NATIONAL STRATEGIC TRANSPORTATION PLANNING STUDY

SOUTHERN NEW JERSEY/ SOUTHEASTERN PENNSYLVANIA URBAN CASE STUDY

MAY 1989

Delaware Valley Regional Planning Commission
The Bourse Building, 21 South Fifth Street, Philadelphia, PA 19101

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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 among the Office of the Executive Director, the Office of Public Affairs, and four line Divisions: Transportation Planning, Regional Information Services Center, Strategic Planning, and Finance and Administration. DVRPC's mission for the 1980s 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: May 1989
National Strategic Transportation Planning Study Southern New Jersey/ Southeastern Pennsylvania Urban Case Study	Publication No. 89011

Geographic Area Covered:

Nine-county DVRPC region: Bucks, Chester, Delaware, Montgomery and Philadelphia counties in Pennsylvania, and Burlington, Camden, Gloucester and Mercer counties in New Jersey. Also, five counties in South Jersey: Atlantic, Cape May, Cumberland, Ocean, and Salem.

Key Words:

Urban Transportation Planning Issues, Population, Employment, Travel Forecasts, Highways, Public Transportation, Freight, Land Use, Air Quality, Energy Conservation, Transportation Safety and Security, Future Technology, Funding Requirements and Investments, Urban Transportation Strategies, Federal Role.

ABSTRACT

This report describes the work efforts of the National Strategic Transportation Planning Study for the Southern New Jersey/Southeastern Pennsylvania region. Urban transportation problems, issues, trends, and opportunities are addressed in the 2015 transportation planning process. Population, employment, car ownership, household, and travel forecasts are presented along with their impacts on the transportation system and the environment. Three alternative transportation investment strategies are developed for the highway and public transportation systems, with capital, operating, and maintenance costs projected to the Year 2015. Comparison between 1987 and 2015 highway and transit travel and cost data are included. Recommendations and strategies are proposed for improving the highway and public transportation systems. A 14-page Executive Summary is provided in a separate document.

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I. INTRODUCTION

This report describes the work effort conducted under the National Strategic Transportation Planning Study for the Southern New Jersey/Southeastern Pennsylvania region. The region is one of five urban areas in the United States selected for detailed analysis to assess urban transportation needs, identify alternative transportation facilities, and estimate capital and operating costs for the Year 2015.

The Southern New Jersey/Southeastern Pennsylvania Metropolitan Area includes three counties in New Jersey (Burlington, Camden and Gloucester) and five counties in Pennsylvania (Bucks, Chester, Delaware, Montgomery and Philadelphia). Mercer County, New Jersey, included in the Trenton Metropolitan Area, is contiguous to Burlington and Bucks counties and is a member of the Delaware Valley Regional Planning Commission (DVRPC). Included also in the Southern New Jersey area for this study are Salem, Cumberland, Cape May, Atlantic, and Ocean counties. This study addresses only general transportation planning issues in these five counties, though data from existing studies of Southern New Jersey, such as county master plans and NJDOT's "South Jersey Highway Improvement Study," are incorporated. Detailed analysis of transportation needs and costs is limited to the counties within the DVRPC region (see Map I).

In June 1956, President Eisenhower signed the law that created the Interstate highway system, the largest public works project in history. The system comprises slightly more than one percent of the nation's total road and street mileage, but carries 21 percent of all highway travel. Since the legislation's original authorization, the Interstate system has received the largest share of federal funding, and with its scheduled completion in 1992, the United States Congress will have to develop new legislation for funding to improve the transportation infrastructure.

A. TRANSPORTATION 2020 EFFORTS

The American Association of State Highway and Transportation Officials (AASHTO) initially conceived the Transportation 2020 consensus program. Over time interested participants, such as the National Association of Regional Councils (NARC), refined the program to meet the transportation needs of the 21st century. The 2020 consensus calls for the cooperation of local and state officials, public and private interest groups and private industry in the creation of a transportation program, including agreement on local, state, and federal roles for meeting America's surface transportation needs.[1]

A wide spectrum of organizations have been invited to participate in the transportation consensus program. State and local officials, representatives of private industry, and leaders of public interest groups are working together as members of a Transportation

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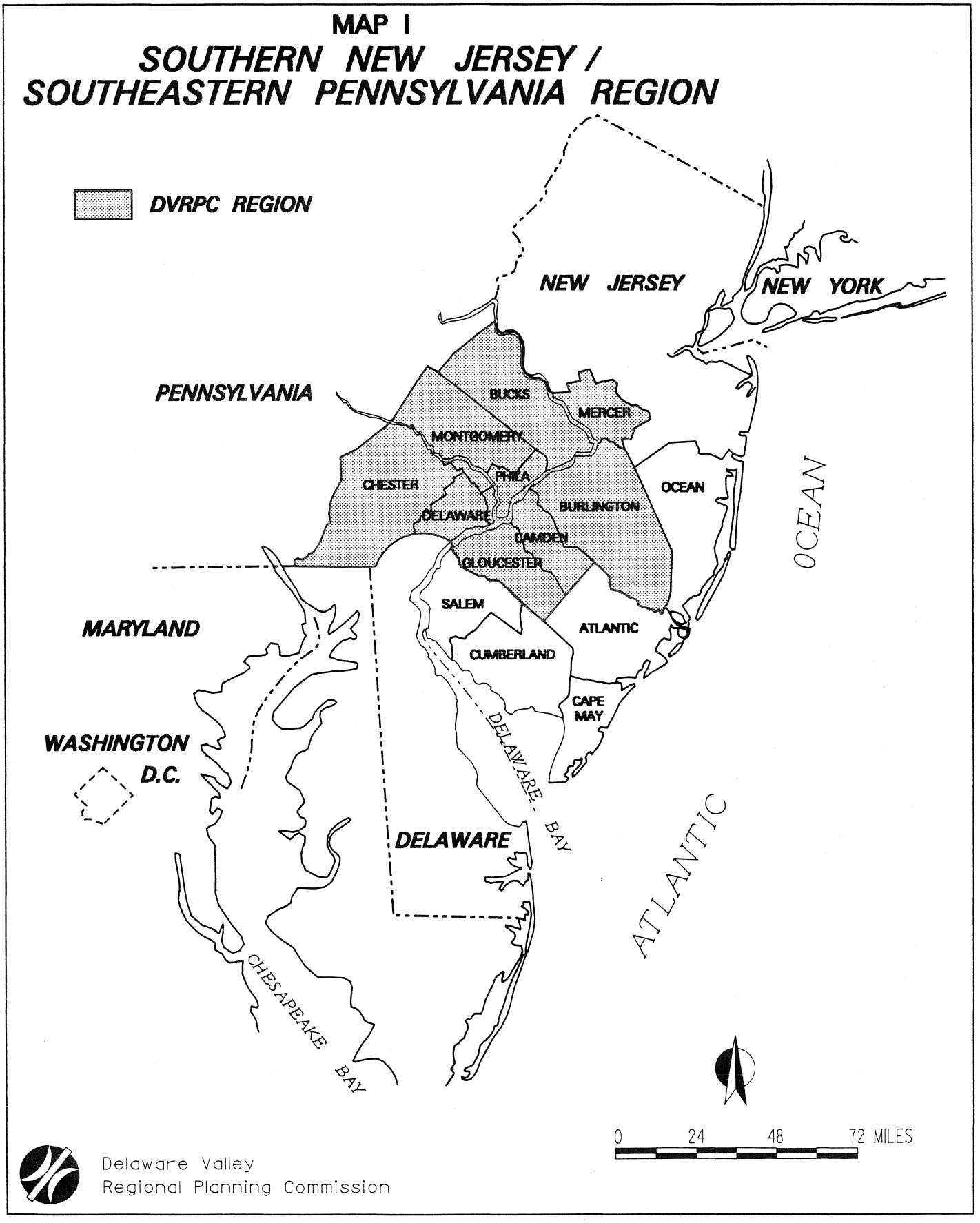
[1] National Association of Regional Councils, "Transportation 2020 A Consensus Approach to Defining a Transportation Program for the 21st Century," Special Report Number 138, Washington, DC, August, 1987.

MAP I

SOUTHERN NEW JERSEY / SOUTHEASTERN PENNSYLVANIA REGION



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Alternatives Group (TAG) to develop common policies, positions, and activities. Representatives from various organizations are currently in the process of formulating an agreement that outlines the multi-year, consensus-building process.

1. National Association of Regional Councils (NARC)

The NARC Board of Directors recently adopted a Statement of Principles developed by its Transportation Task Force on a post-interstate federal surface transportation program.[2] The Task Force is using these principles as guidelines to develop more concrete policies, as well as for a proposed federal assistance program to foster these principles. The Task Force has completed several steps of a process which translates the officially adopted Statement of Principles for a post-interstate program into policies that, in turn, define the new federal program.

2. Transportation Research Board Conference

On June 22-24, 1988, the Transportation Research Board (TRB) conducted a conference in Washington, D.C., titled "A Look at the Future - Conference on Long Range Trends and Requirements for the Nation's Highway and Public Transit Systems."[3] The TRB was requested to organize and conduct the conference for AASHTO, the Federal Highway Administration (FHWA) and NARC, all of whom provided financial support. The conference attendees included a broad range of elected officials, representatives of federal, state, local and regional governmental agencies, representatives of public and private sector associations, and persons from the academic community and the private sector. The proceedings and conclusions of the conference have been published separately.

3. New Jersey Department of Transportation Forums

On January 13 and 27, 1988, the New Jersey Department of Transportation (NJ DOT), in cooperation with AASHTO, NJ TRANSIT, and the New Jersey Alliance for Action (NJAA) hosted southern and northern statewide forums entitled "Transportation 2020." These forums were intended to give New Jersey's citizens an opportunity to participate in shaping future transportation policy. DVRPC's staff participated in NJ DOT's southern

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[2] National Association of Regional Councils, "Report of NARC's Transportation Task Force - A Post Interstate Transportation Program," Working Draft Number 3, Washington, DC, June, 1988.

[3] American Association of State Highway and Transportation Officials, "A Look at the Future - Conference on Long Range Trends and Requirements for the National's Highway and Public Transit Systems," Report to the AASHTO Policy Committee, Washington, DC, June, 1988.

forum on the Transportation 2020 Consensus held at Rutgers University in Camden on January 13, 1988.[4]

B. National Strategic Transportation Planning Study

In December 1987 the U.S. Congress authorized the National Strategic Transportation Planning Study, stating:

> ". . . This study shall forecast long-term needs and costs for developing and maintaining facilities and services to achieve a desired transportation program for moving people and goods in the year 2015. The study shall include detailed analyses of transportation needs, within six to nine metropolitan areas that have diverse population, development and demographic patterns including at least one interstate metropolitan area."[5]

The bill provided a total of $1,750,000 to initiate a comprehensive two-year strategic planning study to assess national transportation needs by the year 2015 and to identify future federal strategies and resource requirements to meet those needs. The study will include the following data and analyses: population and growth patterns, the economy, international developments, travel demand, highways, mass transportation, aviation, other transportation modes, urban area case studies (six to nine areas), human resources, financial resources, and federal programs and policies.

The 1988 Transportation Appropriations Act authorized transportation planning studies in five metropolitan areas as part of a National Transportation Strategic Planning Study. These areas are:

- Nashville/Davidson County
- New York/New Jersey/Connecticut metropolitan region
- Sacramento/San Francisco/Oakland region
- Southern New Jersey/Southeastern Pennsylvania
- Washington, DC region

The findings from the individual urbanized area case studies will be integrated with the national study in the final report to Congress. In this way, transportation alternative solutions for these five urban areas will be discussed as indicative of conditions many of the nation's urban areas will face in the future. The conference agreement of the U.S.

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[4] John J. Coscia, "Statement of the Delaware Valley Regional Planning Commission concerning the New Jersey Department of Transportation's request for Input to the Transportation 2020 Consensus Process," presented at the Public Forum of NJDOT, Camden, NJ, January 1988.

[5] Memorandum from Carl Swerdloff, Chief of Economic Studies Division, U.S. Department of Transportation to officials involved in Urban Area Case Studies: National Transportation Strategic Planning Studies, April 5, 1988.

House and Senate allocated $237,500 from the FY88 federal budget for each of these five metropolitan regions for their portion of the study.

In April 1988, FHWA allocated $150,000 to DVRPC to conduct the study for the Southern New Jersey/Southeastern Pennsylvania area, and requested staff to prepare a work program for the study in order to begin July 1, 1988. On May 8, 1988 DVRPC staff forwarded a detailed description of the study to FHWA and other interested federal and state agencies. The following summarizes activities included in the DVRPC work program (see Table 1).

- Based on various meeting recommendations and existing regional transportation studies, identify problems, issues, goals, and opportunities which should be addressed in the 2015 transportation planning process.

- Evaluate access to major traffic generators and identify any special ground transportation problems - including personal and freight transportation.

- Develop population, employment, car ownership, and household forecasts and estimate the rate and magnitude of change for the period 1987-2015 based on available data and planning methods.

- Describe the future distribution of population and employment by area type, including central business district (CBD), urban, suburban, and rural areas, and analyze the changes from existing conditions.

- Using DVRPC existing data files, estimate future highway and transit travel demand, compare with present activities, and evaluate highway deficiencies by means of quick factoring techniques.

- Estimate three levels of capital investments (no-build option, improve existing system, build additional facilities) and outline role of current and future technologies.

- Based on present and future travel forecasts, develop general estimates of transportation system performance measures, including operating cost per passenger-mile or vehicle-mile for the highway and transit systems, travel speeds, levels of pollution emissions, and other items.

- Summarize transportation problems and issues and prepare general recommendations and solutions for long-range plans in the Southern New Jersey/Southeastern Pennsylvania region concerning transportation improvements, capital and operating costs, funding, and implementation.

Chapter II of this report identifies the problems, issues, goals, and opportunities addressed in the 2015 transportation planning process and evaluates access to major traffic generators, it also identifies special ground transportation problems including freight transportation. Chapter III presents the population, employment, car ownership, and

Table 1

2015 TRANSPORTATION PLANNING STUDY FOR THE SOUTHERN NEW JERSEY/SOUTHEASTERN PENNSYLVANIA REGION

	Activities	Completion Date
I.	Review Previous Transportation Studies and Proceedings	September 1988
II.	Identify Transportation Issues and Opportunities	October 1988
III.	Develop Population, Household, Car Ownership, and Employment Forecasts	November 1988
IV.	Estimate 2015 Travel Demand and Evaluate Impacts	January 1989
V.	Estimate Three Levels of Capital Investments in Transportation	February 1989
VI.	Evaluate Transportation and Non-transportation Impacts of Capital Investments	March 1989
VII.	Summarize Transportation Issues and Impacts and Prepare Recommendations	April 1989
VIII.	Prepare a Final Report for the Study	May 1989
XI.	Hold Several Meetings of the Steering and Technical Committees	May 1989
X.	Prepare Progress Reports and Presentations	June 1989

household forecasts and the rate and magnitude of change for the period 1987-2015 based on available data and planning studies. This chapter also describes the future distribution of population and employment by area type, including central business district, urban, suburban, and rural areas.

Chapter IV presents estimates of future highway and transit travel demand, comparison with present activities, and evaluation of highway deficiencies by means of quick factoring techniques. Chapter V identifies three levels of capital investments and outlines the role of current and future technologies. Chapter VI describes the development of general estimates of transportation system performance measures, including operating cost per passenger-mile or vehicle-mile for the highway and transit systems, travel speeds, levels of pollution emissions, and other items.

Finally Chapter VII summarizes transportation problems and issues and prepares general recommendations for long-range plans in the Southern New Jersey/Southeastern Pennsylvania region concerning transportation improvements, capital and operating costs, funding, and implementation.

II. TRANSPORTATION PROBLEMS, ISSUES, GOALS, AND OPPORTUNITIES

This Chapter describes the major transportation problems and issues in the Delaware Valley region as identified by various meeting proceedings and the findings of several county, regional, and state transportation planning studies. During the past year, DVRPC conducted five meetings on long-range transportation planning for the Transportation Consensus 2020 and the 2015 National Transportation Study, and obtained invaluable input as to future transportation needs, resource requirements and strategies to meet these needs, and federal legislation needed to support planning and funding. DVRPC's staff has also reviewed several recent transportation studies and plans, including the SEPTA Regional Mobility Study, the South Jersey Transit Study, the South Jersey Highway Improvement Study, the DVRPC Year 2000 Transportation Plan, and several county master plans.

The following transportation issues involve the existing transportation system and its impact on the economic and fiscal base of the region. Specifically, this chapter describes the problems, issues, and opportunities concerning:

A. Regional mobility problems and issues;
B. Freight transportation;
C. Land use planning and development;
D. Transportation safety and security;
E. Air quality problems;
F. Energy conservation; and
G. Capital and operating costs and funding requirements.

A. Regional Mobility Issues

1. The Highway System

The Delaware Valley highway system consists of a network of limited access facilities, arterial highways, secondary collector roads, and local streets which reflects the different periods of highway construction and the programs that supported the system. Private companies built the earliest inter-regional roads and charged users a fee to turn aside a pike and gain entry. While these early roads have long since disappeared, their routes are still followed by modern highways. Examples include the arterial portions of US 30 (Lancaster Pike) and PA 309 (Bethlehem Pike). Following this period, building and maintaining roads was generally considered to be a public function, and responsibility gradually shifted from local governments to higher levels. In 1891 New Jersey became the first state to establish a state highway department.

The federal aid primary system created in 1921 established criteria for selecting and marking routes important to interstate commerce. The first continuous coast-to-coast numbered route was US 30, running between Atlantic City and Astoria, Oregon, and passing through Center City Philadelphia. Most of the original primary aid highways were

built as arterials, and for the most part they proved adequate to meet the needs of traffic at that time. However, by the end of the 1930s, New Jersey had dualized major routes, such as US 1, in order to improve safety and add capacity.

It was also becoming evident that urbanized areas and intercity corridors needed better highways, and that existing programs lacked the resources to build them. With east-west commerce constrained by the Appalachian Mountains, Pennsylvania established a public turnpike authority and became the first state to float a bond issue to build a new grade-separated expressway. The initial section of the Pennsylvania Turnpike opened between Irwin and Carlisle in 1940, though the turnpike did not reach the Delaware Valley until after World War II when it was extended eastward to Valley Forge. Tolls imposed on users serviced the bonds and provided the means to maintain and expand the facility. Pennsylvania showed that bonds provided a practical way to finance new highways, and the practice spread to neighboring states, abating only with the passage of the Federal Aid Highway Act of 1956, the act that established the Interstate highway program and the federal trust fund used to pay for it.

The resulting network, composed of layers from several preceding eras, provides access to virtually every developed land parcel in the region (see Map II). This network comprises 8,000 miles of highway routes, of which 5,200 miles are in the Pennsylvania portion of the region and 2,800 miles in the New Jersey portion.[6]

The major existing highway facilities are described below:

a. Limited Access Facilities

The following limited access highways or expressways serve the major travel corridors in the Delaware Valley:

- Pennsylvania Turnpike (I-76 and I-276) - A toll road running east-west across the state of Pennsylvania, which connects the Ohio Turnpike with the New Jersey Turnpike, and serves as a partial circumferential route extending around the northern section of Philadelphia.

- Schuylkill Expressway (I-76) - Parallels the Schuylkill River from the Pennsylvania Turnpike at Valley Forge (King of Prussia) to the Walt Whitman Bridge over the Delaware River.

- Delaware Expressway (I-95) - Parallels the Delaware River and serves the corridor from Wilmington to Trenton, where it terminates at I-295. This facility serves Philadelphia International Airport and Center City Philadelphia.

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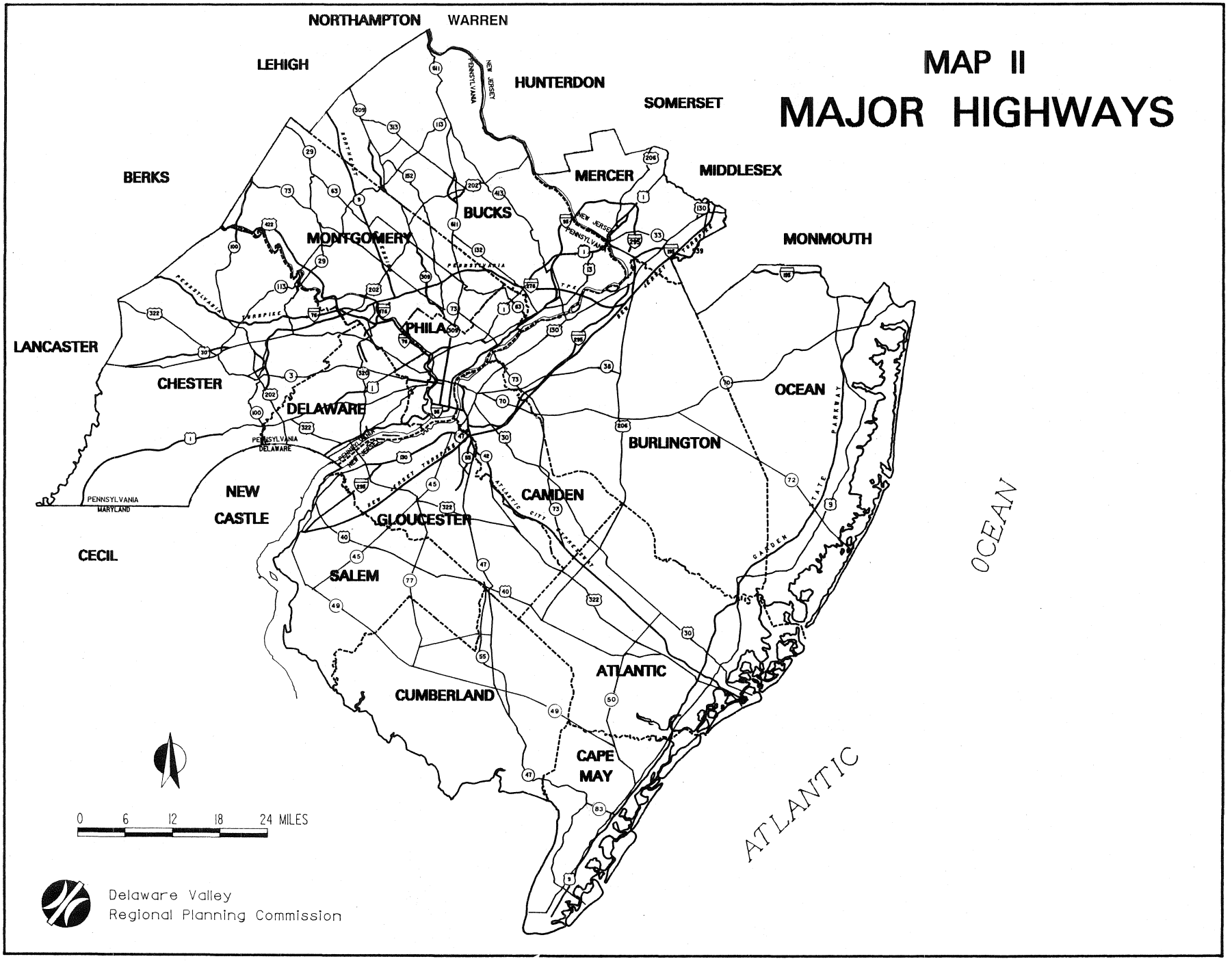
[6] 1987 Travel Simulation, DVRPC, May 1988.


MAP II
MAJOR HIGHWAYS
NORTHAMPTON
WARREN
LEHIGH
HUNTERDON
SOMERSET
BERKS
MERCER
MIDDLESEX
BUCKS
MONTGOMERY
MONMOUTH
PHILA
LANCASTER
CHESTER
DELAWARE
OCEAN
BURLINGTON
CAMDEN
NEW CASTLE
GLOUCESTER
CECIL
SALEM
ATLANTIC
CUMBERLAND
CAPE MAY
OCEAN
ATLANTIC
PENNSYLVANIA
MARYLAND
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- Mid-County Expressway (I-476) - This uncompleted facility transverses a north-south route between I-95 and I-276, and serves as a bypass around Philadelphia through the western and northern suburbs.

- US 422 Expressway - Connects Pottstown with US 202 at King of Prussia and serves a growing corridor in Montgomery County. West of Pottstown the highway continues to Reading as a four-lane arterial.

- Northeast Extension of the Pennsylvania Turnpike (PA 9) - Starting from the Pennsylvania Turnpike at Plymouth Meeting, this toll facility provides access to Scranton/Wilkes Barre and the Pocono Mountains resort area.

- PA 309 Expressway - Provides a bypass of the old Bethlehem Pike. Completed sections run from Northwest Philadelphia to the Springhouse area in Montgomery County, and from Souderton to near Quakertown in Bucks County.

- US 202 Expressway - Portions of this highway have been upgraded to limited access, notably from West Chester to King of Prussia and a bypass section south of Doylestown. It is a circumferential route extending from New Castle County in Delaware to Hunterdon County in New Jersey.

- US 30 Bypass - Portions of this highway have been upgraded to limited access around the Coatesville/Downingtown area.

- New Jersey Turnpike - This toll highway facilitates through travel between the Baltimore/Washington area and the Newark/New York area via the Delaware Memorial Bridge. The New Jersey Turnpike has eight interchanges along its 65 mile length in the Delaware Valley.

- I-295 - Paralleling the New Jersey Turnpike, it serves the corridor from Wilmington to Trenton. Small segments north of Bordentown and in Gloucester County still need to be completed.

- Atlantic City Expressway - This toll facility connects with the North-South Freeway (NJ 42) at Turnersville and crosses New Jersey to Atlantic City, with connections to other south shore resorts via the Garden State Parkway.

- NJ 55 Freeway - This uncompleted facility serves a corridor extending from NJ 42 in Deptford Township to the completed section near Vineland in Cumberland County.

- Trenton Freeway (US 1) - A limited access bypass of old US 1 through Trenton, which connects with an expressway portion through Bucks County, Pennsylvania.

b. Arterial Facilities

To supplement the limited access highway network of this region, there exists an extensive network of major radial and circumferential arterial facilities. An arterial highway is characterized by its use and its design, and is usually the main thoroughfare between the established centers of the region. For the most part, these routes predate the limited access facilities, since many are remnants of the earlier federal-aid primary system and others are upgraded older two-lane roads between country towns.

Some of the original primary highways are now paralleled by newer expressways and as a result serve a local function, often providing access to commercial and industrial areas. Examples include US 13 paralleled by I-95 along the Pennsylvania side of the Delaware River, and US 130 paralleled by I-295 on the New Jersey side.

The network of limited access highways is not complete in the sense that it does not cover all trunk corridors important to regional and interstate commerce. In some cases demand does not warrant the investment, in others lack of available construction funds or environmental objections have delayed or canceled plans for new highways, and sometimes older primary highways are upgraded to expressway status on a piecemeal basis. US 202, which serves a circumferential corridor through the western and northern suburbs of Philadelphia, provides a good example of the latter phenomenon. Arterials also provide the connections needed to fill in the more open grid of limited access and primary highways. Though many of these routes extend radially outward from the region's core of Philadelphia and Camden and, to a lesser degree, from Chester and Trenton, others accommodate circumferential travel.

c. Collector Roads and Local Streets

Collector roads provide connecting links between local streets and the arterial and limited access highways. In Pennsylvania these routes are generally unnumbered and under local control, though some of the minor state highways can be classified as collectors. In New Jersey collectors usually carry secondary route numbers and are under the control of the counties. However, many of the 500 series secondary routes are more properly classified as arterials.

d. Highway Bridges Linking Pennsylvania and New Jersey

The series of bridges spanning the Delaware River and connecting Pennsylvania with New Jersey constitutes another significant element of the highway network. Above the Trenton area, seven highway bridges connect roads in Bucks County with New Jersey, the most important of which is the US 202 toll bridge just above New Hope. Below Trenton, eleven major bridges provide integral links between New Jersey and Pennsylvania. These are the Commodore Barry, Walt Whitman, Ben Franklin, Betsy Ross, Tacony-Palmyra, Burlington-Bristol, Pennsylvania Turnpike, US 1 freeway, and Scudders Falls bridges. Two additional bridges link local streets at Trenton.

e. Major Highways in Southern New Jersey

Many highway facilities serve the study area in Southern New Jersey outside the DVRPC region. The limited access facilities are:

- The Garden State Parkway - Carries north-south traffic parallel to the coast. It is a toll facility.
- NJ 55 - Carries north-south traffic through Gloucester and Cumberland counties, although it terminates 20 miles north of its logical southern terminus at Clermont on the Garden State Parkway.
- The Atlantic City Expressway - Carries east-west traffic through Camden and Atlantic counties.
- I-195 - Serves the northern portion of Ocean County.

Major arterial highways include US 30, US 40, US 322, NJ 47, and NJ 49, which directly link the Delaware River bridges with the Southern New Jersey resort areas and the inland communities of Salem, Gloucester, Cumberland, Atlantic, and Cape May Counties; NJ 70 and NJ 72, which link the DVRPC region with Ocean County; and US 9, which connects the Jersey shore with northern New Jersey. Many of these highways serve the dual purposes of regional arterial highway in rural areas and "main street" in the urbanized areas, with clusters of residential, commercial, and industrial development.

f. Highway Travel Demand

The dominant mode of travel in the DVRPC region is the private automobile. In 1980, for example, about 60 percent of the region's employed persons drove to work alone, 18 percent used a carpool or vanpool, 14 percent used various modes of public transportation, and 9 percent used other means of transportation, such as bicycles and walking, or worked at home. The share of work trips by public transportation (regional rail, subway-elevated, bus, and trolley) has declined steadily from a 25 percent share in 1960. However, the modal split of work trips differs considerably for those who work in Center City Philadelphia; there about 62 percent of workers used public transportation, 19 percent drove alone, and 13 percent used carpools or vanpools. The share of trips by public transportation has declined because most of the growth in travel is occurring in areas difficult to serve by transit. Of all trips in the region, 92 percent are now made on the highway system. A comparison of 1980 traffic volumes with those recorded in

1970 on the highways of the Delaware Valley region shows significant growth, especially in suburban and rural areas.[7]

In 1987, approximately 1.1 million vehicles per day crossed the cordon line - or perimeter - of the DVRPC region. This volume is more than twice the magnitude of that counted in 1975, and about 55 percent higher than the traffic recorded in 1980. The cordon line has experienced significant traffic growth caused by the considerable expansion of residential and commercial developments that has taken place in the suburban and rural areas of the region.[8]

The DVRPC regional highway system carries approximately 80 million vehicle-miles of travel (VMT) on an average day, based on the most recent traffic simulation. The same data show that the VMT was split between the Pennsylvania and New Jersey portions of the network 65 percent and 35 percent, respectively. These proportions roughly equal those by which the physical route-miles are divided between the two states. On a facility-type basis, it is interesting to note that limited access facilities, which comprise roughly seven percent of the network route-miles, carry over 25 percent of travel. The opposite relationship holds true for the collector routes: they constitute about 43 percent of the network route-miles and only carry 15 percent of the daily VMT. The arterial routes, which make up about half of the network, carry over 60 percent of all travel.

g. Highway Congestion

Rapid suburbanization of jobs and housing over the past 30 years has resulted in highly diffused trip-making with major congestion as a consequence. New travel patterns to suburban offices and commercial areas place a severe strain on street and highway facilities designed for much lower levels of activity. Many of these roads now serve both through and local traffic. Concern over traffic congestion is being expressed by citizens and public officials at the local, state, and federal levels.

The suburban land use patterns which have evolved recently reflect the service characteristics of the automobile. Commuting patterns in the country have changed significantly since the 1960s. While central cities and rural populations have remained relatively stable since 1950, rapid growth has occurred in the suburbs, where the national share of population grew from 23 percent in 1950 to 44 percent in 1986.[9] During the 1980s, employment growth has occurred primarily in the suburbs. This type of suburbanization differs markedly from that which occurred in the 30 years following World War II. In the earlier period, residential construction provided the driving force, with jobs

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[7] Thabet Zakaria, "Traffic Trends and Emerging Transportation Planning Issues in the Delaware Valley Region," Transportation Quarterly, Vol. 40, No. 2, April 1986, pp 171-188.

[8] 1987 Travel Simulation, DVRPC, May 1988.

[9] Advisory Committee on Highway Policy 2020 Transportation Program, Beyond Gridlock - The Future of Mobility as the Public Sees It, Highway Users Federation, Washington, D.C., June 1988.

heavily oriented toward the central cities; but in this latter phase, office and other commercial developments moved into a dominant role, creating a largely independent economic base outside the cities.[10]

During the past three decades, the region has experienced significant changes in population, land use development, and employment distribution. Land use changes have been consistent with the rapid growth in suburban development and the slow growth of the cities. The suburban area's share of industrial and commercial land use has increased significantly due to the development of modern industrial parks, high-technology centers, large regional malls, office buildings, and recreational areas. In addition, auto ownership has increased in every county, with the highest percent increases occurring in the suburban counties having the fastest population and employment growth rates.[11]

Traffic congestion is no longer limited to the region's core areas, and many towns in the suburbs are experience traffic levels similar to those of the cities. Due to recent trends in suburban commercial and industrial development, congestion in the suburbs occurs not only during peak hours, as was the case in the past, but throughout the entire day. Locations lacking adequate highway facilities and transit services currently face particularly severe congestion.

DVRPC monitors highway traffic volumes on a continuous basis in the growing corridors throughout the Delaware Valley region, thus providing a data base from which the impact of land use changes on traffic levels can be determined. For each major highway within a corridor, the average volume-to-capacity ratio (V/C) is calculated. This quantity, together with the average speed, provides a measure of the quality, or level-of-service, for each facility, and describes the operational conditions from the perspective of motorists in terms of speed and travel time, traffic interruptions, freedom to maneuver, comfort, and convenience.[12]

A DVRPC regional analysis of overloaded or congested highway facilities has been prepared where specific highways with high V/C ratios are identified and categorized. Map III shows these congested highways by corridor.

Similarly, congestion levels, as determined by V/C and speed, have been estimated for all highways in the region. Map IV indicates the location of congestion levels, and

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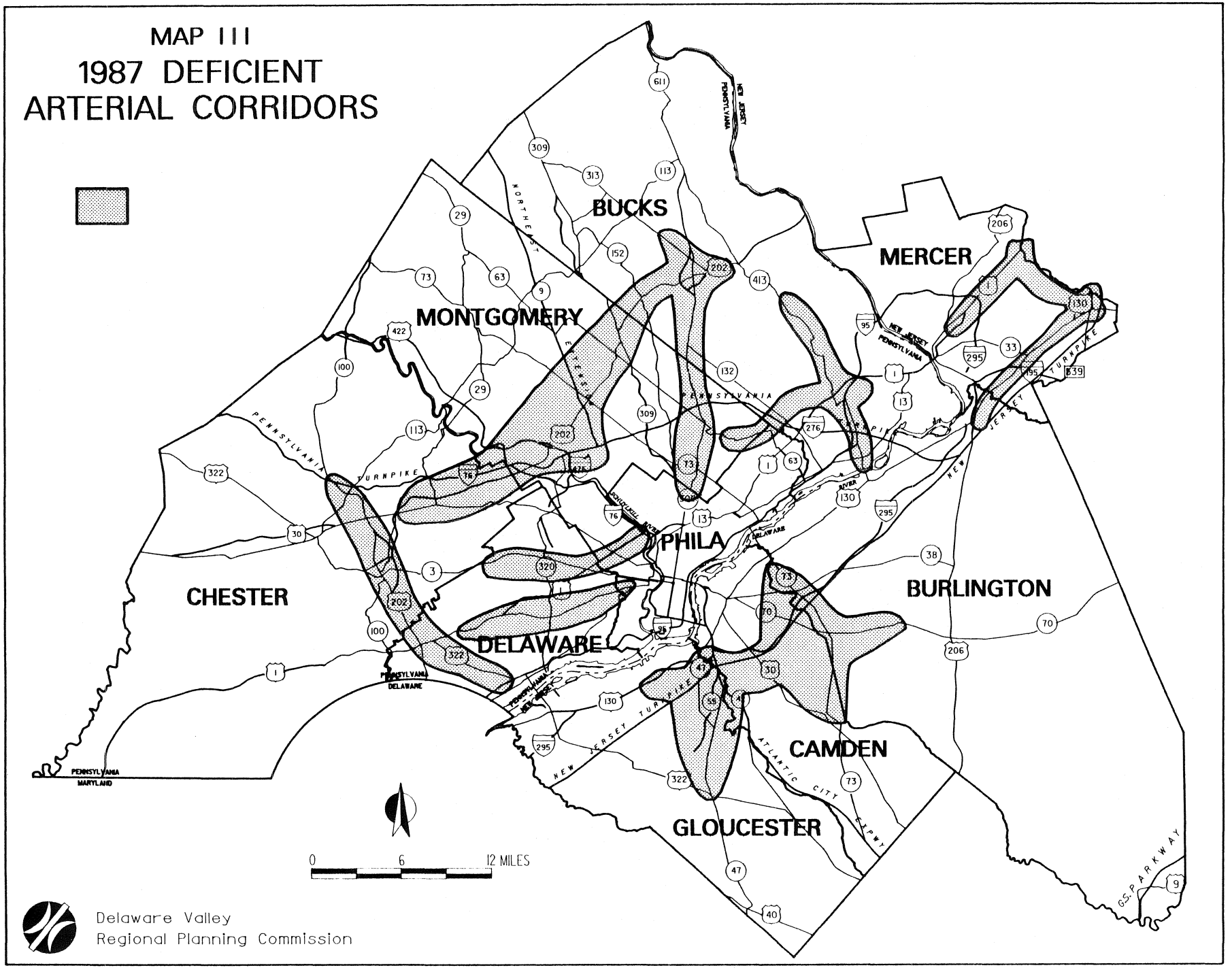
[10] Transmittal letter of June 23, 1988 from Chairman, Robert R. Kiley, APTA Transit 2000 Task Force to All APTA Members regarding Summary Report of the Transit 2000 External Environment Working Group, Washington, DC.

[11] Delaware Valley Regional Planning Commission, Arterial Highway Deficiency Analysis for the Delaware Valley Region, Philadelphia, PA, April 1987.

[12] Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington, D.C. 1985.


MAP 111
1987 DEFICIENT
ARTERIAL CORRIDORS
BUCKS
MERCER
MONTGOMERY
PHILA
CHESTER
DELAWARE
BURLINGTON
CAMDEN
GLOUCESTER
0 6 12 MILES
Delaware Valley
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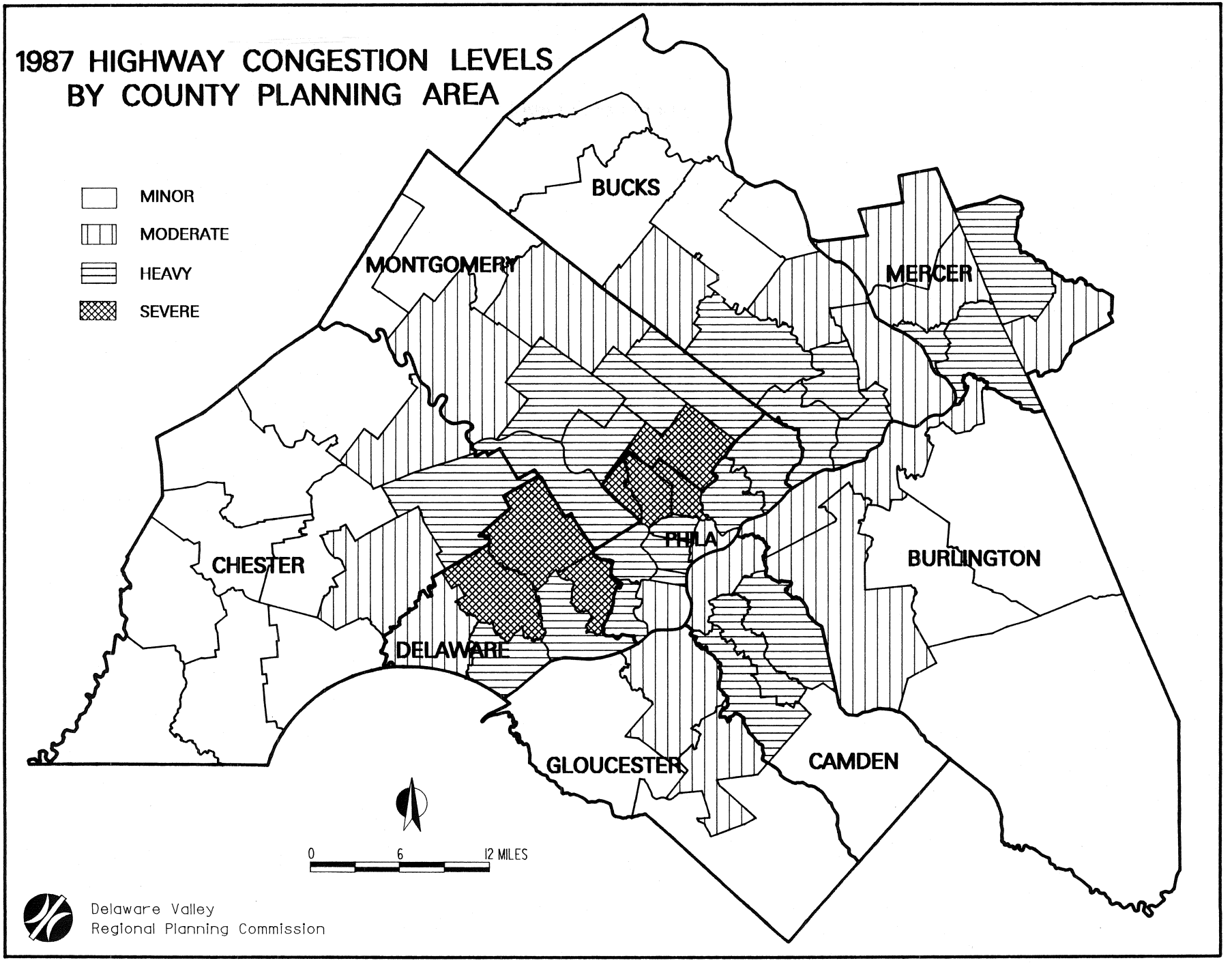
1987 HIGHWAY CONGESTION LEVELS
BY COUNTY PLANNING AREA
MINOR
MODERATE
HEAVY
SEVERE
BUCKS
MONTGOMERY
MERCER
PHILA
CHESTER
BURLINGTON
DELAWARE
GLOUCESTER
CAMDEN
0
6
12 MILES
Delaware Valley
Regional Planning Commission

clearly illustrates that the most congested areas are located in urban or growing suburban areas. The congestion level is calculated according to the following two criteria:

V/C Ratio	Average Speed (mph)	Congestion Level
< 0.6	> 35.0	Minor
0.6 - 0.8	25.0 - 35.0	Moderate
0.8 - 1.0	15.0 - 25.0	Heavy
> 1.0	< 15.0	Severe

A recent New Jersey Department of Transportation study shows that the advent of casino gambling has reversed the long-term decline in travel to Atlantic City.[13] At the same time, there have been substantial increases in travel to other Southern New Jersey resort areas, including Point Pleasant, Seaside Heights, Long Beach Island, Brigantine, Ocean City, the Wildwoods, and Cape May. North of Barnegat Inlet, most travel demand comes from the northern New Jersey/New York metropolitan area, whereas further south the primary demand comes from the Delaware Valley region. In addition, the pace of overall residential and commercial development in the region has quickened. Taken together, these traffic impacts result in increased levels of congestion, particularly on weekends and holidays in the summer. The major corridors to seashore points tend to be jammed in the outbound direction on Friday evenings and Saturday mornings, and the return side jammed on Sunday afternoons and evenings. Local streets in resort areas experience severe congestion throughout much of the summer, though it tends to peak on weekends.

2. Public Transportation Facilities

Historically, the Delaware Valley region has enjoyed good public transportation service supported by an extensive and comprehensive network of rail, trolley, and bus lines. However, much of the physical plant is old and in need of repair and replacement; furthermore, market needs have changed over the years and may no longer be efficiently and effectively met by the existing infrastructure. Available financial resources fall short of the needs for capital replacement required for the continuation of current service, let alone allowing for expansion of service, and not even current operating expenses are covered.

The traditional policy of treating the Pennsylvania and New Jersey portions of the region as separate markets, with little coordination of service and fares, poses an additional problem. The increase in reverse commuting, as well as in intra-suburban commutation, means that the market for interline transit trips is increasing. A general transfer procedure is needed, which would be honored by NJ TRANSIT, PATCO, and SEPTA at interchange points.

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[13] Briefing Memo, The South Jersey Highway Improvement Study, May 1988.

a. Operating Agencies

The Southeastern Pennsylvania Transportation Authority (SEPTA) is the principal carrier operating on the Pennsylvania side of the region, serving both the City of Philadelphia and its suburbs. Service in New Jersey is provided by the Port Authority Transit Corporation (PATCO), which operates a rail transit line between Lindenwold and Philadelphia via the Ben Franklin Bridge, and NJ TRANSIT, which operates the local bus service in Southern New Jersey, as well as bus service to Philadelphia and to seashore points. Mercer County has its own bus service focussed on Trenton and operated semi-autonomously by NJ TRANSIT Mercer.

Philadelphia sits astride three major rail corridors: Amtrak's Northeast Corridor, the Main Line running west to Harrisburg and Pittsburgh, and the Atlantic City Line, which is scheduled to reopen for service in the spring of 1989. SEPTA and NJ TRANSIT operate local rail service on the Northeast Corridor, and NJ TRANSIT will operate local trains to Atlantic City, in each case sharing tracks and stations with Amtrak. In addition Greyhound/Trailways and Bieber Tourways operate intercity bus routes, which also connect intra-regional points. Philadelphia International Airport, which handles an overwhelming share of the region's commercial air traffic, is readily accessible via SEPTA's newest rail line (see Map V).

b. Public Transportation Ridership

SEPTA is certainly the dominant carrier in the region, carrying over 94 percent of the region's transit passengers. This is the result of greater population densities and more comprehensive service in the Pennsylvania portion of the DVRPC region. In 1987 DVRPC estimated that about 72 percent of the region's population lived in Pennsylvania,[14] and a 1984 survey showed that 85 percent of the employees who worked in Center City lived in Pennsylvania.[15] The survey also showed that about 62 percent of the total commutation to Center City moved by transit. Though ridership data is relatively volatile and subject to both short-range and long-range trends, SEPTA's ridership in fiscal 1988 stood at about 1,232,000 unlinked trips on an average weekday.[16] In contrast, the comparable figures for PATCO and NJ TRANSIT are 39,000 and 36,000, respectively.[17] The last figure includes all of NJ TRANSIT's ridership in Southern New Jersey, but excludes that of NJ TRANSIT Mercer, which currently carries about 13,000 trips per weekday.[18] To complete

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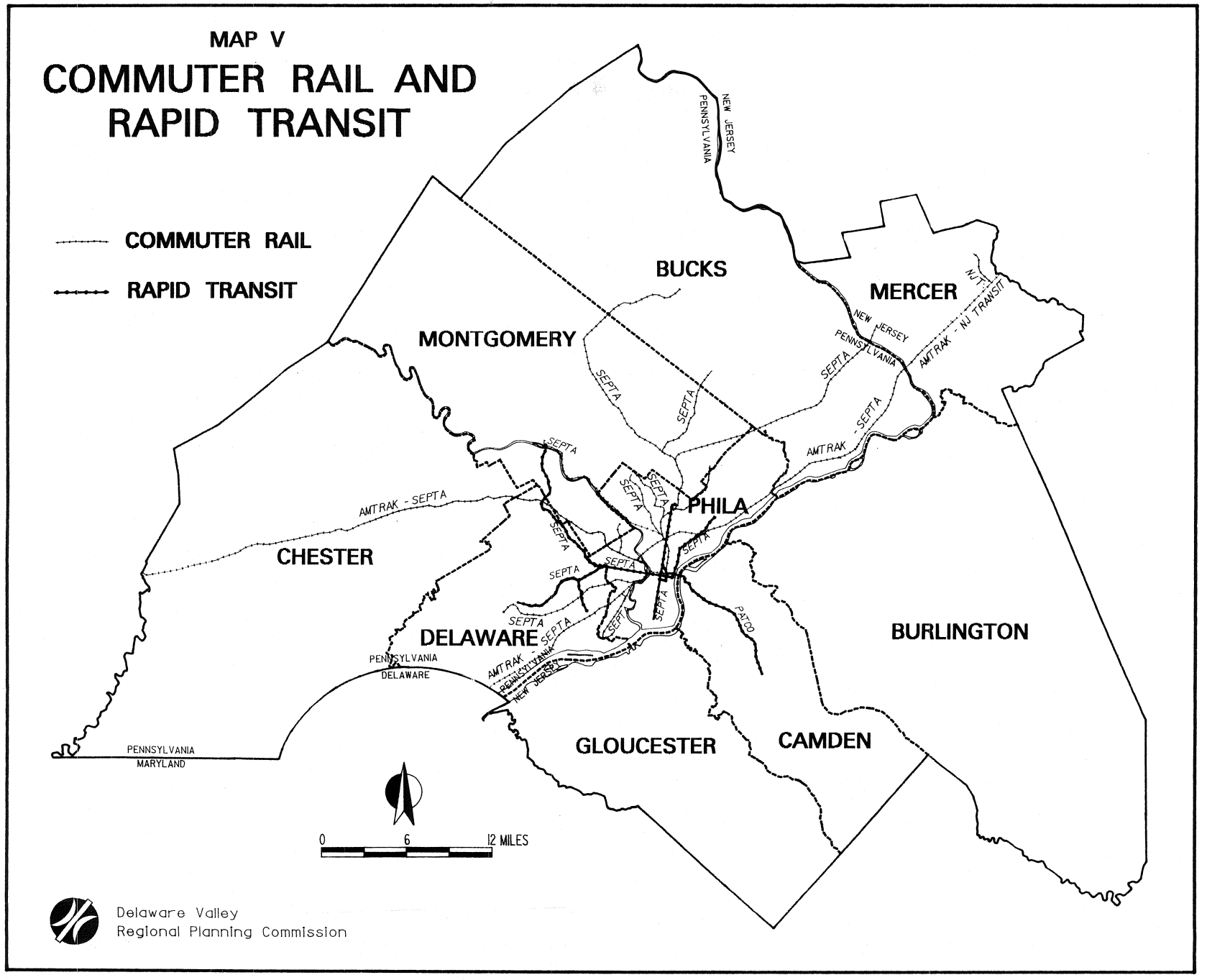
[14] 1987 Municipal Population Estimates for the Delaware Valley Region, DVRPC, May 1987.

[15] Center City Employee Transportation Survey, DVRPC, June 1985.

[16] Revenue Development Department, SEPTA, August 1988.

[17] Operating Statistics, PATCO, 1987-88; Monthly Summaries, NJ TRANSIT Bus Operations, Inc., Southern Div., 1987-88.

[18] Monthly Reports, NJ TRANSIT, 1987-88.


MAP V
COMMUTER RAIL AND RAPID TRANSIT
COMMUTER RAIL
RAPID TRANSIT
BUCKS
MONTGOMERY
CHESTER
DELAWARE
PHILA
MERCER
BURLINGTON
GLOUCESTER
CAMDEN
NEW JERSEY
PENNSYLVANIA
SEPTA
AMTRAK - SEPTA
AMTRAK - NJ TRANSIT
PATCO
PENNSYLVANIA
DELAWARE
PENNSYLVANIA
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the picture, about 40,000 passengers ride Amtrak trains daily through the Delaware Valley region, but only about one-quarter of these board or detrain at local stations.[19]

c. Southeastern Pennsylvania Transportation Authority

Supported by the City of Philadelphia and four suburban counties (Bucks, Chester, Delaware, and Montgomery), the Southeastern Pennsylvania Transportation Authority (SEPTA) provides comprehensive rail and transit services to the Pennsylvania side of the region. These operating services can be classified into three divisions:

i) City Transit Division

Two heavy rail lines, the Market-Frankford Subway/Elevated and the Broad Street Subway, serve as the backbone for City Transit, and are supplemented by eight light rail (trolley), four trackless trolley, and 74 bus routes, which handle over a million linked trips on an average weekday.

- The Market-Frankford Line - Carries approximately 200,000 daily trips and is the most heavily used line in the entire SEPTA system. The line follows an L-shaped route, running east along Market Street from 69th Street in Upper Darby Township through Center City to the Delaware River waterfront, where it turns northward to follow Front Street, Kensington Avenue, and Frankford Avenue to its terminus between Bridge and Pratt streets. The Center City portion between 40th and 2nd streets operates as a subway, and for the remainder of the route trains run on an elevated structure built in 1922. The western terminus at 69th Street serves as a major transfer point to Red Arrow rail and bus routes, as well as City Transit buses, and handles a significant number of Delaware County commuters. The northeastern terminus also provides an important transfer point for travelers to Northeast Philadelphia and adjacent Bucks County, though several other stations on the Frankford end also handle large numbers of transfer passengers. The stations on Market Street have recently been refurbished, and SEPTA completed a major renewal of the 69th Street Terminal in 1988. At the Frankford end, the entire elevated structure is being renewed while under operation in the largest reconstruction project in SEPTA's history. Though the work is needed if operation is to continue into the foreseeable future, the total cost is now estimated at $637 million, and doubts exist that the money can be found to complete the project.[20] Service is provided by a fleet of 250 Budd cars, and though the cars are still reliable, they are noisy and lack amenities such as air conditioning.

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[19] Ridership by Route, Public Affairs Department, Amtrak, 1987-88.

[20] Fiscal Year 1989 Capital Budget, SEPTA, July 1988.

- The Broad Street Subway - A north-south line running between Fern Rock and Pattison Street via City Hall, where it intersects the east-west Market Street subway. The southern terminus (Pattison) serves a major sports complex. A spur under Ridge Avenue provides a direct connection to Eighth & Market streets, but is lightly patronized. Many of the stations have been recently refurbished, but some, such as the busy City Hall station, remain dingy and badly in need of rehabilitation. Comfortable reliable service is provided by a fleet of 125 air-conditioned cars acquired from Kawasaki in 1983. The Broad Street Subway tunnel was built to accommodate four tracks between Walnut Street and Olney Avenue, but express tracks are only physically in place south of Erie Avenue.

- Trolley Car Lines - Eight trolley routes are currently maintained. Five of these routes are in West Philadelphia and are classified as Subway-Surface routes because they use a tunnel from 40th Street (one line enters at 36th Street) to access Center City. The acquisition of a new fleet of air-conditioned Kawasaki cars in 1983 had a positive effect on ridership. The other three lines, which use older PCC cars, comprise the surviving remnants of the North Philadelphia network, though one, Route 23, runs from Chestnut Hill in the northwest corner of the city through Center City to South Philadelphia.

- SEPTA also operates four trackless trolley (electric bus) routes; three that act as feeder to the Frankford Elevated in Northeast Philadelphia, and a crosstown route in South Philadelphia that connects with the Broad Street Subway. Route 66, which runs along Frankford Avenue, is a unique operation, using four sets of overhead wires to operate both local and express service.

- Bus Routes - The City Transit Division operates 74 bus routes, which carry 54 percent of the division's riders. However, the average trip length is somewhat shorter than that for routes using electric power. Several routes go beyond the limits of the city fare zone and penetrate deeply into the zoned areas of Bucks, Montgomery, and Delaware counties.

- Depots - Though SEPTA has opened a new garage on Allegheny Avenue, other depots are in need of modernization or replacement. Current plans call for moving bus maintenance from the 75-year old Luzerne Depot to a new depot scheduled to be built on Midvale Avenue. SEPTA also plans reconstruction of four other depots, though adequate funding has not yet been obtained. Modernization of the older depots will improve the efficiency of SEPTA's vehicle maintenance procedures and extend the useful life of the facilities. Problems in finding a suitable and acceptable site have delayed planning for a new bus garage in Northeast Philadelphia that is badly needed to support the service restructuring now taking place.

ii) Regional Rail Division

Regional rail service was provided historically by the Pennsylvania and Reading railroads. Both companies had extensive route networks that together fanned out in all directions on the Pennsylvania side of the Delaware River. Most of the routes were electrified - indeed electric traction was required for entry into Suburban Station - though the Reading did operate some diesel trains. When Conrail was formed in 1976 from the remains of the Pennsylvania, Reading, and four other bankrupt railroads, it took over operation of the surviving services which were by then operating with public subsidies. Service on non-electrified lines ended in 1981, as it became increasingly difficult to maintain rolling stock operating on scattered lines and no commitment on the part of funding agencies to buy new equipment developed. In 1983 SEPTA took over direct operation of the trains along with ownership of most of the track and structures over which they ran, with the principal exceptions of the Northeast Corridor and the Harrisburg Mainline, which had earlier passed to Amtrak upon the formation of Conrail. The Regional Rail Division carries approximately 90,000 trips per weekday.

At the time of SEPTA's takeover much of the railroad plant was in a deteriorated condition, the result of years of deferred maintenance by the predecessor railroads. The Regional Rail system is still suffering from an inadequately maintained physical plant because of the lack of capital resources. The backlog of capital projects needed just to maintain existing service is now estimated at $1.2 billion.

Though the system had shrunk somewhat from earlier years, SEPTA essentially continued the separate operating practices inherited from the predecessor railroads. However, a major change occurred late in 1984 when the Center City Tunnel opened, connecting the two previously separate rail systems. Reading routes were paired with Pennsylvania routes, and schedules were rewritten to allow run through operation from one side to the other. This meant that riders could reach any of the three Center City terminals, regardless of which route their trip started from, and transfers between all line combinations were now possible.

The construction of a new passenger line to Philadelphia International Airport was the second major capital project completed in recent years that significantly expanded the utility of the rail system. Though the route took advantage of existing track for much of the way, the track had to be upgraded to passenger standards and supplied with overhead power for electric traction.

The Regional Rail Division in 1988 operated thirteen lines with a total route length of 264 miles. One of the problems currently facing the Regional Rail Division is its inability to return ridership to the levels the system enjoyed as late as 1980, when approximately 123,000 trips were taken on an average weekday. Part of the ridership problem is illustrated by the difficulty of marketing non-work or discretionary trips to riders who have choices, and the Airport Line serves as a case in point. Unless some innovative solutions can be found that will boost discretionary ridership, the market for public transportation will be limited to commuters and the transit dependent.

Three of the six lines inherited from the Pennsylvania Railroad are now owned and maintained by Amtrak, a fact which overall has proven beneficial to SEPTA. The pluses include access to well maintained high-speed rights-of-way, modernized signaling and train control, use of 30th Street Station, and the capture of a feeder market for Amtrak's intercity service. However, there are negatives which focus on the loss of control of the right-of-way. This is reflected in delays triggered by interference with Amtrak trains. SEPTA has also been required through federal regulations to equip traction units with automatic speed control and event recorders, in order to operate safely on the 125-mph Northeast Corridor.

SEPTA's service mandate is currently limited to meeting travel needs within the five counties of Southeastern Pennsylvania, with the limited exception of two rail lines which cross the Delaware River to reach Mercer County, New Jersey, and one extended south into New Castle County, Delaware. Several SEPTA rail corridors have natural markets extending beyond the boundary of the region and should be considered in any expansion scenario. A number of issues are involved, including relations with Amtrak and the sharing of markets, the future of Amtrak's Harrisburg service, reintroduction of diesel service, and joint service with NJ TRANSIT to Newark and New York.

iii) Suburban Transit Division

Private carriers once operated most of SEPTA's transit routes. While the majority of city routes were handled by a single company, a plethora of companies, some of which were quite small, served the suburban areas, and some suburban areas were served by extensions of city routes. Melding this collection of services into a logical route network with a coherent fare structure has proved to be a formidable task, and one at which SEPTA has only been partially successful.

The Suburban Transit Division, which carries about 54,000 riders per weekday, is composed of two independent operating entities, the Red Arrow and Frontier divisions, each with its own routes, garages, and labor contracts. The Red Arrow Division operates three rail lines and twelve bus routes out of its principal terminus at 69th Street in Upper Darby Township. Other bus routes focus on the Darby Terminal (subway-surface trolley connections to West Philadelphia and City Hall) and the City of Chester. Three of the bus routes originate in Center City and are shared with the City Transit Division.

The rail routes possess some rather unique characteristics. Route 100 runs for almost fourteen miles through suburbs to Norristown, the county seat for Montgomery County. With its mixture of attributes and rolling stock, the line defies classification as either heavy or light rail. In contrast, the other two rail lines (Sharon Hill and Media) can definitely be categorized as light rail.

The Frontier Division provides bus service to selected outlying portions of the region. One cluster of six routes extends SEPTA's service north and west from Norristown, where a new transportation center is under construction. Additional routes connect King of Prussia with West Chester and Chestnut Hill with Lansdale. A second cluster of four

routes focussed on Oxford Valley Mall in lower Bucks County serves Morrisville, Bristol, and other nearby points. At one time SEPTA operated limited service across the Delaware River to Trenton, but early in l986 SEPTA ended all interstate bus service, scheduled and charter.

Early in 1988 SEPTA created a new class of suburban service - feeder bus routes designed to connect office centers and industrial parks with a nearby Regional Rail station. These routes are scheduled to meet trains and carry special lower fares for transfer passengers. Two routes have been established, one at Fort Washington and the other connecting the Great Valley Corporate Center with Paoli. Patronage on these routes has exceeded expectations and more routes are now in the planning stage.

iv) Fares

Because of historic antecedents, as well as differing service characteristics, SEPTA maintains separate fare structures for its Regional Rail and transit divisions. Rail fares are generally higher than transit fares for similar distances, but travel times are shorter. Zoned tickets are used on the Regional Rail system, with reductions offered for off-peak travel, children, and family groups. A small savings can be obtained by purchasing ten-trip tickets. Transit fares are constructed by adding zone and transfer charges to a base fare. Since the city constitutes one large fare zone, the base fare, which can be paid with a discounted token, covers a ride taken anywhere in the city, and zone charges are only levied for suburban rides. With the exception of a free transfer between subway lines, a transfer charge must be paid for every change of route. No transfers are available for trips combining Regional Rail and transit routes; separate fares must be paid for each.

The pass provides the one fare instrument acceptable for mixed mode travel, and acts as the glue that holds the two systems together. Weekly and monthly passes allow unlimited travel out to the zone specified. While passes are obviously useful to commuters and other frequent riders, they do little to stimulate riding by those whose need is less than daily, and SEPTA does not earn any extra revenue from additional off-peak riding by pass holders. Additional problems posed by passes include revenue shrinkage from abuse, as they can easily be shared, and loss of information on route-specific revenue allocation.

Though the Regional Rail system provides fair coverage of the Pennsylvania side of the region, transit lines must be used to access leisure destinations such as Penns Landing and the South Philadelphia sports complex. A rail/transit transfer would improve the overall utility of the system by allowing SEPTA to operate as a unified system, using rail and transit services to complement each other.

Pennsylvania uses the proceeds from state lottery funds to reimburse transit operators for the free carriage of senior citizens during off-peak hours. While this has proven to be an important source of revenue for operators, it has distorted fare structures and rider demographics. Because the reimbursement is constructed from the base fare paid by cash riders, operators across the state have been induced to set high base

fares, though some, including SEPTA, have tried to protect their regular riders by selling tokens and passes at a deep discount. However, it would be preferable to restructure the reimbursement formula so it does not depend on the fares paid by other riders.

d. NJ TRANSIT

NJ TRANSIT is the principal bus transit service provider in the Southern New Jersey portion of the region, and as such, provides transit service across the Delaware River between New Jersey and Pennsylvania (see Map VI). The agency was scheduled to begin operating a connecting train to Atlantic City in the summer of 1989, but the start up has been delayed at least one year because of a funding shortfall. Additionally, NJ TRANSIT operates bus service through its Mercer Division for Trenton and the surrounding municipalities and provides bus service between Philadelphia and Trenton on the 9/9A bus route via US 130 or parallel local roads in New Jersey.

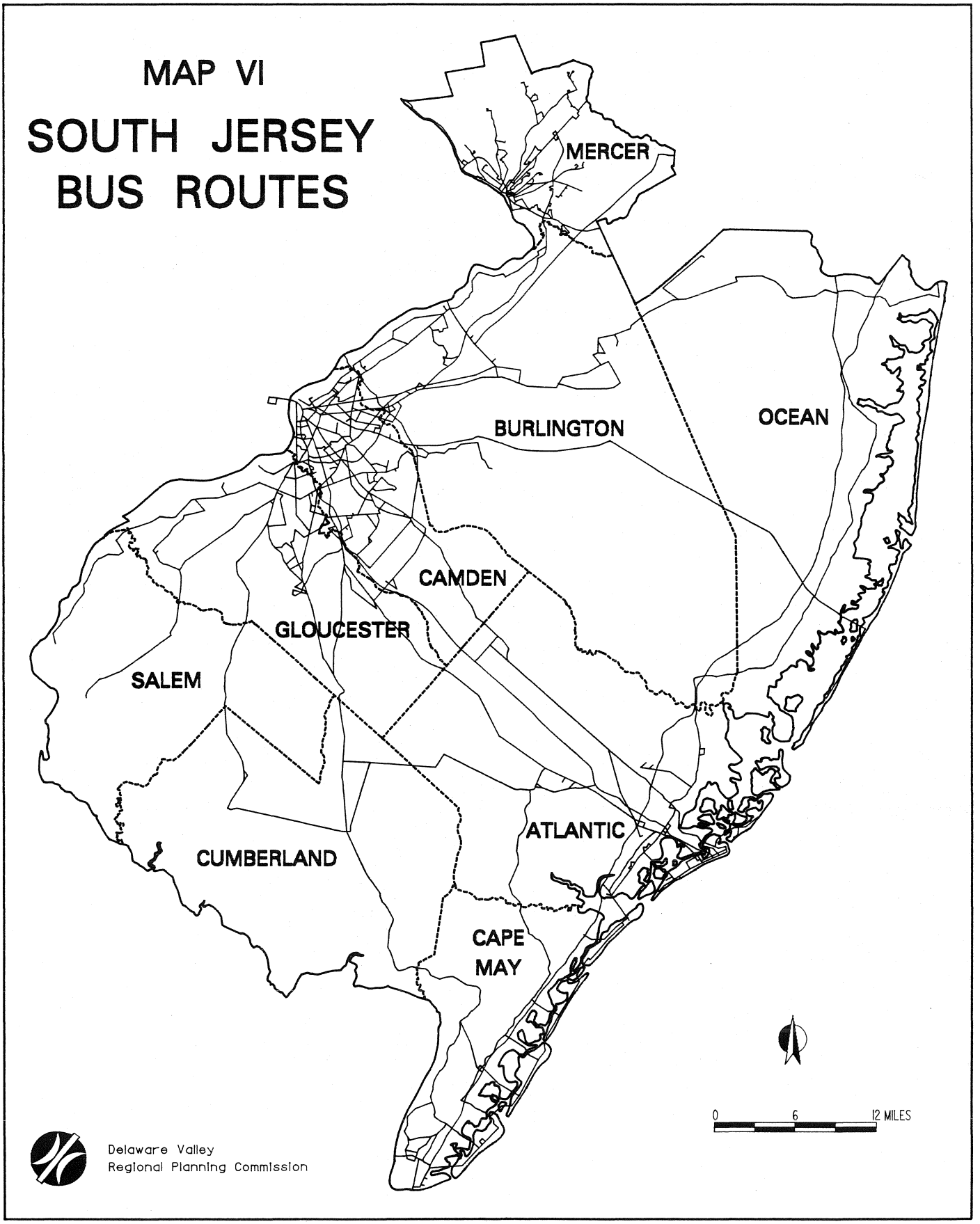
i) NJ TRANSIT Routes and Ridership

Bus ridership for FY88 in NJ TRANSIT's Southern Division totaled about 36,000 per week day. Bus operations in Southern New Jersey consist of 51 bus routes, 18 of which provide service to Philadelphia from Camden, Burlington, and Gloucester counties. These routes carried 61 percent of the ridership for NJ TRANSIT's Southern Division during 1988. Local intrastate service is provided on twelve routes, carrying twelve percent of the ridership. While these latter routes mostly focus on Camden County, some extend into Burlington and Gloucester counties.

Service to shore points is provided by ten bus routes, six of which terminate at Atlantic City. Trips between Philadelphia and seashore points originate and terminate at the Greyhound Terminal located at Tenth and Filbert streets in Philadelphia. Local routes within Atlantic City and adjoining portions of Atlantic County are operated from the Atlantic City garage. A new route connects Bridgeton in Cumberland County with Atlantic City. Designed to meet the needs of casino employees, it has experienced a steady increase in ridership. Seashore service represents 27 percent of the ridership in the Southern Division.

Other transit properties which provide bus service in the Southern New Jersey counties include:

- Burlington County Transit, which provides local bus service for county residents and service to Philadelphia;
- Gloucester County Transit, which provides local bus service for county residents.
- Salem County Transit, which provides local service for county residents and commuter service to residents working in Wilmington, Delaware.


MAP VI
SOUTH JERSEY
BUS ROUTES
MERCER
BURLINGTON
OCEAN
CAMDEN
GLOUCESTER
SALEM
ATLANTIC
CUMBERLAND
CAPE
MAY
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12 MILES
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ii) Rolling Stock and Garages

Although the infrastructure, fixed facilities, and rolling stock of NJ TRANSIT's Southern Division currently remains in adequate condition, steps have been taken to improve the existing service. One of the major initiatives is the addition of eighty-four replacement buses to the existing fleet of 318. These replacement buses will be a combination of suburban and commuter style buses.

Another important addition to NJ TRANSIT's infrastructure is the Washington Township Maintenance Facility, which was completed on July 30, 1988. This project has given NJ TRANSIT a modern maintenance and garage facility for buses operating in Southern New Jersey. This $17 million project is the largest bus facility built in Southern New Jersey since the establishment of NJ TRANSIT.

A new Transportation Center has been constructed in downtown Camden on Broadway, which provides off-street parking and station facilities for both NJ TRANSIT bus lines and the PATCO rail transit line to Philadelphia. Except for some express commuter routes running on I-676, all bus routes passing through Camden stop at the Center. Plans are also being made to renovate the Newton Avenue Garage Building. Once completed, Newton Avenue will again house the administrative offices for the Southern Division, though a portion of the management staff will be transferred to the Camden Transportation Center. Bus maintenance will also continue at the Newton Avenue location.

iii) NJ TRANSIT Mercer

NJ TRANSIT Mercer provides bus service primarily to Trenton and the surrounding municipalities within Mercer County, using 12 routes carrying an average ridership of 16,000 per week day. Some service extends to Hunterdon, Burlington, and Ocean counties. Most of the bus routes originate outside of Trenton, provide local service into downtown Trenton where transfers can be made, and then continue outbound to other suburban communities. This type of radial service also provides accessibility for the citizens in Mercer County to the four colleges in the area. NJ TRANSIT Mercer provides service to McGuire Air Force Base/Fort Dix Army Base along US 206, and summer shore service to Seaside Heights. Most of NJ TRANSIT Mercer riders use the urban service, which serves primarily the transit dependent requiring general mobility and civil servants commuting to state offices.

iv) NJ TRANSIT Issues

Although NJ TRANSIT has generally maintained a sufficient level of service to the population of Southern New Jersey, there exist three issues which, if NJ TRANSIT wishes

to continue or improve its service, will require the attention of planners and decision-makers.

- NJ TRANSIT has seen an eight percent decline in its Philadelphia commuter market. FY87 ridership for this segment was about 25,000 per weekday while FY88 ridership for this same market was about 23,000. There is much speculation as to the cause of the decline, but two probabilities warrant consideration. First, NJ TRANSIT has had two substantial fare increases over the past three years, adversely impacting demand within the Southern New Jersey region. In terms of distance traveled, NJ TRANSIT passengers pay some of the highest transit fare rates in the country. As a result, commuters from Southern New Jersey often consider their cost to commute by NJ TRANSIT buses as higher than that of driving their own car. NJ TRANSIT also charges premium fares for travel to and from Philadelphia. The zone fare charge for inter-state trips is about twice that for intra-state trips, which discourages commuters from using NJ TRANSIT's service. This dichotomy of fares also raises the question of equity within the transit fare structure, since a long interstate trip costs more than the same trip broken into interstate and intrastate components. NJ TRANSIT does provide discounts on the one-way fare by allowing riders to purchase monthly bus passes and ten-trip tickets. Because of low ridership in Southern New Jersey (there are 7.2 riders in northern New Jersey for every rider in Southern New Jersey), NJ TRANSIT should place more effort into making commuters aware of the discounts they could receive, or into otherwise marketing their service in Southern New Jersey. No good system map showing the route structure in Southern New Jersey exists, and the highly schematic route maps shown on timetables are difficult for new riders to fathom.

- Wages and salaries for NJ TRANSIT employees are set by statewide labor contracts and salary scales. Since these are driven by the higher cost of living in northern New Jersey, labor costs in the Southern Division are higher than those of the other two transit agencies in the region, PATCO and SEPTA, and maintain upward pressure on the fare structure.

- The amount of commercial growth now occurring in Burlington, Camden, and Gloucester counties also restrains interstate commuter ridership in this region. Several companies have migrated from Philadelphia to the suburban areas of Southern New Jersey, which reduces the number of commuters into Philadelphia, but offers the possibility of capturing a reverse commute market. However, before the latter can happen, the new employment centers must be adequately served with transit connections and a joint fare needs to be established with SEPTA in order to keep the total fare within affordable limits. Suburban commercial growth in Southern New Jersey requires accessible and coordinated transit service, if traffic congestion is to be managed as suburban development continues. In response to the regional issues involved, Governor Kean has asked NJ TRANSIT to develop a long-range plan for Southern New Jersey. The study is now underway and should be completed by mid-1989.

e. Port Authority Transit Corporation

The only rail transit line currently operating in Southern New Jersey is operated by the Port Authority Transit Corporation (PATCO). The 14.2-mile line was constructed during 1966-69 by PATCO's parent organization, the Delaware Regional Port Authority, using its own financial resources. Costs were minimized by connecting an existing rail line to a reconstructed transit line over the Ben Franklin Bridge.

This line provides rail service 24 hours a day and seven days per week between Lindenwold, New Jersey and 16th and Locust Streets in Philadelphia. In addition to seven stations in suburban Camden County, all of which are adjacent to free park and ride lots, the line has four subway stations in Center City Philadelphia and two in the City of Camden, all providing convenient pedestrian access to commercial and employment areas. The Camden Transportation Center provides transfer connections to buses, as well as providing access to Cooper Hospital and the adjacent portions of the central business district. The City Hall station at Fifth and Market Streets provides access to the Camden campus of Rutgers University.

A 1985 survey taken by DVRPC showed that 47 percent of all employees who work in Center City Philadelphia and reside in New Jersey commuted by PATCO.[21] For Camden County the modal split rises to 58 percent. The line opened in 1969 and carried 6,022,000 riders in its first year. Ridership reached a high of 11,523,000 annual riders in 1976, a 91 percent increase over the ridership total for the first year. Since then ridership has remained relatively stable with minor fluctuations. Total ridership in 1987 was 10,822,000, corresponding to a weekday average ridership of 39,000.

PATCO has been relatively successful compared with other transit systems or suburban railroad lines, with most of its operating expenses covered from farebox revenues. The highest cost recovery ratio achieved was 113.07 percent in 1972; since that time PATCO has maintained an average cost recovery ratio of approximately 88 percent, though in 1987 the operating revenue farebox recovery ratio fell to 76.65 percent.[22]

Consideration has been given to the idea of extending PATCO service into both Burlington and Gloucester counties. While the Burlington County branch seems attractive in view of development in the NJ 38 corridor and of travel patterns within it, the need for the other branch is less clear, as only 4,500 Gloucester County residents work in Center City, in contrast to almost 20,000 Camden County residents and 8,500 in Burlington County.[23]

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[21] PATCO Facts, Port Authority Transit Corporation, Lindenwold, NJ, February 1988.

[22] Ibid.

[23] Vigrass, J. William, Transportation 2020, A Panel Discussion, Rutgers University, Camden, NJ, August 17, 1988.

In its original version, the proposed the Burlington County branch would use 13 miles of existing railroad right-of-way and extend from Camden to a terminus at Mt. Holly. The Year 2000 Plan for the region, which was adopted in 1981, scaled this branch back to little more than six miles with terminus at Maple Shade. A Burlington County branch of PATCO would relieve congestion and would permit coordinating suburban commercial development and transit, especially if the branch extended to Moorestown Mall as later proposed.

The Gloucester County Branch as originally proposed would run to Glassboro using an existing railroad to Mt. Ephraim, and then follow NJ 42/55 to Glassboro. NJ 55 was designed with a wide median to accommodate a rapid transit line. This branch was subsequently scaled back to Deptford Mall and included in the Year 2000 Plan. However, both proposed branches were deleted from the Plan in 1984, when it became evident that no funds would become available for construction.

f. Southern New Jersey Rail Service

At one time the Pennsylvania and Reading railroads jointly ran trains on a network covering Southern New Jersey, providing service to both local suburbs and seashore points. However, the commuter service in New Jersey was never as dense as that operated separately by the two railroads on the Pennsylvania side of the river. The railroads abandoned passenger suburban New Jersey service on a line by line basis through the 1950s and 1960s, until by 1971 only the seashore service was left. When the PATCO transit line opened for service in 1969, the Pennsylvania-Reading Seashore Lines (PRSL) moved its city terminal to Lindenwold, from where it ran connecting trains to Atlantic City, Ocean City, Wildwood, and Cape May. Service on the Wildwood Branch was terminated in 1975, but the remaining three lines were passed to Conrail (under state subsidy) upon its formation in 1976 and continued until 1981-82, when bad track conditions forced cessation of service.

When New Jersey's voters agreed to legalize casino gambling in 1976, they created the conditions that lead to an economic resurgence in Atlantic County. This greatly increased the demand for travel to Atlantic City by both visitors and workers. Initially, this increase was handled by the region's highways, primarily the Atlantic City Expressway and Garden State Parkway connecting the resort to Philadelphia and New York, respectively. Since then the charter bus business has become a growth industry carrying large numbers of day visitors and several airlines have expressed interest in extending service, thereby creating a need for improved access to Atlantic City International Airport. The demand for workers has outstripped the local supply, and the area is now drawing workers from surrounding counties in Southern New Jersey. Bus ridership to and from Atlantic City on both NJ TRANSIT and private carriers is growing, in contrast to a general decline in Southern New Jersey bus riding.

In 1986 Amtrak and NJ TRANSIT signed an agreement that would reinstate passenger rail service to the 64-mile corridor between Philadelphia and Atlantic City.

Amtrak would operate an intercity service for visitors with connections to the Northeast Corridor at Philadelphia, and some through service to and from New York and Washington, and NJ TRANSIT would operate local trains for commuters. Originally NJ TRANSIT's western terminus was placed at Woodcrest, where there is a large park-and-ride lot adjacent to I-295, but in 1988 plans were amended to extend service further west to Cherry Hill. NJ TRANSIT now owns the right-of-way, but Amtrak is responsible for track work and structures. The project is estimated to cost $101 million, including $30 million from Amtrak, and $15 from the Atlantic City Improvement Authority. Amtrak plans to start service in the spring of 1989, but NJ TRANSIT's start up has been delayed until at least 1990.

Though Amtrak expects to tap the intercity travel market to Atlantic City through its connections to the Northeast Corridor and the national rail system at 30th Street Station in Philadelphia, some consideration should be given to extending service to Philadelphia International Airport using SEPTA trackage. This would allow Amtrak to more effectively compete with buses and rental cars for ground transportation to Atlantic City. While the number of travelers flying directly to Atlantic City is expected to increase, airline economics under deregulation virtually ensure that air travelers through Philadelphia will be offered a greater choice of flights at lower fares.

With rail service to Atlantic City restored, service to other points in Southern New Jersey may now be feasible and could play a role in managing increased travel demand. Major highway routes to the shore are overloaded on summer weekends and the resorts themselves could benefit from less dependence on cars. Cape May and Ocean City would be candidates for new seashore service, since both had service as late as 1981.

B. Freight Transportation

Freight transportation in the Delaware Valley is extremely diverse and fragmented, with trips handling a wide variety of cargoes and serving different purposes. Before the early 1980s, interstate freight movement was predominantly regulated by the federal government, but the rail and trucking industries have since become largely deregulated. This has resulted in a more competitive and often more efficient freight network, although there are some associated problems.

Governor Robert P. Casey of Pennsylvania stressed the importance of freight transportation to his state's economy when he laid out the priorities of his administration. The need to revitalize the state's ports and streamline their administration ranked first on his list. In the Delaware Valley he recognized that this requires close liaison with the states of New Jersey and Delaware. Other elements addressed the network aspects of the highway and rail systems, the need to make investments that improve the efficiency of freight movements, and highway safety.

Freight problems in the Delaware Valley region can be organized into three basic areas: trucking operations, the impact of deregulation on rail freight, and access to port facilities and other freight terminals.

1. Trucking

The most recent information available on trucking issues in the Delaware Valley region comes from a 1984 survey of trucking firms in the region. Of the firms responding approximately one-half were common carriers and a quarter were owner-operators. The respondents were divided into three categories: 44 percent hauling truckload cargoes, 22 percent hauling less-than-truckload cargoes, and 33 percent hauling "special commodities" such as household goods or automobiles.[24] The breakdown of trips was 42 percent intra-regional trips, 46 percent inter-regional trips with either the origin or destination in the region, and the remaining 12 percent consisted of through trips with no stops in the region.[25]

Other information gathered from the survey included the major routes and bridges used, as well as descriptions of 25 areas in the highway system in need of improvement. Plans to complete major construction projects on the Interstate Highway System should alleviate many of these concerns by the early 1990s. One major project now under construction is I-476 linking the Pennsylvania Turnpike (I-276) in Montgomery County with I-95 in Delaware County. This should facilitate movement between parts of Chester and Delaware Counties and points north and west of the region. The utility of I-95 to truckers has been greatly reduced by its failure to connect with the rest of the Interstate Highway System north of Trenton. To continue north, traffic must use US 1 or divert eastward to the New Jersey Turnpike. Construction of an interchange between I-95 and the Pennsylvania Turnpike (I-276) in Bucks County could partially alleviate the problem.

One concern identified, which bears further consideration, is the problem of local deliveries in the older cities of the region, such as Camden, Chester, Trenton, and Philadelphia. Drivers often have trouble negotiating narrow streets with parked cars, and the restricted receiving hours of many companies and stores create even more congestion on crowded city streets. A program of expanded (early morning, late evening or weekend) receiving hours by more companies could help resolve this problem, along with traffic management techniques designed to improve the flow of traffic.

2. Rail

The rail freight industry has undergone tremendous change within the Delaware Valley region over the last fifteen years. The consolidation of the Pennsylvania and Reading railroads into Conrail, as well as the incorporation of the Baltimore and Ohio Railroad into the CSX system, remains foremost among these changes. In order to provide some competition, the Delaware and Hudson Railroad was granted trackage rights to Philadelphia. However, the weakened financial condition of the parent company,

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[24] Survey of Trucking Operations, DVRPC, Philadelphia, PA, October 1984, p. 6.

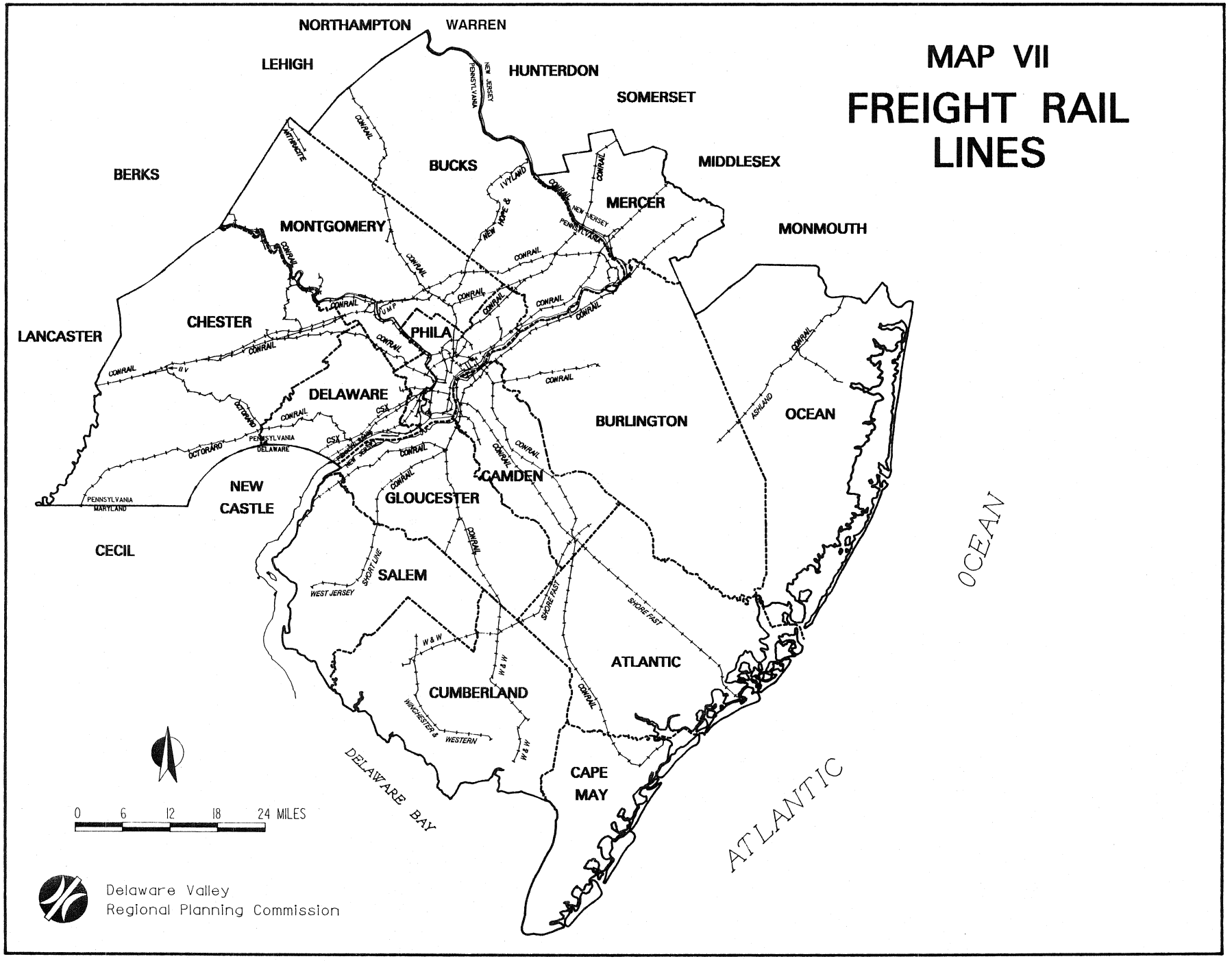
[25] Ibid., p. 8.

Guilford Transportation Industries, raises questions about the effectiveness of this competition and its long-term viability. At this time only three freight railroads have access to the Delaware Valley region (see Map VII). This situation has both advantages and disadvantages. On the positive side are the advantages of a more coordinated and efficient freight movement system throughout the region. The negative side of the situation concerns the problems associated with the formation of a monopoly or oligopoly.

The long-term loss of high and medium value traffic has greatly affected railroads, and has left the industry with predominantly lower value, high volume commodities such as coal, grain, chemicals (including petroleum products and hazardous waste), and sand and gravel. Automobiles and automobile parts provide examples of high value commodities that still move by rail in significant volume.

Coal constitutes the largest component of rail freight movement in this region, but its demand is contingent upon future energy situations, specifically the competition with oil and natural gas and the possibility of future energy crises. Regional markets for coal include: export traffic handled at the Greenwich piers in South Philadelphia and at Port Richmond; steel making, although production has declined considerably in recent years; and generation of electricity. Grain fits well into the rail network because it is a bulk good, but the demand for export is highly variable and therefore grain cannot be counted as a dependable cargo. Petrochemical industries located south of Philadelphia on both sides of the Delaware River generate the principal traffic in chemicals, though smaller shippers are distributed throughout the region. Chemicals and hazardous waste present problems associated with the sheer nature of these products. However, shipping by rail remains the safest way to transport these materials. Sand and gravel are important rail commodities originating in southern New Jersey. CSX Transportation, Inc. has established an intermodal terminal for new automobiles in Delaware County, which receives cars by rail from the factory and then transfers them to highway car carriers for regional distribution. Distribution of imported automobiles from Delaware River piers to interior points constitutes another rail market.

Facing a changed economic environment wrought by deregulation and an increasingly competitive trucking industry, railroads have tried several different tactics in their effort to maintain financial viability. These methods include cutting labor costs, ending duplication of lines, and abandoning low density lines. On the other hand, the state governments have been concerned with maintaining service, or at the least with preserving the right-of-way on lines proposed for abandonment. Shortline operators have acquired some of these spurs and feeder lines. Often these operators are affiliated with major shippers on the affected line; because of their dependence on the rail system, they have been compelled to acquire the line and operate it themselves. Currently seven shortline railroads operate in the nine-county Delaware Valley region, plus one additional line in Southern New Jersey. These eight operators now have almost 200 miles of track


MAP VII
FREIGHT RAIL LINES
NORTHAMPTON
WARREN
LEHIGH
HUNTERDON
SOMERSET
BERKS
BUCKS
MIDDLESEX
MERCER
MONTGOMERY
MONMOUTH
LANCASTER
CHESTER
PHILA
DELAWARE
BURLINGTON
OCEAN
CAMDEN
NEW CASTLE
GLOUCESTER
CECIL
SALEM
ATLANTIC
CUMBERLAND
CAPE MAY
OCEAN
ATLANTIC
DELAWARE BAY
CONRAIL
PENNSYLVANIA
NEW JERSEY
DELAWARE
MARYLAND
CSX
WEST JERSEY
SHORE FAST
W & W
WINCHESTER & WESTERN
ASHLAND
IVYLAND
NEW HOPE &
0 6 12 18 24 MILES
Delaware Valley
Regional Planning Commission

between them.[26] The shortline operators have filled a gap in the provision of rail service with their acquisition of lines that otherwise would have been abandoned.

Both New Jersey and Pennsylvania are working hard on efforts to maintain the rail infrastructure, as well as to improve active lines. The state has projected expenditures of approximately $950,000 for three projects in the four-county New Jersey portion of the region.[27] Much of this money is designated for improvements to lines which will facilitate the movement of freight from Southern New Jersey to the north. Currently, only two routes connect Southern New Jersey with the national rail network - the Delair lift bridge to Philadelphia and the Bordentown Branch, which parallels the Delaware River, to Trenton. The car float to Pigeon Point in New Castle County, Delaware is closed and a 24-mile segment of the former Jersey Central line to Lakehurst has been abandoned. New Jersey has expressed an interest in reopening the latter, seeing potential for increased demand for moving sand, gravel, and clay out of Southern New Jersey.

Rail banking has recently become an important issue in the region. Currently, both states are developing programs to assess the potential of abandoned lines for future transportation use. Even if the right-of-way does not immediately become used for the purpose of transportation, the federal courts have upheld the constitutionality of rail banking. It is interesting to note that in several instances abandoned rail lines are being utilized as recreational trails.

Pennsylvania has developed programs which help shortline operators commence and continue operations on lines abandoned by the major railroads. Pennsylvania also notes in their comprehensive Freight Rail Study that there is a particular advantage which the Philadelphia area enjoys by being within 300 miles of most major cities in the Northeast.[28] Though there has been a reduction in the amount of rail traffic caused by declines in the steel and coal industries, Philadelphia has an excellent opportunity to become a regional distribution center for the Northeast. Several terminals throughout the region, which Conrail and CSX operate, already have the ability to handle TOFC and container traffic.

In competing with the trucking industry for long-distance hauling, the railroad industry has developed such capabilities as trailer on flat car (TOFC) and double stacking. With these innovations the railroads have become much more competitive in the longer hauls (300 to 1,500 miles). Increased weight limits and the use of tandem trailers have also improved the productivity of the trucking industry. The Philadelphia region has been severely hampered in its competition with other regions because of limitations imposed by bridge height restrictions and the current lack of efficient intermodal terminals. PA

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[26] The Official Railway Guide, North American Freight Service Edition. International Thomson Transport Press: New York, NY, Vol. 120, No. 6, May/June 1988.

[27] New Jersey State Rail - 1989 Update, NJ Department of Transportation, Bureau of Freight Services, Trenton, NJ, July 1988, pp. 6-7.

[28] A Comprehensive Freight Rail Study for Pennsylvania, Transportation and Distribution Associates, Inc., Philadelphia, PA, November, 1987, p. vi.

DOT has identified raising vertical clearance at several sites in Philadelphia as a problem demanding immediate attention. Action is needed in order to accommodate double stacked container cars on the Conrail Mainline.

A regional distribution center in the Philadelphia region would require substantial public investment in order to develop an intermodal facility which could connect with major highways, railways, the Port of Philadelphia and Philadelphia International Airport. In support of this idea the Governors of New Jersey and Pennsylvania have recently announced plans to construct an intermodal project at the Greenwich Rail Yard of the Philadelphia Port near the junction of I-95 and I-76, adjacent to Conrail and CSX rail lines.[29]

3. Port Facilities

Several factors have caused port traffic to decline in recent years, namely:

- The change from break-bulk shipped freight to container packaged freight;
- The general decline of the manufacturing sector;
- Fractionated control and promotion of port facilities; and
- The lack of easy accessibility.

Advances in containerized cargo have created many benefits for the cargo shipper. Unfortunately, the ports of the Delaware River have to a great extent failed to upgrade their equipment and facilities in order to take advantage of shippers' desires to increase their efficiency through the use of this new technology. The effect of shippers moving to other ports to use these new facilities, and the associated decline in break-bulk shipping, has resulted in an overall market share loss for Delaware River ports.

The decline of the manufacturing sector has also hurt the region's ports due to decreased imports of raw materials (which has decreased traffic in bulk commodities) and the corresponding decrease in exports of finished products. Both the decline of the manufacturing sector and the trend away from break-bulk goods has led to the abandonment of many piers, especially those near the central business districts. The land and piers adjacent to Center City Philadelphia and downtown Camden have become more valuable for residential, office, and other commercial uses than for port related uses. The federal government recently opened the door for waterfront development by lifting navigational servitude from five sites on the Pennsylvania side of the river. This will allow approximately $550 million of planned development to begin along the river.

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[29] Diaz, Idris Michael, "Casey, Kean Adopt Plan for the Port," Philadelphia Inquirer, Philadelphia, PA, November 2, 1988.

The Delaware River ports, in general, and the Port of Philadelphia, in particular, have recently undergone a major organizational restructuring in an effort to become more competitive relative to other mid-Atlantic ports. In comparison with these nearby ports, items cited as worse at Philadelphia included: higher loading charges, time delays, poor labor productivity, and shipment documentation problems.[30] These problems are being addressed as Pennsylvania and New Jersey look toward changing the management of and renovating the port's facilities. Between 1982 and 1988 the Port of Philadelphia spent $8 million on facilities compared with $157 million spent in Baltimore and $287 million in New York. In November 1988, the Delaware River Port Authority (the DRPA has recently gained a large share of the responsibility for the management and promotion of the Delaware River Ports) approved a $150 million program to redevelop the ports. Pennsylvania has also approved $55 million in funds for improvement to the Port of Philadelphia, in line with Governor Casey's priorities to revitalize ports. Money from both sources will be used to construct additional warehousing and a 50-acre piggyback (trailer/container) rail yard in Philadelphia, as well as a 300,000 square foot International Trade Center in Camden, and to develop a cargo tracking computer system and a $100 million revolving loan fund for port projects on both sides of the river. These are only the first steps in a long process to revitalize the ports of the Delaware River. Future circumstances may warrant joining Delaware ports together with those of Pennsylvania and New Jersey in order to take full advantage of their regional proximity and to end unhealthy competition between ports that could benefit from cooperation.

In surveys conducted in the early 1980s, several problems associated with access and efficiency at the Ports of Philadelphia were identified. These can be grouped into three categories: intermodal connections to rail, truck accessibility, and shipper's concerns.

The railroad's port troubles are much the same as the general troubles mentioned above. Raising overhead clearances near the port, which would allow the use of doublestack equipment, could lead to increases in inland bound traffic. Of the firms that use rail access to the terminals, some expressed concern that the quality and frequency of service by Conrail was inadequate.[31]

Truckers cited a number of problems with access to the ports of Philadelphia, including rough road conditions leading to the port, the need to use city streets, peak hour urban congestion, low overpasses, freeway ramp problems, and weight limits too low to handle trucks on the most direct routes.[32] However, the repaving of Delaware Avenue and the completion of the Delaware Expressway (I-95) have improved highway access.

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[30] Survey of Shippers Using the Ports of Philadelphia, DVRPC, Philadelphia, PA, May 1983, pp. 10-11.

[31] Recent Changes to Conrail and Analysis of Impacts on the Ports of Philadelphia, DVRPC, Philadelphia, PA, May 1982, p. 5.

[32] Survey of Trucking Companies Using the Ports of Philadelphia, DVRPC, Philadelphia, PA, May 1983, p. 2.

4. Airports and Air Freight

Since 1978 the number of commercial flights using Philadelphia International Airport (PHL) has increased 70 percent. In order to ensure safety and avoid delays at PHL, private, business, charter, and general aviation traffic must increasingly rely on reliever airports. However, with the important exception of Northeast Philadelphia Airport, most of these airports are privately owned and, with the acceleration of business and residential development in the suburbs, have come under strong pressure to sell their facilities for non-aviation development. Since 1982 the airport system has lost 11 of 54 facilities, or up to 18 percent of its capacity. The resultant loss of geographic landing options and crowding at remaining airports weakens the aviation system. To counteract this trend, DVRPC has encouraged the FAA to provide capital grants to private owners in return for a contractual commitment to preserve their airport capacity. This capital improvement program is especially critical to the maintenance of the aviation system in the New Jersey portion of the Delaware Valley.

Zoning in the vicinity of airports is also an important issue related to the preservation of a reliever system. Unless airports are protected from encroaching development, many will ultimately close because of friction with neighbors and ensuing political pressure. Many municipalities are reluctant to pass protective ordinances, preferring to realize the higher tax revenue from more intensive development. The significant direct, indirect, and induced economic impact of general aviation airports, as much as $10 million per airport per year, is often overlooked by neighbors and local officials.

High value cargo generated by the service sector and high technology firms dominate air freight traffic, because of the relatively high price associated with air movements and the limited cargo capacity. Cargo at Philadelphia is handled through a separate terminal, Cargo City, at the western end of the main runway with 339,000 square feet of working space. United Parcel Service will open a new East Coast distribution center with 1,000,000 square feet in 1989. Access to Philadelphia International Airport has been recently improved with the completion of I-95 near the airport. Construction on I-476 from the north is scheduled to be completed in 1992, which will greatly increase accessibility from the north and west.

Other full service airports located in the study area include Northeast Philadelphia, Mercer County (Trenton), and Atlantic City International. Though the last serves a growing travel market and is experiencing growth in service, the others have lost service as flights have been shifted from smaller airports to regional hubs. However, these airports do fulfill an important function by providing facilities for cargo and corporate aircraft. Greater Wilmington Airport should also be mentioned in this context, even though it lies outside the study area, as it serves Southern New Jersey, and Chester and Delaware counties in Pennsylvania.

C. Land Use Planning and Development

Efforts to improve personal mobility through the expenditure of public funds in transportation facilities have often been thwarted by subsequent land development. The improved mobility, in terms of service and accessibility, that a new transportation facility provides has frequently resulted in rapid development of the areas surrounding the facility. New facilities provide employment opportunities and potential for real estate speculation. The first round of industrial and commercial development is soon followed by a second round of residential and commercial establishments. Conventional zoning has generally been ineffective in controlling these tendencies because of lack of jurisdictional control and/or the desire of local government to widen their economic base, coupled with the pressures of speculative interests.

At the local level, zoning is sometimes uncoordinated and contrary to the regional and county land use plans which guide the design and implementation of transportation improvements. This uncoordinated development manifests itself in intensive strip development near significant travel generators, such as industrial parks, shopping centers, recreational facilities, and large residential developments.

Governor Kean of New Jersey has submitted three proposed bills, which he has termed "Transplan," to the State Legislature, which should address some of the foregoing issues. The first proposal, signed into law in February 1989, grants more authority to NJ DOT to control access to state highways from adjoining properties. The second establishes a mechanism by which counties can levy impact fees on developers to pay for needed road improvements. This bill is now wending its way through the legislature. The third bill gives counties more say in controlling development, and is the most controversial, as it weakens "home rule" powers long enjoyed by state municipalities. However, NJ DOT is developing a local planning assistance program, which should improve state and local coordination in transportation and land use planning in a manner sensitive to local concerns.

In the Delaware Valley region, the trends and patterns of population and employment growth are clearly reflected by changes in residential and non-residential land use. The land use changes during the last 30 years are consistent with the rapid growth in suburban development that began in the 1940s.[33] The population of the region declined by two percent during the 1970s, while simultaneously more than 65,000 acres were developed for residential use. The biggest amount of land developed for residential use was in the suburban counties, and that trend still continues (see Map VIII).

Although more than 21,000 acres were developed in the region during the 1970s for commercial, industrial, and institutional uses, less than 1,000 of these acres were in Philadelphia. In order to accommodate development in the suburban counties, land was converted from agricultural, forest, and other rural uses. A recent paper entitled,

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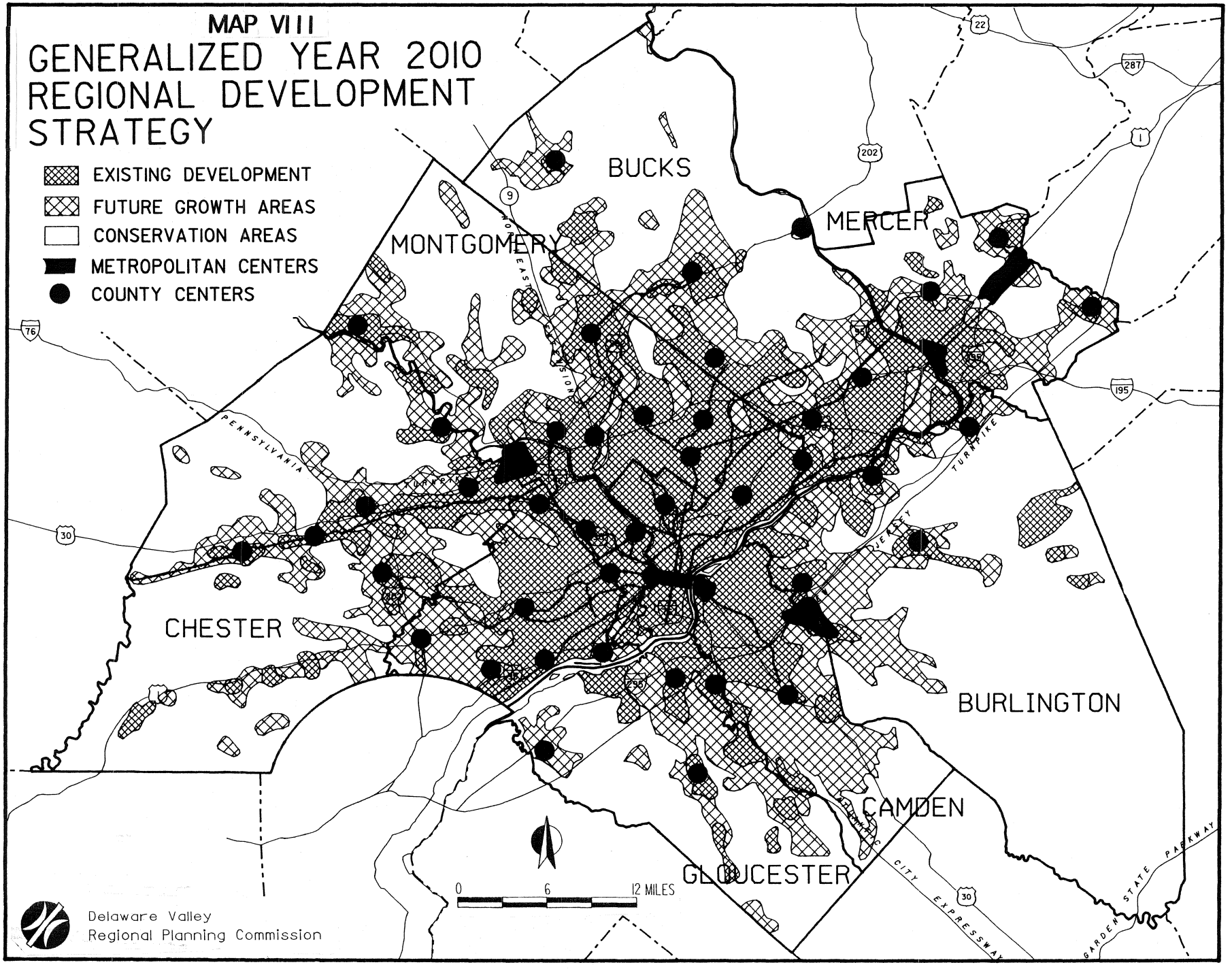
[33] Zakaria, Thabet, "Traffic Trends and Emerging Transportation Planning Issues in the Delaware Valley Region," Transportation Quarterly, Vol. 40, No. 2, April 1986, pp 171-188.


MAP VIII
GENERALIZED YEAR 2010
REGIONAL DEVELOPMENT
STRATEGY
EXISTING DEVELOPMENT
FUTURE GROWTH AREAS
CONSERVATION AREAS
METROPOLITAN CENTERS
COUNTY CENTERS
BUCKS
MONTGOMERY
MERCER
CHESTER
BURLINGTON
CAMDEN
GLOUCESTER
PENNSYLVANIA TURNPIKE
NORTHEAST EXTENSION
JERSEY TURNPIKE
ATLANTIC CITY EXPRESSWAY
GARDEN STATE PARKWAY
0 6 12 MILES
Delaware Valley
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"Jammed in Jersey" describes the plight of the changing land use in New Jersey. Choking on a surge of suburban and exurban growth that has washed over it in the 1980s, New Jersey may become the first industrial state to enact a wide-reaching set of land use controls.[34]

In order to change development patterns fueled by the expanding service economy in the state, the New Jersey State Planning Commission was set up by the legislature in early 1986 to draft a statewide development and redevelopment plan, including a land use plan. The preliminary plan was issued in November 1988,[35] and the final plan is scheduled for adoption in 1989 after cross-acceptance. The plan will attempt to restrict suburban development in areas where growth has recently begun, concentrate rural development around selected towns, confine development along transportation corridors, and encourage growth in older cities and suburbs that have the infrastructure to handle it. The plan's goals are ambitious. The goals for cities involve reversing an expected loss of people and jobs so that by the Year 2010 and beyond, cities in the state would regain their 1985 population and job levels. The plan divides New Jersey into seven categories. The first four, which cover older cities, suburbs, towns, and suburbanizing areas, are designated for growth. The others, future suburbanizing areas, agricultural areas, and environmentally sensitive areas are subject to limited growth or restraints. Even with growth steered to the designated areas, limited growth areas would still absorb one-fourth to one-third of the expected population growth, if the plan takes effect.

1. Core Redevelopment

The functions of the core areas of Philadelphia, Camden, and Trenton in the region have changed markedly over time. Once the major retail and wholesale centers for the region, these areas have lost substantial population and jobs, due to manufacturing, retailing and other activities traditionally concentrated in the core relocating to the suburbs.

Wherever rehabilitation of core areas has occurred, a land use pattern quite different from the previous has emerged. The new functions include some high-rise and luxury apartments, governmental buildings, and retail activities serving the entire region. Core redevelopment will not normally occur without a strong and coordinated public commitment. Such redevelopment requires the concentration of public resources and incentives in order to attract private sector investment. Since coordinated public and private investments tend to guarantee a higher rate of return on the revitalization dollar,

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[34] Guskind, R. and N.R. Pierce, "Jammed in Jersey," Public Management, Vol. 70, No. 8, August 1988, pp 2-5.

[35] New Jersey State Planning Commission, Preliminary State Development and Redevelopment Plan, Vols. I and II, Trenton, NJ, November 1988.

public/private partnerships and incentives to attract office, retail, entertainment, and residential uses should be encouraged.[36]

The relatively high density of the region's cities and older suburbs offers special potential for the use of public transportation. Urban business districts can be restored to a rich mix of uses. In addition, older neighborhoods can be renewed and should be the focus of targeted reinvestment. Land use regulations and infrastructure improvements must be viewed as redevelopment tools.

With the supportive environment in place, these communities can attract long term investments, and provide employment opportunities close to those who most need them. Affordable housing can be built and social services provided. Focusing investment in already developed areas can ease the development pressure on open land and help preserve rural areas.

2. Suburban and Rural Development

The main advantages of a suburban development pattern have been convenience and accessibility. Built upon the idea of widespread private automobile use and the desirability of low density development, there seemed little need for any coordinated planning effort. As a result, however, suburban development often carried a heavy price. Extensive new infrastructure had to be constructed with the consequent neglect and abandonment of older urban and suburban municipalities.[37]

After World War II, the dispersion of the region's metropolitan population became closely associated with a more general economic decentralization. The relative ease of finding adequate land and services in the suburbs attracted firms there, while trends of environmental degradation and everyday strife at the urban core provided the added impetus to move elsewhere. Increasingly, residents of the Delaware Valley region both live and work in the suburbs, relying heavily on the automobile. Suburban development has spurred the construction of primary roadways and highways. Completion of the Schuylkill Expressway, New Jersey Turnpike, and Pennsylvania Turnpike in the 1950s redefined the region's development pattern.

Dispersed economic and residential growth has drained the region's older urban and suburban communities; dispersion of residential and economic development in the 1980s has changed the suburban and rural functions of the region. In general, dispersed development requires expanded public facilities and infrastructure, and often adds to traffic congestion and air pollution. As this chapter will later discuss, estimates of the total current need for improvements and maintenance of the transportation system are several billions of dollars.

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[36] Ibid.

[37] Draft Preliminary State Development and Redevelopment Plan, Vol. I, New Jersey State Planning Commission, Trenton, NJ, January 1988.

The proposed development plan for New Jersey divides the state into seven land use tiers, designated as follows:

Tier 1 - Redeveloping cities and suburbs;
Tier 2 - Stable cities and suburbs;
Tier 3 - Suburban and rural towns;
Tier 4 - Suburbanizing areas;
Tier 5 - Future suburbanizing areas;
Tier 6 - Agricultural areas; and
Tier 7 - Environmentally sensitive areas.

The state will use a growth management approach, which uses infrastructure support rather than zoning to steer new development to the first four tiers. The plan calls for coordination between various levels of government in the siting of new facilities, such as roads, sewers, water lines, schools, and recreational facilities, so as to enhance the plan elements.

D. Transportation Safety and Security

The safe efficient use of the highway system requires accommodating vehicles of different sizes and weights serving different purposes. Transit vehicles, whether running on streets or rail, must operate safely and the facilities must be designed to provide personal securities to riders. Transportation safety and security are the most important factors in planning for highway and transit facilities.

1. Accident Causes and Measurement

Traffic accidents are indicative of failures in the interaction of driver, vehicle, roadway, traffic, and weather conditions. Accident indices for roadway sections may be expressed in terms of the numbers of accidents per person, per vehicle registration, or per vehicle-mile of travel, with the number of accidents per vehicle-mile of travel being the most common index used to evaluate the relative safety of highway or street sections.[38]

Crashes and fatalities involving heavy vehicles have been increasing in recent years. This increase is of concern to traffic safety officials since it represents an increasing hazard to all highway users. Human error has been identified as one of the primary causes of accidents involving heavy trucks in the Delaware Valley region. Among the chief causes are speeding and making unsafe lane changes, with driver fatigue acting as a major contributing factor. Excessive hours at the wheel, irregular scheduling, and variations in daily sleep patterns have been connected with driver fatigue. Mechanical failure and vehicle defects have also played an important role in heavy vehicle crashes.

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[38] Transportation and Traffic Engineering Handbook, Institute of Transportation Engineers, 1976.

Brake failures and inadequate braking ability accounted for the highest proportion of mechanical problems, though tire and wheel failures have contributed their share. Many of these safety issues have been exacerbated by deregulation and a generally more competitive environment. In an effort to cut costs, some truckers have skimped on maintenance and repairs, resorted to overloading their vehicles, and extended the time spent by drivers behind the wheel. Enforcement of regulations is often uneven and varies by jurisdiction. Since these are national issues affecting interstate commerce, there is a need for a federal presence in setting uniform standards and assuring adequate enforcement.

A comparison of highway fatalities and total accidents in the Delaware Valley region over the past ten years shows that fatalities increased from 689 in 1976 to 694 in 1986 (see Figure I). By the Year 2000 it is estimated that 744 persons will lose their lives each year in highway accidents.[39] In 1986 there were 91,393 accidents in the Delaware Valley, 47 percent of these occurred in the New Jersey portion of the DVRPC region. Unfortunately, highway accidents have been increasing since 1983, when the number of total accidents was the smallest in the past 12 years.[40]

2. Public Transportation Accident and Security Issues

With respect to public transportation, two largely separate issues emerge when discussing safety. The first, reducing the accident rate to a minimum, compares to similar concerns already expressed about highway safety; the second involves maintaining security at stations and aboard vehicles.

Buses are subject to accidents as are all other vehicles using the highway system. The main impact that a transit operator has is through driver training programs and line management's emphasis on safe driving. Generally, the record of local operators is good and the risk to passengers is less than if they were driving their own cars. Both SEPTA and NJ TRANSIT operate relatively new bus fleets that are well maintained.

With rail vehicles the problems are those of signaling and control, and several local issues warrant discussion. Signaling fulfills two functions in rail operations, dispatching and collision avoidance. The two are related in that the ability to keep trains separated allows the operator to schedule short headways and to operate safely in traffic that mixes locals, expresses, and freight.

Amtrak owns and controls the dispatching on three of the Regional Rail lines, and additional lines pass through or touch Amtrak territory. This means that SEPTA's trains must be equipped with signaling and train control systems compatible with that used by Amtrak. Following the tragic accident in January 1987 at Chase, Maryland in which 16

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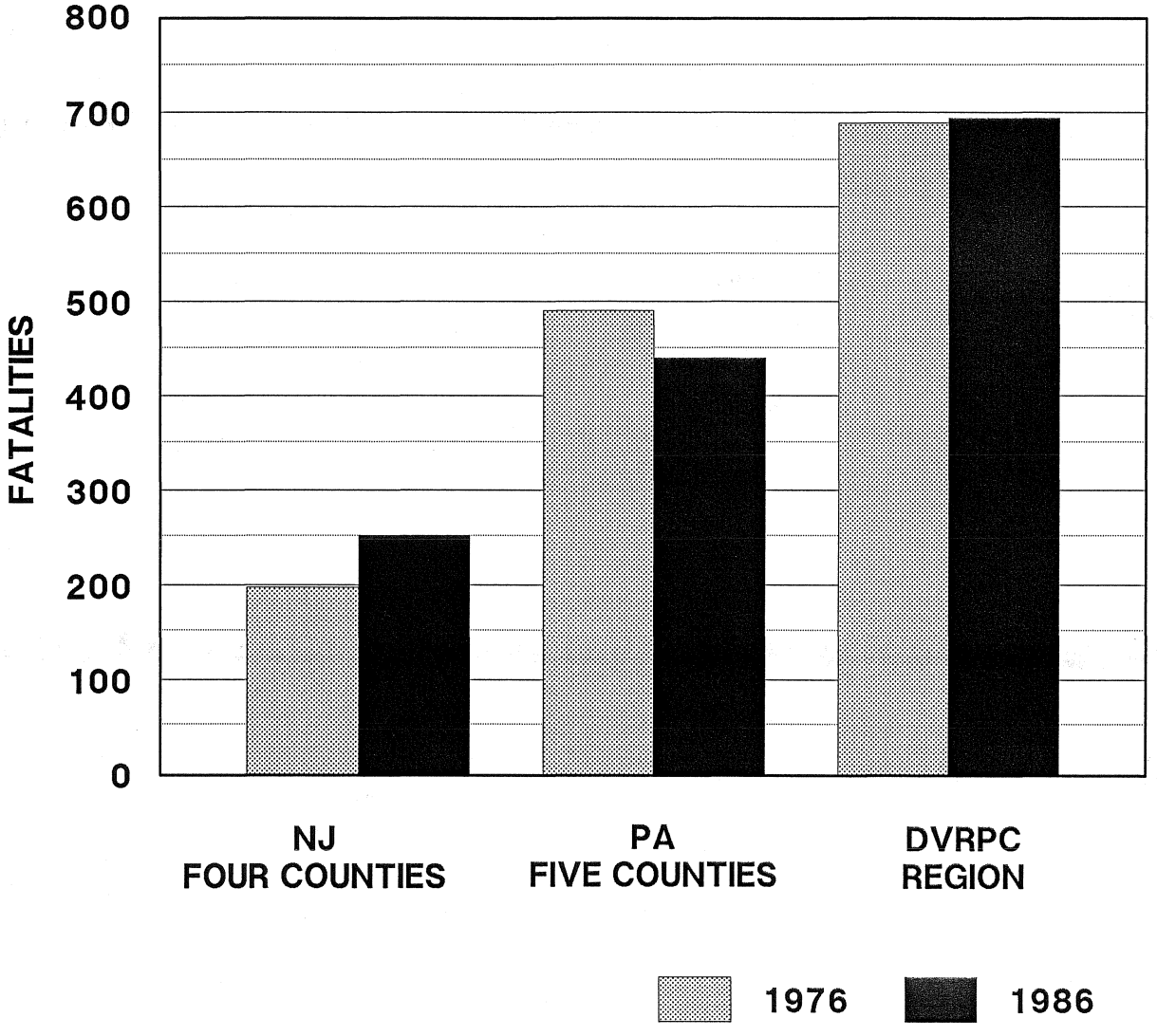
[39] Delaware Valley Regional Planning Commission, Year 2000 Transportation Plan for the Delaware Valley Region, Philadelphia, PA, May 1982.

[40] Traffic Accident Facts and Statistics, Pennsylvania Dept. of Transportation, December 1987.

FIGURE I

HIGHWAY ACCIDENT FATALITIES IN THE DVRPC REGION (1976 & 1986)



Delaware Valley Regional Planning Commission

persons lost their lives, the Federal Railroad Administration added a regulation requiring that all trains operating on the Northeast Corridor, including suburban passenger and freight trains, be equipped with devices that automatically cut power and apply brakes if the train fails to obey a restrictive signal. This has effectively forced SEPTA to retrofit their entire Regional Rail fleet at an expense of $19.5 million.

SEPTA is directly responsible for the signaling on the remaining ten non-Amtrak lines and much of this is in need of modernization or replacement. The FY89 capital budget contains $149 million worth of projects that deal with signaling and communications on Regional Rail and rail transit lines. The importance of this aspect of rail operations is stressed by noting that the previous figure, which includes $31 million carried forward from FY88 for projects not completed, represents 27 percent of all rail capital projects. Major projects are now underway on the Broad Street Subway and between Secane and Elwyn on the West Chester Branch.

A series of four accidents, resulting in two fatalities, on the Norristown High Speed Line (Route 100) in 1985-86 called attention to deficiencies in facilities and rolling stock, as well as operating and maintenance practices on the line. One "trolley" slammed into a wall at the 69th Street Terminal when brakes on the 60-year old car failed, and in the second instance vandals caused a derailment and subsequent collision with an oncoming car. These resulted in a federal investigation and a heightened awareness among the public that some investment was needed to preserve operations on the line, and as a result the FY89 capital budget contains $36 million for new rolling stock and right-of-way improvements.

E. Air Quality Problems

The quality of air in the Delaware Valley region, as well as in other areas in the nation, is of increasing concern. A growing awareness of the seriousness of air pollution has been reflected over the past two decades in a series of legislative and administrative actions designed to give public agencies the tools necessary to achieve satisfactory air quality standards. The causes of air pollution are complex and its elimination, or substantial reduction, is equally complex. One of the serious consequences of the growing use of motor vehicles in the region is air pollution. This can be attributed to the fact that passenger cars, vans, pickups, buses, and other heavy motor and diesel vehicles are still inefficient in their combustion of fuel.

Several gases, vapors, and types of particles have been identified as air pollutants. Carbon monoxide, hydrocarbons, oxides of nitrogen, smoke and particulate matter, lead, and photochemical smog or ozone are the most important. With the exception of ozone, all of these pollutants are called primary pollutants; they are the products emitted by internal combustion engines. Ozone results from a reaction in the atmosphere among oxides of nitrogen, hydrocarbons, and other pollutants in the presence of sunlight. While there are other significant sources of some of these pollutants, transportation sources account for the greatest proportion of carbon monoxide, hydrocarbons, oxides of nitrogen, and lead.

In general, there are two types of transportation-related air quality problems. They are: (1) localized and (2) regional.

1. Local Air Quality Problems

Localized transportation related air quality problems usually result in carbon monoxide (CO) concentrations exceeding either the one-hour 35 parts per million (ppm), or more likely, the eight-hour (9 ppm) CO air quality standard. Factors contributing to this problem include high vehicular traffic volumes occurring under congested traffic conditions frequently found in densely developed portions of urban areas. Although exceeding the federal standard, violations of the CO standards are relatively infrequent.

2. Regional Air Quality Problems

Regional transportation related air quality problems typically result from vehicular and stationary source hydrocarbon (HC) and nitrogen oxide (NO_x) emissions chemically reacting in the atmosphere to produce oxidant pollutants exceeding the one-hour (0.12 ppm) air quality standard. Complex chemical reactions produce oxidants and depend upon many factors, such as prevailing meteorological conditions and the topographic, land use, and industrial characteristics of an area.[41]

Transportation is an important contributor to hydrocarbon and nitrogen oxide emissions. The National Acid Precipitation Assessment Program (NAPAP) estimates for 1980 showed that transportation accounted for 44 percent of all emissions of NO_x and 38 percent of volatile organic compound emissions in the United States.[42]

The Philadelphia urbanized area currently does not meet National Ambient Air Quality Standards (NAAQS) for ozone and carbon monoxide. In particular, ozone continues to present a serious problem in the Delaware Valley region. According to The Philadelphia Inquirer of July 22, 1988, "Ozone pollution this year has New Jersey officials gasping". The state's officials noted the fact that ozone pollution of New Jersey's air in the summer of 1988 reached the highest levels since the state began keeping standardized records. According to the Delaware Valley Citizens Clean Air Council, Philadelphia labored through the worst summer of ozone pollution in 12 years, and the surrounding region also faced one of the worst periods of air pollution on record. At Ancora, New Jersey, for example, were 23 reports of ozone pollution exceeding the federal safety standard (see Map IX). Environmental officials attributed the high ozone levels in the summer of 1988 to the abnormally hot weather and long stretches without wind or rain to dissipate pollution.

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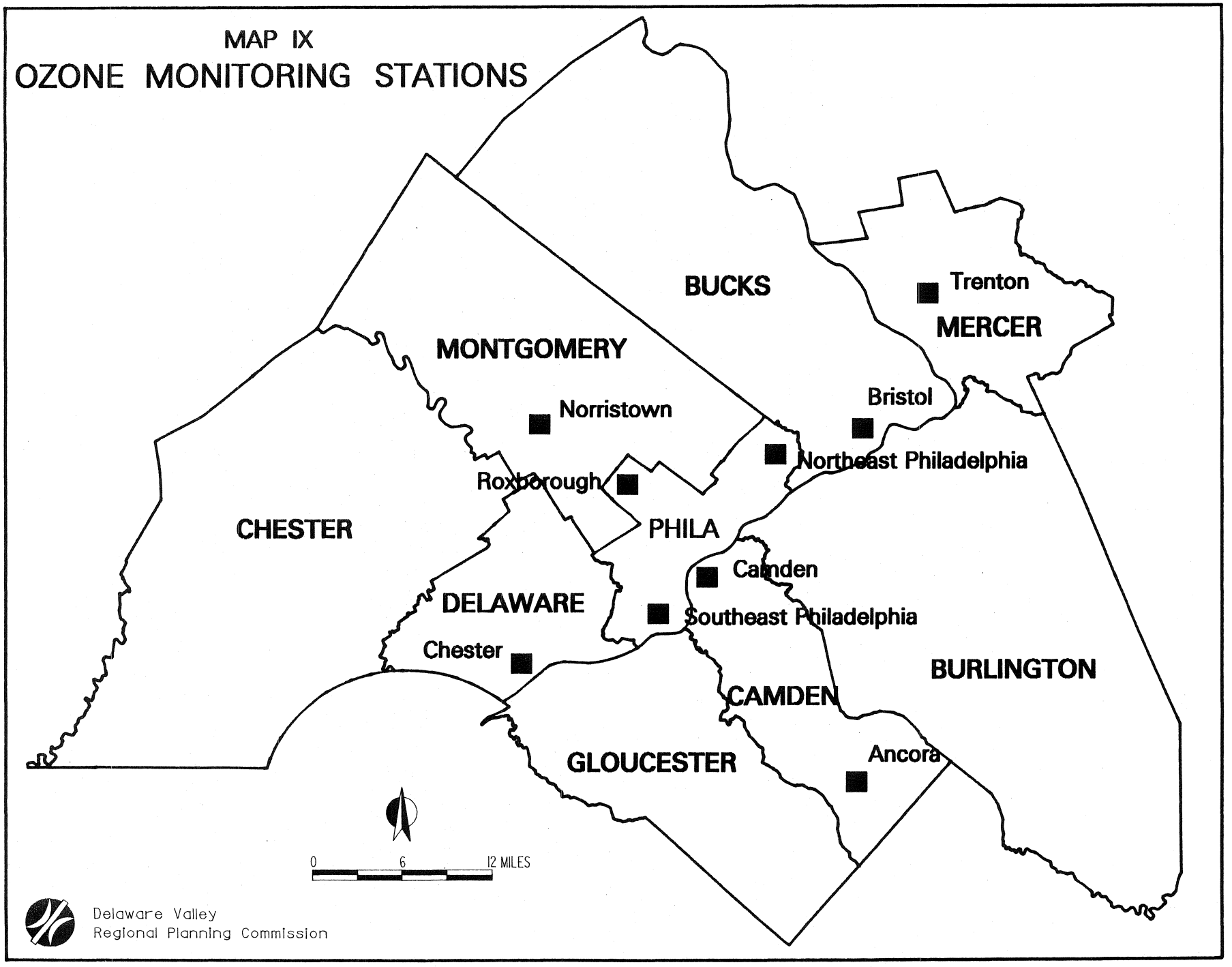
[41] Air Quality Impacts of Transit Improvements, Preferential Lane, and Carpool/Vanpool Programs, Final Report, Environmental Protection Agency, March 1978.

[42] Suhrbier, J.H., and E. Deakin, "Environmental Considerations in a 2020 Transportation Plan - Constraints or Opportunities?" TRB Conference on Long-Range Trends and Requirements for the Nation's Highway and Public Transit Systems, Washington, DC, June 22-24, 1988.


MAP IX
OZONE MONITORING STATIONS
BUCKS
MONTGOMERY
CHESTER
DELAWARE
PHILA
MERCER
BURLINGTON
CAMDEN
GLOUCESTER
Trenton
Norristown
Bristol
Northeast Philadelphia
Roxborough
Camden
Southeast Philadelphia
Chester
Ancora
0
6
12 MILES
Delaware Valley
Regional Planning Commission

Past occurrences and current ozone data for the Delaware Valley region are shown in Table 2. This table presents the number of violations, maximum concentration (in parts per million), and design value for ozone at selected sites in the region between 1978-1988. In the summer of 1980, a significant increase in ozone violations was recorded because of unfavorable meteorological conditions, including a lengthy period of hot weather without wind or rain. In 1986, there were only two sites with six ozone violations in the region. The law permits one violation of the 0.12 parts per million standard for ozone averaged over a three-year period. The fourth highest concentration recorded in the past three years at any station must be 0.12 or less in order for the region to conform to the national ozone standard. This number is called the "design value," and its value for each station is presented in the table for three-year periods ending with the subject year.

3. Legislative Requirements

With the passage of the Clean Air Act of 1970 by the U.S. Congress, a comprehensive national program was undertaken to improve air quality, particularly in urban areas. The Environmental Protection Agency (EPA) established air quality standards and undertook programs to: (1) reduce vehicle-related air pollutants through vehicle emission standards, emission controls (e.g., retrofits), and inspection/maintenance programs; and (2) implement transportation policies, regulations, and projects to further reduce transportation-related emissions.[43]

In accordance with the Clean Air Act of 1970, state, regional, and local agencies, as well as the EPA, developed implementation plans for those urban areas which did not meet air quality standards. The act, as amended, includes several major provisions for reducing travel-related emissions and meeting air quality standards in urban area. The law authorizes EPA to penalize offenders by imposing construction bans or withholding federal funds for clean air planning, highways, and sewage treatment plants.

The EPA has proposed a comprehensive post-1987 ozone and carbon monoxide policy for areas not attaining the NAAQS. Designated non-attainment areas, such as Philadelphia, would be required to submit a revised State Implementation Plan (SIP) demonstrating a minimum average annual emissions reduction of three percent beginning in 1988 from a baseline emissions inventory. The reduction also encompasses emission increases generated by traffic growth. The EPA analyses indicate that most non-attainment areas will have to utilize Transportation Control Measures (TCMs) in order to achieve this target.

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[43] Air Quality Impacts of Transit Improvements, Preferential Lane, and Carpool/Vanpool Programs, Final Report, Environmental Protection Agency, March 1978.

Table 2

OZONE TRENDS AT SELECTED MONITORING SITES

EXCEEDANCES OF STANDARD[1]	1978	1980	1982	1984	1986	1988
Philadelphia						
Northeast	13	14	3	4	3	NA
Roxborough	3	8	8	3	3	18
Southeast	8	0	NA	1	1	NA
Suburban Pennsylvania						
Bristol	11	18	9	7	5	13
Chester	16	26	11	3	4	17
Norristown	19	28	4	3	0	15
New Jersey						
Ancora	5	5	1	7	6	23
Camden	9	16	4	11	6	21
Trenton	4	16	10	5	5	18
MAXIMUM CONCENTRATION[2]						
Philadelphia						
Northeast	.22	.18	.15	.18	.14	NA
Roxborough	.14	.16	.19	.16	.15	.21
Southeast	.23	.12	NA	.15	.16	NA
Suburban Pennsylvania						
Bristol	.245	.201	.148	.230	.148	.205
Chester	.249	.194	.156	.146	.167	.208
Norristown	.186	.196	.139	.174	.118	.204
New Jersey						
Ancora	.147	.140	.125	.152	.169	.178
Camden	.218	.174	.134	.163	.160	.195
Trenton	.165	.194	.163	.208	.141	.204
DESIGN VALUE[3]						
Philadelphia						
Northeast	.19	.18	.17	.16	.15	NA
Roxborough	.17	.16	.16	.16	.15	.15
Southeast	.20	.17	NA	.15	.12	NA
Suburban Pennsylvania						
Bristol	.215	.196	.178	.180	.166	.169
Chester	.215	.180	.167	.157	.150	.167
Norristown	.199	.180	.176	.134	.129	.147
New Jersey						
Ancora	.150	.141	.131	.152	.151	.169
Camden	.175	.166	.166	.159	.153	.177
Trenton	.175	.165	.150	.182	.155	.169

[1]Number of days in which the standard of .12 parts per million (PPM) is exceeded for at least one hour.

[2]In PPM.

[3]Fourth highest concentration in PPM over preceding three-year period.

F. Energy Conservation

Energy conservation considerations have constituted an important element in the transportation planning process in the Delaware Valley region since the 1970s. Various types of low cost, short-term transportation measures for reducing energy consumption fall under this category. Ridesharing, Park-and-Ride, Express Bus Service, and Energy Conservation, Congestion Reduction, and Safety (ECONS) are examples of recent DVRPC projects intended to reduce energy consumption.

1. Travel and Fuel Consumption

As mentioned previously, highways have become the dominant mode for the movement of both passengers and freight. Every alternative transportation mode has been forced to structure its operations in terms of the links it provides to the automobile and the services it offers in competition with the automobile.

A comparison of estimated 1977 and Year 2000 daily fuel consumption by automobiles and trucks in the Delaware Valley region shows interesting results. Fuel consumption by automobiles will decrease by approximately 14 percent from the 1977 level, consumption by light trucks should decline by 11 percent in comparison with 1977 levels, and heavy diesel trucks are expected to consume approximately six percent.[44] Overall, daily fuel consumption is expected to decrease by approximately 12 percent.

The decline in fuel consumption is driven mainly by improvement in engine efficiency and the down-sizing of automobiles. Automobile efficiency expressed in miles per gallon (mpg) is expected to increase from 13.1 mpg in 1977 to 26.5 mpg in the Year 2000, a more than one hundred percent increase. Light trucks will increase from 9.4 mpg in 1977 to 17.2 for an increase of 83 percent. The fuel economy of heavy gasoline trucks is expected to improve by approximately 50 percent, from 3.8 to 5.7 mpg. Similarly, heavy diesel trucks will increase from 4.8 mpg 7.2 mpg, an increase of 50 percent.

A review of the daily energy requirements for public transportation by submode and by operator in the region for 1977, and as forecast for Year 2000, revealed the following results. Energy consumption in the Pennsylvania portion of the region is expected to increase from about 11.6 billion British Thermal Units (btu) to approximately 13.7 billion btu. Similarly, transit energy consumption in the New Jersey portion of the region is expected to increase from about 2.3 billion btu to 2.9 billion btu in the Year 2000, an increase of 26 percent.[45] The increases are driven primarily by an expansion in suburban service.

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[44] Year 2000 Transportation Plan for the Delaware Valley Region, DVRPC, Philadelphia, PA, May 1982 (updated for this study).

[45] Ibid.

Although there will be a decrease in energy requirements for the entire transportation system in the region by the Year 2000 from the 1977 consumption level, energy consumption will continue to be very large. The large demand for petroleum products and fuel has caused national energy shortages in the past. The rapid increase in car ownership has been associated with tremendous growth in automobile travel and significant decreases in car occupancy rates for the journey-to-work. A continued increase in car ownership and travel demand through the Year 2015, coupled with decreasing and uncertain oil supply, places the energy resource problem on the region's agenda of future problems and issues.

The relative costs to provide and maintain one or another form of transportation, depending on the type and amount of fuel used by the power source of each vehicle, can greatly affect the usage, and therefore the mix, of travel modes. The modal mix also may be influenced by federal regulations under a national policy of fuel conservation.

G. Capital and Operating Costs and Funding Requirements

1. Definition of Capital and Operating Costs

Two types of costs are involved in the provision and operation of the highway and public transportation systems. These are:

a. Capital Costs

The capital cost includes the cost of new facilities, improvements to existing facilities, purchases of new transit vehicles, and other minor improvements to both the highway and transit system.

b. Operating and Maintenance Costs

These costs are those incurred routinely for the proper upkeep of the facilities and provision of transportation services. In the case of highways, the following types of costs are included:

- Routine minor repairs to road pavements, including patching, surface treatment, and upkeep of shoulders and approaches;
- Drainage, repair, and cleaning;
- Roadway section restoration, slide/slope erosion correction;
- Bridge and tunnel maintenance and repairs;
- Winter traffic services such as snow removal and surveillance;

- Maintenance of traffic services, pavement markings, signs, guard rails, barriers, fences, lighting, and accident management;
- Roadside services, such as plantings, landscaping, and public services; and
- Labor and appropriate maintenance administration charges.

The normal operating and maintenance expenditures for highways do not include costs for law enforcement or costs associated with general overhead that are not assignable specifically to maintenance activities.

The transit system operating and maintenance costs include the following:

- Maintenance of tracks, vehicles, and power lines;
- Fuel, oil, and electric power;
- Upkeep of depots, storage yards, and other supportive facilities;
- Maintenance of stations, concourses, shelters, etc.;
- Labor for transportation services;
- Cost of supervisory and administrative personnel; and
- Provision of information and police services.

In the past, financial resources have restricted transportation investments throughout the DVRPC region, as the amount of money available to finance transportation improvements has not met the anticipated needs. This is not expected to change significantly in the future. A policy of deferred maintenance to reduce current costs has resulted in unsatisfactory system performance and a backlog of capital expenditures. Both transit and highway maintenance must be supported at a fairly high level for safety reasons, as well as to maintain the quality of transportation service. The amount of funds allocated to system maintenance is an important consideration in developing long-range transportation system plans for the region.

2. Year 2015 Transportation Capital Needs for the DVRPC Region

The highway capital needs for the Year 2015 were derived from previous capital, operating, and maintenance studies prepared for the Year 2000 Transportation Plan for the Delaware Valley region, the New Jersey Transportation Plan, DVRPC Arterial Highway

Deficiency Analysis, and SEPTA, NJ Transit, and DRPA capital improvement programs.[46] None of these transportation facilities and services has been included in the current Transportation Improvement Program (TIP), which will be discussed later in this section. However, it should be noted that no cost analysis has been conducted for the five counties in Southern New Jersey outside the DVRPC region.

a. The Highway System

The highway needs for the period 1993-2015 can be classified into four categories. The first category, major highway and bridge projects, includes new construction, major improvements to existing facilities (such as reconstruction and widening to add lanes), and improvements to the entire highway system. These projects will cost about $3.0 billion. Examples of these improvements include the US 202 Expressway from Doylestown to the proposed North Penn Expressway, and widening US 322 from US 1 to PA 452 in the Pennsylvania portion of the DVRPC region. In New Jersey, widening NJ 70 from NJ 73 to NJ 72 in Burlington County and construction of a new Lumberton Bypass from NJ 38 to County 541 are examples of major highway improvements included in this estimate.

The second category of highway needs covers arterial deficiencies. Projects to correct these deficiencies will cost about $2.0 billion. Examples include PA 413 from Newtown to US 13, US 202 from West Chester to the Delaware state line, and PA 309 from PA 611 to the Montgomery County/City of Philadelphia boundary. NJ 47 from US 322 to NJ 41 in Gloucester County and NJ 33 from County 622 to US 130 in Mercer County are also examples of deficient arterial facilities.

The third category of highway needs, minor improvements, includes bridge repairs, signal improvements, and small reconstruction projects. These projects will cost about $1.6 billion. Examples include rehabilitation of the Randall Avenue bridge over Amtrak in Bristol Township, Bucks County and rehabilitation of the US 1 bridge over the SEPTA Norristown High Speed Line in Haverford and Upper Darby Townships, Delaware County. Examples in New Jersey include the US 30/130 bridge over the Cooper River in Camden County and US 1 at NJ 33 and Barlow Street Circle in Mercer County.

The final category of highway needs, operations and maintenance, will require about $3.5 billion for routine upkeep of existing and future facilities, such as snow removal and sign repairs.

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[46] DVRPC Year 2000 Transportation Plan for the Delaware Valley Region, 1982; New Jersey Regional Transportation Plan, 1984; DVRPC Arterial Highway Deficiency Analysis for the Delaware Valley Region, 1987; and SEPTA and DRPA Capital Improvement Programs, 1988.

b. The Public Transportation System

Public transportation needs for the period 1993-2015 for SEPTA and the Philadelphia portion of PATCO can be categorized into capital facilities and operations and maintenance. The capital facilities needs, which total approximately $4.2 billion, can be exemplified by the purchase of 60 new subway cars for the Market-Frankford line, extension of the Broad Street subway line to Rhawn Street, regional rail system improvements, and a Lindenwold High Speed Line extension to 19th and Market Street. Operations and maintenance of the transit system makes up a significant part of these costs, $7.5 billion. These totals represent public subsidies from the local, state, and federal governments; they do not include revenues from fares.

In the New Jersey portion of DVRPC region, public transit needs for NJ TRANSIT and PATCO can also be categorized into capital facilities and operations and maintenance. The capital facilities needs, which total $750 million, can be exemplified by a PATCO High Speed extension to Maple Shade. Operations and maintenance of the transit system, costing $950 million, represents public subsidies from local, state, and federal governments.

Table 3 shows that about $23.5 billion of public sector investments is needed to improve and maintain the transportation system through the Year 2015 in the Delaware Valley region. Approximately $10.1 billion will be required to improve and maintain the highway system and $13.4 billion will be required to improve and maintain the public transportation system. Of these costs, about $150 million and $700 million per year will required to operate and maintain the highway and public transportation systems, respectively. The difference between the operating and maintenance cost of the transit system and the farebox revenue (together with other revenues, such as advertising fees received by the operators) represents the operating subsidy, which has to be provided from local, state, and federal sources (see Table 3). This is the funding level that would keep the transportation system operating at a minimum level of service.

3. Current Transportation Improvement Program (TIP) for the DVRPC Region

Each year, the Delaware Valley region is the recipient of millions of dollars for highway, bridge, and transit improvements. About $5 billion in transportation improvements has been programmed for the six-year period between 1989 and 1994. This includes new construction, reconstruction, various types of bridge improvements, transit improvements, bus and rail car purchases, and safety projects.

The selection of projects for implementation is a continuous and complex process, which requires a high degree of coordination among the many local recipients of federal and state funds. The DVRPC Board has the task of providing the forum through which the region's elected officials and the representatives of the states and operating agencies determine each year's TIP projects. The coordinated preparation of the TIP through DVRPC gives local elected officials the opportunity to participate in the review of projects

Table 3

TOTAL HIGHWAY AND PUBLIC TRANSPORTATION COST ESTIMATES (1993-2015)

(billions of 1987 dollars)

Facilities	Pennsylvania	New Jersey	Total
A. Highways			
1. Capital Costs			
Major Highway Projects	$ 2.2	$0.8	$ 3.0
Arterial Deficiencies	1.5	0.5	2.0
Minor Improvements	1.3	0.3	1.6
Subtotal Capital	$ 5.0	$1.6	$ 6.6
2. Operating and Maintenance Costs	1.9	1.6	3.5
Total Highway	$ 6.9	$3.2	$10.1
B. Public Transportation			
1. Capital Costs	$ 4.2	$0.8	$ 5.0
2. Operating Subsidies	7.5	0.9	8.4
Total Public Transportation	$11.7	$1.7	$13.4
TOTAL Transportation Costs	$18.6	$4.9	$23.5

initiated by local and state governments, as well as those submitted by the transit operators.

a. Highway TIP

New construction is prominent in both states' anticipated programs. In Pennsylvania, for example, this component constitutes 48 percent of the total six-year TIP allocations; followed by reconstruction, 20 percent; bridge repairs, 19 percent; resurfacing, six percent; traffic improvements, four percent; and safety measures, two percent.[47] Table 4 shows the capital cost summary for the highway TIP. It should be noted that the Interstate completion program dominates the funding in Delaware, Philadelphia, and Mercer counties. The Interstate facilities included are I-476, I-676, and I-295. Table 4 also shows that the highway TIP programs more than $2 billion to be spent in six years, amounting to an annual element of about $850 million, mainly to complete the Interstate system.

b. Public Transportation TIP

Table 5 shows the public transportation TIP for the Delaware Valley region. More than $3 billion is programmed for the next six years. The table also shows the funding source for capital improvements, most of which is expected to come from the UMTA Section 3 program. It is doubtful that the public transportation TIP will be completely implemented because of limited UMTA and state funding.

For example, SEPTA has earmarked $245 million for capital improvements in the FY88 Annual Element to be funded by traditional sources. A supplemental program containing 20 projects worth $235 million has also been developed, but it is uncertain if this money will become available. A steady decline in federal funding since 1983 is projected to continue through the Year 1992, thus widening the gap between total capital needs and available funding to an average of $222 million per year. More discussions at all levels of government must take place in order to determine how to narrow this gap.

The City of Philadelphia, the Delaware River Port Authority, and Pottstown Urban Transit have earmarked a total of $47 million in capital improvements in the FY88 Annual Element. Whenever the project list indicates "unfunded share", it denotes that this project has been included in the Pennsylvania public transit TIP, but not in the approved Commonwealth of Pennsylvania capital budget. However, the project is programmed by the respective transit operator for consideration, provided funding becomes available. Both New Jersey and Pennsylvania have a fiscal constraint policy intended to keep the total amount of projects in the TIP within reasonable levels.

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[47] DVRPC Transportation Improvement Program for 1988-1993, September 1987.

Table 4

HIGHWAY CAPITAL IMPROVEMENT PROGRAM FOR THE DELAWARE VALLEY REGION (FY 1989-1994)

(millions of 1987 dollars)

PENNSYLVANIA Counties

County	Annual Element	Years 2-6	Total
Bucks	$ 37.6	$ 52.4	$ 90.0
Chester	54.4	125.2	179.6
Delaware	318.3	64.5	382.8
Montgomery	100.8	77.5	178.3
Philadelphia	174.1	272.4	446.5
Regionwide	7.3	0.2	7.5
Subtotal*	$692.5	$ 592.2	$1,284.7
NEW JERSEY Counties			
Burlington	$ 81.2	$ 49.4	$ 130.6
Camden	18.3	110.6	128.9
Gloucester	14.1	75.3	89.4
Mercer	39.3	357.4	396.7
Regionwide	3.9	2.7	6.6
Subtotal	$156.8	$ 595.4	$ 752.2
TOTAL	$849.3	$1,187.6	$2,036.9

*Pennsylvania TIP is for FY1988-1993

Table 5

PUBLIC TRANSPORTATION CAPITAL IMPROVEMENT PROGRAM FOR THE DELAWARE VALLEY REGION (FY 1989-1994) (millions of dollars)

I. Capital Cost Summary

Project Sponsor	Annual Element	FY90-94 Years 2-6	FY89-94 Grand Total
SEPTA	$643.2	$2,058.6	$2,701.8
City of Philadelphia	45.3	157.4	202.7
DRPA	32.8	37.6	70.4
NJ TRANSIT	10.6	29.5	40.0
Camden City	10.3	-	10.3
Total	$742.2	$2,283.0	$3,025.2

II. Funding Source Summary

Funding Source	Annual Element	FY90-94 Years 2-6	FY89-94 Grand Total
Urban Mass Transportation Act:			
Section 3	$724.0	$2,135.7	$2,859.8
Section 9	11.5	146.0	157.5
Section 16	0.4	0.8	1.2
Section 18	0.1	0.5	0.7
Section 23	6.1	-	6.1
Total	$742.2	$2,283.0	$3,025.2

In a recent study, Peat Marwick Main & Co. estimated the cost of keeping the existing SEPTA system functioning through the Year 2003 at $4.6 billion.[48] To finance such a large investment, the region would need a new funding source, such as a dedicated local tax or a statewide tax. Current funding sources would not be enough for such an improvement plan.

4. Funding Requirements

An overwhelming portion of the estimated capital costs for both highways and for public transportation improvements is expected to be funded from federal grants. The remaining portion of the capital cost must be made available by the state and local governments and private companies. As shown in Figure II, about $8.7 and $8.0 billion, respectively will be needed to improve the highway and public transportation systems during the period 1989-2015.

An assessment based on the availability of funds in previous years indicates that the estimated capital and operating costs are much higher than the current funding capabilities of the region. A quick review of transportation needs and funding levels indicates that the gap between capital needs and revenues will continue to increase in the future. In 1985, DVRPC compared the highway estimated needs to revenues for the Pennsylvania portion of the DVRPC region and found a shortfall of $700 million, or about 28 percent of estimated needs through 1990.[49]

Also as part of the 1985 DVRPC Infrastructure Study, two funding scenarios for public transportation were assumed, a status quo and a 10 percent federal funding reduction. The most optimistic scenario of no reduction in federal funds results in a shortfall of about $450 million for the six year period (1985-90) in the five Pennsylvania counties of the region.

Anticipated funds for capital improvements over the next 25-year period will be totally dependent upon federal grants, operating revenues, and contributions by the states of New Jersey and Pennsylvania. Additional funds are needed to improve the transportation system and to prevent further deterioration of existing facilities. Such improvements are essential to economic vitality, and provide quality services to the commercial and industrial base of the region, as well as to its residents and commuters. In 1984 New Jersey established a Transportation Trust Fund supported by $3.3 billion in bonds to finance capital improvements to the state's highway and transit systems. Its renewal in 1988 granted an additional bonding authority of $5.7 billion for projects through 1995. Of this additional funding, $200 million will be used for improvements to the transit network.

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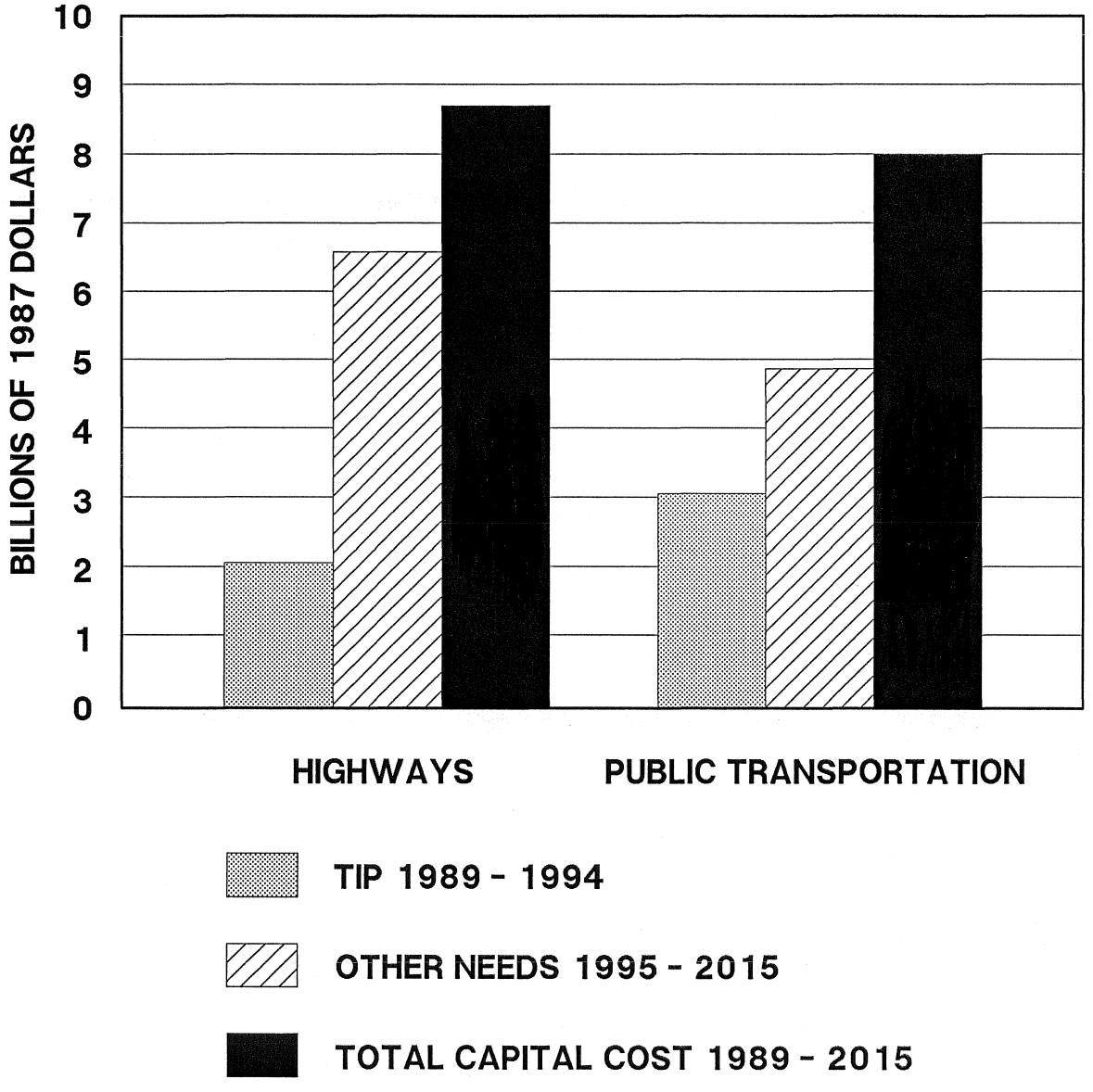
[48] Strategic Plan for Improved Public Transportation Mobility in Southeastern Pennsylvania, Preliminary cost figures for consideration of the Study Steering Committee, September 1988.

[49] Regional Infrastructure Evaluation and Analysis for Southeastern Pennsylvania, DVRPC, December 1985.

FIGURE II

CAPITAL COST ESTIMATES FOR HIGHWAY AND PUBLIC TRANSPORTATION FACILITIES IN THE DVRPC REGION



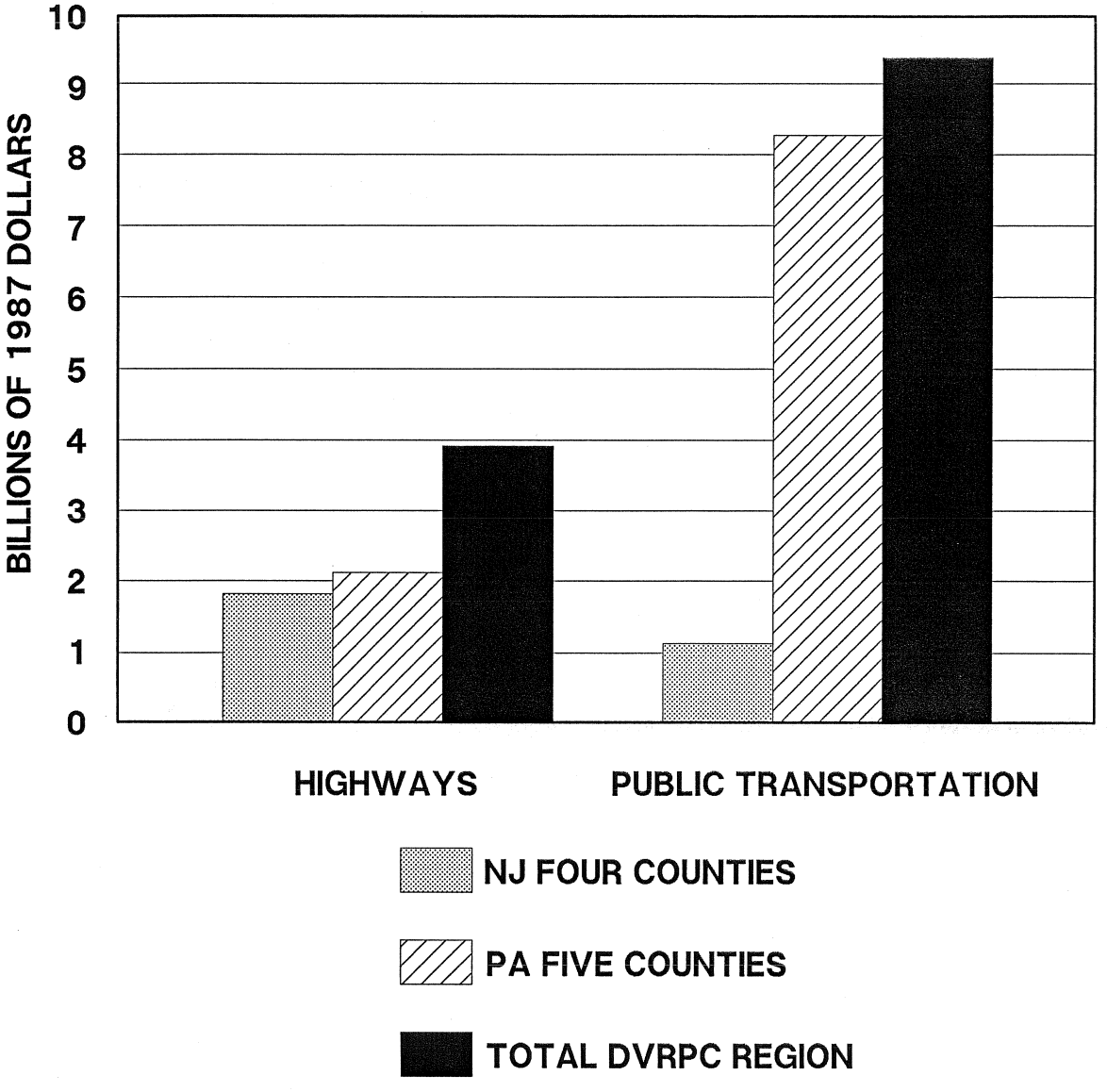
Delaware Valley Regional Planning Commission

As shown in Figure III, the highway and public transportation operating subsidy will be very large, $3.9 billion for highways and $9.4 billion for public transportation. Generally, the states provide funds for the operation and maintenance of highways (other than toll facilities). For roads under county jurisdiction, the state DOTs channel maintenance funds to the counties, and in turn the counties pass funds to their local jurisdictions. In Pennsylvania this appropriation (subsidy) derives from road user revenues in the form of vehicle registration fees and liquid fuel taxes. In New Jersey highway derived revenues constitute a component of general revenues from which highways receive appropriations, though seven cents of the state's 10.5 cents per gallon tax on gasoline is dedicated for transportation purposes.

In the case of public transportation, about 56 percent of the operating and maintenance expenditure is derived from fares and other incidental revenues, a significant improvement from the 46 percent recovered in 1980. However, this improvement was achieved largely by raising fares and pruning service, though improved cost control by the operators also played a role. Operating deficits, when expressed in absolute terms, are expected to increase in future years, because of inflation, the need to extend service to growing areas, the need to restrain fare increases to remain competitive with the private automobile, and a growing population with a larger fraction of senior citizens. If the system is to continue to serve the travel needs of the people of the Delaware Valley, it will be necessary to develop stable funding sources that accommodate future operating deficits, especially in light of decreased federal operating assistance. Most of the estimated subsidies will be provided to SEPTA (see Figure III).

FIGURE III

TOTAL OPERATING SUBSIDY OF THE DVRPC TRANSPORTATION SYSTEM 1989 - 2015



Delaware Valley Regional Planning Commission

III. DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

The demand for transportation largely derives from population and socio-economic characteristics, such as number of households, employment, and car ownership, and as such can be forecast on the basis of these parameters. Thus, the first step in predicting demand for a metropolitan area involves forecasting the regional population for the desired time frame, then using this forecast to construct the other parameters that determine traffic.

The Delaware Valley Regional Planning Commission maintains a data base at the census tract level for the nine counties that make up the Philadelphia metropolitan area and regularly updates its forecasts for population, employment, and other traffic determinants. These serve as the basis for predicting demand for new transportation facilities, as well as providing data to local planners and other interested parties. However, the geographic scope of this study extends beyond the traditional boundary of the Delaware Valley region by including five additional counties in southern New Jersey. Accordingly, DVRPC prepared forecasts of the relevant statistics for the Year 2015 at the county level for all fourteen counties, and to the level of county planning areas for the nine counties of the DVRPC region.

A. Population and Employment

Using 1980 Census data and the latest estimates from the Pennsylvania State Data Center and the New Jersey Department of Labor, DVRPC has forecast population and employment at the municipal level for the decennial years of 1990, 2000, and 2010, the latter having been adopted by the DVRPC Board in July 1988. In addition, intermediate estimates were prepared for 1987. Municipal values of population and employment were then aggregated to the county level and, on the basis of a trend analysis, extrapolated an additional five years to the Year 2015. Basically, this analysis assumes that current growth patterns will continue, but with some adjustment of the more extreme rates of change; i.e., rapid growth will moderate somewhat and decline will stabilize. Tables 6 and 7 show the results for population and employment, respectively.

Regional population is expected to grow 12 percent in the 28 years between 1987 and 2015. The four New Jersey counties should each experience growth in excess of 20 percent, but in Pennsylvania growth will be localized. The population of Bucks County is expected to increase by 35 percent, but Delaware County should increase by less than one percent, and Philadelphia is expected to lose about five percent of its population (see Maps X and XI).

Employment across the region is expected to increase somewhat faster than population, reflecting a continuation of the current trend toward two-earner households. The regional increase should be slightly less than 20 percent, with the number of jobs increasing at 30 percent in New Jersey and 16 percent in Pennsylvania. Because of the larger base in Pennsylvania, the absolute increase will be greater in that state. County

Table 6

POPULATION GROWTH BY COUNTY
DELAWARE VALLEY REGION
(thousands)

County	1980 US Census	1987 DVRPC Estimate	2015 DVRPC Forecast	1987-2015 Growth Absolute	1987-2015 Growth Percent
Bucks	479.2	529.1	716.0	186.9	35.3%
Chester	316.7	346.0	427.0	81.0	23.4%
Delaware	555.0	561.5	566.0	4.5	0.8%
Montgomery	643.6	674.1	753.0	78.9	11.7%
Philadelphia	1,688.2	1,639.6	1,556.0	- 83.6	- 5.1%
PA Counties	3,682.7	3,750.3	4,018.0	267.7	7.1%
Burlington	362.5	388.0	507.0	119.0	30.7%
Camden	471.7	496.3	599.0	102.7	20.7%
Gloucester	199.9	213.0	284.0	71.0	33.3%
Mercer	307.9	327.1	396.0	68.9	21.1%
NJ Counties	1,342.0	1,424.4	1,786.0	361.6	25.4%
TOTAL Region	5,024.7	5,174.7	5,804.0	629.3	12.2%

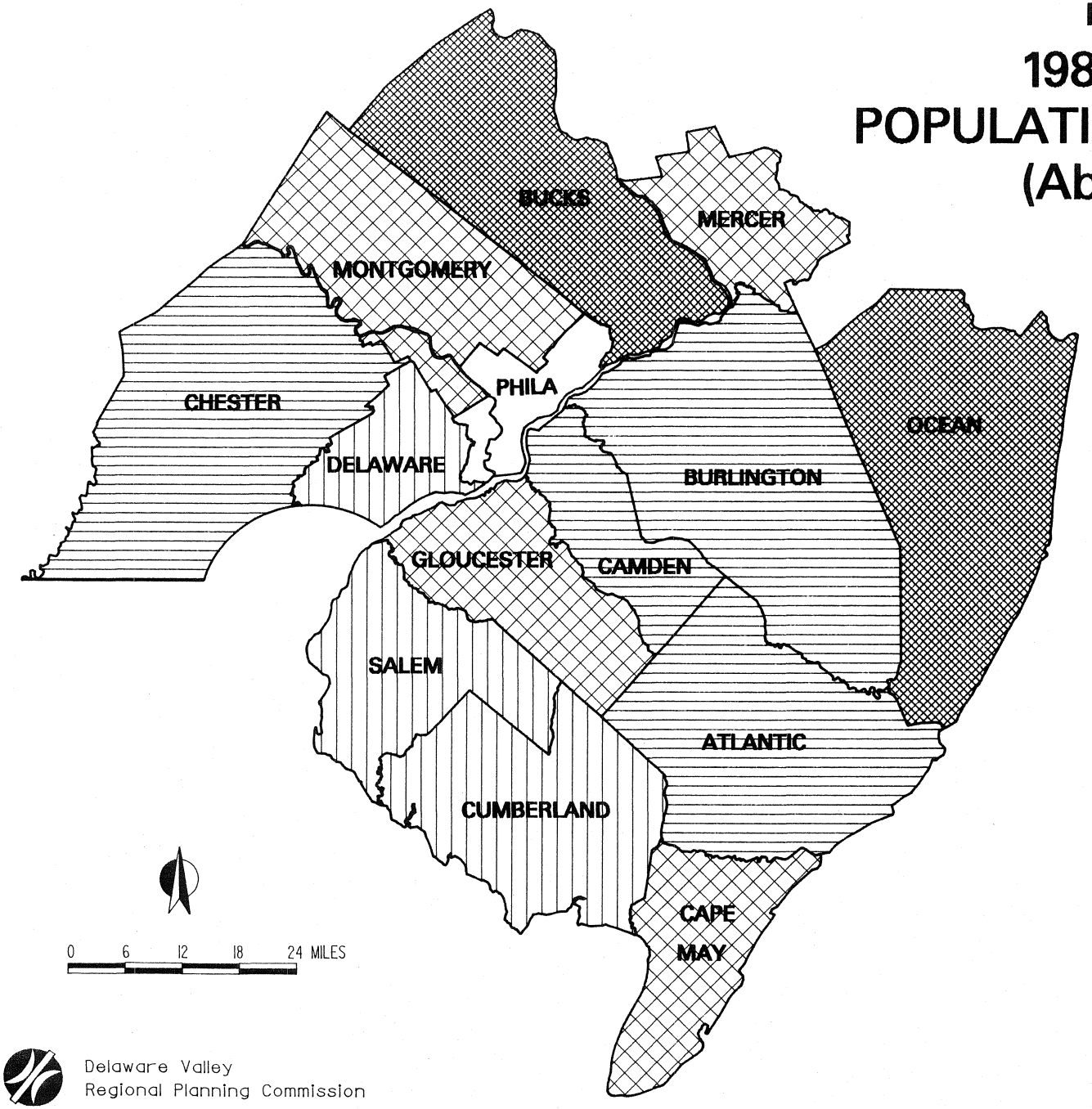
Table 7

EMPLOYMENT GROWTH BY COUNTY
DELAWARE VALLEY REGION
(thousands)

County	1980 BEA Census	1987 DVRPC Estimate	2015 DVRPC Forecast	1987-2015 Growth Absolute	1987-2015 Growth Percent
Bucks	196.5	230.1	311.0	80.9	35.2%
Chester	145.8	165.8	233.1	67.3	40.6%
Delaware	212.2	229.0	246.2	17.2	7.5%
Montgomery	393.9	461.9	554.9	93.0	20.1%
Philadelphia	858.4	835.7	877.1	41.4	5.0%
PA Counties	1,806.8	1,922.5	2,222.3	299.8	15.6%
Burlington	138.3	167.2	232.0	64.8	38.8%
Camden	196.0	226.2	283.6	57.4	25.4%
Gloucester	65.4	76.7	109.9	33.2	43.3%
Mercer	189.4	213.7	266.1	52.4	24.5%
NJ Counties	589.1	683.8	891.6	207.8	30.4%
TOTAL Region	2,395.9	2,606.3	3,113.9	507.6	19.5%

MAP X

1987–2015 POPULATION GROWTH (Absolute)



ABSOLUTE GROWTH

- Under 0 persons
- 0 – 20,000 persons
- 20,000 – 80,000 persons
- 80,000 – 140,000 persons
- 140,000 – 200,000 persons

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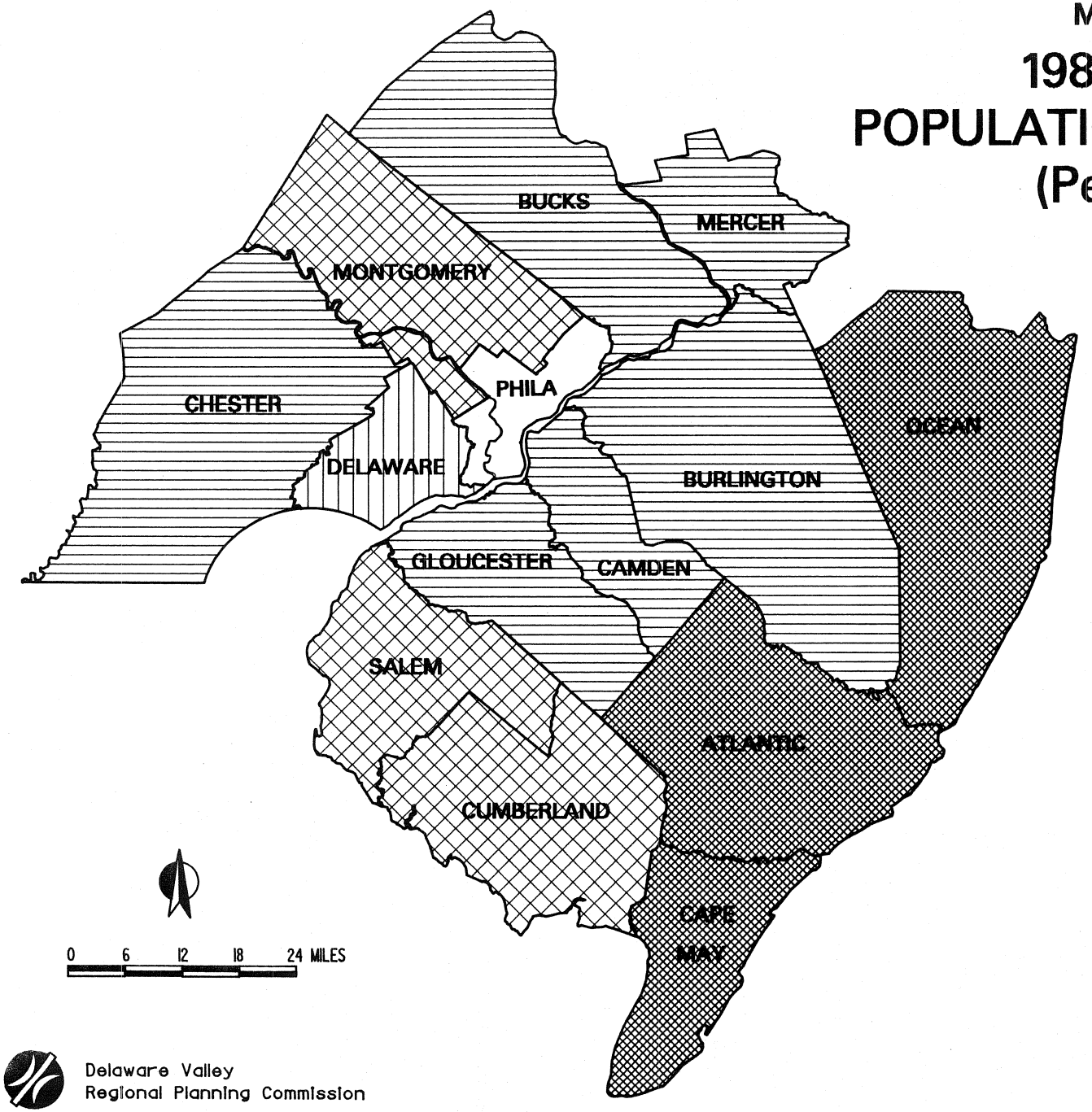
MAP XI

1987–2015 POPULATION GROWTH (Percent)



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growth rates will range from 43 percent in Burlington County down to five percent in Philadelphia.

Population and employment data at the county level for the non-DVRPC portion of Southern New Jersey were obtained from the county planning commissions and the NJ Department of Labor and extrapolated to the Year 2015 by DVRPC with the following results:

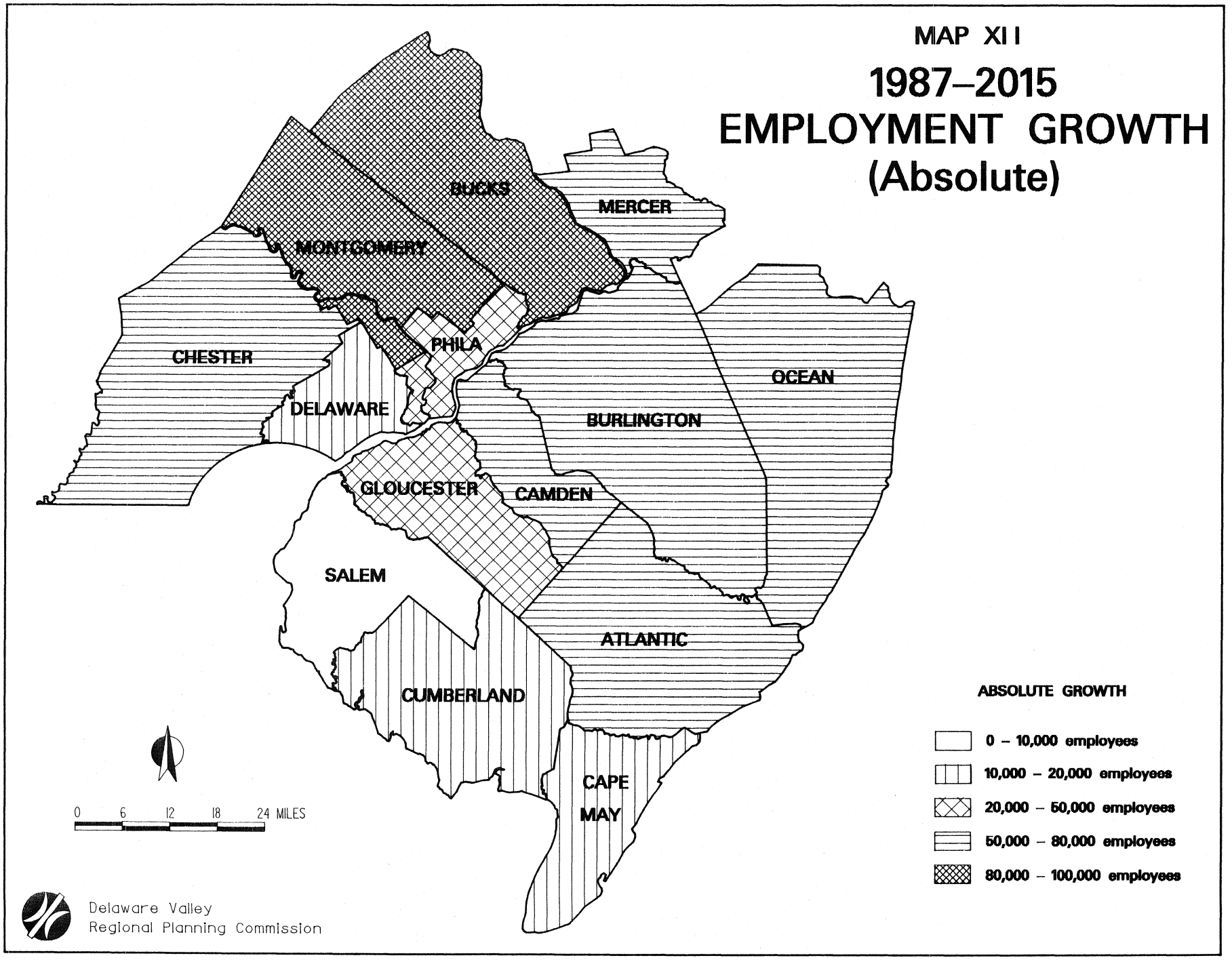
	Population (in thousands)			Employment (in thousands)		
County	1987	2015	Change	1987	2015	Change
Atlantic	208.5	295.3	41.6%	129.2	208.2	61.1%
Cape May	94.2	145.2	54.1%	31.1	46.1	48.2%
Cumberland	137.6	155.1	12.7%	56.7	69.3	22.2%
Ocean	403.0	579.3	43.7%	106.9	168.5	57.6%
Salem	65.4	75.4	15.3%	29.9	36.2	21.1%

Overall for these five counties, population will increase by 38 percent and employment by 49 percent, significantly higher than the equivalent rates for the DVRPC counties. This growth can be expected to lead to severe congestion, unless highway and transit capacities are expanded.

Growth in Atlantic County is driven by the legalization of gambling and the growth of the casino industry in Atlantic City, whereas Cape May and Ocean counties are becoming increasingly attractive for retirees. The northern end of Ocean County is now experiencing suburbanization, as improvements on the North Coast rail line and express buses on the Garden State Parkway make long distance commutation to Newark and New York more attractive. Cumberland and Salem counties have the lower growth rates characteristic of stable mature economies (see Maps XII and XIII).

B. Households and Car Ownership

The number of households is obtained by dividing the population by the estimated household size, which in turn is obtained by extrapolating trends observed at the county level forward to the Year 2015. Since household size has steadily declined over recent decades, (a trend driven by diverse factors such as an increase in single-parent households and a longer-lived population who maintain independent households after their children leave home), the number of households increases faster than the population. Average household size in 2015 is estimated to range from 2.6 in Philadelphia and Montgomery counties to 2.9 in Gloucester County. In 1980, the equivalent range was 2.7 to 3.1. Generally, urban areas and those with mature development have smaller households than those experiencing high percentage growth. Table 8 shows an increase of almost 17 percent for the DVRPC region as a whole, with individual county rates ranging from 46 percent for Bucks County to a decrease of two percent for Philadelphia.


MAP XII
1987–2015
EMPLOYMENT GROWTH
(Absolute)
BUCKS
MERCER
MONTGOMERY
PHILA
CHESTER
DELAWARE
OCEAN
BURLINGTON
GLOUCESTER
CAMDEN
SALEM
ATLANTIC
CUMBERLAND
CAPE
MAY
0 6 12 18 24 MILES
ABSOLUTE GROWTH
0 – 10,000 employees
10,000 – 20,000 employees
20,000 – 50,000 employees
50,000 – 80,000 employees
80,000 – 100,000 employees
Delaware Valley
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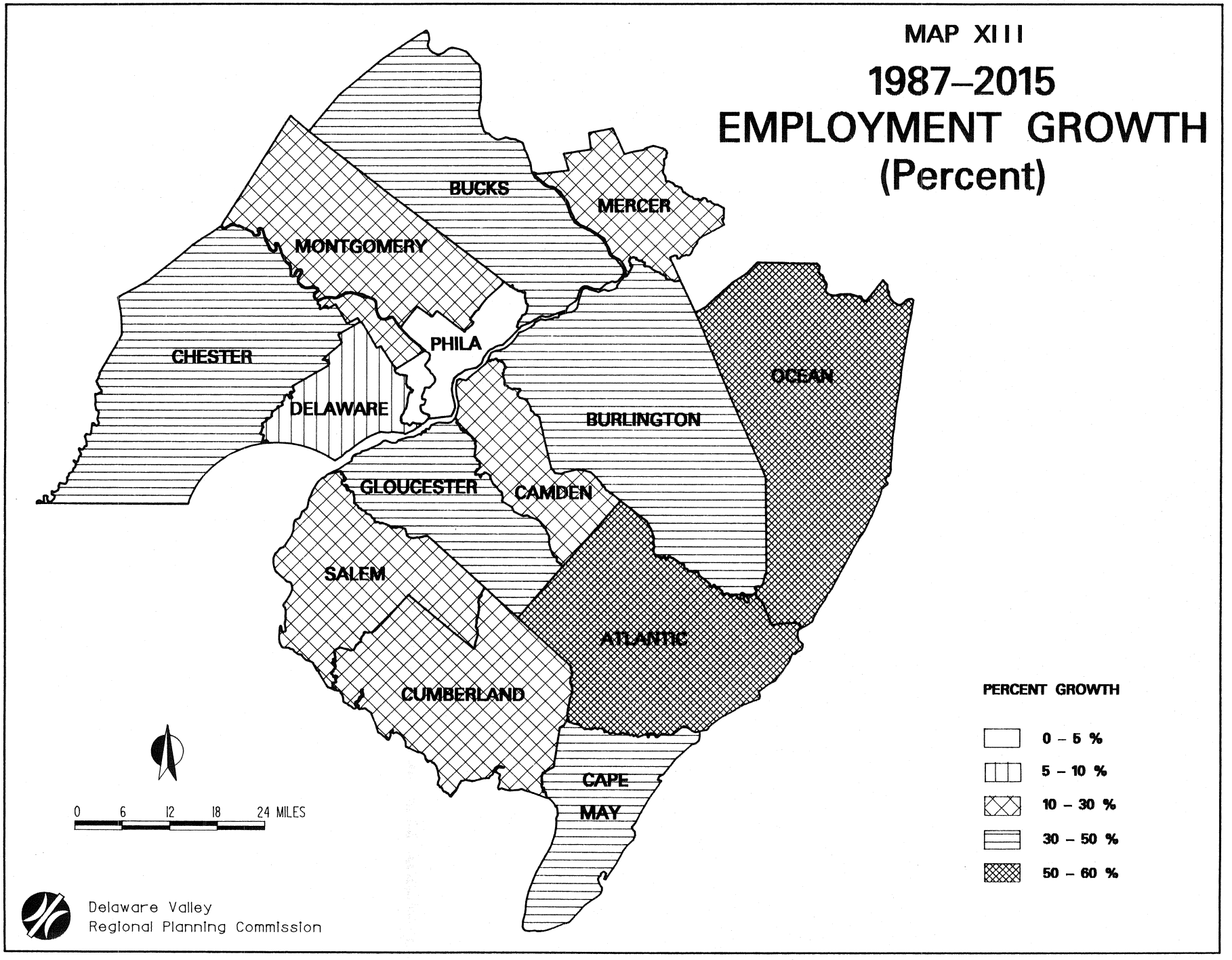

MAP XIII
1987–2015
EMPLOYMENT GROWTH
(Percent)
BUCKS
MERCER
MONTGOMERY
CHESTER
PHILA
DELAWARE
OCEAN
BURLINGTON
GLOUCESTER
CAMDEN
SALEM
ATLANTIC
CUMBERLAND
CAPE
MAY
0 6 12 18 24 MILES
PERCENT GROWTH
0 – 5 %
5 – 10 %
10 – 30 %
30 – 50 %
50 – 60 %
Delaware Valley
Regional Planning Commission

Table 8

HOUSEHOLD GROWTH BY COUNTY
DELAWARE VALLEY REGION
(thousands)

County	1980 US Census	1987 DVRPC Estimate	2015 DVRPC Forecast	1987-2015 Growth Absolute	1987-2015 Growth Percent
Bucks	156.4	179.4	262.2	82.8	46.2%
Chester	105.0	118.8	155.7	36.9	31.1%
Delaware	191.9	202.0	213.0	11.0	5.4%
Montgomery	223.7	242.5	285.8	43.3	17.9%
Philadelphia	620.6	618.6	606.0	- 12.6	- 2.0%
PA Counties	1,297.6	1,361.3	1,522.7	161.4	11.9%
Burlington	115.0	130.0	180.0	50.0	38.5%
Camden	162.8	177.3	221.0	43.7	24.6%
Gloucester	65.3	72.0	99.0	27.0	37.5%
Mercer	105.9	115.9	144.0	28.1	24.2%
NJ Counties	449.0	495.2	644.0	148.8	30.0%
TOTAL Region	1,746.6	1,856.5	2,166.7	310.2	16.7%

This has consequences for travel demand, as individuals in larger households tend to make fewer trips than those living in small units (see Figure IV). The overall growth in households for the five Pennsylvania counties is 161 thousand (12%), and in the four New Jersey counties growth is 149 thousand (30%), as shown in Table 8.

The last parameter estimated is car ownership, because household trip-making is heavily dependent on the number of cars available. Growing affluence, the decline of public transportation, and the dispersion of origins and destinations within the metropolitan area have all contributed to the need for automobiles. The cause and effect here is clearly intertwined, since the availability of automobiles makes these trends possible. The number of cars per household increased markedly in the last decade, which has a significant impact on travel demand. Car ownership is forecast by extrapolating trends in the relative fractions of households owning no cars, one car, two cars, and three or more cars. Results for the DVRPC region are shown in Table 9. For the region as a whole, the number of zero-car households should increase by three percent, one-car households by 12 percent, two-car households by 22 percent, and those owning more than two cars by 47 percent. The total number of cars should increase by 25 percent. Two facts of importance for transportation demand are evident here. First, the increase in car ownership will place increasing stress on the highway network, unless capacity is increased. Second, even though the fraction of carless households is declining, there will still exist 367 thousand households in the region without cars; almost 17 percent of the total. This will fuel a strong residual demand for public transportation. In Philadelphia, almost 38 percent of the households will be without cars in the Year 2015 (see Figure V).

In the five non-DVRPC counties of Southern New Jersey, growth in the number of households and automobiles will follow the pattern established for population; i.e., rapid growth in Atlantic, Cape May, and Ocean counties, with slower expansion in Cumberland and Salem counties. The current and forecast numbers are:

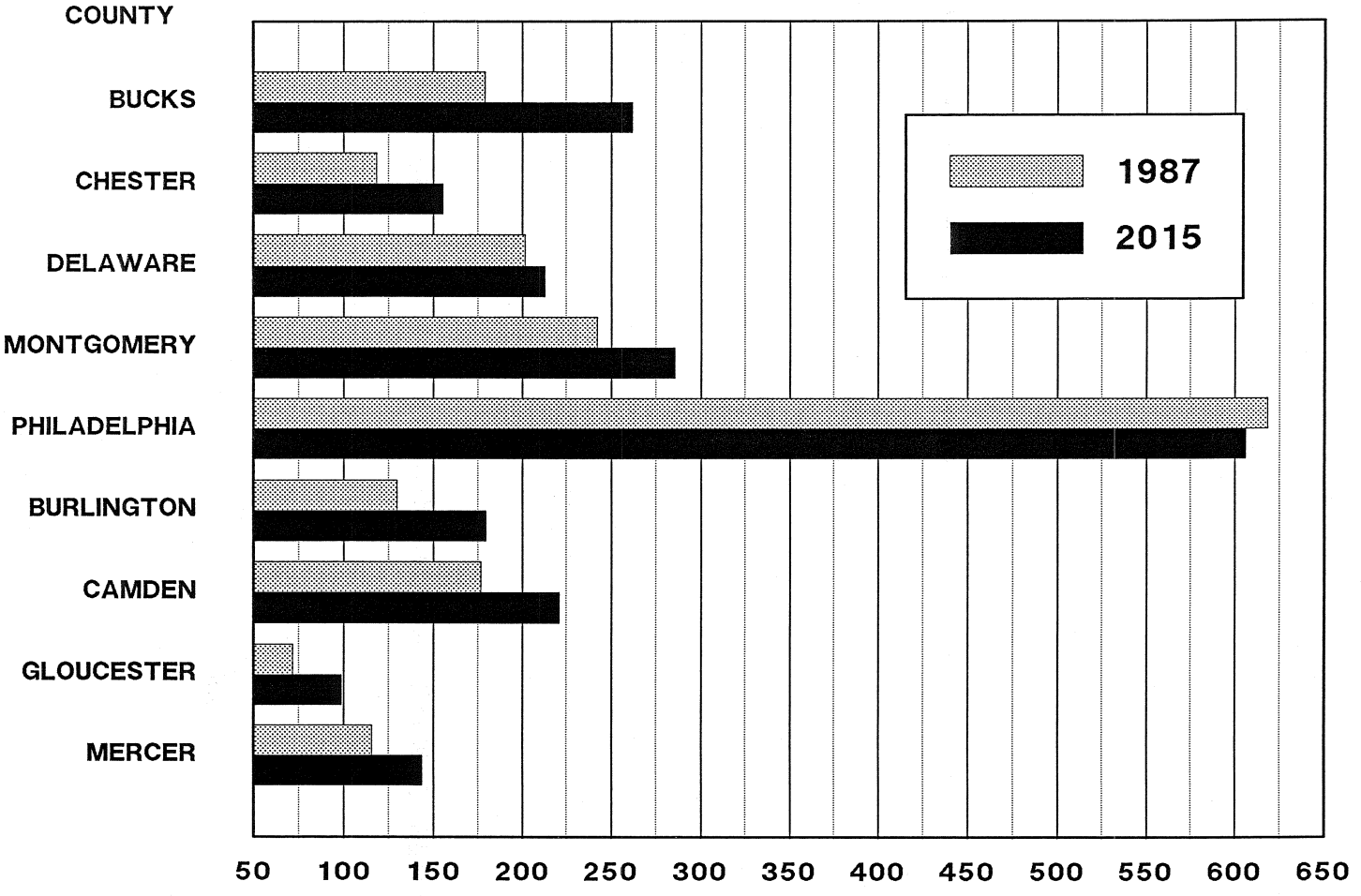
	Population (in thousands)			Employment (in thousands)		
County	1987	2015	Change	1987	2015	Change
Atlantic	77.6	116.1	49.6%	106.4	162.5	52.7%
Cape May	38.6	61.6	59.6%	50.3	81.7	62.4%
Cumberland	46.9	55.8	19.0%	64.6	80.9	25.2%
Ocean	157.2	230.3	46.5%	223.2	334.4	49.8%
Salem	23.1	28.3	22.5%	32.6	41.9	28.5%

While these data predict a significant increase in travel demand within the three coastal counties, they only reflect demand driven by local residency and employment. Superimposed on this will be additional demand from visitors to Southern New Jersey's beaches and the Atlantic City casinos. This traffic has a strong seasonal component, though casinos stimulate year-round traffic.

FIGURE IV

HOUSEHOLD GROWTH IN THE DVRPC REGION

(1987 - 2015)



Delaware Valley Regional Planning Commission

Table 9

CAR OWNERSHIP GROWTH BY COUNTY
DELAWARE VALLEY REGION
(thousands)

	1987 DVRPC Estimates				
County	0 Car Hshld	1 Car Hshld	2 Car Hshld	3+ Car Hshld	Total Cars
Bucks	11.8	69.5	74.4	23.7	294.1
Chester	8.4	46.5	47.9	16.0	193.5
Delaware	25.7	87.5	66.6	22.2	291.7
Montgomery	20.1	93.7	91.8	36.9	395.3
Philadelphia	236.3	266.9	97.9	17.4	518.5
PA Counties	302.3	564.1	378.6	116.2	1,693.1
Burlington	8.1	52.0	51.2	18.7	214.4
Camden	23.3	72.8	58.8	22.4	262.1
Gloucester	6.2	29.3	27.4	9.2	113.4
Mercer	17.0	45.8	36.8	16.3	171.5
NJ Counties	54.5	199.9	174.2	66.6	761.3
TOTAL Region	356.8	764.0	552.8	182.8	2,454.4

	2015 DVRPC Forecasts				
County	0 Car Hshld	1 Car Hshld	2 Car Hshld	3+ Car Hshld	Total Cars
Bucks	18.6	97.3	102.3	44.1	443.0
Chester	10.1	57.3	60.4	27.8	267.1
Delaware	25.5	90.0	71.2	26.2	316.2
Montgomery	22.8	104.5	106.0	52.5	484.5
Philadelphia	229.4	261.2	97.6	17.8	513.4
PA Counties	306.4	610.3	437.5	168.4	2,024.2
Burlington	10.3	68.4	71.8	29.5	306.4
Camden	24.9	85.6	79.4	31.2	344.2
Gloucester	7.3	38.3	39.5	13.9	161.8
Mercer	17.8	53.0	47.2	26.0	230.6
NJ Counties	60.3	245.3	237.9	100.6	1,043.0
TOTAL Region	366.7	855.6	675.4	269.0	3,067.2

Table 9 (Con't.)

CAR OWNERSHIP GROWTH BY COUNTY
DELAWARE VALLEY REGION
(thousands)

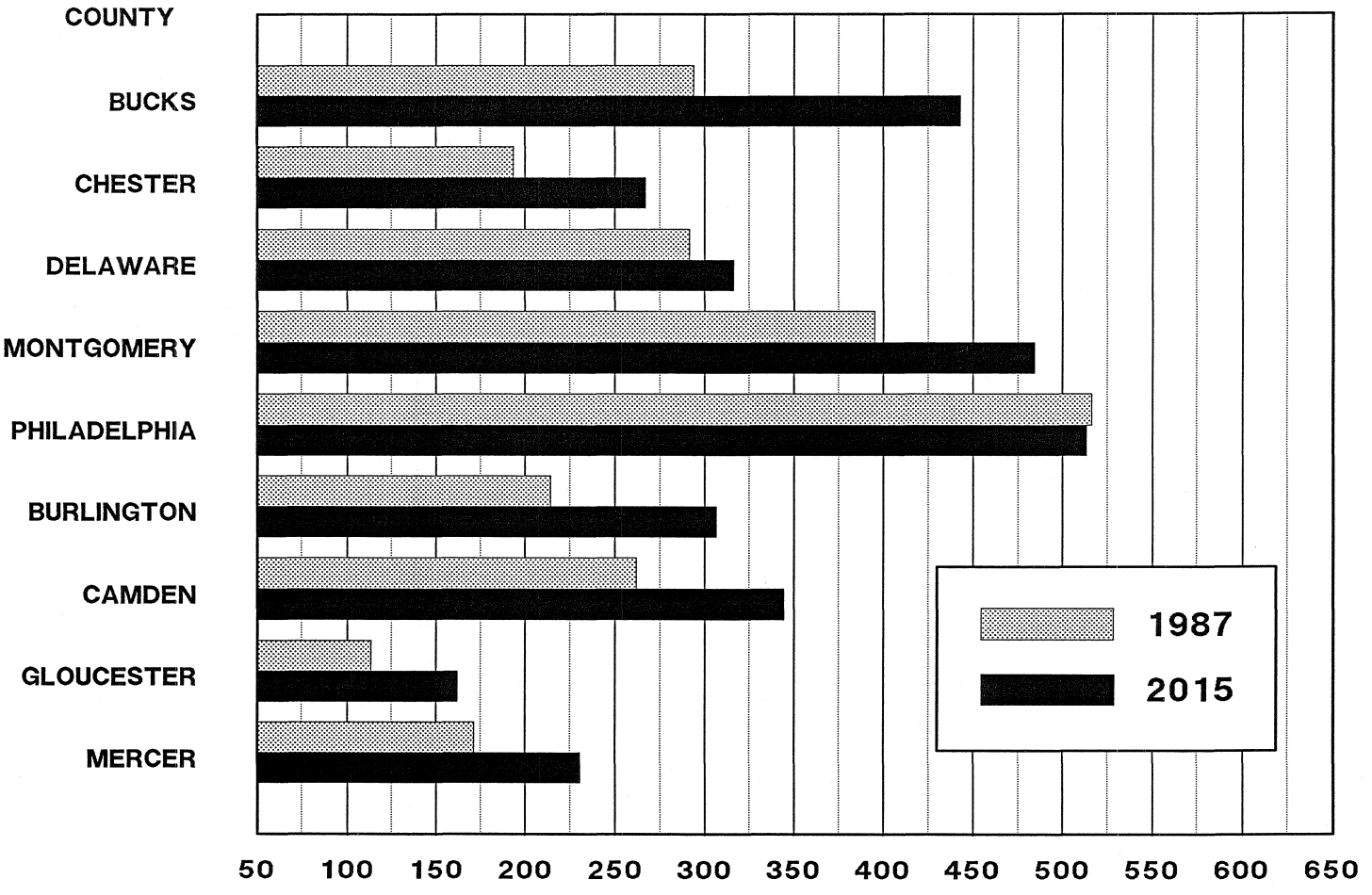
County	0 Car Hshld	1 Car Hshld	2 Car Hshld	3+ Car Hshld	Total Cars
	1987-2015 Absolute Growth				
Bucks	6.8	27.8	27.9	20.4	148.9
Chester	1.7	10.8	12.5	11.8	73.6
Delaware	- 0.2	2.5	4.6	4.0	24.5
Montgomery	2.7	10.8	14.2	15.6	89.2
Philadelphia	- 6.9	- 5.7	- 0.3	0.4	- 5.2
PA Counties	4.1	46.2	58.9	52.2	331.1
Burlington	2.2	16.4	20.6	10.8	92.0
Camden	1.6	12.8	20.6	8.8	82.1
Gloucester	1.1	9.0	12.1	4.7	48.4
Mercer	0.8	7.2	10.4	9.7	59.1
NJ Counties	5.8	45.4	63.7	34.0	281.7
TOTAL Region	9.9	91.6	122.6	86.2	612.8

County	0 Car Hshld	1 Car Hshld	2 Car Hshld	3+ Car Hshld	Total Cars
	1987-2015 Percentage Growth				
Bucks	57.7%	39.9%	37.5%	86.2%	50.6%
Chester	20.2%	23.2%	26.1%	73.8%	38.0%
Delaware	- 0.8%	2.9%	6.9%	18.0%	8.4%
Montgomery	13.4%	11.5%	15.5%	42.3%	22.6%
Philadelphia	- 2.9%	- 2.1%	- 0.3%	2.2%	- 1.0%
PA Counties	1.3%	8.2%	15.6%	44.9%	19.6%
Burlington	27.8%	31.5%	40.1%	57.7%	42.9%
Camden	6.8%	17.7%	35.0%	39.1%	31.3%
Gloucester	18.5%	30.8%	44.4%	51.3%	42.7%
Mercer	4.9%	15.6%	28.2%	60.0%	34.5%
NJ Counties	10.6%	22.7%	36.6%	51.1%	37.0%
TOTAL Region	2.8%	12.0%	22.2%	47.2%	25.0%

FIGURE V

CAR OWNERSHIP GROWTH IN THE DVRPC REGION

(1987 - 2015)



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C. Distribution of Population and Employment within the DVRPC Region

Forecasts of population and employment were carried to the level of county planning areas within the nine DVRPC counties. These units, of which there are 71, were developed by DVRPC and its member counties to facilitate regional planning by providing a level of detail intermediate to that of counties and municipalities. There are 352 municipalities or minor civil divisions (MCD) in the region.

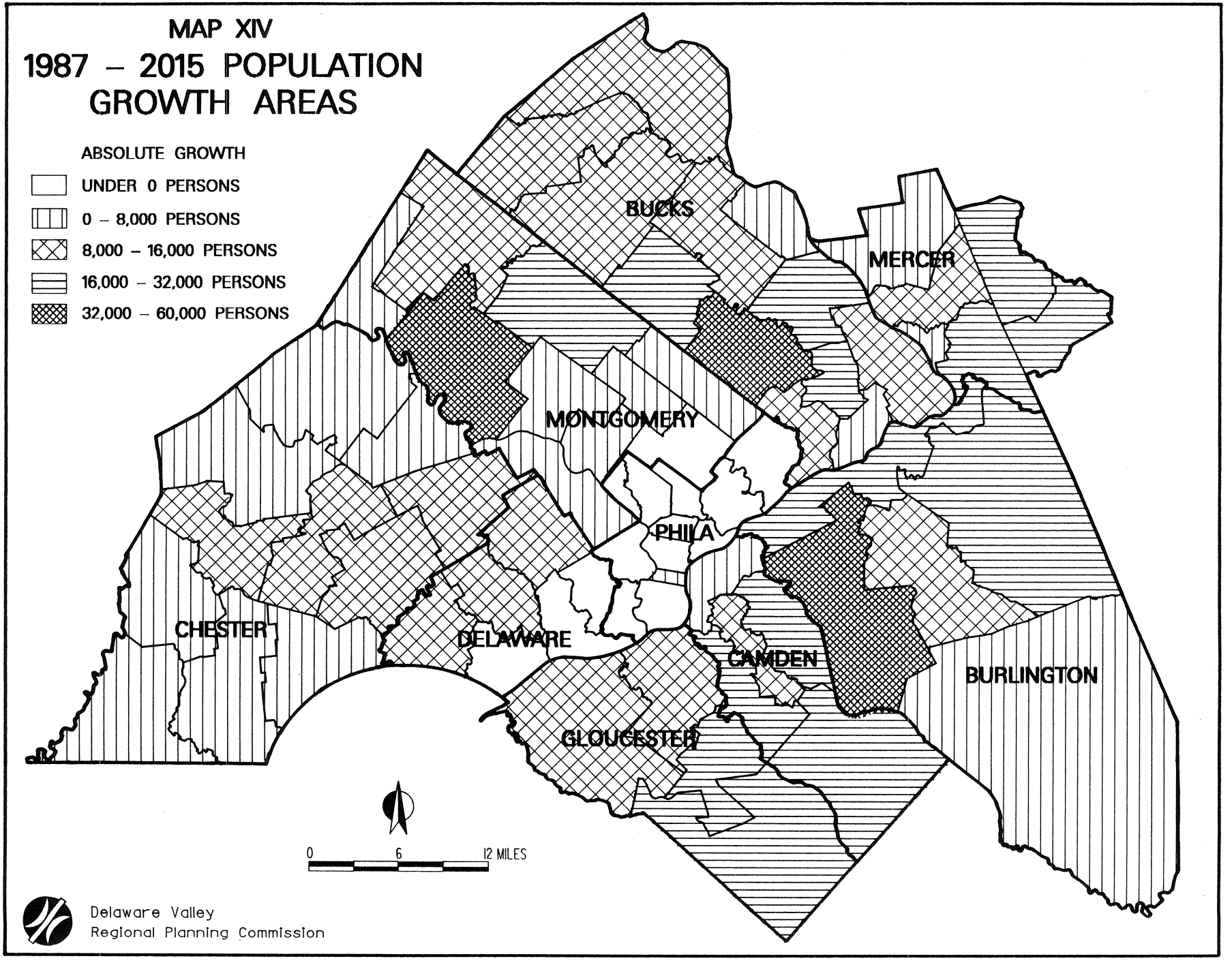
Using 1980 Census data and 1987 estimates developed by DVRPC, and based on known growth and observed trends, population and employment forecasts at the municipal level for the Year 2010 were prepared by DVRPC and adopted by its Board in July 1988. The following methodology was then used to obtain 2015 forecasts of both population and employment. DVRPC first calculated each MCD's share of the county total for the years 1980 and 2010. The method then assumed a linear extrapolation of the changes in share values observed between 1980 and 2010 for an additional five years, but at one-half the earlier rate of change. Specifically:

$$\text{(2015 MCD share)} = \text{(2010 MCD share)} + \frac{1}{2} \times \frac{5}{30} \times [\text{(2010 MCD share)} - \text{(1980 MCD share)}]$$

Essentially this process assumes that earlier trends will continue, but will moderate as development matures. The 2015 MCD values were then calculated by multiplying the MCD share by the previously calculated 2015 county forecasts. The uncertainties in the forecast procedure were reduced by aggregating the values to the 71 county planning areas.

Map XIV shows the absolute population growth or decline, between 1987 and 2015, with the fastest growing county planning areas - those over 32,000 - shown in cross-hatch. The fastest growing county planning areas in absolute terms are: the lower Perkiomen Valley in central Montgomery County and the Warminster area in south central Bucks County, in Pennsylvania; and the Medford area of south central Burlington County in New Jersey. All three areas, which are about 15 to 20 miles from Center City Philadelphia, are undergoing rapid development as rural land is converted to residential tracts, shopping malls, and industrial parks, and are convenient to expressways and turnpikes.

Map XV shows population growth between 1987 and 2015 expressed in percentage terms. The fastest growing county planning areas - those expected to grow by more than 60 percent - are: southwestern Delaware County, east central Bucks County, and the Newtown area (Bucks County) in the Pennsylvania portion; and southeastern Camden County in New Jersey. These are areas about 18 to 25 miles from Center City and are now relatively less developed than other suburban areas at a comparable distance. The lower initial base of population and employment makes it easier to achieve larger percentage growth as rural land is developed. Eastern Bucks County along the Delaware


MAP XIV
1987 – 2015 POPULATION
GROWTH AREAS
ABSOLUTE GROWTH
UNDER 0 PERSONS
0 – 8,000 PERSONS
8,000 – 16,000 PERSONS
16,000 – 32,000 PERSONS
32,000 – 60,000 PERSONS
BUCKS
MERCER
MONTGOMERY
PHILA
CHESTER
DELAWARE
CAMDEN
BURLINGTON
GLOUCESTER
0
6
12 MILES
Delaware Valley
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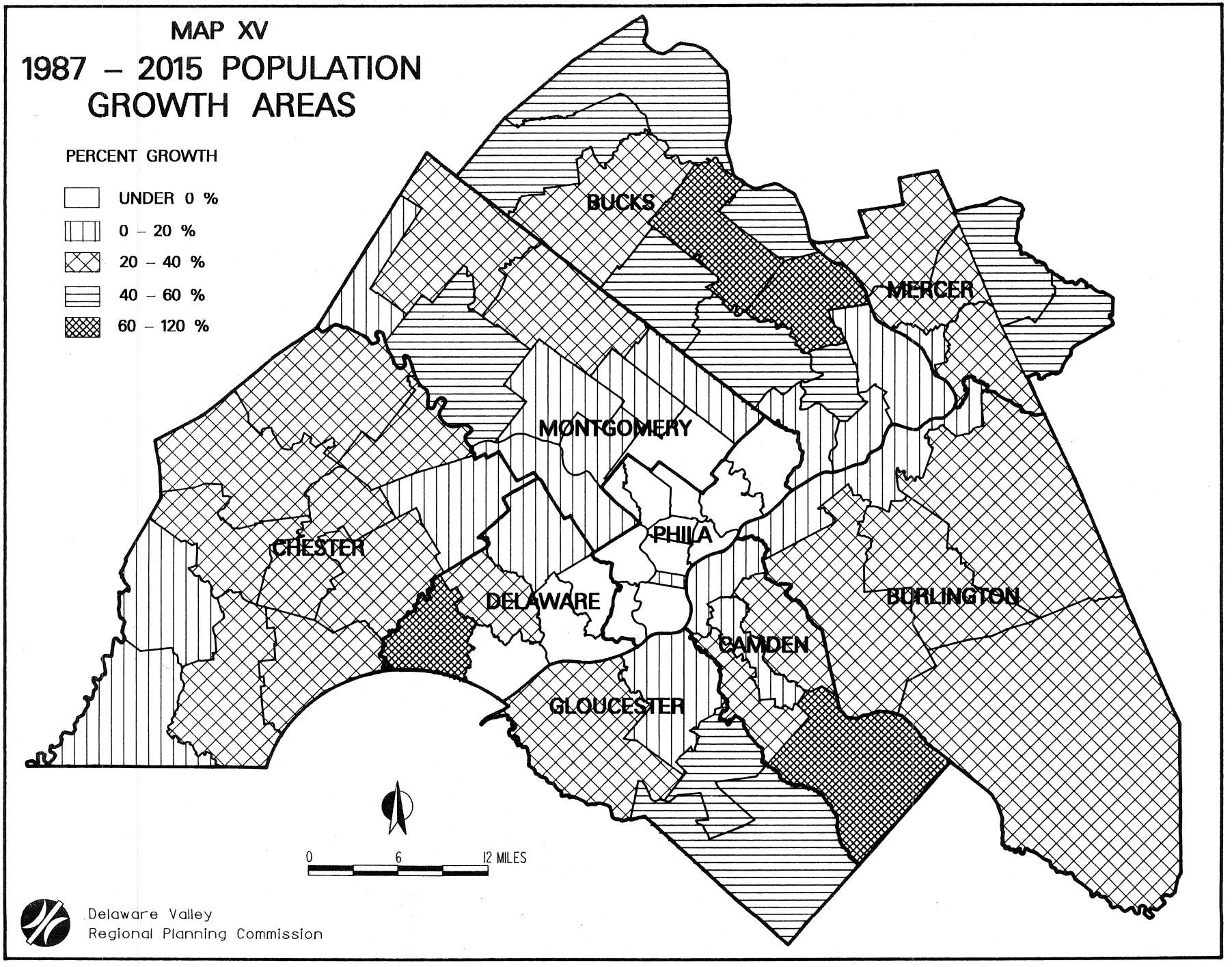
MAP XV
1987 – 2015 POPULATION GROWTH AREAS
PERCENT GROWTH
UNDER 0 %
0 – 20 %
20 – 40 %
40 – 60 %
60 – 120 %
BUCKS
MERCER
MONTGOMERY
PHILA
CHESTER
DELAWARE
BURLINGTON
CAMDEN
GLOUCESTER
0
6
12 MILES
Delaware Valley
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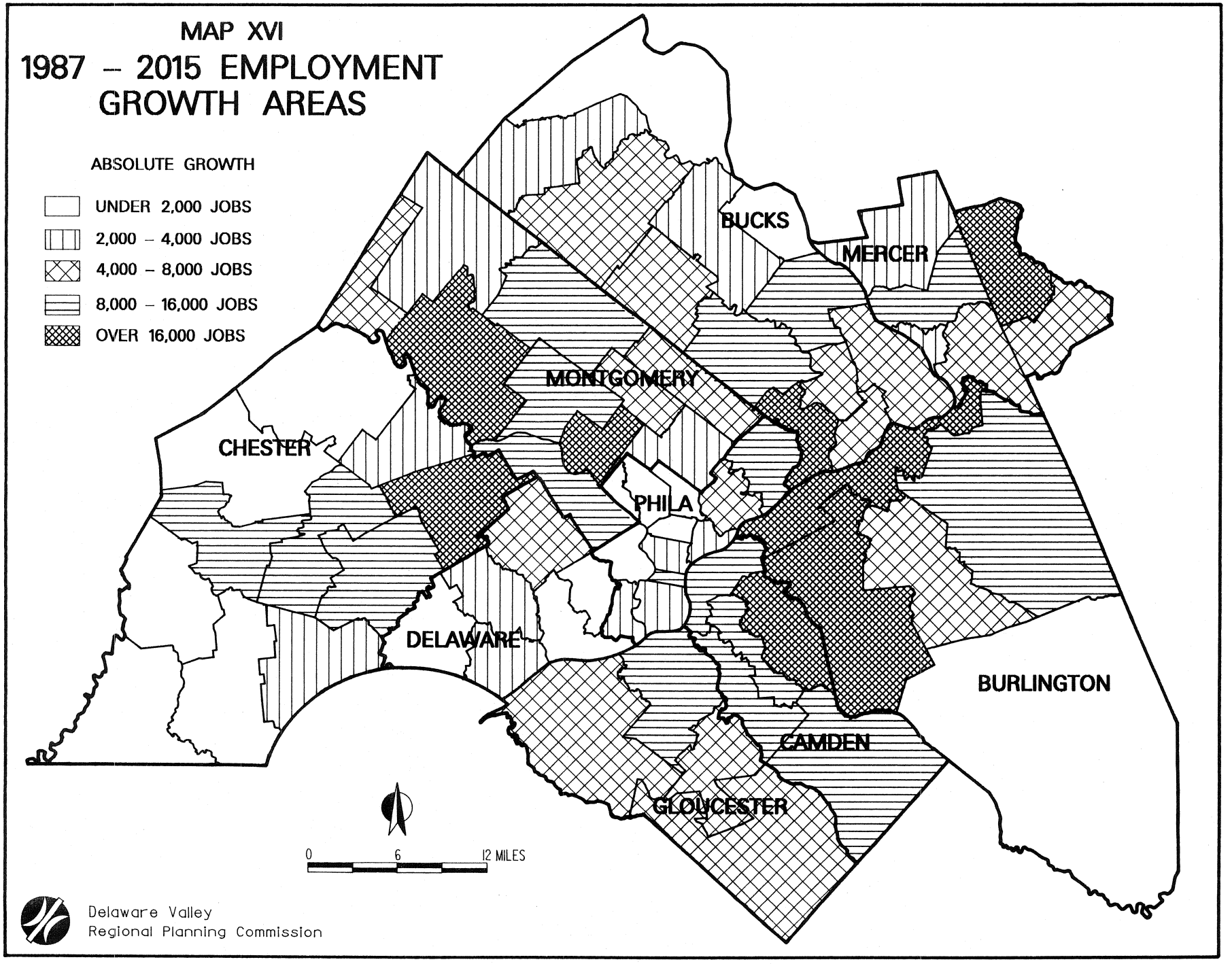
River now represents the western extension of the northern New Jersey/New York commutation area, an attribute which should be reinforced over the next 27 years.

Similarly, Maps XVI and XVII show the 1987-2015 employment growth rates by county planning area, in absolute and percent terms, respectively. The areas expected to provide the most new jobs are: in Pennsylvania, the Upper Main Line in Chester County, the Lower Perkiomen Valley and the Conshohocken area in Montgomery County, and Bensalem Township in Bucks County; and in New Jersey, the Princeton area in Mercer County, the Delaware River communities and the Medford/Moorestown area in Burlington County, and the Cherry Hill area in Camden County. These areas are now experiencing rapid growth in corporate and industrial parks, and are all served by major highways, though the areas along the Delaware River also enjoy deep water access for shipping and see some potential for industrial expansion.

Areas expected to see employment grow by more than 50 percent are: the Upper Main Line in Chester County, the Conshohocken area of Montgomery County, and the Newtown area of Bucks County, in Pennsylvania; the Princeton area of Mercer County, and the Medford/Moorestown area of Burlington County, as well as the outer portions of Burlington, Camden, and Gloucester counties, in New Jersey. These areas also have developing corporate parks, with the exception of the outer portion of Burlington County, which simply starts from a low base.

Several areas of the Delaware Valley region show strong growth in both population and employment, whether expressed in absolute or percentage terms. The Lower Perkiomen Valley in central Montgomery County provides a good example. The recently completed Pottstown Expressway (US 422), major rail freight lines, and easy access to the Pennsylvania Turnpike (I-76/276) all provide this county planning area with good transportation and the potential for significant growth. The Newtown and Warminster areas in central Bucks County provide a similar example. I-95 provides the highway access, and rail branch lines connect industrial sites to Conrail's Trenton Cutoff. In New Jersey, the significant growth areas are in the vicinity of Princeton, south central Burlington County, and the southeastern end of Camden County. High technology industries are filling in vacant land along US 1 near Princeton, an area which also enjoys good rail commuter service to New York and Philadelphia. Unfortunately, highway connections to the north are inadequate. Southern Camden County lies astride the emerging Atlantic City corridor and benefits from good highway and rail connections. However, adjacent growth areas in Burlington County rely heavily on arterial highways for access and mobility.

Though much of the growth now occurs in the suburban portions of the region, Center City Philadelphia is still clearly the principal focus of activity in the Delaware Valley region. Center City Philadelphia is about 2.5 square miles in size bounded by the Delaware and Schuylkill rivers and Vine and South streets, and is the focal point of one of the most extensive regional rail and transit systems in the nation. However, with some exceptions (such as PATCO's Lindenwold Line and the Northeast Corridor), the system needs major renovation and improvement. Several radial highways also provide access to Center City, but as in most large metropolitan areas, these highways cannot handle


MAP XVI
1987 – 2015 EMPLOYMENT GROWTH AREAS
ABSOLUTE GROWTH
UNDER 2,000 JOBS
2,000 – 4,000 JOBS
4,000 – 8,000 JOBS
8,000 – 16,000 JOBS
OVER 16,000 JOBS
BUCKS
MERCER
MONTGOMERY
CHESTER
PHILA
DELAWARE
BURLINGTON
CAMDEN
GLOUCESTER
0
6
12 MILES
Delaware Valley
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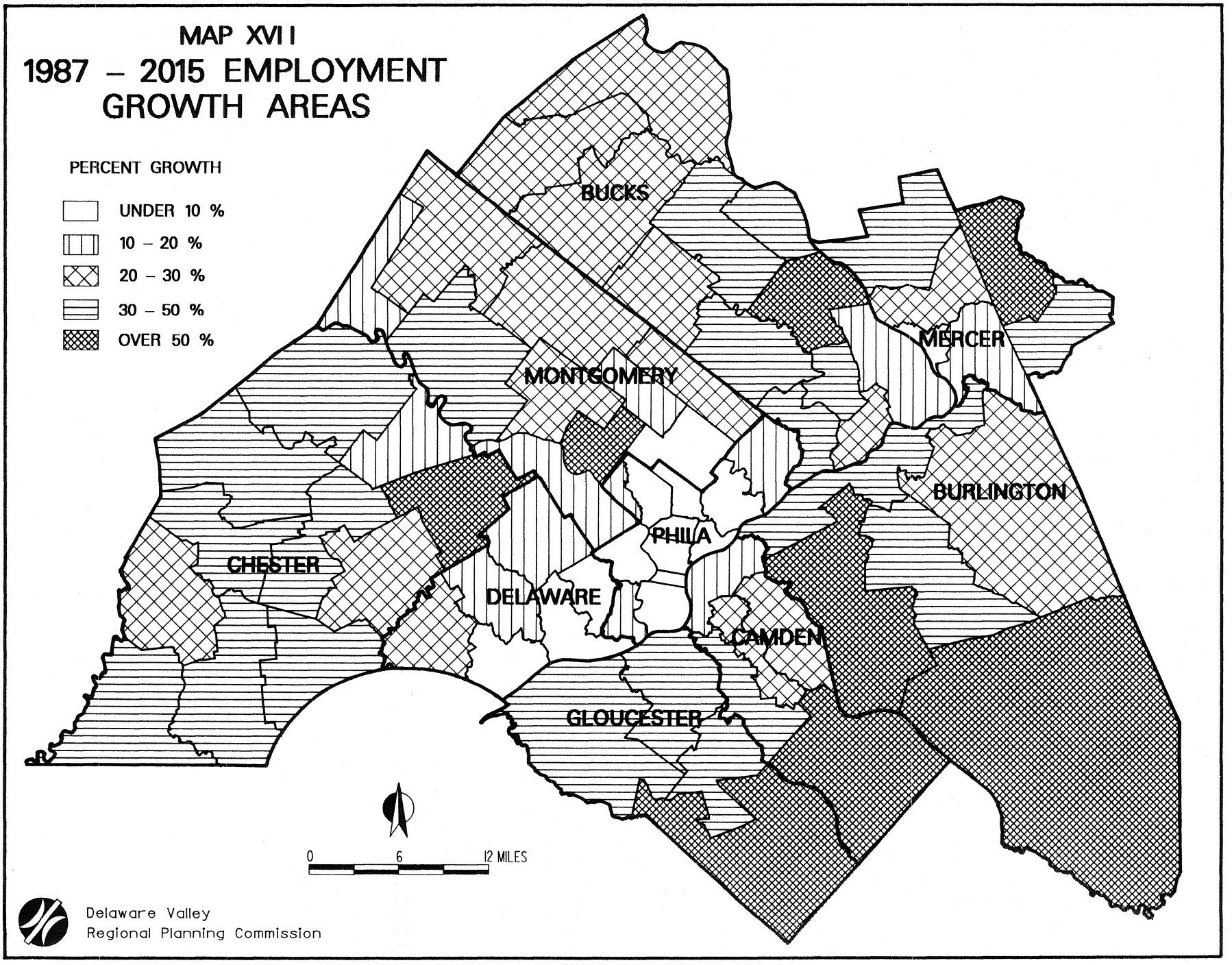
MAP XVII
1987 – 2015 EMPLOYMENT
GROWTH AREAS
PERCENT GROWTH
UNDER 10 %
10 – 20 %
20 – 30 %
30 – 50 %
OVER 50 %
BUCKS
MONTGOMERY
MERCER
BURLINGTON
PHILA
CHESTER
DELAWARE
CAMDEN
GLOUCESTER
0
6
12 MILES
Delaware Valley
Regional Planning Commission

peak traffic volumes without congestion. Center City serves the entire region, including adjacent portions of three states, and also provides a full range of commercial facilities, major financial institutions, headquarters of national corporations, regional offices for federal and state governments, and nationally renowned health, educational, and cultural institutions. It is also home for 42,000 residents.

In 1987 DVRPC estimated that 275,000 persons (11.5 percent of the region's total) were employed in Center City (County Planning Area No. 1), up from 271,000 in 1980. Based on this trend and planned investment in new office buildings and other commercial projects, it is expected that an additional 12,000 persons will be working downtown by the Year 2015. While the growth is not large in percentage terms, it starts from a large base and represents a significant number of people. It also means a continuing need exists to maintain and upgrade those components of the public transportation system important for moving commuters and providing distribution within the central area.

D. Seasonal Impacts

The preceding discussion has focussed on year-round population and employment, which commonly suffices for predicting transportation demand. However, because of their resort nature the three coastal counties, Atlantic, Cape May, and Ocean, experience large seasonal fluctuations in residency and economic activity. Typically, the summer population of beach communities will exceed that measured in the winter by a factor of ten, but good estimates are difficult to obtain and counts are not always taken in a consistent fashion. Recent years have seen a dampening of the seasonal effect as the shore area has become increasingly attractive for retirement, and many vacation homes have been converted to year-round occupancy. In addition, the introduction of casino gambling in Atlantic City has contributed to a leveling of the seasonal component in that county, as well as driving strong economic growth and rearranging area commutation patterns.

Cape May County, whose economic well-being is the most dependent of the three on the resort trade, has compiled the most comprehensive set of data regarding the seasonal impact of tourist traffic. The county estimates that on an average weekend in July 1980 there were 564,000 people in the county, a figure which is 6.85 times the year-round population. Projections show this factor steadily declining to 4.32 by the Year 2020, as the county becomes increasingly attractive to retirees and other permanent residents. The foregoing numbers, which include day and weekend trippers, provide a measure of expected traffic impacts, both for access to the county and for internal circulation. Other measures are provided by occupied housing units and employment. Census figures taken in 1980 showed the number of occupied housing units increasing from 32,000 in the winter to 72,000 in the summer, and employment varying from 31,000 to 54,000.

In Atlantic County the growth of the casino industry in the last decade has drastically changed county trip patterns, and rendered suspect any projections based on the 1980 census. One impact has been to dampen the seasonal variability, since gambling draws

visitors to Atlantic City throughout the year. Current variability can be estimated by looking at total vehicles using the Atlantic City Expressway, which in 1988 varied from an average of 97,000 vehicles per day in February to 151,000 in July.

Though Ocean County is renowned for its beaches, it has a substantial fraction of its population living in non-resort communities. The three largest municipalities, Brick, Dover, and Lakewood townships, are clustered in the northeastern portion of the county and contain 45 percent of the total population. The housing census of 1980 showed that 26 percent of the county's housing units are seasonally occupied. The beach communities depend heavily on tourist activity, with the year-round population of 29,000 boosted to 247,000 on summer weekends.

IV. YEAR 2015 TRAVEL DEMAND AND ITS IMPACTS ON THE TRANSPORTATION SYSTEM

The process used to generate travel forecasts for the Year 2015 is a straightforward application of the travel simulation process developed by DVRPC's staff to evaluate long-range plans and corridor level studies. In 1985, this forecasting process was subjected to extensive validation and recalibration based on data from the 1980 Census Urban Transportation Planning Package (UTPP).[50] Basically, the process consists of applying the following models in sequence:

- Trip Generation - forecasts overall trip productions and attractions;
- Trip Distribution - estimates trip movements between traffic zones;
- Modal Split - divides trips into highway and transit components; and
- Travel Assignment - assigns trips to specific highway or transit routes.

Since DVRPC's data base and files do not cover the five non-DVRPC counties in Southern New Jersey, travel simulation will be limited to the nine counties comprising the Delaware Valley region. Only external-internal travel to or from Southern New Jersey and other areas outside the DVRPC region is considered in this simulation. The following activities were used to forecast highway and transit trips and determine their impact on the transportation system.

A. Areal Systems

Travel forecasting models require that the estimates of demographic and employment data be made for small areas or zones. This requirement derives from the need to assign trip making associated with households and businesses to the streets and transit facilities serving them. For regional travel simulations, the traffic zone system is based on census tracts within the nine-county region. The census tracts defined for Center City Philadelphia and one suburban county, however, do not provide sufficient detail for the "grain" of the network, so block groups, the next smaller level of detail, are used to define the traffic zones in these areas. This results in 1,335 traffic zones for the entire DVRPC region, which encompasses an area of 3,833 square miles.

B. Demographic and Employment Data

The second step in simulating travel demand involves forecasting demographic and employment data for the Year2015 for each zone in the region; this requires estimates for each of the following variables:

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[50] DVRPC, Testing and Adjusting DVRPC Travel Simulation Models with 1980 Census Data, (1985). This will be referenced as the Simulation Report in later notations.

- population;
- households, stratified by auto ownership;
- employed residents;
- total automobiles; and
- employment, stratified into twelve Standard Industrial Classification groups.

DVRPC staff prepared detailed forecasts for population and employment based on the zonal parameters previously estimated for 1987 and developed for the Year 2000 forecast. These forecasts were averaged and then scaled so that the totals for each municipality (or county planning area in the case of Philadelphia) matched those estimated for each county (see Chapter III). The population factors were also used to obtain zonal forecasts for households stratified by car ownership and employed residents, and the employment factors were then used to obtain employment by sector.

C. The Highway and Transit Networks

The Year 2015 simulation derives from the highway and public transportation networks representative of the Year 2000 Transportation Plan.[51] In addition to the facilities listed in the plan, the highway network contains virtually every significant street segment within the nine-county area. Similarly, the transit network contains all transit routes and their morning peak service patterns.[52] Walk and auto links connect residential and commercial zones with the appropriate stations and stops. Though capacity constraints are placed on highway links, none are used in the transit network; the simulation assumes that transit fleets can be expanded to meet demand.

D. Trip Generation

Both internal trips (those made within the region), and external trips (those which cross the boundary of the region), must be considered by any model purporting to simulate regional travel. Internal trip generation is based on the 2015 zonal forecasts for population and employment, whereas external trips extrapolate from cordon line traffic counts based on population and employment growth inside and outside the DVRPC region. The latter also includes trips which pass through the Delaware Valley region. Estimates of internal trip productions and attractions by zone are established on the basis of trip rates applied to the zonal estimates of demographic and employment data.[53]

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[51] DVRPC, Year 2000 Transportation Plan for the Delaware Valley Region, Amended September 1984, (1985).

[52] See the Simulation Report, Ch. V and VI for the highway and transit coding conventions, respectively.

[53] Simulation Report, Ch. III and IV.

Trip generation totals for the region are presented in Table 10. The first three categories -- home based work, home based non-work, and non-home based -- represent person-trips internal to the region. The remaining categories cover trips which are not counted in the person-trip models, such as truck and taxi trips and auto trips with one or both ends beyond the DVRPC region. These trips are classified as external-local auto, light truck, heavy truck, and taxis.

In total, about 18 million person-trips are projected to be made within the Delaware Valley region on an average weekday in the Year 2015. Of these, 4.4 million will be home based work trips. Total trip making is projected to increase by almost 17 percent over the 28-year period between 1987 and 2015.

In the summer of 1988, DVRPC conducted a complete review of cordon stations around the nine-county region. Altogether, 114 cordon stations were identified as significant regional entry/exit points for which a sufficient history of traffic counts existed. A composite growth factor was prepared for each external station, based on anticipated growth in travel across the cordon line. This factor was prepared by establishing growth trends for each station based on 1970, 1975, 1980, 1985, and 1987 traffic counts. The trends implicit in these counts were then extrapolated to the Year 2015. Total cordon traffic is expected to grow to more than 1.6 million daily trips, which is 51 percent higher than that measured in 1987. Cordon traffic represents the fastest growing component in the vehicle-trip simulation model.

E. Trip Distribution

Trip distribution is the process whereby the zonal trip ends established in the trip generation analysis are linked together to form origin and destination patterns in the trip table format. It is not sufficient to know how many trips will originate or be destined to a zone on a daily average; it is necessary to know between what pairs of zones these trips will occur, which is the function of the DVRPC distribution model, a gravity-type model.

The basic premise of the gravity-type distribution model is that the number of trips between a pair of zones is directly proportional to the number of trips produced in the origin zone times the number attracted to the destination zone, and inversely proportional to the highway and public transit travel times and costs (which measure physical separation between the origin and destination zones) raised to a specified exponential power.

For the simulation of Year 2015 travel demands, a series of seven gravity-type distribution models were applied at the zonal level. These models follow the trip purpose and vehicle type established in trip generation. The first three models were used to distribute the person-trips internal to the region by all modes of travel, and models four through seven were used to distribute certain vehicular trips by autos, trucks, and taxis. The through vehicle-trip distribution was prepared manually based on previous trip

Table 10

COMPARISON OF 1987 AND 2015 TRIP GENERATION MODEL ATTRIBUTES
(thousands)

Model Number	Trip Category	Total Daily Trips 1987	Total Daily Trips 2015	Difference Absolute	Difference Percent
Person Trip Models (Internal Trips)					
1	Home Based Work	3,717	4,409	692	18.6%
2	Home Based Non-Work	8,327	9,448	1,121	13.5%
3	Non-Home Based	3,388	4,146	758	22.4%
	Total	15,432	18,003	2,571	16.7%
Vehicle Trip Models					
4	External-Local Autos	712	1,111	399	56.0%
5	Light Trucks	1,164	1,408	244	21.0%
6	Heavy Trucks	712	881	169	23.7%
7	Taxis	156	180	24	15.4%
	Total	2,744	3,580	836	30.5%

patterns between each pair of cordon stations, and did not require an application of the distribution model.[54]

Overall, average trip times are projected to increase slightly as a result of disproportionate increases in travel in the suburban and rural parts of the region.

F. Modal Split

Once the distribution of internal person-trips in the region is determined, trips must be allocated to either the highway or transit system. The model subdivides highway trips into auto drivers and passengers. Those trips allocated to the transit system are ready for assignment to the transit network in order to generate individual facility volumes. Auto driver trips are added to the truck, taxi, and external vehicle trips in preparation for assignment to the highway network.

The model calculates the fraction of each person-trip interchange volume in the trip table which should be allocated to transit, and then assigns the residual to the highway side. The choice between highway and transit usage is made on the basis of comparative cost, travel time, and frequency of service, with other aspects of modal choice. In general, the better the transit service, the higher the fraction assigned to transit, though trip purpose and auto ownership also affect the allocation. The highway and transit networks and the transit service assumptions are listed in the Simulation Report mentioned earlier.[55]

As part of the modal split operations, the internal person-trip tables allocated to highway-oriented travel were converted into vehicular travel by the car occupancy model. The external-local auto driver trips, light and heavy truck trips, and taxi trips from the vehicular distribution models were added to the internal vehicle trips from the modal split model. The 2015 external-external travel (through trips) for autos and trucks were then combined with the other trip tables to form the total vehicle trip table.

The total vehicle trip table produced by these operations accounts for all daily automobile and truck travel. It does not, however, include trips made by public transit vehicles or school buses. In addition, vehicle trips to and from the transit system (auto approaches) are excluded from the trip table. The transit trip table produced by the modal split process represents all internal transit person trips except those made on dedicated school buses.

Table 11 shows the results of the modal split process. Overall, the data projects transit's share of regional trips to decline slightly from 5.8 percent in 1987 to 5.1 percent by the Year 2015, primarily as a result of projected growth in residential and commercial

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[54] Simulation Report, Ch. VII.

[55] Simulation Report, Ch. VII.

Table 11

COMPARISON OF 1987 AND 2015 MODAL SPLIT, AUTO OCCUPANCY, TRANSIT TRIPS, AND AUTO DRIVER TRIPS

	Modal Split (Transit Share)		Auto Occupancy	
Trip Purpose	1987	2015	1987	2015
Home Based Work	14.3%	12.4%	1.14	1.14
Home Based Non-work	3.4%	3.0%	1.68	1.68
Non-home Based	2.5%	2.1%	1.26	1.26
Average	5.8%	5.1%	1.42	1.42

	Total Daily Trips (thousands)					
	Transit			Auto Driver		
Trip Purpose	1987	2015	Percent Change	1987	2015	Percent Change
Home Based Work	532.4	545.4	2.4%	2,783.8	3,389.5	21.8%
Home Based Non-work	279.7	279.2	- 0.2%	4,783.4	5,445.1	13.8%
Non-home Based	83.3	86.2	3.5%	2,615.2	3,213.1	22.9%
Total	895.4	910.8	1.7%	10,182.4	12,047.7	18.3%

activity in suburban and rural areas unserved by transit. Actual transit ridership is projected to increase by 1.7 percent to slightly more than 900,000 trips on an average weekday, but total trip demand is expected to increase by 17 percent. Most of this increase in demand will be accommodated by private automobiles. The number of transit trips is expected to increase by approximately two percent for home based work trips and almost four percent for non-home based trips, but remain level for home based non-work trips (see Figure VI). These trends simply recognize that the overall growth in work trips will generate additional public transportation trips, but that fewer home based non-work trips will be taken on weekdays. Non-home based trips which represent midday trips taken from the work place should increase in parallel with transit commutation.

The average automobile moving on the region's highways now carries 1.43 persons, and this is expected to change little over the next 26 years. Residents are most likely to drive alone when traveling to or from work, averaging an occupancy of 1.14, and least likely when traveling between home and non-work destinations, when the occupancy is 1.68.

Regional automobile trips are expected to increase 18.3 percent to approximately 12 million trips per weekday. Currently, commutation accounts for 27.3 percent of weekday automobile trips. This fraction may increase slightly as the number of non-workers per household declines, which will push non-work trips to weekends. Figure VII shows growth in auto driver trips by trip category. All categories are expected to increase, but the larger increases will be in the home based work and non-home based categories.

G. Trip Assignment

The final step in the travel forecasting process involves assigning trips to the highway and transit networks to obtain facility volumes. Because of their unique characteristics, the assignment procedures differ by mode and will be treated separately.

1. Highway Assignment

The procedure for the highway assignment is based on the "equilibrium" restraining method. In an equilibrium assignment, the trips between zones are allocated to alternate paths in such a way that the travel time over each path is equal, and therefore, no faster path can be found, given prevailing congestion levels.[56]

Once route assignments are made, link volumes and vehicle-mile statistics can be calculated. In the Year 2015 it is anticipated that about 103 million vehicle-miles will be recorded daily in the region, 28.9 percent higher than the amount measured in 1987 (see Table 12). In addition, traffic is increasingly concentrated on expressways and freeways. These limited access facilities, which will constitute 12.2 percent of the Year 2015 network

[56] Simulation Report, Chapter IX.

FIGURE VI

DAILY PUBLIC TRANSPORTATION TRIPS

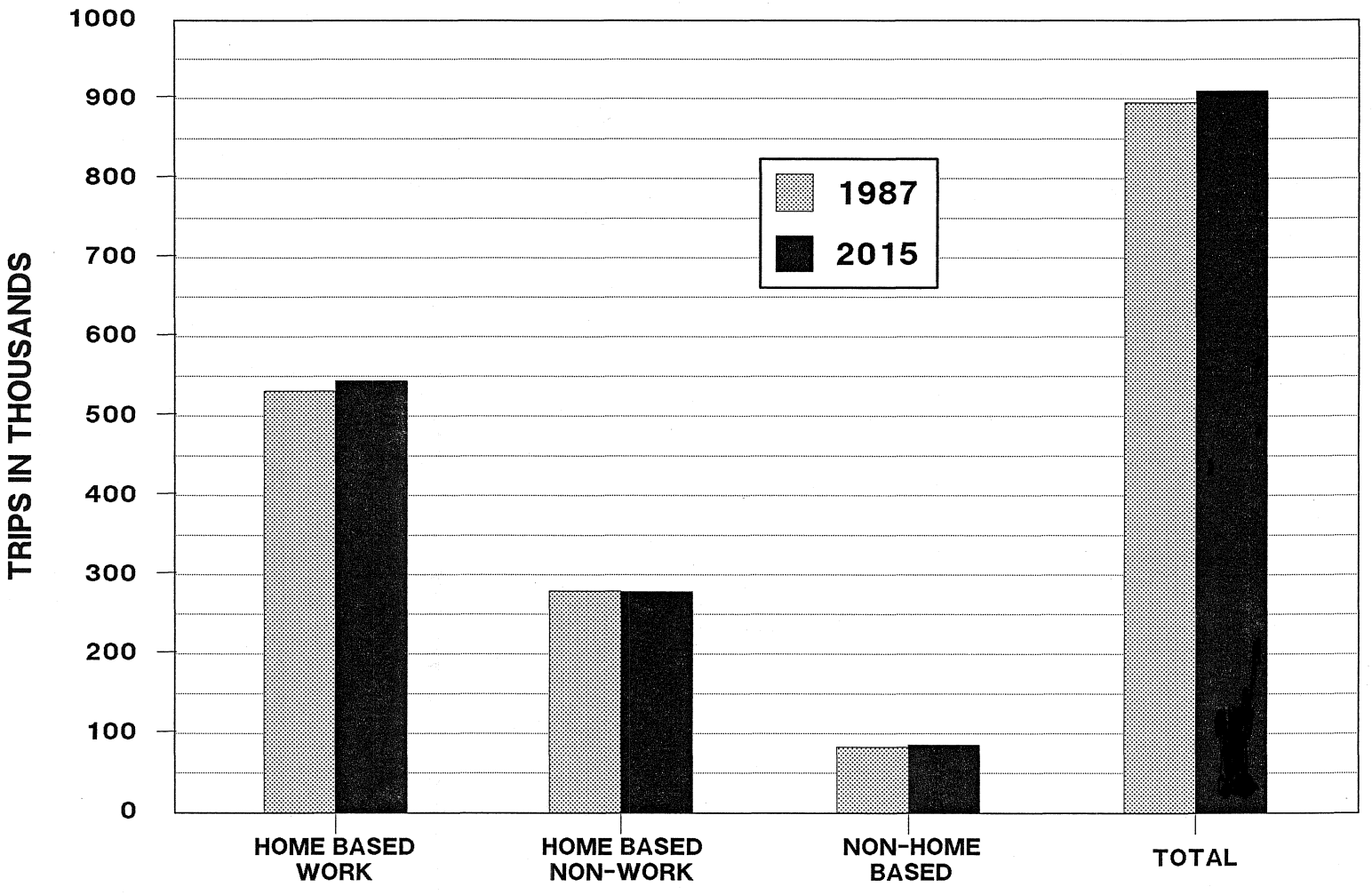

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FIGURE VII

DAILY AUTO DRIVER TRIPS

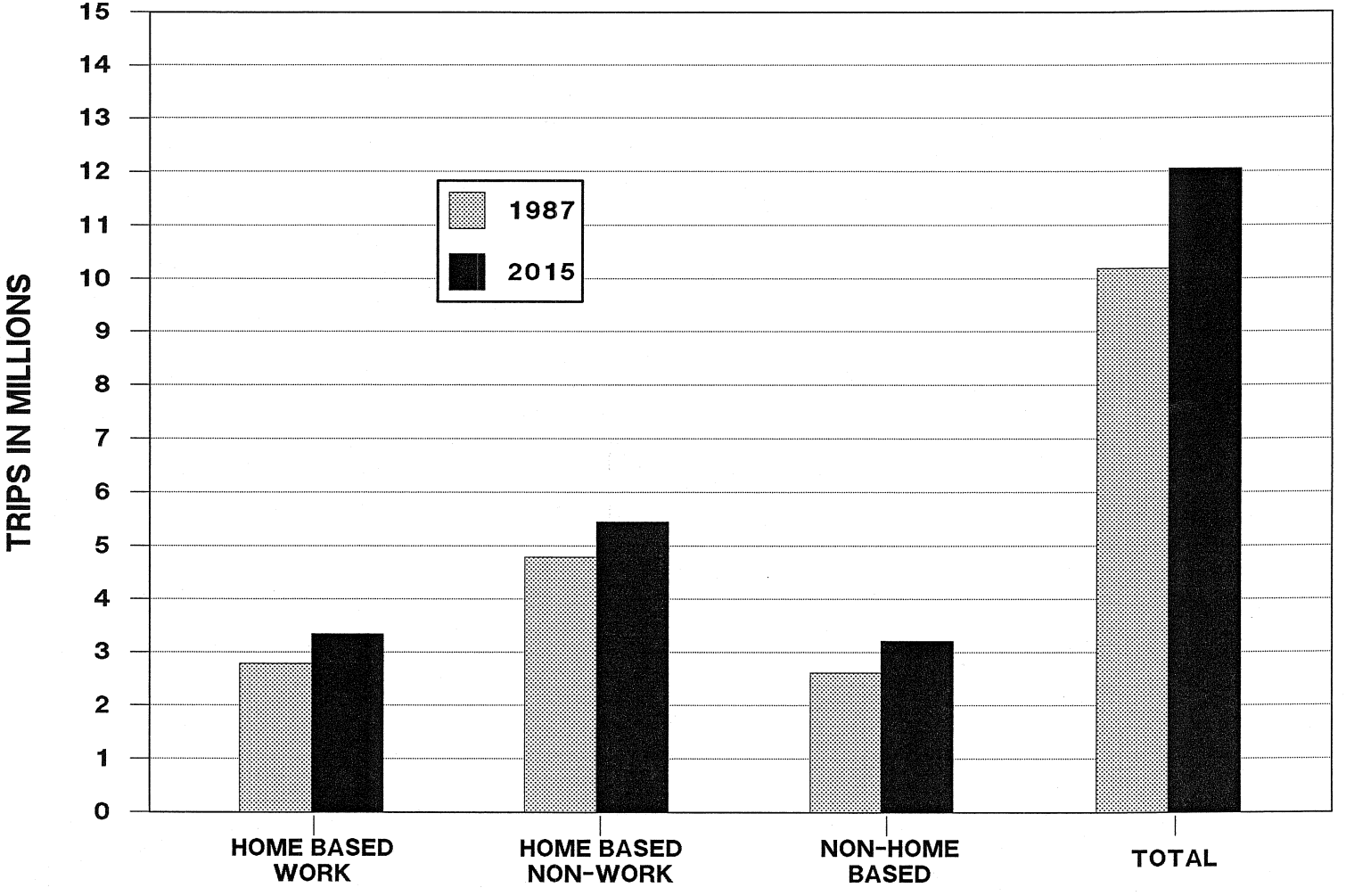

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Table 12

1987 AND 2015 ROUTE-MILES AND VEHICLE-MILES OF TRAVEL BY HIGHWAY FUNCTIONAL CLASSIFICATION

Highway Functional Classification	Route-Miles Included in the Highway Traffic Assignment				Daily Vehicle-Miles (millions)			
	1987	Percent of Total	2015	Percent of Total	1987	Percent of Total	2015	Percent of Total
Freeway and Expressway	738.9	11.1%	823.0	12.2%	22.0	27.5%	31.9	30.9%
Principal Arterial	1,713.1	25.7%	1,728.5	25.5%	28.6	35.8%	35.2	34.1%
Secondary Arterial	2,634.7	39.5%	2,639.5	39.0%	16.6	20.8%	20.9	20.3%
Collector and Local*	1,580.0	23.7%	1,579.3	23.3%	12.8	16.0%	15.1	14.6%
TOTAL	6,666.7		6,770.3		80.0		103.1	

*Includes only portion used in the simulation. Approximately 12,400 miles of local roads were not included in the network.

route length, are forecast to carry 30.9 percent of the traffic, up from 27.5 percent in 1987. New expressways not only divert traffic from arterials, they encourage longer trips.

Though new highways are being built, they are not being added to the network as fast as traffic increases, consequently congestion increases; this increase can be gauged from average weekday vehicle speeds. Overall speeds for the region are expected to decline from 24.4 to 23.3 mph (see Table 13). Average weekday speeds will be somewhat higher in New Jersey, 25.4 mph compared with 22.1 mph in Pennsylvania. This is a result of easier terrain in New Jersey, as well as a greater concentration of expressways. Not surprisingly, the lowest speeds are found in the City of Philadelphia, however, the average speed of 19.7 mph is only slightly lower than that experienced in 1987.

2. Transit Assignment

The transit network assignment procedure accomplishes two major tasks. First, the transit person-trip table produced by the modal split model is "unlinked" to include any transfers that occur either between transit routes or between auto approaches and transit lines. An unlinked trip is defined as one taken aboard a single transit vehicle. Second, the unlinked transit trips are associated with specific transit facilities to produce the daily line, link, and station volumes. This assignment of transit trips is based on the minimum impedance paths constructed throughout the transit network. Unlike the highway network assignment, no capacity restraints are built into the transit network; it is assumed that sufficient buses and rail cars can be supplied to meet demand.

When measured in passenger-miles, average weekday transit travel for the region is expected to increase by 3.4 percent (see Table 14). As a result of the continuing suburbanization of travel, trip lengths are expected to be longer and load factors lower than current values. Table 14 also delineates the geographic differences in the region. Pennsylvania currently has 89 percent of the region's delivered service; this is expected to decline slightly to 87.5 percent by the Year 2015. The four suburban counties in Pennsylvania should see a 23 percent increase in passenger-miles, compared to 3.3 percent decline for the City of Philadelphia as a whole, though ridership in Center City should remain static (see Figure VIII). This results partially from shifts in population and employment, but it also reflects the good service already present in the city and the room for growth available in the suburbs.

Center City Philadelphia is the one portion of the region where a majority of trips occur on public transportation. This tendency is expected to persist into the 21st century, though transit's share is expected to decline slightly from 59.4 percent to 59.1 percent between 1987 and 2015 (see Table 14). When tabulated by mode, the largest increases are expected on the Regional Rail system, where the daily volume will increase by almost 15,000 trips or 16 percent (see Table 15). The Lindenwold Line to New Jersey will grow by almost 13 percent, but bus and trolley ridership will remain flat. The modes showing significant growth are those best positioned to tap growing suburban markets. Within the city, rail transit can achieve better market penetration than the slower buses and trolleys,

Table 13

COMPARISON OF 1987 AND 2015 VEHICLE-MILES OF TRAVEL AND AVERAGE WEEKDAY TRAVEL SPEEDS

	Daily Vehicle-Miles (millions)			Average Weekday Speed (mph)		
Geographic Area	1987	2015	Percent Diff.	1987	2015	Percent Diff.
Philadelphia County	15.2	15.4	1.3%	20.3	19.7	- 3.0%
Pennsylvania Counties	53.2	66.5	25.0%	23.1	22.1	- 4.3%
New Jersey Counties	26.8	36.6	36.6%	27.4	25.4	- 7.3%
REGION TOTAL	80.0	103.1	28.9%	24.4	23.3	- 4.5%

Table 14

COMPARISON OF 1987 AND 2015 TRANSIT PASSENGER-MILES OF TRAVEL AND PERCENT OF TRIPS MADE BY PUBLIC TRANSPORTATION

Geograpahic Area	Daily Passenger-Miles (thousands) 1987	2015	Difference	Transit Share of Total Trips 1987	2015
Philadelphia CBD	637.9	636.5	- 0.2%	59.4%	59.1%
Philadelphia County	3,892.9	3,763.4	- 3.3%	20.6%	20.1%
PA Counties	4,757.0	4,826.4	1.5%	7.6%	6.7%
Trenton	24.8	30.4	22.6%	5.8%	6.4%
NJ Counties	578.5	688.5	19.0%	1.6%	1.7%
TOTAL Region	5,335.5	5,514.8	3.4%	5.8%	5.1%

FIGURE VIII

DAILY TRANSIT PASSENGER MILES OF TRAVEL

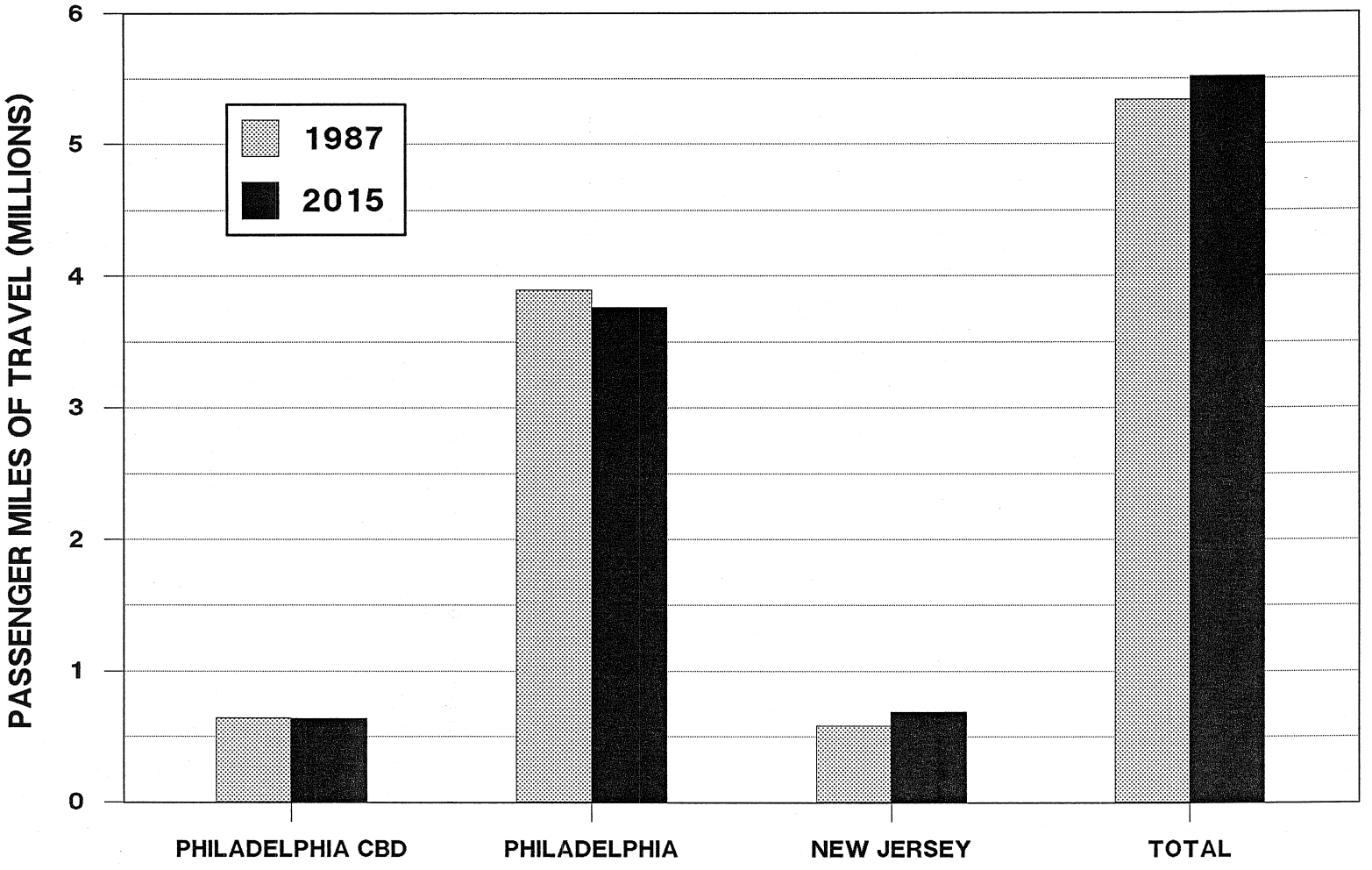

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Table 15

COMPARISON OF 1987 AND 2015 ASSIGNED BOARDINGS BY TRANSIT SUBMODE IN THE DELAWARE VALLEY REGION

	Daily Assigned Boardings		Percent Change From 1987
	1987	2015	
Regional Rail	90,789	105,636	16.4%
Subway/Elevated	302,574	312,986	3.4%
Bus and Trolley	828,680	830,140	0.2%
Lindenwold Line	36,551	41,150	12.6%
TOTAL	1,258,594	1,298,912	3.2%

but even with no growth predicted, buses and trolleys will still carry 64 percent of all transit trips taken within the region.

H. Impacts of 2015 Travel Demand on Transportation

The next step after developing the 2015 travel forecasts involves determining the impacts the simulated travel demand will have on the transportation infrastructure in terms of its ability to meet that projected demand. It is assumed that all of the facilities of the Year 2000 Plan have been built and are in service.

1. Highway Travel Demand

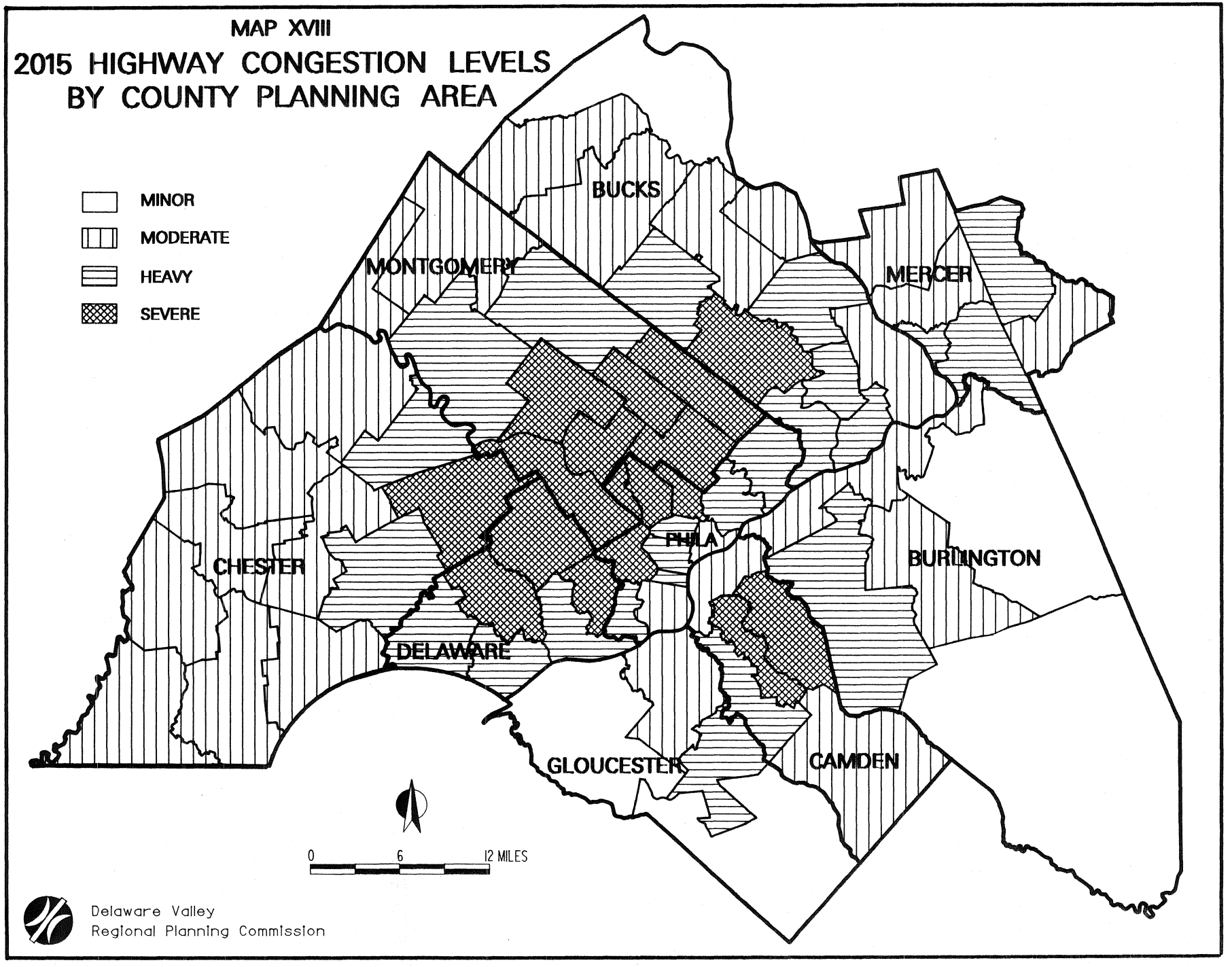
Highway congestion can be quantitatively defined in terms of volume to capacity ratios and average vehicle speed (see Chapter II). In 1987, only seven close-in county planning areas experienced severe congestion, though heavy congestion was experienced in a much wider suburban belt surrounding Philadelphia in Pennsylvania, and in Camden and Mercer counties in New Jersey.

Map XVIII shows the expected congestion levels derived from applying the same methodology as that used in the analysis of 1987 travel demand to the results of the Year 2015 simulation. Even with completion of the remaining infrastructure elements of the Year 2000 Plan, severe congestion will spread to 17 county planning areas, and heavy congestion will spread to most of the contiguous planning areas. Most of the remaining portions of the region will experience moderate congestion. In Pennsylvania, congestion has spread to the western and northern suburbs, and in New Jersey it has spread from the central corridor through Camden County to adjacent areas in Burlington and Gloucester counties. Examples of areas now experiencing severe congestion include King of Prussia, Warminster, and Cherry Hill. Basically, traffic in suburban areas will grow faster than highway capacity, and development will spread further from the center to areas that are now rural. This will strain existing and planned highway facilities.

2. Public Transportation Ridership

The needs of the public transportation system primarily center on restoring the system to a condition of good maintenance and developing new patterns of service to meet changing markets. The system must maintain capacity to handle Center City commutation and circulation needs throughout the urbanized area, and should meet the needs of the transit dependent and offer services attractive enough to develop discretionary markets.

Reverse commute markets have developed in recent years and this trend is expected to continue. The growth of service-related and other jobs at suburban locations, with the bulk of the blue-collar labor pools remaining in the cities and older suburbs, practically guarantees this. While this development provides an opportunity to transit operators, links are needed to connect existing transit corridors with new employment centers. Better


MAP XVIII
2015 HIGHWAY CONGESTION LEVELS
BY COUNTY PLANNING AREA
MINOR
MODERATE
HEAVY
SEVERE
BUCKS
MONTGOMERY
MERCER
PHILA
CHESTER
BURLINGTON
DELAWARE
GLOUCESTER
CAMDEN
0
6
12 MILES
Delaware Valley
Regional Planning Commission

integration of city routes with suburban routes on both sides of the Delaware River is also desirable.

Often new development occurs in urban and suburban corridors not well served by public transportation, but which could be served if workable connections can be made to the larger network. The Central Delaware Waterfront, where older freight piers are being recycled to new uses and changing travel patterns in the process, provides a good example. Other growing corridors amenable to redesigned transit services exist on the fringe of the City of Philadelphia, but if new service is to be successful, the corridors must be carefully selected.

Largely as a result of demographic growth, transit ridership in New Jersey is expected to increase by 19 percent, but this will only occur if new service patterns are developed to meet growing travel markets. Whether this will be met by extensions to PATCO, by additional NJ TRANSIT rail service, or by restructured bus service has yet to be determined through the conduct of detailed studies. As mentioned earlier, no travel forecasts were conducted for Southern New Jersey outside the DVRPC region. However, based on the demographic and employment forecasts documented in Chapter III, highway volumes and public transportation ridership are expected to increase significantly in the future, especially in the Philadelphia-Atlantic City corridor.

V. ALTERNATIVE TRANSPORTATION INVESTMENT STRATEGIES

This chapter describes three alternative transportation investment strategies, including capital, operating, and maintenance costs of the highway and public transportation systems for the Year 2015. As mentioned in Chapter II, the 2015 transportation needs for the region derive from previous capital, operating and maintenance cost studies prepared for the DVRPC Year 2000 Transportation Plan, and Transportation Improvement Programs (TIP). Capital investment covers costs of new highways and transit facilities, major improvements to existing facilities, purchases of new buses and rail rolling stock, and other infrastructure improvements to both the highway and transit systems. Operating and maintenance costs are those incurred routinely for the proper upkeep of facilities and the provision of transportation services, such as: snow removal, maintenance of roadways and transit lines and stations, fuel, and wages. These costs, as well as public transportation subsidies, are included in the analysis of the proposed investment strategies. All costs were estimated in 1987 dollars. No attempt was made to account for the effects of inflation or the value of future investments.

Three Alternative Investment Strategies - I (No-Build), II (Minimum Investment), III (Moderate Investment) - are defined and described below. However, Alternative Investment Strategy II is discussed first, because it mainly includes the improvements planned for the Year 2000 Transportation Plan discussed in Chapter II.

A. Alternative II: Minimum Investment Strategy

Alternative II involves essentially a minimum investment strategy based on the Year 2000 Transportation Plan, and consists of committed major facilities needed to complete missing highway and transit segments that are vital to traffic flow and passenger service.[57] It also includes many small projects needed to improve the existing transportation system and to serve the growing suburban travel demand through the Year 2015. In addition, this investment strategy includes costs of transportation facilities and improvements that are programmed in recent 12-year TIPs. This alternative assumes that the TIP projects and those proposed for the Year 2000 Plan may take up to 26 years (1989-2015) to complete, rather than 12 years as originally scheduled. This conservative approach is taken because of the current shortage of funds to build and operate new facilities. Some of the projects may not be implemented until environmental approvals are obtained and sources of funding established.

1. The Highway System

The highway improvements assumed in Alternative II for the period 1989 to 2015 can be classified into three categories:

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[57] Delaware Valley Regional Planning Commission, Year 2000 Transportation Plan for the Delaware Valley Region, Philadelphia, PA, May 1982.

a. Major Highway and Bridge Projects - This category includes new construction, major improvements to existing facilities, reconstruction of some expressways and arterials, and improvements to the regional highway system, such as the construction of a new Lumberton Bypass from NJ 38 to County 541 and completion of NJ 55 freeway in New Jersey; as well as the Exton Bypass from US 30 to US 202, and the Woodhaven Extension, which connects the Delaware Expressway (I-95) with southeastern Montgomery County, in Pennsylvania.

b. Arterial Widening - Examples include widening US 202 from West Chester to the Delaware state line and widening NJ 47 from US 322 to NJ 41 in Gloucester County.

c. Minor Improvements - This category includes bridge repairs, signal improvements, and small reconstruction projects. Rehabilitation of the US 1 bridge over SEPTA's Norristown High Speed Line in Delaware County and improvements to the US 30/130 bridge over Cooper River in Camden County are examples.

This investment strategy includes $3.9 billion to cover highway operating and maintenance costs from 1989 to 2015. This amount is needed for the routine upkeep of existing and future facilities, and includes snow removal, policing, and sign repairs. The capital cost required to implement this strategy is estimated at $5.6 billion. Thus, under this strategy, about $9.5 billion will be needed to improve and maintain existing and proposed highway facilities.

2. The Public Transportation System

Under this strategy, capital investments will be needed to improve the existing public transportation system, including regional railroad facilities, subway-elevated lines, bus and trolley facilities, and stations and terminals. Investment will also be needed to complete new facilities under construction or recommended for construction. Improvements are also recommended to provide better service on specific existing facilities, including purchase of new cars, station reconstruction, and electrification of rail lines. Replacement of vehicles and improvements to rapid transit line power equipments are also included in this alternative strategy.

a. Pennsylvania side of the Region - The capital cost of public transportation facilities in the Pennsylvania portion of the DVRPC region is estimated at approximately $3.2 billion. This investment includes a variety of projects ranging from the purchase of 60 new cars for the Market-Frankford subway/elevated line to the extension of rail transit to Northeast Philadelphia. The operating subsidy required for the public transportation system between 1989 and 2015 will total $7.5 billion. This represents public subsidies from local, state, and federal governments, but does not include revenues from riders' fares.

b. New Jersey side of the Region - In the New Jersey portion of the DVRPC region, costs of public transit improvements for NJ TRANSIT and PATCO are also

estimated; about $0.8 billion is needed to improve the existing system and build new facilities such as the PATCO High Speed extension to Maple Shade. Operating subsidies for the transit systems will cost about $0.9 billion, which must be provided by local, state, and federal governments, and in the case of PATCO, the Delaware River Port Authority.

In summary, Alternative II investment strategy includes building some extensions to existing rail lines, buying new subway cars and buses, and improving the existing transportation system. Under this investment strategy, capital and operating subsidies for public transportation facilities will cost about $12.4 billion ($4.0 billion for capital and $8.4 billion for operating subsidy).

B. Alternative I: No-Build Investment Strategy

The No-Build Investment Strategy assumes that no new transit and highway facilities will be built, except for those facilities currently under construction. Such a strategy is sometimes called the "Do Nothing Alternative", developed for comparison purposes. However, in order to operate the existing transportation system safely at a minimal level of service, some essential improvements are needed, such as highway and bridge replacement, rehabilitation, restoration, and resurfacing. Others include transit vehicle replacement and minor station improvements. These improvements are also included in Alternatives II and III.

1. The Highway System

In general, highway improvements in this strategy include replacement, rehabilitation, restoration, and resurfacing projects (4R) needed to keep the existing system operating at a minimal level of service. These projects will cost about $2.5 billion. Such projects include replacement of the Fallsington Avenue bridge over Amtrak's Northeast Corridor in Bucks County, deck rehabilitation of the I-95 bridge over Chester and Ridley creeks in Delaware County, Bullens Lane resurfacing in Delaware County, and PA 100 restoration from the Chester County line to Farmington Road in Montgomery County. Highway improvements in New Jersey include rehabilitation of the CO 563 bridge over the Mullica River in Burlington and Atlantic counties, Blue Anchor Road (NJ 73) resurfacing from north of CO 536 to north of Davis Avenue in Camden County, and replacement of the Russell Mill Road bridge over Raccoon Creek in Gloucester County. The operating and maintenance costs of highway facilities included in this strategy is estimated at $3.5 billion.

2. The Public Transportation System

The capital cost of the No-Build Alternative Strategy is estimated at $2.0 billion for the Pennsylvania portion of the DVRPC region. This includes investment in infrastructure rehabilitation and replacement required to continue operating the current public transportation services provided by SEPTA. Two categories of projects are included in this alternative strategy.

- o Category 1 - emergency projects necessary to maintain service in the near future or required by law or agreements.

- o Category 2 - projects necessary to prevent gradual service degradation and to maintain performance and reliability.[58]

Some examples of Category 1 include Regional Rail Division (RRD) trunk line rehabilitation between Brown Street and Wayne Junction in Philadelphia, rehabilitation and modernization of track between Media and West Chester, grade-crossing improvements and structural repairs to bridges, and purchases of new rail transit vehicles and work cars. Examples of Category 2 improvements include track and signal projects to prevent slow orders and in-service failures which disrupt operations. SEPTA's City and Suburban Transit Divisions ongoing program to improve tracks and overhead wires, purchase of new buses, and rehabilitation of depots also come under this category. The operating subsidy of the public transportation system constitutes a significant portion of this investment strategy, $7.2 billion.

In the New Jersey portion of the DVRPC region, significant improvements to NJ TRANSIT and PATCO facilities are also necessary. Capital costs totaling $400 million are required to rehabilitate 17 PATCO bridges in Camden (built between 1902 and 1914), to complete rehabilitation of two substations in Philadelphia and Camden, and to continue replacement of rails on curves, ties, and third rail cover board on the transit system. The operating subsidies required in New Jersey between 1989 and 2015 are estimated at $800 million.

In summary, Alternative I includes investment in infrastructure rehabilitation and replacement required to continue the existing public transportation services at the lowest service level. Public transportation investment for this alternative totals approximately $10.4 billion, including $8.0 billion for operating subsidy.

C. Alternative III: Moderate Investment Strategy

The Moderate Investment Strategy basically encompasses Alternative Strategy II, plus additional investment in new facilities to improve the efficiency of the transportation system and provide better services for both highway and public transportation users. This strategy would satisfy the needs of motorists and public transportation users, and therefore should be considered in the development of long-range plans for the region.

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[58] Strategic Alternatives for Improved Public Transportation Mobility in Southeastern Pennsylvania, Draft Report. Prepared by Peat, Marwick, Mitchell and Company for Bucks, Chester, Delaware, and Montgomery Counties, City of Philadelphia, and Pennsylvania Department of Transportation, February 1989.

1. The Highway System

The additional highway improvements included in this alternative will benefit the entire system. Examples of these new projects include: construction of the Schuylkill Parkway from the Dannehower Bridge to the Betzwood Bridge in Montgomery County; reconstruction of PA 413 from Bridgetown Pike to US 1 in Bucks County; construction of the US 202 Expressway in Bucks and Montgomery counties; and the widening of US 322 in Gloucester County. About $4.2 billion will be required to operate and maintain the existing and proposed facilities included in this alternative. The total investment needed to implement this strategy is estimated at $11.7 billion.

2. The Public Transportation System

A capital investment of approximately $5.2 billion is needed in Alternative III to expand transit service throughout the Pennsylvania portion of the region. Such projects include: extending Route R6 (Norristown line) from Elm Street to Germantown Pike; two additional stations on the Airport Rail Line in Philadelphia; complete overhaul and modernization of the right-of-way, signals, power supply and distribution, catenary system, and bridges for commuter operating facilities; extensive repairs to the structure and modernization of Frankford Elevated Station platforms and their approaches, and extensions to Market Street Subway/Elevated platforms to accommodate the anticipated need for eight-car trains. The operating subsidy between 1989 and 2015 for the transit system in Pennsylvania for this alternative is estimated at $8.5 billion.

In the New Jersey portion of the DVRPC region, public transportation capital investment, which totals $1.4 billion, includes two extensions of the PATCO high-speed line to Deptford Mall in Gloucester County and to Maple Shade in Burlington County.

D. Summary of the Proposed Alternative Transportation Investment Strategies

Table 16 shows capital, operating and maintenance costs, as well as the operating subsidy for highway and public transportation alternative investment strategies during the period 1989-2015. It also shows that approximately $25.4 billion, $31.4 billion, and $37.5 billion, respectively is needed to construct, improve, and maintain transportation systems in the Delaware Valley region for Alternative Strategies I, II, and III. Alternative II investment totals approximately 24 percent more than Alternative I, while Alternative III investment totals almost 48 percent more than the No-Build Alternative. Highway capital costs for Alternatives II and III will increase significantly over Alternative I by approximately 124 and 200 percent, respectively. In contrast, highway operating and maintenance costs for Alternatives II and III will increase only moderately over Alternative I, by about 11 and 20 percent, respectively.

Table 16 further shows that public transportation capital costs for Alternatives II and III increase significantly over Alternative I, by about 67 percent and 175 percent, respectively. The public transportation operating and maintenance costs for Alternatives

Table 16

TOTAL CAPITAL, OPERATING AND MAINTENANCE COST, AND OPERATING SUBSIDY (1989-2015) (billions of 1987 dollars)

	Transportation Alternative Investment Strategies								
	Pennsylvania			New Jersey			Total		
	I	II	III	I	II	III	I	II	III
A. Highways									
1. Capital Cost	1.9	4.2	5.6	0.6	1.4	1.9	2.5	5.6	7.5
2. Operating & Maintenance Cost	1.9	2.1	2.3	1.6	1.8	1.9	3.5	3.9	4.2
3. Total Highway	3.8	6.3	7.6	2.2	3.2	3.8	6.0	9.5	11.7
B. Public Transportation									
1. Capital Cost	2.0	3.2	5.2	0.4	0.8	1.4	2.4	4.0	6.6
2. Operating & Maintenance Cost	14.6	15.4	16.5	2.4	2.5	2.7	17.0	17.9	19.2
3. Total Public Transportation	16.6	18.6	21.7	2.8	3.3	4.1	19.4	21.9	25.8
4. Public Operating Subsidy	7.2	7.5	8.5	0.8	0.9	1.2	8.0	8.4	9.7
C. Total Transportation Public Investments (line A3+B1+B4)	13.0	17.0	21.6	3.4	4.9	6.4	16.4	21.9	28.0

II and III are higher than Alternative I, by approximately five and 13 percent, respectively. The public operating subsidies for Alternatives II and III are also greater than that needed for Alternative I, about five and 13 percent, respectively.

Figure IX illustrates total capital costs for both highways and public transportation, and public operating subsidies for the three alternative transportation investment strategies. The figure shows that Alternative II investment ($21.9 billion) is about 34 percent higher than Alternative I investment ($16.4 billion), while Alternative III investment ($28.0 billion) is almost 71 percent higher than the No-Build Alternative.

E. Annual Capital, Maintenance and Operating Costs

Figure X shows the annual capital costs for highway and public transportation systems for the three alternative strategies during the planning period 1989-2015. These costs are summarized below:

ANNUAL CAPITAL COST
(Millions of 1987 Dollars)

	Highways	Public Transportation	Total
Alternative I	96	92	188
Alternative II	215	154	369
Alternative III	288	254	542

Figure XI shows the annual maintenance and operating costs for the highway and public transportation systems for the three alternative strategies for the period 1989-2015. These costs also are shown in the following tabulation:

ANNUAL MAINTENANCE AND OPERATING COST
(Millions of 1987 Dollars)

	Highways	Public Transportation	Total
Alternative I	135	654	789
Alternative II	150	688	838
Alternative III	162	738	900

FIGURE IX

ALTERNATIVE TRANSPORTATION INVESTMENT STRATEGIES

(1989-2015 TOTAL PUBLIC INVESTMENTS)

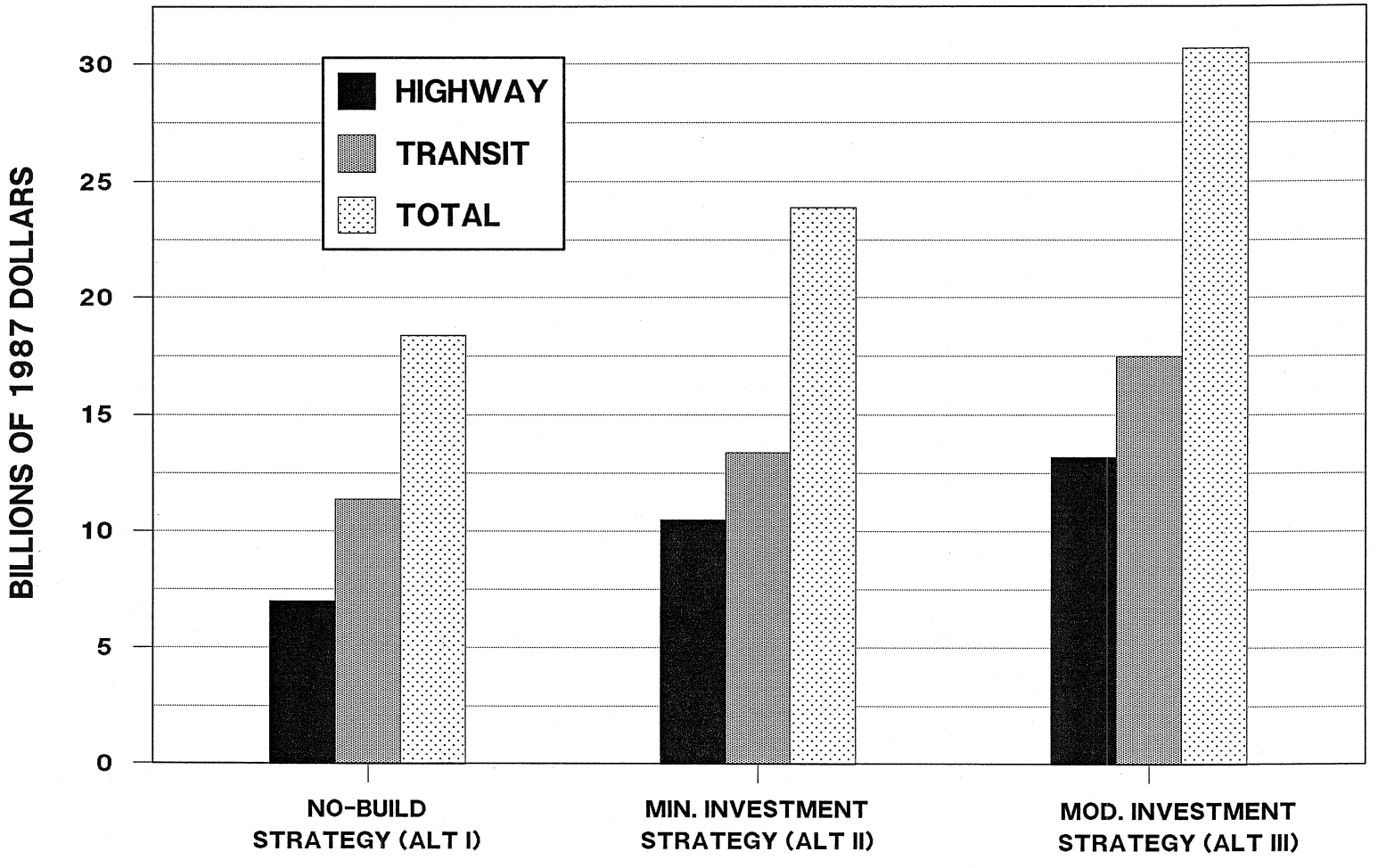

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FIGURE X

ANNUAL CAPITAL COSTS

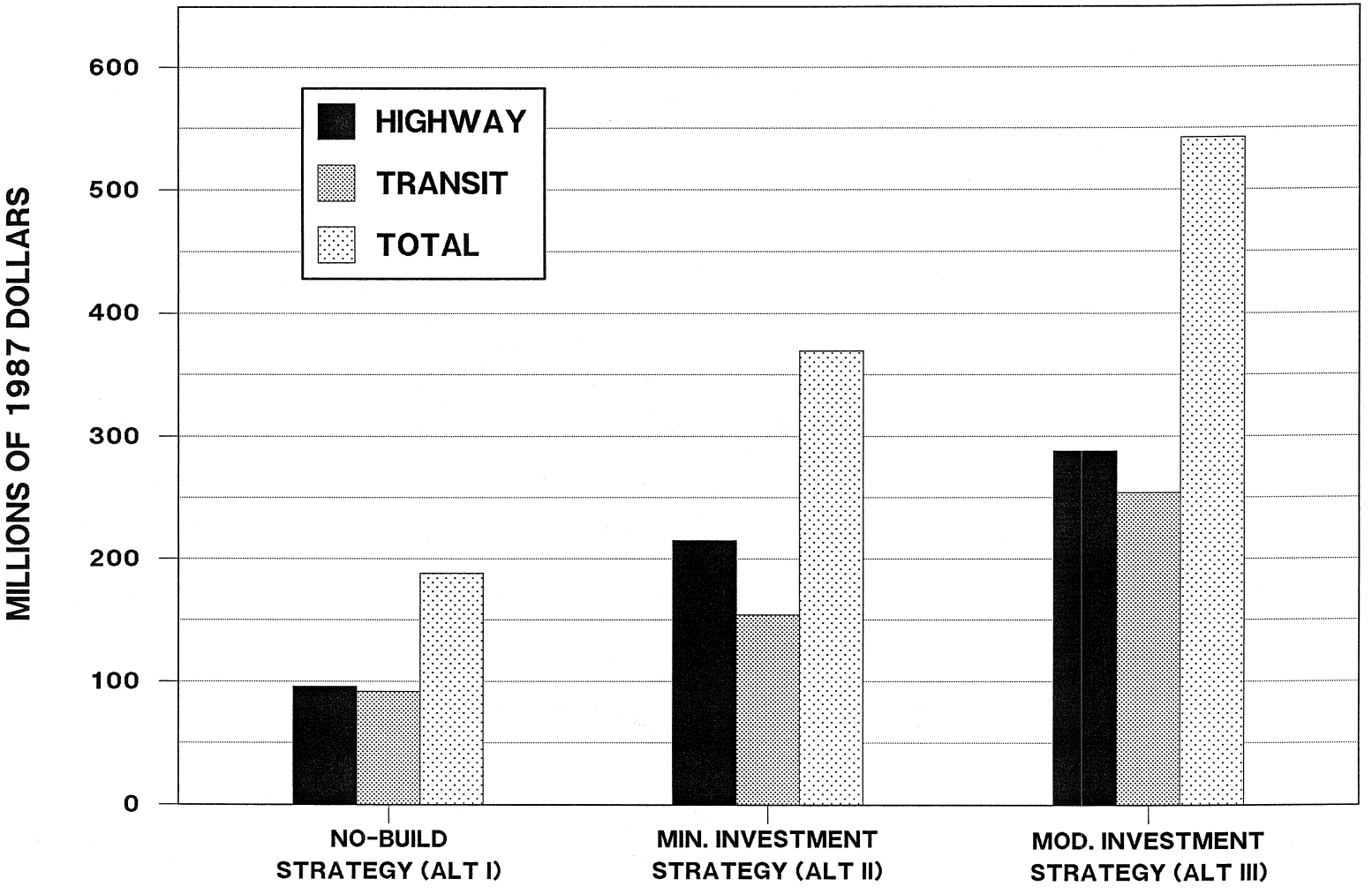

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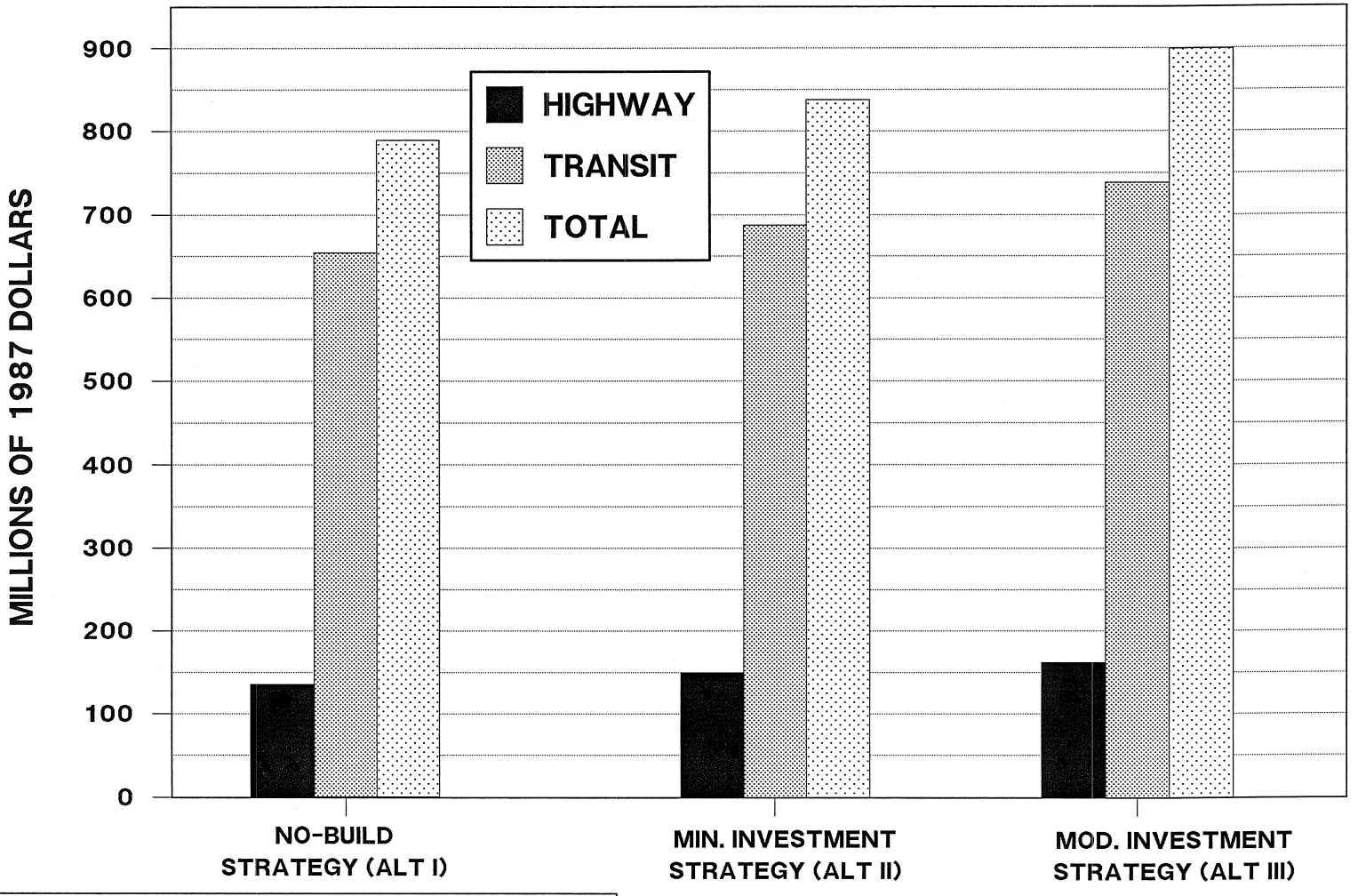
FIGURE XI

ANNUAL MAINTENANCE AND OPERATING COSTS



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VI. IMPACTS OF THE PROPOSED ALTERNATIVE TRANSPORTATION INVESTMENT STRATEGIES

This chapter evaluates the impacts of the three proposed alternative investment strategies described previously. The three alternatives are: No-Build (Alternative I), Minimum Level of Investment (Alternative II), and Moderate Level of Investment (Alternative III). The following transportation and non-transportation impacts of these investment alternatives are estimated and evaluated at the regional level: travel demand and service level, highway safety, air quality, energy consumption, and travel or user cost. These are further disaggregated as follows:

A. Travel Demand and Service Level

- o home based work trips
- o total person trips
- o auto and transit trips
- o transit trips by submode
- o vehicle-miles of travel
- o average and peak-hour speeds
- o transit passenger-miles of travel
- o transit peak-hour speeds

B. Highway Safety

- o accidents and fatalities

C. Air Quality

- o carbon monoxide (CO)
- o non-methane hydrocarbons (NMHC)
- o oxides of nitrogen (NO_x)

D. Energy Consumption

- o fuel consumption

E. Travel Cost

- o user cost

Using the DVRPC simulation model, the impacts of Alternative II were first estimated for the Year 2015.[59] The impacts of Alternatives I and III were then estimated using the

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[59] Delaware Valley Regional Planning Commission, 2015 Travel Simulation for the Delaware Valley Region, December, 1988. (see Ch. IV)

results of the Year 2000 simulation, which DVRPC previously developed for the Year 2000 Transportation Plan.[60] For each performance measure, a factor was developed by dividing the Year 2000 estimate for Alternative I or III by the estimate for Alternative II. This factor was then used to scale the 2015 estimate for Alternative II to Alternative I or III, as illustrated below:

$$\frac{\text{2000 Alt. I}}{\text{2000 Alt. II}} \text{ X 2015 Alt. II} = \text{2015 Alt. I}$$

This procedure assumes that ratios of the effects from the three levels of investment remain essentially the same for each performance measure in the Year 2015 as the ratios in the Year 2000 simulation.

A. Travel Demand and Service Level

1. Travel Demand

As discussed in Chapter IV, regional travel demand is estimated using data for households and employment at the census tract level. Trip rates disaggregated by trip purpose, auto ownership, and area type are used in DVRPC's travel simulation process to generate trip productions and attractions. Because the demographic and employment data are assumed to remain the same for all three alternatives, the number of daily person trips in the region (18,003,000) remains consistent for the three investment strategies. Between 1987 and 2015 the total number of person trips in the region is expected to increase by more than 16 percent, while the number of home based work trips will increase by almost 19 percent. The number of daily home based work trips within the region is projected to be 4,409,000 in the Year 2015 (see Table 17).

Since each of the three investment strategies includes a different mix of highway and transit facilities, the modal breakdown of daily trips differs in each strategy. Generally, the propensity to use public transit depends on the relative service levels of the transit and highway systems. A decrease in the service level of highways will increase transit ridership. The service levels of highway and transit systems are estimated using travel time (both in- and out-of-vehicle time), highway operating costs, transit fares, and parking fees. An examination of Table 17 shows an increase in transit trips and a corresponding decrease in auto trips under Alternatives II and III. When compared with the No-Build Alternative, auto trips decrease by 0.2 percent in Alternative II and 0.3 percent in Alternative III. This slight decrease in automobile trips is balanced by a corresponding increase of 1.9 percent in transit trips in Alternative II and 3.2 percent in Alternative III. When comparing Alternative II with the 1987 level, auto driver trips increase by more than 18 percent, while transit trips increase by only about two percent.

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[60] Delaware Valley Regional Planning Commission, 2000 Travel Simulation for the Delaware Valley Region, 1980.

Table 17

REGIONAL DAILY TRIPS AND TRANSIT BOARDINGS
(thousands)

		2015 Alternative Investment Strategies				
Person Trips	1987	Alt. I	Alt. II	% Diff. from Alt. I	Alt. III	% Diff. from Alt. 1
Home Based Work	3,717	4,409	4,409	0.0	4,409	0.0
Total	15,432	18,003	18,003	0.0	18,003	0.0
Mode of Travel						
Auto Driver Trips	10,182	12,068	12,048	- 0.2	12,033	- 0.3
Transit Trips	895	894	911	1.9	945	5.7
Transit Boardings						
Regional Rail	91	92	106	15.2	107	16.3
Subway/Elevated	339	358	354	- 1.1	433	20.9
Bus and Trolley	829	827	830	0.4	819	- 1.0

Table 17 and Figure XII present a breakdown of daily transit boardings by three submodes: regional rail; subway/elevated rapid transit (which includes PATCO); and bus and trolley (surface transit). Comparing Alternatives II and III with Alternative I regional rail use increases by 15.2 percent and 16.3 percent, respectively. This increase results from the higher levels of investment committed to transit in both alternatives. Patronage on the subway/elevated lines decreases by 1.1 percent in Alternative II relative to the No-Build Alternative, because there are no new rapid transit facilities proposed in Alternative II. Subway/elevated ridership increases sharply in Alternative III because of the proposed PATCO and Northeast Philadelphia extensions. The decrease of more than nine percent in ridership on bus and trolley lines in Alternative III indicates commuters' preference for the new rail lines proposed in this strategy. The 2015 transit boardings for all submodes will increase by about 2.5 percent from the 1987 levels.

2. Vehicle-miles and Passenger-miles of Travel and Service Level

Total daily vehicle-miles and passenger-miles of travel for the region are calculated by determining the best or optimal route (minimum time and cost) through the highway and public transit networks, and subsequently allocating trips to the respective systems. Vehicle-miles of travel include automobile, truck and taxi travel within the region, as well as highway travel with origins or destinations outside the region. Vehicle-miles of travel are expected to increase between 1987 and 2015 by almost 29 percent. Vehicle-miles of travel differ very little between the alternatives for the region as a whole (see Table 18). However, the higher investments involved in the two build alternatives make travel easier on the system by minimizing congestion, raising speeds, and lessening aggravation.

The volume-to-capacity (v/c) ratio in 1987 was 0.58. This compares to an estimated Alternative II v/c ratio of 0.75 in 2015, a significant increase over 1987 levels. This increase results from the added capacity being insufficient to offset the large increase in the number of vehicle trips over the time period. Alternative I can be expected to have an even higher v/c ratio, while Alternative III will have a lower ratio because several new highway facilities will be added. However, all of the 2015 alternatives will have higher v/c ratios than the 1987 ratio.

As shown in Table 18, the average daily speed, as well as the average daily peak-hour speed for the highway system, increases about four percent over the No-Build Alternative in Alternative II, and about eight percent in Alternative III. These increases reflect the higher efficiency provided by new highway facilities and the capacity added to the existing system in the build alternatives.

The increases in passenger-miles of transit travel amount to 4.1 percent in Alternative II and 7.3 percent in Alternative III relative to the No-Build Alternative (see Table 18), reflecting the improved transit services provided in the two build alternatives. Compared to 1987, transit passenger-miles in the No-Build Alternative of 2015 are expected to decrease. However, when more money is apportioned to transit, as in Alternatives II and III, passenger-miles of travel increase.

FIGURE XII

TRANSIT BOARDINGS BY SUBMODE

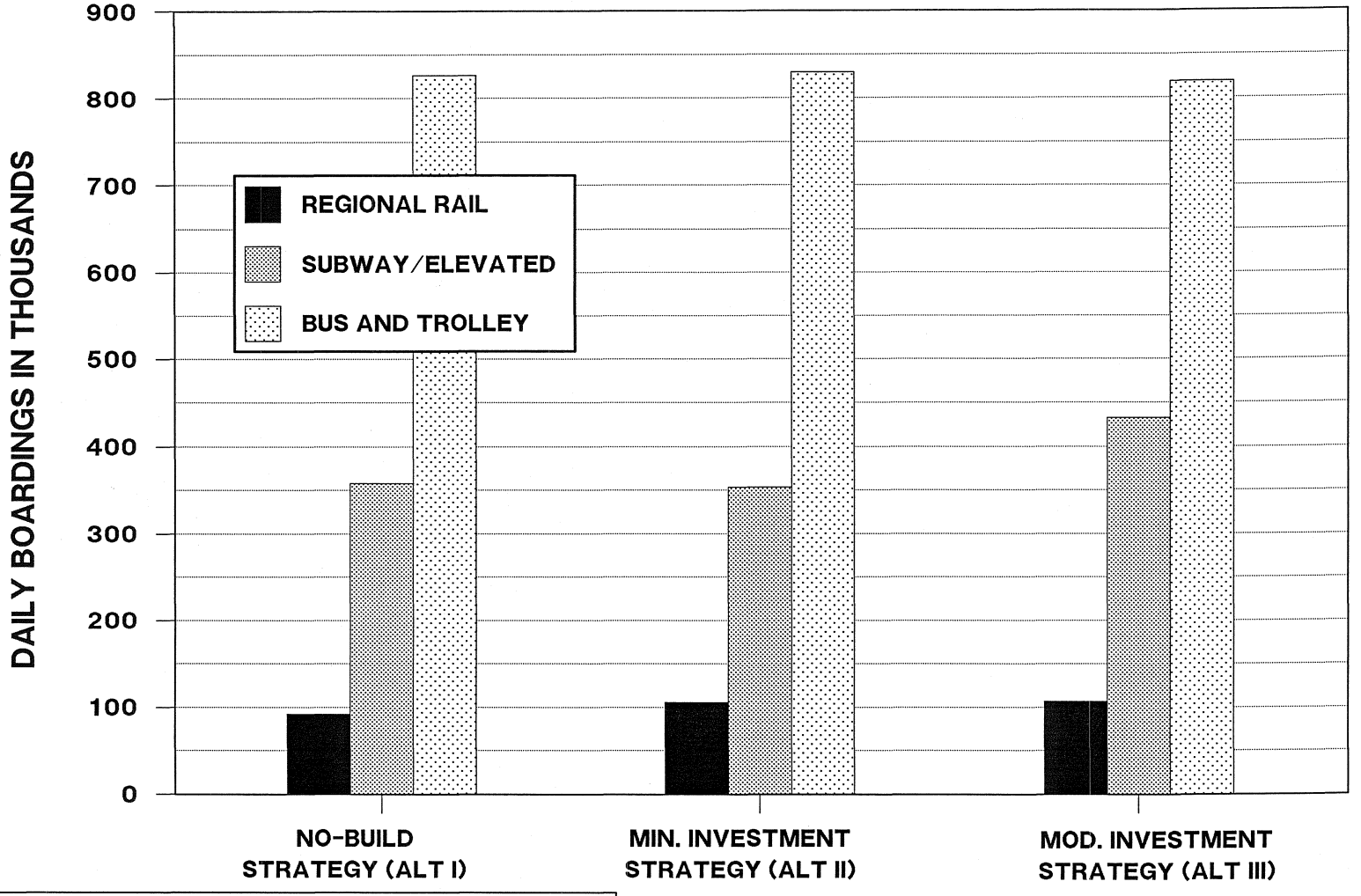

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Table 18

REGIONAL VEHICLE- AND PASSENGER-MILES OF TRAVEL AND TRAVEL SPEEDS

		2015 Alternative Investment Strategies				
Highways	1987	Alt. I	Alt. II	% Diff. from Alt. I	Alt. III	% Diff. from Alt. 1
Weekday Highway Vehicle-Miles of Travel (millions)	80.0	103.3	103.1	- 0.2	103.2	- 0.1
Volume to Capacity Ratio	0.58		0.75			
Average Daily Highway Speed (mph)	24.4	22.4	23.3	4.0	24.2	8.0
Average Daily Highway Peak Hour Speed (mph)	23.3	21.3	22.2	4.2	23.0	8.0
Transit						
Weekday Transit Passenger-Miles of Travel (thousands)	5,336	5,299	5,515	4.1	5,684	7.3
Average Daily Transit Speed (mph)	18.0	18.0	18.8	4.4	19.3	7.2

The average daily speed of the transit network in 2015 is 18.0 miles per hour for the No-Build Alternative, identical to that observed in 1987. The average speed increases by 0.8 mph in Alternative II and 1.3 mph in Alternative III. Again, these increases reflect the greater expenditure for transit in Alternatives II and III.

B. Highway Safety

Table 19 illustrates the changes in highway accidents and fatalities resulting from the different investment strategies, and then compares these results with actual 1986 figures. In the No-Build Alternative, both total accidents and fatalities increase by 12 percent from 1986 to 2015. For the build alternatives, accidents and fatalities increase by only about seven percent, even though vehicle-miles are expected to increase by 28 percent over the time period. The smaller proportional increase in accidents is attributed to several factors in addition to improved and expanded highway facilities. These factors include stiffer penalties for poor and drunk driving, stricter safety inspections, and improvements in vehicle performance.

Alternatives II and III show significant improvements over the No-Build Alternative with respect to safety. Both alternatives show approximately the same results for both accidents (98,000) and fatalities (about 740) when compared with figures of 102,000 accidents and 777 fatalities in the No-Build Alternative. The build alternatives reduce accidents by about four percent and fatalities by five percent. These differences are attributed to the quality of highway service, the magnitude of travel (vehicle-miles of travel), and the proportion of travel on improved or new facilities.

C. Air Quality

One of the region's major long-term concerns centers on the effect that transportation has on air quality. It is estimated that almost 90 percent of the carbon monoxide (CO) and 40 percent of ozone (O_3) in the air is caused by motor vehicle exhaust.[61] Automobile exhaust contains non-methane hydrocarbons (NMHC) and oxides of nitrogen (NO_x), which react in the presence of sunlight and other chemicals to produce ozone.

Pollutants from motor vehicles are expected to decrease significantly from 1977 levels, largely because of increasingly strict fuel efficiency guidelines applied to motor vehicle manufacturers, and continuation of state inspection and maintenance programs (see Table 19). For instance, CO declines by almost 60 percent, NMHC by 70 percent and NO_x by 23 percent when comparing the No-Build Alternative of 2015 with 1977 levels. However, air pollution is expected to continue to be a problem in the Delaware Valley region because of the large increase in vehicular traffic. It should also be noted that although this analysis deals only with surface transportation's role in air pollution, other

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[61] Delaware Valley Regional Planning Commission, Evaluation of Year 2000 Alternative Transportation Plans and Development of the Recommended Plan, 1980.

Table 19

REGIONAL HIGHWAY ACCIDENTS, VEHICLE EMISSIONS, AND FUEL CONSUMPTION LEVELS

			2015 Alternative Investment Strategies			
	Base Year			% Diff. from		% Diff. from
Highway Accidents (annual)	1986	Alt. I	Alt. II	Alt. I	Alt. III	Alt. I
Total Accidents	91,000	102,000	98,000	- 3.9	98,000	- 3.9
Fatalities	694	777	740	- 4.8	736	- 5.3
Emissions (thousands of kilograms per day)	1977					
CO	4,096	1,729	1,709	- 1.2	1,669	- 3.5
NMHC	400	117	113	- 3.4	109	- 6.8
NO_X	267	207	194	- 6.3	193	- 6.8
Fuel Consumption (thousands of gallons per day)	1977					
Motor Vehicle Fuel Consumption	5,208	4,868	4,850	- 0.4	4,849	- 0.4

sources of emissions, such as industrial plants and aircraft operations, play a role in the overall reduction of atmospheric pollutants.

The amounts by which the various 2015 alternatives reduce atmospheric pollutants differ very little. Alternatives II and III reduce CO by 1.2 and 3.5 percent and NMHC by 6.3 and 6.8 percent respectively, compared with Alternative I. Similarly, NO_x is reduced by 6.3 and 6.8 percent in the two alternatives.

D. Energy Consumption

Table 19 compares estimates of daily fuel consumption by motor vehicles for each of the 2015 investment alternatives with 1977 levels. These estimates assume that the efficiency of motor vehicles will greatly increase and that no significant changes will occur in the ways persons travel (i.e., the automobile will continue to be the primary mode of travel). As the table shows, daily fuel consumption in the region remains relatively stable over the three alternatives, although there is a slight decrease, 0.4 percent, from Alternative I to Alternatives II and III. Although vehicle-miles traveled remain consistent in all three alternatives, the efficiency of the highway network is improved in the two build alternatives, and this accounts for the decrease.

Fuel consumption is expected to decline by approximately 6.5 percent between 1977 and 2015, which is particularly impressive when considered in conjunction with the 79 percent increase in vehicle-miles traveled from 1977 to 2015. This result can be attributed primarily to a predicted doubling of automotive fuel efficiency.

E. Travel Cost

Most of the cost of owning, operating, and maintaining vehicles on the highway network is borne by private individuals, whereas public transportation capital, operating, and maintenance costs are largely financed by the public. Therefore, it is useful to estimate the actual user costs for both modes in order to provide a more meaningful comparison of travel costs. Highway user cost is composed of operating costs and ownership costs. Operating costs consist of repairs and maintenance, fuel, oil, tires, parking, tolls, and applicable taxes. Ownership costs include depreciation, insurance, registration and sales tax, and finance charges.[62] For the average automobile the total user cost is estimated to be 28 cents per vehicle-mile. However, taxes and tolls (about three cents) should be excluded because they are "transfer" costs included in the capital investment. Hence, a user cost of 25 cents per vehicle-mile will be used in this analysis. User costs for transit riders are equivalent to the fares paid. All costs are presented in 1987 dollars.

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[62] U.S. Department of Transportation, Federal Highway Administration, Office of Highway Planning, Highway Statistics Division, Cost of Owning and Operating Automobiles and Vans, 1984. pp. 3-6.

In order to find the annual user cost for highway travelers in the region, it is necessary to multiply the user cost per vehicle-mile (25 cents) by the average number of vehicle-miles traveled per weekday for the period between 1987 and 2015 (73.24 million miles), and then multiply this result by 340 to account for weekend travel. Using this calculation, an estimated $6.225 billion will be spent annually by users of the highway system, if Alternative II is implemented.

Using the Year 2000 relationships described previously, the annual user costs can be calculated for Alternatives I and III. The results of these calculations yield annual highway user costs that do not differ significantly between the alternatives. Relative to the No-Build Alternative, annual user costs decline by $111 million in Alternative II and by $117 million in Alternative III (see Table 20).

Transit user costs equal the fares paid on the system. These costs are the difference between operating and maintenance costs and the public subsidy provided to transit through 2015, as estimated in the previous chapter. Annual average user cost is obtained by dividing the total cost by the 26 years between 1989 and 2015. Thus, annual transit user costs amount to $346 million in Alternative I, $365 million in Alternative II, and $385 million in Alternative III. These figures represent increases of 5.5 and 11.3 percent in Alternatives II and III respectively over the No-Build Alternative (see Table 20).

The cost for highway users per person-mile is approximately the same in all three alternatives - slightly less than 18 cents per mile. These figures are obtained by dividing the annual user cost by the yearly total of person-miles for each alternative as shown below:

USER COST PER PERSON-MILE
(cents)

	2015 Investment Alternatives		
Mode	I	II	III
Highway	18.0	17.7	17.7
Transit	21.8	22.1	22.6

The user cost per passenger-mile for the regional transit system ranges from 21.8 cents to 22.6 cents in the three alternatives as shown above. These figures are found by dividing the annual transit cost by the annual passenger-miles of travel. The annual passenger-miles of travel is calculated by multiplying the daily passenger-miles of travel by 300 to convert average weekday travel into annual travel. The user costs increase slightly as more service is provided.

Since 94 percent of regional travel occurs by automobile, the total user cost for the entire regional transportation system, weighted by usage, is close to that for the highway system - 18.2 cents per person-mile - in the No-Build Alternative. This cost does not decrease significantly in Alternatives II and III with the addition of new facilities (see Table 20).

Table 20

REGIONAL HIGHWAY AND TRANSIT USER COSTS

2015 Alternative Investment Strategies

	Alt. I	Alt. II	Alt. III
Auto Users			
Annual Cost (millions of dollars)	6,336	6,225	6,219
Cost per Person-Mile (cents)*	18.0	17.7	17.7
Transit Users			
Annual Cost (millions of dollars)	346	365	385
Cost per Passenger-Mile (cents)	21.8	22.1	22.6
Total			
Annual User Cost (millions of dollars)	6,682	6,590	6,604
User Cost per Person-Mile (cents)*	18.2	17.9	17.9

*Does not include taxes and tolls.

In examining the user costs per person-mile shown in Table 20, it appears that highway users pay a lesser amount per mile than transit users. When taxes and tolls are added back in, the total highway user cost, about 20 cents per person-mile, nearly equals the transit user cost. When comparing user costs for the highway and transit systems, on an average per person-mile basis, there is little significant difference.

VII. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter summarizes existing and future transportation problems and issues in the Delaware Valley region and indicates the major findings, conclusions, and recommendations that should be considered in the development of long range transportation plans and programs. These recommendations, which should be implemented to provide an efficient and adequate transportation system, cover the following topics:

A. Highway system
B. Public transportation system
C. Freight transportation
D. Land use development
E. Transportation safety and security
F. Air quality and energy conservation
G. Future technology
H. Funding requirements
I. Federal role

A. The Highway System

1. Issues, Problems, and Conclusions

The central issue facing the region's highways is ensuring that sufficient capacity will remain available to meet the needs of commerce and general mobility. The experience of the eighties has been that the increase in demand for highways has far exceeded the increase in supply. As indicated in Chapter IV, this tendency is expected to continue through the Year 2015. While some new highways will be undoubtedly be planned and built in this period, emphasis will be placed on completing projects already started, and on relieving bottlenecks through road widening, bridge reconstructions new interchanges, traffic management techniques, and other improvements aimed at increasing the capacity of the existing system.

Important links now under construction or in the planning stage include: the Mid-County Expressway (I-476) in Montgomery and Delaware counties, which will improve access to Philadelphia International Airport and points south from the Pennsylvania Turnpike (I-76) and its Northeast Extension (PA 9); an interchange between I-95 and the Pennsylvania Turnpike (I-276) in Bucks County, which will provide a continuous routing for I-95 through New Jersey and solve the current problem of dumping through traffic on arterials or local roads north of Trenton; the Trenton Complex (I-195, I-295, and NJ 129) in Mercer County, which will complete an expressway loop around Trenton; and NJ 55 in Gloucester County, which will improve access to Vineland and Cape May.

The most severe and intractable congestion problems occur in rapidly developing suburban areas, such as US 202 from Wilmington to New Hope, US 30 in Chester and Delaware counties, US 1 near Princeton, and NJ 73 from Palmyra to Berlin. These areas

have seen farms and woodlands converted to residential tracts, shopping centers, and office parks in what at times can be only described as a frenzy of development.

In addition to providing new highway capacity, the system should be maintained at acceptable standards. Increased traffic levels, together with the heavier axle loads now permitted, have resulted in pavements and structures wearing at a faster rate than earlier. However, more is needed than simply expanding maintenance of the infrastructure. Streamlined procedures are needed to identify and prioritize needs, so that available resources can be used effectively. Reconstruction of older facilities, such as is now being done with the Schuylkill Expressway (I-76), will be needed as these facilities wear out.

With highway construction and maintenance firmly under the control of state departments of transportation, coordination of programs within a state has not generally been a problem. Problems of coordination can develop, however, when one jurisdiction ignores a portion of a through route already built by its neighbor. Independent toll authorities can also generate problems. Three separate authorities, the Delaware River Port Authority, the Burlington County Bridge Commission, and the Delaware River Joint Toll Bridge Commission, operate bridges across the Delaware River, and conflicts between such authorities and the Pennsylvania and New Jersey departments of transportation have often developed over placement, connections to adjacent highways, and tolls charged.

Clear and adequate signs are necessary if motorists are to operate their vehicles safely and find their way with a minimum of difficulty. Traffic regulations need to be communicated clearly to drivers, and even directional signs contain a safety element, since a confused or uncertain driver is more likely to have an accident.

2. Recommendations

The most important strategies for improving the highway system include:

a. Develop a Strategic Highway System of National Significance

The most significant highway issue facing the Delaware Valley region and emerging nation-wide is the challenge of developing a highway system that has the capacity and efficiency required to meet highway needs in spite of changing and very diverse travel patterns. Similar to the NARC Task Force recommendations for the establishment of three highway/transit systems for a joint federal/state/local partnership, DVRPC is proposing a Strategic Highway System of National Significance, which includes Interstate facilities, state highways, and bridges. A selection process similar to the Federal Aid Classification System could be used as a model in defining this strategic highway system. A state and regional perspective is needed to identify the locations and types of improvements to be considered as part of this proposed strategic highway system. Long stretches of major highways need to be analyzed as a single unit on the basis of future traffic flows. Federal funding for this system should be set at a level that recognizes the federal role in each of the following two elements:

- Maintain the existing Interstate facilities and state expressways and complete missing links. The expressway system of the Delaware Valley is still incomplete; some of the missing expressway links planned in the past are not finished. The gaps caused by these unconstructed freeway segments seriously impede traffic flows in urban and suburban areas. Filling in these missing expressway links to achieve a continuous ring/radial freeway system constitutes a critical component of a strategic highway system. Existing interstate facilities and state expressways must be improved and maintained because they provide the backbone of the highway system.

- Upgrade primary arterials. Many important corridors are not served by any expressway facility but rely entirely on arterial facilities. US 202 in Montgomery and Delaware counties, Roosevelt Boulevard through northeast Philadelphia, and US 322 in Gloucester County are prime examples. These arterials have the following characteristics which give them strategic importance in the region's highway system: (1) facility continuity over long distances; (2) heavy traffic volumes; (3) high recognition by the driving public as a major route to transport people and goods; and (4) connect major activity centers in the region. Because of their obvious importance, and in the absence of parallel expressway facilities, these arterials need to be upgraded to ensure their continued operation at acceptable levels of service, especially in the growing suburbs.

b. Improve Maintenance and Operation

With the shift in emphasis from building new highway links to upgrading the existing network comes the need to increase resources devoted to maintenance and operation. Highways wear out and increased traffic levels, combined with the higher axle loads permitted trucks, have accelerated the rate of deterioration in recent years. The program must account for routine maintenance, minor repairs, and traffic services. More effective maintenance procedures should be considered to provide better services, especially during the winter.

Two other strategies should also be considered in the development of highway programs:

c. Improve Signing

Permanent signs identify routes and provide motorists with directional and traffic control information. Other signs, such as those used to mark detours, are temporary in nature, but just as important to the orderly flow of traffic. Numbered routes must be marked, directions provided to important towns and destinations, and motorists must be informed of speed limits and other traffic restrictions. Key turns must be marked and reinforcement must be provided at regular intervals. Procedures need to be in place for the periodic review of signs. These include replacing damaged signs, removing old signs no longer relevant, and modifying existing signs to reflect changing conditions.

d. Improve Access by Non-Automotive Modes

In order to avoid total reliance on automobiles for access and circulation in growing areas, accommodation for pedestrians and bicycles should be built into the planning process. Provisions should be made for pedestrian walkways, sidewalks, bridges, and crosswalks that interconnect workplaces, stores, bus stops, and rail stations. Bicycle lockers or racks should be provided at rail stations, employment sites, shopping areas, and other trip generators, and bicycle routes should be designed which connect these areas with residential areas in order to minimize conflicts with motor vehicles and pedestrians. Innovative techniques, such as carpools, minibus feeders, and demand responsive vans, which reduce dependence on single occupant automobiles, should be deployed to increase travel speed and reduce highway congestion. Such low cost Transportation System Management (TSM) projects should be implemented throughout the region.

B. The Public Transportation System

1. Problems, Issues, and Opportunities

The Pennsylvania side of the Delaware Valley region enjoys an integrated comprehensive public transportation system, which generally provides a good level of service to the developed portions of the region. However, the aging infrastructure requires modernization and maintenance, in order to continue to deliver good service to the region. The elements requiring renewal include track and structures, signaling and train control, stations, and maintenance depots.

In addition, travel demand is changing and attention must be paid to restructuring service to better serve existing markets, as well as adding service to handle new or underserved markets. New service is particularly needed in growing areas, and to handle reverse commutation.

In New Jersey, a need exists to increase the effectiveness and market penetration of the transit system exists. The central Camden corridor is well served by Southern New Jersey's one rail transit line, but other areas could benefit from attractive service. The cost of the bus system could be reduced and ridership increased through a general rationalization of the system. Many potential trips require using more than one carrier, but lack of coordination with respect to service and fares constitutes a major barrier to developing such markets.

Modern fare collection equipment permits the design of fare structures that better relate fares to the cost of providing service and the value of service to the user. Time-of-day pricing can be used to encourage off-peak use, and more closely relating fares to distance could stimulate short trips, while earning more money from long ones. State-of-the-art fareboxes also keep passenger counts and can help transit properties track markets.

Coordination between routes, modes, and carriers is important, and this includes joint fares, connecting services, and common terminals. Basically, the entire system of public transportation from local feeders to intercity routes must work together in a manner that increases ridership and reduces costs.

2. Recommendations

a. Pennsylvania Portion

In order to improve the public transportation system, as discussed in Chapter V, the following major recommendations should be implemented:

- Improve the existing rail system. Establish a program to restore and maintain the rail system in good operating condition. This encompasses track, bridges, power distribution systems, signaling, and stations for the Regional Rail Division and rail transit lines. Major projects required for continued operation include rebuilding the Frankford Elevated and all bridges on the trunk line from the tunnel portal to Wayne Junction.

- Modernize depots, yards, and shops. Modernize depots, yards, and maintenance facilities. This saves money in the long run, because adequate efficient facilities reduce the cost of maintenance, raise employee morale, extend the useful life of vehicles, and improve schedule reliability.

Two other strategies should also be considered in long-range plans and programs:

- Expand the rail system. Extend rail transit to Northeast Philadelphia. Various options should be examined and those judged feasible should be built. Also, build feasible light rail lines to serve growing or underserved corridors in the urbanized portions of the region. This is necessary if new employment areas are not to rely completely on the automobile for access. Extend regional rail service to outlying areas, provided the market warrants service. Diesel locomotives that can be used with push-pull equipment to extend service beyond the electrified territory should be evaluated.

- Extend bus service. Expand bus service on routes not served by rail. Particularly important are feeder routes that connect growing residential and commercial areas with rail stations and established transit terminals, and circumferential routes that can attract intrasuburban passengers.

b. New Jersey Portion

In New Jersey, the most important recommendation is:

- Evaluate the bus system. Restructure bus routes to improve the effectiveness and efficiency of transit service in Southern New Jersey. The number of route

variations should be reduced and service consolidated in routes that can support a reasonable level of service.

Two other recommendations should also be considered in the development of long-range plans and programs:

- Extend PATCO to Burlington and Gloucester counties. Where feasible, build PATCO extensions to serve growing areas in Burlington and Gloucester counties. The original PATCO line to Lindenwold has been very successful, and with the Camden Transportation Center and the Atlantic City Rail Line opening in 1989, it is time to extend rail transit service to additional corridors. An integrated network with good interconnections greatly expands the number of origin-destination pairs served.

- Provide rail service to northern New Jersey. Examine the feasibility of direct rail service to northern New Jersey, either via the Delair Bridge and Frankford Junction, or via the Bordentown Branch and Trenton. Cars for the Atlantic City service will be moved routinely to Kearny for maintenance, and this provides an opportunity to link the two ends of the state.

The following important recommendations should be considered in the region as a whole:

c. Region

- Evaluate the fare structure. Streamline fare collection procedures and develop fare structures that reflect both the cost of providing service and its value to the user. Modern fare boxes now permit flexible structures that adjust fares by time-of-day and distance traveled, can handle stored-value or debit cards that eliminate exact change requirements and reduce boarding delays, recognize the validity of transfers, and collect ridership data. Joint fares on connecting carriers should be developed, at least to the extent that each accepts the others transfer for the base fare.

- Encourage Transportation Management Associations. Expand the use of Transportation Management Associations (TMA) to coordinate transportation resources in fast growing suburban areas. TMAs, which represent business, government, and other local interests, seek to develop and implement innovative transportation strategies based on available resources, and seek to expand the constituency for transportation improvements. TMAs are usually located in areas not easily served by traditional fixed route services, but which are amenable to a combination of carpool, vanpool, feeder and demand responsive services.

C. Freight Transportation

1. Issues and Opportunities

The region, in general, has adequate infrastructure to support the movement of goods, but problems exist concerning access to key areas and in the development of programs to improve the movement of goods. Geographically, the region is ideally located to play a major role in the distribution of goods to the mid-Atlantic states. However, to play a more important part in the national goods movement network the region needs to: improve highway connections to and from economically vital areas; remove bridge height restrictions for trucks and double-stacked trains; utilize new inter-modal technologies; provide better access to the ports; and reorganize the management of the ports. The freight transportation network can be divided into three areas: trucking, rail, and ports.

There are two major issues facing the region's trucking industry: the completion of major interstate connections to improve flow into, out of, and through the region; and that of accessing central city businesses. With the increasing volume and size of trucks, particularly in the older cities of Philadelphia, Trenton, Camden, and Chester, the narrow streets and restricted receiving hours of many companies make deliveries extremely difficult.

Deregulation and the changing mix of commodities carried by rail have greatly changed the way railroads conduct their business. As a result of consolidation after deregulation, only two national carriers now serve the Philadelphia metropolitan area, Conrail and CSX, and CSX's participation in Delaware Valley markets is minimal. To survive, the railroad industry has been forced to reduce costs and streamline operations, resulting in abandoned light-density and feeder lines, a practice which has left some shippers with no direct connections to the rail system. A growing number of short-line operators, sometimes affiliated with the impacted shippers, have emerged to take over operations on these small sections, but the operators are often undercapitalized and lack funds for needed improvements. States have also become concerned with the problem of light-density and abandoned lines and have established rail banking programs in response.

Delaware River ports have lost a substantial share of east coast shipping traffic mainly due to the lack of a unified decision making body overseeing port operations. The resulting inefficiency of port operations has often led shippers to divert to other ports where they receive more consistent and effective service. The lack of investment made in modernizing the facilities and equipment to handle shipments also causes shipper diversion. Also, publicity and advertising for the ports has often been neglected or has been negative. Access to the ports is another major problem which affects both truckers and rail carriers. The Delaware River Port Authority estimates that about $700 million will be needed to improve port facilities in the region.

2. Recommendations

a. Trucking

In order to improve trucking, the following strategies should be implemented:

- Complete missing links in the highway system. Several of these links are important to efficient truck movement, such as an interchange between the Pennsylvania Turnpike (I-276) and I-95, and the Mid-County Expressway (I-476), which improves access from northwest of the region to south of the region.

- Define a regional trucking network. This network should be mapped and needed improvements identified; this will facilitate access to major activity centers by heavy trucks, including those with oversize permits.

Two other strategies should also be considered:

- Improve truck circulation on local streets. Expand receiving hours and use traffic engineering techniques to alleviate the problems derived from inner city deliveries. These actions would assist in the movement of morning traffic particularly.

b. Rail

Efforts to assist the region's rail industry should include the following:

- Modernize terminal facilities and increase bridge clearances. Innovations such as intermodal, trailer and container on flat car, and double stacking should be strongly promoted to alleviate the dependence of rail on low-value bulk goods. These new transportation technologies would make the rail industry in the region more efficient. In order to enter the national double stack network, bridge clearances in the Philadelphia region need to be heightened. Also, there is a need for investment in large intermodal facilities providing links between the ports, rail lines, and highways.

- Expand state programs assisting shortline operators. This would help undercapitalized operators maintain service on light-density lines. The program should also preserve rights-of-way of abandoned lines, when a potential for future transportation or other public use exists.

c. Ports

In order to help the ports, the following recommendations should be implemented:

- Continue the process of bringing port control under one central decision making authority. This authority would have the power to make decisions concerning all facets of port operations.

- Invest money in new equipment and facilities to more effectively compete with nearby ports which have developed extensive container operations.

Also consider the following programs for implementation:

- Publicize the new programs and projects underway as well as efforts realized to draw shipping traffic back to the region.

- Post additional signs, correct current signs, and identify specific truck routes to ensure that trucks bound for the ports interfere with other traffic as little possible.

D. Land Use Development

1. Trends, Issues, and Needs

Development over the past several decades has greatly changed the shape and form of land use across the region, often resulting in sprawling and undirected suburban growth. This is a matter of increasing concern, as widespread agreement exists that some of these areas do not adequately provide the amenities desired by their residents, including a transportation system with capacity sufficient to accommodate their needs. The concern among planners and public officials centers on the fact that, unless development is constrained or channeled, no affordable level of transportation investment will provide sufficient capacity.

Zoning is sometimes uncoordinated between adjacent municipalities and contrary to regional and county land use plans, which guide the design and implementation of transportation improvements. Usually this uncoordinated development results in intensive strip development such as shopping centers, industrial parks, and large residential developments near major highways.

As population densities, traffic flows, and environmental impacts increase, spillover effects from one municipality to the next are inevitable throughout the region. However, neither the option of arbitrary control, which is inconsiderate of effects on neighbors or the region, nor that of state or regional regulation, pose attractive alternatives.

A need exists to maintain current countywide master plans and management policies imposed at the state level. Fragmentation of responsibility among levels and units of municipal government, multiple jurisdictions and authorities, and an inability to develop countywide planning for land use all conspire to thwart attempts to coordinate transportation planning and land development. A municipality which seeks to channel growth may simply see development shifted to an adjoining jurisdiction with a less restrictive attitude. The municipality then still receives adverse impacts, without a compensating increase in revenue. However, in New Jersey, the Transplan legislation, which includes the Highway Access Management Act and two pending bills, does promote regional planning and strengthens the planning authority of counties.

In order to control development patterns caused by a rapid expansion of the economy, in 1986 New Jersey created a State Planning Commission in 1986 with a mandate to draft a statewide development and redevelopment plan. The proposed plan is intended to affect the pattern of growth throughout the state and to make the most efficient use of existing and planned public services. The state is using a cross-acceptance process and a growth management approach, which uses infrastructure support rather than zoning, to steer new development. The plan is sensitive to local planning policies and calls for coordination between various levels of government in the allocation of new facilities, such as roads, sewers, water lines, schools, and recreational facilities.

2. Recommendations

The following major strategies for coordinating land use and transportation should be considered in the development of long range plans:

a. Develop a Regionwide Policy for Growth Management

A growth management policy should delineate areas and corridors in which growth will be supported. Elements should include revitalization of older urban and suburban areas throughout the region, improvement of existing infrastructure facilities, and preservation of agricultural and open land. Growth should be supported in the areas which can be most easily served through extensions of the existing infrastructure.

b. Coordinate Land Use Plans with Transportation Plans

This is needed at all levels of planning in order to reduce traffic congestion and urban sprawl. Traffic volumes generated by land use activities should not exceed the highway capacity of the plan; localities should develop long-range transportation plans that support such land use plans. Activity centers generally require accessibility and visibility, thus, they require coordination with the transportation system. Public transportation should be encouraged to support higher density areas. The implementation of developments which support the use of non-automobile modes, such as walking and cycling, should also be encouraged.

c. Encourage Counties to Maintain Master Plans

Development should be monitored and controlled at the county level through a master plan which shows generalized land use, roads, utilities, public facilities, and other significant developments. This plan should be updated regularly and should conform with the regional growth management plan, so that growth will occur in areas where it can best be managed.

One more strategy should be considered by planners and public officials:

d. Coordinate Zoning Policies between Adjacent Municipalities

Counties should make an effort to ensure compatible land uses on opposite sides of municipal boundaries. This not only promotes orderly development, but also helps avoid the shortcomings of jurisdictional fragmentation with its unexpected consequences.

E. Safety and Security

1. Issues and Problems

Historically, highway safety programs have focussed on the driver, improving his or her driving skills, and on instilling attitudes conducive to safe driving. However, within the last two decades, more attention has been paid to improving highways and vehicles. Programs aimed at promoting safe driving generally rely on educational tools to improve driving techniques and skills, backed by licensing procedures, and enforcement of traffic regulations. With a growing awareness that a significant percentage of accidents are caused by drivers under the influence of alcohol or drugs, penalties have been stiffened in most states for impaired driving to include jail sentences and long-term license suspensions.

New highways offer longer sight distances, shallower grades, wider lanes, more gradual curves, and fewer traffic conflicts than older highways. They generally enjoy lower accident rates in spite of more traffic moving at higher speeds. New roads by themselves reduce accidents simply by diverting traffic from older, more dangerous roads. Since older roads are not generally abandoned, they too require attention in order to mitigate their more dangerous aspects.

Engineering improvements to vehicles can be classified two ways: those which aim to keep vehicles out of accidents, or those which protect the occupants if one occurs. The first category includes improved steering, braking, and suspension systems that help drivers maintain control of their vehicles under a wide range of operating conditions. The passenger protection category includes seat belts, air bags, padded dashes, collapsible steering wheels, and safety glass, all of which attempt to keep drivers and passengers in their seats, and prevent them from colliding with hard or sharp surfaces.

Not only must vehicles be designed with safety in mind, they must also be properly maintained. To this end, many states, including New Jersey and Pennsylvania, require annual inspection of motor vehicles. While not a panacea for eliminating accidents caused by vehicle failure, periodic inspections do tend to remove worn-out vehicles from the roads. An ancillary problem relates to the operation of unsafe trucks. Economic pressures on the trucking industry brought by deregulation have induced owners and operators to skip maintenance or delay repairs. When combined with increased gross weights, both legal and illegal, this becomes a major contributor to accidents on regional Interstates and expressways.

Accident concerns for buses are much the same as for other vehicles operating on public roads. Trains, however, operate on a private right-of-way and rely on signaling systems installed by the owner in order to obtain a clear track and maintain proper separation. Reliable signaling and communications are essential for operation at high speeds or with short headways.

In order to preserve or enlarge the market for public transportation, operators must have effective programs to ensure the personal security of passengers, who must feel safe while using the system. Though the incidence of serious crime is fairly low, minor annoyances and assaults on the senses are not, and a perception of risk pervades parts of the system, especially during evening and night hours.

All buses and trolleys are equipped with radios which can relay information or summon help. Although PATCO uses closed-circuit television to monitor unattended stations, SEPTA generally does not. The presence of uniformed transit police in critical areas during late evening hours could serve to dampen crime and other incidents, and would reassure passengers using the system.

2. Recommendations

Measures to improve safety need to address the three principal components of highway transportation: the driver, the highway, and the vehicle. Each contributes to accidents and is amenable to improvement. The most important programs are listed below.

a. Improve Driver Skills and Attitudes

Education and enforcement programs can be designed to effectively raise driving standards for several classes of drivers, including new drivers, older drivers, drivers of commercial vehicles, and those with a history of moving violations.

- Improve and expand high school driver education courses. This effectively reaches new drivers, since most individuals start driving while in high school, and can help instill good driving habits.

- Periodically test older drivers. Sensory perception and response times tend to deteriorate with age. While many drivers voluntarily restrict their driving in response to these changes, the public does need assurance that all drivers have the requisite skills.

- Remove or reeducate repeat offenders. Motorists with a pattern of frequent traffic violations pose a hazard for other drivers. A program that identifies problem drivers and takes appropriate corrective action, such as license suspension and rehabilitation, would be useful.

- Remove unsafe commercial drivers. More careful licensing procedures, combined with procedures to detect drug and alcohol abuse, could help assure the public that those driving heavy vehicles are qualified to do so.

b. Remove Hazards from Older Highways

Since new highways are designed to higher safety standards, improvements can only be obtained by addressing deficiencies in older highways. A successful program should include both upgrading existing facilities and maintenance.

- Correct observed deficiencies. These include narrow or otherwise inadequate bridges, blind intersections, sharp curves, poor drainage, or anything else which interferes with the safe flow of traffic or which constitutes an identifiable hazard.

- Inspect and maintain older facilities. Existing pavements and structures of many highway facilities are in poor condition or in danger of deterioration. These should be restored to good condition and maintained at that level.

c. Ensure Roadworthiness of Vehicles

Vehicles constitute the third component of a comprehensive highway safety program. Even though most vehicles are built to adequate standards, their owners must provide regular maintenance and timely repairs to keep vehicles in good condition, and steps should be taken to ensure that truckers, who are under economic pressure to lower costs, do not shortchange safety. Spot roadside checks are also needed to monitor out-of-state traffic. Unsafe charter buses may put large numbers of people at risk.

d. Improve Public Transportation Safety and Security

Since the accident risks for buses have been addressed in the highway section, the following recommendations deal with rail transportation and passenger security in general:

- Upgrade signaling and communication systems for rail lines. Modern train control systems can provide flexibility to deal with changing conditions and emergencies, as well as to increase capacity and shorten headways. Though modern control systems do reduce accidents by narrowing the opportunity for human error, they do not eliminate the need to remain alert.

- Reduce human error. Training procedures should be reviewed to ensure that they reflect current conditions and cover all aspects of the job. Not only is it important to train new employees, sessions should be developed for long-term employees to introduce new or revised material and revive old skills. Transit agencies need to provide more consistent supervision of bus drivers and train crews to ensure that vehicles are operated in accordance with accepted procedures, and subject those found in violation of rules to retraining or discipline. Equitable and effective procedures to eliminate drug abuse among employees are also needed.

- o Improve passenger security in stations and onboard vehicles. More attention needs to be paid to improving passenger security at rail and transit stations. Closed-circuit television should be used to monitor unattended stations. Local communities could contribute to maintenance and station improvements to help stretch limited funds. More effective procedures need to be developed to remove disruptive passengers from the system.

F. Air Quality and Energy Conservation

1. Issues and Problems

a. Air Quality

Air quality in the Delaware Valley region has been a matter of growing concern. Over the past two decades the seriousness of air pollution has been reflected in a series of legislative and administrative actions designed to give public agencies tools to achieve satisfactory standards of air quality.

Since 1970, when the U.S. Congress passed the Clean Air Act, emissions of hydrocarbons and carbon monoxide from automobiles have been lowered significantly. However, this progress is being offset by the sheer numbers of cars, trucks, and buses added to the region's roads each year.

During the summer of 1988 street-level ozone (a measure of the magnitude of smog) increased significantly in the Delaware Valley region. Part of the increase is believed to result from the summer's unusual heat and dryness. During hot summer weather, increased volatility causes gasoline vapor to escape from storage tanks and vehicle fuel systems, adding hydrocarbons to the atmosphere and contributing to smog. However, environmental experts agree that the region's growing fleet of vehicles also makes the smog problem worse each year.

In the past few years, experts have come to believe that new anti-pollution strategies may be needed to keep hazardous exhaust emissions under control. Engineers are currently conducting research on small demonstration projects to: improve catalytic converters, prevent gasoline vapors from escaping into the air at pumps, make engines more efficient, and develop alternative fuels that are cleaner than gasoline and diesel fuel.

State, regional, and local governments, as well as public and private organizations, have explored and utilized a broad range of measures or strategies for improving air quality in the Delaware Valley region. Over the past several years, programs which have demonstrated potential for cost-effectively improving either localized (carbon monoxide) or regional (oxidant) air quality, have been coordinated by DVRPC. Because localized and regional measures have failed to close the gap between present emission levels and EPA ambient standards, strong pressure has been generated at both the federal and

state levels to force, by legislation or regulation, implementation of other measures which will reduce air pollution.

b. Energy Conservation

Transportation relies heavily on petroleum-based fuels, and in practice only electric railroads, rail transit, and trolleys are generally exempt from this dependence. Imports currently account for approximately one-third of U.S. oil consumption, which is less than the mid-70s total, but imports have shown signs of increasing recently. Since petroleum is a depletable resource, the price of oil is expected to rise in the future. Even though there are currently no energy problems in the region, the rate and magnitude of fuel consumption caused by increased automobile travel requires recommended measures or strategies to consider before Year 2015, given the uncertain fuel supply.

Improving the energy efficiency of transportation could confer numerous benefits, including:

- Lowered transportation costs, which in turn improve mobility and raise the quality of life;
- Lower inflation, since transportation is a major component of the cost of living and the cost of conducting business;
- Less dependence on imported oil, which lessens the economy's vulnerability to disruption from shortages and embargoes, and which has a positive impact on the balance of trade; and
- Improved air quality, since the volume of pollutants in exhaust emissions increases with greater fuel consumption.

Various strategies, or combinations thereof, could be used to reduce fuel consumption in the transportation sector. These include developing more fuel efficient automobiles and trucks, increasing vehicle occupancy, and shifting trips to transit. Alternative non-petroleum fuels have been developed for highway users, but while such fuels have received some acceptance in vehicle fleets and special applications, their general acceptance is hindered by cost, lack of widespread availability, or low specific energy content. Because of the direct correlation between energy conservation and air quality, recommendations made to improve one aspect usually improve the other.

2. Recommendations

Transportation-related measures or programs that improve air quality and reduce energy consumption in the Delaware Valley region mainly include short-range transit development and traffic flow improvement measures. Further efforts to improve regional air quality and reduce energy consumption through low cost, long-term transportation programs should include the following major programs:

a. Continue State Motor Vehicle Inspection Programs

The state mandatory inspection of vehicles' emission control equipment should continue, because it provides the most powerful means of reducing emissions, next to requiring lower emissions of new vehicles. The inspection and maintenance program not only permits large emission reductions, but also helps assure that emission reductions claimed for new vehicles are in fact achieved.

b. Improve Emission and Vapor Controls

Use emission and fuel economy standards to encourage the development of more efficient engines with effective emission controls. These controls should include catalytic converters and crankcase vapor recovery systems as components. Steps should be taken to prevent gasoline vapors from escaping into the air from vehicle tanks and gas stations. Oil companies should be encouraged to develop alternative fuels that are cleaner than gasoline and diesel fuel. Refiners should reduce the volatility of gasoline during the warmer months.

c. Increase Car and Van Occupancy

Many elements are necessary to develop a successful carpool and/or vanpool program. The program should include: (1) ongoing matching techniques, (2) a public relations program, and (3) incentives to ridesharing. Computerized matching techniques have proven to be useful to DVRPC and other companies at the regional level.

d. Improve the Flow of High Occupancy Vehicles

These measures cover a range of actions such as reserving lanes for the exclusive use of carpools and vanpools on some major radial highways and reserving lanes on some Philadelphia Center City streets for buses and emergency vehicles during weekday peak hours. Such measures should be subject to detailed planning studies.

e. Improve Taxi and Truck Circulation on Local Streets

Actions to improve the efficiency of taxi and truck movements generally relate to travel in congested areas, where efficiencies can be improved by reducing vehicle idling, cruising, or miles of travel per person trip. Efforts to promote more fuel efficient taxis in the Delaware Valley region could include encouraging taxis to pick up additional fares while servicing a passenger. Such a practice can be effective in reducing energy consumption and improving air quality in congested areas. Changing or adjusting the hours of goods delivery in dense urban areas, especially restricting such delivery to night time hours, could result in considerable fuel savings by reducing idling time and allowing more direct routes.

Four other strategies should be considered in the development of programs to reduce energy consumption and air pollution:

f. Increase Transit Patronage

Although public transit improvements have not had significant positive impacts on air quality by themselves, they are essential for reducing highway congestion and fuel consumption. These improvements include, but are not limited to: park-and-ride facilities, demand responsive systems, and bus priority traffic flow improvement programs. Service improvements on the urban transit system usually encourage greater ridership by making transit usage more attractive; these may include scheduling, routing, marketing, and safety improvements. Other means to enhance use of public transportation also exist, such as DVRPC's TransitChek employer subsidy program, which is supported by tax incentives. TransitChek is a regional transit discount instrument designed to facilitate employer support of employee transit fares. Employer fare discounts of up to $15 per month are allowable as tax free employee benefits.

g. Encourage Use of Pedestrian and Bicycle Modes

Walking and bicycling provide alternatives to the use of automobiles. Strategies that would encourage walking and the use of bicycles may include:

- Providing facilities for pedestrians and bicyclists.
- Enhancing the perception of these modes as desirable, healthful, and enjoyable activities.
- Marketing the cost savings involved in the use of bicycles and walking.

h. Impose Transportation Pricing Measures

Impose transportation pricing measures that can lead to a reduction of vehicle-miles traveled (VMT). These measures can apply to the journey, the cost of parking, or the cost of owning an automobile. Usually, pricing measures affect the direct out-of-pocket cost of travel. In general, automobile pricing measures represent a powerful means of changing travel behavior and thus, reducing fuel consumption, but implementation is difficult.

i. Reduce the Need to Travel

Actions that can reduce the need to travel in the region should be considered, such as development of a land use plan that provides for closer proximity of residences and workplaces, and encouraging substitution of telephone and communication services for face-to-face contact requiring auto travel. These are powerful strategies for improving air quality and reducing energy consumption.

G. Future Technology

1. Needs and Trends

Technological developments can help transportation agencies cope with future traffic demands, and help public transit operators provide innovative services that will attract and maintain riders. New highway management techniques are being developed to resolve current transportation problems, with an emphasis on improving traffic flow and providing driver assistance, in order to maximize the potential of existing highways. In public transportation, technological innovation can attract passengers, increase operational efficiency, and improve cash flow.

a. Highway System

One way of reducing congestion is to improve traffic data and control systems. Synchronized traffic signal controls can direct and expedite traffic through congested areas. Innovative motorist information systems can transmit data on traffic conditions through signs, computer networks, and ultimately through highway navigation and guidance systems that offer information to drivers through in-vehicle devices. In addition, driver augmentation systems, or automated highways, can assist drivers with collision avoidance, night vision, lane following, and even adaptive speed controls, which change cruise control settings according to the local environment, weather, and posted speeds. In addition to these innovations, electronic scanners and special identity plates (transducers) are being developed for use on vehicles in order to allow drivers to pay tolls without slowing down.

Electronic license plates may also serve to reduce traffic delays; they collect data from vehicles with coded destinations and reschedule traffic signal timing to match demand. Ramp metering can be used to limit the amount of traffic entering highways to that which can be accommodated, so that traffic flow is enhanced and kept moving. High Occupancy Vehicle (HOV) lanes on highways can also be used to increase highway capacity to move people, reduce the number of vehicles used during peak hours, and reduce pollution. Some people look to the communications industry to help relieve congestion through "telecommuting"; i.e., allowing the average employee to work at home and commute by telephone, though to date such shifts have been minimal.

To increase fuel efficiency, automobile manufacturers are beginning to down-size cars and use lighter materials, such as plastic and aluminum, in the construction of these vehicles. New safety systems, such as anti-skid brakes and airbags, are being applied to new cars. Heads-up dashboard display represents an immediate benefit from military research in ergonomics. This involves projecting a visual display of vehicle instrumentation onto the road in front of the driver. This allows drivers to keep their eyes on the road and avoid accidents. The Automatic Vehicle Control (AVC) systems now under development incorporate functions such as radar braking, automatic headway, variable speed control, and automatic steering control. Advanced navigational systems could link automobiles directly to a network of computerized sensors throughout a metropolitan area and guide the driver along the optimum route. Similar changes can be expected to

benefit the motor truck industry. Trucks are already being designed to be more aerodynamically efficient, which reduces fuel consumption. Replacing double tires with wide base single tires and using radial tires at higher pressure could increase pavement life, while continued development of air suspension systems could reduce road damage.

b. Public Transportation System

The use of modern technology in the areas of communications and signaling, electric traction, vehicle control and monitoring, and automatic fare collection can have a positive effect on the transit systems in this area as a whole. New innovations in communications technology will enable transit operators to evaluate, regulate, and control processes, and will also reduce the need for human intervention.

The use of lighter rail cars will reduce the amount of power required to operate rail systems. Regenerative braking, which transforms kinetic energy to electricity and feeds it back to the overhead wires, creates another source of energy for rail systems. Rail signaling and control devices which automatically cut power, reduce speeds, and apply brakes if trains fail to obey a signal are now being used along Amtrak's Northeast Corridor.

Automatic vehicle location functions displayed on computerized maps can allow central control systems to monitor and control service performance on bus routes, as well as to coordinate dispatching of vehicles in emergency situations. Coordinating traffic signals with transit routes and vehicle movements can significantly reduce bus travel times. Advances have been made in bus engine technology, especially in the area of maintenance. Electronically controlled engines require less maintenance than their mechanical counterparts. These electronic controls can prevent minor problems from becoming major catastrophes; by using electronic sensors, problems can be detected and corrected immediately.

Ticket vending machines are now available which dispense magnetic fare cards and transfers to passengers and also make change. These machines can provide paper and plastic-based tickets with magnetic encoding that can be used in turnstiles and bus pass readers. The vending machines can accept coins and dollar bills, but many also feature the capability to process credit cards. The cards can store value on the basis of the number of trips or money deposited, and then subtract values as trips are taken. Fares can now be set by distance, time-of-day, or quality of service without imposing undue complexity on the passenger.

Automated pass readers are being developed which function as a stand-alone units or as add-ons to the farebox, and which register fares based on where the bus currently is and where the passenger wants to go. They also collect revenue and ridership data, and print receipts. By using optically or magnetically encoded passes, the reader frees transit personnel from the need to visually inspect each pass and manually register its use by class of passenger.

2. Recommendations

The following recommendations should be considered in order to improve mobility:

a. Highway System

- Introduce ramp metering system. Ramp metering can increase the capacity of area highways, as well as reduce congestion and air pollution. Area planners should be encouraged to use these traffic control devices to improve traffic flow and effectiveness.

- Monitor systemwide traffic flow. A transportation communication system should be established which can monitor traffic on a area-wide basis and adjust signals and posted speeds to optimize flow. This system would also serve as a central control unit to transmit regional information on emergencies and route guidance. An organization called TRANSCOM has already been developed for the New York City metropolitan area to provide these functions.

Two other programs should be considered in long-range planning:

- Develop motorist information systems. These systems can advise motorists of changing road or traffic conditions, through roadside signs or onboard vehicle monitors, and would deliver variable messages in real time to motorists.

- Encourage manufacturers to apply new technology. Technology can be used to increase fuel efficiency through: downsizing cars; using lighter materials such as aluminum, plastic, glass; improving aerodynamics; improving engine performance; computer monitoring and control of engine functions; and new engines that use alcohol-based fuels more efficiently. Technology development should also be fostered in the use of Automatic Vehicle Control (AVC).

b. Public Transportation System

- Develop automatic fare collection equipment. User-friendly equipment should be incorporated into the system which can support flexible fare structures designed to increase revenue without decreasing ridership.

- Improve efficiency of electric propulsion systems. This along with regenerative braking should be used wherever feasible.

- Deploy advanced signaling and train control systems. This can reduce headways, permit higher speeds with safety, and reduce manpower requirements.

- Expand the use of vehicle monitoring systems. Use of these systems can improve dispatching and improve responses to service disruptions and emergencies.

Three other programs should also be considered.

- Encourage the use of automotive technology in bus operations. Electronic monitoring and trouble-shooting equipment can reduce hours of wasted mechanic's time and needless vehicle downtime.

- Automate user aids. Develop user aids that can provide riders with route, schedule, and fare information, and can respond in real time to changing conditions. Through the use of touch-tone phones, passengers can obtain information on schedules, fares, transit connections, or emergency information.

- Streamline toll collection procedures for bus fleets. Transducers installed on buses can allow them to pass through toll barriers without stopping or exchanging cash.

H. Funding Requirements

1. Needs, Issues, and Options

As stated in Chapter V, about $7.5 and $6.6 billion will be needed during the period 1989-2015 to improve the highway and public transportation systems, respectively for the Moderate Investment Strategy, Alternative III. Highway and transit operating and maintenance costs of Alternative III are estimated to be $4.2 and $19.2 billion during this same period. The transit operating cost includes a public operating subsidy of $9.7 billion, with the remainder coming from the farebox. However, the anticipated capital funding level for both highway and public transportation facilities does not provide for many projects planned in the Year 2000 Transportation Plan, or included in the 1989 Transportation Improvement Program. Analysis of the current public expenditure level indicates that the anticipated future funding level for transportation facilities ($17.5 billion) represents a shortfall of about 40 percent of the capital funding needed for Alternative III.

If the region is to continue its current economic vitality and prosperity, adequate funding for transportation projects should be provided to maintain the existing infrastructure and to improve mobility and reduce traffic congestion, especially in the growing suburbs. Since the public transit infrastructure in southeastern Pennsylvania is deteriorating and collapsing, a higher level of capital investment should be raised to ensure continued safe service to those dependent on transit for their daily trips. A balanced funding approach to the transportation system should give a higher priority to rebuilding the transit system, encouraging ridesharing and park and ride/express bus service, expanding parking at regional rail stations, and implementing management strategies which reduce highway travel demand. These measures are especially important with funding for new expressways in such short supply and transit ridership not anticipated to increase significantly in the future. Given currently anticipated funding levels, the existing transportation user charges, fees, and taxes should be increased significantly in order to build and operate the transportation system proposed in the Moderate Investment Strategy.

Many options exist for raising additional funds for the proposed transportation improvements and operations described in Chapter V. User charges, joint venture with the private sector, and charges to properties benefiting from these improvements represent possible financing options. However, user-based funding has been the primary, if not the exclusive, basis for federal, state, and local transportation improvement programs. Motor fuel taxes generally provide for highway operation and maintenance, but transit subsidies are appropriated mainly from the general fund.

Capital investment and operating subsidies should be based on stable and optimal funding sources which encourage private sector productivity and the development of new technology. Such sources should be reliable, in order to assure a long-term commitment to the increased investments needed for both the highway and public transportation systems.

2. Recommendations

A combination of funding sources should be used to provide adequate transportation service that enhances economic development and improves the quality of life in the Delaware Valley region. The following recommendations are proposed to meet the financial shortfall of the proposed investment strategies (Alternatives II and III):

a. Increase Federal Fuel Taxes

Federal fuel taxes should be increased from nine and 15 cents per gallon for gasoline and diesel, respectively, by three or six cents, depending on which alternative strategy is chosen (see Table 21). In order to maintain good transit systems in metropolitan areas, one-third of the proposed tax increase should be earmarked for public transportation. Federal taxes now amount to about $11 billion per year. The two proposed tax levels would increase revenues by $8 and $11 billion, respectively. Thus, the state apportionment of federal funding from the Trust Fund would increase accordingly and fulfill regional needs. The highway portion of the gasoline tax would increase from the current eight cents to 12 or 14 cents, while the transit portion would increase 300 or 400 percent, from one cent to three or four cents, respectively.

b. Increase State Fuel Taxes

State and local revenues used to match federal funds needed for transportation purposes should be increased from current levels. In 1987, the Delaware Valley Regional Planning Commission (DVRPC) and Southwestern Pennsylvania Regional Planning Commission (SPRPC) evaluated their highway needs and concluded that current and projected needs far exceed the available funds from existing federal and state programs. The elected officials of both commissions have mutually agreed to support, at a minimum, a four-cent increase in the Commonwealth's gasoline tax and a 10 percent increase in the vehicle registration fee.

Table 21

FUNDING OPTIONS FOR THE PROPOSED INVESTMENT STRATEGIES

Funding Option	Current Tax Level	Proposed Strategies Alt. II	Proposed Strategies Alt. III	Additional Revenues Generated Per Year ($Million) State Share Alt. II	State Share Alt. III	DVRPC Region Share Alt. II	DVRPC Region Share Alt. III
a. Increase federal fuel taxes	Gas: 9¢/gal.	15¢/gal.	18¢/gal.	PA $340	$470	$ 74	$103
	Diesel: 15¢/gal.	21¢/gal.	24¢/gal.	NJ $220	300	28	36
b. Increase state fuel taxes*	PA 17¢/gal.	20¢/gal.	23¢/gal.	PA $159	318	36	72
	NJ 12¢/gal.	15¢/gal.	18¢/gal.	NJ $129	258	15	30
c. Increase vehicle registration fees	PA&NJ $24/year	$27/year	$30/year	$ 38	75	9	18
					Total	$162	$259

d. Encourage private/ public partnership	Applicable in both PA and NJ.	Local development impact fees and private financing are important funding options.
e. Establish a transportation trust fund for Southeastern Pennsylvania	Applicable in PA only (bonds, sales tax, fuel tax, etc.).	This option is especially important to public SEPTA financing.
f. Establish highway toll districts	Applicable in both PA and NJ.	Tolls are proportional to use and may cover the costs of new expressway facilities.

* Average of gasoline and diesel fuel taxes.

DVRPC's staff supports this agreement and proposes an increase of three or six cents in the Pennsylvania fuel tax. Pennsylvania now has a tax of about 17 cents per gallon and ranks 20th among the 50 states. An increase of this magnitude is certainly warranted. Each additional cent in the fuel tax would increase state revenues by about $53 million per year. The share for the DVRPC region would total about $12 million (see Table 21).

In New Jersey the Kean administration attempted in 1986 to increase the gasoline tax by five cents per gallon for transportation improvements. After nearly two years of discussion and negotiation, the state legislature approved an increase of 2.5 cents, rather than the five cents originally proposed for new roads and transportation improvements. This increase brings the total state gasoline tax to 10.5 cents per gallon. New Jersey's tax is among the lowest in the country; for example, Connecticut has a tax of 20 cents, Maryland 18.5 cents, and Virginia 17.5 cents. DVRPC recommends an increase of three or six cents a gallon in the State of New Jersey. These additional revenues should be used to improve the highway and public transportation systems as deemed necessary by the New Jersey Department of Transportation. Each penny added to the motor fuel tax would raise about $43 million in revenues per year. Thus, the proposed alternative tax increases would generate approximately $129 or $258 million for the State's Transportation Trust Funds. The share for the DVRPC region would increase by the amounts shown in Table 21.

c. Increase Vehicle Registration Fees

Vehicle registration fees in Pennsylvania and New Jersey could be increased by about 12.5 and 25 percent for Alternatives II and III, respectively. Since New Jersey does not earmark motor vehicle registration fees for transportation purposes, a statutory change is needed. These fees are relatively low in both states. They are paid annually by the users of the highway system, and can be collected easily and efficiently by existing state agencies. As indicated in Table 21, the proposed increases in registration fees would generate about $9 and $18 million per year for the two respective alternatives.

The proposed increases in federal and state fuel taxes and vehicle registration fees will not completely eliminate the capital shortfalls. About $0.2 and $3.8 billion additional revenue would still be required (see tabulation below). Therefore, additional sources of revenue should be identified. The following funding options should be considered in order to meet the capital shortfall of the Moderate Investment Strategies:

Costs and Revenues (billions of dollars)	Alt. I	Alt. II	Alt. III
Total Public Capital and Operating Costs	$16.4	$21.9	$28.0
Anticipated Funding Level	17.5	17.5	17.5
Additional Revenue from the Proposed Increases in Fuel Taxes and Registration Fees	-	4.2	6.7
Surplus (Shortfall)	$1.1	($0.2)	($3.8)

d. Encourage Public/Private Partnership

As the federal subsidy for operating the public transportation system decreases, small business entrepreneurs should be encouraged to develop innovative, self-sustaining transportation services tailored to suburban and inner city persons not well served by the existing transit system. Transportation Management Associations (TMA) should be established in the growing suburbs to develop and implement low-cost strategies for reducing traffic congestion.

The current federal and state push for competitive contracting (privatization) in the transportation area should continue. Municipalities should be encouraged to establish transportation improvement districts to collect assessment fees on new development. Developers should share the cost of highway or transit facilities which serve their properties, and such a partnership should reduce the financial burden on governmental agencies at all levels.

e. Establish a Transportation Trust Fund for Southeastern Pennsylvania

The concept of issuing bonds or using dedicated taxes to finance capital transportation improvements for both highways and public transportation in the Pennsylvania portion of the DVRPC region, similar to the bonds which support the New Jersey Trust Fund, should be considered. This funding option is especially important for providing an adequate funding base for SEPTA to maintain and improve the public transportation system.

f. Establish Highway Toll Districts

Toll districts should be established in the Pennsylvania and New Jersey portions of the DVRPC region to collect tolls on some new or toll-free congested expressways; enabling legislation is required to establish these districts. Feasibility studies should first be conducted to define such districts, estimate costs and revenues, and to address the question of federal funding payback for existing expressways. Currently, several

successful bridge and turnpike authorities exist in the region, such as DRPA, the PA and NJ Turnpike Authorities, and the Atlantic City Expressway Authority.

g. Consider Other Funding Options

Creative funding options are now more critical than ever. The need for private and local funding sources is essential if the region is to achieve its full funding potential. Examples include a regional sales tax and a regional tax on employers and developers. Also, federally funded urban "block grants", or similar funding devices may give local officials greater flexibility in directing funds to minor highway or transit improvements.

I. Federal Role

1. Issues and Trends

Past federal highway programs were certainly instrumental in planning and constructing an extensive national highway system, including Interstate facilities, primary highways, and urban extensions. The continuity, quality and reach of the Interstate Highway System as it exists today was accomplished largely as a result of a comprehensive national program. This effort will have spanned almost half a century before its official completion in 1992. Under the federal lead, its direct and indirect participants have included public and private entities at all levels.

Federal transit programs have provided funding for planning, improving, and operating the transit system in the Delaware Valley region. Without such programs, the public transportation system would now be in much poorer condition. However, the federal government has cut transit assistance substantially during the 1980s. Federal capital funding for SEPTA has decreased about 60 percent in the past ten years. This trend seems likely to continue because of federal budget cuts and the huge deficit.

2. Recommendations

In order to promote regional growth, economic development, and public/private partnerships, and to meet the needs of motorists, truckers, and transit passengers in the Delaware Valley region, the federal role should be re-examined and new federal transportation programs should be developed for the next 30 years. The following are some recommendations concerning the federal role in funding, administration, planning, and coordinating regional transportation activities:

a. Place the Highway Trust Fund on a Permanent Basis

The federal government should establish the Highway Trust Fund on a permanent basis and redirect its priorities to meet changing travel demand. A dedicated portion of these funds should be allocated to reconstruct, rehabilitate, and improve the transit system, as was recommended previously. The federal government should continue to

provide funding for highway programs which improve traffic flow and reduce accidents and congestion. The revenues that accrue to the Highway Trust Fund should be spent as soon as possible on highway and public transportation projects, and not be held back to achieve a paper reduction of the federal deficit.

b. Increase Federal Transit Operating Assistance

In order to avoid frequent fare increases in the region, since fares already rank among the highest in the country and cause ridership decreases, the federal government should reverse the recent trend of reducing transit subsidies and increase its operating assistance to SEPTA, NJ TRANSIT, and PATCO. State and local governments by themselves cannot provide adequate funding to operate the transit system.

c. Strengthen the Regional Transportation Planning Process

The regional MPO "3C" planning process should be maintained and strengthened in order to continue coordination among local governments, chart future trends, monitor actual growth, and help target the resources and facilities necessary to meet the mobility needs of the region, not only for the 1990's, but into the next century. The MPO planning process should be adequately funded by the federal government in order to provide an effective and conscious effort to overcome the shortcomings of jurisdiction fragmentation in the region.

Two other federal programs should also be considered in the future.

d. Keep Federal Role in Planning and Funding of Major Capital Projects

The federal government should play a major role in the regional planning process, and in funding the Strategic Highway System of National Significance proposed earlier. Federal highway responsibility would be best placed on the Interstate and arterial facilities which link major centers such as Philadelphia, Atlantic City, Trenton, and Wilmington. The arterial road system must receive thorough attention, since it provides the key to accommodating existing and future travel demand, particularly in suburban growth areas. Reconstruction, Rehabilitation, Resurfacing, and Restoration (4R) programs should be given a high priority.

Federal responsibility for public transit should also continue into the future. Funds should be provided to support the existing system, enhance operations in urban cores, and to provide system extensions which would serve people and businesses in the region, especially in suburban growth areas. This also assures that public transportation will provide access to all population groups across the full economic and geographic spectrum of the region.

e. Increase Research and Development Programs

The federal government should allocate an increased percentage of the Highway Trust Fund to planning, research, and development in order to solve transportation

problems in the future. Innovative transfer programs in planning, engineering, new technology, operation, and administration should remain a federal responsibility. The federal government should also continue to be a facilitator in achieving common goals, in setting high standards for safety and quality of facilities and services, and in maintaining a balance among the states in the nation.

In summary, all the recommended strategies, measures, and programs mentioned in this chapter should be implemented in order to meet future mobility requirements and to enhance economic development. Such strategies could be modified, combined, or adjusted to produce a package of programs which would achieve a balanced transportation system that provides adequate service for highway and transit users throughout the Delaware Valley region and Southern New Jersey.