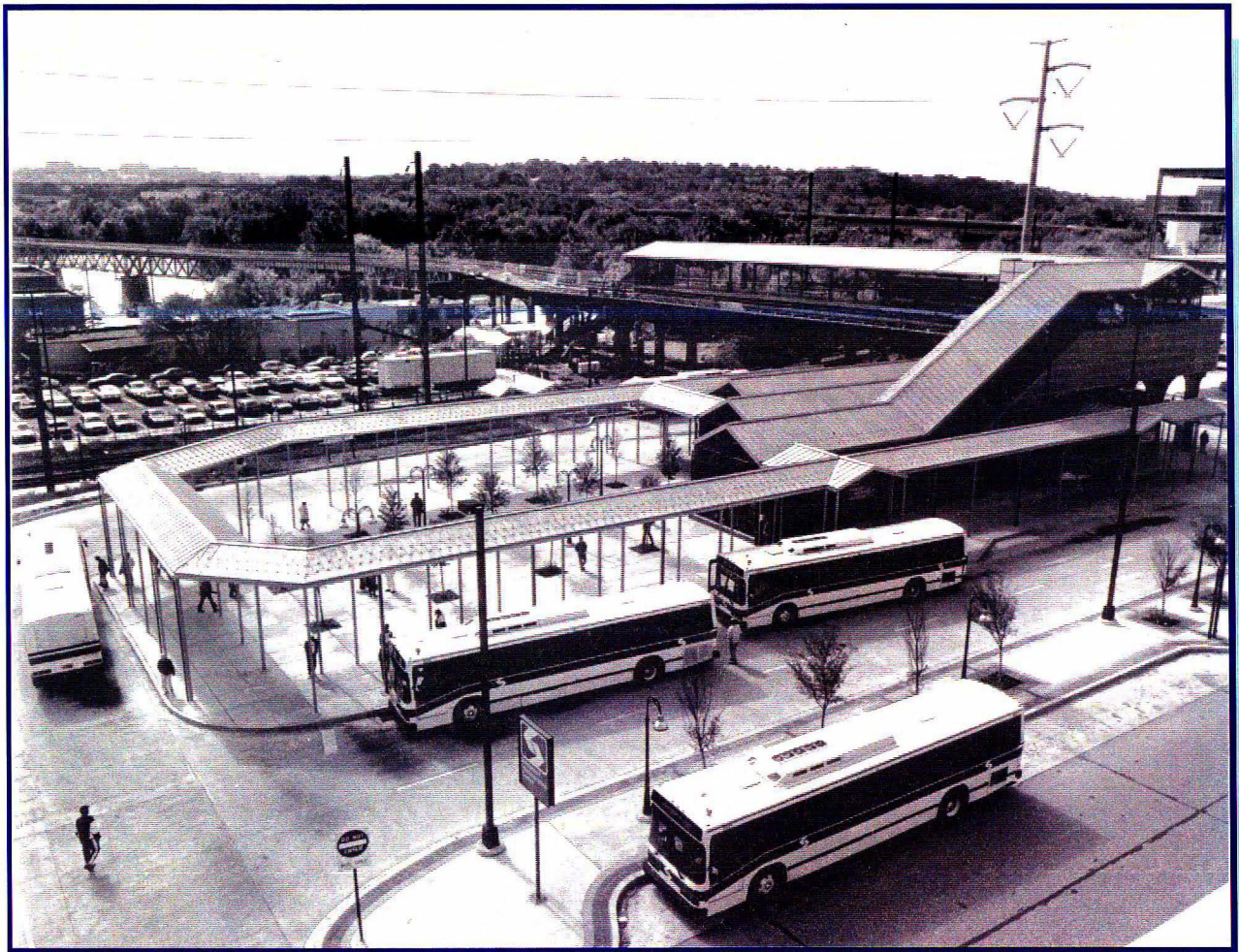


TRANSIT ACCESSIBILITY IN THE DELAWARE VALLEY REGION



Delaware Valley Regional Planning Commission
June 1998

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**Delaware Valley Regional Planning Commission
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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 Planning, 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

TITLE	Date Published: June 1998
Transit Accessibility in the Delaware Valley Region	
	Publication No. 98015

Geographic Area Covered:

Delaware Valley Region comprising five counties in Pennsylvania (Bucks, Chester, Delaware, Montgomery, and Philadelphia); and four in New Jersey (Burlington, Camden, Gloucester, and Mercer)

Key Words:

Public transportation, accessibility, transit service, bus, trolley, subway-elevated, regional rail, rail stations, population, employment, time of service

ABSTRACT

A Geographic Information System (GIS) was used to determine the share of the region's population and jobs that are located within various distances from bus and trolley lines, and rail stations. The analysis is broken down by submode and time of service.

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Executive Summary	1
I. Introduction	3
II. Methodology	5
III. Pennsylvania Counties	17
IV. New Jersey Counties	33

TABLES

<u>Table</u>	<u>Page</u>
1. 1990 Population and Employment in the Delaware Valley	6
2. Population and Employment in Pennsylvania Served by Regional Rail Lines	16
3. Population and Employment in Pennsylvania Served by Rail Transit Lines	16
4. Population and Employment in Pennsylvania Served by Bus and Trolley Routes	16
5. Population in Pennsylvania Served by by Bus and Trolley Routes by Time of Service	26
6. Population and Employment in New Jersey Served by Regional Rail Lines	32
7. Population and Employment in New Jersey Served by Rail Transit Lines	32

8.	Population and Employment in New Jersey Served by Bus Routes . .	32
9.	Population in New Jersey Served by Bus Routes by Time of Service	42

FIGURES

<u>Figure</u>		<u>Page</u>
1.	Rail Lines in the Delaware Valley Region	7
2.	Areas Served by Regional Rail Stations in Pennsylvania	19
3.	Areas Served by Rail Transit Stations in Pennsylvania	21
4.	Areas Served by SEPTA Bus and Trolley Lines	23
5.	Areas Served by SEPTA Bus and Trolley Lines on Weekdays	27
6.	Areas Served by SEPTA Bus and Trolley Lines on Weekends	29
7.	Areas Served by Regional Rail Stations in New Jersey	35
8.	Areas Served by Rail Transit Stations in New Jersey	37
9.	Areas Served by NJ TRANSIT Bus Lines	39
10.	Areas Served by NJ TRANSIT Bus Lines on Weekdays	43
11.	Areas Served by NJ TRANSIT Bus Lines on Weekends	45

EXECUTIVE SUMMARY

A Geographic Information System (GIS) was used to measure the current accessibility of the Delaware Valley Region's residents and jobs to public transportation services. The measure of accessibility used was the distance to the nearest rail station or bus/trolley route. To do this, TransCAD was used to develop separate GIS networks for regional (commuter) rail lines [SEPTA, NJ TRANSIT, Amtrak], rail transit lines [SEPTA, PATCO], SEPTA bus and trolley routes, and NJ TRANSIT bus routes, and overlaid on 1990 demographic and employment data at the zonal level.

TransCAD estimated the population and employment found within $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 miles of rail stations, and within $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, and 1 mile of bus and trolley routes. Maps showing the areas covered by these distance belts are included in the report.

On the Pennsylvania side of the region, 70 percent of the residents live and 66 percent of the jobs are located within two miles of a regional rail station. When the distance is reduced to a quarter mile, commonly accepted as walking distance, the share of population and employment falls to 5 and 11 percent, respectively. Rail transit lines, which include the subway/elevated lines plus the suburban rail lines radiating from 69th Street, place a higher number of residents and jobs within the one quarter mile belt, 6 and 16 percent, respectively, primarily because of their closer station spacing and service to the most densely developed portions of the region. Because of their comprehensive coverage throughout the city and its suburbs, buses and trolleys are able to bring a much larger fraction of the region's population and employment within walking distance of a route, 64 and 65 percent, respectively. When the distance is extended to one-half mile, these figures rise to 75 and 77 percent.

SEPTA does provide reasonably good coverage to the Pennsylvania side of the Delaware Valley Region. Most of the unserved areas are low-density areas with relatively few residents and jobs. Buses provide comprehensive coverage, while rail lines offer generally speedier service, both from outlying points and through congested areas.

Regional rail service to the New Jersey counties is far sparser than on the Pennsylvania side of the river. NJ TRANSIT only operates two lines, with a spur, in the Delaware Valley Region, and stations are fewer and further apart. In consequence, only 17 percent of the residents and 26 percent of the jobs are located within two miles of a station. At one quarter mile access, the share falls to 0.3 and 1.1 percent, respectively. The one rail transit line, the PATCO Hi-Speed Line serves roughly twice as many residents and jobs at the one quarter mile distance, 0.7 and 2.5 percent, but fewer at two miles, 15 percent for both residents and jobs. As on the Pennsylvania side, it is buses that provide the comprehensive coverage, placing 68 percent of the

population and 77 percent of the employment within one-half mile of a route. The shares within the one quarter mile walking distance are a still respectable 49 and 57 percent. As on the Pennsylvania side of the region, buses in New Jersey supply the bulk of the coverage. Because the New Jersey counties lack the concentration of population and employment found in Philadelphia, the share of residents and jobs served by transit is smaller.

I. INTRODUCTION

The Delaware Valley Regional Planning Commission (DVRPC) has established a Geographic Information System (GIS) using TransCAD that incorporates regional transit routes and basic operating data. Since the GIS will also incorporate Census data and other socio-economic parameters, it should prove to be a useful planning tool. This report describes one of its first applications, measuring the accessibility of the region's residents and jobs to public transportation. Accessibility provides an indication of how well the region is served by local transit operators.

The Delaware Valley region comprises five counties in Pennsylvania (Bucks, Chester, Delaware, Montgomery, and Philadelphia) and four in New Jersey (Burlington, Camden, Gloucester, and Mercer), which collectively constitute the greater Philadelphia metropolitan area. Comprehensive transit service is provided on the Pennsylvania side of the region by the Southeastern Pennsylvania Transportation Authority (SEPTA) and on the New Jersey side by NJ TRANSIT, although both carriers cross the Delaware River to access terminals in the opposite state. In addition, the Port Authority Transit Corporation (PATCO) operates a single rail line between Lindenwold in Camden County and Philadelphia, and Amtrak provides intercity rail service, with some local carriage, along the Northeast (Boston-Washington) and Keystone (Philadelphia-Harrisburg) corridors. Rail, bus, and trolley routes operated by these carriers have been incorporated into the GIS with information on the mode and type of service provided.

TransCAD was used to calculate the number of residents or jobs located within specified distances of transit routes or stations. The route network can consist of all services offered, or be limited by mode, time of day, or day of week. Generally, areas were considered accessible if they were within two miles of a regional rail or rail transit station, or within one mile of a bus or trolley route, but smaller gradations were used to determine the degree of accessibility.

Section II of the report outlines the methodology used to determine accessibility, along with descriptions of the zonal data required, the transit networks, and the method of analysis followed by the GIS. Using maps and tables the results for the Pennsylvania counties are presented in Section III, and that for the New Jersey counties in Section IV.

In this report, accessibility to rail stations and bus/trolley routes was calculated for various distances by mode and by state. Because of the incompatibility of the modal networks, it is not possible, at least at this time, to combine the networks and ask what share of the residents or jobs are located within a specified distance of any transit service, regardless of mode.

It would also be useful to look at accessibility for smaller geographic areas or subpopulations, and that can be done now. Breaking the data down by county, or even county planning areas, would provide information on how transit services are distributed, and how well served are the various subdivisions. Disaggregating population by income or car ownership, for example, could help transit operators monitor service to target markets.

II. METHODOLOGY

A. Population and Employment

The population and employment used in this study to define accessibility were based on the 1990 Census, as tabulated at the level of Traffic Analysis Zones (TAZ). Typically, the TAZs are equivalent to census tracts, although in some cases they are defined by block groups. The 1990 Census geographic coding split many of the 1980 census tracts into two or more new tracts to reflect growth in some suburban and rural areas of the region, and the 1990 TAZs have been updated to match these changes. The 1990 zonal system retains the block group designation in Center City Philadelphia, where 12 census tracts are subdivided into 54 TAZs based on block groups. In addition, combinations of 1990 block groups were used as 1990 TAZs in selected suburban areas that are growing rapidly.

Population refers to the total number of inhabitants without regard to race, gender, age or any other socio-economic variable, whereas employment refers to the total number of full-time jobs found in a TAZ. Both were obtained from the Urban Element of the 1990 Census Transportation Planning Package, which is based on the long-form questionnaires distributed to about 17 percent of all households. Since the census employment data is based on trips taken by workers to their primary job during the census week, it has been adjusted upward to account for absences and second jobs. The employment data are available by industrial sector, but in this study only total employment was used. To achieve data consistency, the zonal demographic and employment were factored to match the municipal totals derived from the census full population count and the employment count adopted by the DVRPC Board. For a detailed tabulation of the data used, see 1990 Data Bank for Transportation Planning, DVRPC Publication No. 94030, October 1994. County totals for population and employment are shown in Table 1.

The Delaware Valley region as a whole is a mature region that is growing only slowly, its population having only increased by three percent between 1980 and 1990. However, within the region significant changes are taking place. Although Philadelphia's 1.6 million residents still comprise the largest concentration of people in the region, its population is slowly declining, losing about six percent of its residents during the 1980s. In contrast, the suburban counties as a whole are growing, having increased by almost eight percent during the same decade. And further, the fastest growth is occurring in the outer portions of these counties.

While overall population may have been static, employment is not. During the 1980s the total number of jobs in the region increased by 17 percent. Philadelphia held its own, closing the decade just above where it started, while jobs in the suburban

Table 1

**1990 Population and Employment
in the Delaware Valley**
(in thousands)

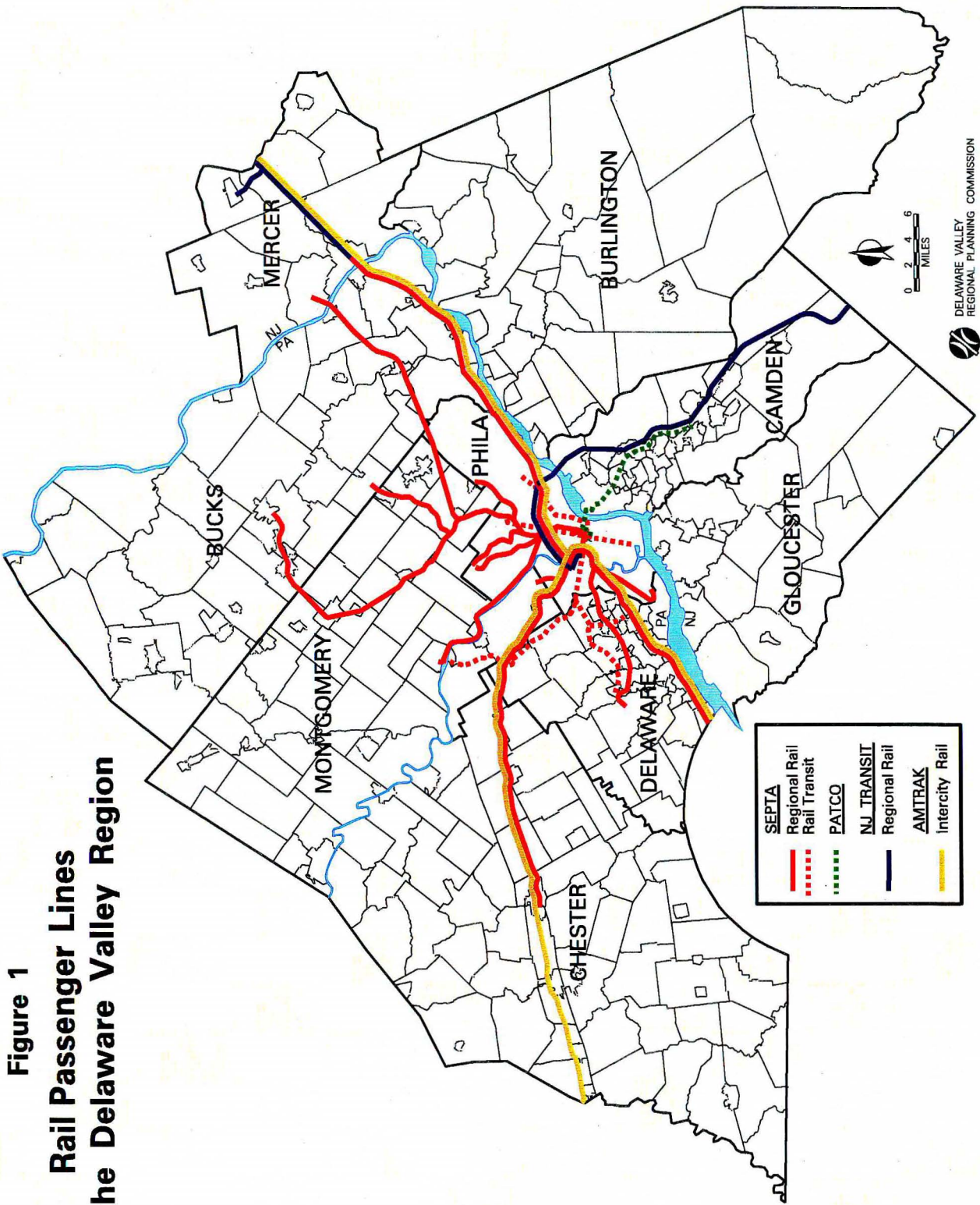
County	Population	Employment
Bucks	541	245
Chester	376	198
Delaware	548	230
Montgomery	678	458
Philadelphia	1,586	837
PA Total	3,729	1,968
Burlington	395	191
Camden	503	228
Gloucester	230	86
Mercer	326	221
NJ Total	1,454	726
Region Total	5,183	2,694

counties increased by 27 percent. This has greatly shifted commutation patterns, increasing the number of intrasuburban and reverse commutes, while leaving the number of traditional radial trips to Center City relatively level.

B. Transit Network and Operators

Taken together, SEPTA, NJ TRANSIT, and PATCO handle almost all of the public transportation trips carried within the Delaware Valley region. All three operators are interstate carriers in that they cross the Delaware River, SEPTA with two rail lines and a bus route to Mercer County, PATCO with its rail line over the Benjamin Franklin Bridge, and NJ TRANSIT with one rail line and 19 bus routes linking Philadelphia with South Jersey communities and the Jersey shore. SEPTA also operates rail and bus service to Wilmington, DE. In addition, intercity rail service is provided by the National Railroad Passenger Corporation, better known as Amtrak. For a map of the region showing municipal boundaries and principal rail lines, see Fig. 1.

Because of the prevalence of one-way streets in Philadelphia, as well as the use of interchange ramps and circulatory loops throughout the region, bus and trolley routes were coded by direction. Routes and service levels replicate that in place at the end



of 1996. As stated earlier, the population and employment data are based on the 1990 Census.

The following transit operators serve the Delaware Valley Region, as described below:

1. Southeastern Pennsylvania Transportation Authority

SEPTA provides comprehensive public transportation services to most of the urbanized portion of the Pennsylvania side of the DVRPC region, using a mix of regional rail, subway-elevated, bus, trolley, and trackless trolley routes.

The regional rail network consists of thirteen routes radiating from Center City and reaching all five Pennsylvania counties. In addition, two of the lines cross the Delaware River to New Jersey terminating at Trenton and West Trenton, respectively, and a third line enters the State of Delaware terminating at Wilmington. Three stations serve Center City: 30th Street, shared with Amtrak and NJ TRANSIT; Suburban, the busiest on weekdays; and Market East, which replaced Reading Terminal when the Center City Commuter Tunnel was completed in 1984. The R1 Airport line was opened the following year, and since then new stations have been built at Temple University and the University of Pennsylvania. Compared to rail lines in other metropolitan areas, SEPTA's lines are relatively short, the furthest extension being Doylestown, less than 35 miles from Suburban Station. Service is provided seven days per week, generally from 6:00 am to 12 midnight, the one exception being the R6 Cynwyd line, which sees only limited weekday service.

Subway/elevated services consists of two city lines, the Market-Frankford line and the Broad Street Subway, the latter with a spur to 8th and Market streets. While largely contained in the city, the Market-Frankford line extends westward to the 69th Street Terminal at Upper Darby in Delaware County. These lines, together with Routes 100 (Norristown), 101 (Media), and 102 (Sharon Hill) radiating from 69th Street, are categorized in this report as rail transit, for reasons explained on page 6 under Modes.

The once extensive Philadelphia trolley system has been reduced to five surviving Subway-Surface lines, so-called because they are street running in West Philadelphia and underground in Center City. Two of these routes extend into Delaware County. There are also five trackless trolley or electric bus routes, three in Northeast and two in South Philadelphia. None extend beyond the city limits.

More than one-half (56%) of SEPTA's riders are on its 111 bus routes, which are split between its City and Suburban Transit operating divisions. Although most of the City Transit routes are contained within Philadelphia, several extend deeply into the suburban counties, reaching destinations such as Chester, Ardmore, and Doylestown.

The Suburban Transit routes are in turn split between the Victory and Frontier districts. Victory routes serve mainly Delaware and Chester counties, many radiating from 69th Street, although two expressway routes link Center City with King of Prussia and Chesterbrook. Frontier routes largely radiate from Norristown, with a smaller cluster focused on Neshaminy Mall in lower Bucks County. One of the latter group crosses the Delaware River at Trenton, and provides rail connections to New York. Frontier also operates four '200 series' shuttles linking regional rail stations with nearby employment centers. In addition, SEPTA sponsors one contract route linking West Chester with Wilmington, DE.

2. New Jersey Transit Corporation

NJ TRANSIT provides comprehensive bus service throughout southern New Jersey, but operates regional rail service on only a few lines.

Although NJ TRANSIT's rail service is focused on North Jersey, two of its routes and a spur serve the Delaware Valley region. Northeast corridor trains run north from Trenton to New York at thirty minute intervals over much of the week, with a connecting spur at Princeton Junction for passengers to/from Princeton. After an eight-year hiatus, NJ TRANSIT resumed rail service between Lindenwold and Atlantic City. This was later extended westward across the Delair Bridge to Philadelphia's 30th Street Station, and service expanded to 13 daily round trips.

Comprehensive bus service is provided to most of the communities in the four counties comprising the New Jersey portion of the region. These routes can be conveniently grouped into Philadelphia commuter, Camden local, seashore, and Mercer County services. The commuter routes circulate through Philadelphia Center City on a clockwise loop defined by Sixth, Market, Broad, and Vine streets, whereas the seashore routes use the Greyhound Terminal in Philadelphia adjacent to SEPTA's Market East Station. The first group comprises fifteen routes from Philadelphia Center City that cross the Ben Franklin Bridge and then fan out to destinations ranging from Trenton in the north to Pennsville in the south. Most trips pass by the Walter Rand Transportation Center in Camden, although some peak trips run express directly to/from the bridge. Four of these routes extend beyond the boundary of the region, running to destinations in Salem and Cumberland counties, and one route provides through service between Philadelphia and Trenton.

The Philadelphia routes are supplemented by nine intrastate routes providing local service in Camden County and the adjacent urbanized portions of Burlington and Gloucester counties. Five of the routes are focussed on the City of Camden, two serve intrasuburban markets, and two feed the Avandale park-and-ride lot in Winslow Township, where connections can be made to Atlantic City buses.

Four routes depart from Philadelphia headed for New Jersey shore destinations, such as Cape May, Atlantic City, and Asbury Park. Additional trips to Atlantic City are mounted from the Lindenwold PATCO station, and another route passes through the easternmost corner of Burlington County en route from Lakewood to Atlantic City. Atlantic City is the only destination in southern New Jersey that receives all night service. Although the aforementioned seashore service is offered year round, service levels are adjusted to match seasonal demand. In addition, summer only routes are added from Philadelphia to Great Adventure, Beach Haven, and Cape May.

Finally, a cluster of eleven routes serve Mercer County and adjacent portions of Hunterdon, Somerset, and Middlesex counties. All but one route pass through Trenton, linking the state capital with nearby communities. The one exception serves the Princeton area. The Trenton rail station has evolved into a major transportation center, where connections can be made between Amtrak, NJ TRANSIT, and SEPTA rail lines, as well as NJ TRANSIT and SEPTA bus routes.

3. Port Authority Transit Corporation

PATCO service is limited to a single 14-mile rail line between Lindenwold and Philadelphia. The route serves the "main line" communities of Camden County, linking them with the City of Camden and Philadelphia Center City. At Lindenwold connections can be made to NJ TRANSIT trains and buses, at the Walter Rand Transportation Center in Camden to NJ TRANSIT buses, and in Philadelphia to SEPTA trains, subways, and buses. Service is provided 24 hours per day, seven days per week.

4. National Railroad Passenger Corporation

Amtrak owns the Northeast Corridor and the Harrisburg Line, which it shares with SEPTA and NJ TRANSIT, and itself operates rail service within and through the region. However, most of its stops are also served by either SEPTA or NJ TRANSIT, the exceptions being Parkesburg and Coatesville on the Harrisburg Line. Because these two stations were served by SEPTA's R5 line until November 1996, and are still served by Amtrak's *Keystone* trains, they have been included in the analysis for regional rail. Only on this line does Amtrak handle measurable numbers of intra-regional commuters.

Frequent service is provided on the Northeast Corridor north to New York and Boston, and south to Baltimore and Washington. The corridor is also used by trains traveling to more distant destinations, such as Miami, New Orleans, Chicago, and St. Albans (VT). The *Keystone* Corridor handles eight daily round trips weekdays, and four on

weekends, between Philadelphia and Harrisburg, with one extending to Pittsburgh, plus the through New York-Chicago *Three Rivers*.

5. Other Carriers

In addition, Pottstown Urban Transit (PUT) provides local bus service at the western end of Montgomery and Chester counties, and there are several private carriers operating in the region, such as Suburban Transit in New Jersey; and Bieber Tourways, Krapf's Coaches, and Capital Trailways in Pennsylvania. However, this study will limit its consideration of bus services to that provided by SEPTA and NJ TRANSIT.

It is clear from the above description that transit agencies in the Delaware Valley operate various modes with service levels that vary by time of day or day of week.

Regional rail, which includes service operated by SEPTA and NJ TRANSIT, as well as Amtrak's corridor trains, is also known as commuter rail, although strictly speaking, commuter rail refers to service limited to rush hour slots. Most of the regional rail lines in this region are full service lines with midday, evening, and weekend trips. Rail transit includes the subway-elevated lines operated by SEPTA and PATCO, as well as the three suburban light rail lines radiating from the SEPTA's 69th Street Terminal in Upper Darby. In this study the latter have been grouped with the subway-elevated lines because they primarily operate on segregated rights-of-way, use discrete stations - some with parking, and transfer passengers to/from the Market-Frankford subway-elevated line at 69th Street. In contrast, SEPTA's five subway-surface trolley routes operate in the street through West Philadelphia and the adjacent portions of Delaware County and operate more like buses. Thus, these are classified as bus and trolley, a category which also includes SEPTA's five trackless trolley routes.

Accessibility to transit services varies by time of day and day of week. On weekdays, the most service is generally offered during peak hours, with decreasing amounts provided during the middays, in the evenings, and during the late night (owl) hours. On weekends, there is usually more service on Saturdays than on Sundays. To provide an indication of when service was available to given areas, routes were labeled as to their time of operation on weekdays and whether they had weekend service. The following categories were used:

Peak	Roughly defined as 6:00 to 9:00 am and 3:30 to 6:30 pm on weekdays. Route offers at least one trip in the am and pm peaks, but may be unidirectional in a given peak.
Midday	Route offers bidirectional service at regular intervals between the am and pm peaks.

Evening	Bidirectional service offered until at least 9:00 pm on week nights.
Owl	Some service offered between 1:00 and 4:00 am on weekdays.
Saturday	All day.
Sunday	All day.

Originally, the intent was to look at all modes together with respect to time of service variations, however, because of incompatible formats, it proved impossible to combine the rail networks with the bus and trolley networks. However, since most of the rail lines in the Delaware Valley region run weekdays from the morning rush hour into the late evening hours (only PATCO's Lindenwold Line runs all night), and on Saturdays and Sundays, almost all the variation occurs with the bus and trolley lines. Thus, because of these constraints and considerations, the time-of-service variations were calculated only for the latter.

Since a much larger share of off-peak transit trips are taken for non-work purposes, the accessibility calculations in this part of the study were limited to population. This is not to gainsay the importance of being able to travel to shift jobs, but rather a recognition that the time-of-service variation would be sufficiently elicited by using population only, and that the study effort needed to be kept to a manageable level.

C. Method of Analysis

1. Background

The Geographic Information System (GIS) is a computerized data base management system for the capture, storage, retrieval, analysis, and display of spatial data. A GIS contains two broad classifications of information: geocoded spatial data and attributed data. Geocoded spatial data define objects that have an orientation and position in two-dimensional space. Each object is classified as either a point (such as rail station), a line (e.g., a bus route), or a polygon (e.g., number of people living within a block) and is tied to the geographic coordinate system. These objects have precise definitions and maintain a defined geometric relationship to each other. Moreover, a GIS contains the same attribute data that are found in traditional databases. For example, the regional rail database can include attributes, such as daily ridership and station parking spaces; and the bus route database can include attributes, such as level of service and ridership. The TransCAD package was used for this analysis.

A transportation system network representation consists of nodes, links, and attributes distributed in two-dimensional space. Events happen within this system at a point (rail

station), along a segment (level of service), or within a geographical area (the number of people living within ¼-mile of a bus route).

2. Transit Network Development

A transit network was developed for this study. This network was divided into three modes: regional rail, rail transit, and bus and trolley, and were further grouped by state. The network consists of links and nodes, links representing the routes and nodes the stations or junctions. The regional rail and rail transit networks initially were based on the National Transportation Atlas Data Bases from the Bureau of Transportation Statistics (BTS) of the US Department of Transportation. These databases are available on CD ROM from the BTS. However, these databases were all in ASCII file format and in order to develop a GIS database, they required extensive data processing, such as writing specific computer programs to extract data for the DVRPC region from the national databases.

Moreover, these databases did not have current information. For some segments of the network, the data was almost 10 years old. Consequently, these databases had to be checked and modified link by link and node by node.

Validating the transit network for bus routes was the most labor intensive. First, all the bus routes had to be identified including those with route variations, such as express buses during the peak hours. Then this information was transformed into a GIS database file using the digitizing technique (for the Pennsylvania portion of the region) and the 1995 TIGER/Line from the Bureau of the Census (for the New Jersey portion). These processes were not easy tasks. For example, the computer file that was developed using a digitizing method, contained segments that did not connect with each other. These had to be found and corrected. Further, the TIGER database also needed to be checked, as it included too many unnecessary segments. These extra segments created problems, such as taking excessive space in the computer's memory, and consequently slowing subsequent processing tasks during the analysis phase.

3. GIS Demographic Database

The demographic database contains the 1990 Census population and employment at various geographic levels, such as county, municipality, and TAZ. The details of how these databases and/or specific data attributes were constructed are described in Information System for Transportation Planning, DVRPC Publication No. 95007, May 1995.

To calculate transit accessibility, the TransCAD software uses an overlap procedure, which estimates the attributes within a specified area around a feature by superimposing them over other features, and figuring out the extent to which they overlap. In this case, the individual transit modal networks (i.e., regional rail, rail transit, trolley and bus) with their respective distance belts were superimposed over the population and employment databases at the TAZ level. These demographic attributes were then assumed to be distributed uniformly over the area of each TAZ, with the share assigned to each distance belt from a line or station based on the proportional area intercepted.

Table 2

**Population and Employment in Pennsylvania Counties
Served by Regional Rail Lines**

Access Distance (1) (miles)	Population Served (000)	Percent of Total Population (3)	Employment Served (000)	Percent of Total Employment (3)
< ¼	194	5.2%	208	10.6%
< ½	667	17.9%	575	29.2%
< 1	1,564	41.9%	999	50.8%
< 2	2,616	70.2%	1,301	66.1%

Table 3

**Population and Employment in Pennsylvania Counties
Served by Rail Transit Lines**

Access Distance (1) (miles)	Population Served (000)	Percent of Total Population (3)	Employment Served (000)	Percent of Total Employment (3)
< ¼	233	6.2%	311	15.8%
< ½	561	15.0%	522	26.5%
< 1	1,058	28.4%	678	34.4%
< 2	1,597	42.8%	861	43.7%

Table 4

**Population and Employment in Pennsylvania Counties
Served by Bus and Trolley Routes**

Access Distance (2) (miles)	Population Served (000)	Percent of Total Population (3)	Employment Served (000)	Percent of Total Employment (3)
< 1/8	1,782	47.8%	996	50.6%
< ¼	2,372	63.6%	1,274	64.8%
< ½	2,806	75.3%	1,523	77.4%
< 1	3,110	83.4%	1,706	86.7%

Notes:

- (1) Distance from nearest regional rail or rail transit station.
- (2) Distance from nearest bus or trolley route.
- (3) Total population or employment in Bucks, Chester, Delaware, Montgomery, and Philadelphia counties based on 1990 Census.

III. PENNSYLVANIA COUNTIES

Transit accessibility was estimated for the following modes:

1. Regional Rail

The population and employment in the five Pennsylvania counties served by regional rail lines are tabulated in Table 2. Because rail services can only be accessed where trains stop, distances have been measured from stations, rather than from the lines. Since SEPTA's stations are for the most part closely spaced, this did not have a major impact on overall access, although it did reduce the numbers for the shorter distances. The analysis considered a total of 150 stations, the 147 Pennsylvania stations served by SEPTA, plus two served solely by Amtrak (Parkesburg and Coatesville) and Trenton. Although the last is located in New Jersey, it was included because of its importance to Bucks County residents for commutation to New York.

SEPTA has a total of 195.9 route-miles on 13 lines in revenue service in Pennsylvania. NJ TRANSIT adds another 2.1 non-redundant route-miles in Philadelphia as part of its Atlantic City service, but this adds no stations, as its only station in Pennsylvania, 30th Street, is shared with SEPTA and Amtrak. Disregarding separate trackage in the vicinity of 30th Street Station, Amtrak adds another 15.9 route-miles west of Downingtown in Chester County, as part of its *Keystone Service* to Harrisburg.

About 70 percent of the region's residents in Pennsylvania live within two miles of a regional rail station, and 42 percent live within one mile. The coverage, as can be seen in Figure 2, blankets the central portion of the area with fingers extending into the more distant suburbs. Many of the stations are located in older communities, which enhances walking access, but often constrains parking and vehicular access. In other words, most of the residents of the five Pennsylvania counties have rail service available within two miles of their homes. However, only 5 percent live within the normally accepted walking distance of a quarter mile, and if this is stretched to one-half mile, the share rises to 18 percent.

With respect to employment, almost 11 percent of the jobs are within a quarter mile of a station and 29 percent are within one-half mile, shares that are respectively higher than for population. About two-thirds (66%) of the area's jobs are located within two miles of a rail station, which is slightly less than the share of population found within a similar distance. However, here it is the share within the shorter distances that are more important. If commuters are to be attracted to a rail line in significant numbers, the destination for most must be within walking distance of a station. Even though

decentralizing trends have affected both population and employment, the distribution of jobs remains more concentrated than that for residents.

2. Rail Transit

Access to rail transit lines in Pennsylvania is tabulated in Table 3. As with regional rail, access is measured to stations, rather than to lines. However, in this case the close station spacing found on these lines reduces the impact of the distinction.

The SEPTA system, which includes the Market-Frankford Subway-Elevated, the Broad Street Subway, and three suburban lines radiating from the 69th Street Terminal in Upper Darby, encompasses 121 non-duplicative stations on 51.8 route-miles. PATCO's Lindenwold Line adds three stations and 2.2 miles, all in Center City Philadelphia and in close proximity to SEPTA's lines. Coverage, shown in Fig. 3, is concentrated closer to the urban core than is the case with the regional rail lines, and for the most part serves areas with higher population and employment densities in Philadelphia and Delaware counties. The Montgomery County portion of Route 100 does serve lower density areas in that county, as well as an adjacent corner of Chester County.

Because of these higher densities and in spite of a smaller route structure with fewer stations, a larger share of the area's residents (6.2%) and jobs (15.8%) are within walking distance ($\frac{1}{4}$ -mile) of rail transit stations than regional rail stations. However, the situation is reversed at greater access distances, where the rail transit lines reach fewer residents and jobs, a consequence of the shorter reach into the suburbs and closer station spacing. Using an access distance of two miles, 42.8% of the population and 43.7% of employment is reachable by rail transit.

3. Bus and Trolley

Although SEPTA's surface transit network is heavily focussed toward the center, the coverage is almost complete over the more densely developed portions of the area, and does extend significant distances into the suburban counties. As can be seen in Fig. 4, most of Philadelphia lies within the $\frac{1}{4}$ -mile zone, and coverage at larger distances is almost complete for eastern Delaware County, and the closer in portions of Montgomery and Bucks counties.

As a consequence of this blanket coverage, the bulk of SEPTA's riders (60.5% based on linked trips) are carried on its bus and trolley routes, and this is reflected in Table 4, which shows that almost one-half the population (47.8%) in the Pennsylvania counties live within a quarter mile of a bus or trolley line and more than one-half of the

Figure 2
Areas Served by Regional Rail Stations in Pennsylvania

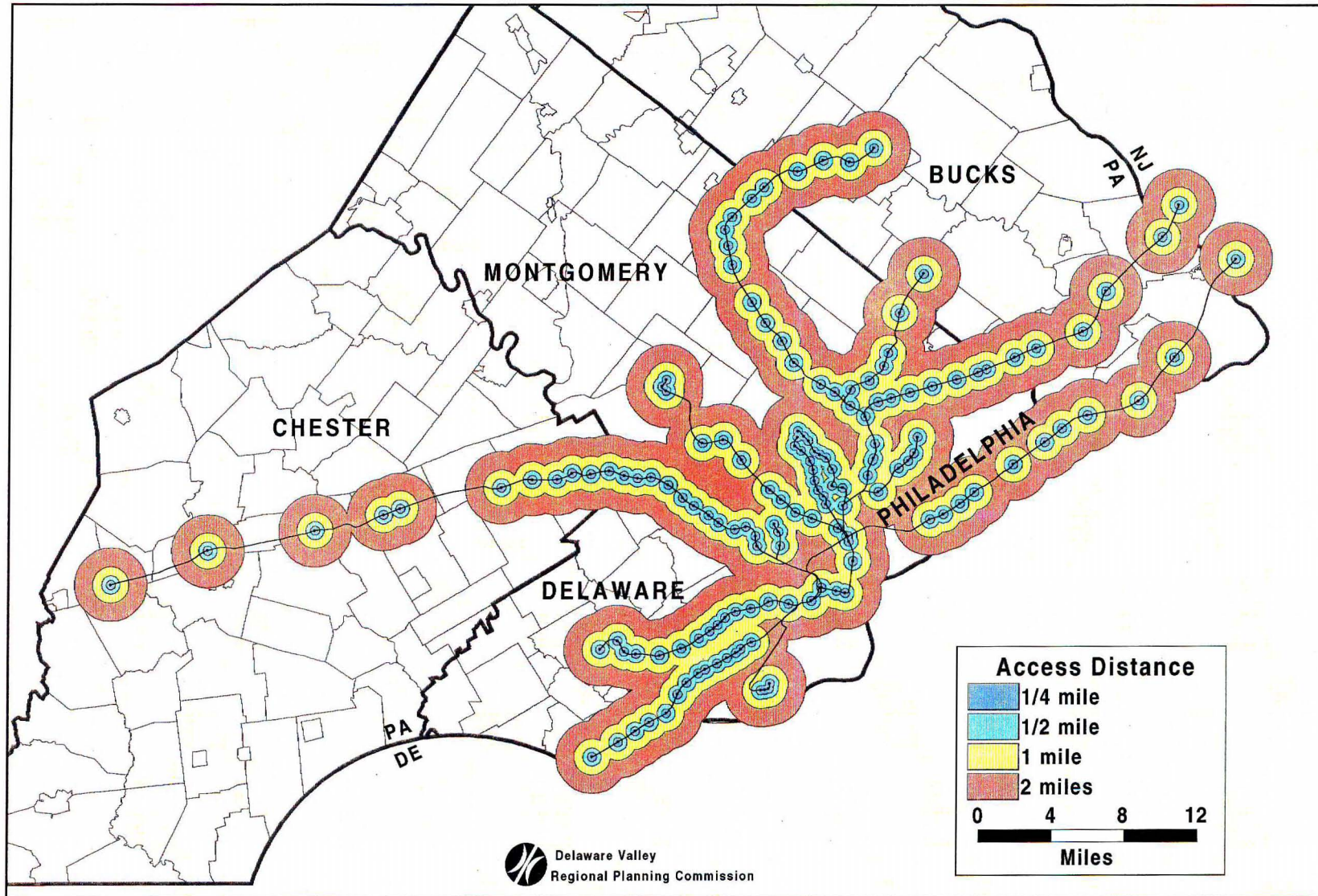


Figure 3
Areas Served by Rail Transit Stations in Pennsylvania

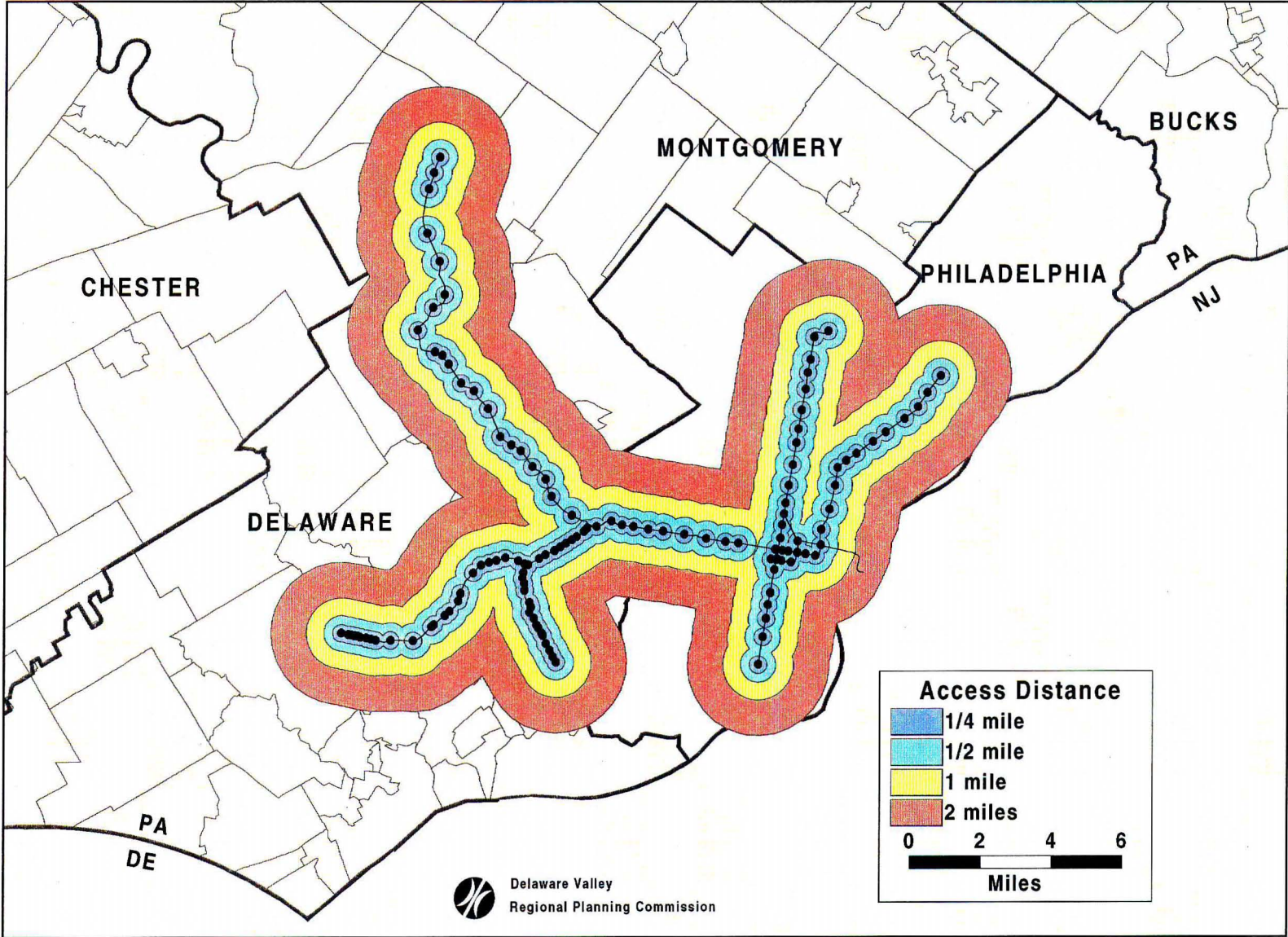
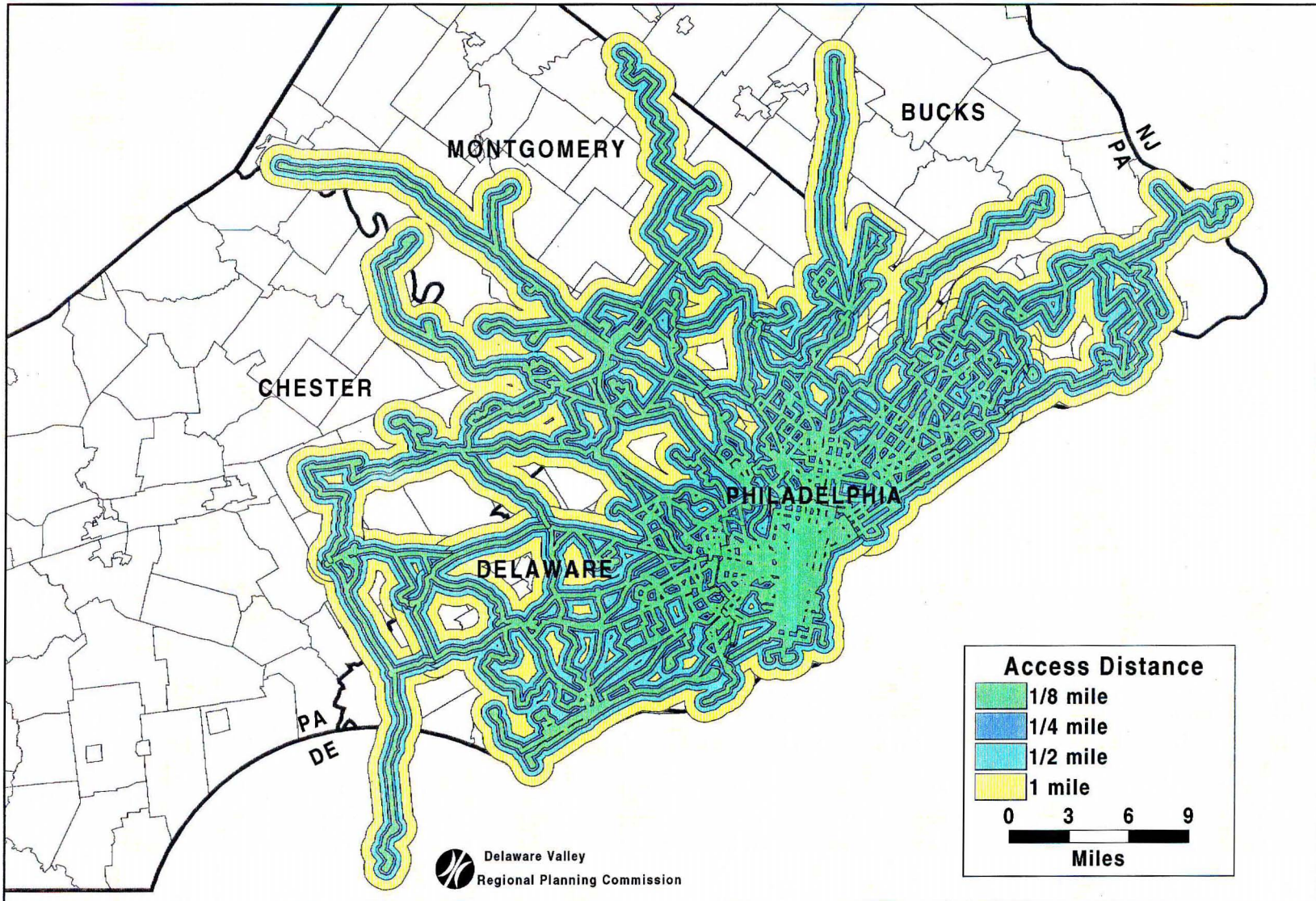


Figure 4
Areas Served by SEPTA Bus and Trolley Lines



jobs (50.6%) are located within the same zone. The one-half mile belt contains more than three-fourths of the area's residents and jobs (75.3% and 77.4%, respectively).

4. Time of Service

With minor exceptions, the service tabulated in Tables 2 through 4 and displayed in Figures 2 through 4 reflects the service offered during the peak commutation hours. Less service is usually offered at other times of the day and on weekends.

Table 5 shows how SEPTA's bus and trolley service varies over the course of a weekday and through the week. For mapping purposes, coverage shown is for one-half mile access. In this case midday coverage is only slightly less than that available during the peaks. Headways may be longer, but basically most of the places accessible by transit during the peak are still accessible at midday. For example, 81 percent of the Pennsylvania residents reside within one mile of a bus or trolley line running at midday, compared to 83 percent during the peak, with most of the loss occurring in the suburbs. For the one quarter mile walking distance, the share is 60 percent, compared to 64 percent at the peak. Moving to evening service, however, the reduction is relatively large, with the one mile coverage falling to 56 percent and the one quarter mile to 36 percent. (See Fig. 5)

Only a few areas in southeastern Pennsylvania receive bus service limited to peak hours, these being primarily office parks and a few communities, such as Gladwyne and Yardley, and the latter is on a full service rail line. Evening routes, however, is more restricted, with many of the longer suburban routes losing service. These include circumferential routes, such as West Chester to Wilmington, and King of Prussia to West Chester and Chester; and radial routes to Pottstown, Telford, Bristol, and Trenton. The last two destinations are served by rail. Owl service is limited to core routes in Philadelphia.

On weekends Saturday service is just a shade below that offered at midday on weekdays, with 81 percent of the population residing within one mile and 60 percent within a quarter mile. SEPTA's Sunday service is positioned about halfway between that offered at midday and in the evening on weekdays. The one-mile coverage is 67 percent and the one quarter mile is 48 percent. (See Fig. 6)

Bus routes with Saturday service, but with nothing on Sunday, include West Chester and Chester to King of Prussia, and Oaks to Willow Grove; and radial routes running to Royersford, Pottstown, Telford, Newtown, and Bristol, and Trenton.

Table 5
**Population in Pennsylvania
 Served by Bus and Trolley Routes
 by Time of Day and Day of Week**
 (Population in thousands)

Access Distance (1) (miles)	Time Period											
	Peak		Midday		Evening		Saturday		Sunday			
	Number	Share (2)	Number	Share (2)	Number	Share (2)	Number	Share (2)	Number	Share (2)		
< 1/8	1,782	47.8%	1,668	44.7%	940	25.2%	1,631	43.7%	1,346	36.1%		
< 1/4	2,372	63.6%	2,253	60.4%	1,327	35.6%	2,220	59.5%	1,798	48.2%		
< 1/2	2,806	75.3%	2,692	72.2%	1,682	45.1%	2,672	71.7%	2,149	57.6%		
< 1	3,110	83.4%	3,034	81.4%	2,085	55.9%	3,012	80.8%	2,487	66.7%		

Notes:

- 1) Distance from nearest bus or trolley route.
- 2) Based on total 1990 population in Bucks, Chester, Delaware, Montgomery, and Philadelphia counties.

Figure 5
Areas Served within 1/2-Mile by SEPTA Bus and Trolley Lines on Weekdays

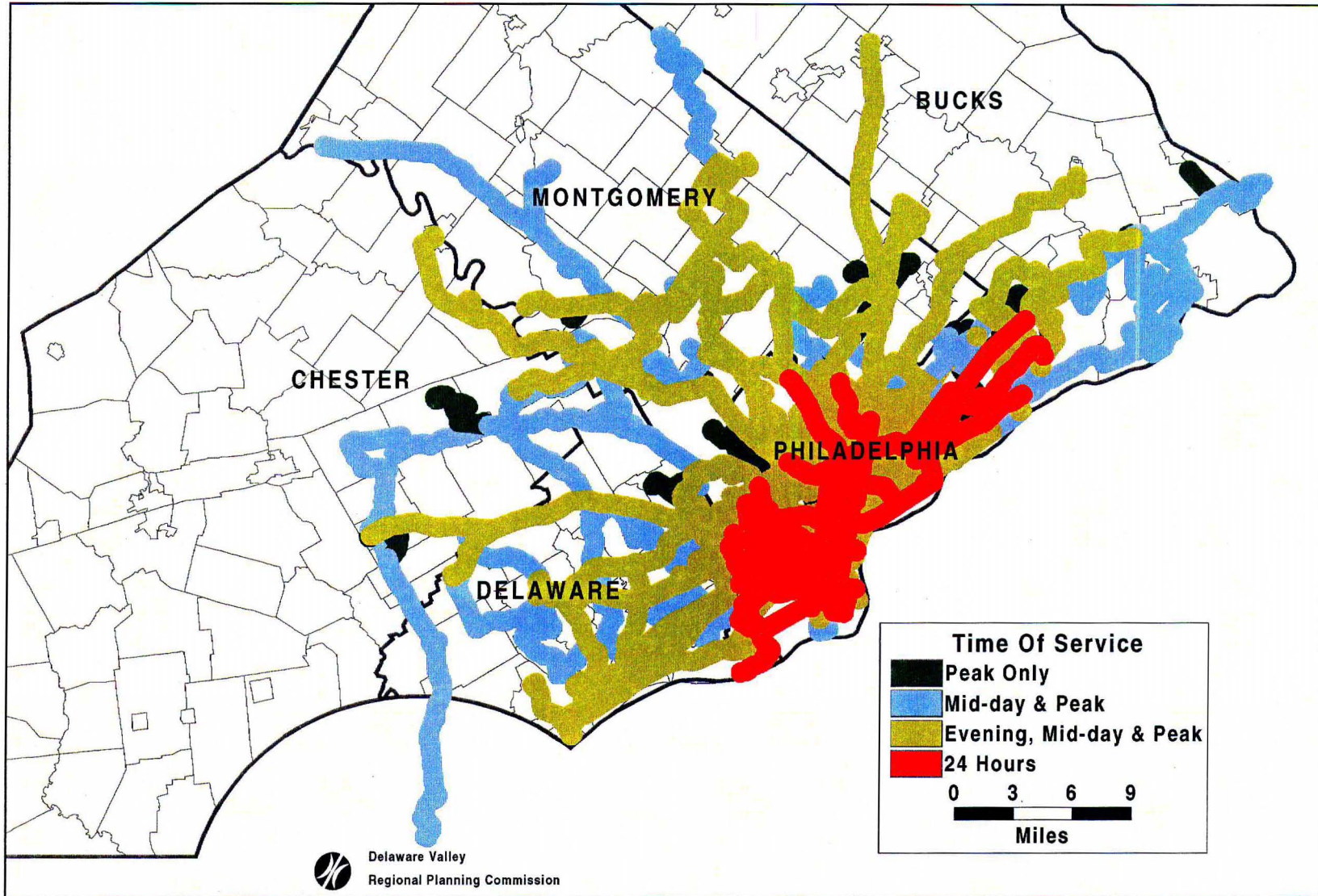
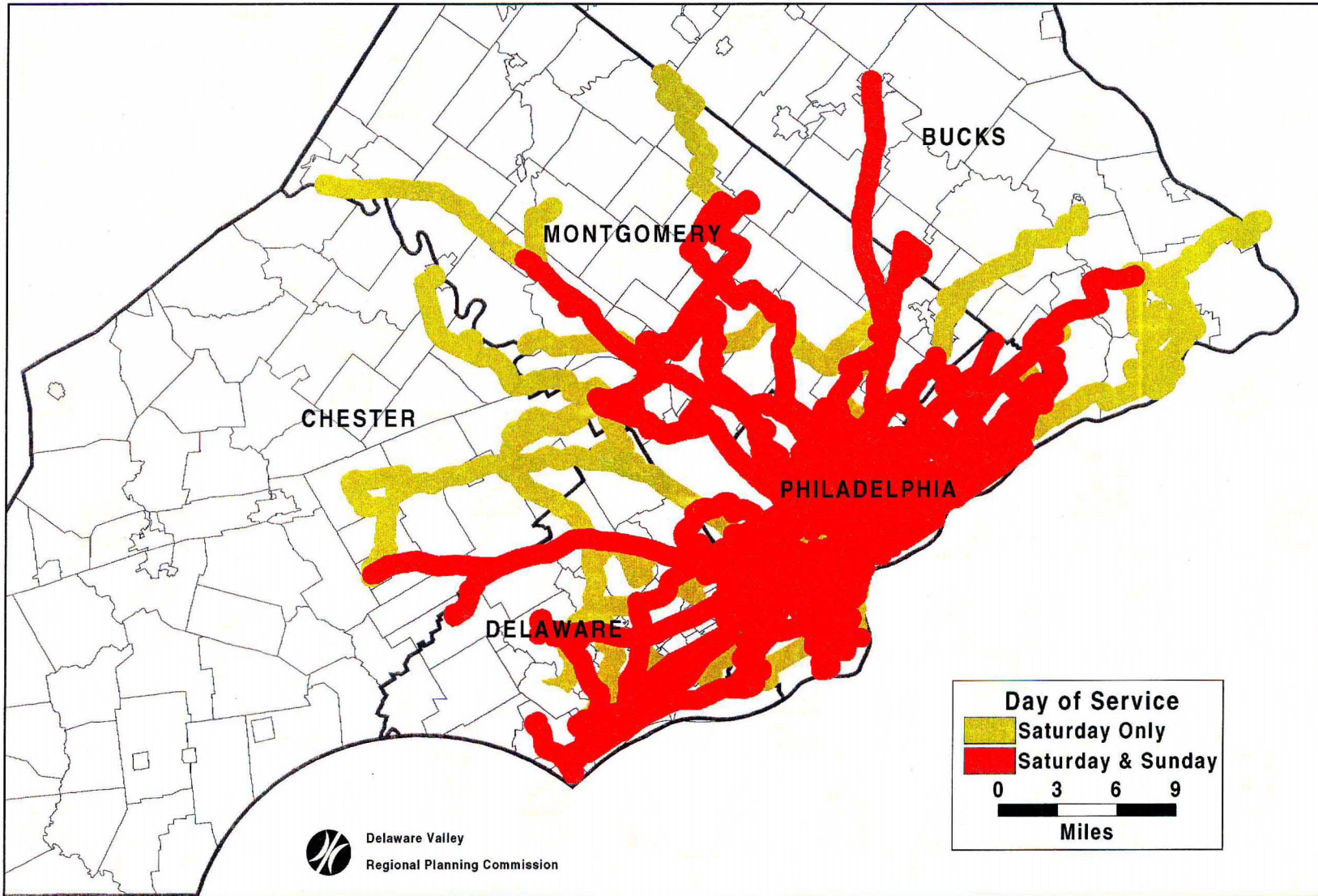


Figure 6
Areas Served within 1/2-Mile by SEPTA Bus and Trolley Lines on Weekends



It should be noted, however, that some of the areas without midday, evening, or weekend bus service, such as Yardley, Bristol, and Trenton, do receive regional rail service at these times.

Table 6

Population and Employment in New Jersey Counties Served by Regional Rail Lines

Access Distance (1) (miles)	Population Served (000)	Percent of Total Population (3)	Employment Served (000)	Percent of Total Employment (3)
< ¼	4.9	0.3%	7.9	1.1%
< ½	19.4	1.3%	27.9	3.8%
< 1	79.3	5.5%	80.7	11.1%
< 2	251.3	17.3%	189.3	26.1%

Table 7

Population and Employment in New Jersey Counties Served by Rail Transit Lines

Access Distance (1) (miles)	Population Served (000)	Percent of Total Population (3)	Employment Served (000)	Percent of Total Employment (3)
< ¼	10.6	0.7%	17.9	2.5%
< ½	35.1	2.4%	32.7	4.5%
< 1	96.2	6.6%	64.9	8.9%
< 2	212.3	14.6%	111.9	15.4%

Table 8

Population and Employment in New Jersey Counties Served by Bus Routes

Access Distance (2) (miles)	Population Served (000)	Percent of Total Population (3)	Employment Served (000)	Percent of Total Employment (3)
< 1/8	439	30.2%	274	37.8%
< ¼	710	48.9%	416	57.4%
< ½	993	68.3%	556	76.6%
< 1	1,210	83.3%	651	89.7%

Notes:

- (1) Distance from nearest regional rail or rail transit station.
- (2) Distance from nearest bus route.
- (3) Total population or employment in Burlington, Camden, Gloucester, and Mercer counties based on 1990 Census.

IV. NEW JERSEY COUNTIES

Similar to the Pennsylvania counties, transit accessibility was estimated for the following modes:

1. Regional Rail

While NJ TRANSIT does operate an extensive array of rail services, most of it serves northern New Jersey with relatively little of it located within the Delaware Valley region. In this region services are limited to the Northeast Corridor running south from New York to Trenton with a spur to Princeton and the Atlantic City line running southeast from the Delaware River crossing at Pennsauken. These two lines plus the spur serve only six stations in the New Jersey portion of the region, leading to a bull's-eye pattern on the accessibility map (Fig. 7). The seventh station on the map, West Trenton, is a SEPTA station offering rail service to Philadelphia.

The combination of few lines and sparse station distribution reduces the number of residents and jobs that have easy access to rail service, and this is borne out by the data presented in Table 6. Less than 5,000 residents (0.3% of the total) live within walking distance ($\frac{1}{4}$ -mile) of a station, although this increases to 19,000 residents (1.3%) at one-half mile. Going to a two-mile radius from stations brings in just over 250,000, but this still represents only 17.3 percent of the total population. In contrast, 2.6 million people, or 70 percent of the total, reside within two miles of a regional rail station on the Pennsylvania side of the Delaware River.

On the employment side less than 8,000 jobs (1.1% of the total) are located within a quarter mile of a station; increasing the access distance to one-half mile brings the number of jobs up to almost 28,000 (3.8%). The corresponding figure for the Pennsylvania counties at the one-half mile radius is 575,000 jobs (29.2%). Going to two miles, however, brings just under 190,000 jobs (26.1%) within reach. All of this implies that if regional rail is to bring significant numbers of commuters to jobs in the New Jersey portion of the region, good connecting transit or shuttle services will be required.

Only two of the seven stations (Trenton and Princeton) are located in urbanized or central locations, the remainder being in suburban locations with weak pedestrian access. And even in Trenton, the state government offices are almost one mile from the rail station, although a bus shuttle running every ten minutes during the peak does provide a connecting link.

2. Rail Transit

Only one rail transit line, albeit a well-patronized one with 24-hour service, operates in the New Jersey counties. PATCO's Lindenwold Line connects the spine of Camden County with Center City Philadelphia and has nine stations distributed along its 12-mile length in the county. At its eastern end, it provides connections to the Atlantic City rail line.

In spite of its shorter length, the PATCO line places twice as many residents and jobs within walking distance of its stations than does the regional rail network. The ¼-mile zone encloses almost 11,000 residents (0.7% of the total) and 18,000 jobs (2.5%), as is shown in Table 7. At one-half mile the coverage expands to include 35,000 residents (2.4%) and 33,000 jobs (4.5%). Although rail transit serves more residents and jobs than regional rail at distances up to one-half mile, its advantage diminishes as the access distance increases, and at two miles, PATCO reaches fewer residents and jobs, 212,000 (14.6%) and 112,000 (15.4%), respectively, than does NJ TRANSIT's rail service.

Basically, as seen in Figure 8, the PATCO line is serving the City of Camden and the older communities of the county. Although extensive parking is provided at many of the stations, and at least one, Woodcrest, is almost exclusively park-and-ride, most of the stations have retained pedestrian access to the surrounding communities. Regional rail looks better at the larger distances because of its ability to cover the jobs in Trenton and along US 1 near Princeton Junction.

3. Bus

NJ TRANSIT currently relies on buses to provide most of the mass transit coverage in these four counties. There are no surviving trolley lines. An extensive and complex network of bus routes serve the communities of these four counties and link them to Philadelphia, Camden, and Trenton. Additional routes traverse the area while en route to seashore resorts in Monmouth, Ocean, Atlantic, and Cape May counties.

As a measure of the network's comprehensiveness, 710,000 residents (48.9% of the total) and 416,000 jobs (57.4%) are encompassed within the one quarter mile zone, and 993,000 residents (68.3%) and 556,000 jobs (76.6%) within one-half mile, as can be seen in Table 8. Although significant, the one-half mile coverage is less than that in Pennsylvania, where more than three-fourths of the residents and jobs are found within a similar zone. Even at one-eighth mile, the coverage includes almost one-third of the population and more than one-third of the jobs. At one mile, these numbers increase to 1,210,000 residents (83.3%) and 651,000 jobs (89.7%). In Pennsylvania, the bus/trolley network does reach a somewhat higher shares of

Figure 7
Areas Served by Regional Rail Stations in New Jersey

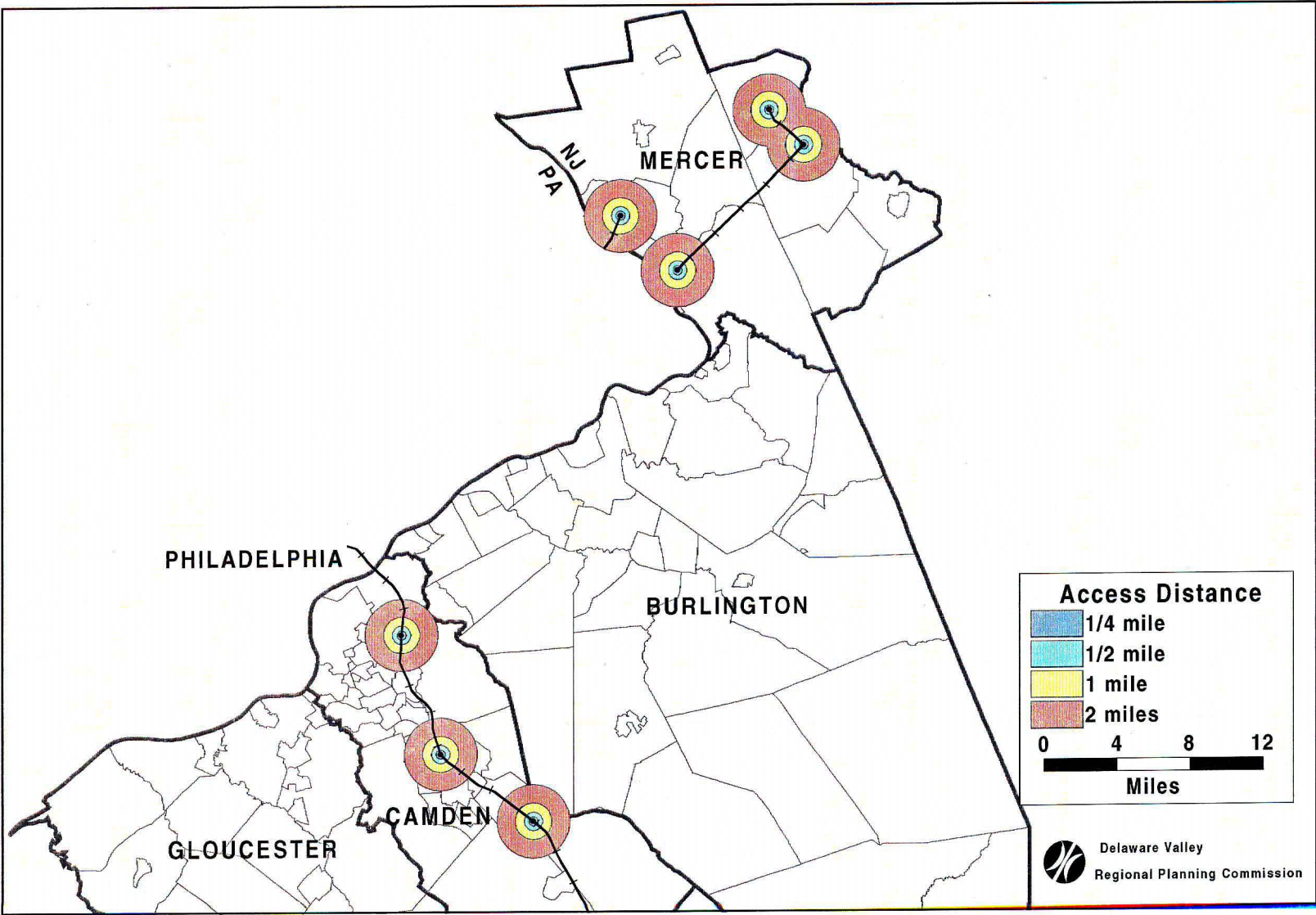


Figure 8
Areas Served by Rail Transit Stations in New Jersey

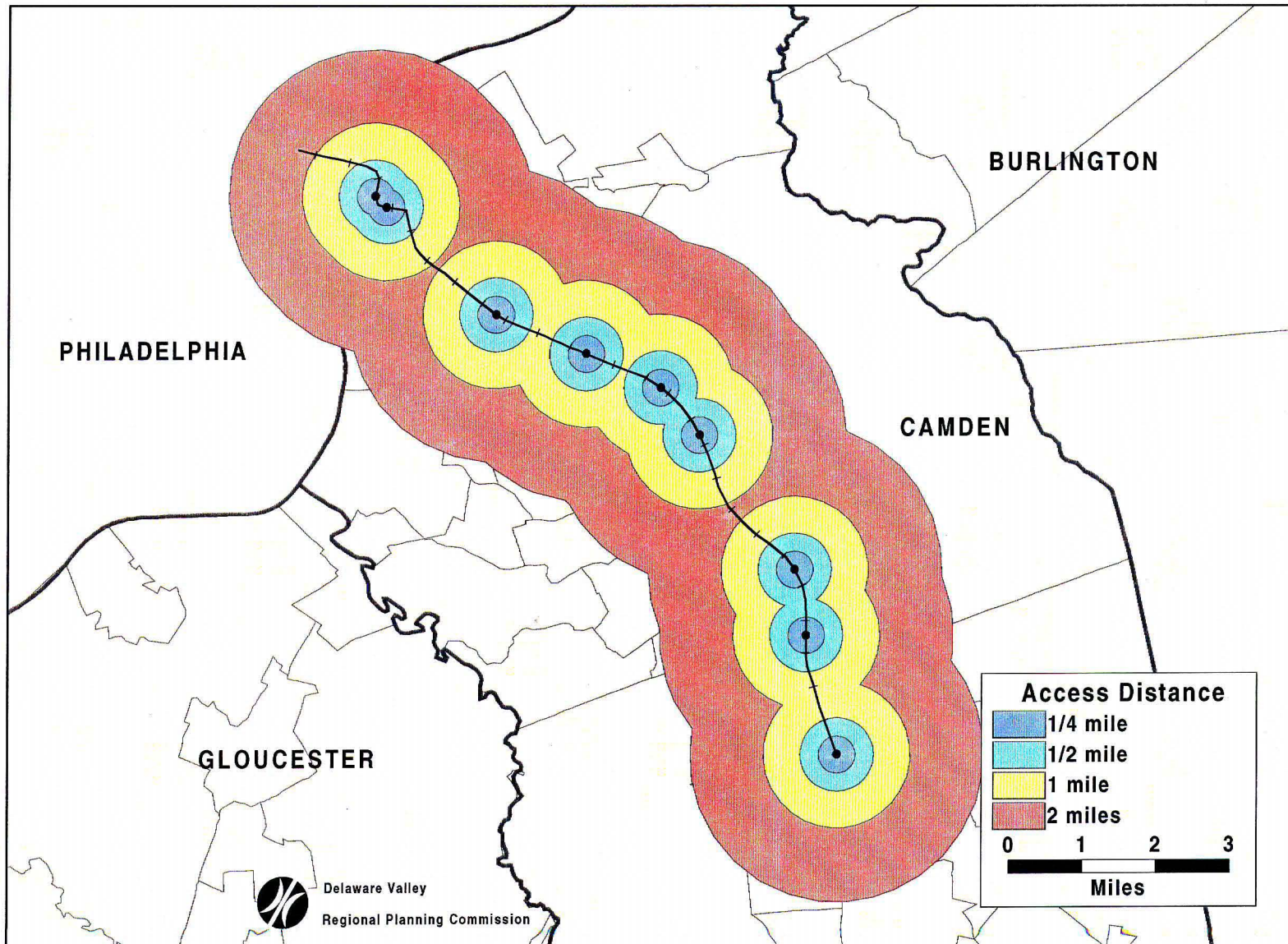
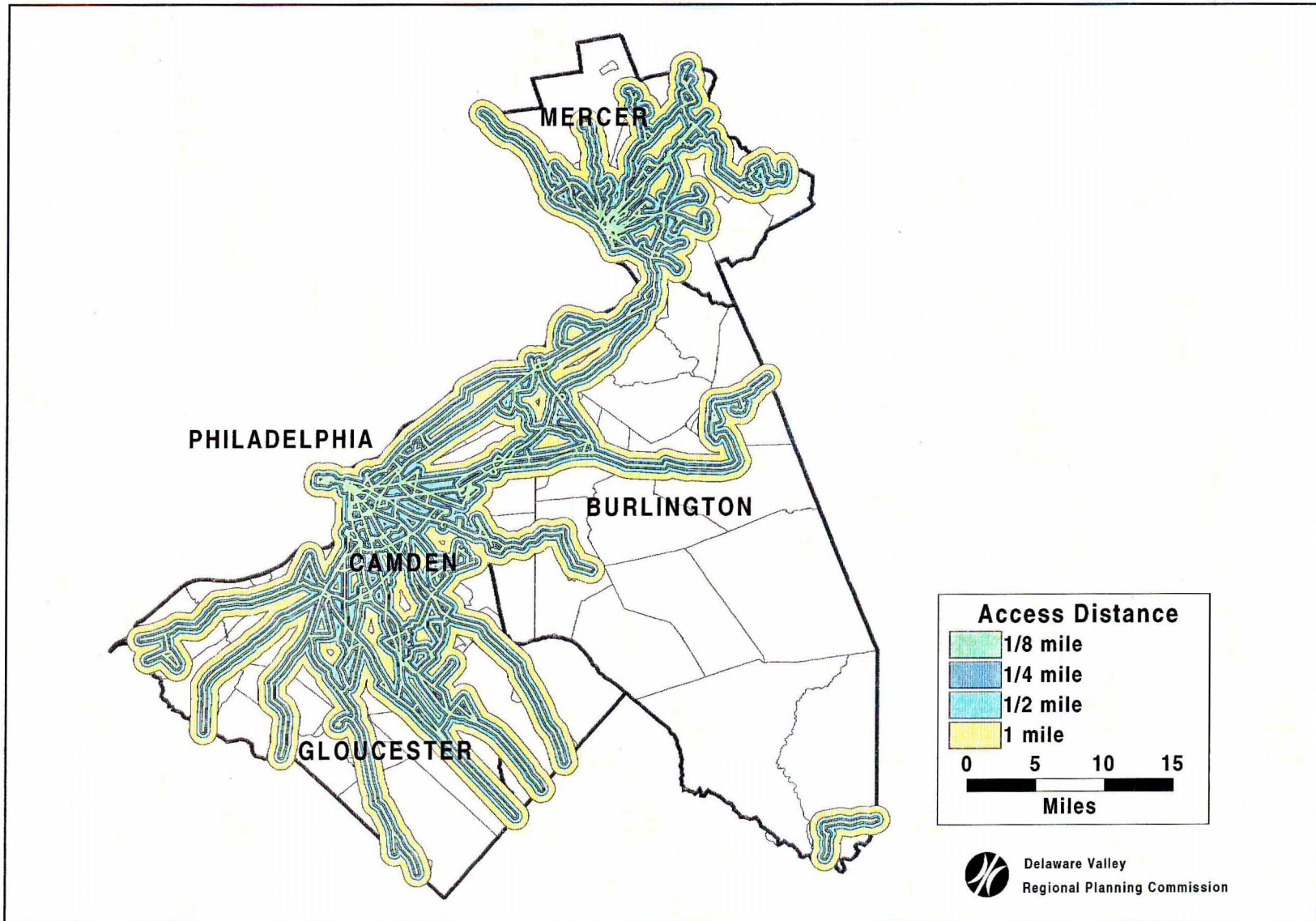


Figure 9
Areas Served by NJ TRANSIT Bus Lines



residents and jobs for the shorter distances, but by one mile, the shares in both states are almost equal.

As can be seen in Figure 9, bus service is available to most of Gloucester, Camden, and Mercer counties, and in Burlington County to a swath paralleling the Delaware River. In addition, service is provided along numerous corridors radiating from the urban core areas to more distant locations, many of which are outside the region. While enjoying extensive coverage, bus patronage, aside from trips to Philadelphia, is largely limited to the transit dependent. In many cases, service is neither fast enough nor frequent enough to draw riders from their cars, and sidewalks and other pedestrian facilities are lacking along the majority of the area's highways and arterials.

4. Time of Service

The variation by time of day or day of week is tabulated in Table 9, and mapped for one-half mile access to bus routes in Figures 10 and 11 for weekdays and weekends, respectively. Owl service is limited to the Atlantic City routes and one route linking Camden with the UPS facility near Philadelphia Airport. Most routes operate a full service from early morning into the evening, the principal area lacking evening service being the US 1 corridor in Mercer County. The primary routes where service is restricted to peak hours include express service on I-295, north along the Delaware River to Lambertville, east to Medford Lakes, and a local circulator to Hightstown.

On weekdays at peak hours, about 68 percent of the residents in the four New Jersey counties have access to bus service within the ½-mile distance. This falls to 59 percent at midday, and 41 percent in the evening.

On weekends, 58 percent have service on Saturdays, about the same as midday on weekdays, and 53 percent on Sundays. Principal routes lacking Sunday service include Woodbury via Wenonah to Glassboro in Gloucester County, Mount Holly to Burlington in Burlington County, and Pennington in Mercer County.

This variation is not significantly different from that observed for the Pennsylvania counties. However, there is a bigger drop from peak to midday coverage, but less of a differentiation between that for Saturday and Sunday, on the New Jersey side. SEPTA does reduce its service considerably from peak to midday, but it is mostly a matter of increasing headways or eliminating express trips, rather than reducing coverage. NJ TRANSIT, in contrast, has many variations on its bus routes that operate only during the peak. On weekends, the operating philosophies of the two carriers is a little different. SEPTA does drop its one-half mile coverage by 14 percentage points between Saturday and Sunday, whereas NJ TRANSIT's coverage only falls by less than six percentage points. Some of this is a consequence of NJ

Table 9
Population in New Jersey Served by Bus Routes by Time of Day and Day of Week
 (Population in thousands)

Access Distance (1) (miles)	Time Period											
	Peak		Midday		Evening		Saturday		Sunday			
	Number	Share (2)	Number	Share (2)	Number	Share (2)	Number	Share (2)	Number	Share (2)		
< 1/8	439	30.2%	347	23.8%	195	13.4%	340	23.4%	289	19.9%		
< 1/4	710	48.9%	583	40.1%	358	24.6%	577	39.7%	506	34.8%		
< 1/2	993	68.3%	854	58.7%	599	41.2%	849	58.4%	777	53.4%		
< 1	1,210	83.3%	1,086	74.7%	875	60.2%	1,084	74.6%	1,036	71.3%		

Notes:

- 1) Distance from nearest bus or trolley route.
- 2) Based on total 1990 population in Burlington, Camden, Gloucester, and Mercer counties.

Figure 10
Areas Served within 1/2-Mile by NJ TRANSIT Bus Lines on Weekdays

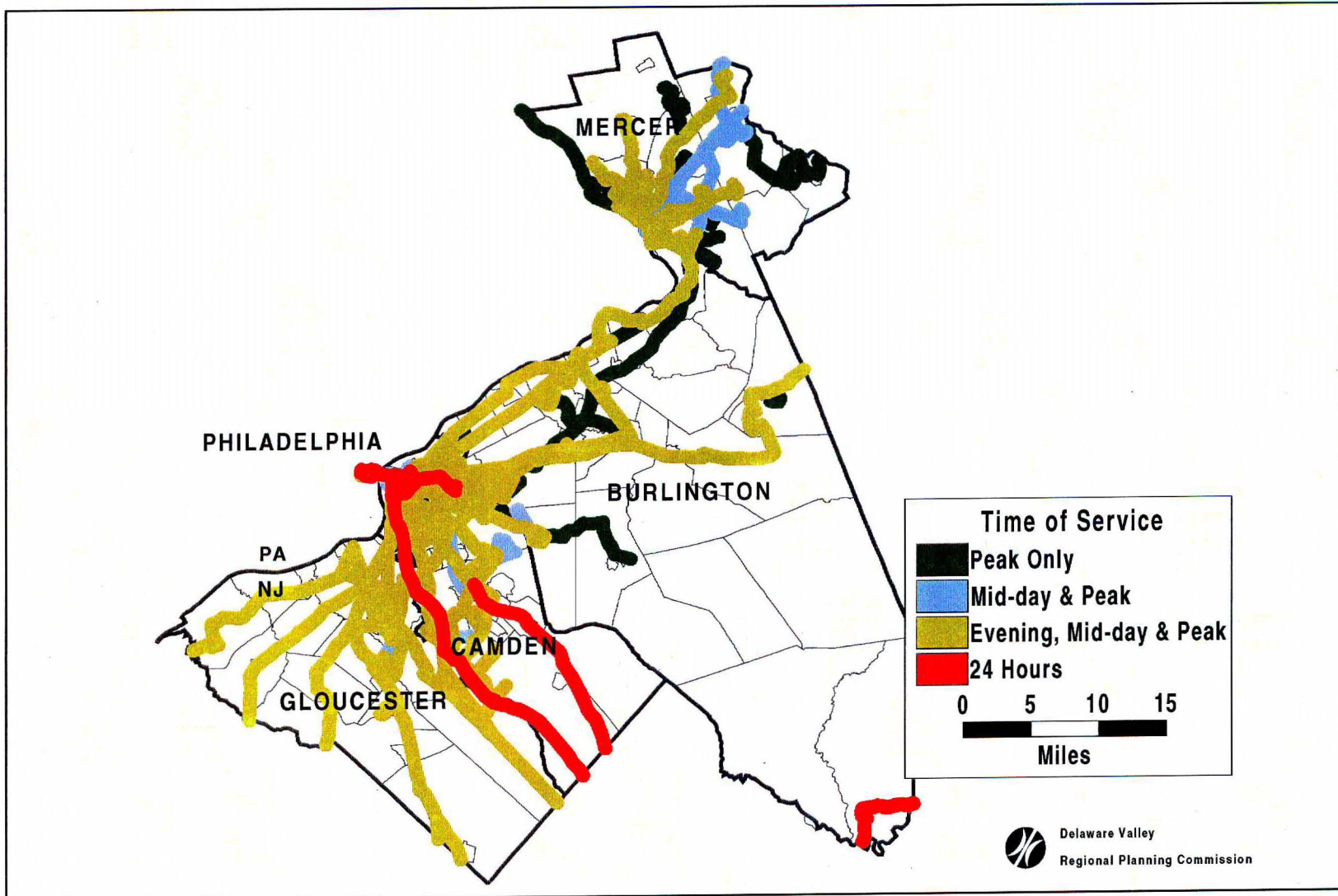
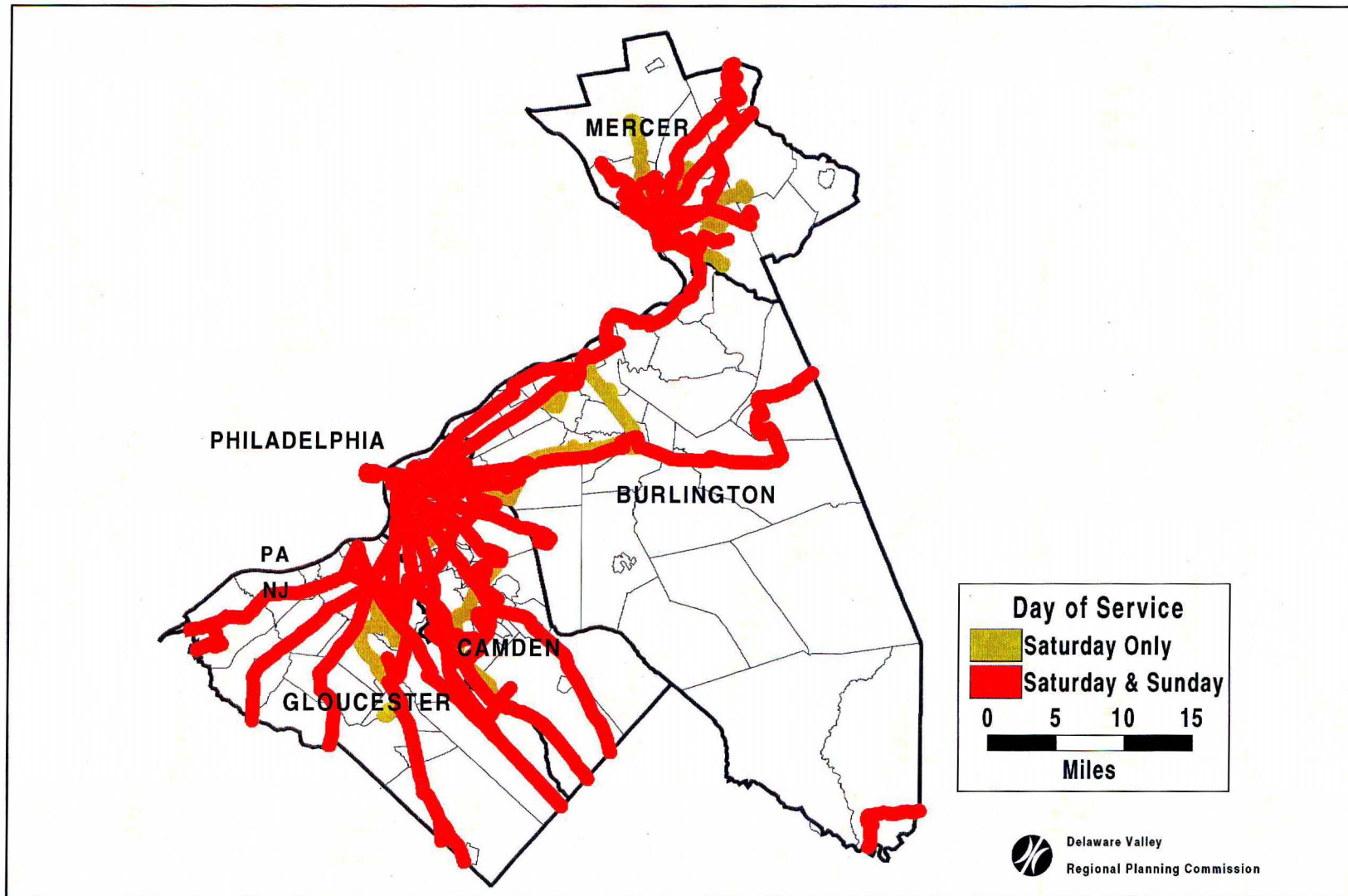


Figure 11
Areas Served within 1/2 Mile by NJ TRANSIT Bus Lines on Weekends



TRANSIT's seashore service, which carries more riders on weekends than on weekdays.

*Cover photograph courtesy of SEPTA.
Norristown Transportation Center.*