# TRANSIT POTENTIAL IN THE NEW JERSEY COUNTIES

October 1993



Delaware Valley Regional Planning Commission

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Delaware Valley Regional Planning Commission The Bourse Building 21 South 5th Street Philadelphia, PA 19106

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Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty and intercity agency which provides continuing, comprehensive and coordinated planning for the orderly growth and development of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties, as well as the City of Philadelphia, in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer counties in New Jersey. The Commission is an advisory agency which divides its planning and service functions between the Office of the Executive Director, the Office of Public Affairs, and three line Divisions: Transportation Planning; Regional Information Services Center, which includes the Regional Planning Office; and Finance and Administration. DVRPC's mission for the 1990s is to emphasize technical assistance and services, and to conduct high priority studies for member state and local governments, while determining and meeting the needs of the private sector.



The DVRPC logo is adapted from the official seal of the Commission and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River flowing through it. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey. The logo combines these elements to depict the areas served by DVRPC.

## DELAWARE VALLEY REGIONAL PLANNING COMMISSION

## **Publication Abstract**

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#### **Geographic Area Covered:**

Burlington, Camden, Gloucester, and Mercer counties

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## ABSTRACT

This report assesses the potential for transit service in the four New Jersey counties of the DVRPC region using population, number of households, auto ownership, the age structure of residents, and employment for 1990 and 2010. The underlying data is disaggregated to the level of traffic zones and is based on 1990 census data and latest DVRPC forecasts. Transit potential is highest in the Camden and Trenton central business districts and declines with distance from these centers. It generally shows good correlation with existing transit service, but several corridors were identified that might benefit from a higher level of service and thus warrant further study. The 2010 potential is not significantly different from that for 1990, as most of the growth in travel demand is now occurring in areas with low transit potential.

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#### EXECUTIVE SUMMARY

This report presents the results of an investigation of the existing and future market potential for transit services in the New Jersey portion of the DVRPC region. As part of the long-range planning process, several key transit indicators were selected to determine the feasibility of operating or expanding rail and bus services in travel corridors. The indicators used to measure transit potential in Burlington, Camden, Gloucester, and Mercer counties included population, household size, auto ownership, age distribution within the population, and employment. The potential was mapped for 1990 and 2010 as an abstract index based upon the areal density of each indicator, i.e., the quantity per acre, with one representing the threshold for supporting fixed route service. The underlying data was derived from the 1990 Census and DVRPC forecasts, disaggregated to the level of traffic zones.

Since the current market for transit services is closely related to the density of development, the market in New Jersey remains focused on circulation within the urbanized areas surrounding Camden and Trenton, and in corridors carrying trips to Philadelphia, Camden, and Trenton. Six corridors with moderate potential, and four others with less but measurable potential, were identified. However, much of the newer development in the region lacks sufficient density and supporting pedestrian facilities to attract a strong transit market.

Overall the potential maps correlate well with existing transit service, although ridership in the following corridors could be increased with improved service: Camden to Mount Holly; Camden to Glassboro; along the Delaware River between Camden and Trenton; and Trenton to Princeton. Through bus service in a circumferential corridor from Woodbury to Maple Shade could attract intrasuburban trips, and if extended across the Delaware River could provide connections to northeast Philadelphia. The maps provided only a fair match to the distribution of regional employment centers as determined in a 1986 study conducted by DVRPC, as much of the new employment is being located outside the corridors served by transit.

Significantly, the 2010 potential map is not drastically different from that for 1990. Most of the growth in travel demand is now occurring in low density areas with little potential to capture transit riders. The potential for transit trips is expected to increase about four percent over the twenty-year period, but the distribution of trips should not change markedly. These findings have implications for both the transit operators and DVRPC, as each agency continues to develop its long-range plans, and for the region's counties and municipalities in their efforts to plan and coordinate land use decisions and the potential for future transit service.

#### INTRODUCTION

In 1992 at the behest of SEPTA, the Delaware Valley Regional Planning Commission (DVRPC) conducted a study examining the potential for future transit service in the Pennsylvania portion of the region. This resulted in a report published in October 1992<sup>1</sup>, which used 1990 and projected 2010 demographic variables at the traffic zone level to gauge the theoretical ridership base. The intent was to use a broad-based approach to examine how well existing service matched the current potential for capturing riders, and where development of new routes and services should be focused.

While increasing auto ownership and the dispersion of activities to lower density suburbs have reduced the share of trips taken on public transportation, several factors may mitigate this trend in the coming decade. For one, there is a core of population who do not have access to automobiles, and for whom public transportation is a necessity if they are to enjoy any mobility at all. These are people who are too young or too old to drive, or too poor to own an automobile, or those with handicaps that preclude driving. For another, transit access permits higher density development than can be accommodated by a total reliance on automobiles for access. And finally, it should be noted that Burlington, Camden, Gloucester, and Mercer counties are classified as non-attainment areas with respect to ozone, and this triggers an employer trip reduction mandate. If this program is to stand any chance of success, workers will have to increase their use of public transportation.

The potential for transit use is driven by a number of variables, including population, employment, and auto ownership. In order to support transit service in a given area, some combination of these variables must be present in sufficient density. Household density (dwelling units per acre) has been used in other metropolitan areas as an indicator of the potential to use transit. However, this provides only a rough measure of an area's ability to generate trips, and measures neither the transit dependency of the resident population nor the area's ability to attract trips from other locations. The failure to include attractors, such as employment, is basically making the tacit assumption that all trips are destined to the central business district. No allowance is made for reverse commuting or other trips to suburban locations. In order to provide the full measure of transit potential, it was believed necessary to include additional determinants, such as auto ownership and the age structure of the population.

The results of the earlier study for Pennsylvania showed transit potential to be highest in Center City Philadelphia and in radial routes largely defined by traditional rail commuter routes. The dynamic range across the region was large. Using an arbitrary index of one to define the minimum conditions needed to support fixed route bus service, the potential in Center City was found to exceed 300.

<sup>&</sup>lt;sup>1</sup><u>Transit Potential in the Pennsylvania Counties</u>, DVRPC Pub. #92020, October 1992.

This report describes the results obtained by applying the same methodology to the four New Jersey counties (Mercer, Burlington, Camden, and Gloucester) that are included in the DVRPC region. Unlike the earlier study, which was conducted prior to the release of the 1990 Census data, the current study uses a revised data base for New Jersey incorporating data from the Census Transportation Planning Package. The Pennsylvania data base will also be revised and a new map covering the entire region will be released during FY94.

## METHODOLOGY

Though transit trips can be generated from wherever people are when the need to go somewhere else arises, consideration in this study was limited to the majority of trips which come from residential areas. Population provides the most direct measure of potential demand, and higher densities generate higher demand for transit services. Trip making is also related to the number of households; large households do generate more trips than smaller ones, but not in proportion to size. Low auto ownership increases transit demand, as zero-car households rely on public transportation for almost all of their trips, and one-car households need transit to supplement the auto. Finally, the age structure of the population affects transit demand, as senior citizens and young people rely more heavily on transit for mobility than does the general population. The only attractor be considered was employment, though other activity centers, such as stores, schools, and medical facilities, also attract non-work trips.

Each of these variables was assumed to have the potential for generating trips on public transportation, which in a given area will be proportional to the areal density for that variable. All densities were specified in terms of gross acres.<sup>2</sup> In addition, potentials were normalized by choosing appropriate thresholds for each of the variables. The threshold represents the minimum value needed to support fixed route transit service. The lower the threshold the greater the importance of that variable in determining transit demand.

The population threshold was set at three per acre, which is equivalent to 1,920 persons per square mile and in rough agreement with the value found in New York as the minimum density that will support fixed route transit service.<sup>3</sup> The threshold for households was then set at one per acre, as this gives a population to household ratio that agrees with the average household size in the region. Zero-car households are largely dependent on public transportation (or the generosity of others) for trip making and their threshold was set at one-half the level used for all households. The threshold for one-car households was set at one, which reflects average

<sup>&</sup>lt;sup>2</sup>Other studies have specified densities in terms of net residential acres. In developed areas roughly one-fourth of the land is used for housing. Since transit lines must traverse both residential and non-residential areas, use of gross acres may be more appropriate.

<sup>&</sup>lt;sup>3</sup>Pushkarev, Boris S. & Jeffrey M. Zupan, <u>Public Transportation and Land Use Policy</u>, Indiana University Press, Bloomington, 1977.

transit usage. Though senior citizens make fewer trips overall, their transit ridership is stimulated by public policy which reduces fare for seniors during off-peak hours. Accordingly, their threshold was set at one per acre. The age limits for defining youth were set by noting that twelve is typically the minimum age for independent travel, and that car availability increases rapidly after age 18. Youth were considered to generate transit trips at one-half the rate of senior citizens. The threshold for employment was set at 2.5 jobs per acre, which provided a rough balance between the potentials for trip generation and attraction. The thresholds used are summarized in Table 1.

## Table 1

Variable	Subset	Threshold
Population		3.0 per acre
Households		1.0 per acre
Auto Ownership	0-car Households	0.5 per acre
	1-car Households	1.0 per acre
Age Segmentation	Seniors (>65)	1.0 per acre
	Youth (12-18)	2.0 per acre
Employment		2.5 per acre

#### THRESHOLD DENSITIES FOR TRANSIT SERVICE

Potentials were calculated for each parameter as abstract indices representing multiples of the threshold. The total potential for generating trips is the average of the individual potentials for population, households, auto ownership, and age structure. Averaging avoids double-counting, but still grants extra weight to zones with large numbers of senior citizens or carless households. The overall, or composite, potential for each zone was then obtained by adding the potential for

generating trips to that for employment. A more detailed explanation of the theory used is found in Appendix I.

## NEW JERSEY DEMOGRAPHIC AND EMPLOYMENT DATA

For analytical purposes the New Jersey four-county area has been divided into 347 traffic zones, largely conterminous with census tracts. The data for each zone was tabulated as densities, e.g., population per acre. Ideally, zones should be constructed with a one-half mile mesh in order to capture the potential within walking distance of a station or stop. This is not practical, and the growing importance of park-and-ride in suburban and rural areas has somewhat obviated the need for walking access. Averaging densities across broader zones does, however, partially mask the presence of high-density trip generators or attractors with easy access to transit services. A finer net would improve the representation in areas with developing employment centers.

A set of transit potential maps for the New Jersey area were prepared for 1990 and 2010, in order to reflect current circumstances and to show the changes expected in the future. Individual maps show the potentials generated separately by population, auto ownership, the presence of youth or senior citizens, and employment. The composite, or total, potential is shown on a final pair of maps, which effectively combines the impacts of each of the separate parameters.

The 1990 data for households, car ownership, and age groups are obtained from the 1990 census population counts. The employment data were also obtained from the U.S. Bureau of the Census journey-to-work data. A 2010 forecast was prepared at the zonal level in 1987, and was adjusted to reflect the 1990 census data and the recent municipal population and employment forecasts adopted by the DVRPC Board in June 1993. County totals of demographic and employment variables are shown in Appendix II.

Table 2 shows county averages of the densities used to calculate the potentials. The averages are weighted by zone, i.e., they represent an average of the densities calculated for each zone. Three points should be noted when scanning the table. First, the spread in values between Mercer and Camden counties at the high end, and Burlington and Gloucester counties at the low end is significant. The cities of Trenton and Camden provide the first two counties with population and employment densities sufficient to support good transit service, whereas Burlington and Gloucester counties have average densities that barely meet the threshold for service. This is not to say that these counties do not have areas deserving of service, but rather that the need is limited to specific areas and corridors. Second, transit demand resulting from low auto ownership and high concentrations of senior citizens is for the most part limited to Camden and Mercer counties. Third, while the four-county area is expected to grow in the twenty-year period from 1990 to 2010, the growth is not expected to be large enough to trigger significant changes in the potential demand for transit.

## Table 2

#### AVERAGE DENSITY OF DEMOGRAPHIC AND EMPLOYMENT VARIABLES

County	Popu-	House-	Auto Ov	vnership	Age (	Group	Employ-
	lation	holds	0-Car	1-Car	Seniors	Youth	ment
Burlington Camden Gloucester Mercer	4.1 8.2 3.3 12.7	1.4 2.9 1.2 3.5	0.1 0.6 0.1 0.8	0.5 1.1 0.4 1.4	0.4 1.1 0.4 1.4	0.4 0.8 0.3 0.9	1.7 4.3 1.4 7.7

2010

County	Popu-	House-	Auto Ov	wnership	Age	Group	Employ-
	lation	holds	0-Car	1-Car	Seniors	Youth	ment
Burlington	4.3	1.5	0.1	0.4	0.4	0.4	2.1
Camden	8.4	2.9	0.5	0.9	1.1	0.8	5.0
Gloucester	3.8	1.4	0.1	0.4	0.4	0.3	1.7
Mercer	13.3	3.5	0.7	1.2	1.5	0.9	8.7

#### **1990 FINDINGS**

Map 1 shows the 1990 transit potential for the four New Jersey counties. For mapping purposes four ranges are displayed, each range four times larger than its predecessor. The transit potential in a large metropolitan area spans a large dynamic range, and using a geometric progression to set range boundaries allows mapping the potential in dense urban cores, which can support transit service running on short headways, as well as in the mostly rural fringes, where service is likely to be limited to selected corridors. Though actual ridership depends on circumstances unique to each corridor, generally a potential above one is needed to support conventional fixed route service, and it should be above four if all day service on an hourly

headway or better is to be considered. As calculated, the potential ranged from a high of almost 32 in the vicinity of Camden's City Hall to near zero deep in the pine barrens of Burlington County. Only four traffic zones showed high transit potential, i.e., a potential higher than 16, and these were evenly split between the Trenton and Camden central business districts (CBD). Table 3 shows the distribution of transit potential by county among the 317 traffic zones comprising the study area.

#### Table 3

## DISTRIBUTION OF TRANSIT POTENTIAL

		Number of Zones				
Index	Potential	Burl.	Camden	Glou.	Mercer	Total
$16 \le P$ $4 \le P < 16$ $1 \le P < 4$ P < 1	high moderate low very low	- 6 54 49	2 38 69 9	- 1 11 17	2 25 24 10	4 70 158 85
Total		109	118	29	61	317

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		Number of Zones				
Index	Potential	Burl.	Camden	Glou.	Mercer	Total
$16 \le P$ $4 \le P < 16$ $1 \le P < 4$ P < 1	high moderate low very low	- 7 58 44	2 39 69 8	- 1 11 17	2 27 23 9	4 74 161 78
Total		109	118	29	61	317

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Approximately one-fourth of the zones (23%) within the four-county area show high or moderate potential, but 91 percent of these are in Camden or Mercer counties, with most either in or clustered around Camden (city) and Trenton. Clusters of moderate potential are also found in Cherry Hill and Stratford in Camden County, and in Princeton and Hightstown in Mercer County. The zones in Burlington County with moderate potential are in five scattered locations: Maple Shade, Burlington (city), and Mount Holly, which are older traditional communities; and Willingboro and Evesham, which represent newer but mature tract development. The zone covering Woodbury was the only one in Gloucester County that reached the moderate level.

The zones in the low category comprise one-half of the zones in the four New Jersey counties. When combined with zones in the moderate category, they outline several corridors that may offer promise in the future, especially if development can be focused so as to yield higher densities. Most are radial corridors emanating either from Camden or Trenton, but several circumferential suburban corridors can also be identified. Radial routes include Trenton north to Pennington, Trenton northeast to Princeton, Trenton east to Hightstown, Camden northeast to Burlington and beyond to Trenton, Camden east along NJ 38 to Moorestown and beyond to Mount Holly, Camden east along NJ 70 to Cherry Hill and Marlton (Evesham Twp.), and Camden south to Woodbury and Glassboro. Circumferential routes include Princeton to Hightstown in Mercer County; Palmyra through Maple Shade, Cherry Hill, Haddonfield, and Barrington to Woodbury, circumscribing an arc of radius 6.5 miles about Camden; and Mount Holly through Marlton and Stratford to Glassboro. These and other corridors will be more fully described in the discussion comparing transit potential with existing service.

Table 4 shows the average potentials, both partial and total, by county. Again a clear division is seen between Mercer and Camden counties on the high end, and Burlington and Gloucester on the low end. The counties in the former group have urban cores with a concentration of jobs and transit dependent population, surrounded by older more densely developed suburbs, whereas much of the development in the latter group has been more recent and is more sprawling. The average transit potential found in Mercer County is five times higher than that found in Gloucester County. All the counties showed a higher potential to generate transit trips than to attract them, although Mercer County comes closest to a balance. This imbalance is simply a reflection of significant commutation by public transportation to jobs in Philadelphia and New York. [There is more commutation by residents of the four counties to external job sites than there is by non-residents to local workplaces.] The average transit potential for these counties was 3.1, with 1.7 obtained from trip generation and 1.4 from employment.

#### 2010 FINDINGS

The 2010 findings, shown in Map 2, are not strikingly different from that compiled for 1990, but perhaps it should be expected that the maps will show little change. Each of the categories shown by shading covers a dynamic range spanned by a factor of four, and unless a zone is already close to a boundary, it is not likely that growth will be large enough to push it up to the

## Table 4

	Transit Potential Index						
Variable	Burl.	Camden	Glou.	Mercer	Average		
Population Households Autos Age	1.20 1.27 0.60 0.59	2.72 2.88 2.24 1.48	0.82 0.87 0.46 0.43	3.29 3.60 3.12 1.83	2.01 2.16 1.60 1.08		
Generators (avg)	0.91	2.33	0.64	2.96	1.71		
Employment	0.68	1.72	0.47	2.69	1.39		
Total	1.59	4.05	1.12	5.65	3.10		

### AVERAGE POTENTIAL INDEX

#### 1990

	Transit Potential Index					
Variable	Burl.	Camden	Glou.	Mercer	Average	
Population Households Autos Age	1.29 1.41 0.51 0.64	2.81 2.92 1.97 1.55	0.95 1.01 0.37 0.48	3.44 3.57 2.72 1.94	2.12 2.23 1.39 1.15	
Generators (avg)	0.96	2.31	0.70	2.92	1.72	
Employment	0.79	1.85	0.57	2.88	1.52	
Total	1.75	4.16	1.27	5.80	3.25	

next category. However, other forces are also at work. Most of the areas on the 1990 map showing moderate to high potential are mature areas that are no longer growing. Although most of these areas are expected to retain their potential, they will probably not gain much. In contrast, most of the rapid growth is occurring in open or rural areas, and the development itself is usually only of low to moderate density. This suggests that most of the changes that are expected to occur will be in the lowest categories, i.e., from very low to low, and indeed this



is what was found. In the four counties as a whole, no zones were observed to move up from the moderate category to high, but four moved from low to moderate and eight from very low to low. No consistent pattern is apparent other than to note that one-half of the twelve zones are in Burlington County.

Comparing the forecast 2010 potentials with the existing 1990 potentials, it is seen that the average transit potential for the four counties is expected to increase by 4.8 percent (from 3.10 to 3.25), but the growth is uneven among the counties (see Table 4). The potential in the more urbanized Mercer and Camden counties are expected to increase by 2.7 percent, whereas in the more rural Burlington and Gloucester counties the average potential should increase by 10.1 and 13.4 percent, respectively. Almost all of the increase in transit potential will come from increasing employment. While population growth, which includes a good boost from the senior citizen component, is expected to boost the potential for the four counties by 5.1 percent, this will largely be nullified by an increase in car ownership. Overall, the average potential to generate transit trips will only go up slightly.

#### COMPARISON OF TRANSIT POTENTIAL WITH EXISTING SERVICE

As part of its statewide operation, NJ TRANSIT provides most of the rail and fixed-route bus service in the four-county area. Frequent rail service is provided on the Amtrak-owned Northeast Corridor between Trenton and New York (with some peak trips using Hoboken as a terminus) and on a branch line to Princeton. In South Jersey, NJ TRANSIT operates rail service to/from Atlantic City, with some of the trips recently extended westward from Lindenwold in Camden County to Philadelphia. NJ TRANSIT's Southern Division provides local and express bus service to the developed portions of Burlington, Camden, and Gloucester counties. Local bus service in Mercer County is provided by NJ TRANSIT Mercer.

Other important carriers include the Port Authority Transit Company (PATCO), who operates a rail line between Lindenwold and Philadelphia (the only rail transit line in South Jersey); the Southeastern Pennsylvania Transportation Authority (SEPTA), who operates rail and bus service from Bucks County across the Delaware River to Trenton and West Trenton; and Suburban Transit, a private operator with local and express bus service from Princeton north to central New Jersey and New York. PATCO is the transit operating arm of the Delaware River Port Authority, and SEPTA is the primary transit provider throughout the Pennsylvania side of the Delaware Valley region. Another private carrier, New Jersey Southern, operates peak hour bus service between Willingboro and Philadelphia.

DVRPC is currently studying the feasibility of improving transit services in two corridors radiating from Camden. One to Burlington County runs east from Camden through Merchantville and Maple Shade to Moorestown with possible extension to Mount Holly. The other to Gloucester County runs south through Woodbury to Glassboro. Alternatives under consideration include busway, light rail, and heavy rail transit (subway/elevated). Existing service is limited to local bus routes to Camden and Philadelphia supplemented with peak hour express buses to Philadelphia.

Map 3 shows existing rail lines and bus service areas. A comparison of this map with Maps 1 and 2, indicates a reasonable correlation between existing service and the calculated potential.

Generally, the radial corridors from Camden and Trenton indicate the highest potential and produce the highest ridership. However, travel demand for circumferential (suburb-to-suburb) trips is growing faster and some of these corridors now show some potential for future transit service.

The following corridors that have the potential to support transit service were identifified:

- 1. The corridor defined by US 30 along the spine of Camden County is well served by the PATCO and Atlantic City rail lines, and supplemented by NJ TRANSIT bus service. Moderate potential is indicated as far east as Stratford, but good service and adequate station parking has allowed the PATCO line to draw from lower density areas away from the line. For the past several years average PATCO weekday ridership has hovered around 40,000.
- 2. The Burlington County corridor now under study shows moderate potential as far as Maple Shade and some potential to Moorestown. East of that point little potential exists until Mount Holly, which is the county seat, is reached, although it is possible that good service could draw customers from residential tracts to the north. Pemberton and Browns Mills, respectively five and ten miles east of Mount Holley, and Fort Dix and McGuire Air Force Base, about ten miles northeast of Mount Holly, provide additional clusters of moderate potential. Current service is provided by buses running on local roads to Moorestown and on NJ 38 via Moorestown to Mt. Holly. Service to locations east of Mount Holly are provided as part of the seashore service to Asbury Park.
- 3. The other corridor under study, the Gloucester County corridor, shows moderate potential to Woodbury, which is also a county seat. Proceeding south, some potential is observed at Pitman and Glassboro, but most of the new development taking place in the corridor is of fairly low density. However, Rowan College with almost 10,000 students is located at Glassboro and could provide a concentrated market. The corridor is currently served by buses running via Delsea Drive (NJ 47) to Pitman and Glassboro, and via Woodbury and CR 553 to Glassboro. The Camden to Woodbury portion is particularly well-served, as several other routes merge with these at Woodbury.
- 4. The Delaware River corridor between Camden and Trenton is currently served by buses running on River Road and US 130. The former route only operates south of Burlington, but it serves older river communities, such as Riverside and Palmyra. The latter serves newer development, such as Willingboro; as well as older communities, such as Florence and Bordentown, north of Burlington. Most of the trips are local in nature, although some express trips are operated between Willingboro and Philadelphia. A higher level

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of service, express bus or rail, could generate bidirectional commuter traffic, south to Philadelphia and north toward New York. Such a service could run on an existing rail freight line, provided steps are taken to preserve the right-of-way in the event portions are abandoned.

- 5. A corridor extends north from Trenton along NJ 31 to Pennington. The construction of I-95/I-295 has stimulated growth in Ewing Township, and the presence of Trenton State College creates additional demand. The corridor could be extended five miles further to Hopewell, though little potential is seen until Hopewell is reached. Existing service terminates at Pennington.
- 6. Trenton to Princeton is probably the highest potential corridor within Mercer County, and growth in Lawrence Township is expected to push the potential higher. Employment is growing along US 1 in West Windsor Township. The Northeast Corridor rail line parallels US 1 and provides long-haul commuter service, but station spacing is too large to meet local transportation needs. Local buses link Princeton with Trenton via US 206, with additional buses serving the shopping malls and employment sites along US 1.

The preceding list represents the strongest corridors identified, but the maps reveal other corridors where potential exists although not quite as strong. Some of these are circumferential in nature, or in areas where densities are less but travel demand is growing. Others run to new service areas, or have good potential over part of the route, but show open stretches where little market is likely to exist; and still others provide useful connectivity. Following are brief descriptions of some of the corridors identified:

- 7. A circumferential route around Camden that shows some potential runs clockwise from Maple Shade (Burlington County corridor) through Cherry Hill, Haddonfield (Camden County corridor), and Barrington to Woodbury (Gloucester County corridor). Several large shopping centers, including Cherry Hill and Deptford malls, lie along the route, and current bus service is largely oriented toward delivering shoppers and employees to these malls. To develop the full potential, however, a faster more direct routing is needed that is coordinated with PATCO service and enhanced service in the other two corridors. The potential could be further expanded by extending the corridor north through Palmyra and across the Delaware River to northeast Philadelphia.
- 8. Another circumferential corridor showing some promise runs southwest from Mount Holly through Mount Laurel, Evesham, and Stratford to Glassboro. This is a route that provides connectivity between rapidly growing zones with moderate potential that are interspersed among zones of lower potential. It also connects growth areas in Burlington County with the county seat at Mount Holly. Aside from local service in Camden County, there is no existing transit service in this corridor.
- 9. A cross-county corridor, currently with hourly bus service, runs southeast from Burlington to Mount Holly. At the Burlington end the corridor could be extended across the Delaware River to Bristol, where it would connect with SEPTA rail and bus service. At the Mount Holly end, it could be extended to Pemberton.

10. In Mercer County growth in East and West Windsor townships is filling in a corridor between Princeton and Hightstown. The eastern end of this corridor currently enjoys no local transit service, although some service is provided by the Suburban Transit Corporation as part of its through bus service to New York. Recent residential and commercial development, as well as the growth of retirement communities, have strengthened the potential, but to take full advantage of this development, the corridor should be extended eastward two miles to Twin Rivers.

It is certainly possible to find other corridors defined on the transit potential maps, but the ten delineated above appear to be the strongest candidates.

## COMPARISON OF TRANSIT POTENTIAL WITH EMPLOYMENT CENTERS

The movement of jobs from urban cores to suburban locations has been responsible for much of the changing travel patterns in the region. Unfortunately, this trend has increased the dependency on automobiles for local trip making, as many of the trips are poorly served by public transportation and much of the newer suburban development is designed around automobile accessibility. Not only are suburban residents increasingly traveling to suburban work sites, a reverse flow of city residents has also developed. Since many of the latter group will be strongly oriented toward using transit, it is important that good transit links be maintained to the city.

Map 4 was originally developed as part of the <u>Regional Employment Centers Study</u> conducted by DVRPC in 1986.<sup>4</sup> It still adequately represents existing and developing employment centers in the four New Jersey counties. While the shaded areas represent employment concentrations, the total employment in each area varies widely, ranging from about 54,000 in the Trenton CBD to less than 1,000 in outlying centers. Accessibility by transit also varies widely. The Camden and Trenton CBDs are well served, but even in these locations, given the ready availability of free parking, use of transit is largely limited to the transit dependent. In suburban areas, employment density is low and some industrial areas are not served at all.

A major problem in developing transit markets to suburban locations consists of designing services that can deliver riders efficiently to dispersed sites. The job would be made easier if developers would include transit and pedestrian facilities in their plans, and not just surround commercial sites with acres of parking and roadways that pedestrians find difficult to cross.

Only 25 traffic zones, or less than 8 percent of the total, showed employment densities in 1990 sufficient to attract even a moderate level of ridership; and only 4 zones fell into the high category. Most of these zones were in Camden or Trenton or in townships immediately

<sup>&</sup>lt;sup>4</sup><u>Regional Employment Centers Study</u>, Employment Report No. 4, DVRPC, September 1986.



adjacent, although a few other towns, such as Mount Holly and Princeton, made the list. Most of the employment centers shown in Map 5 are in zones with densities too low to attract discretionary riders, and unless a conscious effort is made to locate new employment in high density zones, the situation is not likely to change.

#### CONCLUSIONS

The map of transit potential in the four New Jersey counties shows peaks in the Camden and Trenton CBDs surrounded by concentric rings of declining potential. Superimposed on this pattern are several corridors radiating from these urban centers, as well as several circumferential corridors. The principal corridors identified are:

Name/Location	Range
Camden County	Camden to Atco
Burlington County	Camden to Mount Holly
Gloucester County	Camden to Glassboro
Delaware River	Camden to Trenton
Trenton North	Trenton to Pennington
Northeast Corridor	Trenton to Princeton
Inner Suburban	Woodbury to Maple Shade
Outer Suburban	Glassboro to Mount Holly
Burlington Cross County	Burlington to Mount Holly
Mercer Cross County	Princeton to Hightstown

The Camden corridor is currently well served by PATCO's Lindenwold line and the Atlantic City rail line, but the remainder could benefit from upgraded service. The existing bus routes are slow and do not generate a high level of ridership. An improved service operating on a separate right-of-way in the Burlington County, Gloucester County, and Delaware River corridors could capture trips now taken by automobile. In the Mercer County commutation needs to Newark and New York are adequately handled by rail service running on the Northeast Corridor, but improved local transit services are needed to develop the market for shorter trips. Hightstown is not served at all.

The future, as evidenced by the 2010 transit potential map, will not be significantly different from the present. Most of the growth in travel demand is now occurring in areas with low transit potential, making it difficult to attain the threshold level in the forecast period. Areas with moderate or high potential are generally not growing as fast, but should maintain stable ridership. Transit works best in a pedestrian friendly environment and where heterogeneous activities are clustered near one another. To the extent that new development can meet these requirements, it can attract transit patronage. Clustering also reduces the need for employees to have cars available at work, which also increases the likelihood that transit will be used for the work trip.

This study represents a first step in assessing the long-term needs for public transportation in the New Jersey portion of the Delaware Valley Region, and can identify underserved areas or corridors that deserve a closer look. However, this is a broad brush approach that uses demographic and employment parameters to gauge the potential for transit service at the zonal level. Before any new service can be initiated or existing service restructured, a detailed feasibility assessment is needed that looks at land use, travel patterns, connections to other routes, and the propensity to use transit.

It is important to acknowledge that the study approach and methodology are limited in scope, and the results of the study must be viewed with this in mind. The application of the seven variables to measure transit potential represents a variation of the transit overlay technique.<sup>5</sup> While this methodology features several advantages, including ease of data collection and graphical representation of variables, it does look at relatively broad geographic areas. Specific details on potential trip generators or attractors are not provided. Hence, although this study used the smallest readily available unit of spatial analysis - the traffic zone - it is still too generalized to yield a sufficient grain of analysis for conducting detailed route and service planning.

This report also provides a foundation for conducting more detailed analysis and illustrates, on a general basis, the employment and demographic trends in the region as they relate to future public transportation. The information contained herein is intended to serve as an indicator of potential transit corridors which need to be strengthened and supported by conscious public policies, if transit service is to be feasible.

<sup>&</sup>lt;sup>5</sup>Corradino, Coomer, and Upshaw, "Successive Overlays - A Small City Transit Surveying Process," <u>Traffic</u> <u>Engineering</u>, December 1974.

# APPENDICES

## APPENDIX I - THEORY

The transit potential of each zone is a composite resulting from combining partial potentials derived separately for each relevant variable. It will be assumed that each partial potential responds linearly to its underlying variable, i.e.,

$$P_i(x_i) \propto x_i$$

where  $x_i$  is the variable measured and  $P_i(x_i)$  the potential accruing from  $x_i$ . All variables are expressed as areal densities, i.e., per acre. In this way the zonal potentials are not determined by the size of the zone, and more accurately reflect that parameter's ability to drive demand. A linear response implies that if the parameter driving demand doubles, then the demand itself should double.

The potential P<sub>i</sub> will be normalized so that

$$P_i(A_i) = 1$$

where  $A_i$  is the threshold for supporting transit service. This is accomplished by setting

$$P_i = \frac{X_i}{A_i}$$

and can be visualized in the following graph:



Essentially the potential,  $P_i$ , is an abstract number that provides a relative measure of potential transit demand.  $P_i$  between 1 and 4 indicates low transit potential, between 4 and 16 moderate potential is indicated; and greater than 16 high potential. The dynamic range of this variable is fairly large, as the potential in the Camden CBD can exceed 30.

Trip generation will be assumed to be determined by four demographic parameters: population, households, auto ownership, and age structure. Auto ownership is specified by the number of zero-car and one-car households, and since these subsets are mutually exclusive the potential generated by auto ownership is equal to the sum of the two subsets, i.e.,

$$P_{auto} = P_{0-car} + P_{1-car}$$

Similarly, age structure is also divided into two subsets, youth and senior citizens, and the potential based on age segmentation is obtained by adding that for seniors and for youth, i.e.,

$$P_{age} = P_{senior} + P_{youth}$$

The overall generating potential will be the average of the individual potentials, i.e.,

$$P_{gen} = \frac{1}{4} \left[ P_{pop} + P_{hh} + P_{auto} + P_{age} \right]$$

Averaging allows each to have an impact on the overall potential, without affecting the normalization process. A zone that is strong with respect to some parameters, but weak with the remainder, may fare less well than a zone which shows moderate strength across the board.

Since a given zone can both generate and attract trips, and employment is the only attractor that is being considered, the total potential is found by adding the potentials for each, i.e.,

$$\mathbf{P} = \mathbf{P}_{\text{gen}} + \mathbf{P}_{\text{emp}}$$

# APPENDIX II - DEMOGRAPHIC AND EMPLOYMENT VARIABLES USED TO CALCULATE TRANSIT POTENTIAL

(all values in thousands)

County Area (acres)	Area	Area Popu-	House-	Auto Ownership		Age Group		Employ-
	lation	holds	0-Car	1-Car	Seniors	Youth	ment	
Burlington Camden Gloucester Mercer	532.7 144.0 217.7 146.8	395.1 502.8 230.1 325.8	136.6 178.8 78.8 116.9	6.7 23.8 5.4 14.8	43.6 63.7 24.3 40.3	42.2 61.2 24.8 42.2	37.0 47.4 22.6 28.0	191.3 227.9 86.1 220.6
Total	1,041.2	1,453.8	511.1	50.6	171.9	170.4	135.0	726.0

1990

2010

County	Area Popu (acres) lation	Popu-	House- holds	Auto Ownership		Age Group		Employ-
		lation		0-Car	1-Car	Seniors	Youth	ment
Burlington Camden Gloucester Mercer	532.7 144.0 217.7 146.8	455.1 567.1 290.7 370.9	166.5 204.6 101.4 133.3	6.1 22.0 4.9 13.1	40.0 59.4 21.6 38.1	49.9 68.5 30.9 48.0	42.5 53.5 28.5 31.9	227.3 253.8 113.2 266.6
Total	1,041.2	1,683.7	605.7	46.2	159.0	197.3	156.4	861.0