EVALUATION OF THE GREENWOOD DRIVE
FRINGE PARKING FACILITY

by

M. J. Demetsky
Faculty Research Engineer

R. N. Robertson
Research Engineer

and

Robert E. Jalette
Graduate Assistant

(The opinions, findings, and conclusions expressed in this
report are those of the authors and not necessarily those of
the sponsoring agencies.)

TRANSPORTATION PLANNING RESEARCH ADVISORY COMMITTEE

ABSTRACT

The application of a procedural method for planning express bus-fringe parking transit to determine why the Greenwood Drive service in Portsmouth, Virginia, failed to attract more riders than it did is described.  The analysis of the study area revealed that many of the conditions which have been shown to prevail where the majority of successful express bus-fringe parking services have been implemented do not exist in the Portsmouth-Norfolk area.  An analysis of the demand for the service indicated that the low levels of patronage that have been experienced could be expected.  It was determined that when the Greenwood Drive service was originally planned, a competing subscription bus service was not properly considered. It was also shown that the methodology employed improves the general capability for developing successful park and ride transit operations.

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## INTRODUCTION AND PURPOSE

In most of the areas in Virginia the private automobile and public bus transit are the two primary means of transportation. Fringe parking (or park and ride) lots are designed to draw upon the benefits of both modes by utilizing the private automobile to collect trips in low density residential areas and carrying the trips along high density transportation corridors by transit. Through the use of standard transit buses on freeway lanes or reserved bus lanes, the efficiency of the highway in terms of moving people per lane can be increased.

The Virginia Department of Highways and Transportation has cooperated in the provision of many fringe parking lots in Northern Virginia, Tidewater, and Richmond. Many of the facilities have been successful in reducing vehicle miles of travel (VMT) on streets and highways, which is a positive effort toward conserving energy, reducing vehicle emissions, and relieving traffic congestion. On the other hand, several lots, most notably the Greenwood Drive lot in Portsmouth, have not been fully utilized. One factor that may have contributed to the development of such under utilized parking facilities is the lack of proper planning procedures for use in preliminary feasibility studies and subsequent transit planning efforts for park and ride facilities and services.

To assist transit planners in developing park and ride facilities, Wester and Demetsky proposed a procedural method for express bus-fringe parking transit planning.[1] The proposed methodology was based on the analysis of population, service, and urban development characteristics of park and ride operations in Richmond and Virginia Beach.[2,3] In addition to determining the feasibility of the operation, the methodology estimates the demand for the bus service.

This present study was requested by the Department and the purpose was to apply the procedural method for planning express bus-fringe parking transit as recommended by Wester and Demetsky to the Greenwood Drive parking facility to determine if the methodology would, in fact, estimate the low levels of usage of the service. In addition to the evaluation of the proposed methodology, the study was to review the strategies that could be implemented to improve the demand for the facility.

## HISTORY OF FACILITY

The Greenwood Drive park and ride lot was jointly developed by the Federal Highway Administration, the Virginia Department of Highways and Transportation, the Tidewater Transportation District Comission (TTDC), and the city of Portsmouth. The lot, located at the interchange of Interstate 264 and Greenwood Drive in southwest Portsmouth as shown in Figure 1, was dedicated on May 17, 1976. On the same day a new bus service from the lot to downtown Norfolk (the CBD) and the naval bases at Sewell's Point was instituted. This service was designed and marketed to meet the needs of the people living in the vicinity of the lot and working at the Naval Operations Base (NOB), the Naval Air Station (NAS), and the Norfolk CBD.

The lot, constructed at a cost of $415,000, provides 335 free parking spaces and includes a kiss and ride area, an enclosed passenger shelter, bicycle racks, lighting, landscaping, and easy access for both transit and private passenger vehicles. Figures 2 and 3 show the lot area and the passenger shelter, respectively. The lot is operated and maintained by the TTDC, which is also responsible for the bus operations, schedules, routes, and fare structure.

The initial service consisted of a total of six buses departing the lot during the morning and returning during the afternoon. Three traveled between the lot and the NOB/NAS, while the others served the Norfolk CBD. Due to insufficient passenger demand the service to the CBD was discontinued in April 1977. The present service consists of departures to the NOB/NAS at 5:50 a.m., 6:30 a.m., and 7:00 a.m. Buses leave the NOB/NAS at 3:20 p.m., 4:05 p.m., and 6:30 p.m. These schedules are based on the staggered working hours of the naval base employees and the bus route is shown in Figure 1. The buses also serve another free parking lot located at the Midcity Shopping Center and stops on demand at the Old Dominion University and Public Health Hospital and on Hampton Boulevard north of Little Creek Road. Although only three buses with a capacity of either eighteen or twenty-five passengers are assigned to this service, the TTDC is ready to add buses if the demand increases.
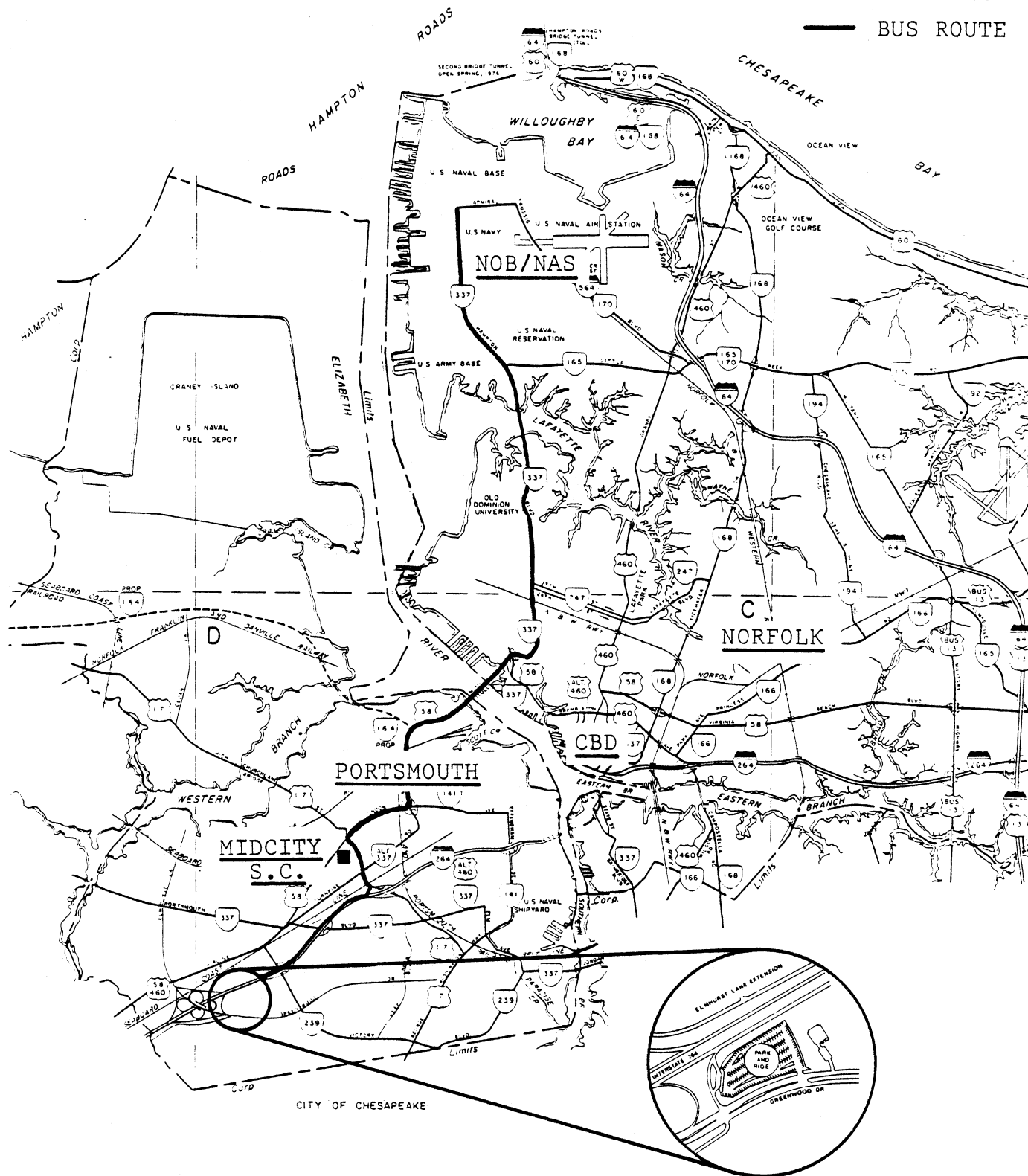
Figure 1. Location of Greenwood Drive fringe parking lot.

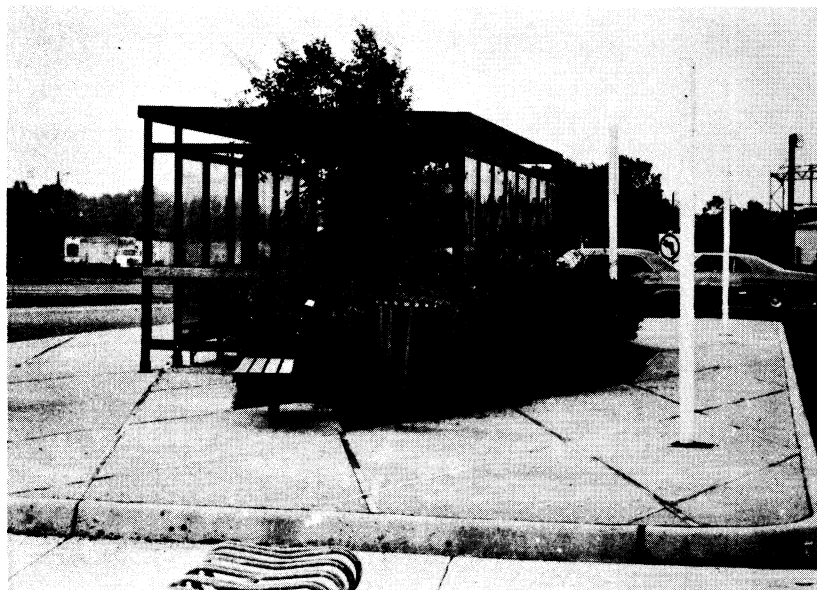Figure 2. Greenwood Drive fringe parking lot.



Figure 3. Bicycle racks and passenger shelter at lot.

Before the Greenwood Drive lot was opened an extensive marketing program was instituted. This included both feature and news stories in newspapers and on television. Also, approximately 2,000 bus schedules and complimentary ride tickets were distributed door to door in the neighborhoods surrounding the lot. Two advertisements were placed in Soundings, the naval base newspaper, which also ran a feature article. Posters were placed at various locations on the base and additional information was distributed through the naval base newsletter. However, no marketing has been done since the initial program.

The usage of the park and ride lot and the ridership on the bus service have been very low from the beginning, frequently only 15-20 vehicles are parked in the lot daily. Table 1 summarizes the bus patronage through October 1977. Approximately 30 person trips are made daily in each direction on the three buses operating between the Greenwood Drive lot and the NOB/NAS.

Table 1

Ridership of Greenwood Drive
Park and Ride Bus Service

|  | Average Daily Ridership | |
| --- | --- | --- |
| Week Beginning | NOB/NAS | CBD |
| 5-17-76 | 18 | 8 |
| 6-14-76 | 33 | 17 |
| 7-19-76 | 63 | 24 |
| 8-16-76 | 63 | 31 |
| 9-13-76 | 58 | 31 |
| 10-18-76 | 61 | 29 |
| 11-15-76 | 69 | 29 |
| 12-13-76 | 77 | 19 |
| 1-17-77 | 57 | 21 |
| 2-14-77 | 63 | 19 |
| 3-14-77 | 65 | 18 |
| 4-11-77 | 58 | Terminated |
| 5-16-77 | 63 | |
| 6-13-77 | 62 | |
| 7-18-77 | 61 | |
| 8-15-77 | 52 | |
| 9-12-77 | 66 | |
| 10-17-77 | 58 | |

OBJECTIVES OF ANALYSIS

The objectives of the analysis which follows was to —

1.  determine why the Greenwood Drive lot service failed to attract more riders than it did; and

2.  test the ability of the methodology for planning express bus-fringe parking to show why the Greenwood Drive lot project was not more successful.

ANALYSIS

The procedural method for planning express bus-fringe parking transit was applied step-by-step to determine why there has been a low demand for the bus service.

### Study Area

### Parking

More than adequate parking is available for workers at the CBD at a cost averaging between 75 and 80 cents a day. The parking capacity at the NOB/NAS is adequate for the demand at those places. Problems with parking at the NOB/NAS result from the desire of tripmakers to park close to their places of employment. In an effort to remedy such problems, in June 1977 a shuttle bus service was provided from parking areas to the major work areas.

### Roadways

There is no serious congestion on the route between the market area and the Norfolk CBD and the NOB/NAS. The greatest amount of traffic congestion occurs in the vicinity of the Midtown Tunnel where tolls are collected. No exclusive treatments of the express buses have been provided to reduce the delay at the toll facility or anywhere along the route. All other points on the route operate at a C level of service during peak periods.

### Travel Costs

The toll at the Midtown Tunnel is 25 cents. No excessive travel costs were found.

In view of the above observations, it is concluded that the conditions which have been shown to prevail where the majority of successful express bus-fringe parking services have been implemented do not exist in the Portsmouth-Norfolk area.

Corridor and Market Area

The area served by this service is made up of single family houses and townhouses. The census tracts making up the market area are shown in Figure 4.[4] The numbers of home-to-work trips to the Norfolk CBD and the NOB/NAS, by census tract are given in Table 2.

Table 2

Greenwood Drive Corridor Market Area
Home-to-Work Trips

| | | Home-to-Work Trips* | |
| Census Tract | Population | CBD | NOB/NAS |
|---|---|---|---|
| 127.01 | 4,568 | 29 | 228 |
| 127.02 | 5,893 | 29 | 249 |
| 128.0 | 7,541 | 46 | 126 |
| 213.01 | 1,887 | 16 | 26 |
| 214.04 | 2,531 | 39 | 64 |
| 215.01 | 3,396 | 6 | 57 |

* The figures in this table were estimated from the 1970 census by assuming that all nonlocal government workers employed in Norfolk work at the NOB/NAS.

Greenwood Drive Site

Observations from an on-site survey and an analysis of the area around the Greenwood Drive park and ride lot are summarized below as advantages or disadvantages.

A. Advantages

1. The site is located along an existing travel corridor from the cities of Chesapeake and Portsmouth to the city of Norfolk.

2. It is located at a major interchange of Interstate Route 264 and Greenwood Drive, which makes it accessible to both auto and transit vehicles. A special transit entrance to the lot is provided.

3. It is located on the outskirts of a residential area and not surrounded by any large comercial establishments.
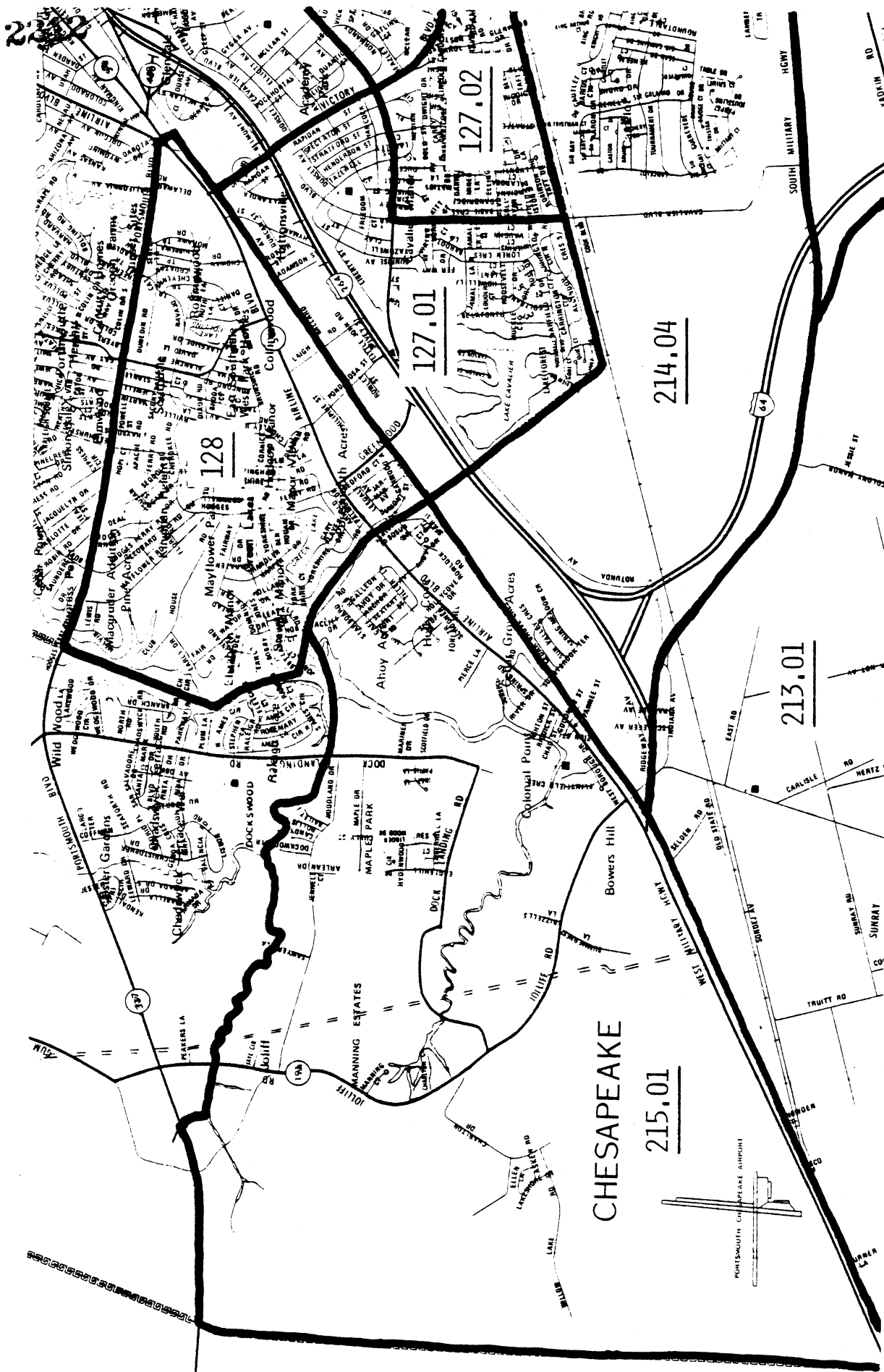
Figure 4.  Census tracts comprising market area for Greenwood Drive bus service.

4. The site has been landscaped and special user facilities are provided including a bicycle rack, a passenger shelter, and adequate lighting facilities.

5. The lot is visible from Interstate Route 264 as well as Greenwood Drive.

B. Disadvantages

1. There are no signs along the major travel corridor to inform commuters of the existence of the park and ride lot.

2. No schedules are posted at the lot to inform potential passengers of the route or schedule of the buses.

3. The physical maintenance of the lot facilities is not very satisfactory. A field survey of the lot site in June 1977 revealed the following shortcomings:

   a. Trash receptacles were full of water

   b. Broken glass covered areas of the parking lot

   c. The passenger shelter had a broken light fixture and all plexiglass windows had been defaced

   d. Improper drainage had caused large puddles of standing water

4. The townhouses in the immediate vicinity of the lot have been defaced to give the area a run-down look.

5. No security provisions have been made for individuals and stored vehicles at the lot site. The lot environment provides a sense of isolation.


## Demand Estimation

The demand for the Greenwood Drive fringe parking-express bus service was estimated with a model calibrated for a service that originated at the Princess Anne Plaza in neighboring Virginia Beach.[2] This model was chosen because of the similarities between the two transit operations and the respective markets as summarized in Table 3.

Table 3

Characteristics of Greenwood Drive and Princess Anne Plaza
Parking Facilities

| Characteristics | Greenwood Drive | Princess Anne Plaza |
|---|---|---|
| Average Annual Family Income | $9,625 | <$12,000 |
| Distance to Destination | 11.7 mi. | 11 mi. |
| Average Parking Cost per Day,* Including Free Parking | 14¢ | 31¢ |
| Express Bus Headway | 30 min. | 30 min. |

* The average parking cost is obtained by multiplying the number
of home-to-work trips from Table 2 by the cost of parking at
the work trip destination (parking cost figures obtained from
the study area analysis portion of this report) and taking the
average.

The traffic zones used in past studies of the area and
shown in Figure 5 provided the basis for the demand analysis.
A correspondence of the zones with the census tracts was estab-
lished in order to apply the work trip data shown in Table 2 to
the traffic zones.

The probability ($P_b$) of choosing the express bus was
determined by using the following logistic formula from the
Princess Anne Plaza modal choice model.

$$P_b = \frac{e^{G(x)}}{1 + e^{G(x)}} , \qquad (1)$$

where

$G(x)$ = a linear function of explanatory variables and is
given by

$$G(x) = 1.2444 - 3.2961X_1 + 2.8541X_2 + 2.0156X_3. \quad (2)$$

In equation 2 the explanatory variables by definition are:

$$X_1 = \frac{\text{number of household autos}}{\text{number of licensed drivers}} \quad \text{and} \qquad (3)$$

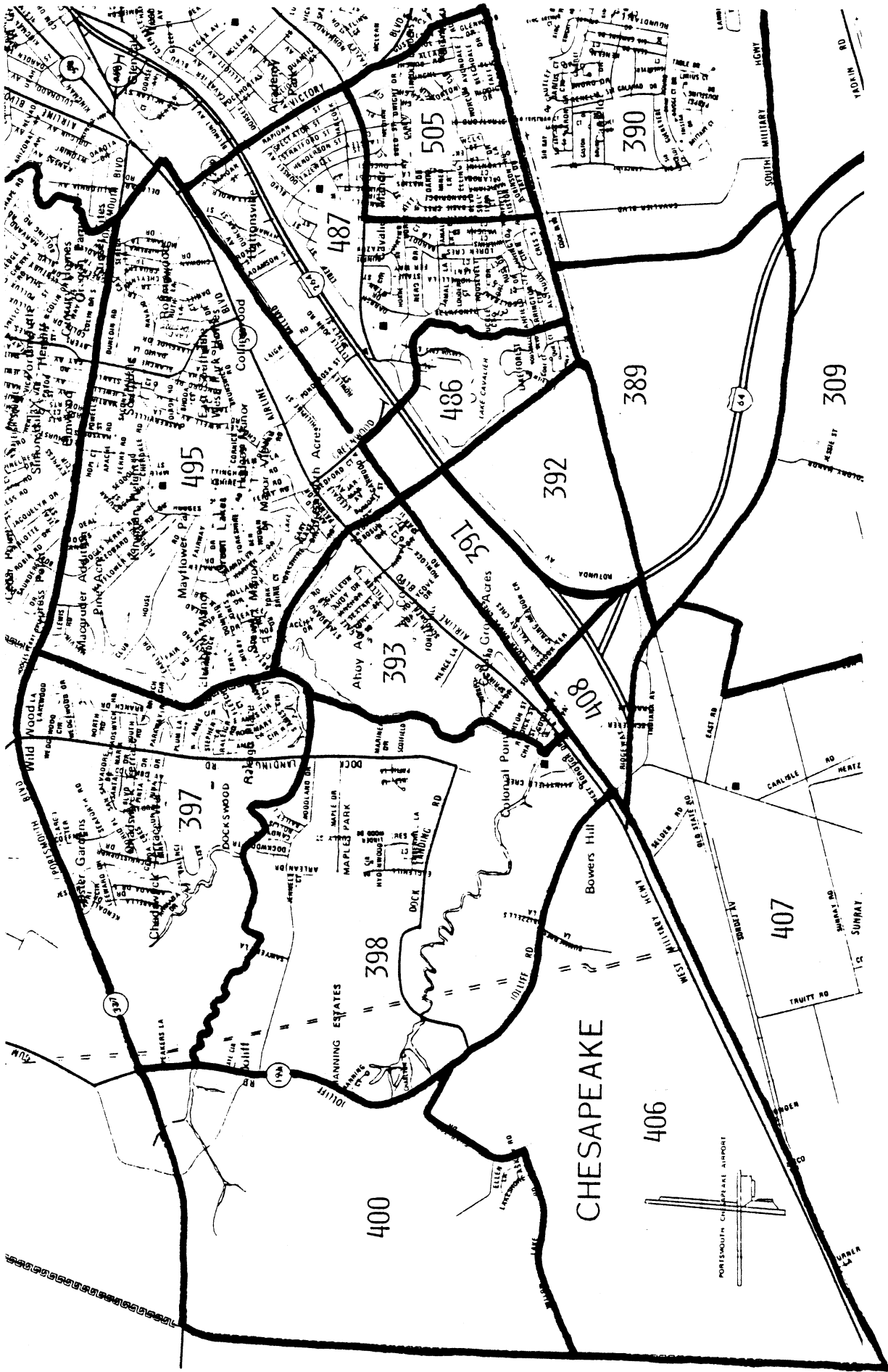$$X_2 = \frac{T_a - T_b}{(T_a + T_b)/2} , \qquad (4)$$

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Figure 5. Traffic zones within market area of Greenwood Drive parking lot.

where

$T_a$ = Travel time via auto,

$T_b$ = Travel time via bus,

and

$$X_3 = \frac{C_a - C_b}{(C_a + C_b)/2} ,$$  (5)

where

$C_a$ = Cost of using auto and

$C_b$ = Cost of using bus.

The explanatory variable, $X_1$, for all traffic zones in the Greenwood Drive market area is derived in Table 4. In order to determine the zonal values for the variables $X_2$ and $X_3$ the following data were used.

1. <u>Operating Cost of Auto.</u> An estimate of 6 cents per mile was used. This is based on the assumption that fuel costs 60 cents per gallon and an automobile achieved 15 miles per gallon. Two cents were added to this cost per mile for oil and regular service for a total of 6 cents per mile. The purchase price of the automobile, insurance, and major repairs were not considered.

   The 25 cents per trip toll at the Midtown Tunnel and one-half of the daily parking cost were also included.

2. <u>Transit Fare.</u> The present transit fare is 60 cents per one-way trip.

3. <u>Travel Times.</u> The highway travel times for the two modes were considered equal at 45 minutes. This was determined by driving the route during the rush hour.

4. <u>Excess Times.</u> The following excess times were assumed.

   a. Drive into lot and park - 3 minutes
   b. Walk to boarding point - 1 minute
   c. Wait for bus - 5 minutes
   d. Passenger boarding and stops along the route - 3 minutes

   Total excess time - 12 minutes

5. <u>Parking Cost.</u> The parking cost in the Norfolk CBD is 75 cents at off street parking lots. Parking at the NOB/NAS is free.

6. <u>Auto Captive Riders.</u> The estimate of auto captive riders was assumed to be equal to that found in the Princess Anne Plaza express bus-fringe parking lot case study[1] because of the similarity of study areas.

Auto Captivity = 47.7%

   With the foregoing information known, values for $X_2$ and $X_3$ were calculated using equations 4 and 5. An example of the calculations used to obtain $X_2$ and $X_3$ for the bus service to the NOB/NAS is given below.

$$X_2 = \frac{T_a - T_b}{(T_a + T_b)/2} = -.2352,$$

when

$T_a$ = highway travel time = 45 minutes and

$T_b$ = highway travel time and excess time = 45 + 12 = 57 min.

$$X_3 = \frac{C_a - C_b}{(C_a + C_b)/2} = .4536,$$

when

$C_a$ = cost of travel by auto + toll + 1/2 of daily parking fee = (11.7 mi.) (6¢/mi.) + 25¢ + 0 = 95.2 cents, and

$C_b$ = express bus fare = 60 cents.

   The probability of using the express bus service was evaluated for each zone in the market area and the results are listed in Table 5.

Table 4

$X_1$ Data by Traffic Zones

| Traffic Zone | Licensed Drivers* | Autos** In Zone | $X_1 = \dfrac{\text{Autos in Zone}}{\text{Licensed Drivers}}$ |
|---|---|---|---|
| 389 | 64 | 38 | .594 |
| 390 | 450 | 273 | .607 |
| 391 | 108 | 65 | .602 |
| 393 | 900 | 510 | .567 |
| 398 | 603 | 341 | .566 |
| 400 | 167 | 93 | .557 |
| 406 | 173 | 97 | .561 |
| 407 | 412 | 299 | .726 |
| 408 | 58 | 35 | .603 |
| 487 | 2,506 | 1,242 | .496 |
| 495 | 4,145 | 3,271 | .789 |
| 505 | 3,232 | 1,535 | .475 |

* The number of licensed drivers per zone was not tabulated by the Virginia Division of Motor Vehicles until 1975. It was assumed the ratio of licensed drivers to population did not change from 1970 to 1975 to obtain an estimate of the number of drivers in 1970.

** From 1970 census data.[4]

Table 5

Probability of Using the Express Bus Service

| Zone | Probability | |
|---|---|---|
| | To NOB/NAS | To CBD |
| 389 | .4204 | .4667 |
| 390 | .3747 | .4196 |
| 391 | .3785 | .4239 |
| 393 | .4060 | .4520 |
| 398 | .4069 | .4528 |
| 400 | .4140 | .4602 |
| 406 | .4108 | .4569 |
| 407 | .2882 | .3282 |
| 408 | .3778 | .4229 |
| 487 | .4635 | .5104 |
| 495 | .2475 | .2841 |
| 505 | .4807 | .5276 |

The estimate of the demand for the express bus service is considered next.  The number of captive riders must be subtracted from the zonal NOB/NAS and Norfolk CBD work trips. The numbers of work trips, by traffic zone, to the NOB/NAS and Norfolk CBD are given in Table 6.

Table 6

Work Trips to NOB/NAS and Norfolk CBD

| Traffic Zone | Work Trips | |
|---|---|---|
| | NOB/NAS | CBD |
| 389 | 3 | 2 |
| 390 | 19 | 12 |
| 391 | 5 | 3 |
| 393 | 25 | 3 |
| 398 | 17 | 2 |
| 400 | 5 | 0 |
| 406 | 5 | 0 |
| 407 | 10 | 6 |
| 408 | 2 | 1 |
| 487 | 243 | 29 |
| 495 | 126 | 46 |
| 505 | 249 | 29 |

An example of how automobile captives are accounted for is shown for zone 487.

Number of NOB work trips (from Table 6)-------243
Auto captive riders (47.7% x 243 = 116)--------116
Potential express bus ridership----------------127

The estimated express bus ridership is equal the probability of ridership (Table 5) multiplied by the potential express bus ridership (above), or (.4635) (127) = 59

A summary of the ridership estimates, by zone, for the express bus service from the market area is given in Table 7.

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Table 7

Ridership Estimates by Traffic Zone

| Traffic Zone | Number of Riders | |
| --- | --- | --- |
| | To CBD | To NOB/NAS |
| 389 | 1 | 1 |
| 390 | 3 | 4 |
| 391 | 1 | 1 |
| 393 | 1 | 5 |
| 398 | 1 | 4 |
| 400 | 0 | 1 |
| 406 | 0 | 1 |
| 407 | 1 | 2 |
| 408 | 0 | 0 |
| 487 | 8 | 59 |
| 495 | 7 | 16 |
| 505 | 8 | 63 |
| Total | 31 | 157 |

## Demand Analysis

The NOB/NAS is unique in that a bus service that closely resembles that provided by the Greenwood Drive fringe bus-parking operation was available prior to the institution of the new service. Buses are privately owned and operated by employees of the NOB/NAS. Personnel interested in utilizing this service contact an owner and arrange a pickup point. A current directory shows that nine 65-passenger buses operate in the Greenwood Drive parking lot market area. The cost of this bus service ranges from 60 to 75 cents per trip. Accordingly, the express bus service faces direct competition from the established subscription bus service. In order to determine the expected patronage for the Greenwood Drive lot service, the submodel split between the subscription buses and the Greenwood Drive express bus was estimated.

Only one of several passengers questioned while traveling on the Greenwood Drive express bus service stated that he had used the subscription bus service, which indicated a low diversion of subscription transit riders to the new service. Accordingly, since the travel time and cost of the established subscription bus service are similar to those of the new Greenwood Drive express bus service and the new service requires an additional access mode while the subscription bus provides door-to-door pickup, it was assumed that the majority (80%) of the current subscription bus passengers would continue with that service.

These passengers must then be subtracted from the total estimated demand for express bus service from the market area in order to get an accurate estimate of the number of people who will actually utilize the bus service.

Table 8 shows the percentage of workers, by zone, who utilized the subscription bus service to the NOB/NAS in 1970. This table also shows the percentage of workers who will continue to ride the subscription bus service after the Greenwood Drive service is in operation. Table 9 shows the final estimates of ridership for the Greenwood Drive express bus service.

Table 8

NOB/NAS Subscription Bus Percentages from Market Area

| Traffic Zone | Percent Workers* Using Subscription Bus | Percent Workers to Choose Subscription Bus Over Greenwood Drive Express Bus |
|---|---|---|
| 389 | 6.1 | 4.9 |
| 390 | 6.1 | 4.9 |
| 391 | 6.1 | 4.9 |
| 393 | 15.0 | 12.0 |
| 398 | 15.0 | 12.0 |
| 400 | 15.0 | 12.0 |
| 406 | 15.0 | 12.0 |
| 407 | 1.8 | 1.4 |
| 408 | 6.1 | 4.9 |
| 487 | 18.6 | 14.9 |
| 495 | 7.0 | 5.6 |
| 505 | 22.5 | 18.0 |

* The number of workers per zone utilizing bus transportation to work comes from the 1970 census data. This bus transportation was assumed to be subscription bus as no other buses operate between these zones and the NOB. The ratio of these workers to the total workers per zone gives the percentage of workers using the subscription bus.

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An example of the calculations used to obtain the figures in Table 9 are given below for zone 487.

Express bus ridership estimate--------------59

Total number of workers from the
zone (Table 6) multiplied by the
percentage of workers choosing
subscription bus (Table 8) (243 x 14.9%)-----36

Final estimate of Greenwood Drive
ridership-------------------------------------23

Table 9

Final Estimate of Greenwood Drive Express Bus Ridership

| Traffic Zone | Number of Riders | |
|---|---|---|
| | To CBD | To NOB/NAS |
| 289 | 1 | 1 |
| 390 | 3 | 3 |
| 391 | 1 | 1 |
| 393 | 1 | 1 |
| 398 | 1 | 1 |
| 400 | 0 | 0 |
| 406 | 0 | 0 |
| 407 | 1 | 1 |
| 408 | 0 | 0 |
| 487 | 8 | 23 |
| 495 | 7 | 9 |
| 505 | 8 | 17 |
| Total | 31 | 57 |

The final step of the procedure for planning fringe parking-express bus transit is to determine the number of autos that will be parked at the fringe parking lot. This is accomplished using a submodal split model for each zone in the market area.

$$P_b = \frac{e^{G(x)}}{1 + e^{G(x)}} \quad \text{and} \tag{6}$$

where

$$G(x) = -5.7146X_1 + 3.4796, \tag{7}$$

$P_b$ = probability of a car being parked and

$G(x)$ = a linear function of the explanatory variable $X_1$.

The results of these calculations are provided in Table 10. The estimate of the number of cars parked is found by multiplying the probability of parking by the estimate of the express bus ridership. These results are in Table 11.

Table 10

Probability, by Market Zone, of Parking an
Automobile at the Greenwood Drive Lot

| Traffic Zone | Probability of Parking Auto |
|---|---|
| 389 | .521 |
| 390 | .552 |
| 391 | .510 |
| 393 | .559 |
| 398 | .561 |
| 400 | .574 |
| 406 | .568 |
| 407 | .339 |
| 408 | .509 |
| 487 | .656 |
| 495 | .263 |
| 505 | .682 |

Table 11

Estimate of Automobiles Parked in Greenwood Drive Lot

| Traffic Zone | Number of Autos Parked | |
|---|---|---|
| | CBD | NOB/NAS |
| 389 | 1 | 1 |
| 390 | 2 | 2 |
| 391 | 1 | 1 |
| 393 | 1 | 1 |
| 398 | 1 | 1 |
| 400 | 0 | 0 |
| 406 | 0 | 0 |
| 407 | 0 | 0 |
| 408 | 0 | 0 |
| 487 | 5 | 15 |
| 495 | 2 | 2 |
| 505 | 5 | 12 |
| Total | 18 | 35 |

The estimated ridership for the express bus service as given in Table 9 is approximately double that actually realized as reported in Table 1. Much of this discrepancy between the actual and predicted values is attributed to the numerous assumptions that were required in order to account for the subscription bus service and the error to be expected by borrowing models. The demand analysis, however, did indicate that the service would experience levels of patronage much lower than those for which the lot and service were designed.

## CONCLUSIONS

The application of the methodology for planning express bus-fringe parking transit to the Greenwood Drive service revealed that the low levels of patronage that have been experienced could be expected. It appears that when the Greenwood Drive service originally was planned, the competing subscription bus service was not properly considered. Although the planning methodology was not designed to deal directly with such unique issues as this other bus service, it was shown that the comprehensive study approach could be adapted to special local problems such as this competition. Accordingly, it is concluded that the methodology improves the general capability for developing successful park and ride transit operations.

The following observations were made regarding the future potential of the Greenwood Drive lot service for attracting riders.

The competing subscription bus service clearly dominates the market for transit to the NOB/NAS.

The site is somewhat isolated from the local neighborhoods.

The service should have been continually advertised and more directional signs should have been provided on local roads.

The lot design is adequate, but better maintenance and security are desirable.

In view of the above findings plus other factors considered, it does not appear that demand for the service will grow in the near future. Only when the area to the south of the lot (Chesapeake and Suffolk) is developed, will it be possible for the lot and service to be anywhere near successful.

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