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This report summarizes data collected from the 18 urban public transit systems in Texas and other sources to describe the role of transit in each urban transportation system, and the costs and benefits associated with transit operation. Data pertaining to transit operation, ridership characteristics, transit and automobile trip patterns and the impact of transit on urban transportation congestion levels were analyzed for systems where information was available.

The benefits of the transit systems in Texas were estimated in two areas. First, the benefits of transit in the six largest urban areas of reduced congestion, delay, operating costs, accidents, and fuel consumption were estimated for 1987 and projected to 1992. Second, using an input-output model, the benefits of expenditures by the 18 urban transit systems on income and employment were estimated.

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THE COST AND BENEFITS OF URBAN PUBLIC TRANSIT IN TEXAS

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Research Study Number 2-10-89-2003

Research Report 2003-1F

Sponsored By

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November 1989

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in²	square inches	645.2	millimetres squared	mm²
ft²	square feet	0.0929	metres squared	m²
yd²	square yards	0.836	metres squared	m²
mi²	square miles	2.59	kilometres squared	km²
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
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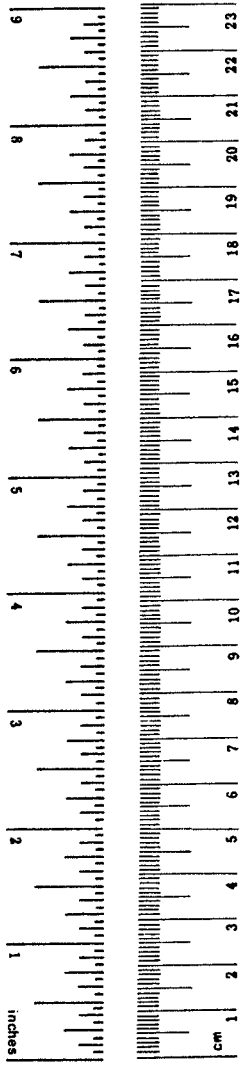
yd³	cubic yards	0.0765	metres cubed	m³

NOTE: Volumes greater than 1000 L shall be shown in m³.



TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm²	millimetres squared	0.0016	square inches	in²
m²	metres squared	10.764	square feet	ft²
km²	kilometres squared	0.39	square miles	mi²
ha	hectores (10 000 m²)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m³	metres cubed	35.315	cubic feet	ft³
m³	metres cubed	1.308	cubic yards	yd³

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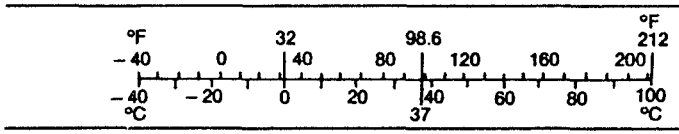

These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

ABSTRACT

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The benefits of the transit systems in Texas were estimated in two areas. First, the benefits of transit in the six largest urban areas of reduced congestion, delay, operating costs, accidents, and fuel consumption were estimated for 1987 and projected to 1992. Second, using an input-output model, the benefits of expenditures by the 18 urban transit systems on income and employment were estimated.

Key Words: Public Transit, Benefit/Cost, Mode Share, Trip Purpose, Mobility, Congestion Analysis

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Highways and Public Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

IMPLEMENTATION STATEMENT

The data summarized in this project can be used by Texas Department of Highways and Public Transportation (TDHPT) staff and planning sections of the urban public transit agencies in Texas to compare operations, service, ridership characteristics, mode share and impact of transit on roadway operation. Additional information in the Appendix details the operation of transit systems in Texas since 1976 using TDHPT data and other transit statistics.

SUMMARY

The urban public transit systems in Texas provide an alternative to the private automobile in 18 urban areas. Metropolitan transit authorities have been authorized by voters in six large urban centers -- Austin, Corpus Christi, Dallas, Fort Worth, Houston and San Antonio -- and are supported by a dedicated sales tax. El Paso has a city transit department with financial support from a dedicated sales tax. Smaller cities have municipal transit departments that are part of city governments.

Service provided by these agencies can be grouped into two principal activities. The transit service provided to the transit dependent residents of cities offers basic mobility to those with no automobile or other mode of transportation available. Suburban express service to major activity centers typifies the mass transit function used by residents with a vehicle available for their trip.

Large Transit System Characteristics

This study characterized the large Texas transit systems as those with 75 regular route buses, service every day of the week and operating in a metropolitan area with a population in excess of 500,000. These areas included Austin, Dallas, El Paso, Fort Worth, Houston and San Antonio. Some portions of the freeway and street systems in all of these areas are congested during the peak hour.

Almost half of the riders surveyed in these systems indicated they were using transit for work-related purposes and approximately one-fourth were on social, recreational, shopping, personal business or other trips. Approximately one-third of the transit riders came from households with no vehicle, compared to only eight percent of the total population. Seventy percent of the riders surveyed did not have a vehicle available for their trip. This significant portion of the system ridership represents the transit dependent group of transit patrons. While this is not a large part of the total daily trip movement in the urban area, few transportation alternatives exist for these urban residents.

A trip pattern with a significant portion of total trips served on transit is the peak-period travel to downtown. More than 30 percent of the trips to the Dallas and Houston central business districts (CBD) used transit. Approximately 20 percent of trips to the San Antonio CBD were on transit and a higher than areawide average of nine percent of trips to the Fort Worth CBD were on transit.

An analysis of passenger-miles of travel yielded an average of 2.4 percent of weekday peak-period volume and 1.5 percent of daily volume on transit. This increase in travel market share during the peak was more typical of the larger systems than the other systems studied, and is consistent with the work trip orientation of transit service in the larger urban areas. In major urban freeway corridors the transit travel percentage has an even greater peak-period focus due to park-and-ride lot service and the predominance of work trips during this time.

An analysis of the impact on urban area congestion estimated a two to four percent increase if the transit systems in Dallas or Houston were discontinued. The remaining large cities were estimated at two percent or less. The Dallas and Houston impacts were estimated as being equivalent to a combined total of 70 to 130 lane-miles of freeway and principal arterial street in each urban area.

Characteristics of Smaller Transit Systems

The other 12 transit systems in Texas had an average of 15 buses in regular route service and generally operated six days each week. Average daily ridership for these systems was less than 10,000 trips in 1986.

While work trips averaged one-third of the ridership in these systems, the highest percentage of trips was the social, recreational, shopping, personal business and other that constituted almost half of the transit ridership. More than 70 percent of transit riders responding to this survey had no automobile available for the trip, and more than half the riders came from households with no vehicle. These statistics illustrate that transit in

smaller urban centers provides a very important mobility component that would be difficult or impossible to obtain otherwise.

The difference between average daily travel and peak-period travel percentage on transit is not as large as in the large systems studied, but is present. The 12 smaller systems averaged 1.1 percent of daily passenger-miles in the urban area and 1.7 percent of peak-period miles traveled. The significantly lower roadway congestion levels in these cities reduced the importance of transit as a congestion relief element of the transportation system.

Motorist Benefits of Transit

One of the biggest benefits transit systems provide is to take motorists and vehicles off the road and put them as passengers in higher occupancy buses. This reduces the congestion, fuel consumption, and accidents for all motorists. This is particularly true in urban areas with significant congestion during peak periods.

The motorist benefits of transit are estimated by comparing the current situation in an urban area with an alternative scenario without the transit system. It is assumed that all passengers using the transit system switch to the highways in private vehicles. The change in speeds, delay, vehicle operating costs, and accidents are then estimated. The difference is defined as the motorist benefits of transit.

The results of the analysis found that transit systems in these cities are providing about $348 million in benefits to motorists, which is estimated to increase to about $484 million in 1992. Of this about 50% consists of lower motorist operating costs, 40% lower time costs, and 10% lower accident costs. There is also a substantial reduction in fuel consumption, about 69 million gallons in 1987, and about 90 million gallons in 1992.

Income and Employment Effects of Transit Expenditures

Transit systems also provide benefits to the communities they serve and the State through their expenditures. This money provides jobs, wages, and increased sales. There is also a multiplier effect as that money circulates through the economy. One method of estimating the effects of those expenditures is to use an input-output model. Two of the main areas impacts of expenditures are estimated are on household income and employment. Only the money received by the transit systems from federal subsidies were used to make the estimates, since it represents additional money in the Texas economy, not transfers from one sector to another.

The results of the input-output analysis found that the income impacts of transit expenditures of the 18 transit systems are substantial, over $243 million for 1986. The employment impacts are also impressive, 2,907 additional jobs. It is apparent that the State derives significant benefit from the federal subsidies the transit systems receive.

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INTRODUCTION

The Texas urban public transit industry is comprised of two general types of organizations -- municipal transit agencies and independent authorities. The six independent authorities provide service in most of the largest urban areas of the state (Austin, Corpus Christi, Dallas, Fort Worth, Houston and San Antonio) and are supported by a dedicated sales tax on some items purchased within the service area. In addition, El Paso has a city transit agency with services supported by financial assistance from a dedicated sales tax.

The size of these systems ranges from more than 800 vehicles in operation during peak periods, to less than ten. A range such as this indicates the presence of some significant differences in operating characteristics and procedures. The ridership market, type of trip served, equipment purchases and service decisions would also be significantly different in a range of agency sizes.

Identifying common operating statistics that illustrate the performance of each of these types of systems is difficult. Some concerns that are common to all the urban transit systems can be examined with annual reporting data and special studies conducted for individual operations. The important social service role of transporting residents who do not have access to a personal automobile or those for whom personal transportation is not an economically feasible alternative, is usually referred to as public transportation. The transit-dependent portion of each urban area is typically not a large portion of the population, but is a group which relies on others for transportation to work, shopping, medical facilities, and recreational locations. The public transportation function of urban transit systems also serves the elderly and disabled passengers with demand-responsive transit service or modified fixed-route transit buses.

The term mass transportation is often used to refer to the peak-period, focused origin and destination service provided to the commuting public in the larger urban areas. Significant traffic congestion on the major roadways, lack of parking spaces or high parking cost have been the traditional incentives for commuters to utilize park-and-ride lot or

express route service oriented to the central business district (CBD) or other major activity centers.

The typical mass transportation user differs from the usual regular route patron in many respects, but a key difference is described by the personal vehicle availability statistics. The differences between mass transit and public transit are examined in this report as they impact the role of transit in providing mobility -- both during the peak period and on a daily basis -- to urban residents.

Transit operating agencies benefit the urban area not only in the transporting of people, but also providing those residents with a method to participate in the work force. The agency payroll and equipment purchases also benefit state and local economies. This investigation summarized those benefits, as well as the increased mobility enjoyed by automobile commuters in larger urban areas due to the shift of auto drivers to transit service, providing greater person movement capacity for the remaining auto commuters.

THE ROLE OF TRANSIT IN URBAN TEXAS PERSON MOVEMENT

The public transportation systems in Texas were responsible for moving 184 million persons in 1987 (1)[1]. For some of these patrons, transit represented the most convenient mode of travel due to the lack of an available personal vehicle. For others, transit represented a better alternative to congested peak-period driving. The impact of transit on the person movement travel patterns and volume are estimated in this Chapter.

Travel Pattern and Ridership Survey Data

Assessing the role of transit in urban transportation in Texas requires travel data for both highway and transit modes. The necessary data vary according to urban area size and development pattern, but some components are common to all systems. Ridership surveys, however, are expensive to conduct and analyze, and may be viewed as less important than capital or operating expenses when budgetary decisions are made. Where applicable, central business district (CBD) cordon line counts estimate the use of transit for peak-period trips, the market which traditionally has the highest transit mode share.

This report documents available data from federal, state, and local planning and transit agencies. No new ridership surveys or cordon counts were conducted for this study; the data base is, therefore, incomplete. Several systems have not recently conducted the extensive survey of transit patrons necessary to estimate travel patterns and behavior.

Transit System Operating Characteristics

Table 1 lists factors which distinguish the urban transit systems in Texas. For this study the systems with more than 75 regular route buses are considered "large" systems. These systems (Austin, Dallas, El Paso, Fort Worth, Houston and San Antonio) have the following characteristics in common.

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[1]Denotes number of document listed in Reference section.

Table 1: 1986 Urban Transit System Operations

Urban Area	Number of Days of Operation Per Week	Average Number of Buses on Regular Routes	Average Number of Employees
Abilene	6	12	26
Amarillo	6	14	43
Austin	7	172	649
Beaumont	6	14	37
Brownsville	6	16	62
Corpus Christi	6	39	153
Dallas	7	586	1,731
El Paso	7	87	319
Fort Worth	7	103	311
Galveston	6	8	29
Houston	7	790	2,883
Laredo	7	20	79
Lubbock	6	29	68
Port Arthur	6	6	21
San Angelo	6	6	13
San Antonio	7	447	1,022
Waco	6	10	28
Wichita Falls	6	7	16
Large Systems Avg	7	364	1,153
Other Systems Avg	6	15	48

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio

Source: Reference 1

- Seven-day transit service
- 1986 Metropolitan area populations in excess of 500,000
- Peak-period roadway congestion

Most of the remaining systems do not have Sunday transit service, have a significantly smaller route structure, and offer few express commuter bus trips due to the lack of significant roadway congestion outside the morning and evening peak hour.

Operating data for 1982, 1984, and 1986 are presented in Table 2. The difference between the "large" and "other" systems is also apparent in these data. The magnitude of the values is certainly different, but the large system factor averages increased over the illustrated time period, while the "other" system averages are indicative of relatively constant situations. Most of the large system increase was due to service expansions in Austin, Dallas and Houston. Average daily ridership for the 18 systems in Table 2 approached 530,000 for 1986, more than 90 percent of that in the six largest systems. There were more than 2.5 million average daily passenger-miles of transit travel, with more than 2.3 million

in the six large urban areas. Passenger-miles of travel increased in all the large urban areas, with the exception of San Antonio, where a significant decrease was reported in the American Public Transit Association statistics (2) (see Appendix A, Tables A-1 to A-5). It was determined, however, that the route structure was changed for the VIA Metropolitan Transit Authority in San Antonio in 1986. This should explain the decrease in passenger-miles of travel given essentially no change in the number of passenger trips.

Table 2: Operating Data For Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips			Daily Vehicle-Miles of Service			Daily Passenger-Miles of Service		
	1982	1984	1986	1982	1984	1986	1982	1984	1986
Abilene	1,300	1,400	1,350	1,600	1,400	1,500	4,400	5,700	5,400
Amarillo	2,400	2,700	2,500	2,400	2,400	2,400	5,600	7,400	5,400
Austin	15,000	14,300	19,200	8,000	8,000	17,000	66,000	44,000	61,000
Beaumont	4,900	4,800	4,000	2,000	2,100	2,000	14,000	15,300	16,600
Brownsville	7,700	6,600	6,600	2,300	2,700	2,500	30,000	19,000	22,000
Corpus Christi	5,100	5,200	5,800	4,600	4,100	5,700	10,000	18,000	21,000
Dallas	96,000	119,000	132,000	40,000	44,000	72,000	500,000	535,000	735,000
El Paso	25,000	25,500	26,100	11,500	10,500	12,000	120,000	205,000	158,000
Fort Worth	16,000	14,900	14,500	9,300	9,500	11,900	80,000	71,000	68,000
Galveston	3,500	2,600	2,100	1,400	1,300	1,200	10,400	7,000	5,300
Houston	144,000	195,000	195,000	65,000	90,000	101,000	715,000	955,000	1,035,000
Laredo	8,700	9,200	8,700	2,300	2,400	2,400	N/A	23,000	21,000
Lubbock	9,500	8,300	8,400	3,300	3,400	3,600	11,300	12,200	12,400
Port Arthur	900	980	1,150	640	700	1,000	2,700	5,400	7,000
San Angelo	1,400	1,500	1,150	1,050	970	1,000	5,900	7,500	6,000
San Antonio	95,000	95,000	97,000	40,000	41,000	46,000	270,000	355,000	315,000
Waco	1,900	2,500	2,500	1,200	1,130	1,100	14,000	7,800	7,000
Wichita Falls	900	700	620	880	900	900	N/A	N/A	3,700
Large Systems Avg	65,167	77,283	80,633	28,967	33,833	43,317	291,833	360,833	395,333
Other Systems Avg	4,017	3,873	3,739	1,823	1,958	2,108	10,830	12,050	11,067

N/A - Not available

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio

Source: Tables A-1, A-3, and A-5

Transit Ridership Trip Purpose

While comparable trip purpose surveys have not been conducted at all urban Texas transit systems, Table 3 summarizes recent available information. The "home" purpose was not reported by all agencies; some percentage of these "home" trips would have been noted as work trips in the other systems (i.e., riders going from work to home).

Accounting for this difference in question formulation, the data in Table 3 appears to indicate that the larger systems carry a higher percentage of work trips than systems in smaller cities. With no adjustment for the "home" trip purpose, the large system surveys indicated work trips accounted for 48 percent of the trips, while the smaller areas averaged 32 percent work trips. The commuter traveller market served by large city transit systems probably accounts for the significant difference. Large and small system averages were not calculated for the "medical" or "home" trip purposes due to the inconsistent data available for these types of trip purposes.

Table 3: Purpose of Transit Ridership Trip Making

Urban Area	Trip Purpose (Percent of Responses)				
	Work	School	Medical	Home	Social/Recreational/Shopping Personal Business/Other
Austin	48	14	N/A	N/A	38
Beaumont	44	24	N/A	N/A	32
Brownsville	30	6	7	N/A	57
Corpus Christi	39	14	7	19	21
Dallas	72	8	3	N/A	17
El Paso	45	22	33[1]	N/A	N/A
Fort Worth	66	11	N/A	N/A	23
Galveston	25	7	6	N/A	62
Houston	38	8	N/A	36	18
Laredo	33	17	N/A	N/A	50
Port Arthur	25	19	N/A	N/A	56
San Angelo	30	24	4	N/A	42
San Antonio	19	10	N/A	57	14
Large System Avg	48	12			22
Other System Avg	32	16			46

N/A - Data either not available or not collected

Note: "Large" systems include Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio

[1]Reported as Medical, Social, Other

Source: Local Transit Agency Data

Auto Availability

Table 4 illustrates the survey results collected for auto availability data from patrons of urban Texas transit systems, as well as auto availability data for the Metropolitan Statistical Areas (MSAs) (5). The smaller systems have higher proportions of riders with no automobiles in the household, but approximately the same percentage with no auto available for travel as in the larger systems. As with the trip purpose summary, the data in Table 4 may indicate the large city systems have a higher percentage of suburban

commuter trips, which generally originate in households with a choice of modes other than transit. The higher percentage of riders on the smaller systems with no auto in the household may indicate a larger percentage of "transit-dependent" patrons compared to the large city systems. The data in Table 4 also show that the percentage of transit riders with no automobile available is much higher than the percentage of households in the MSA with no automobile available, indicating a greater overall reliance on transit among the transit riders relative to the urban residents.

Table 4: Auto Availability Among Urban Texas Transit Riders

Urban Area	Auto Available To Transit Riders For Trip (Percent)		Number of Autos in Transit Rider Households (Percent)			MSA Household Avg. No. of Autos	Percent Zero Auto Household in MSA
	Yes	No	0	1	2+		
Austin	N/A	N/A	35	31	29	2.1	7.1
Beaumont	42	58	44	33	23	2.1	8.2
Brownsville	N/A	N/A	48	37	15	1.8	12.2
Corpus Christi	N/A	N/A	75	14	11	2.1	7.9
Dallas	32	68	35	35[1]	25	2.1	6.5
El Paso	22	78	54	46	N/A	1.9	10.9
Fort Worth	N/A	N/A	38	33	29	2.1	6.5
Galveston	N/A	N/A	63	24	13	2.0	10.0
Houston	34	66	N/A	N/A	N/A	2.1	7.0
Laredo	19	81	41	39	20	1.7	18.1
Port Arthur	25	75	44	33	23	2.1	8.2
San Angelo	24	76	12	29	59	2.0	6.5
San Antonio	N/A	N/A	N/A	N/A	N/A	2.1	10.2
Large System Avg	29	71	36	33	28	2.1	8.0
Other System Avg	28	72	52	30	18	2.0	10.2

N/A - Not available
MSA - Metropolitan Statistical Area

Note: "Large" systems include Austin, Dallas, El Paso, Fort Worth, Houston and San Antonio

[1]Includes one or more automobiles and is not included in large system average

Source: Local Transit Agency Data and Reference 5

Transit's Role in Peak-Period Downtown Travel

The impact of transit on urban area peak-period traffic was estimated relative to the overall daily transit travel for the larger urban areas in Texas. The most significant mobility related role of transit in large urban areas is peak period travel to the central business district (CBD). A limited number of CBD cordon counts have been conducted in Texas cities in recent years.

Houston

While urban area peak-period transit travel represents 4.0 percent of total passenger-miles of travel in Houston, a 1986 CBD study (6) estimated that 34 percent of the morning peak inbound person trips utilized public transit. Vanpool ridership accounted for three percent of trips, and private vehicles, trucks and taxis for the majority of the 113,000 CBD-bound trips (63 percent). The average of morning and evening peak period inbound and outbound transit passengers was also 34 percent of total passengers.

During the 6:30 a.m. to 6:00 p.m. study period, an average of 27 percent of the persons crossing the CBD cordon line were in buses (including airport shuttle and intercity coaches). This was a significant increase from the 1976, 1979 and 1982 studies when bus riders accounted for approximately 15 percent of total person movement.

Dallas

Inbound morning peak traffic counts were conducted in the Dallas CBD in 1983 and 1985 (7). Bus passengers accounted for 31 percent of the 1985 person volume and 29 percent in 1983. Total person trips to the CBD in the morning peak increased from 86,700 to 98,000 from 1983 to 1985, meaning the transit share increased even as the downtown travel market was growing.

Fort Worth

The CBD transit passenger cordon count (7) in Fort Worth also showed an increase, from seven to nine percent of total inbound travel, between 1983 and 1985. Total inbound morning peak trips increased 14 percent from 36,900 to 42,100 between 1983 and 1985.

San Antonio

No formal vehicle classification and occupancy count has been conducted recently in San Antonio, but 1983 traffic volume counts and a 1986 transit system ridership survey were used to estimate travel mode to the CBD. Using an average of 1.2 persons per vehicle and a 2.3 percent average annual traffic growth rate (from TDHPT automatic traffic recorder stations (4) near downtown) a 1983 vehicle volume count (8) was factored to a 1986 estimate of 34,600 persons in vehicles other than transit buses entering the CBD for the morning peak period. The 1986 VIA transit survey (9) estimated 8,500 persons entered the CBD on buses, a 20 percent transit mode share.

The role of transit in peak-period downtown travel is summarized in Table 5 for the urban areas of Dallas, Fort Worth, Houston, and San Antonio. Table 5 illustrates the total CBD-bound person trips and the percent of those person trips that utilized transit in each of these urban areas.

Table 5: Role of Transit in Peak-Period Downtown Travel

Urban Area	CBD Bound Person Trips	Percent Person Trips Utilizing Public Transit
Dallas[1]	98,000	31
Fort Worth[1]	42,100	9
Houston[2]	113,000	34
San Antonio[2]	43,100	20

Note: All data shown represents morning peak period

[1]1985 Data
[2]1986 Data

Source: References 4, 5, 6, 7, and 8

Roadway and Transit System Passenger Travel

Annual Transit Trips Per Capita Comparison

One way to compare transit systems is on the basis of annual transit trips per capita. Annual transit trips per capita data from 1978, 1980, 1982, 1984, and 1986 are presented

in Table 6 for the 18 cities studied. The population data used to compute the annual transit trips per capita were initially obtained on both a city limit and a metropolitan area basis. While these two methods of calculation produced similar proportions within the 18 urban areas studied, the population data based on the city limits was believed to produce results that were more indicative of the actual transit system service areas. The calculation of annual transit trips per capita based on metropolitan area populations for 1986 is shown in Table 6 to illustrate that the proportions within the cities studied are fairly similar to those based on city limit population data.

Table 6: Annual Transit Trips Per Capita For Texas Transit Systems -- 1978 to 1986

	Annual Transit Trips Per Capita					
Urban Area	1978	1980	1982	1984	1986	1986[1]
Abilene	2.05	2.10	3.13	3.29	2.91	2.52
Amarillo	3.82	3.86	4.38	4.09	3.58	3.03
Austin	12.16	11.43	8.98	9.76	19.46	10.89
Beaumont	8.27	9.80	10.05	9.51	7.38	2.44
Brownsville	10.15	16.40	20.05	18.46	19.70	7.42
Corpus Christi	6.20	6.24	4.87	4.73	5.04	3.64
Dallas	29.44	30.97	33.00	39.07	37.80	15.57
El Paso	20.11	19.23	17.13	18.52	17.97	15.10
Fort Worth	11.41	11.13	12.12	11.03	9.76	3.27
Galveston	17.30	16.13	13.47	11.59	10.18	2.97
Houston	22.51	23.46	24.91	27.25	31.62	17.04
Laredo	30.74	34.84	29.18	28.89	26.90	24.91
Lubbock	13.11	14.80	17.77	12.67	12.45	9.97
Port Arthur	N/A[2]	4.34	4.10	4.34	4.16	.76
San Angelo	3.08	3.39	4.00	3.78	2.85	2.50
San Antonio	29.49	36.83	35.07	36.81	33.56	22.34
Waco	4.60	4.92	4.33	4.35	4.38	2.45
Wichita Falls	2.22	2.61	2.32	1.96	1.80	1.40
Large System Avg	20.86	22.17	21.87	23.74	25.03	14.04
Other System Avg	9.23	9.95	9.80	8.97	8.44	5.33

N/A - Not available

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio.
Note: All population data are obtained within city limits unless otherwise noted.

[1]Population data presented for metropolitan area.
[2]The Port Arthur Transit System began operation in May, 1979

Average Daily Traffic

Average daily passenger-miles of travel for the mobility providing portions of the roadway system (freeways and principal arterial streets) are compared to transit passenger loads in Table 7. Transit routes typically operate on freeways and major streets, with few route miles on local streets. The illustration of the amount of travel removed from the

roadway system by transit, therefore, focused on freeway and principal arterial street traffic. Service areas for the urban transit systems are not always as large as the urbanized area boundaries used for roadway statistics, (therefore, the city data were used in the previous comparison) and reliable traffic data for these service areas are seldom available. Consistent data for the urbanized areas, however, do exist, and when comparing urban travel conditions, comparison on an urban area basis, rather than a transit service area basis, is considered more appropriate. Urban area boundaries were, therefore, used for data acquisition purposes and for uniformly illustrating the urban travel conditions in the various areas analyzed in this study.

Table 7: Passenger Travel on Roadway and Transit Systems

Urban Area	Daily Passenger-Miles of Travel (1000)[1]						Percent of Daily Travel on Transit		
	Freeway & Principal Arterial Streets[2]			Transit					
	1982	1984	1986	1982	1984	1986	1982	1984	1986
Abilene	920	1,160	1,030	4	6	5	.4	.5	.5
Amarillo	1,580	1,540	1,910	6	7	5	.4	.5	.3
Austin	4,950	6,150	8,990	66	44	61	1.3	.7	.7
Beaumont	1,730	2,170	2,080	14	15	17	.8	.7	.8
Brownsville	460	510	610	30	19	22	6.1	3.6	3.5
Corpus Christi	3,060	3,250	3,380	10	18	21	.3	.6	.6
Dallas	27,970	33,080	36,970	500	535	735	1.8	1.6	1.9
El Paso	6,190	6,740	7,600	120	205	158	1.9	3.0	2.0
Fort Worth	14,740	16,440	17,970	80	71	68	.5	.4	.4
Galveston	590	650	610	10	7	5	1.7	1.1	.9
Houston	36,970	42,290	41,910	8	955	1,035	.0	2.2	2.4
Laredo	470	400	550	N/A	23	21	N/A	5.5	3.7
Lubbock	2,170	2,320	2,750	11	12	12	.5	.5	.4
Port Arthur	N/A	N/A	1,390	3	5	7	N/A	N/A	.5
San Angelo	330	300	400	6	8	6	1.8	2.6	1.5
San Antonio	13,350	14,840	16,970	270	355	315	2.0	2.3	1.8
Waco	1,480	1,820	2,050	14	N/A	7	.9	.0	.3
Wichita Falls	1,170	1,040	1,250	N/A	N/A	4	.0	.0	.3
Large Systems Avg	17,360	19,920	21,740	174	361	395	1.2	1.7	1.5
Other Systems Avg	1,270	1,380	1,500	11	12	11	1.3	1.4	1.1

N/A - Not Available

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio

[1]See Appendix A for more detail concerning freeway and principal arterial street travel
[2]A vehicle occupancy ratio of 1.2 was used

Source: Tables A-1 and A-2, Reference 3

An average of 1.2 to 1.7 percent of the total average daily passenger travel is carried on public transit in the large cities. The significant passenger-mile decrease reported for San Antonio is responsible for the decline between 1984 and 1986.

A significant increase from 1984 to 1986 in vehicle-miles of travel on the freeway and principal arterial street systems in Amarillo, Laredo and Lubbock resulted in an overall decrease in percent of transit travel in the small and medium cities. Laredo and Brownsville had the highest percentage of urban passenger-miles made by transit in the 18 cities studied.

Peak Travel Period Comparison

While average daily travel is a readily accessible means of comparing highway and transit modes, a more accurate estimation of the mobility impact of transit is derived by examining weekday peak-period travel. The urban areas for which roadway and transit travel information could be obtained are listed in Table 8. Most of the roadway data are derived from the Texas Department of Highways and Public Transportation (TDHPT) automatic traffic recorders (4) and pertain to the urban freeway systems, while some of the data are estimates based on available data from other transit and highway systems. The peaking characteristics of the principal arterial street system and the urban freeways are, for the purposes of this analysis, similar, and differences should not affect the analysis results.

The data illustrate that transit ridership is more oriented toward peak-period weekday travel than freeway and major street traffic volumes. A greater percentage (123 for transit vs 109 for roadway) of average daily traffic is recorded during the weekday in the 17 urban areas listed in Table 8. The daily transit averages for the "other" transit systems, with the exception of Laredo, reflect a six day per week operation, while the large transit systems operate every day. All of the weekday transit ridership patterns have equal or higher peak system loads than roadway systems according to the data developed for Table 8, with an average of 58 and 42 percent for large and "other" transit systems and 43 and 33 percent for freeways and major streets.

Table 8: Texas Urban Area Vehicle and Transit Traffic Characteristics

Urban Area	Vehicle Travel Data		Transit Travel Data	
	Percent of Avg Daily Traffic on Weekdays[1]	Percent of Weekday Traffic in Peak Period[2]	Percent of Avg Daily Riders on Weekdays[1]	Percent of Weekday Riders in Peak Period[2]
Abilene[3]	100%	30%	110%	40%
Amarillo[3]	100	30	105	40
Austin	110	40	120	55
Beaumont	105	25	110	40
Brownsville[3]	110	35	110	40
Corpus Christi	110	30	105	40
Dallas	110	40	130	70
El Paso	110	45	115	45
Fort Worth	105	45	125	60
Galveston[3]	100	40	115	45
Houston	110	40	125	60
Laredo[3]	100	30	120	55
Lubbock[3]	105	35	110	40
San Angelo[3]	100	40	105	40
San Antonio	110	45	120	55
Waco[3]	100	35	105	40
Wichita Falls[3]	105	35	115	45
Large System Avg	109	43	123	58
Other System Avg	103	33	110	42

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio

[1]Percentage of average daily traffic during average weekday
[2]Percentage of average weekday traffic during morning and evening weekday peak period (total of 5 or 6 hours)
[3]Estimates based on limited data and data from other transit and highway systems

Source: Reference 4 and Local Transit Agency Data

Table 9 presents the application of the weekday peak-period travel factors to the daily passenger-miles of travel (PMT) data. The weekday and peak-period travel percentages (Table 8) are multiplied to the 1986 daily PMT values in Table 2. A comparison of the daily and peak-period person travel percentages indicates the greater use of transit in the weekday morning and evening peak periods relative to the average daily usage. Reliance on transit in Houston and Dallas, while still fairly low, is 65 and 100 percent higher during the peak periods, relative to the average daily travel percentage. Changes in transit travel percentage in the large transit systems ranged from 5 to 100 percent, while the "other" transit systems exhibited a change in transit travel percentage ranging from 5 to 105 percent. The large transit systems were characterized by an average percentage change of 50 percent, with an average of 35 percent for the "other" transit systems.

Table 9: 1986 Roadway and Transit Peak-Period Travel Comparison

Urban Area	Roadway Pass-Miles		Transit Pass-Miles		Percent of Travel on Transit	
	Daily (1000)	Weekday Peak-Period (1000)	Daily (1000)	Weekday Peak-Period (1000)	Daily	Weekday Peak-Period
Abilene	1,030	310	5	2	.5	.7
Amarillo	1,910	570	5	2	.3	.4
Austin	8,990	3,950	61	40	.7	1.0
Beaumont	2,080	550	17	7	.8	1.3
Brownsville	610	230	22	10	3.5	4.0
Corpus Christi	3,380	1,120	21	9	.6	.8
Dallas	36,970	16,270	735	670	2.0	4.0
El Paso	7,600	3,760	158	82	2.0	2.1
Fort Worth	17,970	8,490	68	51	.4	.6
Galveston	610	240	6	3	1.0	1.2
Houston	41,910	18,440	1,035	775	2.4	4.0
Laredo	550	170	21	14	3.7	7.5
Lubbock	2,750	1,010	13	6	.5	.6
Port Arthur	1,390	580	7	3	.5	.5
San Angelo	400	160	6	3	1.5	1.6
San Antonio	16,970	8,400	315	210	1.8	2.4
Waco	2,050	710	7	3	.3	.4
Wichita Falls	1,250	460	4	2	.3	.5
Large System Avg	21,740	9,890	395	305	1.5	2.4
Other System Avg	1,500	510	11	5	1.1	1.7

Note: "Large" systems include Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio
Note: Roadway data refers to freeways and principal arterial streets

Impact of Transit on Roadway System Operation

A study of urban mobility in the seven largest urban areas of Texas resulted in the development of a congestion index for the major roadway systems of each area for 1986 (3). The methodology used daily vehicle-miles of travel per lane-mile of roadway as an indicator of urban roadway system congestion, and was also applied to the additional urban areas analyzed in this study.

Table 10 illustrates an analysis of the impact on the freeway and principal arterial street system congestion index value if the trips made on transit were transferred to private automobiles. The illustration in Table 10 is a liberal estimate in that it assumes all transit travel would result in auto trips. The number of transit patrons without access to a private vehicle, and thus dependent on transit service for mobility, may result in a somewhat lower value for additional vehicle-miles of travel; some trips would not be made.

Table 10: Impact of Transit on Roadway Congestion Levels -- All Transit Riders in Automobiles

Urban Area	Daily Passenger-Miles of Transit Travel (1000)	Equivalent Auto Vehicle-Miles of Travel on Transit (1000)[1]	Additional Auto Vehicle-Miles of Travel on Transit (1000)[2,3]	1986 Congestion Index[4]		
				Actual Situation	With Transit Riders in Autos[5]	Percent Increase[6]
Abilene	5	6	4	.14	.14	0.4
Amarillo	5	6	2	.23	.23	0.1
Austin	61	76	49	.98	.99	1.0
Beaumont	17	24	21	.33	.33	1.2
Brownsville	22	21	17	.23	.24	3.4
Corpus Christi	21	22	13	.71	.71	0.5
Dallas	735	1,265	1,150	1.05	1.09	3.6
El Paso	158	138	118	.75	.77	2.3
Fort Worth	68	90	71	.87	.87	0.3
Galveston	5	5	3	.27	.28	0.7
Houston	1,035	1,470	1,309	1.21	1.26	3.8
Laredo	21	39	35	.23	.24	7.6
Lubbock	12	12	6	.22	.22	0.3
San Angelo	6	5	4	.14	.15	1.1
San Antonio	315	350	280	.91	.92	1.4
Waco	7	7	5	.23	.23	0.3
Wichita Falls	4	5	3	.14	.14	0.3
Large System Avg	395	565	496	.96	.98	2.1
Other System Avg	16	20	15	.31	.32	1.3

Note: "Large" systems include Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio.

[1]Vehicle-miles of travel resulting from shift of transit trips to automobiles; adjusted for different peaking characteristics in transit and personal vehicle trips
[2]Equivalent auto vehicle-miles minus transit bus vehicle-miles
[3]As estimated in Equation 2
[4]A Congestion Index above 1.0 indicates an undesirable urban area major roadway operating condition
[5]Impact of additional vehicle-miles of travel on 1986 roadway system
[6]Percentages determined using calculated congestion index values; congestion index values presented in Table are rounded

A more conservative estimate of auto trips resulting from the absence of transit service is, therefore, shown in Table 11. In this instance, only transit riders that had an automobile available were assumed to produce additional auto vehicle-miles of travel. The results shown in Table 11 were computed through the use of the auto availability data in Table 4.

Equations 1, 2, and 3 summarize the adjustment factors used to calculate the equivalent vehicle-miles of transit passenger travel that could utilize the roadway system. The greater weekday peak-period use of transit relative to private vehicle traffic required the adjustment ratios in Equations 2 and 3. Those travel patterns result in a greater peak-period travel impact than was assumed in the development of the congestion index (which was based on vehicle travel patterns with transit service).

The automotive-equivalent miles of travel represented by the transit bus vehicle traffic that would be removed under the more liberal scenario is subtracted from the value derived in Equation 2 to estimate the additional automobile vehicle-miles of travel (Table 10). A more conservative estimate of the additional automobile vehicle-miles of travel (Table 11) is calculated by subtracting the auto-equivalent miles of travel represented by transit bus vehicle traffic from the value derived in Equation 3.

$$\text{Daily passenger-miles of transit travel} \div \text{1.2 persons per auto} = \text{Daily auto traffic volume on transit} \qquad \text{Equation 1}$$

$$\text{Daily auto traffic volume on transit} \times \frac{\text{Transit weekday rider percentage}}{\text{Roadway weekday traffic percentage (Table 8)}} \times \frac{\text{Transit peak-period travel percentage}}{\text{Roadway peak-period travel percentage (Table 8)}} = \text{Equivalent auto vehicle-miles of travel on transit (Table 10)} \qquad \text{Equation 2}$$

$$\text{Equivalent auto vehicle-miles of travel on transit (Equation 2)} \times \text{Percentage of transit riders with auto available (Table 4)} = \text{Equivalent auto vehicle-miles of travel on transit (Table 11)} \qquad \text{Equation 3}$$

The shift of traffic volumes from transit to autos results in a congestion index increase approximately equal to one or two years growth in traffic volumes in Dallas and Houston. Congestion index changes were less in the other five large urban areas, as well

Table 11: Impact of Transit on Roadway Congestion Levels -- Transit Riders with Access to Automobiles

Urban Area	Daily Pass-Miles of Transit Travel (1000)	Percent of Transit Riders With Auto Available (%)[1]	Equivalent Auto Vehicle-Miles of Travel on Transit (1000)[2,3]	Additional Auto Vehicle-Miles of Travel on Transit (1000)[4]	1986 Congestion Index[5]		
					Actual Situation	With Transit Riders in Autos[6]	Percent Increase[7]
Abilene	5	48	3	2	.14	.14	0.2
Amarillo	5	48	3	1	.23	.23	0.1
Austin	61	60	46	29	.98	.99	0.8
Beaumont	17	56	13	12	.33	.33	0.7
Brownsville	22	52	11	9	.23	.23	1.7
Corpus Christi	21	25	6	3	.71	.71	0.1
Dallas	735	60	759	690	1.05	1.07	1.9
El Paso	158	46	63	54	.75	.76	1.3
Fort Worth	68	62	56	44	.87	.87	0.1
Galveston	5	37	2	1	.27	.27	0.3
Houston	1,035	61	897	798	1.21	1.24	2.2
Laredo	21	59	23	20	.23	.24	4.5
Lubbock	12	48	6	3	.22	.22	0.1
San Angelo	6	48	3	2	.14	.14	0.5
San Antonio	315	61	214	171	.91	.92	0.6
Waco	7	48	3	3	.23	.23	0.1
Wichita Falls	4	48	2	2	.14	.14	0.1
Large System Avg	395	61	339	298	.96	.97	1.1
Other System Avg	16	48	11	8	.31	.31	0.7

Note: "Large" systems include Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio

[1] See Table 4
[2] As estimated in Equation 3
[3] Vehicle-miles of travel resulting from shift of transit trips to automobiles; adjusted for different peaking characteristics in transit, personal vehicle trips, and auto availability
[4] Equivalent auto vehicle-miles minus transit bus vehicle-miles
[5] A Congestion Index above 1.0 indicates an undesirable urban area major roadway operating condition
[6] Impact of additional vehicle-miles of travel on 1986 roadway system
[7] Percentages determined using calculated congestion index values; congestion index values presented in Table are rounded

as the "other" urban areas, where mobility has not yet reached an undesirable level. The analysis in Table 10, with all transit riders transferring to automobiles, illustrates an average of approximately twice the impact of the more conservative estimates. The actual mobility impact of transit would likely be somewhere between these two estimates.

Transit's impact on roadway construction requirements can be estimated by the roadway capacity that would be required to regain the 1986 congestion index level if the transit person trips were shifted to automobiles. Approximately 35 to 55 lane-miles of freeway and 45 to 75 lane-miles of principal arterial in Houston would be necessary to regain the 1986 congestion index level. Similar analyses for Dallas indicate approximately 35 to 60 lane-miles of both freeway and principal arterial street would be required. These capacity improvements alone (not including other transit benefits which will be enumerated in subsequent sections) represent $92.5 to $147.5 million in roadway costs in Houston and $87.5 to $150.0 million in Dallas. The total of all the impacts in the other 15 study areas, some of them very small, was estimated as $80 to $140 million of facilities. (These improvement cost estimates are based on $2 million per lane-mile for freeways and $0.5 million per lane-mile for principal arterials.)

ESTIMATION OF TRANSIT BENEFITS IN TEXAS

The transit systems in Texas provide a variety of benefits to the users of the systems and to the communities they serve. Since a significant portion of the transit expenditures are subsidized by public revenues, it is important to attempt to quantify some of these benefits. These benefits, however, are difficult to identify, and more importantly to quantify. This section attempts to quantify some of these benefits, given the limited amount of data described in previous sections of this report.

The benefits of transit systems include:

(1) reduced congestion on urban arterials by reducing the number of vehicles on the road, especially during peak periods;

(2) safety improvements by reducing the number of vehicles on the road and using buses, which are safer vehicles;

(3) reduced fuel consumption and other vehicle operating costs by reducing the number of vehicles on the road;

(4) increased air quality by reducing the number of vehicles on the road;

(5) increased mobility for those who do not have access to an automobile;

(6) increased income and employment resulting from expenditures in the transit systems.

The estimation of benefits for items (1), (2), (3), and (6) are provided in this section. Estimation of benefits for the other items was not possible due to the limited data and difficulty in quantifying some of those effects. That is particularly the case with mobility. There is not sufficient and consistent survey data on transit users to make an estimate of the benefits. It is unfortunate that it is not possible to quantify one of the major objectives of transit systems, providing mobility. It does indicate a need to expand and standardize the data collected by individual transit systems.

Motorist Benefits of Transit

One of the biggest benefits transit systems provide is to take motorists and vehicles off the road and put them as passengers in higher occupancy buses. This reduces the congestion, fuel consumption, and accidents for all motorists. This is particularly true in urban areas with significant congestion during peak periods. There is an incentive for motorists making work trips during peak periods to switch to a viable alternative. This is one of the reasons high-occupancy lanes, park-and-ride lots, etc. are becoming increasingly popular.

The motorist benefits of transit are estimated by comparing the current situation in an urban area with an alternative scenario without the transit system. It is assumed that all passengers using the transit system are forced onto the highways in private vehicles. The change in speeds, delay, vehicle operating costs, and accidents are then estimated. The difference is defined as the motorist benefits of transit. Of course not all transit passengers would actually replace their transit trips with an equal amount of private vehicle trips, but that is offset by the loss of mobility. There would be an opportunity cost involved for those unable or unwilling to replace those trips. This would involve lost jobs, lost wages, lower expenditures, and other consequences of reduced mobility. In addition, as described below, the analysis is unable to capture specific peak-hour effects, when the benefits of transit would be highest. Overall the assumption of transit trips being replaced by automobile trips seems reasonable given the large uncalculated costs of loss of mobility and peak period congestion.

The only comprehensive data base available for estimating the motorist costs of urban transportation systems is the Highway Performance Monitoring System (HPMS) (13). HPMS was developed by FHWA to monitor the current status of the highway system in the United States, and to make estimates of future needs. Each state submits a limited amount of data on all the public highways in the state (excluding the local functional class), and detailed data on a stratified sample of highways. In Texas each urbanized area is sampled individually, allowing for analysis of the highway system in any urbanized area.

FHWA also developed a package of computer programs to analyze that sample data. The package is used to estimate the current condition of highways and future needs. A version of that package of programs was made available to the states for their use. The HPMS sample data and Analysis Package are used in this study to make the estimates of motorist benefits of transit.

Estimates of the effects of transit were performed for the six largest transit systems in Texas, Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio. The motorist impacts were calculated for the current (1987) conditions and compared to the conditions if all transit passengers were using private vehicles. Estimates were also made for projected traffic volumes in 1992 using the same technique. Since most transit systems operate on the freeways and major arterials, only those functional classes were used in the analysis for each of the six urban areas.

In addition, since there is no comprehensive data available on the transit ridership during peak periods it was assumed that the increase in vehicle traffic without transit would be spread throughout the day. This was accomplished by increasing the ADT on each highway section by the percent the transit passenger-miles traveled compared to the total passenger-miles, shown in Table 7. The 1987 and 1992 transit mileage numbers used in the analysis were calculated using the 1986 numbers with an assumed six percent annual growth rate in transit use. These were converted into vehicle miles using an occupancy rate of 1.2 for automobiles. A vehicle distribution of 3% trucks was also assumed.

The output from the HPMS Analysis Package was then used to calculate the motorist costs of each scenario. The equations for the calculation of motorist benefits are given below.

$$\text{Lower Time Costs} = (1/SPD_{wo} - 1/SPD_{w}) * VT * VMT_{wo} * 1000 * 365 \quad \text{Equation 4}$$

$$\text{Lower Operating Costs} = [(OC_{wo} * VMT_{wo}) - (OC_{w} * VMT_{w} + OC_{b} * VMT_{b})] * 365 \quad \text{Equation 5}$$

$$\text{Lower PDO Costs} = [(ACNP_{wo} * VMT_{wo} - ACNP_{w} * VMT_{w}) / 100{,}000] * ACCP * 365 \quad \text{Equation 6}$$

$$\text{Lower Injury Costs} = [(ACNI_{wo} * VMT_{wo} - ACNI_{w} * VMT_{w}) / 100{,}000] * ACCI * 365 \quad \text{Equation 7}$$

$$\text{Lower Fatality Costs} = [(ACNF_{wo} * VMT_{wo} - ACNF_{w} * VMT_{w}) / 100{,}000] * ACCF * 365 \quad \text{Equation 8}$$

Lower Accident Costs = Lower PDO Costs + Lower Injury Costs + Lower Fatality Costs Equation 9

Lower Fuel Consumption = $[(FC_{wo} * VMT_{wo}) - (FC_w * VMT_w + FC_b * VMT_b)] * 365$ Equation 10

where

SPD_{wo} = average daily speed (mph) of vehicles without transit (HPMS output)

SPD_w = average daily speed (mph) of vehicles with transit (HPMS output)

VT = weighted average of value of time for cars ($8.30 per passenger) and trucks ($19.70), taken from Reference 14 and updated to 1987, = (8.3 * 1.2) * 0.97 + 19.7 * 0.03 = 10.2522

VMT_{wo} = daily vehicle miles traveled on freeways and principal arterials without transit (HPMS output)

VMT_w = daily vehicle miles traveled on freeways and principal arterials with transit (HPMS output)

VMT_b = daily vehicle miles traveled by transit system buses (Table 2, updated using 6% annual growth in transit)

OC_{wo} = average daily vehicle operating cost per 1000 vehicle miles without transit (HPMS output)

OC_w = average daily vehicle operating cost per 1000 vehicle miles with transit (HPMS output)

OC_b = average daily vehicle operating cost per 1000 vehicle miles by transit system buses = 484 (taken from Reference 15, updated to 1987)

$ACNP_{wo}$ = number of PDO accidents per 100 million vehicle miles without transit (HPMS output)

$ACNP_w$ = number of PDO accidents per 100 million vehicle miles with transit (HPMS output)

ACCP = cost of a PDO accident = 1000 (taken from Reference 16, All Urban Accidents, updated to 1987)

$ACNI_{wo}$ = number of injury accidents per 100 million vehicle miles without transit (HPMS output)

$ACNI_w$ = number of injury accidents per 100 million vehicle miles with transit (HPMS output)

ACCI = cost of an injury accident = 13,200 (taken from Reference 16, All Urban Accidents, updated to 1987)

$ACNF_{wo}$ = number of fatal accidents per 100 million vehicle miles without transit (HPMS output)

$ACNF_w$ = number of fatal accidents per 100 million vehicle miles with transit (HPMS output)

ACCF = cost of a fatal accident = 779,200 (taken from Reference 16, All Urban Accidents, updated to 1987)

FC_{wo} = average gallons fuel consumption per 1000 vehicle miles without transit (HPMS output)

FC_w = average gallons fuel consumption per 1000 vehicle miles with transit (HPMS output)

FC_b = average gallons fuel consumption per 1000 vehicle miles by transit system buses = 204 (taken from Reference 15)

The results of the calculations are given in Table 12. Overall transit systems in these cities are providing about $348 million in benefits to motorists, which is estimated to increase to about $484 million in 1992. Of this, about 50% consists of lower motorist operating costs, 40% lower time costs, and 10% lower accident costs. There is also a substantial reduction in fuel consumption, about 69 million gallons in 1987, and about 90 million gallons in 1992.

Overall the estimated benefits are substantial. However the bulk of the benefits are generated in Houston and Dallas where the congestion is the highest, as shown in Table 11. This is not surprising since the calculations were based upon the impacts of additional vehicles in the absence of public transit in these urban areas. That increased congestion would have a substantial detrimental impact in those cities. The impacts of the other cities, while smaller, are significant considering the size of the cities and the size of the transit systems.

Table 12: Estimate of Motorist Benefits of Transit

Urban Area	Lower Fuel Consmp. (Millions of Gal.)		Lower Time Costs (Millions of $)		Lower Oper. Costs (Millions of $)		Lower Acc. Costs (Millions of $)		Total Benefits (Millions of $)	
	1987	1992	1987	1992	1987	1992	1987	1992	1987	1992
Austin	0.35	0.51	2.35	2.93	0.99	1.36	0.76	1.02	4.10	5.32
Dallas	28.50	37.58	44.59	69.73	74.49	99.93	14.47	18.54	133.54	188.21
El Paso	2.91	4.00	2.09	3.56	7.01	10.04	1.67	2.39	10.77	15.99
Fort Worth	1.26	1.41	0.64	3.90	3.06	3.52	0.89	1.13	4.58	8.55
Houston	31.08	40.13	64.62	98.88	88.23	108.27	14.97	20.28	167.82	227.43
San Antonio	4.71	6.47	11.46	16.41	12.11	16.49	3.51	5.21	27.08	38.11
Total	68.81	90.10	125.75	195.41	185.89	239.61	36.27	48.57	347.89	483.61

Income and Employment Effects of Transit Expenditures

Transit systems also provide benefits to the communities they serve and the state through their expenditures. This money provides jobs, wages, and increased sales. There is also a multiplier effect as that money circulates through the economy. One method of estimating the effects of those expenditures is to use an input-output model. These models

estimate the transactions between major sectors of the economy and can be used to estimate the effects of a change in expenditures in the economy as a whole or in specific sectors.

Two of the main areas of impact on expenditures are household income and employment. The effects are estimated using multipliers, the effect of a change in expenditures in a given sector on income and employment. There are three levels of impacts, the direct impact of the actual expenditures, the indirect impact in supply industries of those expenditures, and the induced impact of increased consumer spending. If the change in expenditures comes from "outside the system," then all three impacts are valid and can be used in the analysis. Changes of expenditures within the system are much more difficult to evaluate, since any increase in one sector must be accompanied by a corresponding decrease in one or more other sectors. This transfer between sectors may have a positive effect, a negative effect, or no effect at all. It is difficult to estimate and generally much smaller than changes from outside. As a result, input-output multipliers must be used with some care. In this study only federal subsidies are used since they come from outside the Texas economy. Locally generated fare box revenue, sales tax, and other state and local revenues are generally simply transfer payments, and therefore do not represent a net increase to the Texas economy.

The most recent input-output estimates for Texas were compiled by the Texas Water Resource Board (12). These estimates are for 1979, so the estimates are becoming dated, especially given the structural changes in the Texas economy since 1979. However they are the most recent estimates and are therefore used in this study.

The Texas Transit Association (TTA) recently published a report detailing estimates of the economic and employment impacts of transit expenditures in Texas using a similar input-output methodology (11). It is therefore appropriate to make some comments on the TTA study before presenting the results of the analysis in this study.

The overall methodology developed to estimate the economic benefits of transit expenditures using an input-output model is reasonable and valid. However several of the

assumptions and application of the model seem to indicate a lack of understanding of input-output analysis or are designed to estimate the maximum benefits possible for transit. For example, even though the exact operating and capital expenditures used in the TTA analysis are not given, it is apparent that the multipliers are applied to the entire transit expenditures. As indicated above this is generally not valid, since much of that money represents transfers from other sectors in the Texas economy. This approach gives some very high benefits, especially employment. The TTA study estimates 33,400 full-time equivalent jobs are generated in FY 1986 from transit expenditures, even though there were only 7,490 transit employees in 1986 (1, 1986) and the multiplier they used was 1.852 jobs for every transit job. That would give only 13,871 jobs, far less than the 33,400. This is a good example of the danger in using input-output multipliers.

There are some other significant problems with the TTA study that should be mentioned. First, the capital expenditures seem to be inflated. The TTA study gives an estimated capital expenditure of $299 million for FY 1986. However the actual expenditure for calendar year 1986 was only $94.8 million (1, 1986). There is also a problem with the employment multipliers used in the study. The Water Resource Board employment multipliers are given for 1979 expenditures. For later years those multipliers must be adjusted for inflation. This was not done in the TTA study. All of these problems have a tendency to overestimate the benefits of transit expenditures.

The results of this study, using a more valid and conservative approach, are presented in Table 13. As can be seen, only the money received from federal subsidies was used to make the estimates. Even with that approach, the income impacts of the expenditures are substantial, over $243 million for 1986. The employment impacts are also impressive (2,907 jobs) even though far less than estimated in the TTA study. It is apparent that the State derives significant benefit from the federal subsidies the transit systems receive.

Table 13. Income and Employment Effects of Transit Expenditures in Texas

Item	Operating Expenses	Capital Expenses	Combined Total
Federal Transit Subsidies			
1986 (Mill $)	12.42	85.09	97.51
Multipliers[1]			
Income Multiplier	1.7842	2.6032	
Employment Multiplier			
Unadjusted (1979)	55.1835	43.5383	
Update Factor (1979-86 CPI)	1.5106	1.5106	
Adjusted (1986)	36.5308	28.8219	
Effect on Income and Employment			
Increased Household Income (Mill $)	22.17	221.51	243.68
Increased Employment	454	2,453	2,907

[1]Income multipliers are from Income Multipliers-Type II. Employment multipliers are from Employment Multipliers-Type II. The operating expense multipliers are taken from Item 120, "Local Suburban Transportation." The capital expense multipliers are a weighted average of Item 105, "Motor Vehicles & Parts" (12%); and Item 25, "Facility Construction" (88%). The employment multipliers are adjusted for inflation to 1986 values using the Consumer Price Index (CPI).

Source: Reference 1, 1986, p. 6; and Reference 12.

CONCLUSIONS

This report examined the roles of transit and the costs and benefits associated with its operation in the municipal transit agencies and the independent transit authorities. Regularly reported data and other special studies were used to identify the services provided by transit, ridership characteristics, trip patterns, operating data and financial information. The two travel markets served by the Texas transit operators analyzed in this study can be characterized as the social service provision to those with no automobile available, and the transportation service typically used by commuters who chose transit over other modes due to travel cost, time, reliability or other factors.

Data Requirements

Some analyses included in this report did not present data for all urban public transit systems in Texas. In some cases this did not impact the analysis. Central business district cordon counts, for example, are not significant elements of the planning data base for smaller urban areas, although they are desirable. Other data elements obtained from surveys of transit patrons, however, such as trip purpose and auto availability would substantially enhance the description of the type of service provided by all transit systems. Similar phrasing of questions and the inclusion of equivalent demographic information would assist in the delineation of similar and dissimilar features of each transit system relative to others in the State.

Significant planning efforts and ridership surveys have been conducted in many Texas transit systems. A coordinated effort to include similar questions in surveys of all the transit systems could increase the ability to compare operating and ridership characteristics. More frequent surveys could also be of assistance, but a more important aspect of studies like this one would be comparable data for all systems.

The Role of Urban Public Transit in Texas

The transit systems in Texas cities were divided into two size categories for an analysis of operating and ridership characteristics. The larger systems of Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio served areas of more than 500,000 population with transit operations scheduled for all seven days of the week.

Almost half of the riders on these larger systems were using transit for work trips, compared to approximately one-third of those in smaller systems. Census data and transit ridership surveys indicated a disparity in auto ownership between transit rider households and the general populace in the metropolitan area. Only eight to ten percent of urban Texas households in the 1980 census had no automobile. Thirty-six percent of large urban system riders and 52 percent of riders in other systems, however, reported no vehicle in the household. More than 70 percent of riders in both system sizes reported that there was no automobile available to them for the surveyed trip. A substantial portion of riders in all the systems for which data were available could be characterized as transit dependent.

Annual transit trips per capita allows comparison of the amount of usage in each transit system. While comparison between individual systems of different size is not appropriate for all measures, a general conclusion is that the larger systems have two to three times the number of trips per capita as the smaller systems.

An analysis of passenger-miles of travel indicated that large transit systems served a higher percentage of peak-period miles relative to the smaller systems. The overall percentage of these miles was low, even in large urban areas. A significant percentage (20 to 34 percent) of trips to the large central business districts were carried by transit, however, reflecting the importance of the commuting function of transit to these areas.

Transit System Benefits

The transit systems in Texas generate significant benefits to the communities they serve and to the Texas economy. These benefits include reduced congestion on urban highways, increased income and employment, and increased mobility. Criticism has been directed toward transit systems for their heavy reliance on public subsidies. However this criticism should be tempered given the substantial benefits transit systems provide to the economy.

The benefit to motorists of reduced congestion in the six cities in Texas with the largest transit systems are estimated to be about $348 million in 1987, and projected to increase to about $484 million in 1992. These estimates do not include the specific effects of transit on peak period congestion, which would substantially increase the estimated benefit.

The benefit of transit expenditures is estimated to be about $244 million in additional household income and 2,900 jobs. This is based upon the federal subsidies received by Texas transit systems, using multipliers to calculate the impacts. This is again a conservative estimate, since some of the other transit expenditures would probably have some positive impact. However the size of that impact cannot be estimated, given the data available.

It is apparent that transit systems provide substantial benefits, but some of those benefits cannot be quantified. Much of the problem is the lack of standardized and comprehensive data on transit riders, routes served, and passenger travel by trip purpose and time of day. Improved data collection should be a priority because it would enable more comprehensive estimates of transit impacts, justifying continued and potentially increased subsidies in the future.

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El Paso

Transit Passenger Survey, 1985.

Ridership data

Fort Worth

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Galveston

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APPENDIX A

Transit System Statistics

Table A-1: 1986 Operating Data for Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips					Daily Vehicle-Miles of Service					Daily Passenger-Miles of Service			
	D-11[1]	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit	D-11[1]	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit
Abilene	1,330			1,370	1,350	1,490			1,530	1,500			5,440	5,400
Amarillo	2,500				2,500	2,400				2,400				5,400
Austin	21,680		16,710	42,720	19,200	16,840		15,070	20,480	17,000		53,430	128,680	61,000
Beaumont	3,730		4,170		4,000	1,840		2,150		2,000		16,610		16,600
Brownsville	6,100		7,070		6,600	2,420		2,630		2,500		2,440		22,000
Corpus Christi	5,630		3,230	6,080	5,800	6,060			5,390	5,700		2,840	21,270	21,000
Dallas	130,220		157,000	134,070	132,000	62,400		80,070	75,250	72,000		746,030	728,620	735,000
El Paso	25,570		26,970	26,510	26,100	11,970		11,340	12,280	12,000		161,120	155,890	158,000
Fort Worth	13,550		15,070	14,820	14,500	10,600		12,000	13,980	11,900		67,140	92,430	68,000
Galveston	2,240		2,040		2,100	1,180		1,230		1,200		5,290		5,300
Houston	199,930		198,710	188,290	195,000	101,610		96,790	105,090	101,000		1,020,000	1,045,590	1,035,000
Laredo	8,960			8,300	8,700	2,410			2,380	2,400			20,750	21,000
Lubbock	7,990		8,580	8,640	8,400	3,710		3,620	3,550	3,600		12,210	12,480	12,400
Port Arthur	1,020		1,180	1,370	1,150	930		910	1,160	1,000		6,500	7,540	7,000
San Angelo	1,170				1,150	980				1,000				6,000
San Antonio	92,740			101,960	97,000	46,860			45,480	46,000			316,050	315,000
Waco	1,990			2,980	2,500	1,110			1,140	1,100			7,000	7,000
Wichita Falls	620				620	890				900				3,700

[1]Reference 1
[2]Reference 9
[3]Reference 10
[4]Reference 2

Table A-2: 1985 Operating Data for Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips					Daily Vehicle-Miles of Service					Daily Passenger-Miles of Service			
	D-11[1]	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit	D-11[1]	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit
Abilene	1,350	1,310			1,350	1,510	1,460			1,500	5,670			5,700
Amarillo	2,680	1,870			2,700	2,380	2,910			2,400	5,590			5,600
Austin	15,830	21,790	13,700		15,000	10,990	12,460	10,410		11,000	64,070	42,470		50,000
Beaumont	4,410	4,400	4,490		4,400	2,160	2,140	2,020		2,100	16,560	16,580		16,600
Brownsville	5,840	7,500	7,540		7,000	2,940	3,140	3,060		3,000	19,500	3,030		20,000
Corpus Christi	5,010	5,730	4,980	5,730	5,400	3,960	3,680		3,680	3,800	21,240	4,200	21,240	21,000
Dallas	130,100	126,570	133,580	126,570	129,000	56,210	59,540	68,070	59,540	60,000	686,310	686,580	686,310	685,000
El Paso	26,530	25,790	25,790	25,790	26,000	11,900	11,520	8,090	11,520	11,700	141,430	141,430	141,430	141,000
Fort Worth	14,730	14,900	14,900		15,000	10,560	11,700	11,640		11,300	66,330	66,330		66,000
Galveston	2,120	3,680	2,240		2,200	1,210	1,240	1,230		1,200	9,530	5,800		5,800
Houston	213,150	181,860	181,860	181,860	190,000	91,190	106,660	87,810	105,350	94,000	954,300	942,060	954,300	955,000
Laredo	9,250	8,170			9,200	2,340	2,490			2,400	21,720			22,000
Lubbock	8,150	8,800	8,620		8,500	3,550	3,450	3,550		3,500	12,560	12,380		12,500
Port Arthur	1,100	1,120	1,110	1,120	1,100	950	1,100	1,110	1,130	1,100	6,140	6,140	6,140	6,100
San Angelo	1,390	1,790			1,500	990	970			1,000	7,540			7,500
San Antonio	98,640	97,130		97,130	98,000	43,510	44,850		44,850	44,000	371,710		371,700	370,000
Waco	1,950	2,980		2,980	2,500	1,120	1,140		1,140	1,100	7,010		7,010	7,000
Wichita Falls	670	790			700	880	890			900	3,730			3,700

[1]Reference 1
[2]Reference 9
[3]Reference 10
[4]Reference 2

Table A-3: 1984 Operating Data for Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips					Daily Vehicle-Miles of Service					Daily Passenger-Miles of Service			
	D-11[1]	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit	D-11[1]	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit
Abilene	1,400	1,400			1,400	1,440	1,440			1,400	5,670			5,700
Amarillo	2,690	2,750			2,700	2,450	2,350			2,400	7,370			7,400
Austin	13,800	14,720			14,300	8,440	7,220	8,200		8,000	43,940			44,000
Beaumont	4,690	5,000	4,810	4,620	4,800	2,170	2,060	2,050	1,910	2,100	16,190	14,440	14,290	15,300
Brownsville	5,450	7,010	7,040		6,600	2,680	2,560	2,850		2,700	18,930	2,680		19,000
Corpus Christi	4,980	5,530	4,790		5,200	4,110	4,230			4,100	17,960	5,530		18,000
Dallas	119,090	116,680	116,190	116,100	119,000	45,510		42,970	38,010	44,000		549,450	521,250	535,000
El Paso	25,300	25,310	25,310	25,160	25,500	11,560	10,300	10,380	9,130	10,500		205,450	203,970	205,000
Fort Worth	14,740	14,740	14,870	14,740	14,900	10,120	8,600	9,940	8,600	9,500	71,030	72,380	71,030	71,000
Galveston	2,700	4,430	2,760	4,430	2,600	1,390	1,360	1,260	1,360	1,300	3,900	7,140	11,500	7,000
Houston	164,600	191,040	186,410	222,440	195,000	94,600	91,810	87,220	77,700	90,000	972,680	950,030	955,500	955,000
Laredo	9,170	9,190		9,190	9,200	2,350	2,420		2,423	2,400	2,400		23,200	23,000
Lubbock	7,960	6,260	8,550		8,300	3,660	3,310	3,510	2,980	3,400	9,280	12,220		12,200
Port Arthur	980	970	970	950	980	660	800	820	640	700	5,370	5,370	650	5,400
San Angelo	1,440	1,790			1,500	1,000	940			970	7,530			7,500
San Antonio	100,070	92,770		92,550	95,000	43,260	40,910		38,150	41,000	357,120		354,790	355,000
Waco	1,920	2,960		3,070	2,500	1,120	1,140			1,130	7,820			7,800
Wichita Falls	700				700	900				900				

[1]Reference 1
[2]Reference 9
[3]Reference 10
[4]Reference 2

Table A-4: 1983 Operating Data for Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips					Daily Vehicle-Miles of Service					Daily Passenger-Miles of Service			
	D-11[1]	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit	D-11[1]	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit	UMTA S-15[2]	TTA[3]	APTA[4]	Best Fit
Abilene	1,340	1,300			1,300	1,490	1,430			1,500	6,060			6,100
Amarillo	2,680	1,870			2,500	2,390	2,350			2,400	5,600			5,600
Austin	11,960	16,390		16,120	14,300	8,160	8,370		6,430	8,200	46,090		44,390	45,000
Beaumont	4,830	2,720	4,790	4,780	4,800	2,130	1,920	1,930	2,050	2,000	9,500	14,290	9,500	13,000
Brownsville	5,070	6,460	6,460		6,100	2,370	2,070	2,400		2,300	18,720	2,230		19,000
Corpus Christi	4,780	5,120	4,740		5,000	4,260	4,390			4,300	15,370	4,760		15,000
Dallas	98,510	102,360	104,430	98,110	101,000	42,610	38,740	36,560	42,260	40,000	489,250	494,250	461,940	480,000
El Paso	24,260	24,030	24,090	24,060	24,100	11,610	11,640	11,650	10,620	11,600	172,550	171,520	179,690	175,000
Fort Worth	14,250	14,200	14,380	14,470	14,300	9,140	8,600	8,950	8,590	8,900	67,200	95,920		67,000
Galveston	2,810	4,430		2,870	2,600	1,400	1,330		1,400	1,400	11,440		10,700	11,000
Houston	141,300	151,490		142,850	145,000	78,910	64,210	68,350		70,000	843,160		725,800	780,000
Laredo	8,650	9,160		8,630	8,800	2,360	2,130		2,130	2,200	43,960			44,000
Lubbock	6,990	8,080	8,190		7,600	3,310	3,290	3,400		3,300	11,520	11,610		11,500
Port Arthur	880	900	870		880	640	780	640	640	640	3,750			3,800
San Angelo	1,400	1,500			1,450	1,050	1,010			1,000	6,540			6,500
San Antonio	94,590	91,840		91,600	92,000	40,330	36,130		37,450	38,000	410,350		406,150	408,000
Waco	1,860	5,120		1,880	1,900	1,130	1,220		1,130	1,150	14,030			14,000
Wichita Falls	740	1,260			800	960	950			950	7,570			7,600

[1]Reference 1
[2]Reference 9
[3]Reference 10
[4]Reference 2

Table A-5: 1982 Operating Data for Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips				Daily Vehicle-Miles of Service				Daily Passenger-Miles of Service		
	D-11[1]	UMTA S-15[2]	TTA[3]	Best Fit	D-11[1]	UMTA S-15[2]	TTA[3]	Best Fit	UMTA S-15[2]	TTA[3]	Best Fit
Abilene	1,350	1,270		1,300	1,610	1,540		1,600	4,410		4,400
Amarillo	2,790	2,040		2,400	2,520	2,350		2,400	5,610		5,600
Austin	12,990	17,150		15,000	8,150	6,020		8,000	65,760		66,000
Beaumont	4,890	3,970	4,970	4,900	2,060	1,920	1,950	2,000	18,650	14,170	14,000
Brownsville	5,650	7,540	7,930	7,700	2,240	2,140	2,390	2,300	30,240	2,230	30,000
Corpus Christi	5,090	5,340	4,940	5,100	4,560	4,730		4,600	9,870	5,360	10,000
Dallas	96,290	89,060	101,720	96,000	40,610	37,660	85,150	40,000	610,170	499,730	500,000
El Paso	22,540	25,510	27,410	25,000	12,360	11,180	10,010	11,500	120,040		120,000
Fort Worth	15,810	13,540	16,190	16,000	9,370	9,460	9,020	9,300	85,710	47,100	80,000
Galveston	3,090	3,830		3,500	1,390	1,300		1,400	10,370		10,400
Houston	142,470	146,510	115,170	144,000	70,880	58,610	53,650	65,000	713,140		715,000
Laredo	8,690			8,700	2,320			2,300			N/A
Lubbock	10,700	3,290	8,150	9,500	3,280	3,150	3,340	3,300	11,160	11,500	11,300
Port Arthur	890	920	920	900	640	640	640	640	2,710		2,700
San Angelo	1,440	1,310		1,400	1,070	1,030		1,050	5,930		5,900
San Antonio	94,370	96,380		95,000	39,930			40,000	271,780		270,000
Waco	1,880	3,280		1,900	1,110	1,480		1,200	5,360		14,000
Wichita Falls	900			900	880			880			N/A

[1]Reference 1
[2]Reference 9
[3]Reference 10

Table A-6: 1980 Operating Data for Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips				Daily Vehicle-Miles of Service			
	D-11[1]	UMTA S-15[2]	TTA[3]	Best Fit	D-11[1]	UMTA S-15[2]	TTA[3]	Best Fit
Abilene	1,010	1,440		1,200	990	1,250		1,100
Amarillo	2,400	2,140		2,300	2,730	3,165		2,950
Austin	16,010	18,000		17,000	8,130	7,800		8,000
Beaumont	4,800			4,800	1,970			2,000
Brownsville	4,380	5,870		5,100	1,830	1,700		1,800
Corpus Christi	6,030	5,210		5,600	4,420	4,780		4,600
Dallas	92,310	103,480		97,900	37,360	38,120		37,700
El Paso	25,100	24,760		24,900	11,590	11,280		11,400
Fort Worth	17,370	20,280		18,800	8,680	8,220		8,500
Galveston	3,690	3,950		3,800	1,450	1,390		1,400
Houston	128,480	128,500		128,500	50,640	44,730		47,700
Laredo	9,470	9,180		9,300	2,250	3,030		2,650
Lubbock	8,740	4,030		6,400	3,280	3,450		3,400
Port Arthur	900	890		900	630	640		640
San Angelo	1,070	1,420		1,250	830	820		830
San Antonio	96,410	88,940		92,700	40,150	43,850		42,000
Waco	2,040	2,570		2,300	1,530	1,400		1,470
Wichita Falls	990	610		800	930	910		920

[1]Reference 1
[2]Reference 9
[3]Reference 10

Table A-7: 1978 Operating Data for Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips				Daily Vehicle-Miles of Service			
	D-11[1]	UMTA S-15[2]	TTA[3]	Best Fit	D-11[1]	UMTA S-15[2]	TTA[3]	Best Fit
Abilene	930			930	1,020			1,020
Amarillo	2,010	2,080		2,050	2,710	2,530		2,600
Austin	16,480	21,790		19,100	7,790	7,150		7,500
Beaumont	3,970	4,530		4,250	1,800	1,800		1,800
Brownsville	2,570			2,550	1,570	430		1,600
Corpus Christi	5,800	6,000		5,900	4,100	4,560		4,300
Dallas	90,190	89,520		89,900	37,860	37,770		37,800
El Paso	23,830			23,800	10,910			10,900
Fort Worth	14,260	20,140		17,200	8,470	8,060		8,250
Galveston	4,300	1,690		3,000	1,710	1,630		1,650
Houston	118,500			118,500	46,320			46,300
Laredo	7,640			7,650	2,010			2,000
Lubbock	7,450			7,450	3,160			3,150
Port Arthur	N/A			N/A	N/A			N/A
San Angelo	900			900	870			870
San Antonio	76,270			76,300	37,160			37,200
Waco	1,820	2,300		2,050	1,550	1,500		1,550
Wichita Falls	830			850	940	910		950

[1]Reference 1
[2]Reference 9
[3]Reference 10

Table A-8: 1976 Operating Data for Texas Transit Systems

Urban Area	Daily Unlinked Passenger Trips				Daily Vehicle-Miles of Service			
	D-11[1]	UMTA S-15[2]	TTA[3]	Best Fit	D-11[1]	UMTA S-15[2]	TTA[3]	Best Fit
Abilene	580			600	750			750
Amarillo	3,200			3,200	2,690			2,700
Austin	16,620			16,620	6,970			6,950
Beaumont	3,610			3,600	2,240			2,250
Brownsville	1,230			1,250	880			900
Corpus Christi	4,830			4,850	4,280			4,300
Dallas	80,400			80,400	34,560			34,600
El Paso	26,200			26,200	11,290			11,300
Fort Worth	12,350			12,350	8,080			8,100
Galveston	3,450			3,450	1,650			1,650
Houston	102,340			102,300	40,500			40,500
Laredo	2,670			2,650	780			800
Lubbock	8,290			8,300	2,550			2,550
Port Arthur	N/A			N/A	N/A			N/A
San Angelo	630			650	770			750
San Antonio	66,900			66,900	20,180			20,200
Waco	2,290			2,300	1,540			1,550
Wichita Falls	990			1,000	930			950

N/A - Not available

[1]Reference 1
[2]Reference 9
[3]Reference 10

Table A-9: 1986 Roadway and Transit Travel

Urban Area	Daily Vehicle-Miles of Travel (1000)			Daily Passenger-Miles of Travel (1000)[1]			Daily Passenger-Miles of Transit Travel (1000)	Percent of Transit
	Freeway	Prin Art	Total	Freeway	Prin Art	Total		
Abilene	525	335	860	630	400	1,030	5	.5
Amarillo	945	650	1,595	1,130	780	1,910	5	.3
Austin	2,190	5,300	7,490	6,360	2,630	8,990	61	.7
Beaumont	1,095	640	1,735	1,315	765	2,080	17	.8
Brownsville	175	330	505	210	400	610	22	3.5
Corpus Christi	1,420	1,400	2,820	1,700	1,680	3,380	21	.6
Dallas	22,575	8,230	30,805	27,090	9,880	36,970	735	1.9
El Paso	3,420	2,915	6,335	4,100	3,500	7,600	158	2.0
Fort Worth	10,725	4,250	14,975	12,870	5,100	17,970	68	.4
Galveston	145	360	505	175	435	610	5	.9
Houston	24,115	10,810	34,925	28,940	12,970	41,910	1,035	2.4
Laredo	160	295	455	195	355	550	21	3.7
Lubbock	680	1,615	2,295	815	1,935	2,750	12	.4
Port Arthur	525	630	1,155	630	760	1,390	7	.5
San Angelo	70	265	335	85	315	400	6	1.5
San Antonio	9,560	4,585	14,145	11,470	5,500	16,970	315	1.8
Waco	1,085	620	1,705	1,305	745	2,050	7	.3
Wichita Falls	485	560	1,045	580	670	1,250	4	.3
Large Systems Avg	12,615	5,495	18,110	15,140	6,590	21,730	395	1.5
Other Systems Avg	610	640	1,250	730	770	1,500	11	1.1

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio

[1]An average vehicle occupancy ratio of 1.2 was used

Table A-10: 1985 Roadway and Transit Travel

Urban Area	Daily Vehicle-Miles of Travel (1000)			Daily Passenger-Miles of Travel (1000)[1]			Daily Passenger-Miles of Transit Travel (1000)	Percent of Transit
	Freeway	Prin Art	Total	Freeway	Prin Art	Total		
Abilene	500	350	850	600	420	1,020	6	.6
Amarillo	730	590	1,320	875	705	1,580	6	.4
Austin	4,890	2,000	6,890	5,870	2,400	8,270	50	.6
Beaumont	1,070	665	1,735	1,285	795	2,080	17	.8
Brownsville	140	355	495	165	425	590	20	3.3
Corpus Christi	1,400	1,370	2,770	1,680	1,640	3,320	21	.6
Dallas	21,100	7,950	29,050	25,320	9,540	34,860	685	1.9
El Paso	3,120	2,880	6,000	3,745	3,455	7,200	141	1.9
Fort Worth	10,070	4,140	14,210	12,085	4,965	17,050	66	.4
Galveston	150	265	415	180	320	500	6	1.2
Houston	24,115	10,850	34,965	28,940	13,020	41,960	955	2.2
Laredo	45	300	345	50	360	410	22	5.0
Lubbock	615	1,535	2,150	740	1,840	2,580	13	.5
Port Arthur	460	625	1,085	550	750	1,300	6	.5
San Angelo	60	255	315	75	305	380	8	1.9
San Antonio	9,080	4,285	13,365	10,895	5,145	16,040	370	2.3
Waco	1,035	565	1,600	1,240	680	1,920	7	.4
Wichita Falls	375	580	955	450	700	1,150	4	.3
Large Systems Avg	12,065	5,350	17,415	14,475	6,425	20,900	378	1.6
Small Systems Avg	550	620	1,170	660	740	1,400	11	1.3

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston and San Antonio

[1]An average vehicle occupancy ratio of 1.2 was used.

Table A-11: 1986 Roadway and Transit Peak-Period Travel Comparison

Urban Area	Weekday Peak-Period Roadway Passenger-Miles of Travel (1000)			Weekday Peak-Period Transit Pass-Miles of Travel (1000)	Percent of Weekday Peak Period Travel on Transit
	Freeway	Prin Art	Total		
Abilene	190	120	310	2	.7
Amarillo	340	230	570	2	.4
Austin	2,795	1,155	3,950	40	1.0
Beaumont	345	205	550	7	1.3
Brownsville	80	150	230	10	4.0
Corpus Christi	565	555	1,120	9	.8
Dallas	11,920	4,350	16,270	669	3.9
El Paso	2,030	1,730	3,760	82	2.1
Fort Worth	6,080	2,410	8,490	51	.6
Galveston	70	170	240	3	1.1
Houston	12,735	5,705	18,440	776	4.0
Laredo	55	105	160	14	7.8
Lubbock	300	710	1,010	5	.5
Port Arthur	N/A	N/A	N/A	N/A	N/A
San Angelo	35	125	160	3	1.5
San Antonio	5,680	2,720	8,400	209	2.4
Waco	450	260	710	3	.4
Wichita Falls	215	245	460	2	.4
Large System Avg	6,870	3,010	9,880	305	2.4
Other System Avg	220	240	460	5	1.7

N/A - Not available

Note: "Large" systems include Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio

Table A-12: Annual Transit Trips Per Capita 1978-1986
Based on City Population

Urban Area	1978 Data			1980 Data			1982 Data			1984 Data			1986 Data		
	Annual Transit Trips	City Pop'n	Annual Transit Trips/ Capita	Annual Transit Trips	City Pop'n	Annual Transit Trips/ Capita	Annual Transit Trips	City Pop'n	Annual Transit Trips/ Capita	Annual Transit Trips	City Pop'n	Annual Transit Trips/ Capita	Annual Transit Trips	City Pop'n	Annual Transit Trips/ Capita
Abilene	205,000	100,000	2.05	215,000	102,300	2.10	327,900	104,600	3.13	352,000	107,000	3.29	317,900	109,300	2.91
Amarillo	558,100	146,000	3.82	582,000	150,800	3.86	681,800	155,600	4.38	656,000	160,500	4.09	591,400	165,300	3.58
Austin	4,012,100	330,000	12.16	3,990,500	349,100	11.43	3,308,000	368,200	8.98	3,782,400	387,400	9.76	7,912,200	406,600	19.46
Beaumont	964,300	116,600	8.27	1,161,500	118,600	9.80	1,210,100	120,500	10.05	1,164,000	122,400	9.51	917,200	124,300	7.38
Brownsville	801,100	78,900	10.15	1,368,000	83,400	16.40	1,762,700	87,900	20.05	1,706,500	92,400	18.46	1,909,300	96,900	19.70
Corpus Christi	1,412,000	227,800	6.20	1,475,600	236,500	6.24	1,194,500	245,100	4.87	1,199,200	253,700	4.73	1,322,800	262,400	5.04
Dallas	25,557,600	868,000	29.44	27,821,000	898,300	30.97	30,650,900	928,700	33.00	37,469,600	959,000	39.07	37,396,200	989,400	37.80
El Paso	8,226,700	409,100	20.11	8,166,800	424,800	19.23	7,541,800	440,400	17.13	8,446,100	456,000	18.52	8,476,500	471,600	17.97
Fort Worth	4,282,600	375,200	11.41	4,302,200	386,500	11.13	4,819,400	397,700	12.12	4,510,100	408,900	11.03	4,103,100	420,200	9.76
Galveston	1,051,900	60,800	17.30	987,800	61,300	16.13	831,200	61,700	13.47	720,400	62,200	11.59	637,000	62,600	10.18
Houston	32,913,800	1,461,900	22.51	35,927,900	1,531,500	23.46	39,880,700	1,601,200	24.91	45,531,000	1,670,900	27.25	55,041,400	1,740,500	31.62
Laredo	2,659,300	86,500	30.74	3,234,600	92,800	34.84	2,894,200	99,200	29.18	3,048,600	105,500	28.89	3,009,000	111,800	26.90
Lubbock	2,203,000	168,000	13.11	2,531,500	171,000	14.80	3,092,900	174,000	17.77	2,242,700	177,000	12.67	2,241,200	180,000	12.45
Port Arthur	N/A	56,700	N/A	255,200	58,800	4.34	250,000	60,900	4.10	273,600	63,000	4.34	270,800	65,100	4.16
San Angelo	220,600	71,600	3.08	255,000	75,200	3.39	315,300	78,900	4.00	311,800	82,500	3.78	245,700	86,200	2.85
San Antonio	23,417,000	794,100	29.49	29,757,400	808,000	36.83	28,825,700	821,900	35.07	30,768,100	835,800	36.81	28,516,800	849,732	33.56
Waco	458,100	99,600	4.60	496,800	100,900	4.92	442,500	102,200	4.33	450,600	103,500	4.35	458,800	104,800	4.38
Wichita Falls	213,900	96,200	2.22	253,100	97,000	2.61	226,600	97,700	2.32	193,200	98,500	1.96	178,500	99,300	1.80
Large System Avg	16,401,600	706,400	20.86	18,327,600	733,000	22.17	19,171,100	759,700	21.87	21,751,200	786,400	23.74	23,574,400	813,000	25.03
Other System Avg	977,000	109,052	9.23	1,068,000	112,400	9.95	1,102,500	115,700	9.80	1,026,600	119,000	8.97	1,008,300	122,300	8.44

N/A - Not Available

Note: "Large" systems include Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio
Note: The Port Arthur Transit System began operation in May, 1979
Sources: City populations were obtained from the Texas Almanac
Transit trip data are from D-11

Table A-13: Annual Transit Trips Per Capita 1978-1986
Based on Metropolitan Population

Urban Area	1978 Data			1980 Data			1982 Data			1984 Data			1986 Data		
	Annual Transit Trips	Metro Pop'n	Annual Transit Trips/ Capita	Annual Transit Trips	Metro Pop'n	Annual Transit Trips/ Capita	Annual Transit Trips	Metro Pop'n	Annual Transit Trips/ Capita	Annual Transit Trips	Metro Pop'n	Annual Transit Trips/ Capita	Annual Transit Trips	Metro Pop'n	Annual Transit Trips/ Capita
Abilene	205,000	135,100	1.52	215,000	139,200	1.54	327,900	118,600	2.76	352,000	122,300	2.88	317,900	125,900	2.52
Amarillo	558,100	165,800	3.37	582,000	173,700	3.35	681,800	182,600	3.73	656,000	188,900	3.47	591,400	195,200	3.03
Austin	4,012,100	505,400	7.94	3,990,500	536,500	7.44	3,308,000	577,100	5.73	3,782,400	651,800	5.80	7,912,200	726,400	10.89
Beaumont	964,300	369,700	2.61	1,161,500	375,500	3.09	1,210,100	387,700	3.12	1,164,000	381,800	3.05	917,200	375,800	2.44
Brownsville	801,100	193,100	4.15	1,368,000	209,700	6.52	1,762,700	230,500	7.65	1,706,500	243,900	7.00	1,909,300	257,300	7.42
Corpus Christi	1,412,000	314,700	4.49	1,475,600	326,200	4.52	1,194,500	344,100	3.47	1,199,200	353,700	3.39	1,322,800	363,300	3.64
Dallas	25,557,600	1,866,200	13.70	27,821,000	1,965,800	14.15	30,650,900	2,081,200	14.73	37,469,600	2,194,800	17.07	37,396,200	2,401,400	15.57
El Paso	8,226,700	457,300	17.99	8,166,800	479,900	17.02	7,541,800	513,400	14.69	8,446,100	537,500	15.72	8,476,500	561,500	15.10
Fort Worth	4,282,600	957,900	4.47	5,302,200	1,009,100	5.25	4,819,400	1,050,000	4.59	4,510,100	1,126,600	4.00	4,103,100	1,253,900	3.27
Galveston	1,051,900	195,700	5.38	987,800	195,900	5.04	831,200	207,600	4.00	720,400	211,200	3.41	637,000	214,800	2.97
Houston	32,913,800	2,708,800	12.15	35,927,900	2,905,400	12.37	39,880,700	3,446,500	11.57	45,531,000	3,338,600	13.64	55,041,400	3,230,700	17.04
Laredo	2,659,300	92,100	28.87	3,234,600	99,300	32.59	2,894,200	109,900	26.33	3,048,600	115,400	26.43	3,009,000	120,800	24.91
Lubbock	2,203,000	205,900	10.70	2,531,500	211,700	11.96	3,092,900	216,700	14.27	2,242,700	220,800	10.16	2,241,200	224,800	9.97
Port Arthur	N/A	369,700	N/A	255,200	375,500	.68	250,000	387,700	.64	273,600	381,800	.72	270,800	375,800	.76
San Angelo	220,600	80,700	2.73	255,000	84,800	3.01	315,300	90,700	3.48	311,800	94,400	3.30	245,700	98,100	2.50
San Antonio	23,417,000	1,048,400	22.34	29,757,400	1,072,000	27.76	28,825,700	1,141,000	25.26	30,768,100	1,208,700	25.46	28,516,800	1,276,400	22.34
Waco	458,100	166,100	2.76	496,800	170,800	2.91	442,500	175,500	2.52	450,600	181,500	2.48	458,800	187,600	2.45
Wichita Falls	213,900	131,100	1.63	253,100	130,700	1.94	226,600	125,500	1.81	193,200	126,300	1.53	178,500	127,100	1.40
Large System Avg	16,401,600	1,257,300	13.10	18,327,600	1,328,100	14.00	19,171,100	1,468,200	12.76	21,751,200	1,509,700	13.61	23,574,400	1,575,100	14.04
Other System Avg	977,000	201,700	6.20	1,068,000	207,700	6.43	1,102,500	214,800	6.15	1,026,600	218,500	5.65	1,008,300	222,200	5.33

N/A - Not Available

Note: "Large" systems include Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio
Note: The Port Arthur Transit System began operation in May, 1979.
Note: Port Arthur is in the same metropolitan area as Beaumont
Sources: Populations are from the Texas Almanac
Transit trip data are from D-11

Table A-14: Daily Transit Trips per Vehicle-Mile of Service

Urban Area	Daily Transit Trips, 1976	Daily Vehicle Miles, 1976	Transit Trips per Veh-Mi, 1976	Daily Transit Trips, 1978	Daily Vehicle Miles, 1978	Transit Trips per Veh-Mi, 1978	Daily Transit Trips, 1980	Daily Vehicle Miles, 1980	Transit Trips per Veh-Mi, 1980
Abilene	600	750	.77	930	1,020	.91	1,200	1,100	1.02
Amarillo	3,200	2,700	1.19	2,050	2,600	.74	2,300	2,950	.88
Austin	16,620	6,950	.95	19,100	7,500	2.12	17,000	8,000	1.97
Beaumont	3,600	2,250	1.61	4,250	1,800	2.21	4,800	2,000	2.44
Brownsville	1,230	900	1.40	2,550	1,600	1.64	5,100	1,800	2.39
Corpus Christi	4,830	4,300	1.13	5,900	4,300	1.41	5,600	4,600	1.36
Dallas	80,400	34,600	2.33	89,900	37,800	2.38	97,900	37,700	2.47
El Paso	26,200	11,300	2.32	23,800	10,900	2.18	24,900	11,400	2.17
Fort Worth	12,350	8,100	1.53	17,200	8,250	1.68	18,800	8,500	2.00
Galveston	3,450	1,650	2.09	3,000	1,650	2.51	3,800	1,400	2.54
Houston	102,340	40,500	2.53	118,500	46,300	2.56	128,500	47,700	2.54
Laredo	2,670	800	3.42	7,650	2,000	.82	9,300	2,650	4.21
Lubbock	8,290	2,550	3.25	7,450	3,150	2.36	6,400	3,400	2.66
Port Arthur	N/A	N/A	N/A	N/A	N/A	N/A	900	640	1.43
San Angelo	630	750	.82	900	870	1.03	1,250	830	1.29
San Antonio	66,900	20,200	3.32	76,300	37,200	2.05	92,700	42,000	2.40
Waco	2,290	1,550	1.49	2,050	1,550	1.17	2,300	1,470	1.33
Wichita Falls	990	950	1.06	850	950	.88	900	920	1.06
Large Systems Avg	49,135	20,265	2.16	56,590	24,750	2.29	62,615	26,090	2.40
Other Systems Avg	2,890	1,735	1.66	2,930	1,950	1.50	3,795	1,905	1.99

N/A - Not Available

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio
Source: Daily transit trips and vehicle-miles data are from D-11.

Table A-14: Daily Transit Trips per Vehicle-Mile of Service (cont'd.)

Urban Area	Daily Transit Trips, 1982	Daily Vehicle Miles, 1982	Transit Trips per Veh-Mi, 1982	Daily Transit Trips, 1984	Daily Vehicle Miles, 1984	Transit Trips per Veh-Mi, 1984	Daily Transit Trips, 1986	Daily Vehicle Miles, 1986	Transit Trips per Veh-Mi, 1986
Abilene	1,300	1,600	.84	1,400	1,400	.97	1,350	1,500	.89
Amarillo	2,400	2,400	1.11	2,700	2,400	1.10	2,500	2,400	1.04
Austin	15,000	8,000	1.59	14,300	8,000	1.64	19,200	17,000	1.29
Beaumont	4,900	2,000	2.37	4,800	2,100	2.16	4,000	2,000	2.03
Brownsville	7,700	2,300	2.52	6,600	2,700	2.03	6,600	2,500	2.52
Corpus Christi	5,100	4,600	1.12	5,200	4,100	1.21	5,800	5,700	.93
Dallas	96,000	40,000	2.37	119,000	44,000	2.62	132,000	72,000	2.09
El Paso	25,000	11,500	1.82	25,500	10,500	2.19	26,100	12,000	2.14
Fort Worth	16,000	9,300	1.69	14,900	9,500	1.46	14,500	11,900	1.28
Galveston	3,500	1,400	2.22	2,600	1,300	1.94	2,100	1,200	1.90
Houston	144,000	65,000	2.01	195,000	90,000	1.74	195,000	101,000	1.97
Laredo	8,700	2,300	3.75	9,200	2,400	3.90	8,700	2,400	3.72
Lubbock	9,500	3,300	3.26	8,300	3,400	2.17	8,400	3,600	2.15
Port Arthur	900	640	1.39	980	700	1.48	1,150	1,000	1.10
San Angelo	1,400	1,050	1.35	1,500	970	1.44	1,150	1,000	1.19
San Antonio	95,000	40,000	2.36	95,000	41,000	2.31	97,000	46,000	1.98
Waco	1,900	1,200	1.69	2,500	1,130	1.71	2,500	1,100	1.79
Wichita Falls	900	880	1.02	700	900	.78	620	900	.70
Large Systems Avg	64,080	30,215	2.12	72,935	35,580	2.05	80,615	41,715	1.93
Other Systems Avg	3,945	1,975	2.00	3,675	1,995	1.84	3,605	2,120	1.70

Note: "Large" systems are Austin, Dallas, El Paso, Fort Worth, Houston, and San Antonio
Source: Daily transit trips and vehicle-miles data are from D-11 data.

APPENDIX B

HPMS Output for Use in Calculating Motorist Benefits of Transit

Table B-1. HPMS Output - Austin

		1987		1992	
		With Transit	W/O Transit	With Transit	W/O Transit
DVMT	(000)	6,457	6,508	7,547	7,618
Speed	(mph)	21.367	21.323	21.180	21.134
Op cost	($/1,000 VM)	216.62	216.68	215.97	215.98
PDO	(100 mil VM)	484.6	484.6	481.0	481.0
Fatal	(100 mil VM)	2.056	2.056	1.929	1.929
Injury	(100 mil VM)	149.73	149.73	149.19	149.19
Bus Daily VM*	(VM)	18,020		24,115	

*Taken from Table 2.

Table B-2. HPMS Output - Dallas

		1987		1992	
		With Transit	W/O Transit	With Transit	W/O Transit
DVMT	(000)	27,928	29,147	32,630	34,262
Speed	(mph)	32.877	32.441	31.840	31.298
Op cost	($/1,000 VM)	208.95	208.48	206.87	206.45
PDO	(100 mil VM)	326.3	330.4	336.3	338.0
Fatal	(100 mil VM)	1.673	1.659	1.569	1.563
Injury	(100 mil VM)	107.20	108.37	110.69	111.25
Bus Daily VM*	(VM)	76,320		102,133	

*Taken from Table 2.

Table B-3. HPMS Output - El Paso

		1987		1992	
		With Transit	W/O Transit	With Transit	W/O Transit
DVMT	(000)	4,575	4,700	5,270	5,437
Speed	(mph)	26.943	26.857	26.912	26.786
Op cost	($/1,000 VM)	218.41	218.00	215.70	215.65
PDO	(100 mil VM)	391.2	393.1	394.3	395.6
Fatal	(100 mil VM)	2.228	2.215	2.156	2.152
Injury	(100 mil VM)	123.62	124.03	124.78	125.40
Bus Daily VM*	(VM)	12,720		17,022	

*Taken from Table 2.

Table B-4. HPMS Output - Fort Worth

		1987		1992	
		With Transit	W/O Transit	With Transit	W/O Transit
DVMT	(000)	13,284	13,359	15,706	15,808
Speed	(mph)	35.438	35.422	34.666	34.587
Op cost	($/1,000 VM)	198.37	198.34	196.26	196.12
PDO	(100 mil VM)	339.8	339.8	339.3	339.6
Fatal	(100 mil VM)	1.850	1.850	1.700	1.698
Injury	(100 mil VM)	110.33	110.33	111.06	111.11
Bus Daily VM*	(VM)	12,610		16,875	

*Taken from Table 2.

Table B-5. HPMS Output - Houston

		1987		1992	
		With Transit	W/O Transit	With Transit	W/O Transit
DVMT	(000)	32,789	34,179	38,585	40,442
Speed	(mph)	28.623	28.215	27.259	26.782
Op cost	($/1,000 VM)	220.28	219.91	217.77	216.82
PDO	(100 mil VM)	337.1	337.4	340.3	340.9
Fatal	(100 mil VM)	1.497	1.490	1.420	1.415
Injury	(100 mil VM)	110.65	111.00	112.08	112.56
Bus Daily VM*	(VM)	107,060		143,270	

*Taken from Table 2.

Table B-6. HPMS Output - San Antonio

		1987		1992	
		With Transit	W/O Transit	With Transit	W/O Transit
DVMT	(000)	7,359	7,656	8,756	9,154
Speed	(mph)	29.761	29.411	28.764	28.373
Op cost	($/1,000 VM)	202.30	201.87	200.01	199.70
PDO	(100 mil VM)	379.4	380.1	389.4	389.6
Fatal	(100 mil VM)	2.117	2.083	2.013	2.011
Injury	(100 mil VM)	119.58	120.44	123.04	123.16
Bus Daily VM*	(VM)	48,760		65,252	

*Taken from Table 2.