PLANNING CRITERIA FOR EXPRESS BUS-FRINGE PARKING OPERATIONS

Volume I

of

Express Bus-Fringe Parking Planning Methodology

by

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and

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Virginia Highway & Transportation Research Council
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ABSTRACT

Tripmaker reactions to two recent express bus-fringe parking operations in Richmond and Norfolk-Virginia Beach, Virginia, are examined. This travel behavior is interpreted to establish planning and design guidelines for locating and designing fringe lots and establishing operational policy for associated bus services. A market area for each service is defined in view of residential accessibility to the terminal. The primary improvements to the service that were suggested by automobile travelers who were surveyed related to the level of service provided; specific improvements here included expansion of the service area and hours of operation. The transit riders cited comfort and system design features for upgrading the service to their standards as their primary recommendations.

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INTRODUCTION

This report describes tripmaker reaction to two recent express bus-fringe parking services in Virginia – the Parham Express in Richmond and the Plaza Express in the Virginia Beach-Norfolk area. Travel behavior is interpreted to establish planning and design guidelines for locating and designing fringe lots and establishing operational policy for associated bus services. Volume II of this study report, entitled "Demand Estimation for Express Bus-Fringe Parking Services," describes the derivation of mathematical models of the demand for the service as a function of the accessibility of the lot to residential areas, tripmaker characteristics, and the dimensions of alternative travel choices. The findings reported here were employed to establish the major hypotheses necessary for developing models.

SCOPE OF STUDY

A previous study by this organization summarized the state of the art of planning tools that can be applied to assist in developing express bus-fringe parking transit operations.[1] Many reports are available which describe recent experiences with express bus-fringe parking operations.[2,3,4,5,6,7] Also, the state of the art of traffic engineering measures for increasing the efficiency of bus use of highways has been reported.[8]

The literature reveals that a formalized planning strategy for new express bus-fringe parking services must consider the definition and characteristics of the market area, the location and design of the parking facility, and level of service provided by all modes serving the destination(s) under consideration, particularly the express bus. Accordingly, the planning guidelines that are recommended in this report refer to these three primary areas of analysis and provide a consensus among those found in the literature and the case study findings.

The tripmaker data which describe two Virginia experiences with fringe parking services were obtained for both the Parham Express and the Plaza Express by sampling the users of the transit service and automobile travelers who entered the expressway in the vicinity of the facilities' parking lots. The questionnaires employed are shown in a prior report[1] and Volume II of this study.

CASE STUDIES

Corridor and Service Descriptions

The corridor is used to define the subarea served by a particular express bus-fringe parking service. A corridor is defined as a set of opportunities located along and at the extreme points of a major transportation (highway) link. Included within this areal specification are those areas whose development is influenced by the existence of corridor related opportunities and/or transportation facilities. The subareas served by the Parham Express and the Plaza Express are described on the basis of the corridor.

The Parham Express

The corridor associated with the Parham Express is shown in Figure 1. This spine of development follows Broad Street (U.S. 250) and I-64 northwest from the city of Richmond into Henrico County, where the developed area extends circumferentially for about 11 miles. The portion of the corridor located within the Richmond city limits is predominantly a mixture of industrial and commercial areas, the latter being concentrated along Broad Street. In Henrico County, the land use is residential with apartment buildings and single-family units. No significant transit service has been available to the residents of Henrico County in recent years.

The Parham Express originates at a recently constructed fringe parking facility located 8.9 miles (13.9 km) northwest of downtown Richmond (Figure 1). The land use in the vicinity of the lot consists of single-family residential units with a scattering of apartment buildings and small shopping areas.

Access to downtown Richmond from this section of Henrico County is provided by I-64, with entrances at Parham Road and at Glenside Drive, and by arterial streets — Broad Street (U.S. 250) and Patterson Avenue (Va. 6). Trips via the interstate pay a toll of 25 cents. Motorists using the arterials encounter heavy congestion during peak periods. In the vicinity of the lot, Parham Road is a major arterial connecting western Henrico County with the I-95 corridor and serves as both a connector and a primary local service street. During the peak hours, traffic congestion causes significant delays at several intersections and at the entrance to I-64.

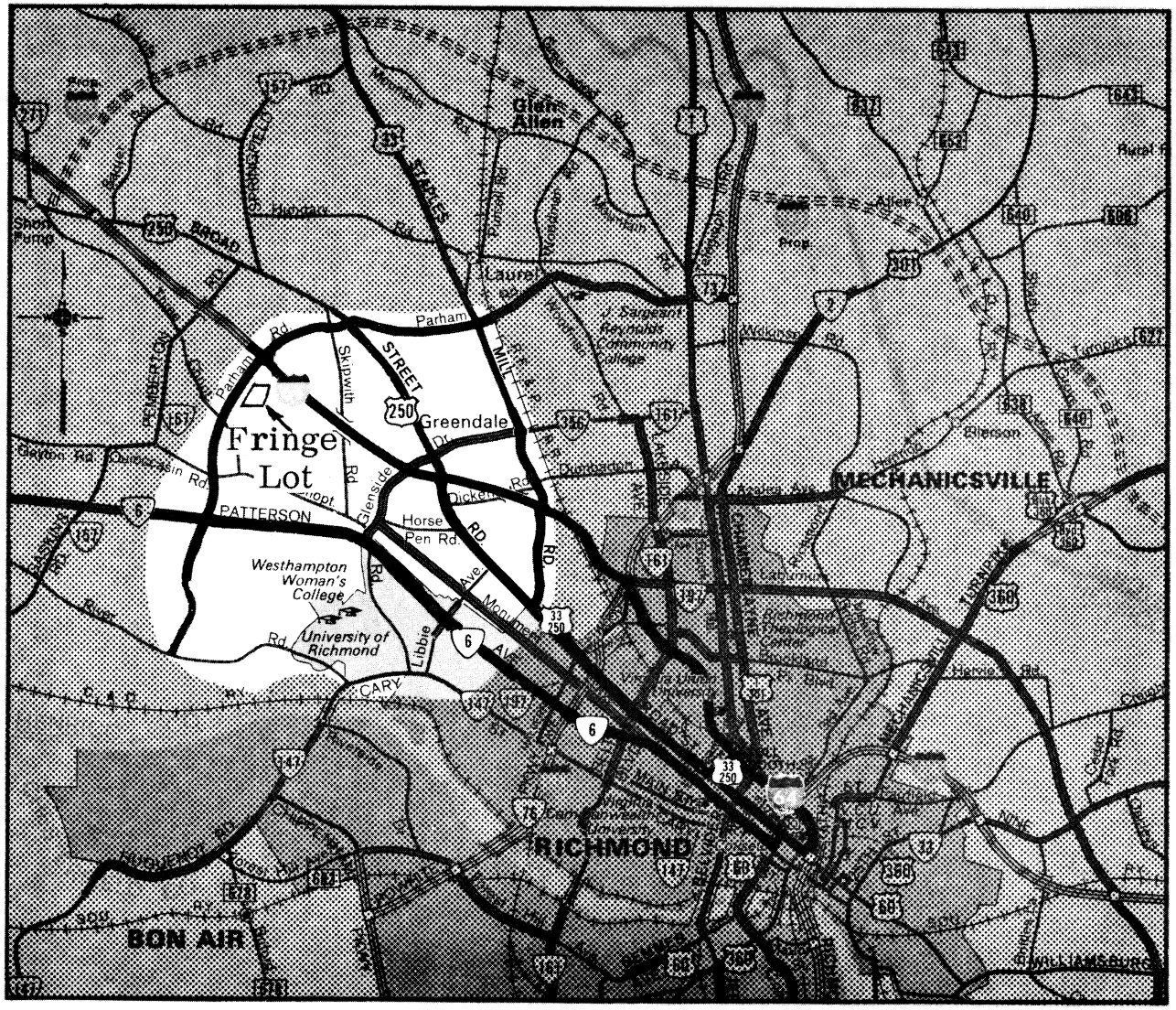


Figure 1. Parham Express service area.

The Parham Express began service on 2 July 1973 with 178 parking spaces and six bus trips in both the morning and evening peak periods, and provides nonstop service via I-64 and I-95 to downtown Richmond, where it loops through the central business district (CBD). The parking capacity of the lot was subsequently expanded to 337 spaces and the service increased to fourteen trips per peak period. The one-way fare for the Parham Express is 50 cents as compared to the regular city bus fare of 35 cents.

The Plaza Express

The corridor served by the Plaza Express is shown in Figure 2 and extends approximately 20 miles (32 km) from the oceanfront to downtown Norfolk. This corridor centers around Virginia Beach Boulevard (U.S. 58) and the Norfolk-Virginia Beach Expressway (Va. 44). The Boulevard is best described as a strip of commercial development with adjacent residential areas. Virginia Beach has no CBD as its non-residential activities are clustered in several dispersed areas. The major commercial areas within Virginia Beach include the strip along the Boulevard, the resort area along the oceanfront, and the Civic Center at Princess Anne Court House. The majority of work trips originating within Virginia Beach head toward employment concentrations in Norfolk and Portsmouth. Within the Virginia Beach city limits there are large employment centers at the Oceana Naval Air Station, Little Creek Amphibious Base, and Fort Story. Another major attractor of work trips is the main Naval Operating Base and Naval Air Station at Sewell's Point. The downtown area of Norfolk is much smaller than Richmond's and is in reality a secondary employment center. In this respect, the aforementioned corridor running from Virginia Beach to Norfolk branches at I-64 toward the naval facilities.

Access from Virginia Beach to downtown Norfolk is provided by two parallel highway facilities, Virginia Beach Boulevard (U.S. 58) and the Norfolk-Virginia Beach Expressway (Va. 44). Virginia Beach Boulevard is a four-lane divided arterial highway having a two-way service road on each side and very little access control. Because of heavy traffic and other impedances, the travel time between Princess Anne Plaza and downtown Norfolk via this route is close to one hour. The Expressway is a four-to-six lane freeway with full access control which consumes only one-half the time as Virginia Beach Boulevard does to travel to Norfolk. The segment of this highway within Virginia Beach is a toll facility. A trip to downtown Norfolk which enters the toll road at or east of Rosemont Road pays a toll of 25 cents, while those entering at Independence Boulevard or Witch Duck Road pay a toll of 10 cents. Consequently, the average daily traffic (ADT) on Virginia Beach Boulevard drops by almost 5,000 vehicles east of Independence Boulevard.

The Plaza Express provides peak hour express service from Princess Anne Plaza, a shopping center located 11 miles (17.6 km) from downtown Norfolk to the Norfolk CBD. This service was instituted on September 17, 1973, when 125 parking spaces were provided behind Princess Anne Plaza for commuters along with five bus trips in both the morning and evening periods. The initial daily ridership averaged 100 riders and had increased to 180 by December 10, 1973, at which time service was suspended due to a strike against Carolina Trailways, operator of the Express service. The service was routed on the Norfolk-Virginia Beach Expressway and the downtown Norfolk area. Since there is no entrance to the Expressway at Plaza Trail, the buses used Virginia Beach Boulevard for about 0.5 mile (0.8 km) to Rosemont Road, where they entered the toll road. The fare for a one-way trip was 60 cents with books of commuter tickets reducing this to 40 cents, a fare structure in line with those of prior operations in the area.

Figure 2. Plaza Express service area.

Data Analysis

Identification of the Market Area

An accurate estimate of the patronage for a subarea service requires a specification of the market area. The market area for an express bus operation is defined as the geographic area whose residents are potential users of the service. The express bus trips described by the Parham Express data originated from thirty zones surrounding the fringe parking lot, but only twelve exhibited a substantial number. Accordingly, the market area for that service is shown by the zones underlined in Figure 3 and accounts for 78.9% of the auto and 84.2% of the express bus trips that were surveyed. Table 1 illustrates the modal split between auto and express service in these zones for trips to the Richmond CBD.

The effects of zonal access to the lot are reflected in a number of ways. Zones 360 and 373, which are closest to the lot, account for all trips that access the lot via walking (19.4% and 12.5% of the express bus riders residing in zones 360 and 373, respectively), and exhibit relatively high transit usage factors of 0.36 and 0.28.

The minimum path from zone 371 to the CBD passes in very close proximity to the fringe lot and has a typically high transit split of 0.34 (the average is 0.20). Zones 381 and 372 exhibited similar characteristics and had modal split ratios of 0.22-0.78 and 0.20-0.80, respectively.

Zones 349 and 358 have minimum paths which run at a considerable distance from the lot due to their geographic location. Only 11% of the auto trips originating at zone 358 entered I-64 eastbound at Parham Road. The remaining 89% and all of the auto trips originating at zone 349 took Glenside Drive to enter I-64, which indicates that the fringe lot was highly inaccessible from zones 349 and 358. This fact is also supported by very low transit split figures of 0.07 and 0.10 for these respective zones.

The preceding analysis shows that the users of the express bus experience varying levels of service depending on the accessibility of the fringe parking lot from their residential zones. In this respect, the residential zones of the market area can be placed into accessibility levels 1, 2, and 3 based on the following criteria:

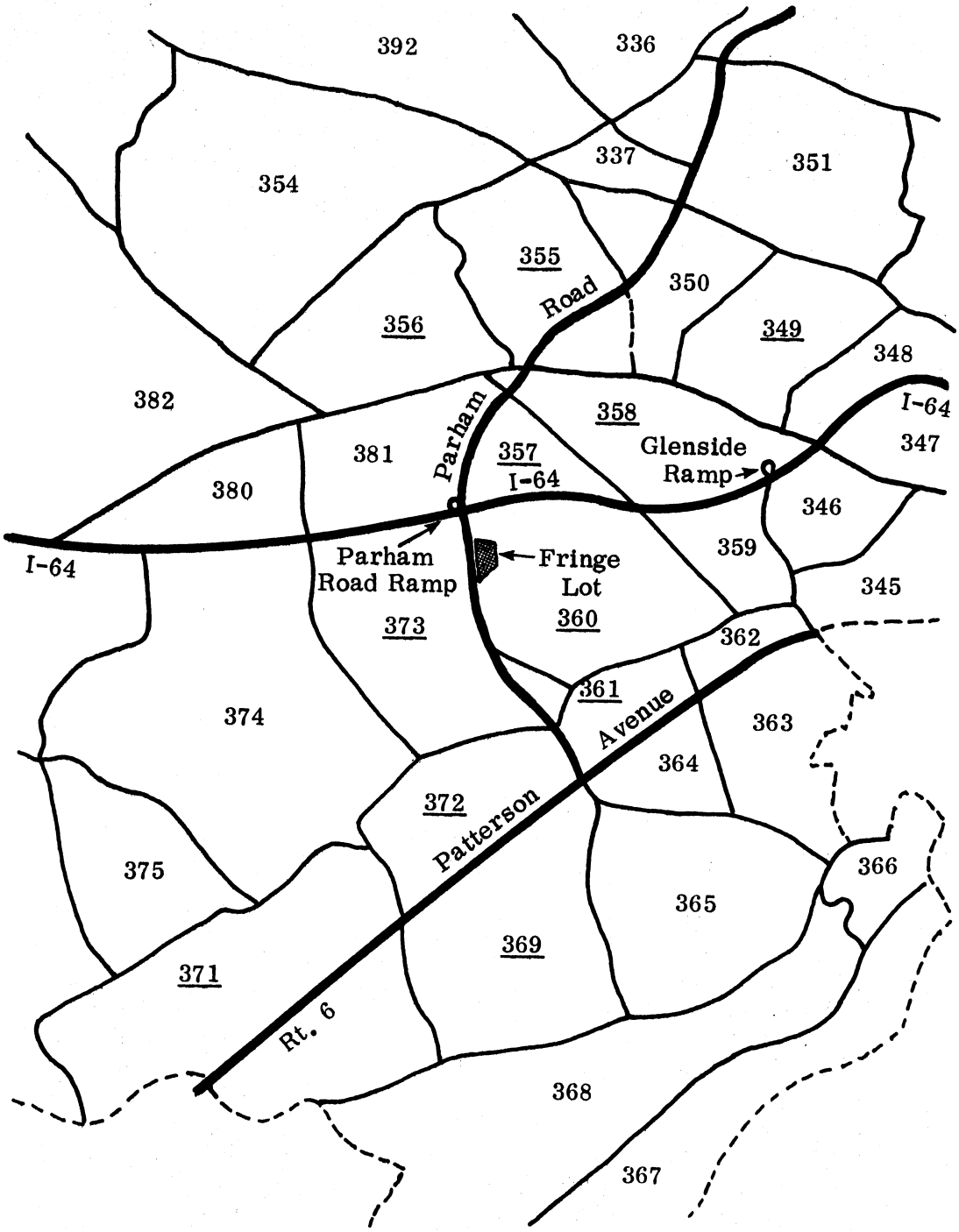
1) The zone is located adjacent to the zone with the lot;

2) the zone's minimum time route to the CBD falls in close proximity to the fringe lot; or

3) the lot is out of the way of the best route to the CBD from the residential zone.

Analysis of the data showed that accessibility of the fringe lot was highly related to the zonal transit usage, as relatively high transit split figures were indicated for zones to which the fringe lot was convenient.

In the Virginia Beach case, the primary market area for the service was composed of the thirteen zones underlined in Figure 4, which accounted for approximately 70% of the auto and bus trips surveyed.



Underlined numbers indicate zones included in the analysis

Figure 3. Parham Express potential market area.

Table 1

Modal Split Between Auto and Express Bus for Trips to Richmond CBD

Origin Zones	Auto Split	Bus Split
349	0.93	0.07
355	0.85	0.15
356	0.89	0.11
357	0.85	0.15
358	0.90	0.10
360	0.64	0.36
361	0.88	0.12
369	0.66	0.34
371	0.66	0.34
372	0.80	0.20
373	0.72	0.28
381	0.78	0.22

Average Auto-Bus Split = 0.80-0.20

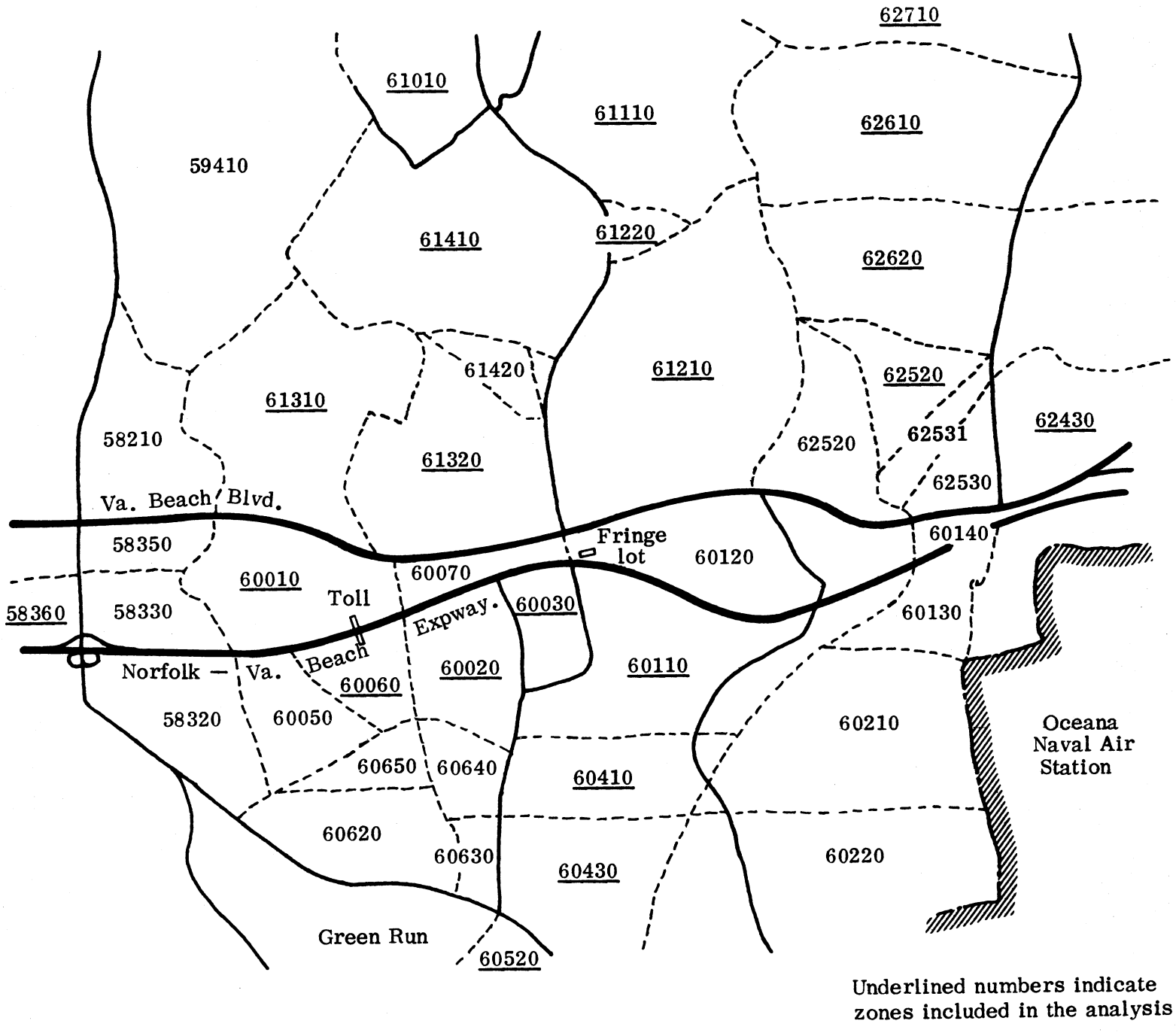


Figure 4. Plaza Express market area.

Travel Behavior

Summary statistics from each site are given in Tables 2 and 3 for the bus and automobile trips. This analysis of the Parham Express data was employed to establish the basic structure of the models reported in Volume II of this study report.

Auto Ownership

Auto ownership per household for those who drive to the CBD does not differ significantly from that of the express bus riders, but the express bus riders have a slightly higher average auto ownership figure.

Sex and Age

Female commuters showed a higher propensity to use the express service than did males. A variation between male and female behavior relative to express bus access was also noted, but to a lesser degree.

The data showed variations in behavior between the (25-44) age group and all other age groups relative to auto and express bus mode split. These variations were less significant in the case of express bus access.

Household Income

There was virtually no difference in the household income distributions of auto and transit commuters. For the Parham Express, both distributions were characterized by very high frequencies at the $12,000+ level and a very low percentage at the $4,000- level. The same observation was true for the access modes. This can be attributed to the fact that the commuters exhibited a homogeneous population in terms of income.

Travel Cost and Time

Auto travel cost figures were estimated by summing the freeway toll (25 cents), one-half of the parking cost, and an assumed operating cost of 4 cents per mile. (In the case where there were passengers, it was assumed that the riders shared the travel cost with the driver.) Transit costs consisted of the 50 cents fixed fare and the cost associated with getting to the lot.

A statistical analysis was carried out to determine if the distribution of travel cost for the bus population was different from that of the auto population. The travel cost figures for the auto sample were highly dispersed with a standard deviation of 29.6 cents, whereas the travel cost values for the bus sample varied only slightly from the average (standard deviation = 4.3 cents). The t and F tests indicated that both the mean and the variance of the bus population were significantly different from those of the auto population at a .01 significance level.

The survey provided information on the perceived time for each trip. A chi-square test was run to compare the auto population and the bus population with respect to perceived travel time. This test indicated a substantial difference in distribution at the .005 significance level. The results of a t test at the .05 significance level further showed that the auto and bus populations also differ with regard to mean values of travel time.

Table 2

Bus Rider Survey Summary

Item	Parham Express	Plaza Express
1. Number surveyed	230	74
2. % Work trips	99.6	97.3
3. % Choice trips	96.5(222)	93.2(69)
4. % Originating in primary market area	81.3	89.2
5. Sex Distribution (%)		
Male	57.1	36.1
Female	42.9	63.9
6. Age Distribution (%)		
16-24	24.5	17.6
25-44	48.0	48.6
45-65	26.7	27.0
65+	0.8	6.8
7. Auto Ownership		
Average number of autos per household	1.87	1.87
Average number of licensed drivers per household	2.33	2.26
8. Mode of travel to lot (%)		
Auto Driver	63.8	60.8
Kiss'n Ride	26.2	31.0
Auto Passenger	3.9	1.4
Walk	4.8	6.8
Bicycle	1.3	—
9. Average Walking time from bus to destination (miles)	2.69	2.08

Note: The data also revealed that the average income for the respondents in the Parham Express was significantly greater than that for the Plaza Express users.

Table 3

Automobile Travel Survey Summary

Item	Parham Express	Plaza Express
1. Number surveyed	1165	899
2. Number of responses with CBD destination	381	149
3. Number responses excluding auto captives	223	78
4. % Work trips	93.8	89.8
5. % Originating in primary market area	78.9	73.8
6. Sex Distribution (%)		
Male	66.7	70.9
Female	33.3	29.1
7. Age Distribution (%)		
16-24	11.9	12.1
25-44	51.9	61.3
45-65	34.1	25.6
65+	2.1	1.0
8. Auto Ownership		
Average number of autos per household	1.95	1.95
Average number of licensed drivers per household	2.24	—
9. Average auto occupancy	1.31	1.23
10. % Traveling alone	80.3	82.5
11. Average daily parking cost ($)		
Total	0.55	0.31
Excluding free parking	0.66	0.51
12. % Willing to use bus service if improvements are made	53.5	38.9

Tripmaker Attitudes

The comments provided by bus riders and automobile users were summarized to determine those transit planning and design factors which influenced travel decisions. Figure 5 summarizes the reasons given by respondents in both case studies for choosing the auto, the most frequent being that the car was needed during the workday. The other factors influencing the automobile mode choice in order of importance were the inconvenience of transit, economy of the auto, inadequate transit service hours, problems relative to the lot location, a general preference for driving, the desire to include other activities with the trip that require stops along the way, and unwillingness to change to the transit mode because of its uncertain future.

The main attractions of the transit service as given in Figure 6 were convenience and economy. Other minor factors included the impact of the energy crisis which occurred during the Virginia Beach survey, dislike for driving in peak hour traffic, and CBD parking problems.

Each automobile user questionnaire provided space for suggested improvements to the transit service which would make that mode an acceptable alternative. In both studies, the primary concerns included the area served by the lot and the hours of service. Regarding the former, better lot locations were cited, as well as a desire for feeder bus services. General system improvements that were cited as desirable included improving the downtown routing, newer equipment, transfer with other transit services, and better conditions at the waiting areas, particularly at the lot. The various improvements cited by the auto user are summarized in Figure 7.

Figure 8 shows the frequency of bus survey responses concerning preferences for service improvements. The system changes cited by the Parham Express users included the need for more buses during the peak and expansion of the off-peak period, a more efficient downtown route, modern equipment, and more amenities for those waiting at the lot. About 50% of the responses from the Parham Express users were directed toward this general category of system-service improvements, while the majority of the people using the Plaza Express (74.4%) cited an expanded service area and publicity as the major needs. This difference in emphasis between areas was indicative of the relative degree of service and community acceptance that can be associated with the two operations. In Richmond, with ten trips in each peak hour, the concern was for additional buses to ease crowded conditions; while in Virginia Beach, where only five scheduled trips provided excess capacity, the concern was with attracting more patrons in order to assure continuation of the service.

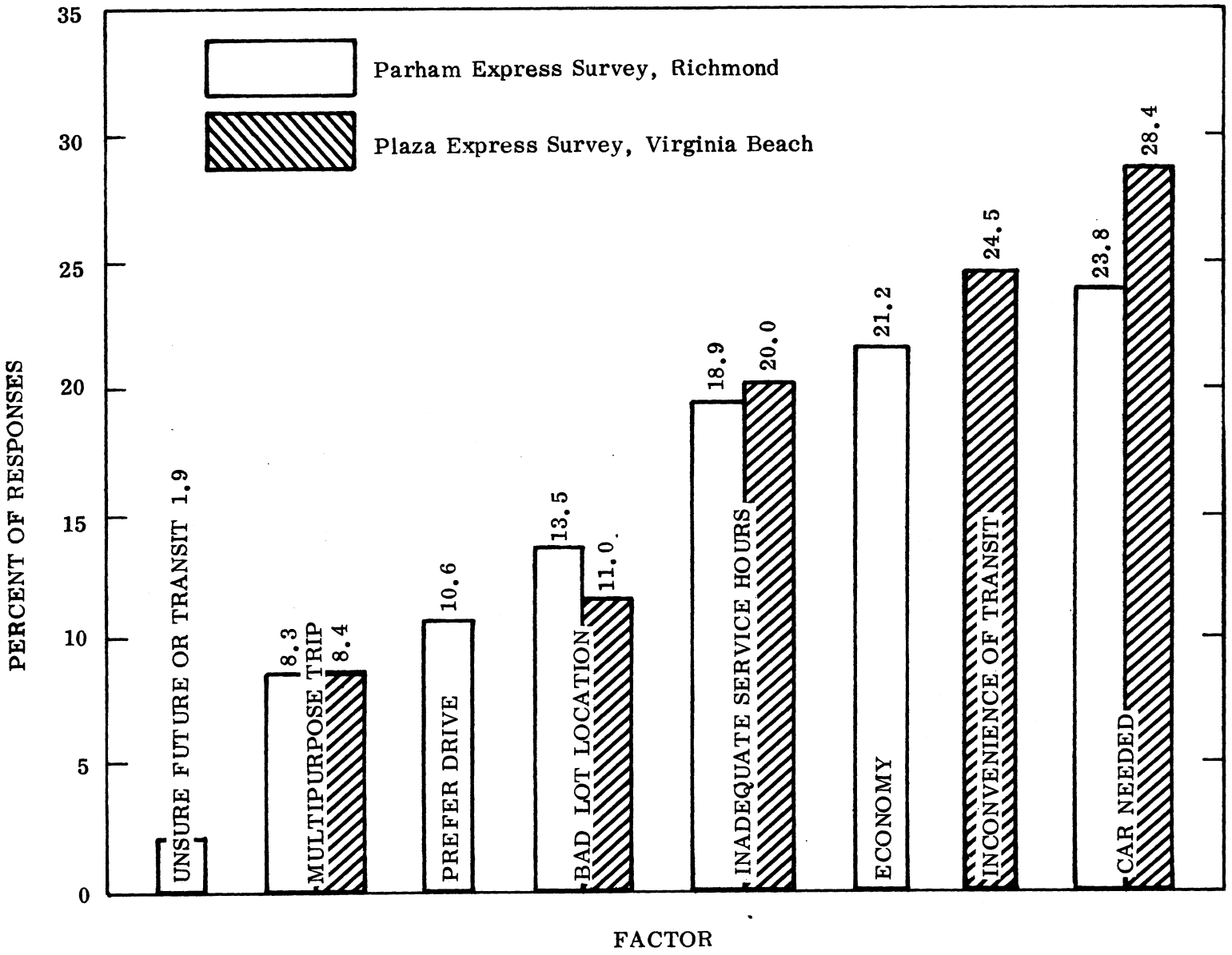


Figure 5. Reasons for driving to CBD.

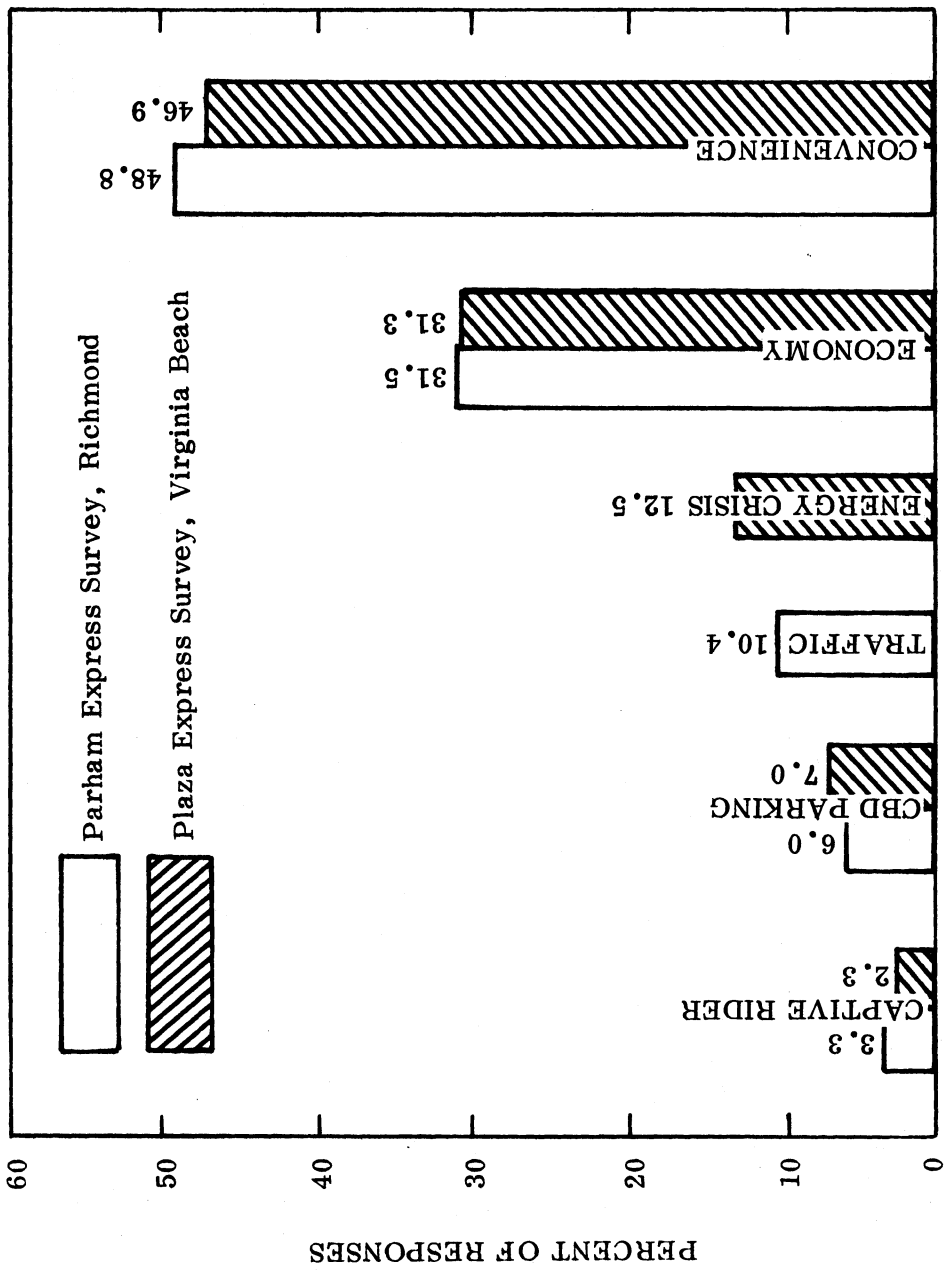


Figure 6. Reasons for using fringe lot.

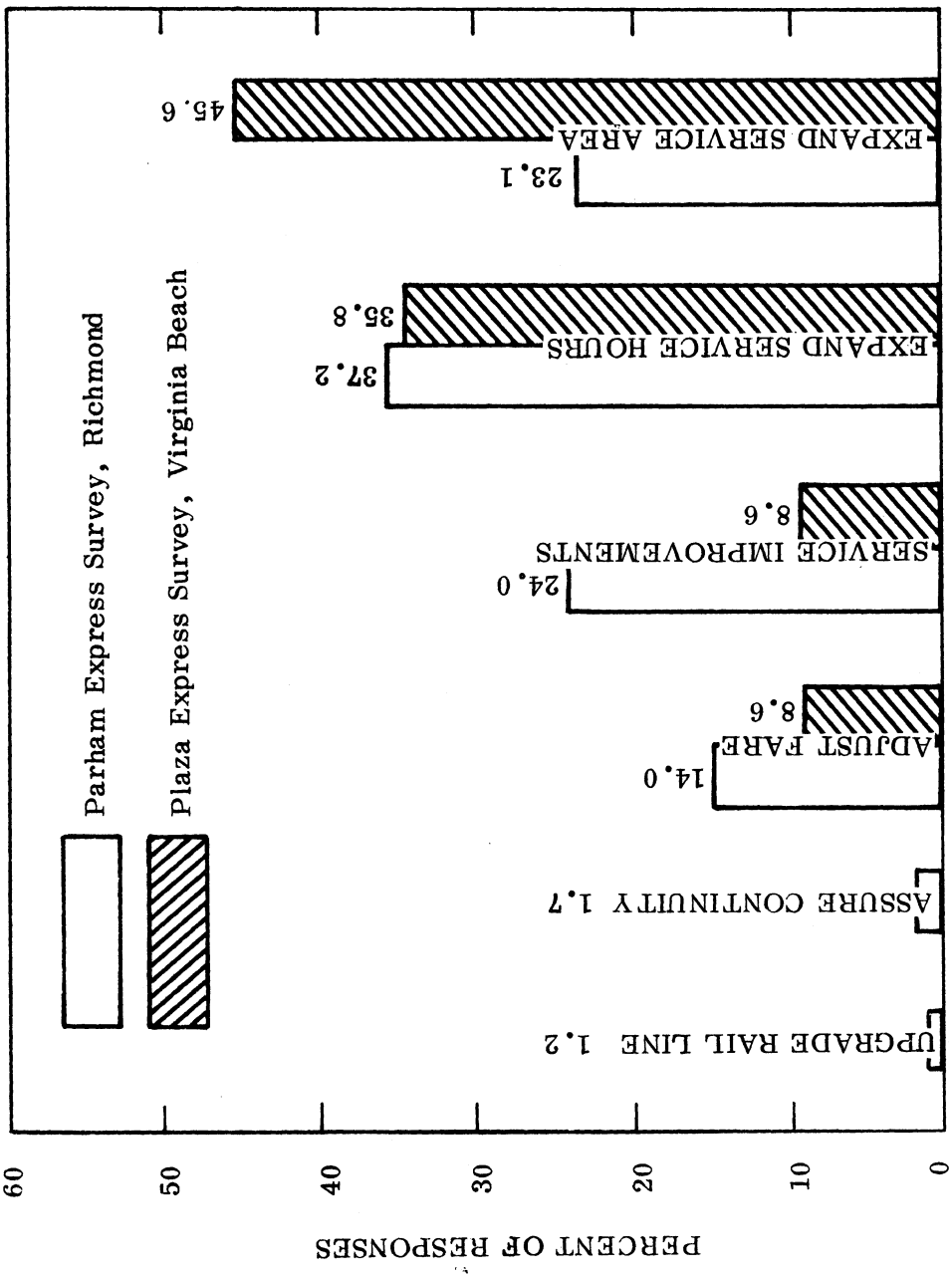


Figure 7. Auto users' suggested improvements.

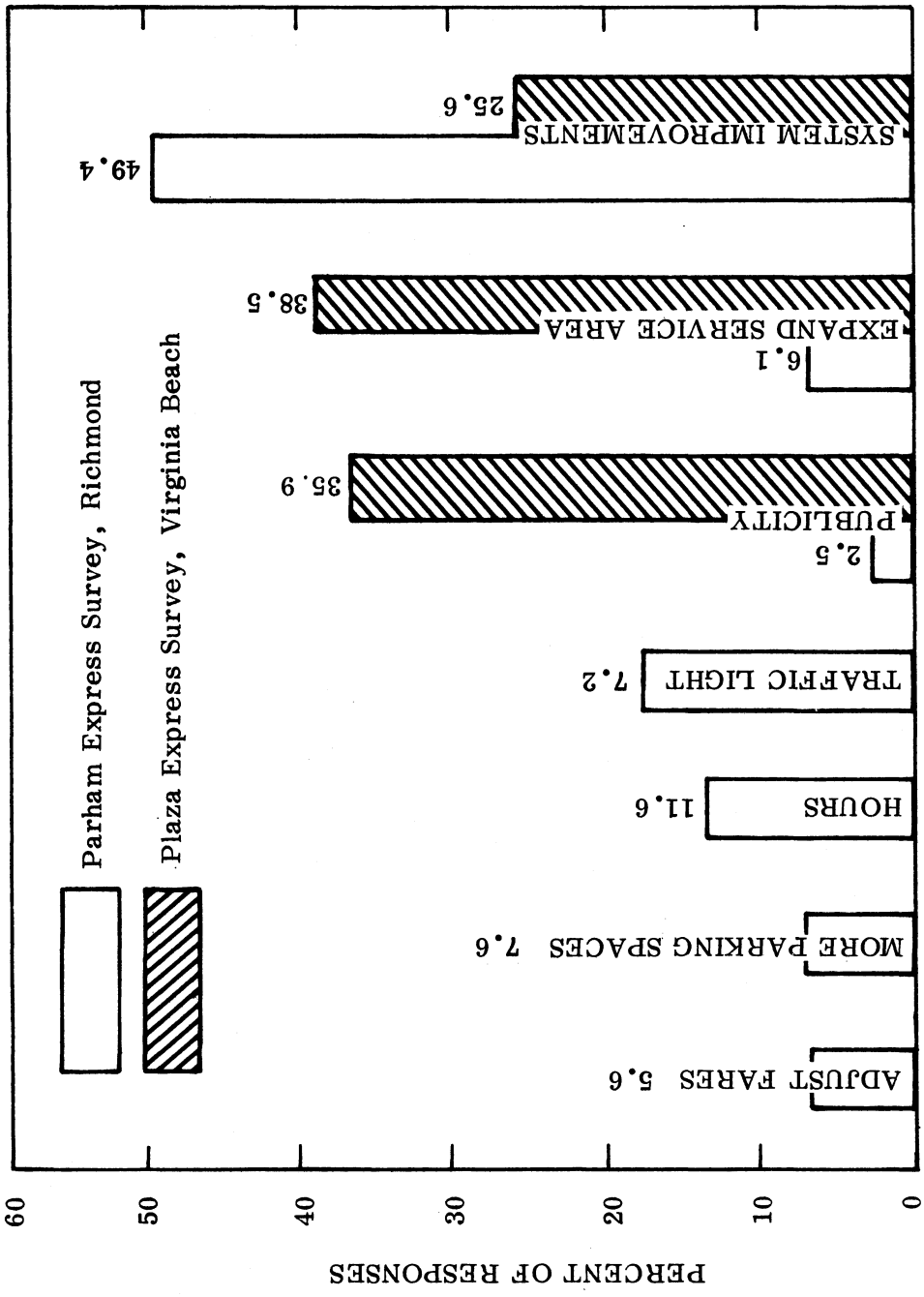


Figure 8. Bus users' suggested improvements.

CONCLUSIONS AND RECOMMENDATIONS

Planning and design concepts for express bus-fringe parking services which have been derived and/or verified through the analysis of two case studies are now presented. Initially, a market area for this subarea service is established that is based on the accessibility of residential zones to the lot. In this manner increasing levels of transit usage can be related to increasing zonal accessibility to the lot and thus provide a measure upon which an evaluation strategy for assessing alternative lot locations can be developed. If there is a large population within zones of high accessibility, then pedestrian and bicycle accommodations should be given high priority in the access and circulation system design. Kiss 'n ride and park 'n ride provisions are the dominant need for the trips from accessibility groups 2 and 3.

Since more females than males used the services that were studied, efforts should be made to market the service to male commuters. Income is seen to be typically homogeneous across a suburban subarea and is important mainly for interarea comparisons. Auto users indicated that the factors which, if improved, may encourage them to switch modes included convenience features, economy, the service period, access to the lot, and stability of the service. However, the transit users stated that the primary reasons for selecting that mode were convenience and economy. These apparently conflicting statements support the conclusion that this type of transit provides varying levels of service to different travel groups. Accordingly, new services should be developed which provide a high level of service to the maximum number of people.

The primary improvements to the service that were suggested by the automobile users related to the service provided; specifically they cited the area of service and the hours during which the bus service operated. This indicates that the level of transit service is perceived as low by the auto users. On the other hand, the transit riders stressed comfort and system design features for upgrading the service to their standards. These factors were also mentioned by the auto users, but as being of secondary importance.

More specific findings concerning aspects of the lot, the transit service, and the study area are summarized below.

1. Lot location

    a) The lot should be located along an established travel corridor.
    b) The lot should be highly accessible by the local and arterial street system.

2. Traffic movement

    a) Vehicle movements into and from the lot should experience a minimum of delay.
    b) The bus route should be free of congestion and priority measures should be taken to eliminate delays.

3. Lot design and associated services

   a) Facilities and services for non-drivers should be provided including bicycle racks, pedestrian access ways, feeder bus service, and kiss 'n ride drop off areas.
   b) Adequate security should be provided for individual safety and safe storage of vehicles. In this respect, the lot should be highly visible to the passing public at all times.
   c) A pleasing lot environment should be provided and maintained. The facility should be well lighted and clean. Amenities such as seating and concessions should be provided for persons waiting.

4. Bus service

   a) The bus service should serve all major attractors; i.e., all places with heavy trip end concentrations such as the CBD.
   b) An adequate service period should be maintained. If only peak hour service is offered, the service period should not be so short that it discourages patronage.
   c) Commuter tickets should be available, particularly if an exact fare policy is in effect.
   d) The service should be marketed as a permanent improvement.

5. Area characteristics

   At least one central area of high trip end concentration exists.

6. Parking supply

   a) High parking rates should prevail at the area served.
   b) Parking facilities should experience near capacity utilization.

If the desirable features of express bus-fringe services identified in this report are incorporated in the planning for new services of this nature, highly successful operations should result. It is envisioned that as more experience is gained with sub-area transit services, a formal set of evaluation criteria and service standards based on interarea comparisons will be developed.

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