuted; managers rated the productivity improvement at 30 percent.

Pacific Bell: Managers estimated a 20 percent increase in productivity and telecommuting were considered far greater than the costs, not even including the savings of at least $500,000 in office space costs.

Another typical approach to estimating the impact of telecommuting is shown in Table 5.9. This Table shows the impact of a 5 percent participation rate in telecommuting in seven Texas cities (Turnbull et al 1995).

The impact of telecommuting on the performance of the transportation system will clearly depend on the rate at which it is adopted by firms and accepted by individuals. However, given the trend in the use of telecommunications, it seems likely that successful TDM programs in the future will have to include telecommunications as a mobility strategy. Telecommuting is not for everyone; but a substantial market for telecommuting is developing rapidly along with the monumental changes occurring in the use of computers and large-scale communications networks (Risse, Risse and Williams 1994).

The impact of telecomuting on the performance of the transportation system will clearly depend on the rate at which it is adopted by firms and accepted by Individuals.

The cost associated with telecommuting occurs primarily to organizations or groups implementing such a program. Costs include personnel training for those telecommuting as well as for those managing such a workforce, installation and operating charges, computer purchases and/or maintenance, other fixed costs (e.g., the building and furniture for a satellite center), and administration costs. A two-year telecommuting demonstration project with City of Los Angeles employees cost $970,000 with the resulting costs per employee per year of about $970 (Southern California Association of Governments 1989). Another study estimated first year cost at $530 per participant, declining to $258 per year

Table 5.9: Estimated Impacts of Telecommuting in Texas *(assuming 5% Participation)*

Location	Austin	Corpus Christi	Dallas	El Paso	Fort Worth	Houston	San Antonio	Total
Workers	244258	109254	500566	199385	204846	772957	395551	2426817
Avg. Person/Veh	1 09	1 11	1 1	1 11	1.11	1 11	1 1	1 1
Percent SOV	74%	76%	72%	74%	77%	72%	73%	74%
Avg Trip Dis	14.0	12 7	16 9	14 8	14 6	16 9	16 6	15.3
Base VKT	1569 1	625.9	3828 0	1331 3	1356 2	5889.1	2968 1	17567
Base SOV work trips	90	41	181	74	79	277	145	887
Annual savings in:								
Annual VKT	23 3	9.3	57 0	19.8	20 1	87.5	44.1	261 0
SOV work trips	1.2	0 5	2 4	1 0	1 0	3 62	1 9	11 6

Note VKT = Vehicle Kilometers Traveled (in millions)
SOV work trips in millions

Annual Emission Reductions From a 5 Percent Level of Commuting (in metric tons)

	HC	CO	NOx	HC	CO	NOx
Austin	17 6	177 5	11,4	12.2	113.9	10 2
Corpus Christi	7 0	71 0	4 6	4 9	45 5	4 1
Dallas	42 9	433 2	27.9	29 8	277.6	25 0
El Paso	14.9	150 5	9 7	10 3	96 4	8.7
Fort Worth	15 2	153 0	9 9	10 5	98 0	8.8
Houston	65 9	665 8	42 9	45 7	426 6	8 3
San Antonio	33 2	335 3	21 6	23.0	214 8	19 3
Total	196 7	1986 3	128 0	136 4	1272 8	114 4

Source. Turnbull et al 1995

The implementation of telecommuting strategies as part of a TDM program requires a strong mixture of public sector support and private sector action To be effective at an area level, telecommuting must have the participation of numerous private companies

thereafter (Nilles and Siembak 1991). In most of the studies conducted to date, however, the benefits of investing in societal benefits (i.e., reduced costs) of lower congestion and improved air quality (see Table 5.10).

Implementation: The implementation of telecommuting strategies as part of a TDM program requires a strong mixture of public sector support and private sector action. To be effective at an area level, telecommuting must have the participation of numerous private companies. Given this participation, the following elements appear to be critical for a successful telecommuting program: (Valk and Hellot 1997).

- Top Management Support: Management must be willing to provide necessary resources to implement a program, as well as approval for changes to administrative procedures.
- Policies and Human Resource Support: Clear articulation of company policies concerning telecommuting is necessary to establish the boundaries of employee expectations. Human resource personnel should be ready to assist telecommuters with difficulties.
- Job Tasks: Only certain job tasks are appropriate for telecommuting. An early effort to identify these will provide benefits later on in targeting specific employee groups and in establishing realistic expectations.

Table 5.10: Benefits of Travel Through Telecommunications

From the Point of View of:		
Employer	Advantages	Increased productivity Reduced facility space and expenses Difficult shifts covered Retention to valued employees Lower sick leave, reduced health care costs Telework useful as on-call workforce Savings in relocation expenses Off-hour utilization in mainframe computers Savings on shift work, overtime Improved motivation of employees
	Disadvantages	Change in basic organizational practices Competition from offshore labor Possible increased need for computers
	Issues/Concerns	Decreased productivity/worker accessibility Loss of corporate culture and office quality Trust and control of employees Lack of experience in remote supervision Union opposition Security, confidentiality of property and ideas Insurance issues Health and safety issues
Employee	Advantages	Reduction or avoidance of commuting time Cost savings on wardrobe, parking, meals Proximity to family and community Autonomy and control over work conditions Relaxation of time-space constraints Improved quality of life
	Disadvantages	Speedups and/or electronic monitoring Forced subcontracting Lack of support
	Issues/Concerns	Exacerbation of existing family problems Isolation from colleagues Tendency to overwork Pressure to work harder to justify teleworking Career sidetracking Possible lower wages, benefits, etc Widening of money and autonomy gaps
Transportation Planner	Advantages	Reduced total and peak hour vehicle miles Leveling out of peak hour transit use Reduced infrastructure maintenance Possible mitigation of land use pressures Mitigation of congestion and air pollution Reduced traffic accidents and corresponding costs Possibly positive mode change effects
	Disadvantages	Not under the direct control of public agencies
	Issues/Concerns	Uncertainty as to magnitude of benefits Uncertainty as to whether congestion will be less Unknown impact on ridesharing and transit Possible residential relocation farther from CBD
Telecommunications Industry	Advantages	Enhanced demand for telecommunications products
	Issues/Concerns	Increased pressures on capacity of networks Multinational connectivity/political problems Extent of government regulation unclear Degree of technology necessary Compatibility of technology
Society	Advantages	Increased energy conservation/cleaner air Control of infrastructure costs Less highway congestion/improved highway safety Contribution of healthy business climate Stronger connection of workers to families Greater sense of community
	Issues/Concerns	Possible acceleration of downtown abandonments Land use sprawl

Source: U S DOT 1993

- Supervision: Telecommuting cannot be undertaken in a normal chain-of-command structure where supervisors provide direct oversight. New supervisory procedures and employee evaluation approaches will most likely have to be developed.
- Ongoing Monitoring: Successful telecommuting programs will likely require periodic adjustments. This implies the existence of on-going monitoring efforts.

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Complementary Support Measures

Description: One of the common findings. from TDM program evaluations is that their effectiveness is directly related to the degree to which complementary measures are used to encourage the use of TDM actions. Some reports, in fact, have stated that without some form of financial incentive, program effectiveness will be minimal. Such sup port measures can include a wide variety of actions most of which fall into the following categories: (Cambridge Systematics, Inc. 1994)

Financial incentives

- Transportation allowance
- Bike subsidy
- Carpool subsidy
- Transit pass subsidy
- Other fianancial subsidy
- Vanpool seat subsidy
- Transit subsidy
- Vanpool subsidy
- Walk subsidy
- Additional time off with pay

Assistance Programs

- Commuter information center
- Commuter fairs
- New hire orientation
- Marketing
- Special interest group marketing
- Regional rideshare match
- Employer-based rideshare match
- Information booths
- Company-owned/leased vanpool
- Parking management

Flexible Work Schedules

- Flexible work hours
- Telecommuting program
- Compressed work week

Award Programs

- Recognition in newsletter
- Prize drawing/free meal certificate

Other

- Child care center
- Auto service
- On-site services (e.g. post office)

These actions were found in a sample of employers in the Los Angeles metropolitan area. As shown, support measures can be grouped into five categories: financial incentives, alternative work hours and telecommunications, assistance programs, award programs, and other on-site services (Cambridge Systematics, Inc. 1994). Statistically, financial incentives were the only strategies that proved significant in explaining resulting mode share. Another study based on extensive case studies assessed the relative importance of different support strategies shown in Figure 5-4 (Comsis Corporation 1994). As noted in this report, "perhaps no action has a greater single effect on discouraging the use of single occupant vehicles and increasing the attractiveness of alternatives than placing a price on parking."

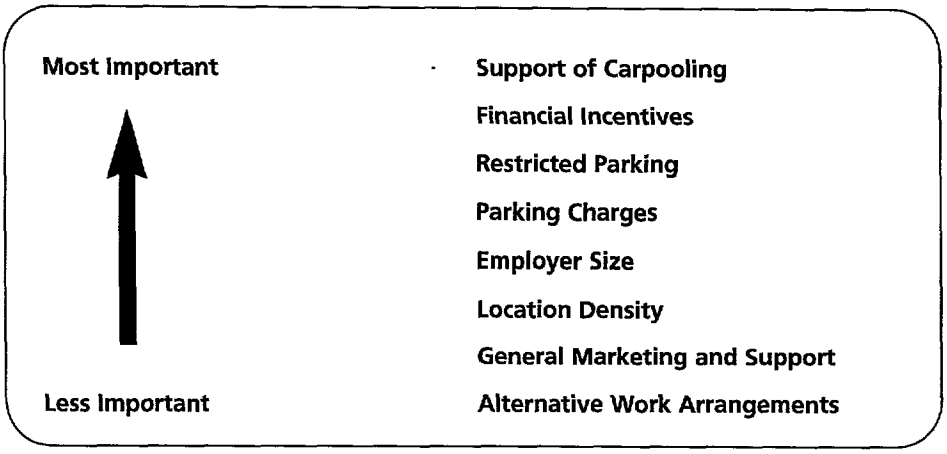
The different types of major support measures include the following:

Economic Incentives/Disincentives: A key determinant in a traveler's trip-making decision is the time and cost associated with the travel. Thus, any action which adds or reduces the perceived cost of a particular mode will greatly influence the likelihood of it being chosen (assuming it is available for the trip). Common incentives and disincentives found in

Major support measures include:

- *Economic Incentives1 Disin cen* tives
- *Preferential Treatment*
- *Supporting Services*
- *Site Amenrties and Design* Marketing

Figure 5.4: Relative Importance of TDM Support Measures



Financial incentives will have an even bigger impact if implemented in conjunction with other support measures However, support measures without financial incentives will likely have little impact on travel behavior.

TDM programs include:

Transit Fare Subsidies: The employer provides the total or partial purchase of transit passes or fares. In Seattle, for example, King County employees receive a $20 per month subsidy toward transit costs.

Operating Subsidies: Usually applied to vanpool operations, employers provide some portion of the cost to use a van for vanpooling. This could include the van itself, free or subsidized fares, coverage of liability, or free use of the van for the driver.

Travel Allowance: A monthly stipend is provided to a commuter which can be used to "purchase" any form of transportation desired. Parking is usually charged at full cost which thus provides an incentive to seek cheaper modes of travel.

Parking Charges: Use of company-provided parking facilities is charged at different rates depending on vehicle occupancy. Those with higher occupancy have reduced or zero charge.

Personal: These incentives are used to entice commuters to consider rideshare modes. Examples include earning cash bonuses for every 120 days that a commuter uses an alternative mode, monthly prize drawings, extra vacation days, and cash prizes for recruiting more users of alternative modes. Commuter Bonus Plus in Seattle provides a $20 certificate per month for King County employees who work outside the downtown and who carpool, bike, walk to work at least 51 percent of their total workdays. The certificates can be used at local retail stores.

Parking Cash Out: An employer-funded program where the employer offers to provide a cash allowance to an employee equivalent to the parking subsidy that the employer would otherwise pay to provide the employee with a parking space. The employee can then decide to spend this allowance on parking or on other means of transportation thereby receiving a financial benefit, assuming these other means are cheaper than the parking charge.

Such financial incentives as these will have an even bigger impact if implemented in conjunction with support measures such as those described below. However, support measures without financial incentives will likely have little impact on travel behavior.

Preferential Treatment: As noted in Chapter 2, preferential treatment of high occupancy vehicles is an important tool for providing time advantages to those who rideshare. At the regional or corridor level, the most common tool is the HOV lane along a roadway or at congested locations. At the site level, preferential treatment can also be provided to add to the time advantage that comes from regional HOV facilities. For example, ridesharers could be allowed to park closer to the entrance of a building, or provided with more convenient access and egress to the site.

Supporting Services: Successful TDM programs usually have strong supporting services that reinforce the desirability of using alternative modes. A transportation coordinator for a site can simplify the information and decision process for commuters. The use of a guaranteed ride home service has had significant impact at some sites by eliminating commuters' fears that they will be stranded at work with no way to get home or respond to emergencies. Any combination of the following is often used to provide guaranteed ride home service: (Orski 1993)

- Company cars or vans
- Taxi services (usually for employees who work less than 20 miles from the worksite)
- Car rentals (usually for employees who work more than 20 miles from the worksite)
- Limousines
- Straggler vanpools (a vanpool that serves late-night or overtime workers)
- Ad hoc Carpools (with advance notice, rides can be shared with other employees)
- Public transit (subsidized use of public transit services)
- Safety escort services (security guard escort to nearest transit stop)

Site Amenities and Design: The goal of these measures is to make a particular site more "friendly" to the use of alternative modes. Measures could include designs to accommodate bus and van movements, attractive rideshare loading areas, bicycle storage and showers, and pedestrian-friendly walkways. Other amenities include providing on-site cafeterias, convenience shopping, day care facilities, automatic teller machines, and other activities that would have to be accomplished with a personal auto if not available on site. (See Chapter 4, Transit-Oriented Development, and Urban Design, later in this chapter.)

Marketing: Given the challenge of convincing travelers to change their behavior, marketing activities become critical to the success of TDM programs. Such marketing could consist of posters, bulletin boards (electronic and otherwise),

Successful TDM programs usually *have strong supporting services that reinforce the desirability of using alternative modes.*

newsletters, promotional events, and extensive use of surveys to better understand the customers' desires.

Benefits/Costs: The difficulty in assessing the benefits of support measures is that they are often implemented as a package; thus, individual impacts are not easily distinguished from one another. One of the few studies that has attempted to do this examined major employers in Los Angeles (Cambridge Systematics, Inc. 1994). The results are shown in Table 5.11 which seem to indicate that the reduction in drive-alone trips ranges from 2.7 to 5.4 percent for subsidies and from 0.9 to 5.7 percent for conducive land use characteristics. This range of reductions corresponds well to the conclusions of another major study that estimated the impacts of support measures to be: (ITE 1993).

- Shifts to ridesharing as a result of information programs can be expected to be only 0 to 3 percent. The presence of an on-site transportation coordinator seems to make TDM programs slightly more effective.
- Work site design and the presence of on-site services may contribute incrementally to employees' decision to rideshare...
- Guaranteed ride home is a very important incentive for a very small percentage of commuters and perhaps strongly contributes to the mode choice decision of 2 to 5 percent of commuters who shift to ridesharing.
- Financial incentives are effective in reducing trips by 8 to 18 percent. Disincentives in the form of parking charges can also produce similar results.

Gwen the challenge of convincing travelers to change their behavior; marketing activities become critical to the success of TDM programs.

Table 5.11: Impact of TDM Support Measures on Drive Alone Mode Share

Strategy	Percent Change in Drive Alone When Absent	Percent Change In Drive Alone When Present	Difference (TDMs Present - TDMS Absent)
Bicycle Subsidy	-4.4%	-7.1%	-2.7%
Vanpool Seat Subsidy	–47%	-10 1%	-5.4%
Transit Subsidy	-3.2%	-6.3%	-3.1%
Vanpool Subsidy	-44%	-7.7%	-3.3%
Other Employee Benefits	-3.9%	-8 0%	-4.1%

	Percent Drive Alone		
Land Use	Sites with Land Use Characteristics Missing	Sites With Land Use Characteristics Present	Absolute Percent Change
Mix of land Uses	71.7	70.8	-0.9
Accessibility to Services	72.1	70.5	-1.6
Preponderance of Convenient Services	72.4	69 6	-2.8
Perception of Safely	73.2	706	-2.6
Aesthetic Urban Setting	72.3	66.6	-5.7

Source: Cambridge systematics, Inc. 7994

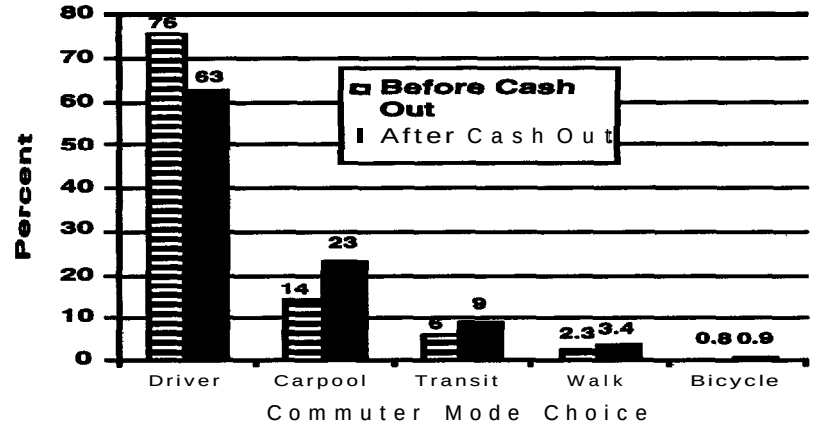
This latter conclusion illustrates the importance of parking management to travel behavior. For example, a study of eight locations in Los Angeles that implemented parking "cash out" programs showed the results in Figure 5-5 (Shoup 1996). On a per employee basis, the parking cash out programs at these eight sites reduced 43 vehicle trips per employee per year, 652 vehicle miles per employee, 1.8 pounds of ROG emissions, 1.5 pounds of NOx emissions, 15.9 pounds of CO emissions, 1 .l pounds of PM10 emissions, 26 gallons of gasoline, and 514 pounds of CO2 emissions, all per employee per year The total benefit to society per employee was estimated to be $99.13, and the costs were $24.53 for an approximate benefit/cost ratio of 4/l.

The costs associated with support measures will vary by situation. Table 5.12 shows a typical calculation of the costs relating to program marketing and a guaranteed ride home. It should be noted in this Table that the cost estimates for the guaranteed ride home assumes actual use of such a service. In Bellevue, Washington, of the 250 people registered for such a program, only 30 took taxi rides during the first year. Therefore, real costs of such programs tend to be much less than the theoretical cost liability of program administration that is considered upfront in proposals (Seattle METRO 1989).

Implementation: The most important factor in the implementation of support measures is that they need to be implemented in conjunction with tangible TDM actions. By themselves, support measures will have very little impact. Some important lessons learned from recent studies: (ITE 1993)

- Marketing and information materials should be targeted to the characteristics and attitudes of the customers
- Marketing should be highly visible and continuous
- Prizes and other incentives should be clearly defined as rewards for participating in the TDM program

Figure 5.5: Effects of Parking Cash Out On Commute Mode Choice



Source Shoup 1996

Table 5.12: Typical Costs of TDM Support Measure Program

Program Marketing	
Employer Programs	
• *fewer* than 1.000 *employees*	$10,000 to $55,000 per year
• over I.000 employees	$18 000 to $100,000+ per year
areawide Programs	$62.000 to $250,000+ per year
Guaranteed Ride Home	
Planning/Administration	$3,000 to $15,000
Estimated Annual Trip Cost (15 miles)	
• *7 00 eligible commuters*	$20 to $30
• *500 eligible commuters*	$150 to $1,500
• 5,000 eligible commuters	$1,500 to $15,000

Program marketing includes costs for one staff member (65%), marketing materials (15%), special promotions (15%). other (15%)

GRH trip cost ranges assume 1 % to 10% use rate (percent of eligible employees who use GRH during a year) and I5-mie average tnp ($30 per tnp by taxi or rental car)

Source Seattle *METRO 1989*

- Compliance with the incentive and disincentive policies should be closely monitored
- TDM program goals and objectives should be evaluated on a regular basis
- Spread the Word

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AREA WIDE STRATEGIES

To truly make a difference in a community, TDM strategies will have to be implemented at an areawide level. As noted in an essay on the role of transportation in improving air quality (Replogle 1993),

"It is essential that the limitations of work-trip related transportation control measure (TCM) planning and implementation should not lead to a false *conclusion that demand management is not a viable or cost-effective approach to* addressing air pollution, congestion, or other transportation-related *problems.* There are several other groups of demand management *strategies with significant* potential *for cost-effective emission reduction which to date have received relatively* little consideration by MPOs , states, and local governments--

Pricing TCMs . . . *better* internalizing in market prices the *costs* of transportation.. .

Short Trip TCMs . . ensuring the right to *walk in one's own community and enhancing the bicycle-friendliness* of street networks.. .

Growth Management TCMs . . . wider use of growth management strategies, *implemented* through zoning and *development permit processes, site-*specific impact fees, or facility-specific transportation facility *pricing. . . "*

These types of demand management strategies are oriented to area-wide applications.

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Growth Management

Description: Growth management can be defined as the use of public policy to regulate the location, geographic pattern, density, quality and rate of growth of development. By knowing the trip generation characteristics of various land uses and then exercising control over those uses, one can theoretically limit the trip generation of a particular area to any given level (Washington State DOT 1994). This level would be consistent with the capacity of the existing infrastructure (e.g., roads, water supply, sewer) and the level of service desired. A comprehensive growth management strategy can include not only transportation actions, but also actions dealing with housing, economic development, open space, and community infrastructure. Three growth management examples follow:

Montgomery County (Maryland) Adequate Public Facilities Ordinance: The Montgomery County Council enacted the Adequate Public Facilities Ordinance (APFO) in 1975. The law is quite simple:

"New Subdivisions may not be approved unless the Planning Board *determines that there* will be adequate *public facilities to* support the development. "

By knowing *the trip generation characteristics of various* land uses *and then exercising control over those uses, one can theoretically limit the trip generation of a particular area to* any given level

The Montgomery County Planning Board has the authority to withhold subdivision approval if existing roads, plus new roads, plus transit scheduled to be completed in the capital improvements program will not satisfactorily handle the additional traffic from the proposed subdivision plus traffic from existing and previously approved development. In essence, the APFO allows the County to delay new development until "adequate" transportation facilities are in place. An elaborate technical process, involving sophisticated predictive techniques and allowing credit for demand management actions, is used to determine whether the facilities are "adequate." The County adopts an annually updated Annual Growth Policy that identifies public facilities and needs and provides a means of balancing the amount of private subdivision approvals with the availability of public facilities (Montgomery County Council 1996).

The traffic test of the APFO is applied through a local area review (LAB), which represents a typical impact study of nearby intersections and through a policy area review (PAR), which involves an areawide analysis. PAR divides Montgomery County into 27 travel sheds called "policy areas," which are classified into seven categories of allowable traffic congestion. In the southern portion of the county, where development densities are high and transit service is extensive, higher levels of traffic congestion are allowed before the policy areas' road capacity is deemed "inadequate." In the less urbanized portions of the county, where transit service is poor or nonexistent, lower levels of traffic congestion are allowed. Each year, the traffic generated by existing and approved development is simulated on a network of existing and programmed transportation facilities to determine the amount of additional residential and non-residential development that can be accommodated in each policy area before the threshold level of service is met. If the forecasted congestion is worse than the standard in a policy area, no more development can be approved through the subdivision process until more capacity is created. If the simulated level of service is higher than the standard, then the proposed development must still pass the LAR test. The level of service standards for the LAR test vary with lower levels of service permitted in areas with greater transit service and higher levels of service that need to be met in areas with less transit service. Strategies that have been utilized by developers to address PAR and LAR deficiencies include roadway construction to increase capacity or the implementation of TDM programs to reduce a sufficient number of trips to mitigate the impact of the capacity deficiency.

Portland (Oregon) Growth Management Policy: In 1973, Oregon's legislature passed the Land Use Act which outlined statewide planning goals for all cities and counties in the state. This was one of the first attempts in the United States to establish a comprehensive framework that would guide local investment decisions. In 199 1, a transportation rule was adopted that required full

integration of land use planning and transportation planning in the Portland metropolitan region. The goal of this rule was to reduce the dependence on the personal automobile for mobility in the region, and to coordinate transportation investments with land use policies. Portland Metro, the metropolitan planning organization for the region, adopted its own regional urban growth goals and objectives and initiated a long-term study to evaluate various growth scenarios and what investment policies would be necessary to encourage each scenario to occur (Metropolitan Service District of Portland 1992). An important tool in Portland's growth management policy is the establishment of an urban growth boundary (UGB). The UGB in Portland is a boundary established within the regional governance structure that promotes greater densities and urban design within the boundary, and limits the extension of urban services to locations outside the boundary. In this way, closer coordination can occur between those providing community infrastructure and those approving development decisions.

In addition, the City of Portland has adopted several innovative policies aimed at encouraging the use of transit. These policies include: establishing a cap of 44,322 parking spaces downtown (not including residential and hotel), maximum parking ratios ranging from 0.7 parking space per 1,000 square feet in a transit mall to 1.0 space per 1,000 square feet away from the mall, prohibition of new stand-alone parking garages, short term parking meters, residential parking permit programs to avoid spillover effects, and the implementation of an areawide TDM program. This TDM program has several tools that have been discussed already in this chapter. The basis for trip reduction was the required Employee Commute Options (ECO) Rule resulting from the 1990 Clean Air Act (but later amended to be voluntary) that required employers with 50 or more employees to develop trip reduction programs. The target was a 10 percent reduction in trips for employers with 50 to 100 employees; a 20 percent reduction for employers with more. Given the voluntary nature of this Rule, Portland officials have relied on a package of TDM actions to achieve the target values. This package includes:

Ridesharing: Establish use of car-pool/vanpool matching. Preferred parking for carpools/vanpools. Subsidies for carpool/vanpool passengers. Furnish employer-provided vehicles for ridesharing.

Public Transit: Sell transit tickets/passes on site. Provide subsidies to transit users. Supply on-site transit route maps and schedules. Create shuttle between transit stations and work site.

Bike/Pedestrian: Offer subsidies to cyclists and pedestrians. Install lockers and showers for cyclists/pedestrians. Provide bikes for commuter use and/or worksite use.

Parking Management: Eliminate employer allowances. Shift parking subsidies to transportation allowances. Offer free or reduced

rates to car/vanpools. Implement a charge for employer parking.

Elimination of Trips: Establish telecommuting programs. Allow flextime for employees who rideshare. Schedule compressed work weeks.

Provision of On-Site Services: Offer guaranteed ride home. Provide childcare at or near worksite. Create on-site services such as cafeterias, banks, etc. Designate an employee transportation coordinator. Add site modifications to enhance commute alternatives.

The ultimate savings result *from* not *having to build new highways* or *other large scale infrastructure to serve development that locates throughout a metropolitan region.*

Broward County (Florida) Traffic Concurrency System: In 1985, the Florida State Legislature enacted the Omnibus Growth Management Act which created an array of mechanisms to implement a growth management process throughout the state. The principal focus of the growth management process was the legislative mandate for each local government to adopt a comprehensive plan and a set of subsequent land development regulations. The Act required greater enforcement of local plans and consideration of capital facilities and the means to pay for them. A major thrust of the new Act was for localities to project their needs for roads, water, sewer and other facilities, then ensure that the facilities are funded and constructed concurrent with the growth they serve. Each community was to develop levels of service for transportation, education and other services. Communities could not issue building permits or adopt zoning changes which would result in a decline in the level of service below the standards or until the necessary infrastructure was in place "concurrent" with the phasing of development.

In 1989, Broward County established a concurrency management system to implement the requirements of this state law (Montgomery County Planning Department 1991). Applications for new development must satisfy two required determinations relating to the adequacy of the surrounding road network. Any development near a regional roadway that affects the capacity of this roadway will not be permitted until sufficient capacity is provided. This is the so-called "concurrency" requirement. The second test reflects a situation where a proposed development will affect the roadway system. In this case, a fee is assessed to improve any over-capacity roadways that will be affected by the proposed development.

Local plans for implementing the state's growth management policy must be consistent with state and regional plans. Failure to adopt a comprehensive plan could result in the withholding of state funds, including transportation funds.

Benefits/Costs: The benefits of a growth management strategy primarily rest in the enhanced efficiencies in service provision that can result from development patterns that are easier to serve. The ultimate savings result from not having to build new highways or other large scale infrastructure to serve development that locates throughout a metropolitan region. The closer one can relate development levels to the capacity of

the transportation system for handling development-generated trips, better decisions can be made on where and how to provide options for mobility. A comprehensive growth management strategy can also be used to help a community better understand the type of future it desires, and alternative strategies for getting there.

Some administrative costs are usually associated with implementing a growth management strategy. Depending on the specific actions implemented, administrative oversight and planning activity is required to assure equitable application of the growth management requirements.

Implementation: Experience with growth management strategies has shown that the following steps are critical to success:

1. Identify the most pressing symptoms of growth management-related problems.
2. Consider alternatives for quick responses to the pressing symptoms taking into account the community's administrative, financial, and political situation.
3. Combine these quick responses with short-term steps to address the need to plan and initiate a broad-based growth management effort.
4. Begin the long-range task of comprehensive planning and on-going land use management and administration.
5. Establish a base inventory of current services and infrastructure serving your community, and the current service levels being experienced.
6. Create an equitable allocation mechanism for assigning costs of development-generated demands on this infrastructure to new developments.

Some regulatory tools that are available to many communities include amendments to zoning language, modifications to zoning maps, adoption of new subdivision regulations, changing other permitting procedures (e.g., driveway permits), etc. Many of these tools can be very controversial so it is important that the general public be made aware of what is being proposed and the implication of taking no action at all.

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Urban Design

(See also, Transit-Oriented Development)

Description: Urban design strategies can include many different initiatives for enhancing personal mobility, including creating greater develop ment densities, promoting mixed use developments, providing a balance of jobs and housing to minimize long distance travel, and incorporating more pedestrian and transit-friendly site designs into development plans. The general consequence of these types of strategies is that walk trips increase, ridesharing becomes a more feasible option to commuters, and shared use parking is possible. Cervero, for example, found that every 20 percent increase in the share of floorspace that is devoted to retail and commercial uses in suburban office developments is associated with a 4.5 percent increase in the share of trips by car-pool, vanpool, and transit (Cervero 1989). More recent studies indicated that there is much that can be gained by thinking very carefully about urban design. A Transit Cooperative Research Program project reviewed studies done by several metropolitan areas on the relationship between urban form and transportation services and made the following observations: (Transportation Research Board 1995)

Urban design strategies can include creating greater development densities, promoting mixed use developments, providing a *balance of jobs and housing to minimize long distance travel, and incorporating more pedestrian-* and *transit-friendly site designs into development plans*

Middlesex County, New Jersey

Forecast growth in trips would decline by 30 percent and vehicle miles of travel growth would decline by 33 percent if urban design measures such as clustering suburban employment growth occurred.

Montgomery County, Maryland

The pattern of development in the region has more influence on congestion than the rate of growth or the job and housing mixtures. Dispersed origins and destinations produced more congestion.

Baltimore

Concentrating growth in urban counties and/or near transit stations caused declines in vehicle miles traveled and improved air quality.

Washington D.C.

Adding households to zones where highest employment growth rates were to occur resulted in increased transit work trips and a 10 percent decrease in VMT per household.

Figure 5-6 shows the results of a study in the San Francisco Bay Area that related residential densities to vehicle miles traveled per resident (Harvey 1990). As shown, such a relationship for this region does seem to exist, with a rule of thumb established of reducing vehicle miles traveled per resident by 30 percent for every doubling of density.

One of the most comprehensive studies of the impact of urban design on a community occurred in the early 1990's in Washington County, a suburban area of the metropolitan Portland, Oregon region. Called LUTRAQ, this study and subsequent program was based on three principles (1000 Friends of Oregon 1997).

- "Land use plans should direct higher intensity development to locations well-served by transit and should ensure that develop ment is designed for pedestrians,

Figure 5.6: Relation of Residential Density to VMT Per Resident in San Francisco Bay Area

Source: Harvey 1990

bicyclists, and transit riders, as well as auto drivers.

- The transportation system should serve and reinforce the nature of that development.
- Market strategies should further support that development by correcting some of the current distortions in the pricing of the transportation system and other public facilities."

The LUTRAQ scenario envisioned transit-oriented development occurring in three varieties—mixed use centers, urban sites primarily near transit stations, and neighborhoods located on feeder bus lines. The transportation component of this scenario included light rail, express bus service to major activity centers, local feeder buses, demand-responsive transit, bicycle and pedestrian improvements, and modest road improvements. Supporting policies in the scenario included a $2 parking charge for all commuters who drove alone and free transit for all those working in the study area.

At the site-specific level, urban design means primarily providing for the most pedestrian- and transit-friendly location and form for proposed development. The strategies associated with this type of urban design can range from the provision of sidewalks, to the design orientation of an entire subdivision that is more open to pedestrian movement. When pedestrian-friendly environments are combined with mixed use development patterns, possibly significant changes in overall trip generation could occur because of the decrease in the need to travel elsewhere for desired activities. A 1993 study of five regional shopping centers in California, for example, found that

At the site-specific level, urban design means primarily providing for the most pedestrian- and transit-friendly location and form for proposed development.

land use mix along with some travel reduction measures could reduce the amount of trips by 5 to 7 percent to these destinations (JHK & Associates 1993). Another study in San Francisco showed that an older, more traditional neighborhood had 23 percent trips made by walking and 22 percent by transit, whereas suburban residents made only 9 percent of trips by walking and 3 percent by transit (Fehr and Peers Associates 1992).

Figure 5-7 shows a preferred development pattern to facilitate walking compared to a typical suburban development more oriented to automobile access (Regional Transit District 1995). The pedestrian-oriented development pattern provides straight and uninterrupted interconnections between activities at this site. This site could be adapted to provide a development pattern surrounding a transit station (see Chapter 4 for a discussion on Transit-Oriented Development).

The benefits of urban design strategies to enhance mobility are primarily found in the increased use of alternative modes of transportation and *the reduction in vehicle miles traveled for these types of communities*

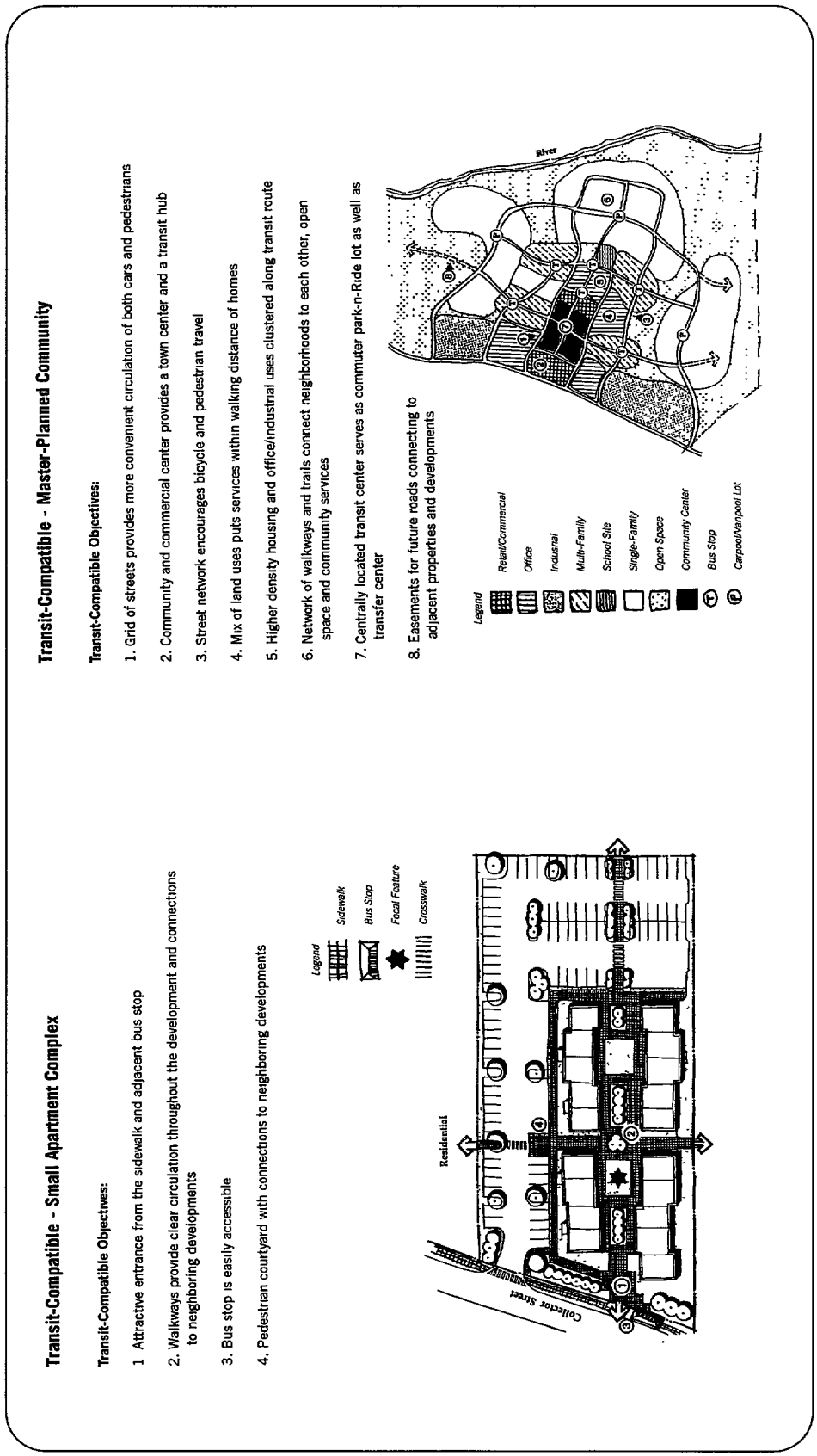
Benefits/Costs: The benefits of urban design strategies to enhance mobility are primarily found in the increased use of alternative modes of transportation and the reduction in vehicle miles traveled for these types of communities. Mobility for residents is still maintained; it simply occurs over shorter distances and often in a variety of forms. If applied at a large scale, such results could have a positive effect on air quality and energy consumption. A study in the Bay Area by Cervero showed that the pedestrian/bicycle mode shares and trip generation rates were all higher in traditional, older neighborhoods. Transit-oriented neighborhoods generated about 70 percent more transit trips and 120 percent more pedestrian/bicycle trips than nearby auto-oriented neighborhoods. Each additional dwelling unit per acre in the traditional neighborhoods raised the share of transit work trips by 2 to 3 percentage points relative to auto-oriented neighborhoods (Cervero 1996).

Results of a recent study of suburban neighborhood centers showed that site design (that is, the completeness of pedestrian facilities and route directness provided for pedestrian traffic) appeared to significantly affect the number of pedestrian trips (Moudon, et al 1997). The study also found that despite ample parking, people chose to walk to the suburban neighborhood shopping center because such capability was possible.

The LUTRAQ study mentioned previously illustrates the potential impact of a livable communities approach toward urban development. In comparing the LUTRAQ proposal to an alternative that would have relied on adding highway capacity to accommodate growth, the LUTRAQ alternative had:

- 22.5 percent fewer work trips made in single-occupant vehicles.
- 27 percent more trips made on transit and by non-motorized transportation modes
- 18 percent less highway congestion and 10.7 percent fewer vehicle hours of travel during the afternoon peak hour
- 21 percent greater access to jobs

Figure 5.7: Automobile-Oriented Development Pattern Compared to Transit Friendly Development



Source Regional Transit District 1995

Urban design can range from the provision of sidewalks, to the design orientation of an entire subdivision that is more open to pedestrian movement

- Reduced emissions (6 percent reduction in hydrocarbons, 8.7 percent reduction in nitrogen oxides, and a 6 percent reduction in carbon monoxide)
- 7.9 percent fewer emissions of greenhouse gases
- 7.9 percent less energy consumed

The costs of urban design strategies are not readily apparent. Given he residential housing and commercial/office development markets, costs to individuals would be minimal in hat those desiring not to live in such a community would not locate there.

Many communities have zoning rules and regulations that constrain mixed use developments and/or require development characteristics that work against the urban design concept The implementation of a different urban design strategy for a community thus clearly starts with modifying the design guidelines that influence development.

Implementation: The implementation of urban design strategies can often be complex and controversial. Many communities, for example, have zoning rules and regulations that constrain mixed use develop ments and/or require development characteristics (such as a minimum number of parking spaces) that work against the urban design concept. The implementation of a different urban design strategy for a community thus clearly starts with modifying the design guidelines that influence development. For example, the LUTRAQ proposal recommended that new design standards be established for:

- Transit stops-located adjacent to core commercial areas
- Street configuration-designed and landscaped to provide multiple routes in neighborhoods and assuring connectivity
- Pedestrian connections-provided throughout the community and directly linked to local destinations
- commercial contribution clustered close to transit stations or stops
- *Budding* entries-oriented toward plazas, parks, and pedestrian-oriented streets
- *Building* setbacks-reduced and standardized to provide closure for street space
- Mixed housing-encourage a mix of housing densities, ownership patterns, and building types
- Parks and public spaces-placed next to public streets, residential areas and retail uses to create community focal points
- On-srreet parking-provided on all streets except major arterials
- Off-street parking-located on the side or in the rear of buildings
- Parking configuration-should not dominate pedestrian-oriented streets or interrupt pedestrian routes
- Integrated uses-integrate existing uses by respecting on-going operations, access requirements, and building mass and architecture
- Auto-oriented uses-should be limited or prohibited

In addition, the development community responds to market signals that reflect consumer desires as well as government rules. If consumers do not know what they want or do not have experience with different urban design concepts, improved urban designs will not be easily implemented. The use of urban design as a strategy in a transportation toolbox entails a great deal of education, public outreach, and willingness to change longstanding planning requirements that were initially developed to protect the public interest primarily in relationship to automobile access. A successful community-wide implementation of improved urban design principles or strategies would include the participation of developers, architects, environmental groups, financing institutions, government officials, as well as the transportation community.

If consumers do not know what they want or do not have experience with different urban design concepts, improved urban designs will not be easily implemented. The use of urban design as a strategy in a transportation toolbox entails a great deal of education.

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Congestion Pricing

Description: Congestion pricing, which charges a premium to motorists who wish to drive during peak travel periods or on congested facilities, uses such techniques as tolls, entrance fees, and parking charges (Transportation Research Board 1994). Individual drivers could react to this additional cost of tripmaking by, 1) accepting it, 2) adopting another mode of transportation, 3) going another route, 4) including more passengers in the trip to share the cost, or 5) foregoing the trip. The intent of road pricing then is to "price" highway facilities so that a sufficient supply of highway capacity is provided for those willing to pay this "price." Congestion pricing is

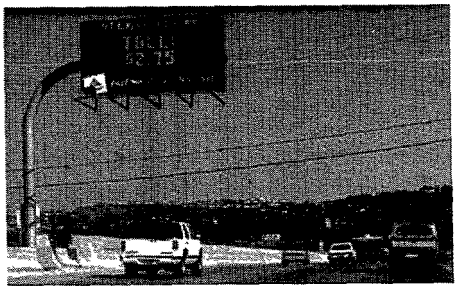
considered an important tool for areawide TDM in that numerous studies have shown that pricing is the most effective means of changing ravel behavior.

Several experiments have been adopted in foreign countries where advanced technologies (e.g., automatic vehicle identification) are used to monitor the vehicle use of congested areas or facilities. At least six types of congestion pricing can be found world-wide: parking surcharges in congested areas, point pricing at a specific location, cordon pricing in which charges are affixed to any vehicle crossing a boundary, zone pricing in which vehicles in a particular zone are charged a fee, prices based on distance traveled in congested areas, prices based on time spent on congested facilities, and congestion-specific pricing which is a combination of distance traveled and time spent in travel (Gomez-Ibanez and Small 1994). Another way of looking at possible congestion pricing schemes is shown in Figure 5-8 (Oregon DOT 1995).

Six types of congestion pricing are:

- *parking surcharges in congested areas*
- *point pricing at* a *specific* location
- *cordon pricing in which charges are affixed to any vehicle* crossing *a boundary*
- *zone pricing in which vehicles in a particular zone are charged a fee*
- *prices based on d/stance traveled in congested areas*
- congestion-specific pricing *which is a combination of d/stance* traveled *and time spent in* travel

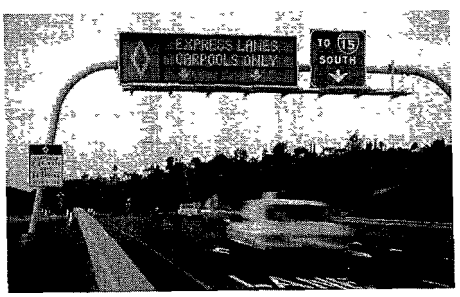
In the United States, congestion pricing has just begun to be considered seriously in selected communities. ISTEA established a Congestion Pricing Pilot Program that would reimburse communities for the costs associated with implementing such programs. Although few projects have yet to be implemented, it is useful to note the following proposals for congestion pricing projects that provide some indication of how such projects could eventually occur in the United States (Federal Highway Administration 1995).



California State *Route 91 Express Lanes.*

California State Route 91:

State Route 91 in Orange County, California is the first fully automated highway in the United States. Two median lanes have been added in both directions to an existing highway, funded through tolls. Tolls are automatically collected by a windshield-mounted device (called a transponder) that debits a driver account. Tolls are distributed into five pricing levels-$0.25, $0.50, $1.00, $1.50, and $2.50 depending on the time of day of travel (CPTC 1995).

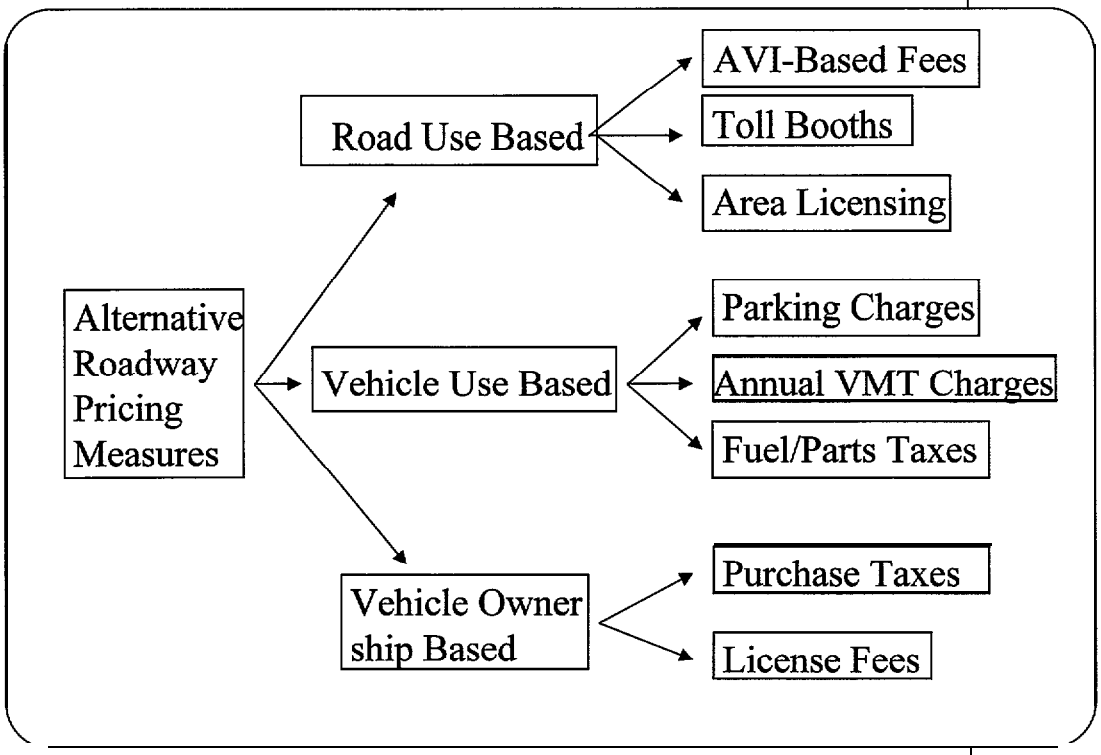


I- 75 San Diego, California

San Diego I-15 Project:

Single occupant vehicles will be able to pay to use the existing HOV lanes in a section of I-15 in northeast San Diego. Revenues generated in this manner will support additional transit operations in the corridor (Duve 1994).

Figure 5.8: Road Pricing Measures



Source. Oregon DOT 1995

Lee County, Florida Toll Bridges:

Lee County, Florida proposes to use peak period tolls collected with transponders. Reduced tolls or no tolls at all will be used to encourage the mobility of specific travel markets, e.g., elderly and carpoolers.

San Francisco/Oakland Bay Bridge:

The Metropolitan Transportation Commission (MTC) proposed charging a $2.00 surcharge during morning and evening peak periods with free passage to high occupancy vehicles (Frick, Heminger, and Dittmar 1995).

Maine Turnpike:

Maine voters passed a referendum requiring the Maine Turnpike Authority to try all possible alternatives before lanes were added to the Turnpike. The Authority disseminated coupons providing for $1.60 off peak period tolls for those traveling on five Fridays and Sundays during the summer. About 13,000 vehicles used the coupons during the first weekend, which represented 16 percent of the off-peak usage.

I-10 (Katy Freeway) Houston:

Existing HOV lanes are restricted to vehicles with three or more occupants. Houston METRO and the Texas DOT are considering allowing HOV vehicles with two occupants to "buy" into this lane through electronic tolling of such vehicles.

Adoption of congestion pricing strategies in the United States has become more technically feasible because of the advancement in electronic toll collection which allows the "price" of travel to be artomati-

Adoption of congest/on pricing strategies in the United States *has become more technically feasible* because *of the advancement in electronic toll collection which* allows *the "price" of travel to be automatically collected as vehicles pass a specific location*

cally collected as vehicles pass a specific location. The convergence of this technology advance with concerns about air quality and equitable allocation of travel costs could create increased interest in congestion pricing over the next several years.

Benefits/Costs: The benefits of congestion pricing could be rather substantial if applied at a regional level. A Transportation Research Board study estimated that a $0.06 to $0.09 per mile charge or a $2.00 to $3.00 per round trip perceived cost would reduce total travel during peak periods by roughly 10 to 15 percent (Transportation Research Board 1994). A review of selected U.S. studies of congestion pricing is shown in Table 5.13. Many of these studies indicate a significant reduction in vehicle-kilometers traveled and in air pollution. The Federal Highway Administration estimated the costs and benefits of applying region-wide pricing to a hypothetical city (Kane and DeCorla-Souza 1993). Table 5.14 shows the types of costs and benefits that could be achieved. Benefits are associated with savings in vehicle operations, reduced parking costs to many users, savings in travel time, and estimated benefits related to reduced accidents. Costs reflect the actual administrative costs of collecting the congestion fees and the costs of implementing a regional rideshare program. In addition, regional air quality would be improved significantly with regional congestion pricing programs. Table 5.15 also shows an estimate of reductions in hydrocarbon emissions with the implementation of a pricing strategy. Table 5.16 shows the estimated impact in the Washington D.C. area of differing levels of areawide pricing, and Table 5.17 shows a similar exercise for areawide pricing schemes in Los Angeles.

Benefits are associated with savings in vehicle operations, reduced parking costs to many users, savings in travel time, and estimated benefits related to reduced accidents.

Table 5.13: U.S. Studies on Congestion Pricing

Author	Type of Pricing	Toll	Estimated Effects
Keeler and Small (1977)	Optimal long-run toll	$0 05 to 0 36/VMT Avg of $0 15/VMT	Balance of supply and demand
Kraus, Mohring and Pinfold (1976)	Optimal long-run toll	$0 01 to $0 13/VMT (in 1976 $)	Annual welfare losses of at least $1 billion nationwide
Small (1983)	Optimal short run	$0 27, $0.98, $2 20 per pass round trip	Eliminate delays of 3, 12, and 30 minutes
Gomez-Ibanez and Fauth (1980)	Area licensing or parking fees	$1.00/day	Auto trips to central Boston reduced 40%; transit increase of 28%; regional VMT reduced 3-4%
Shoup and Willson (1992)	Cash option in lieu of parking subsidy	NA	Work solo driving in LA reduced 20%, work VMT reduced 17%
Urban Institute and K T Analytics (1991)	All freeways in LA Area Pricing at 20 to 30 activity centers	$0 15/VMT $2.00/day	VMT reduced 4-6%; ave. trip time reduced 10-15 min. Commute trips reduced 10%;trip times reduced 6-10 minutes
Viton (1980)	Optimal short run	$0.15/auto mile, $0.25 /bus mile, $0 33/truck mile	Optimizes traffic flow

Source Transportation Research Board 1994

Table 5.14: Estimated Impacts of Regional Peak Period Pricing

Costs Toll Collectron	$54,400
Ridesharing Program	23,300
Total Public Cost	**77,700**
Revenues	**$685,280**
Cost/Revenue Ratio	*011*
Commuter Cost Savings	
Vehicle Operation	$78,120
Parking	$221,350
Travel Time	$360,000
Total	659,470
Accident Cost Savings	$110,000
Benefit/Cost Ratio	
Excluding accident cost savings	8.5
including accident cost savings	9.8

Source: Kane and DeCorla-Souza 1993

Table 5.15: Changes in Hydrocarbon Emissions (1990)

	Base	Pricing
Diurnal Emissions		
No of Vehicles	466,350	454,700
Daily Emissions (gms)	1,865,000	1 818,800
Trip related Emissions		
No of Trips	863,500	747,000
Daily Emissions (gms)	17.270.000	14.940.000
VMT-related Emissions	8.830.000	7.900.000
Ave. speed (mph)	20	25
Emissions/mile (gm)	035	0.26
Daily emissions (gm)	3.090.500	2,054,OOO
Total Emissions (gm)	**22,225,900**	Home instruction, college instruction at the worksite

Source: Kane and DeCorla-Souza 1993

Table 5.16: Projected Effect of Area-Wide Pricing in Washington, DC

Fee	$0.75	$1.50	$2.25	$3.00
Trips Reduced	7.0%	13 8%	20 2%	26.4%
VMT Reduced	5.9%	11 6%	17 2%	22.7%
Annual Revenue (millions)	$25.8	$47.9	$66 5	$81.7

Source: REplogle 1993

Table 5.17: Estimated Impact of Pricing Strategies

	Average Price per Vehicle	Percent Reduction in: VMT	ROG
Region-wide Pricing	$3 00/day	-5.0%	-8.0%
Employee Parking Pricing	$2 25/day	-1 5%	-1.5%
Non-employee Parking Pricing	$0 30/day	-3 4%	-3.7%
Smog-base Registration Fee	$110/year	-0 4%	-3 8%
Deregulate Private Transit		-1 7%	-2.0%
Combined Effect	$5-$6/day	-12%	-19%

Source: Replogle 1993

Table 5.18: Estimated Response in Five Cities to Travel Pricing Measures

Strategy	L.A.	Sacramento	San Diego	San Fran.	Seattle	Mean	Std. Dev.
VMT							
Regional Congestion Pricing	-2 2	-0 3	-0 7	-1.7	-1 3	-1.2	0 8
Employee Parking of $3	-1 6	-1 8	-1 7	-1 1	-1 9	-1.6	0 3
Emissions Fee	-0 4	-0 2	-0 3	-0 2		-0.3	0 1
Gas Tax of $2	-9 7	-8 4	-8 3	-8.1	-7 2	-8.3	0 9
Mileage-based Fee of $0 06/mi					-9 3		
Joint Effects	-16 5	-12 5	-12 9	-13 1	-18.1	-14.6	2 5
Trips							
Regional Congestion Pricing	-2 2	-0 4	-0 6	-1.6	-1 2	-1.2	0 7
Employee Parking of $3	-2 0	-2 1	-2 0	-1.3	-2 4	-2.0	0 4
Emissions Fee	-0 2	-0 2	-0 2	-0.1		-0.2	0 4
Gas Tax of $2	-9 3	-7 8	-7 7	-7.6	-6 7	-7.8	0 9
Mileage-based Fee of $0 06/mi							
Joint Effects	-16.3	-12 3	-12 3	-12 5	-17.2	-14.1	2 4
SOV Work Trips							
Regional Congestion Pricing	-9 6	-1 6	-2 4	-11 9	-5 8	-6.3	4 5
Employee Parking of $3	-8 8	-8 4	-8 1	-9.6	-11 7	-9 3	1 5
Emissions Fee	-0 3	-0 1	-0 2	-0.1		-0.1	0 1
Gas Tax of $2	-6 1	-5 6	-5 4	-2.9	-3 9	-4 8	1 3
Mileage-based Fee of $0 06/mi		-18 4			-5 0		
Joint Effects	-29 4		-18 9	-28.9	-24 2	-24.0	5 3
CO Emissions							
Regional Congestion Pricing	-4.7	-1 2	-2.3	-4 7	-3.0	-3 23	1.5
Employee Parking of $3	-1 7	-1 8	-1 9	-1 2	-2.2	-1 8	0 4
Emissions Fee	-17 4	-16.0	-16 2	-15.6		-16 3	0.8
Gas Tax of $2	-9.4	-8 0	-7.8	-7 6	-7.0	-8.0	0.9
Mileage-based Fee of $0.06/mi					-8 6		
Joint Effects	-42 3	-33 4	-35 2	-36 6	-19.0	-33 3	8 7
NOx Emissions							
Regional Congestion Pricing	-1 9	-0.4	-0 4	-1.4	-0 9	-1.0	0 7
Employee Parking of $3	-1 6	-1 7	-1 6	-1.2	-1 9	-1 6	0 3
Emissions Fee	-14.7	-13 6	-14.1	-13 1		-13.9	0 7
Gas Tax of $2	-9 5	-7 9	-8 0	-7.6	-6.9	-8 0	1.0
Mileage-based Fee of $0 06/mi					-8.6		
Joint Effects	-34 5	-28.9	-29 6	-28.7	-46 9	-27 7	6.5

Source: Portland State University 1995

In addition to the change in travel behavior expected with pricing strategies, the fees collected could be used to encourage other forms of mobility or compensate those who are unduly affected by congestion fees (e.g, low income households). The amount of the revenues collected would not be insignificant. The TRB study referenced above estimated that by applying congestion pricing on all thoroughfares in Los Angeles during peak periods, over $3 billion in congestion fees would be raised annually. A study of congestion pricing in Minneapolis/St. Paul indicated that tolling between 1,300 and 1,500 miles (808 and 932 kms) of congested roads with a one percent increase in the time-plus-cost of trips would reduce traffic volumes by 12 percent on average and by about 25 percent on the most heavily congested freeways. In the aggregate, travelers would lose about $250,000 during the morning peak hour and about $1 million daily. As noted in the report, "tolling would yield $1.50 to $1.75 in revenue for each dollar of costs incurred by the average traveler. Thus, tolling would make it possible to compensate losers fully with substantial money left over. Because most would be made worse off, gaining support for congestion pricing from a majority of Twin Cities' peak-period travelers would require coupling tolls with a plan for distributing toll revenues that would benefit them more than the tolls would cost them" (Anderson and Mohring 1996).

The results of a comprehensive study that examined the impacts of different forms of pricing on travel behavior are shown in Table 5.18 (Portland State University 1995). As can be seen in this Table, the joint effects of all these measures combined range from an approximate 14 percent reduction in vehicle miles traveled to a 33 percent reduction in carbon monoxide emissions.

Implementation: The implementation challenges of a road pricing scheme are often quite formidable. The technology is now available to collect congestion fees in an unobtrusive way. However, an areawide application over all users and all facilities would be difficult. In an urban area, however, the effectiveness of such a scheme would depend on an areawide application to minimize diversions to roads not subject to pricing.

Perhaps the most difficult aspect of implementing this scheme is political feasibility. Toll roads are widely used and accepted throughout the country. However, most individuals would likely view an areawide road pricing scheme as another form of taxation. Several proposed congestion pricing demonstrations have faltered because of political and public opposition. In fact, many of the congestion pricing studies funded to date have been oriented toward educating government

officials and the general public on what can be achieved with congestion pricing. Extensive public involvement will be necessary before any meaningful congestion pricing program can be put in place. A list of issues that should be considered in developing a congestion pricing program includes: (Kane and DeCorla-Souza 1993).

Political Issues

Equity: How will the impacts on low income single occupant vehicle users be reduced?

Public Opposition: How will the general public react to additional costs associated with travel?

Intergovernmental *Cooperation:* Many jurisdictions have control over a region's road system. How will the necessary coordination be provided?

Several proposed congestion pricing demonstrations have faltered because *of political and public opposition. In fact, many of the congestion pricing studies funded to* date *have been oriented toward educating government officials and the general public on what can be achieved* with *congestion pricing.*

Use of *Revenues:* Should resulting revenues be limited just to highway users? Or should and can they be used to subsidize other modes or travelers such as low income travelers?

Privacy: How will individual privacy be protected if vehicle-specific information is being collected at identifiable times?

Technical Issues

Compatibility : How will users outside the urban area be charged? How to coordinate technology deployment among many jurisdictions?

Enforcement: How will HOV facilities be monitored and enforced?

Price Determination: How will prices be set at various locations?

Impact Assessment: How will behavioral and secondary impacts of congestion pricing schemes be evaluated?

Clearly, the most critical implementation issue is garnering public support for the proposed scheme. The following six principles have been suggested to develop public support for congestion pricing (Jones 1995).

- The stated objectives of congestion pricing must meet public concerns.
- One must demonstrate there is no effective alternative solutions.
- The revenues are pledged and alternatives are provided.
- Keep implementation as simple as possible.
- Use appropriate and adequate technology.
- Equity issues must be addressed.

Another perspective on implementing congestion pricing is found in the following questions that serve as a point of departure for implementation analysis (Federal Highway Administration 1992).

- How can public and political support for congestion pricing be developed?
- Who wins and who loses because of congestion pricing?
- How should revenues generated by congestion pricing be used?
- What are the objectives of congestion pricing in particular and the transport system in general?
- What are the true costs of congestion, and to what extent will congestion pricing reduce congestion and improve air quality? The potential benefits of congestion pricing need to be quantified and effectively communicated to those who will benefit.
- What data are needed to effectively forecast impacts of congestion pricing, and what data need to be collected during the application of pricing in order to evaluate its effectiveness?
- Are there adequate transportation alternatives for those who cannot afford to pay congestion charges?
- Is congestion pricing consistent with the goal of increasing overall mobility?
- Is the technology used to collect and enforce the congestion charges efficient, user-friendly, and reliable?
- Have the necessary institutional relationships been developed?

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An auto restricted zone refers to any area where vehicular travel is prohibited in some manner Techniques include. physical *barriers to auto access, parking controls, exclusive use* lanes, *and turn prohibitions.*

Auto Restricted Zones

Description: An auto restricted zone (ARZ), in its broadest sense, refers to any area where vehicular travel is prohibited or restricted in some manner. A variety of techniques have been used to accomplish this, including physical barriers to auto access, parking controls, exclusive use lanes, and turn prohibitions. ARZ's can be implemented for many reasons, but experience has shown that the three most stated objectives are: 1) to preserve and enhance the vitality of urban centers; 2) to improve the environmental quality in urban centers, and 3) to encourage the utilization of non-auto modes. An ARZ is often referred to as a pedestrian or transit mall, with the latter implying some access to the site for transit vehicles. Various alternatives have been tested to restrict or partially

restrict personal vehicles from pedestrian environment. These have included: (Zegeer 1988).

Residential Yards: Shared streets that are designed for driving, playing, cycling, walking, and parking where vehicles are restricted to certain areas and driving speeds.

Play Streets: Residential streets closed to vehicular traffic during certain hours to allow supervised programs to occur.

Transit/Pedestrian Malls: Pedestrians share space with buses and often trucks and taxis, but other motor vehicles are not allowed.

Many cities contemplated the implementation of ARZ's during the 1970's, with several ARZ's such as those in Boston, Philadelphia, New York, and Minneapolis receiving a great deal of attention. However, despite the success of these malls, experience since the 1970's has been limited and modest in scale.

A review of U.S. experience with ARZ's concluded that: (Herald 1977)

- ARZ's can be applied successfully in urban areas of different sizes.
- Any area proposed for ARZ treatment must have a stable base of attractiveness as a minimum for renewing economic activity.
- Completely prohibiting automobile traffic is not the only way of achieving the desired results.
- The extent of transportation impacts is directly related to the degree of automobile restriction.
- The most important transportation issue is maintaining accessibility.

Benefits/Costs: Depending on the size and purpose of the ARZ, the impacts can vary from insignificant to substantial. The advantages and disadvantages of ARZ's have been described as follows: (Federal Highway Administration 1987)

Advantages

- May reduce pedestrian delays and/or relieve pedestrian congestion
- May enhance aesthetic and social environment of the area
- Can provide greater accessibility to retail merchants
- Can increase the use of public transit
- May decrease noise and air pollution on affected streets
- Can increase revenues, sales, and land values
- Can be implemented in stages

Disadvantages

- Generally high cost of installation and maintenance
- Vehicle traffic must be rerouted to other streets
- May increase noise and air pollution on adjacent streets
- May disrupt utility and emergency services
- Can disrupt bus routes and delivery of goods
- Could create parking problems
- Must have additional security and police resources

The three most stated *objectives of ARZs* are: *1) to preserve and enhance the* vitality *of urban centers; 2) to Improve the environmental quality in urban centers, and 3) to* encourage *the utilization of non-auto modes.*

Where retail activities exist, an ARZ generally seems to have a positive effect on business. Pedestrian volumes, as expected, increase. The costs of the ARZ's also varied by type of facility. The costs of an ARZ can range widely depending on the context in which it is being implemented. A study done for the Federal Transit Administration found that the average capital cost of 27 downtown ARZ's was approximately $9 million (Loukissas and Mann 1984).

Where retail activities *exist, an ARZ generally seems to have* a *positive effect on business Pedestrian volumes,* as *expected, increase.*

Implementation: The most effective strategy is one that focuses on facilitating existing pedestrian and transit patterns, with subsequent stages dealing with latent activity and development potential. A great deal of attention must be given to the design of the ARZ, including pedestrian amenities, goods delivery, security, utility location, landscaping, lighting, and access to stores. The redesigned street system which now provides circulation to diverted traffic must also be structured in a way that is not confusing to drivers. This includes unambiguous signing, buffers between automobile and pedestrian traffic, and clear access to parking locations.

The following implementation problems were found in cities where ARZ's were implemented, as well as those that were planned, but not constructed. (Loukissas and Mann 1984).

Implementation Problems Identified By Officials For:

ARZ Projects Implemented

1. Obtaining funds
2. Underestimation of costs
3. Changes in local government
4. Impact of project on CBD activities
5. Unforeseen economic changes
6. Lack of public understanding
7. Finding suitable developer
8. No private sector responsibility
9. Project took longer than expected

ARZ Projects Not Implemented

1. Obtaining funds
2. Length of time for securing funds
3. Construction difficulties
4. Priority not high enough
5. No clear project responsibility
6. Land acquisition
7. Lack of merchant support

One of the most critical aspects of implementing an ARZ is working with the business community that is affected by the new auto restrictions. Businessmen are often opposed to anything that they perceive will hurt customer access. Automobile access is considered critical to retail success. A successful implementation strategy must therefore include efforts to incorporate business concerns into project planning and design (Meyer and Lloyd 1984).

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Parking Management

Description: Parking management is a very important tool for managing transportation demands (a discussion of specific parking management actions is found in Chapter 2). Almost all parking in the United States is provided free to the user. Analysis of the 1990 National Personal Transportation Survey (NPTS) found that 95 percent of all automobile trips receive free parking. A survey conducted for the Chicago Regional Transportation Authority found that 97 percent of Cook County employers of 100+ employees provided free parking for all their employees (Shoup and Breinholt 1995). Data on the share of auto commuters who park free at work from some US. cities include: (Regional Transportation Authority 1995).

To be truly effective as part of a regional congestion relief or mobility enhancement strategy, parking management needs to be implemented at an area-wide level. The development and management of parking supply involves many public and private sector groups. Government agencies set parking requirements in codes, some localities build and manage parking facilities, almost all communities regulate on-street parking, and often local governments regulate parking rates. For their part, private commercial parking lot operators provide a substantial amount of parking space in most urban areas. Developers provide parking as part of development projects, and retailers often provide large amounts of parking for easy automobile access.

An area-wide parking management strategy relies on two key components: pricing and supply management.

Hartford	98 %	Portland	97 %	Detroit	96 %	Miami	96 %
Los Angeles	96 %	Philadelphia	96 %	Boston	94 %	Chicago	94 %
Cleveland	94 %	New York	94 %	Seattle	94 %	Dallas	93 %
Houston	93 %	Milwaukee	93 %	Pittsburgh	93 %	Buffalo	92 %
San Francisco	93 %	Cincinnati	88 %				

An area-wide parking management strategy relies on two key components: pricing and supply management. Pricing actions for government agencies might include: (ITE 1993)

- Impose or increase fees and surcharges for single occupant vehicles or long term parkers using public parking facilities
- Give price preference to carpools or vanpools
- Tax the providers of parking
- Impose parking pricing mechanisms through regional regulations
- Tie investment in road improvements to the implementation of parking management actions

Developers, employers, and employer organizations can also play a key role in pricing in the following ways:

- Remove or reduce employer-provided parking subsidies
- Reverse "early bird" incentives that encourage long-term commuter parking
- Provide preferential pricing to high occupancy vehicle users
- Develop parking regulations and pricing that reflect true cost of parking provision

With regard to managing the supply of parking, communities can best influence what occurs in their jurisdiction through parking requirements in the zoning code, use of on-street controls such as meters or neighborhood preferential parking, and controlling the amount of publicly-provided parking spaces. Some examples:

Madison, WI: A peak period parking surcharge of $1.00 was applied at municipal garages combined with new shuttles. Between 5 to 8 percent of commuters switched to transit, 22 percent shifted parkmg location, and 6 percent parked after the peak period (Charles River Associates 1984).

Seattle: Carpool parking receives daily discounts at public garages from a normal $25 to $5 for carpoolers at one facility and not charged at another. About 45 percent of new carpoolers came from transit, 29 percent previously used car pools, and 25 percent were previously single drivers (Olsson and Miller 1978).

San Francisco: Parking rates at public and commercial garages were increased by 25 percent with mixed results. Overall, the number of parkers declined about 2 percent (Kulash 1974).

Chicago: Parking rates were raised from 30 to 120 percent bringing municipal lot prices in conformance with nearby commercial lots. The number of cars parked declined by 35 percent and parking duration decreased. The number of all day parkers arriving before 9:30 a.m. dropped by 72 percent (Miller and Higgins 1983).

Eugene, Oregon: Daily parking rates at municipal garages went from $16 to $30 in one year; surface lot rates went from between $6-$16 to $16-$34. Monthly parking permit sales declined from 560 to 360. About half of these parkers

Communities can *manage the supply of parking through parking requirements in the zoning code, use of on-street controls such as* meters or *neighborhood preferential parking, and controlling* the *amount of publicly-provided parking spaces.*

became carpoolers or rode a free shuttle service; the other half changed parking locations (Peat, Marwick, Mitchell & Co. 1985).

Portland, OR: A threshold (43,914 parking spaces) has been established on the total number of parking spaces that will be allowed in downtown. Parking is not required for non-residential development and a maximum is set at typically one space per 1,000 square feet.

Hartford: The office parking requirement downtown is one space per 1,000 square feet. Parking requirements can be reduced up to 30 percent in exchange for discounted carp001 parking, rideshare promotions, subsidized transit passes and shuttle service from off-site parking (Miller and Higgins 1983).

University of Washington: Shortly after the State of Washington implemented a Commute Trip Reduction law, the University of Washington implemented a comprehensive transportation demand management program. Parking fees were raised substantially causing a significant change in mode choice. In addition, a pass program called U-PASS was created that consisted of increased transit services, shuttles, car-pools, vanpools, bicycles, reimbursed ride homes, commuter tickets, and merchant discounts. Monthly transit trips increased 35 percent; total ridership on the transit system from 1991 to 1993 grew by 60 percent; and parking permits declined sig nificantly. However, parking spillover to adjoining neighborhoods has caused the City to institute residential parking permit programs.

Benefits/Costs: Perhaps more than any other TDM action (other than congestion pricing), parking management can have a dramatic impact on travel behavior. An areawide parking management program can be an important incentive in encouraging travelers to use alternative modes of transportation (see section on Multimodal Access). As noted in the previous examples, reductions in single-occupant vehicles using a facility can range from a small percentage to a significant amount depending on the circumstances. Importantly, parkers may well go to alternative parking facilities, shorten their stay, switch to alternative modes, or respond with a combination of the above. It is because of these many varied responses that a comprehensive parking management program should be implemented on an areawide basis.

Perhaps more than any *other TDM action, parking management can have a dramatic impact on travel behavior An areawide parking management program can be* an *important Incentive in encouraging travelers to use alternative modes of transportation.*

In addition to an areawide implementation, an effective parking management program should include incentives / disincentives to encourage developers and employers to adopt parking management strategies that reflect the goals of the community program. The use of parking charges and restricted parking is a very important variable in explaining trip reduction [see Table 5.19 for the

Table 5.19: Estimated Mode Share In Portland With Varying Levels of Parking Prices and Transit Accessibility

		City				Suburb			
Parking Price	#. Bus Lines	Walk	Transit	SOV	Carpool	Walk	Transit	SOV	Carpool
$30	1	0 148	0.032	0.707	0.113	0 029	0 070	0 763	0.137
$50	2	0 176	0.051	0 663	0 111	0.034	0 119	0 715	0.131
$80	3	0 221	0.090	0.583	0 105	0 042	0 213	0 626	0 118
$100	4	0 248	0 137	0 517	0 098	0 045	0 315	0 536	0.104
$120	5	0 269	0 200	0 443	0 088	0 046	0 437	0 432	0.085
$150	6	0 290	0 305	0 334	0 072	0 044	0 604	0 293	0 059
$30	6	0.133	0 086	0 676	0.105	0 026	0 172	0 680	0.122
$50	5	0 163	0 092	0 640	0 105	0 031	0 199	0 651	0 120
$80	4	0 215	0 109	0 573	0 103	0 040	0.249	0 598	0.113
$100	3	0 257	0 113	.0529	0.101	0 048	0 273	0 569	0.110
$120	2	0.304	0.116	0 482	0.098	0 057	0 298	0 539	0.106
$150	1	0 376	0.129	0 405	0.090	0 072	0 358	0 474	0.096

Source Kane and DeCorla-Souza 1993

In addition to an areawide implementation, an effective parking management program should include incentives/disincentives to encourage developers and employers to adopt parking management strategies that reflect the goals of the community program

results of an analysis in Portland, Oregon (Portland State University 1995)].

An important benefit to developers of reduced parking requirements is the savings in construction costs associated with reduced parking. The actual savings in costs will vary from one locale and situation to another. One study, for example, estimated a cost savings for structured lots of $4,200 per space constructed and $200 per year in maintenance (K. T. Analytics 1990). A more recent study estimated that the capital cost of parking structures at UCLA was at least $23,600 per parking spaced added, and that the average cost of providing parking was at least $124 per space per month (Shoup 1995). In addition, it was estimated that the UCLA Commuter Assistance Program could maintain a person in a carpool or alternative mode for about $500 per year versus the debt service on parking spaces of over $1,200 per space. The cost per parking space associated with the construction and operation of parking spaces for different types of parking facilities in the United States was found to be (in 1989 U.S. dollars): (Municipality of Seattle 1993)

Average Cost Per Parking Space for a:

	Surface lot	Freestanding Multilevel Structure	Above-grade Multiuse Structure	Below-grade Multiuse Structure
Average # Spaces	450	1,000	520	430
Development Costs	$4,972	$20,125	$29,872	$39,477
Operating Costs per Year	$955	$2,756	$3,541	$4,504

The important point in any calculation of benefits and costs is that providing parking is an expensive proposition, and efforts to reduce parking supply will not only help influence travel demand, but could provide potentially significant cost savings to the private sector.

Implementation: As could be expected when considering an action that directly affects the every day trip of an employee, implementing parking management programs can be very complex and controversial. Because the specifics of a parking management program will vary from one community to another, implementation must begin with a careful assessment of key variables. Implementation lessons for communities interested in parking supply management include:

- Careful assessments must be made of parkmg demand and lender/developer preferences before instituting maximum, minimum, or flexible parking requirements.
- Incentives for reduced requirements must be attractive not only to employers, but to developers as well.
- Tight maximum requirements near transit stations and trunk lines should be implemented only after assessing what the market will bear
- Implementation of a supply constraint should not be done with burdensome requirements on developers.

With regard to the pricing of parking, the following lessons apply:

- Assess the travel market to determine what actions will be appropriate
- Determine the institutional environment for parking pricing strategies including such things as, what proportion of the parking is under the control of the public sector, are public parking rates at par with commercial rates, are employees generally subsidized for parking, and are alternatives available for parkers displaced from a parking facility?
- Carefully consider key policy issues that could become subject of intense scrutiny, such as, where will increased revenues go, how will local residential streets be protected from overflow parking, and what are the equity implications of the pricing strategy on low income households?

The most critical aspect of successful implementation of a parking management program is to view such an effort from a comprehensive perspective. That is, what is the geographic scope of the program? Are alternatives available to parkers? Are the private operators of parking lots and major employers involved in the substance and timing of program implementation? How could revenues generated from such a program be used to sup port transit and travel alternatives? And importantly, has the general public been educated on the overall goals of the program and the benefits that will accrue to the community?

A recent study in King County, Washington, that looked at a regional approach for parking charges in suburban areas, offers an interesting checklist of how to implement a potentially controversial parking pricing program aimed at employer sites (King County Department of Metropolitan Services 1995).

How to implement a potentially controversial parking pricing program aimed at employer sites

1. Implement the parking fee with ridesharing incentives to "soften the blow" on employees.
2. Provide a transportation allowance (a salary increase that will cover the cost of increased parking fees but which could be pocketed if cheaper forms of transportation were used).
3. Use an employee transportation committee for the development of the parking fee
4. Support the parking fee with monitoring and enforcement
5. Communicate with employees.
6. Base the parking fee on the cost of providing ridesharing incentives and what is appropriate for the area in which the employer is located
7. Apply the fee to all employees equally.
8. Empower employee transportation coordinators to negotiate with top management
9. Gain visible support from top management
10. If an environmental ethic or community ethic exists within the organization, use it as a vehicle to gain employee acceptance of the parking fee.
11. Use a newsletter to keep employees informed

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Trip Reduction Ordinances

Description: Trip reduction ordinances use a community's regulatory authority to limit trip generation from development sites. Ordinances appeal to local officials on several grounds: 1) they can potentially achieve more significant trip reductions because they usually cover an entire local political subdivision rather than just an individual project; 2) they spread the burden more equitably between existing and future development; and 3) they may be less vulnerable to legal challenges than conditions imposed on development approvals (Flynn and Glazer 1989). Trip reduction ordinances are not limited to new development sites. Such mandates in Washington State, Phoenix, Tucson, Salt Lake City, and Silver Spring, Maryland place requirements on existing employers to meet trip reduction targets.

The City of Alexandria's Traffic Mitigation Ordinance: In May 1987, the City of Alexandria, Virginia, enacted an ordinance "to mitigate traffic and related impacts of certain.. .land uses through the requirement that a...special use permit be issued for such uses containing terms and conditions that require the implementation of an appropriate transportation management plan." The application for the special use permit must provide the results of a traffic impact study showing projections of future traffic volumes and level of service for designated intersections, and must propose a traffic mitigation plan.

The permit will be approved if the city council determines that the actions proposed in the plan "will produce a significant reduction in traffic." The ordinances set forth the following criteria for evaluating the adequacy of the actions: (a) l0-30 percent of the morning peak period trips generated by the project will utilize "a mode of travel other than single occupancy vehicle (SOV)" or (b) no more than 40 percent of SOV trips generated by the project between 6 a.m. and 10 a.m. or between 3 p.m. and 7 p.m. will occur during the peak hour.

The trafic mitigation actions shall be "fully and continuously implemented throughout the life of the proposed project." The special use permit incorporating the traffic mitigation conditions shall be incorporated into the land convenants and shall be binding on the developer and his successors-in-interest.

Trip reduction ordinances use a community's regulatory authority to limit trip generation from development sites.

The Silver Spring, Maryland, Transportation Management District: Downtown Silver Spring, a suburban center in metropolitan Washington, D.C., has become the target of significant urban revitalization efforts. In order to accommodate proposed new commercial development without going against the County Annual Growth Policy (which sets development limits as a function of available transportation capacity), the county has established a special Transportation Management District (TMD).

Authority to create such districts derives from Article 25A of the Maryland Code, which gives "chartered" counties broad powers to establish "special taxing areas," exercise planning and zoning controls, and enact local ordinances "for the protection and promotion of public safety.. .health and welfare.. .relating to the use of streets and highways."

The aim of the District was to maintain traffic levels consistent with "commuting goals" specified in the County's Annual Growth Policy, which, in the case of the Silver Spring central business district, require a 25 percent transit modal split, and a 1.30 auto occupancy or any combination along with nonmotorized travel that results in no more than 54 percent single occupant vehicle use. Thii "commuting goal" is to be reached by enlisting the business community in a concerted program of demand management. All employers of more than 25 workers are required to submit traffic mitigation plans and participate in an annual commuter survey. All new developments are required to enter into binding traffic mitigation agreements as a condition of subdivision approval and must meet a 30 percent transit modal split and a 1.30 auto occupancy in any combination along with nonmotorized travel that results in no more than 50 percent single occupant vehicle use. An advisory board of local citizens and business leaders oversees the program and evaluates the progress in attaining the commuting goals.

Significantly, the legislation provides no penalties against employers who fail to meet the traffic reduction goals. However, fines are levied for failure to comply with procedural requirements- i.e., for not making a good faith effort to carry out the intent of the legislation. Developer agreements, on the other hand, will contain binding sanctions, and will be enforced through financial security assurances and liquidated damages. The program may become mandatory for employers as well if the commuting goals are not met through voluntary efforts.

The most novel feature of the Silver Spring TMD legislation is its aggressive use of public incentives and parking controls to secure private sector cooperation and achieve the desired commuting goals. The package of incentives includes park-and-shuttle service into the CBD, discounted transit and commuter rail passes, and discounts for carpools and vanpools in the county-operated parking facilities. Employers who exceed the modal split goal will receive additional incentives.

Of even greater significance is the county's ability to control the supply of downtown parking and its avowed determination to constrain the supply of commuter parking within the Transportation Management District, while at the same time vigorously enforcing commuter parking bans in the surrounding residential neighborhoods.

Eastern Pima County Travel Reduction Program (TRP): Eastern Pima County (Tucson, Arizona) first introduced trip reduction programs in 1988 when five local ordinances were adopted (Kicksey and Maglio 1996). The purpose of these ordinances was to improve air quality (the area was nonattainment for carbon monoxide) and reduce traffic congestion by requiring major employers (over 100 employees at a single work site) to meet targeted trip reduction goals. These goals related to percent usage of alternative modes at least once per week and/or a reduction in vehicle kilometers traveled by employees. The goal was to achieve 15 percent alternative mode usage (which included compressed work weeks, telecommute, or use of alternatively fueled vehicles) by the end of the first year, 20 percent by the end of the second year, and 25 percent by the end of the third year. Alternatively, compliance could be attained by having similar reductions in employee vehicle kilometers traveled. The benefits and costs of this program are discussed below.

Benefits/Costs: Responses to trip reduction ordinances suggest that ridesharing and transit trips have slightly increased and some auto trips have been shifted out of the peak period. If monitored and enforced, trip reduction ordinances could have an impact on alleviating future congestion in a community. For example, the Eastern Pima County Travel Reduction Program (TRP) had 94,000 participating employees in 1994 representing 217 sites. The TRP achieved a regional alternative mode usage of 28.6 percent compared to a 1989 baseline of 17.6 percent. Vehicle kilometers traveled decreased by 4.5 percent over the same time period. The weighted average of staff and out-of-pocket expenses for this program was $18.14 per employee in 1993. The average dollars spent per employer site was $4,917, but the median cost was $340. Sixty-one percent of the employer sites spent under $500, and only 5 percent spent over $10,000. Surveys estimated a savings of 20 million vehicle miles traveled during 1994 which reflected an employer cost of $0.05 per mile saved. The cost to the employer of each trip saved was $0.09.

Implementations: An examination of existing traffic mitigation ordinances reveals a large degree of commonality in the way local jurisdictions are approaching the subject of regulating automobile use (Colorado/Wyoming Section of ITE 1987).

Extent of Coverage. Most of the ordinances apply both to new and existing development and explicitly cover employers. However, some ordinances (Alexandria, Hartford, Los Angeles/Coastal Corridor) apply only to new development, and other ordinances (Contra Costa County, Pleasanton, Seattle) impose more stringent requirements on major employers than on small employers. There is an almost universal exemp tion for residential uses; enforcement of traffic mitigation requirements against residents is felt to be too onerous and virtually unenforceable. Where the ordinance applies to developers or property owners, it usu-

Responses to trip reduction ordinances suggest that ridesharing and transit trips have slightly increased and some auto trips have been shifted out of the peak period.

ally remains silent as to tenants. As a matter of practice, however, developers and property managers often incorporate the ordinance conditions in their leases. In those instances where there are "spillover" effects from one community to another, there is a need to provide an area-wide trip reduction program. Otherwise, one community's efforts will be overwhelmed by another's inability to control traffic growth.

Most ordinances apply both to new and existing development and expliutly cover employen. Some ordinances apply **only to new** *development, and other ordlnances impose more stringent requirements on major employers than on small employers.*

Flexibility of Means. Some ordinances (Placer County, Sacramento, Seattle, Bellevue, Hartford) require implementation of specific TSM measures. Most ordinances, however, only prescribe traffic mitigation goals, without specifying how these goals are to be met. The targets are typically expressed in terms of: (1) percentage reduction in peak-hour vehicle trips; (2) percentage of "driver-only" vehicles; (3) average vehicle ridership in the peak hour; or (4) "acceptable" traffic conditions at designated survey points ("Level-of-Service Ordinantes")

Enforcement and Sanctions. Should failure to reach a prescribed goal be penalized? Or should only "good faith efforts" be required? The majority of the ordinances provide penalties for failure to comply with procedural requirements, such as the submission of a TSM plan or a survey report. A few go somewhat further and penalize failure to implement an approved TSM plan (Contra Costa County, Pleasanton, Santa Clara County). However, none of the ordinances impose penalties for non-attainment of the trip reduction goals. Indeed some ordinances (LA, Phoenix, Tucson) explicitly state: "Having made a reasonable effort to duly comply with the provisions of this Section, failure.. . to meet the applicable goals shall not be considered a violation of this Section."

Some ordinances require the traffic mitigation conditions applicable to new development be recorded as covenants running with the land. Failure to carry out the traffic mitigation programs is thus enforceable not only against the initial developer but also against all subsequent owners of the property.

Oversight/Monitoring/Citizen Involvement. Virtually every ordinance provides for some kind of a collaborative public/private oversight, but the ordinances vary in the degree of power and responsibility accorded to the oversight bodies. Most are purely advisory (Contra Costa County, Concord, Los Angeles), but at least in one case (Pleasanton) the "TSM Task Force" also has the power to approve or reject TSM plans, refer violators to the City Council, and recommend changes to the ordinances.

The burden of monitoring is almost invariably placed on the private parties who are required to submit an annual progress report. Many jurisdictions also require submission of annual surveys of employee commute patterns.

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Negotiated Demand Management Agreements

Description: Local governments often mandate private sector involvement in traffic mitigation as a condition of individual development approval. Negotiated traffic mitigation agreements have become a common practice in numerous jurisdictions, including Dallas, Fairfax County Virginia, Los Angeles, Montgomery County Maryland, Orlando, San Francisco, and Seattle (Commuter Transportation Services, Inc. 1988). The agreements set a traffic reduction goal (often expressed in terms of a minimum level of ridesharing participation or a stipulated reduction in the number of automobile trips), but differ in the degree of prescription concerning implementation methods. An example of a non-prescriptive approach are the trip reduction agreements negotiated by the Montgomery County (Maryland) Planning Board. The agreements specify the number of vehicle trips to be ultimately eliminated from a given development but leave wide latitude to the developers in deciding how those reductions are to be achieved. Other jurisdictions have adopted a more prescriptive approach (Curtin and Aischke 1988). Thus, the "Development Disposition Agreements" negotiated by the Community Redevelopment Agency of Los Angeles (see below) not only set a performance requirement, but also list a number of specific actions the developers must adopt to carry out the intent of the agreement. A description of these instruments follows.

Trip Reduction Programs Negotiated by the Montgomery County Planning Board:

Montgomery County's Adequate Public Facilities Ordinance requires the County's Planning Board to examine each applicant's proposed subdivision to determine whether there are sufficient transportation facilities to adequately handle the additional traffic generated by the new development. If the Planning Board finds that adequate transportation facilities are not available, the Board may disapprove construction of the subdivision in question.

One way, however, for an applicant to obtain immediate approval in such circumstances is to agree to implement a "trip reduction" program. Trip reduction programs must compensate for the peak-hour trips

Negotiated Demand Management Agreements: Local governments mandate private sector involvement in traffic mitigation as a condition of individual development approval

generated by the certain stipulated measures and achieving specific trip reduction goals, which are normally set high enough so that after the new development has been occupied, the traffic situation is at least no worse than it was before. If a program does not perform as expected and no way can be found to strengthen it, then the program goes into default and the developer forfeits a substantial letter of credit or bond, the proceeds of which are used by the county to operate the program itself.

Negotiated Demand Management agreements specify the number of vehicle trips to be ultimately eliminated from a given development but leave wide latitude to the developers in deciding how those reductions are to be achieved.

One of the first employer-based trip reduction programs commenced operation in 1986 by the developers of Democracy Plaza and Rock Spring Plaza. These two developments were approved for a total of approximately 1.1 million square feet of office space over five buildings. Subsequent to the initial approval, one building was modified to a hotel. Democracy Plaza and Rock Spring Plaza are located in North Bethesda in the Rock Spring Park corporate park that contains over four million square feet of development. The final 400,000 square feet of the 1.1 million total required roadway improvements that were not feasible for the developer. As a result, subdivision approval was granted by the Montgomery County Planning Board with the condition that the developers agree to: (a) establish and maintain a ridesharing/transit promotion program that covered the entire Rock Spring Park and whose ultimate goal was to eliminate 532 peak hour trips from the Park (later reduced to 358 due to the modification of one building from office to hotel, (b) establish an interim goal of 50 percent of the final trip reduction goal before building permits are permitted for the fourth building of the five buildings, (c) establish and maintain a full time ridesharing administrator for the program; (d) monitor and report on the progress of the ridesharing program and calculate the resulting trip reductions; and (e) post an irrevocable bond or letter of credit in the amount of $772,000 which, in the event of failure to achieve the stated ridesharing goal, will be considered as liquidated damages and used by the county to finance the operation of the county's ridesharing program for the balance of the 10-year term of the agreement. This program finished operation in 1996 and was considered a success.

Similar trip reduction agreements have been concluded by the Planning Board with several other major commercial complexes.

Development Disposition Agreements of the Community Redevelopment Agency (CRA) of Los Angeles: The CRA's Development Disposition Agreements (DDAs) probably contain the most elaborate set of traffic mitigation requirements on record. CRA's decision to promulgate traffic mitigation conditions stems from the

city's concern about the effects of additional office development on the already badly congested downtown area. To stem the influx of yet more commuter automobiles into the crowded central business district, the CRA has begun to impose ridesharing requirements on new downtown office buildings. The DDAs stipulate that a certain percentage of office employees must arrive at the sites by other means than single occupant automobiles. In a recent case involving a new office tower, the ridesharing goal was set at 44 percent. The DDAs also commit the developers to certain specified implementing actions, such as hiring a "Commuter Transportation Coordinator," providing rideshare incentives, and monitoring employee participation in the ridesharing program. Finally, the agreements contain a long list of "recommended policies" i.e., actions that are considered supportive of the requirement but are not obligatory. Among them are subsidized transit passes, preferential parking policies for Carpools and vanpools, and involvement of tenants in traffic mitigation programs through lease conditions (Cervero 1986).

The agreements are enforceable through a complex set of provisions that require developers to provide (or pay for) free van seats equivalent to the shortfall between the rideshare performance requirement and the actual number of rideshare participants, in the event a project fails to achieve the rideshare performance requirement.

Benefits/Costs: Similar in impact to trip reduction ordinances, negotiated agreements are focused on a particular site and thus do not provide areawide consistency in reducing generated trips.

Implementations: The basis for such agreements is often found in legislation or regulations that give community officials some leeway over development characteristics. Successful implementation of negotiated agreements depends on having technical staff capable of negotiating with developer's consultants. The level of mitigation required and the contribution of individual mitigation measures is often the point of contention in such negotiations. Communities need to have the technical capability for analyzing the impact of mitigation measures (Orski 1987).

Successful implementation of negotiated agreements depends on having technical staff capable of negotiating with developer's **consultants.**

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Regional Multimodal Traveler Information Systems

Descriptions: Regional Multimodal Traveler Information Systems (RMTIS) use intelligent transportation systems (ITS) technologies to provide up-to-date information to travelers on the performance of the transportation system and the specific characteristics relating to the mode of transportation being taken. Some of the applications of RMTIS to demand management include: providing real-time information on all modes, enhancing the convenience of transit and ridesharing, enhancing parking information and parking management systems, enhancing congestion pricing projects, enhancing alternative work schedules, and improving the ability to monitor and evaluate demand management efforts (Turnbulll996). Some of the technologies that could be applied in this context include cable television, computers/Internet, cellular phones, personal paging devices, information kiosks, information screens, changeable message signs, and highway advisory radios.

Benefits/Costs: The benefits/costs and implementation characteristics of RMTIS are discussed in Chapter 6.

Implementations: The benefits/costs and implementation characteristics of RMTIS are discussed in Chapter 6.

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Transportation Management Associations

Descriptions: Transportation management associations (TMAs) are organizations created to offer service to employers, travelers, and others users of the transportation system in targeted areas. In recent years, many of the TDM activities at the subregional level have been conducted under the auspices of TMAs. They are particularly well-suited for putting together a package of TDM actions that can serve many different traveler markets.

Benefits/Costs: The benefits/costs and implementation of TMAs are discussed in Chapter 7.

Implementations: The benefits/costs and implementation of TMAs are discussed in Chapter 7.