PARK-AND-RIDE FACILITIES:
PRELIMINARY PLANNING GUIDELINES

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ABSTRACT

This report presents a preliminary evaluation of park-and-ride facilities. A literature review was conducted and, from this, characteristics of park-and-ride service in the United States were documented. Also, each Texas city providing park-and-ride service was surveyed, and the existing or projected park-and-ride operations in five Texas cities are documented. Based on the review of these data, preliminary guidelines that can be used in planning park-and-ride facilities are discussed.

Key Words: Park-and-Ride, Transit, Mass Transportation, Urban Transportation, Bus-Rapid-Transit, Transportation Planning

SUMMARY

Park-and-ride represents a means of providing mass transportation that has demonstrated its applicability to major Texas cities. It is an approach that increases the person movement capability of existing streets and highways. Park-and-ride systems utilize both the private auto and the transit bus; the auto serves as the collection-distribution vehicle while the bus provides the line-haul transit service.

Park-and-ride has numerous advantages. It has the potential of reducing total vehicular travel, conserving energy, reducing pollution emissions, and allowing needed parking facilities to be developed in relatively inexpensive, remote land areas. Park-and-ride has the additional advantages of being able to use existing transportation facilities and also offers considerable flexibility in both implementation and operation. However, park-and-ride has the definite disadvantage of requiring a change of mode, thus, depriving the individual of the privacy associated with the automobile.

The potential advantages of park-and-ride have recently been recognized by both the federal and state governments. Federal financial assistance for both facility construction and transit vehicle procurement is available through both the Federal Highway Administration and the Urban Mass Transportation Administration. State appropriated monies can be used to finance up to 65 percent of the monies required to match the federal funds.

Characteristics of Park-and-Ride Operations

The typical park-and-ride patron uses the system on a daily basis for his work trip. He is employed in a white collar, office position, owns two or more autos, and earns an annual income in excess of $12,000. He lives within 5 miles (8.0 km) of the park-and-ride lot, and before patronizing

the park-and-ride service, used his private auto to serve the trip.

Most park-and-ride facilities utilize unused portions of existing shopping center lots and provide between 250 and 450 spaces. The lots are generally located 4 to 10 miles (6.4 to 16.1 km) from the CBD, and the parking is commonly provided at no direct cost to the user.

Buses usually depart from park-and-ride facilities on 4- to 15-minute headways and operate at average speeds of 20 to 30 mph (32.2 to 48.3 km/hr.). A one-way fare of 35 to 55 cents is charged. This revenue is not sufficient to cover total operating expenses.

Park-and-Ride in Texas

Park-and-ride service is presently available in Fort Worth, Austin, Dallas, and San Antonio. A total of 23 park-and-ride routes operate in these cities, and 2100 Texans use this service on a typical weekday. Service will open in Garland, a northeast Dallas suburb, in October 1975. The Texas cities have used different approaches to providing park-and-ride service, and these approaches are summarized in Table S-1.

Future Park-and-Ride Applications

At present, park-and-ride has been used basically to serve large CBD developments in major urban areas, and this is probably the primary application of this form of mass transportation. However, much potential innovation appears to exist for implementing service to other major activity centers in both the larger and smaller urban areas. In summary, many additional park-and-ride applications appear to exist in Texas. To identify and develop these applications in a prudent manner, planning methodologies that can be used to determine lot feasibility, location, and potential ridership need to be formulated.

Table S-1: Characteristics of Texas Park-and-Ride Operations

City	No. of Routes Operated	Daily One-Way Ridership	Type of Parking Facilities Utilized	Type of Transit Service Provided
Fort Worth	16	∿300	Existing private lots provided to city at no cost	Park-and-ride lot is an additional stop on local bus routes
Austin	3	310	Existing private lots provided to city at no cost	Express
Dallas	3	1288	Leased private lots (lots improved by city)	Express
San Antonio	1	175	Developed new lot on leased land	Express
Garland (projected)	2	800	Developed new lots on land purchased by city	Express

IMPLEMENTATION STATEMENT

Historically, transit operations have been a local responsibility. During the 1960's, federal assistance was made available to local agencies. Recently, the State of Texas has also become integrally involved with transit problems in the state, and the creation of the State Department of Highways and Public Transportation and the availability of the state financial assistance for transit indicate that the state will continue to take a more active role in transit.

Park-and-ride represents a form of transit operation that is becoming increasingly popular in both the United States and Texas; it has proven its applicability to Texas cities. However, at present, only a limited number of park-and-ride operations exist in Texas.

In the near future, additional travel corridors in Texas cities will require evaluation regarding their ability to support park-and-ride facilities. At present, no well defined planning techniques are available that can be utilized in evaluating potential park-and-ride locations. Although park-and-ride is non-capital intensive, some techniques are required in order to determine basic feasibility, required lot size, and optimal location.

This report is the first of two reports that will address park-and-ride transit operations. This report identifies characteristics of park-and-ride facilities in the United States and Texas and discusses factors that need to be considered in evaluating park-and-ride feasibility. As such, it will provide some immediate assistance to those individuals responsible for implementing park-and-ride facilities.

A subsequent report, which will be prepared by August 1976, will develop

detailed planning methodologies that can be used to determine feasible lot locations and required lot size. Also, design requirements will be developed.

INTRODUCTION

The Concept

During the past 25 years, the intensity of development in major activity centers such as the central business district (CBD) has continued to increase; there is reason to expect that this trend will continue in major Texas cities. Coincident with the growth in activity centers, there has been a continued need for increasing the capacity of the transportation system serving the activity centers. During the 1950's and the better part of the 1960's, the need for increased vehicular capacity was generally met by constructing new transportation facilities. Recently, however, for reasons such as cost, land availability, environmental concerns, and interference with socioeconomic systems, the ability to construct new facilities to accommodate increasing vehicular traffic demands has been curtailed.

As a result, considerable attention is presently being focused on increasing the person movement capability of existing transportation systems rather than expanding vehicular capacity by constructing new facilities. Transit represents a readily implementable, low cost means of increasing the person movement capability of existing transportation systems.

However, with the pattern of development that is characteristic of Texas cities, it is difficult to provide effective transit service between low density residential areas and high density activity centers. While transit is quite economical and efficient in moving large masses of people between fixed points, it is neither economical nor efficient in providing the collection-distribution service at the low density end of the trip (i.e., within the residential areas).

The park-and-ride concept allows both the private automobile and the

bus to operate relatively efficiently. The private automobile serves the residential collection-distribution function; the individual leaves his home when he desires and drives directly to the park-and-ride lot. The park-and-ride lot, thus, accumulates the transit demand and the transit service can then serve the high volume line-haul travel between fixed points. The park-and-ride lots allow the parking to be accommodated on relatively low valued, remote land rather than forcing this demand to be accommodated on high valued land within the activity center.

Using this system, the individual does not need to completely forsake the convenience provided by his private automobile. As long as the bus headways are quite short, the individual is able to use the park-and-ride service and still leave his home when he chooses and receive relatively direct transportation service to his destination. The reduced parking costs and probable time savings associated with the bus service cause it to be an attractive alternative.

Also, the system has inherent flexibility. Existing parking areas, either unused or partially unused, can be utilized initially, and if a sufficient demand is generated, new lots can be built at a subsequent date. Bus service can usually be readily implemented, or if the demand proves to be insufficient, terminated.

Use of the bus on the line-haul portion of the trip has positive impacts on congestion, pollution, and energy consumption. The buses may or may not provide direct express service from the park-and-ride lot to the activity center. In some instances, the transit service utilizes freeway facilities for a portion of the line-haul trip, although in many cases freeway facilities are not used. Also, priority treatment is sometimes given to buses serving park-and-ride lots, although this, too, is certainly

not an essential or even a typical feature of park-and-ride service.

Thus, the concept of park-and-ride is sound; this alternative form of transportation service offers many potential benefits. The widespread use of park-and-ride concept is, however, still in its infancy. Funds have been spent on implementing numerous park-and-ride lots that have not been successful. Part of the reason for this occurrence appears to lie in the fact that insufficient planning information is currently available to those individuals responsible for determining feasibile park-and-ride locations. Consequently, a need exists to develop viable planning techniques that can be utilized in locating future park-and-ride facilities. This report reviews the park-and-ride experience in both the United States and Texas. Based on this review, guidelines are presented that can be used in the preliminary planning of future park-and-ride systems. Although park-and-ride service is applicable to both bus and rail transit, this report primarily addresses its application to bus transit.

History

As is the case with many transportation concepts that have been intensively pursued in recent years, the park-and-ride idea is not new. Indeed, bus park-and-ride facilities have been in existence for over 30 years.

As early as the late 1930's Detroit opened eight small park-and-ride lots (using gas stations) adjacent to existing transit lines. None of these were successful and all were discontinued. Perhaps the first major bus park-and-ride facility in the United States was opened in Forest Park, a suburb of St. Louis, in 1953 (1)*. This facility consisted of a 1000-car

*Denotes number of reference listed at the end of report.

lot located 5 miles (8 km) from the central business district (CBD); bus transit service was provided between the parking lot and the CBD.

In 1955, the Port of New York Authority opened the first bus park-and-ride lot serving Manhattan. The park-and-ride lot was located west of the Lincoln Tunnel and provided service between New Jersey and Manhattan (2). In that same year the initial park-and-ride facility serving Washington, D.C., was opened. An 800-car lot was constructed in the northwest section of Washington, D.C., and buses served the 22-minute trip from the lot to downtown (3). By the late 1950's, Boston had also implemented park-and-ride service (2).

During the 1960's, park-and-ride service was implemented in numerous United States cities. This concept was used in Fort Worth, Texas in 1963 (3). A parking lot was provided one mile (1.6 km) outside of the CBD at the terminus of the subway operated by Leonard's Department Store.

The earliest park-and-ride applications were somewhat different from many of those being considered today. Little planning was associated with the initial efforts, and the emphasis was more on accommodating existing demand rather than on generating new demand.

Today, however, most major transit improvement plans call for at least some use of the park-and-ride mode. In fact, in some cities the use of this mode has become relatively extensive; over 60,000 park-and-ride parking spaces are available in Cleveland, over 22,000 spaces are provided in Chicago, and more than 17,000 spaces exist in Boston (the majority of the spaces in all three of these cities serve rail transit) (3). The number of park-and-ride spaces available continues to increase, and some individual facilities such as the one in north Dade County, Florida, have over 2000 parking spaces (4).

Energy Considerations

Over the past two years the need to conserve energy, especially petroleum, has become apparent. The transportation sector, which uses 60 percent of the petroleum consumed in the United States, is a logical area to evaluate in identifying potential means of conserving energy.

Use of the park-and-ride mode, in relation to private auto travel, is relatively fuel efficient (Table 1). The mode used for access to the park-and ride facility does significantly influence the overall fuel efficiency of the trip.

TABLE 1: Fuel Efficiencies of Alternative Urban Modes

Mode	Passenger-Miles Per Gallon	(Passenger-km Per Liter)	Percent Improvement Over Standard Auto
Standard Auto (1.1 persons/vehicle)	14	(5.95)	--
Kiss-Ride/Express Bus	22	(9.35)	57
Park-Ride/Express Bus	35	(14.88)	150
Dial-A-Bus/Express Bus	40	(17.00)	186

Based on an 8-mile (12.9 km) express trip and a 2-mile (3.2 km) access distance to the park-and-ride facility.

Source: Reference 5

The park-and-ride mode does offer significant fuel savings for those trips it is able to serve. However, the relative magnitude of park-and-ride fuel savings in relation to total fuel consumption is somewhat minimal due to the low percentage of total trips that can realistically be accommodated by park-and-ride service.

Funding Legislation

Park-and-ride facilities represent a non-capital intensive approach to providing transit service. Many park-and-ride facilities have been opened using existing parking lots as well as existing transit equipment. In these instances, the initial capital cost is generally minimal, and the local government has frequently financed the entire project.

Some park-and-ride facilities involve land acquisition, new facility construction, and new bus acquisitions. The expense of these projects can be substantial and, if the projects had to be entirely financed locally, the potential for developing such projects would be curtailed. However, federal and state assistance are available for both park-and-ride facility construction and for transit equipment purchases.

Facility Construction

Federal highway money and Urban Mass Transportation Administration money are available for facility construction (6, 7, 8). Section 121 of the Federal Aid Highway Act of 1973 reads, in part, as follows:

> To encourage the development, improvements, and use of public mass transportation systems operating motor vehicles on Federal Aid Highways for the transportation of passengers, so as to increase the traffic capacity of the Federal aid systems for the movement of persons, the Secretary may approve as a project on any Federal-aid system the construction of exclusive or preferential bus lanes, highway traffic control devices, bus passenger loading areas and facilities (including shelters), and fringe and transportation corridor parking facilities to serve bus and other public mass transportation passengers.

This money is available for use on all federal-aid systems. On Interstate systems the federal share is 90 percent, while on primary, secondary, and urban systems the federal share is 70 percent. The source of these funds is the Highway Trust Fund.

Urban Mass Transportation Administration capital grant monies can also

be used for facility construction. The federal share of these projects is 80 percent.

Bus Procurement

Federal funds may also be used for buying buses. The 1973 Federal Aid Highway Act is one source of these funds. This act authorizes $800 million per year for urban systems, either transit or highway. For fiscal year 1974, only those funds actually spent on highways could be charged to the Highway Trust Fund. During fiscal year 1975, up to $200 million could be spent from the Highway Trust Fund to purchase buses. In fiscal rear 1976, any authorized urban transportation option--highway, bus, or rail--may be paid out of the Highway Trust Fund.

Also, UMTA capital grant money is a common source of funds for purchasing buses. As is the case with facility construction, the federal share of the purchase is 80 percent.

State Monies

In 1975 the state legislature established the Texas Public Transportation Fund. These appropriated monies may be used to finance up to 65 percent of the required matching money for capital improvement projects.

PARK-AND-RIDE EXPERIENCE IN THE UNITED STATES

Numerous bus park-and-ride facilities have been implemented in the United States, and a literature review was conducted to document these park-and-ride experiences. Although data describing these facilities have not been extensively reported in the literature, sufficient data are available to identify the characteristics of park-and-ride facilities. The characteristics can be divided into two general categories, one that addresses ridership characteristics and another that describes service characteristics. Descriptions of both types of characteristics are presented and, following these descriptions, a discussion of the manner in which various characteristics influence the success of a park-and-ride facility is provided.

Ridership Characteristics

Trip Purpose Served

Park-and-ride facilities are generally designed to serve work trips destined to a central activity area. Available data indicate that the vast majority of trips being served are trips to and from work (Table 2). Other trip purposes such as shopping and school represent a very small percentage of the total trips served by the park-and-ride mode.

Arrival Mode

Auto oriented travel is the primary means of arriving at park-and-ride lots (Table 3). The percentage of individuals driving themselves and the percentage using kiss-and-ride varies considerably between different park-and-ride facilities. Also, at some facilities, walking is a rather commonly used arrival mode.

TABLE 2: Trip Purpose of Individuals Using Bus Park-and-Ride Facilities (Percent), U. S. Data

Trip Purpose	Park-and-Ride Location								
	Northeast Corridor (Suburban N.Y.C.)	Washington, D.C.	Seattle, Wash.		Richmond, Va.	Milwaukee, Wis.		Lincoln Tunnel, N.J.	Hartford Conn.
			1970	1971		Mayfair	Bayshore		
Work	91	92	85	86	99	88	83	88	98.7
Business	4	--	9	3	--	--	--	4	0.4
School	2	--	--	--	1	--	--	--	0.5
Shopping	3	4	1	2	--	--	--	--	--
Other	--	--	5	9	--	12	17	8	0.4
Not Reported	--	4	--	--	--	--	--	--	--
Total	100	100	100	100	100	100	100	100	100

Sources: References 1, 9, 10, 11, 13

TABLE 3: Mode Used to Arrive at Bus Park-and-Ride Facility (Percent), U. S. Data

Mode	Park-and-Ride Location							
	Washington, D.C. (Combined Data for 3 lots)	Rochester, N.Y.	Richmond, Va.	Seattle Wash.		Milwaukee, Wis.		Hartford Conn.
				1970	1971	Mayfair	Bayshore	
Auto Oriented	94	78	94	96	82	79	76	95
Drove Self	76	32	64	76	61	39	38	61
Was Driven & Car Parked	9	10	4	5	4	35	28	--
Was Driven & Car Not Parked	9	36	26	15	17	5	10	--
Walked	3	13	5	4	16	16	17	5
Combination	--	6	--	--	--	--	--	--
Other	3	3	1	--	2	5	7	--
Total	100	100	100	100	100	100	100	100

Sources: References 1, 9, 10, 11, 12, 13

Previous Travel Mode

Information describing the travel mode used by individuals prior to using the park-and-ride mode is presented in Table 4. Park-and-ride facilities have attracted many former auto users. In general, it appears that about 50 percent of the park-and-ride patrons previously used auto oriented modes. Also, numerous trips that were previously not being made are now

being made using the park-and-ride mode, indicating that this mode can serve a latent travel demand.

TABLE 4: Mode of Travel Used Prior to Bus Park-and-Ride Mode (Percent), U. S. Data

Mode	Park-and-Ride Location					
	Seattle, Wash.		Washington, D.C.*	Milwaukee, Wis.		Hartford Conn.
	Feb. 1971	June 1971		Mayfair	Bayshore	
Auto Oriented	74	52	54	40	50	72.5
Driver	67	43	40	33	38	56.0
Passenger	7	9	14	7	12	16.3
Other Transit	16	28	46	40	35	23.5
Did Not Make Trip	10	20	--	20	15	4.4
Total	100	100	100	100	100	100

*Data do not include riders who previously did not make the trip

Sources: References 1, 6, 8, 13

Travel Distance to Park-and-Ride Lot

Over 60 percent of the individuals using the park-and-ride mode live within four miles (6.4 km) of the facility (Table 5). Only 10 to 20 percent of the park-and-ride users live more than six miles (9.7 km) from the lot.

TABLE 5: Distance Travelled From Home to Bus Park-and-Ride Facilities, U.S. Data

Distance		Park-and-Ride Location								
Miles	(km)	Seattle, Wash.		Milwaukee				New Brunswick, N. J.		Richmond, Va.
				Mayfair		Bayshore				
		%	Cumulative	%	Cumulative	%	Cumulative	%	Cumulative	Cumulative
0-1.0	(0-1.6)	19	19	16	16	26	26	10	10	--
1.1-2.0	(1.7-3.2)	28	47	34	50	33	59	13	23	--
2.1-3.0	(3.3-4.8)	11	58	24	74	10	69	23	46	--
3.1-4.0	(4.9-6.4)	9	67	10	84	14	83	20	66	~80
4.1-5.0	(6.5-8.0)	8	75	7	91	4	87	10	76	--
5.1-6.0	(8.1-9.7)	9	84	1	92	3	90	5	81	--
Over 6.0	(Over 9.7)	16	100	8	100	10	100	19	100	--

Sources: References 1, 9, 10, 11

Employment

Limited data suggest that the park-and-ride mode is being used primarily by "white collar" workers (Table 6). Office workers are the primary users of this mode.

TABLE 6: Employment of Individuals Using Bus Park-and-Ride Mode (Percent), U. S. Data

Employment	New Brunswick, N. J. Park-and-Ride
"White Collar"	79
Office	69
Retail	10
Student	3
"Blue Collar"	13
Manufacturing	8
Construction	5
Unemployed	5
Total	100

Source: Reference 9

Frequency of Use

Considerable variation exists in the limited data concerning the frequency with which riders use the park-and-ride mode. However, the majority of riders use the facility for more than four round-trips per week (Table 7).

TABLE 7: Frequency of Use of Bus Park-and-Ride Mode (Percent), U. S. Data

Round Trips Per Week	Park-and-Ride Location		
	Seattle, Wash.		Lincoln Tunnel, N.J.
	1970	1971	
Less than one	--	--	19
1	2	5	--
2	2	6	--
3	2	4	--
4	4	8	--
One to four	10	23	27
More than four	90	77	54
Total	100	100	100

Sources: References 1, 11

Income

Users of the park-and-ride mode have relatively high incomes. The vast majority of riders have annual incomes in excess of $12,000 (Table 8).

TABLE 8: Income of Individuals Using Bus Park-and-Ride Facilities (Percent) U. S. Data

Annual Income Range (Dollars)	Park-and-Ride Location	
	Richmond, Va.	Lincoln Tunnel N. J.
0- $12,000	27	15
over $12,000	73	85
$12,000 - $20,000	--	43
over $20,000	--	42
Total	100	100

Sources: References 1, 10

Auto Availability

The majority of park-and ride users have an auto available that could have been used for the trip. In Milwaukee, 63 percent of the riders at Mayfair Shopping Center and 62 percent of the riders at the Bayshore Shopping Center had an auto available to serve the trip (9). In Richmond, Virgina, 65 percent of the riders using the park-and-ride mode owned two or more automobiles, and 88 percent of the riders had an automobile available to serve the trip (10).

Ridership Characteristics, Summary

The park-and-ride mode primarily serves work trips being made by white collar employees. The majority of park-and-ride users arrived at the parking lot via an auto oriented (auto driver or passenger) mode, and prior to using the park-and-ride mode, most of these riders had used a private automobile to make their trips. Park-and-ride facilities also generate a significant number of new trips.

The park-and-ride mode provides a type of transit service, and transit services in general can be considered to provide either public or mass

transportation. Public transportation provides some minimal level of mobility to those individuals who do not have access to private transportation; it serves a social need. This is the type of transit service commonly provided in Texas.

Mass transportation provides for the rapid movement of relatively large numbers of individuals along major travel corridors to destinations within major activity centers. Thus, it primarily accommodates workers destined to major activity centers, and the type of employment existing in these centers tends to be white collar. From this, it can be concluded that park-and-ride facilities are providing mass rather than public transportation.

Service Characteristics

Service characteristics are comprised of two elements. The first considers the physical characteristics of the parking lot while the second addresses the bus service provided at the park-and-ride facility. Service characteristics of certain park-and-ride facilities in the United States are presented in Tables 9 and 10.

Parking Facility Characteristics

A wide range exists in the number of parking spaces available at park-and-ride lots; most facilities provide between 250 and 450 spaces. In general, more than 50 percent of the available spaces are utilized and, typically, the parking is provided at no direct cost to the user. Existing parking areas, such as unused portions of shopping center lots, are commonly used as park-and-ride facilities.

Park-and-ride lots are generally located between 4 to 10 miles (6.4 km

TABLE 9: Characteristics of the Parking Lots Provided at Park-and-Ride Facilities, U. S. Data

Park-and-Ride Location	Parking Spaces Provided	% of Spaces Utilized	Route Distance to CBD		Parking Fee (Dollars)	Type of Lot Utilized
			Miles	Minutes		
Average of 37 U.S. Lots*	415	87	5.9	--	~0.20	--
Average of 12 U.S. Lots*	375	--	4.5	--	--	--
Seattle Blue Streak	525	100	7.0	--	free	Shopping Center
Hartford, Conn.	250	60	7.0	13-18	free	Shopping Center
Richmond, Va.	337	100	11.0	18-23	free	New Lot
Lincoln Tunnel, N.J.	1600	99	2.5	--	free	New Lot
St. Louis	1000	100	5.0	17	free	--
Louisville, Ky.	170	--	8.5	--	--	--
Rochester, N.Y. (average of 25 lots)	67	--	18.2	49	free	--
Washington, D. C.	800	--	--	--	free	--
Milwaukee, Wis.						
Mayfair	300	50	10	21	free	Shopping Center
Bayshore	150	77	7	10	free	Shopping Center
Treasure Island South	100	50	10	20	free	Shopping Center
Treasure Island North	100	30	12	22	free	Shopping Center
Country Fair	50	50	14	20	free	Shopping Center
Spring Mall	100	30	10	15	free	Shopping Center

Sources: References 1, 3, 9, 10, 11, 12, 13, 14
*Independent Studies

TABLE 10: Characteristics of Bus Service Provided at Park-and-Ride Facilities, U.S. Data

Park-and Ride Location	Type of Roadway Used for Line-Haul	Express Service	Type of Priority Treatment, If Any	Peak Period			One-Way Fare (Dollars)	Passengers Carried Per Day (One-way)
				Headways (Minutes)	Ave. Speed mph	(km/hr.)		
Average of 37 U.S. Lots	--	--	--	9	19	(30.6)	~0.40	--
Seattle Blue-Streak	Freeway (I-5)	Yes	Reversible Median Lanes	4	30	(48.3)	0.35	780
Hartford, Conn.	Freeway (I-84)	Yes	None	10	28	(45.1)	0.45	250
Richmond, Va.	Freeway (I-64)	Yes	None	9	30	(48.3)	0.50	550
Lincoln Tunnel, N.J.	Freeway/Tollway (I-495)	Yes	Exclusive Lane Through Toll Plaza	4	--	(--)	0.65	~2200
St. Louis	--	Yes	--	--	--	(--)	0.50	--
Louisville, Ky.	--	Yes	Contra-Flow Bus Lane	--	22	(35.4)	--	--
Rochester, N.Y. (Composite data for 7 routes, 25 lots)	--	No	Exclusive Highway Lane	--	22	(35.4)	0.50-0.70	--
Washington, D. C.	--	Yes	None	--	--	(--)	0.30	--
Milwaukee, Wis.								
Mayfair	Freeway (US 45, I-94)	Yes	None	5-10	29	(46.7)	0.50	400
Bayshore	Freeway (US 141)	Yes	None	10-15	42	(67.6)	0.50	300
Treasure Island South	Freeway (US 45, I-94)	Yes	None	20-30	30	(48.3)	0.50	200
Treasure Island North	Freeway (US 45, I-94)	Yes	None	30	33	(53.1)	0.50	100
Country Fair	Freeway (I-894, I-94)	Yes	None	30	42	(67.6)	0.55	125
Spring Mall	Freeway (I-894, I-94)	Yes	None	30	40	(64.4)	0.55	42

Sources: References 1, 3, 9, 10, 11, 12, 13, 14

to 16.1 km) from the central business district. Travel time during peak periods from the lot to the CBD commonly ranges from 10 to 20 minutes.

Bus Service Characteristics

Express bus service (direct from the park-and-ride lot to the activity center) is available at most park-and-ride facilities. Buses generally use freeway facilities for the line-haul portion of the trip, and average peak period travel speeds are usually in the 20 to 30 mph (32.1 to 48.3 km/hr) range. Bus headways during peak periods are commonly between 4 and 15 minutes. Buses typically provide service to park-and-ride lots throughout the workday. The ITE study (3) found that 60 percent of the lots surveyed had bus service available at least 14 hours per day.

The one-way bus fare, which in some instances such as the Lincoln Tunnel includes a parking fee, usually ranges from 35 to 55 cents. Ridership varies substantially between lots.

Limited data are available concerning the financial success of park-and-ride lots. It is noted in the literature that the fare box revenue in neither Richmond, Virginia (10) nor Hartford, Connecticut, (13) is currently covering bus operating expenses. It appears that a break even situation (fare box revenue equal to bus operating expenses) is about the best situation that can be expected to occur.

Factors Influencing Park-and-Ride Utilization

The experiences with park-and-ride in the United States have identified certain factors that appear to influence the utilization of these facilities. A discussion of park-and-ride utilization and the more pertinent factors

affecting this utilization is presented below.

Measure of Park-and-Ride Utilization

In reviewing the relationships presented in this section, it is necessary to realize that the variable commonly used to measure utilization has significant limitations. In the literature, park-and-ride utilization is usually measured by the ratio of autos parked per available parking space, the assumption being that the higher this ratio is the greater is the utilization of the facility.

Autos parked per available space is a measure of utilization. However, the number of parking spaces available at many park-and-ride facilities is the number of spaces that are in the existing lot (church, shopping center, etc.) that is being used as a park-and-ride facility. As an example, if a 2000-car drive-in theatre lot is used as a park-and-ride facility and is used by 400 cars per day, the autos parked per available space ratio would be 0.2, implying a rather low utilization. On the other hand, a 50-parking-space church lot used by 40 cars per day would have a utilization ratio of 0.8, a relatively high ratio. Thus, the ratio of autos parked per available space is influenced as much by the size of the lot as it is by the use of the lot.

This utilization ratio is of very little value for planning purposes. The relationships presented subsequently in this section relate utilization (autos parked/space) to variables such as downtown parking cost, transit headways, transit traveltime, etc. Using these relationships, it would be possible for a planner to determine that, by providing a certain level of transit service in a city with a high CBD parking cost, he would achieve a certain percentage of utilization regardless of the number of parking spaces provided. It is apparent that he probably will not achieve the same

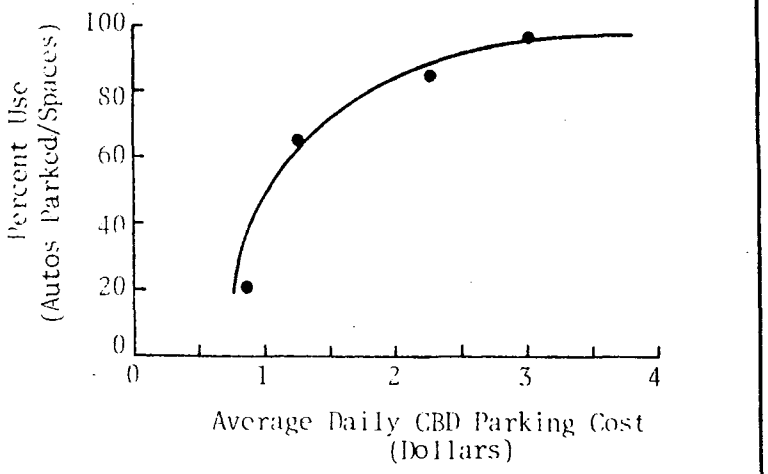
percentage of utilization in a 2000-car lot that he would in a 200-car lot.

Other utilization measures might be used. Absolute ridership might be one measure, although it is restricted by the size of the lot and it may not be economical to provide the level-of-service needed to maximize ridership. From the transit operator's viewpoint, it would be desirable to provide a level of service that would continually generate 80 to 90 percent load factors. The traffic engineer would want to provide a level-of-service that would minimize total vehicular traffic volumes. These are not necessarily consistent goals.

Thus, at present, no measure of utilization is available that both adequately describes existing operations and can also be used to plan the required lot size for new facilities. Additional research is needed to identify such a measure. The measure of utilization (autos parked per available space) used in the literature does provide some indication of the manner in which certain variables influence utilization at existing facilities, but it has definite limitations and is not directly applicable to the planning process.

Parking Costs in the Activity Center

Several studies have concluded that downtown parking costs are the single most important factor in determining the success of a park-and-ride facility. This conclusion was reached in both Rochester (14) and Seattle (11). A study (9) of several U.S. park-and-ride facilities also reached this conclusion, and downtown parking costs were viewed as the second most influential factor in Hartford, Connecticut (13). The study (3) of 37 park-and-ride facilities conducted by the Institute of Traffic Engineers also supports this conclusion (Figure 1). These data indicate that utilization of park-and-ride facilities increases significantly as downtown parking costs increase.



Source: Reference 3

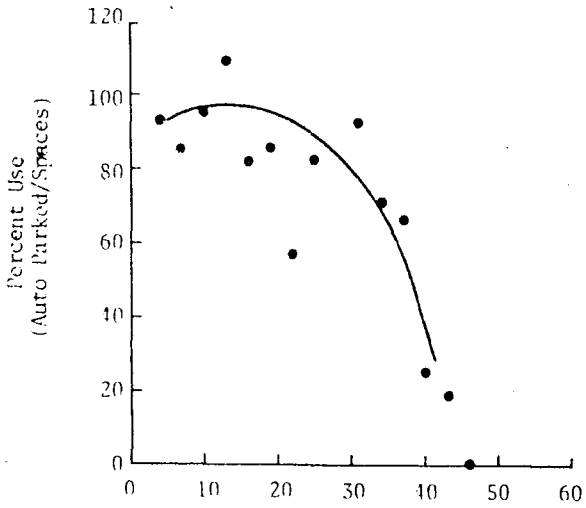
FIGURE 1: Park-and-Ride Utilization as a Function of CBD Parking Cost

However, some information lessens the importance of the downtown parking cost. For example, in certain cities some park-and-ride facilities have been widely used while others have not, even though the same downtown parking cost affected the utilization of both the intensely and the lightly used facilities. Also, a recent study (15) has demonstrated that those individuals who park their cars in downtown areas are not highly sensitive to the price of parking, the price elasticity of demand being approximately -0.3. This implies that the high parking cost may not be as major of a factor as it was thought to be in some of the earlier studies.

Nevertheless, CBD parking costs are a consideration in determining the feasibility of park-and-ride lots. Additional research is needed to more accurately determine the relative role of this factor.

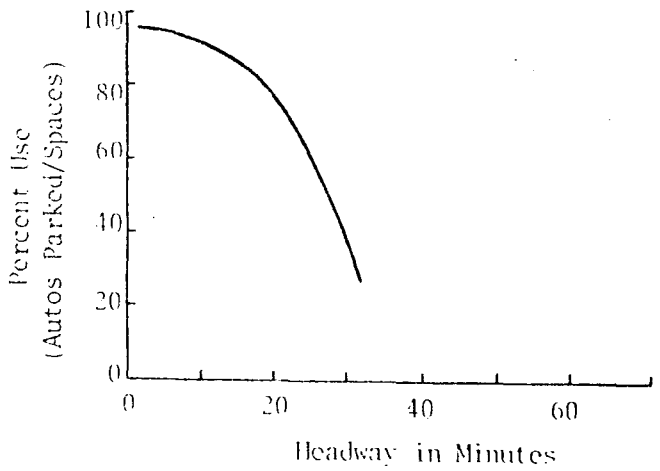
Travel Time

Bus travel time to the activity center has also been observed to influence park-and-ride utilization. Rochester (14) noted that the second most important factor affecting ridership was bus quality and speed. Quick travel times were observed to be a major consideration in the Seattle Blue Streak study (11).



Source: Reference 3

FIGURE 2: Influence of Peak Period Traveltime on Park-and-Ride Utilization



Source: Reference 3

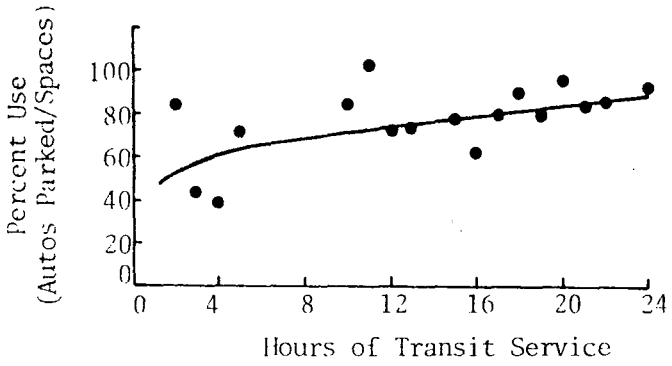
FIGURE 3: Park-and-Ride Utilization as a Function of Transit Headways

The study (3) of 37 United States bus park-and-ride lots also related peak period travel time to facility utilization (Figure 2). The data collected in that study suggest that after transit traveltime exceeds about 25 minutes utilization of the park-and-ride lot decreases rather rapidly.

Bus Headways

Short bus headways are generally felt to be necessary to encourage ridership. Voorhees noted the need for frequent bus service in their Seattle report (11). Data collected by the Institute of Traffic Engineers (3) suggested that ridership at park-and-ride facilities is not adversely affected until headways exceed about 15 minutes (Figure 3). This is in general agreement with the

findings of a New Jersey consultant (2) who contended that 10 minute headways represented a practical maximum.



Source: Reference 3

FIGURE 4: Park-and-Ride Utilization as a Function of Hours of Transit Service Available

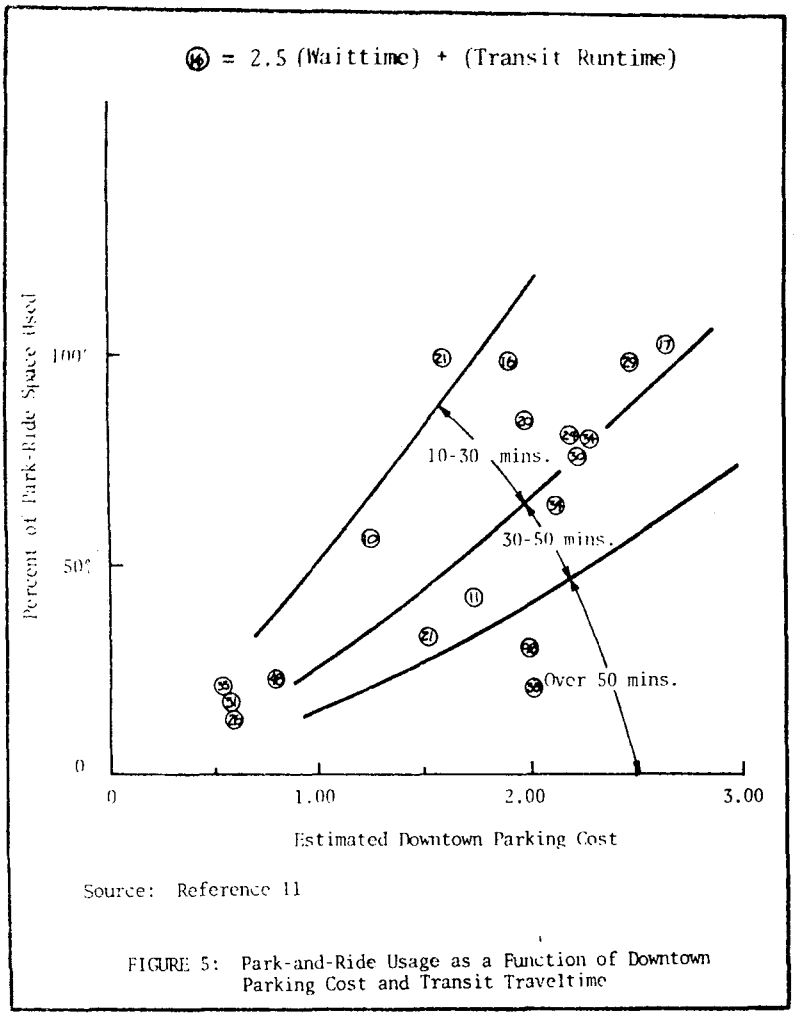
Other Influences

The ITE study (3) found that utilization of bus park-and-ride facilities increased somewhat as the hours of operation increased (Figure 4). It is reasonable to expect ridership to increase as hours of operation increase. The increased hours of operation provide more flexibility in serving work trips and also increase potential utilization by individuals for trip purposes other than work. However, the vast majority of the ridership can be attained with rather minimal hours of operation, and this may, in many instances, be the most economical approach.

Data from Hartford (13) indicate that individuals primarily used that park-and-ride service for personal convenience and to avoid driving in congested traffic. Also, a study (9) of U.S. park-and-ride operations emphasized a need to provide free parking at the park-and-ride lot. Most existing U.S. facilities do provide free parking.

A Utilization-Parking Cost-Transit Time Relationship

Voorhees (11) developed a "model" that relates lot utilization, CBD parking costs, and transit travel time. Although this model does not



Source: Reference 11

FIGURE 5: Park-and-Ride Usage as a Function of Downtown Parking Cost and Transit Traveltime

accurately represent all U.S. park-and-ride facilities studied by Voorhees, it does provide general guidelines concerning the manner in which the three variables interrelate. This relationship is depicted in Figure 5.

In determining transit traveltime, Voorhees weighted the time spent waiting for a bus by a factor of 2.5. This approach emphasizes a need for relatively short bus headways. Total transit time, as used in the Voorhees model, is equivalent to 2.5 (waiting time) plus the transit run time. This transit trip time is shown for each data point in Figure 5.

From this model, it can be concluded that, in general, the more successful (measured in terms of percent utilization of spaces provided) park-and-ride facilities offer a relatively quick transit trip time to CBDs characterized by high daily parking costs. If daily parking costs fall below $1.50 and/or if transit traveltime exceeds 30 minutes, the Voorhees model indicates that lot utilization can be expected to be less than approximately 60 percent.

General Lot Location Guidelines

In general, the U.S. experience indicates that the initial step in determining park-and-ride lot locations is to identify densely utilized travel corridors that are serving a significant volume of CBD destined trips (or trips destined to other major activity centers). Several techniques, including use of census data, mail-out questionnaires, and origin-destination data have been used in various locations to identify such traffic corridors. These techniques will be described in more detail in a subsequent report.

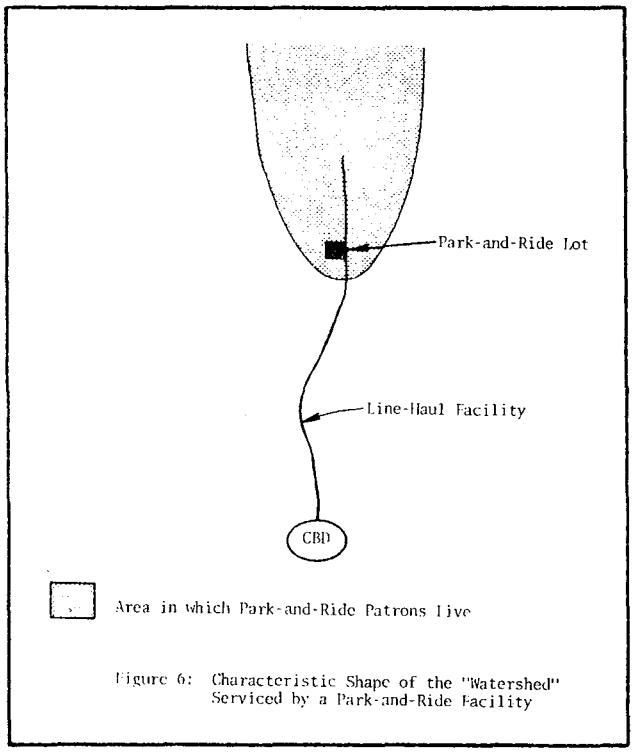


Figure 6: Characteristic Shape of the "Watershed" Serviced by a Park-and-Ride Facility

Once a potential travel corridor is determined, the location of the lot becomes a function of transit level-of-service and capital cost. The lot must be located where it can "intercept" traffic. To understand this problem, it is necessary to realize the travel patterns of individuals using park-and-ride lots. The park-and-ride "watershed" is generally parabolic, similar to that shown in Figure 6. Very few individuals backtrack to use a lot; only 14 percent of the riders in Seattle (11) had backtracked to make use of the lot. This suggests that the lot must be located sufficiently close to the activity center to be able to

intercept significant ridership.

However, in general, land costs increase the closer the lot is to the CBD. Thus, to save on land costs, a location removed from the CBD is frequently desirable.

Transit service must then be considered, and this relates to the volume of traffic the facility can intercept. Sufficient traffic needs to be intercepted to justify short bus headways. As distance from the CBD increases, less traffic is susceptible to being intercepted and, thus, it becomes economically unrealistic to provide short headways. Failure to provide short headways will further curtail usage.

Thus, for each potential travel corridor, an optimal park-and-ride location will exist. This location will be site specific, and it will be a trade off between land costs and the volume of passengers that can be intercepted. This volume will determine the transit headways that can economically be provided, and unless relatively short headways are provided, utilization of the park-and-ride facility will probably be low.

PARK-AND-RIDE EXPERIENCE IN TEXAS

Park-and-ride service existed in Fort Worth as early as 1963; a parking lot was provided at the terminus of the Leonard's Department Store subway. In recent years, park-and-ride has become more common in Texas. This service is now available, to some extent, in Fort Worth, Austin, Dallas, and San Antonio. Service will be implemented in Garland in the near future. A description of the park-and-ride experience in these urban areas is presented in this section.

Fort Worth, Texas

Fort Worth refers to their service as "Park-and-Go." Sixteen separate lots are provided throughout the city. Characteristics of these lots are presented in Table 11, and the location of the lots is shown in Figure 7.

Parking Facility Characteristics

Fort Worth's approach to park-and-go has taken advantage of the non-capital intensiveness of this form of transit operation. Arrangements have been made with various organizations and groups (churches, shopping centers, etc.) to utilize unused portions of their existing lots. These parking areas are provided to the city at no cost, and no parking fee is charged to park-and-go patrons.

Between 50 and 250 parking spaces are available at each lot. Although this is well below the number of spaces commonly provided at park-and-ride lots (refer to Table 9, page 14), it is more than ample to serve the demand at all locations.

Table 11: Characteristics of Park-and-Go Facilities, Fort Worth, Texas 1975

Lot Location*	Type of Lot Utilized	Parking Cost	Route Distance to CBD			Peak Period			Basic Bus Fare (Dollars)	Express	Type of Priority Treatment, if Any	Line-Haul Roadway	Daily One-Way Ridership
			Miles	(km)	Minutes	Headways (min.)	Ave. Speed (mph)	(km/hr)					
1. St. Giles	Church	Free	12	(19.3)	40	15	18	(29.0)	0.35	No	Exclusive CBD Bus Lane	Highway (Bus. US 180)	10-20
2. Levitz Furniture	Business Lot		9	(14.5)	29	5-10	19	(30.6)		No	Exclusive CBD Bus Lane	Highway (Bus. US 180)	10-20
3. Ridglea Baptist	Church		6	(9.7)	15	20-60	24	(38.6)		Yes	CBD Bus Lane Manual Signal Preempt	Highway (Bus. US 180)	65-85
4. Arlington Hts. Christian	Church/School		4	(6.4)	15	20-30	16	(25.7)		No	Exclusive Bus Lane in CBD	Highway (Bus. US 180)	10-20
5. Cook's	Business Lot		4	(6.4)	19	15	13	(20.9)		No		Streets	
6. Springdale	Church		5	(8.0)	15	30	20	(32.2)		No		Streets	
7. Church	Church		13	(20.9)	39	--	20	(32.2)		No		D-FW Turnpike	
8. Meadowbrook	Church		7	(11.3)	12	35	35	(56.3)		Yes		D-FW Turnpike	
9. Handley Baptist	Church		9	(14.5)	32	30	17	(27.4)		No		Highway (US 80)	
10 Handley Methodist	Church		9	(14.5)	37	30	15	(24.1)		No		Highway (US 80)	
11. Herman Clark	Stadium		11	(17.7)	50	60	13	(20.9)		No		Streets	
12. Oakbrook	Shopping Center		6	(9.7)	30	25-30	12	(19.3)		No		Streets	
13. K-Mart	Business Lot		9	(14.5)	35	20-38	16	(25.7)		No		Streets	
14. Edge Park	Church		10	(16.1)	44	15-30	14	(22.5)		No		Streets	
15. Hulen Square	Shopping Center		12	(19.3)	29	15	25	(40.2)		Yes		Freeway (IH-30)	
16. Tanglewood	Shopping Center		7	(11.3)	17	15	25	(40.2)		Yes		Freeway (IH-30)	

*Location number keyed to map, Figure 7.

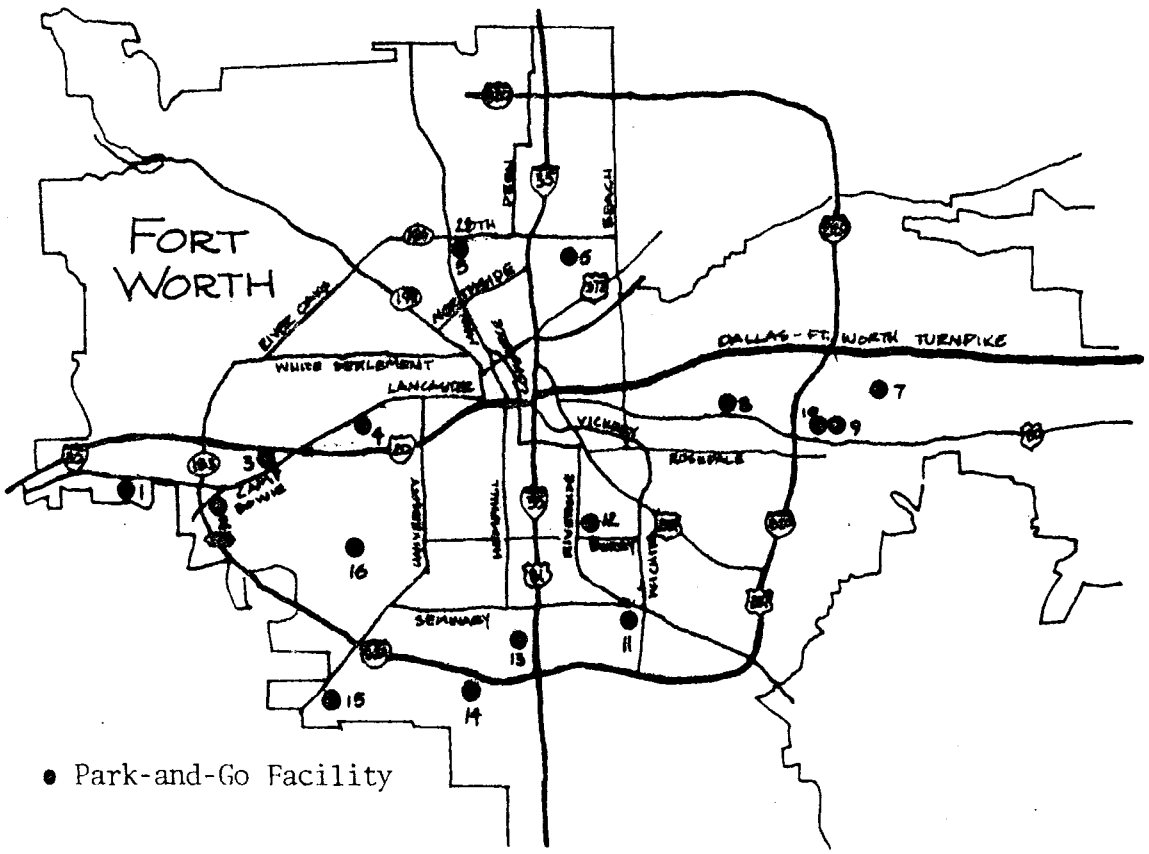


FIGURE 7: Location of Park-and-Go Lots, Fort Worth

Bus Service

All of the Fort Worth park-and-go lots are located adjacent to existing local bus routes. The buses make a stop at each facility. During peak periods, approximately 75 buses operate over 26 routes to serve the park-and-go facilities.

Since the park-and-go lots are located along existing bus routes, express service from the lot to the CBD is not provided at most (12) of the facilities. However, express service is available from 4 of the facilities (Table 11). Short headways were previously identified as being critical to the success of a park-and-ride facility. Only one of the park-and-go lots

has headways less than 15 minutes.

Because the line-haul service is typically provided over local routes, average peak period speeds are relatively slow. The non-weighted average peak period line-haul speed in Fort Worth is about 19 mph (30.6 km/hr.) (average speed on express routes is 27 mph (43.4 km/hr.), on local routes 16 mph (25.7 km/hr.)). The slower Fort Worth speeds can be attributed to two factors. First, most of the Fort Worth speeds are on local routes, while most U.S. routes are express. Secondly, U.S. routes typically utilize freeways while the Fort Worth routes do not (of the 16 Fort Worth routes, 2 use the tollroad, 2 use freeways, 6 use highways, and 6 use city streets).

Priority treatment is, to a limited extent, provided to park-and-go transit service. Exclusive bus curb lanes exist on Throckmorton Street in the CBD, a street used by all park-and-go routes. One route (from the Ridglea Baptist Church to the CBD) has additional priority treatment. Police officers manually preempt traffic signals at major intersections to expedite bus movement. This is estimated to save 5 minutes on the trip to the CBD.

A basic 35-cent one-way fare exists. An unlimited ride monthly commuter pass may be purchased for $13. Also, handicapped individuals, senior citizens, and students are eligible for special rates.

Ridership

Utilization of the Fort Worth park-and-go system has not been high. At all lots, except one, daily one-way ridership is less than 20 persons. At the lot with priority treatment for the trip to the CBD (Ridgelea Baptist Church Lot), 65 to 85 daily one-way passengers use the service. Thus, in total for all the Fort Worth routes, daily one-way ridership is less than 400 persons.

Expansion Plans

Fort Worth is presently planning to expand their park-and-go system by providing three new lots. These will be permanent lots and express bus service will exist to the CBD. A brief description of these sites is presented below.

- West Freeway near Guilford Road, just north of the existing lot at Ridglea Baptist Church. A 3.7-acre (14,974 sq m) site will be developed to accommodate 180 cars.
- I-820 South at Old Granbury Road within the Wedgewood Shopping Center development. A 1.9-acre (7689 sq m) site will be developed to accommodate about 150 cars.
- I-820 East at East Lancaster Avenue. A 4.25-acre (17,200 sq m) site will be developed to provide 350 parking spaces.

All of these routes are adjacent to interstate highways. Fort Worth anticipates using Federal aid highway money to construct the facilities.

Private Participation

Private developers in Fort Worth have shown an interest in park-and-ride. A new shopping center is being planned in the general vicinity of the northwest quadrant of the West Freeway (I-30)-Highway 183 intersection. This is an area that presently does not have transit service.

The private developer, using his own funds, is providing park-and-ride parking spaces and a bus shelter as well as landscaping. The city has agreed to provide bus service to this facility. As far as can be determined, this is the first time in the United States that a private developer has considered active participation in park-and-ride facilities during the planning stage of a development.

Austin, Texas

Austin initiated its park-and-ride service as part of a transportation energy conservation program, and 3 park-and-ride routes are presently being operated. The initial service was offered from a theatre parking lot on the city's north side in March 1974. Two separate park-and-ride routes now operate from this north lot; one route provides service to the University of Texas and the CBD while the other offers service to the IRS Complex in south Austin.

Park-and-ride lots were opened in south Austin in August 1974. One south route provides service from two closely located shopping centers to the CBD and the University of Texas.

Characteristics of these lots and routes are presented in Table 12. Parking lot locations are shown in Figure 8.

Parking Facility Characteristics

In some ways, the Austin park-and-ride system is similar to the non-capital intensive Fort Worth system. Both systems utilize unused portions of existing lots, and the city is allowed to use these lots at no cost. In both cities no parking charge is assessed to the park-and-ride patron. All of the Austin lots have parking capacities of approximately 200 vehicles, and this is adequate at the present time.

Bus Service

Unlike the Fort Worth system, the Austin system provides express bus service from the park-and-ride lots to the destination points. The Austin CBD routes operate for a 1.5-hour period during both the morning (7:00 am to 8:30 am) and the afternoon (4:00 pm to 5:30 pm). Fifteen-minute headways are used during these periods, and seven buses operate on the routes during

TABLE 12: Characteristics of Park-and-Ride Facilities
Austin, Texas 1975

	Lot Location	Type of Lot Utilized	Parking Cost	Route Distance to CBD or Destination			Peak Period		Basic Fare	Express Service	Type of Priority Treatment If Any	Line Haul Roadway	Daily One Way Ridership (Average)	Lot Capacity # Autos
				Miles (km)		Minutes	Headways (minutes)	Ave. Speed mph (km/hr.)						
Fox Theatre North Lot	CBD Route	Theatre	Free	5	(8.0)	22	15	14 (22.5)	$.30	Yes	None	City Streets	90	200
	IRS Route			8.7	(14.0)	30	1 Departure (2 Buses)	17 (27.4)		Yes		Freeway (I-35)	120	
South Lots	HEB Woolco	Shopping Centers	Free	5.3	(8.5)	18	15	18 (29.0)	$.30	Yes	None	City Streets	100	200
	Gibsons		Free				15							200

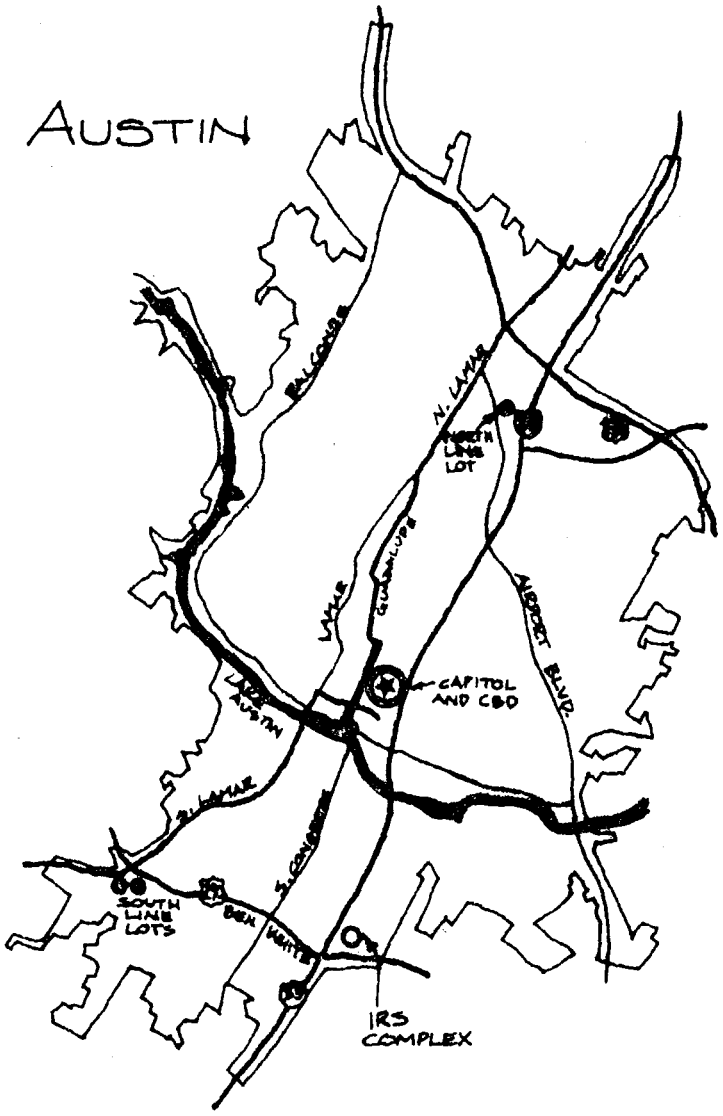


Figure 8: Location of Park-and-Ride Lots, Austin.

the peak periods. No midday service is offered.

The route to the IRS Complex has only one scheduled departure time. Two buses depart from the north lot at 6:45 am and return from the IRS Complex at 4:00 pm.

Priority treatment is not given to the buses serving the park-and-ride lots. This, in addition to using city streets and a heavily congested freeway (I-35), accounts for average speeds being in the range of 14 mph (22.5 km/hr.) to 18 mph (29 km/hr.).

Bus fare for a one-way trip is 30 cents, the same as the peak period charge on the regular transit routes. A special monthly commuter pass may be purchased for $10.

Ridership

Initially, the north route to the CBD served about 20 one-way passengers. This route presently serves approximately 90 persons; thus, the average bus accommodates 13 persons (7 buses). The north route to the IRS Complex is used by about 120 one-way passengers, and two buses are utilized.

When it was first opened, the south route to the CBD was used by about 46 persons. This has grown to 100 one-way passengers.

Total one-way ridership for all 3 routes is currently about 310 persons per day.

Cost of Operation, Expansion Plans

Since there is no parking fee, the fare box is the sole source of revenue. The 310 one-way daily passengers generate approximately $900 of revenue per week. The city estimates that providing the bus service to the park-and-ride lots costs $2000 per week. Thus, the city experiences a weekly deficit slightly in excess of $1000.

In spite of this deficit, Austin is considering expanding the service. At present, appropriate locations for new lots are being studied.

Dallas, Texas

Dallas opened its initial park-and-ride facility on North Central Expressway (US 75) to complement the Urban Corridor Demonstration Project being undertaken in Dallas. After the successful opening of this facility, two additional park-and-ride lots were opened, one in southwest (Oak Cliff) and one in southeast (Pleasant Grove) Dallas. Characteristics of the three facilities are presented in Table 13, and lot locations are shown in Figure 9.

System Development

Dallas is among several U.S. cities participating in a Department of Transportation Urban Corridor Demonstration Program. The program in Dallas focuses on the North Central Expressway (US 75) corridor; the basic objective is to improve traffic flow in that corridor.

To complement this program, the City of Dallas initiated a park-and-ride lot at the north end of the demonstration corridor. In addition to aiding the demonstration program, the placement of the lot allowed it to also serve as a terminal for the new Dallas Surtran system, Surtran being the system providing bus transit to the new Dallas-Fort Worth Airport. Also, implementation of the park-and-ride lot fulfilled a city obligation to the Environmental Protection Agency.

The North Central Expressway park-and-ride lot began operating on November 27, 1973, at a site between the Expressway (US 75) and Coit Road. The lot was previously a 4.5-acre (0.018 sq km) privately owned, partially paved auto distribution center. The city leased the lot and existing building for two years at $60,000 per year. An additional $20,000 was spent to repair the lot and building. This provided a bus shelter, 450 paved parking spaces and considerable unpaved space for additional parking.

TABLE 13: Characteristics of Park-and-Ride Facilities, Dallas, Texas, 1975

Lot Location	Type of Lot Utilized	Parking Cost (Dollars)	Route Distance to CBD		Peak Period		Basic Fare (Dollars)	Express Service	Type of Priority Treatment, If Any	Line Haul Roadway	Daily One Way Ridership (Average)	Lot Capacity/ Autos Parked
			Miles (km)	Minutes	Headways (Minutes)	Ave Speed Mph (km/hr)						
North Central	Drive-In Theatre	0.25	11 (17.7)	20	5	33 (53)	0.50	Yes	CBD Bus Lanes	North Central Expressway (US 75)	829	1000/477
Pleasant Grove	High School Stadium	0.25	8.4 (13.5)	22	15	34 (55)	0.50	Yes	CBD Bus Lanes	City Streets and Freeway (US 175)	292	710/196
Oak Cliff	City Developed Lot	0.25	6.5 (10.5)	22	15	26 (42)	0.50	Yes	CBD Bus Lanes	R.L. Thornton Freeway (I-35 E)	167	625/118

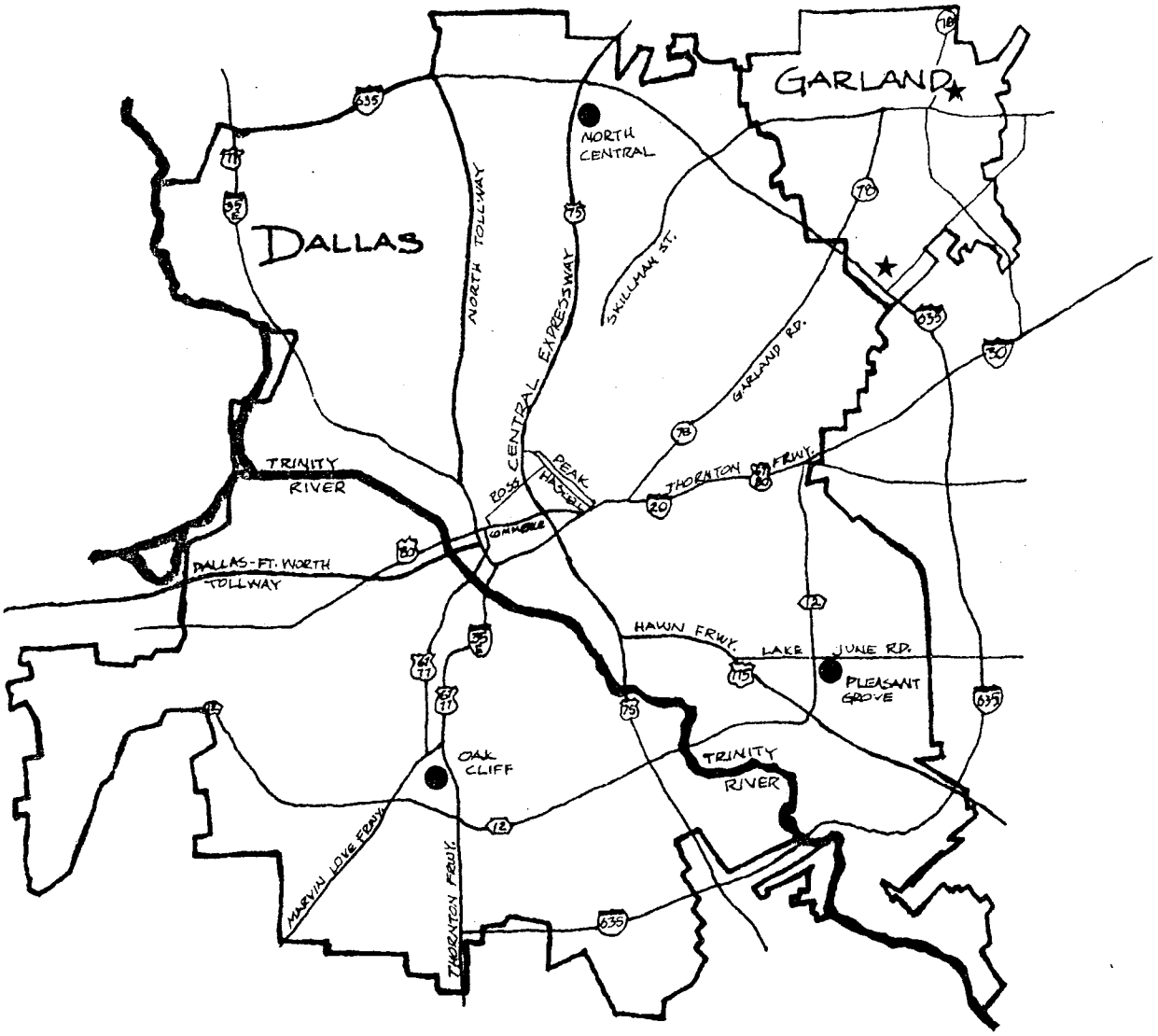


Figure 9: Location of Park-and-Ride Lots, Dallas and Garland

The number of cars parked at the lot immediately exceeded the available paved spaces. During the first three days of operation, 692, 679, and 628 park-and-ride cars were parked in the lot. In response, several hundred additional parking spaces were provided.

When Surtran opened in January 1974 it became apparent that the lot had insufficient capacity to serve both the park-and-ride and the Surtran parking demand. A drive-in theatre lot, located across the Expressway from the original lot, was selected as a new site for the park-and-ride facility. Surtran continued to use the original lot. Service began at the theatre on January 22, 1974, and is still in operation. The theatre parking area is being leased by the city for $24,000 a year.

After the success of the North Central lot, the city began pursuing plans for additional park-and-ride facilities. Service was provided to Pleasant Grove in southeast Dallas on January 23, 1974. A paved high school football stadium parking lot was leased from the Dallas Independent School District for $15,000 per year. Lighting and a shelter were provided at an additional cost of $8,300.

On April 3, 1974, Dallas opened its third park-and-ride lot in the southwest, Oak Cliff section. A 5-acre (0.02 sq km), unimproved tract of land was rented for two years at a cost of $4,017 per month. This amount includes improvement costs which amounted to a total of approximately $50,000. The lot is located adjacent to South R.L. Thornton Freeway (I-35E) just north of Loop

Parking Facility Characteristics

At present, ample parking is provided at the 3 Dallas park-and-ride lots. The North Central lot contains 1000 spaces and approximately 475 of these are used on a daily basis. The Pleasant Grove facility has space for 710 vehicles and approximately 200 cars occupy this lot on a typical weekday. The new

Oak Cliff lot has a capacity of 625 autos and is currently occupied by about 120 autos per day.

Unlike the other Texas park-and-ride facilities, Dallas assesses a 25 cent parking fee per vehicle at each lot. This fee is used to help pay for lot rent, maintenance, and security.

Bus Service

Express bus service is provided from each of the 3 lots to the CBD. A one-way fare of 50 cents is charged. The only priority treatment given to park-and-ride buses is the exclusive bus lanes in the CBD.

Inbound buses start departing from the North Central lot at 6:12 a.m. Five minute headways are provided for most of the period from 6:45 to 8:00, with hourly headways provided during the day until the afternoon peak. The afternoon peak is serviced with buses operating on 5-minute headways. Buses serving the North Central facility primarily use North Central Expressway (US 75) for the 11-mile (17.7 km), 20-minute trip to the CBD. Average operating speed is 33 mph (53 km/hr.).

Bus service to the North Central lot is not a breakeven operation. As a part of the Corridor Demonstration Program, UMTA paid $61,228 for operating losses incurred from July 1, 1974 to June 30, 1975. The City of Dallas is currently paying all operating expenses.

Characteristics of service provided at the Pleasant Grove and Oak Cliff lots are quite similar. At both facilities, bus service begins at about 6:20 a.m. and operates on 15-minute headways for approximately 2.5 hours. No service is provided during the day until afternoon service begins at about 4:00 p.m., operating on 11- to 20-minute headways for approximately 2.5 hours.

The Pleasant Grove lot is located 8.4 miles (13.5 km) from the CBD. Buses require 22 minutes to complete the trip, averaging 34 mph (55 km/hr.).

The Oak Cliff lot is 6.5 miles (10.5 km) from the CBD. Route time from the lot to downtown is 22 minutes, averaging 26 mph (42 km/hr.).

Ridership Characteristics

Ridership on the various Dallas routes fluctuated initially but has remained reasonably stable since September 1974. Trends in ridership at the Dallas lots are presented in Figure 10.

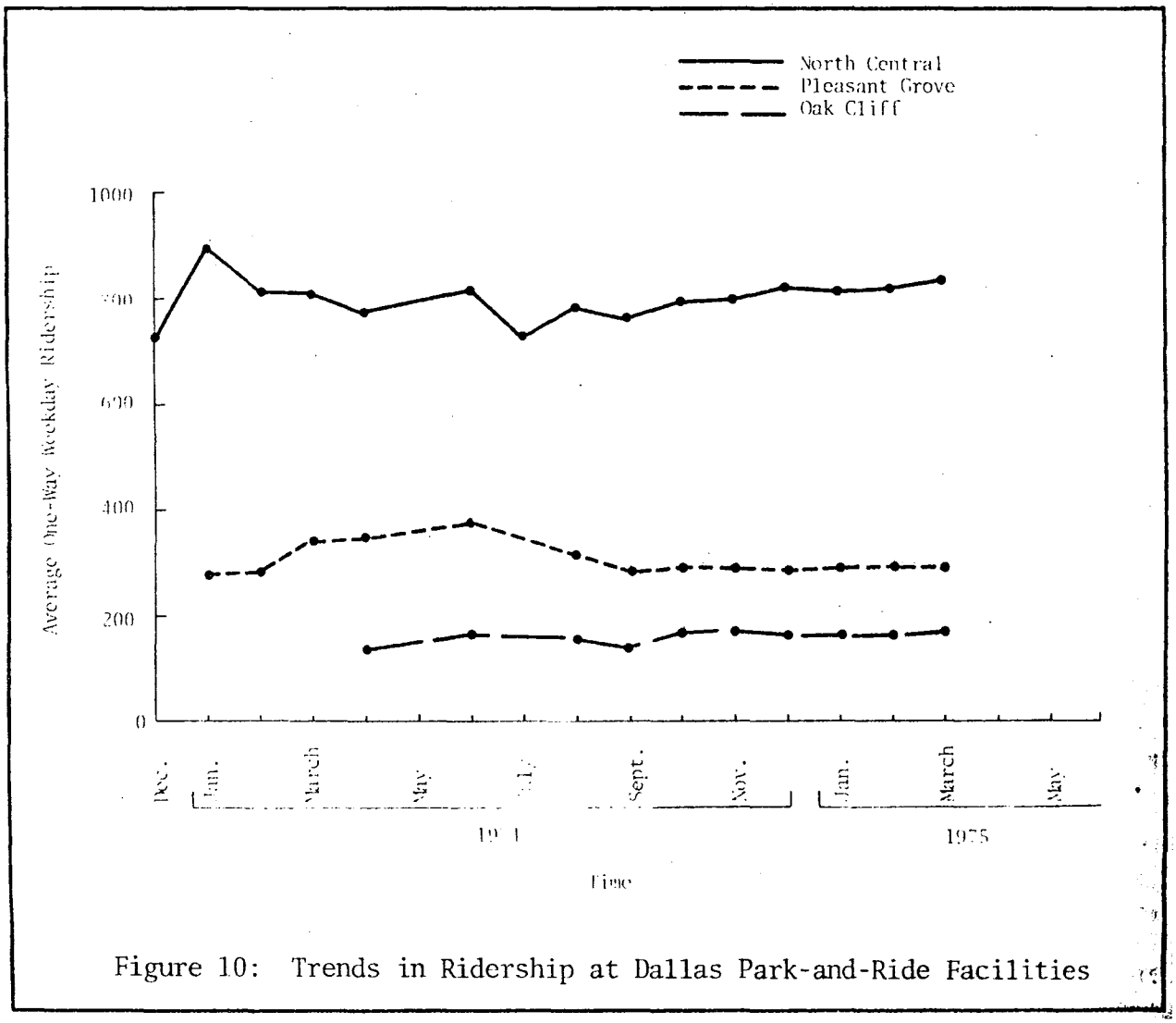


Figure 10: Trends in Ridership at Dallas Park-and-Ride Facilities

Dallas has conducted two ridership characteristic surveys at the North Central facility and one survey for the entire park-and-ride system. The "typical" park-and-ride patron is married, between 35 and 65 years old, lives within 5 miles (8 km) of the lot, and owns two or more cars. Sex varied by lot, with 78 percent of the Pleasant Grove users being female and 61 percent of the north Central users being male.

The income of patrons also varied by lot. This information is summarized in Table 14.

Table 14: Income Characteristics of Dallas Park-and-Ride Patrons, Percent

Annual Income Range (Dollars)	Combined Data for 3 Lots	North Central Lot
0 - 10,000	43	29
10,000 - 20,000	41	46
over 20,000	16	25

Other significant ridership characteristics determined from the North Central surveys are itemized below.

- 87 percent of the trips being served are work trips.
- 85 percent of the inbound riders board the bus between 6:15 a.m. and 8:45 a.m.
- The "average" patron lives 4.54 miles (7.3 km) from the lot and 75 percent of the riders live within 5 miles (8.0 km) of the lot.
- 83 percent of the riders use park-and-ride five days per week.
- Convenience is listed as the primary purpose for using park-and-ride.

Future Plans

The North Central lot was originally designed to be a combined park-and-ride/Surtran lot. Since the combined demand was greater than anticipated, it became necessary to operate two separate lots to serve these needs. Certain economies could be achieved by combining the two lots into one larger lot, and this idea is being actively pursued. The city is planning to purchase a 28-acre (0.113 sq km) site near the LBJ Freeway (I-635) and North Central Expressway (US 75). Total project costs are estimated to be $3.5 million; the city has applied for 90 percent federal financing through the Federal Highway Administration.

Dallas is also considering implementation of up to 8 new lots over the next two years. These lots are part of an 8 terminal park-and-ride sub-regional transportation plan.

Garland, Texas

Garland, a northeast suburb of Dallas, is preparing to open two park-and ride lots (Figure 9, page 37). These lots are presently scheduled to open October 1, 1975. Dallas Transit Service will provide the bus service from these lots to downtown Dallas and will be reimbursed on a guaranteed hourly basis by Garland.

The major lot will be located just north of the Garland CBD at 5th and Walnut. The city purchased approximately 4 acres (0.016 sq km) of land at that site for $217,000. An UMTA grant of $352,000 has been applied for to construct both a 312-car parking area and a 1500 sq ft. (138.0 sq m) bus terminal.

The land for the second lot, located near LBJ Freeway (I-635), has been leased at a nominal fee by Garland for two years. The city, using relatively inexpensive construction techniques, will pave a 300- to 350-car lot on this

land. If, after the two year lease expires, the lot is considered a success, a permanent facility will be provided.

The buses will stop at both of these lots. Direct, express service will be provided from the second lot to the Dallas CBD. A ridership of 800 one-way patrons per day will be required for Garland to break-even financially. Projected characteristics of this service are presented in Table 15.

San Antonio, Texas

San Antonio initiated its park-and-ride service in mid 1974. Two park-and-ride lots were opened, one at the Wonderland Shopping Center and the other at McCreless Shopping Center. Park-and-ride began at Wonderland on March 18, 1974, and is still in operation. The McCreless lot opened July 22, 1974 but temporarily closed in November of that year.

Characteristics of the Wonderland lot are presented in Table 16. The locations of the Wonderland and McCreless lots are shown in Figure 11.

Parking Facility Characteristics

The Wonderland Shopping Center and park-and-ride lot are located at the intersection of Interstate Highways 10 and 410, approximately 7.5 miles (12.1 km) northwest of the CBD. The original Wonderland operation utilized a portion of the existing shopping center lot. However, a separate facility has subsequently been provided for the park-and-ride operation. A 10.43-acre (0.042 sq km) site is being developed in phases. The initial phase consisted of paving 3 acres (0.012 sq. km) at a cost of $150,000; 329 parking spaces were provided. Landscaping and shelter development is expected to cost an additional $60,000. The ultimate parking area will be able to accommodate 1000 vehicles.

The McCreless lot is located on Interstate 37 approximately 5 miles

TABLE 15: Projected Characteristics of Park-and-Ride Facilities, Garland, Texas, 1975

Lot	Location	Type of Lot Utilized	Parking Cost	Route Distance to CBD			Peak Period			Basic Fare (Dollars)	Express Service	Type of Priority Treatment, if Any	Line Haul Roadway	Projected Daily One-way Ridership	Lot Capacity # of Spaces
				Miles	(km)	Minutes	Headways (Minutes)	Ave. Speed mph	(km/hr.)						
Garland Lots	North of CBD	New Construction	Free	18.7	30.0	45	20	25	40	0.75	Yes	CBD Bus Lanes	I-30 I-635	400	312
	Adjacent to LBJ Freeway	New Construction	Free	14.0	22.5	--	20	--	--	0.75	Yes	CBD Bus Lanes	I-30 I-635	400	300-350

TABLE 16: Characteristics of the Park-and-Ride Facility, San Antonio, Texas 1975

Lot Location	Type of Lot Utilized	Parking Costs (Dollars)	Route Distance to CBD		Peak Period		Basic Fare (Dollars)	Express Service	Type of Priority Treatment, If Any	Line Haul Roadway	Daily One Way Ridership (Average)	Lot Capacity # Autos
			Miles (km)	Minutes	Headways (minutes)	Ave Speed mph (km/hr)						
Wonderland Park	City Paved Lot, Adjacent to Shopping Center	Free	7.5 (12.1)	15-20	10-20	25 (40.2)	0.50	Yes	None	Freeway (I-10)	175	329

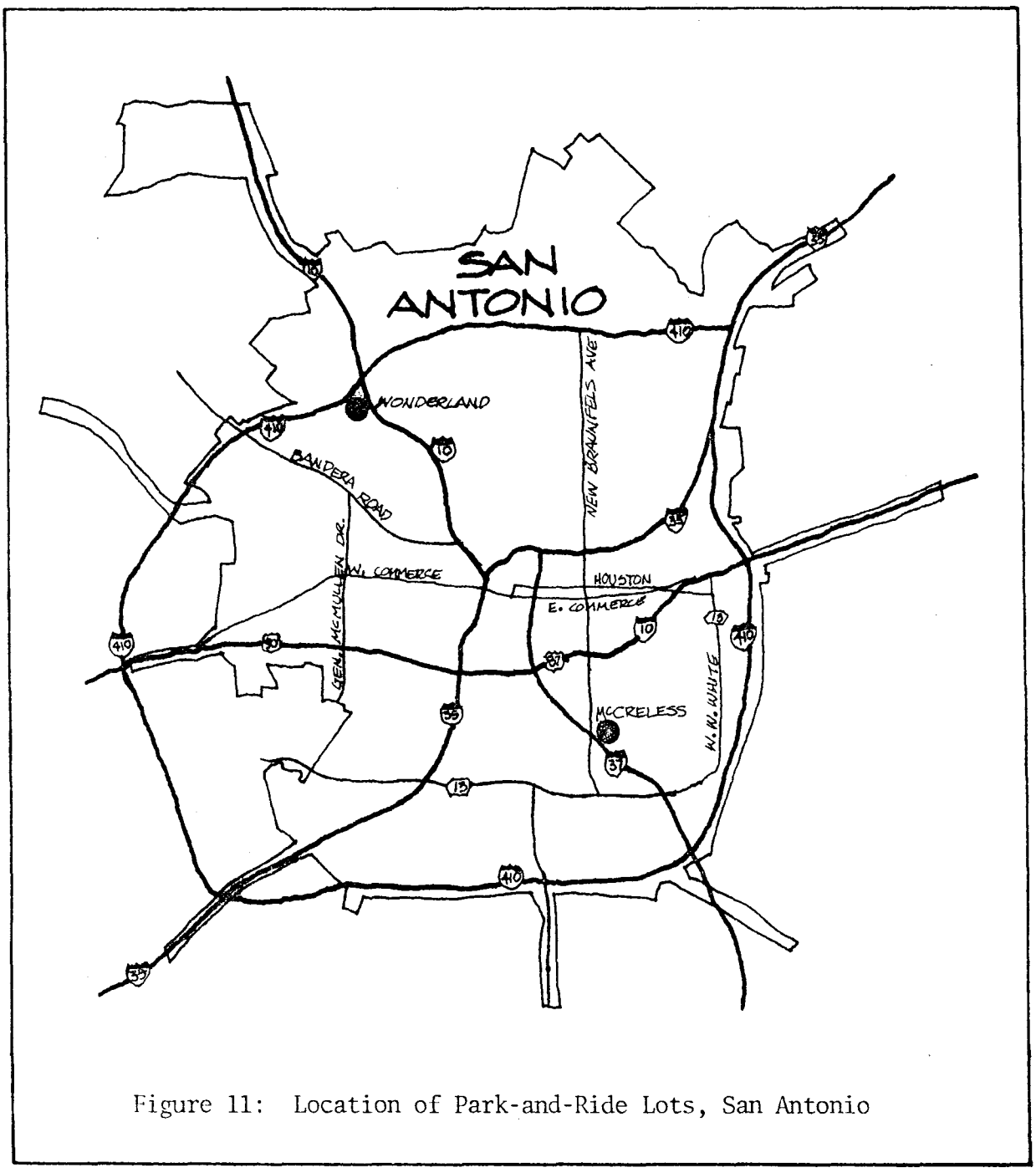


Figure 11: Location of Park-and-Ride Lots, San Antonio

(8.0 km) from the CBD and 21 miles (33.8 km) from the University of Texas at San Antonio (UTSA) campus; bus service was provided from the McCreless lot to both these locations. The McCreless park-and-ride utilized a portion of the existing shopping center lot.

Due to low ridership the McCreless park-and-service was terminated in November 1974. The following factors contributed to the low ridership.

- UTSA did not open in 1974 and, consequently, student ridership did not develop.
- Interstate 37 is a new, 8-lane facility with relatively little congestion.
- The lot may have been located too close to the CBD (5 miles, 8 km).

The McCreless service is scheduled to reopen in September 1975 when UTSA opens.

Bus Service

San Antonio Transit provides express bus service from the Wonderland lot to the CBD. One-way bus fare is 50 cents. Eleven buses depart from the Wonderland lot between 6:38 a.m. and 9:15 a.m. and 12 return trips are made between 3:15 p.m. and 6:15 p.m. The 15-to 20-minute trips depart on headways of 10 to 15 minutes. The Wonderland buses operate primarily on Interstate 10 at average speeds of approximately 25 mph (40.2 km/hr.).

Ridership Characteristics

During Wonderland's first 4 months of operation at the temporary lot, weekday one-way ridership ranged between 193 and 207 riders. Construction inconveniences reduced this ridership; current ridership (June 1975) is 175 daily one-way riders and is increasing slowly.

San Antonio conducted two surveys of ridership characteristics. The

major findings are listed below.

- All respondents indicated that park-and-ride is serving the work trip.
- All patrons arrive at the park-and-ride lot by an auto oriented mode; 77 percent use park-and-ride while 23 percent use kiss-and-ride.
- 77 percent of the patrons use the park-and-ride service on a daily basis.
- 56 percent of the riders are male.

Future Plans

In addition to expanding the Wonderland service and reopening the McCreless route, San Antonio is planning to expand park-and-ride to other areas of the city. Two additional sites are presently being evaluated, and San Antonio Transit foresees a need for an additional 2 to 3 more park-and-ride facilities in the more distant future.

Summary and Comparison of Texas Park-and-Ride Data

Four major Texas cities (Fort Worth, Austin, Dallas and San Antonio) have already implemented park-and-ride service. A fifth city (Garland) is preparing to open two park-and-ride lots. This experience with this form of transit has demonstrated that park-and-ride operations have applications in Texas cities.

Capital Intensiveness

Park-and-ride systems are non-capital intensive in nature. However, as illustrated by the Texas experience, park-and-ride systems can be operated in alternative manners that require varying amounts of capital investment.

The Fort Worth operation is representative of a minimal capital investment system. Businesses and churches are allowing the city to use parking facilities at no cost. These lots are located adjacent to existing local bus routes, and the local buses make an additional stop to serve the park-and-ride lot. Thus, this system fully utilizes both existing parking areas and transit equipment. However, this low capital approach does not appear to maximize ridership. Express bus service is generally not available and bus headways are relatively long at many of the lots.

The operations in Austin are representative of a somewhat more capital intensive system. Austin, like Fort Worth, utilizes existing parking areas that are provided to the city at no cost. However, Austin provides express bus service from the park-and-ride lots to the destination points. Thus, unlike Fort Worth, Austin is committing a portion of its transit fleet to park-and-ride service during peak periods.

Dallas is similar to Austin in that it provides express bus service

from the park-and-ride lots to downtown. However, unlike Austin and Fort Worth, Dallas is paying lease fees for all of its lots. In some instances Dallas spent rather substantial sums of money to upgrade the parking facilities.

The park-and-ride service in San Antonio and the proposed service in Garland are representative of a still more capital intensive system. In these cities, rather than utilizing existing parking areas, an optimal location for a park-and-ride facility was determined. The cities proceeded to procure land at these sites and develop new parking facilities. Express bus service is provided from these new lots to the destination points.

To date, rather minimal efforts have been made in Texas to provide priority treatment for the buses on the line-haul portion of the route. Provision of priority treatments such as exclusive bus ramps, bus lanes, and signal preemptions represents the next higher level of capital intensiveness. The highest level of capital intensiveness for a park-and-ride system would consist of new parking areas developed exclusively as park-and-ride lots and served by express bus service that is being afforded priority treatment for the line-haul portions of the routes.

Ridership

Ridership at park-and-ride facilities varies substantially both within and between Texas cities. At present, approximately 2100 Texans are using the available park-and-ride service on a typical weekday. Over 60 percent of this ridership is being generated in Dallas (Table 17).

The ratio of park-and-ride patrons generated per parked vehicle in Dallas is approximately the same as the U.S. value. In general, total one-way ridership from a park-and-ride lot is approximately 50 percent greater than the number of parked vehicles (Table 18).

Table 17: Summary of 1975 Park-and-Ride Ridership in Texas

City	Average Weekday Ridership (One-way)
Fort Worth (16 lots)	∿300
Austin (3 routes)	310
Dallas (3 lots)	1288
San Antonio (1 lot)	175
TOTAL	2073

Table 18: Relationship Between Parking and Ridership at Park-and-Ride Lots

Park-and-Ride Location	Average Daily One-Way Ridership	Vehicles Parked	Park-and-Ride Patrons Per Parked Vehicle
Seattle Blue Streak	780	525	1.5
Hartford, Conn.	250	150	1.7
Richmond, Va.	550	337	1.6
Milwaukee (data for 6 lots)	1167	401	2.9
Dallas, Texas			
North Central	829	477	1.7
Pleasant Grove	292	196	1.5
Oak Cliff	167	118	1.4

Ridership Characteristics

Ridership surveys have been performed in both Dallas and San Antonio. It appears that ridership characteristics in Texas are similar to those in the rest of the United States (Table 19).

Table 19: Ridership Characteristics in the U.S. and Texas (Data expressed in percent)

Characteristic	Representative* U.S. Value	Dallas	San Antonio
Trip Purpose			
Work	90	87	100
Mode of Arrival At Lot			
Auto Oriented	87	--	100
Drove	56	--	--
Passenger	14	--	--
Kiss-n-ride	17	--	23
Frequency of Use			
5 round trips/wk.	74	83	77
Distance from Park-and-Ride Lot			
0-5 Miles	82	75	--
Annual Income			
0-$10,000	--	28	--
0-$12,000	21	--	--
Over $10,000	--	72	--
Over $12,000	79	--	--
Percent of Riders Owning Two or More Automobiles	63	73	--

*Averages of data presented in Tables 2, 3, 4, 5, 7, and 8.

CONCLUSIONS

Park-and-ride represents an alternative means of providing mass transportation. Many of the characteristics associated with park-and-ride are compatible with urban development patterns in Texas, and park-and-ride service has proven that it can be successfully implemented and operated in Texas cities. Some Texans will quit using their private autos to take advantage of park-and-ride service. Although park-and-ride is non-capital intensive, the Texas experience has demonstrated that several alternative approaches can be pursued in implementing and operating park-and-ride service.

Presently park-and-ride operations exist primarily in large cities and serve large, intensely developed central business districts. Consequently, the characteristics of park-and-ride patrons are also the characteristics of the types of individuals that tend to work in the CBD. Although service to large CBDs is probably the primary application of park-and-ride, other applications also appear to exist. Other major employment and activity centers may be conducive to service by park-and-ride; Austin provides park-and-ride service to both the IRS Complex and the University of Texas. Smaller urban areas with large developments such as universities may find applications for park-and-ride. In general, to date, little innovation has been pursued in planning and implementing park-and-ride facilities, and a great deal of potential for innovation appears to exist.

Thus, in considering future park-and-ride applications, the range of potential offered by this form of transit service needs to be considered. At present, individuals apparently are using park-and-ride because they perceive it to be either more convenient or economical. However, changing conditions may cause a great many more individuals to view park-and-ride as

the desired travel mode. For example, it appears that all the events itemized below are, to some extent, occurring, and all should encourage additional usage of park-and-ride.

- Parking costs in activity centers are increasing and relative parking availability decreasing. Some cities, such as Dallas, plan to build no additional parking in the core of the CBD.
- Fewer new roadways are being built and more attention is being given to increasing the person movement capability of existing roadways.
- Park-and-ride service is more fuel efficient than is the private auto and, thus, it offers an alternative means of travel if energy availability and/or cost create major problems.
- The costs of owning and operating a private automobile are increasing.

At present, little methodology has been developed that can be used in planning future park-and-ride facilities. It is postulated in the literature that a large number of factors may affect the success of a park-and-ride facility; for reference purposes a list of these factors is included in Table 20.

However, although many factors may affect the success of a park-and-ride facility, the relative importance of the various factors is presently unknown. Additional research is required to develop planning methodologies and procedures that can be used in determining the feasibility of additional park-and-ride facilities.

Table 20: Planning and Design Considerations for Park-and-Ride Facilities

Transit Service at the Park-and-Ride Facility

- Length of Headways Provided
- Cost of using transit relative to cost of using the private auto (including parking costs)
- Transit travel time relative to auto travel time
- Cost of providing transit service
- Availability of express bus service
- Availability of off-peak bus service
- Transit fare collection procedure
- Availability of alternative transit service
- Seat-for-all policy
- Provision for transfer to other transit routes
- Marketing program

Parking Facility Considerations

Location

- Lot location relative to location of activity center
- Surrounding land use and the environmental impact on that land use
- Cost of developing the lot and making necessary improvements to the adjacent streets
- Potential for serving travel demand to more than one activity center
- Existing traffic congestion in the area
- Accessibility to the lot by all applicable modes
- Distance and travel time from the lot to the line-haul transit route
- Time required to implement park-and-ride lot
- Potential for joint use with other transportation services
- Compatibility with long-range transportation plans
- Sufficient land area for lot to offer expansion flexibility
- Distance to nearest alternative park-and-ride location
- Visibility of lot

Operation

- Availability of terminal and waiting area
- Assessment of a parking charge
- Security
- Lighting
- Paving, marking, landscaping
- Maintenance
- Simple, uncomplicated circulation design
- Separation of bus and auto movements
- Walking distance to bus boarding area

Conditions at the Activity Center

- Parking--Cost, availability, and location
- Number of individuals employed
- Volume/capacity ratio for thoroughfares within activity center
- Walking distance from park-and-ride stops to places of employment

Characteristics of the Corridor Served by Park-and-Ride

- Population
- Density of trips destined to the activity center (generally work trips)
- Socioeconomic "homogeneity" of the park-and-ride draw area
- Traffic conditions on line-haul facilities within corridor

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