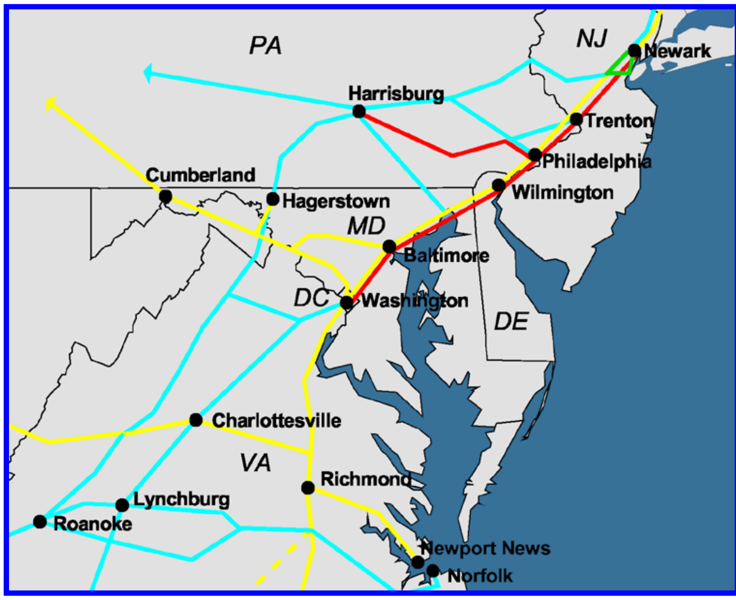

I-95 Corridor Coalition

Mid-Atlantic Rail Operations Phase II Study

Final Report

I-95 CORRIDOR COALITION

December 2009

Mid-Atlantic Rail Operations Phase II Study

Final Report

Prepared for:

I-95 Corridor Coalition

Sponsored by:

Delaware Department of Transportation,
New Jersey Department of Transportation,
Pennsylvania Department of Transportation,
Maryland Department of Transportation,
Virginia Department of Transportation

I-95 Corridor Coalition

Prepared by:

Cambridge Systematics, Inc.

December 2009

This report was produced by the I-95 Corridor Coalition. The I-95 Corridor Coalition is a partnership of state departments of transportation, regional and local transportation agencies, toll authorities, and related organizations, including law enforcement, port, transit and rail organizations, from Maine to Florida, with affiliate members in Canada. Additional information on the Coalition, including other project reports, can be found on the Coalition's web site at http://www.i95coalition.org.

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Executive Summary

The MAROps Phase II study examines the condition and performance of the regional rail system, updating the findings of the 2002 MAROps Phase I study. The studies are part of continuing initiative of the I-95 Corridor Coalition, five Mid-Atlantic states (Delaware, Maryland, New Jersey, Pennsylvania, and Virginia) and three railroads (Amtrak, CSX, and Norfolk Southern) to understand the impact of rail choke points on rail freight transportation and the economy of the region.

The study finds that the Mid-Atlantic region faces clear challenges to moving freight in the future. The population of the five-state area is projected to grow from 36 million in 2008 to nearly 45 million in 2035 and employment is expected to grow from 23 million jobs to 31 million jobs. With these changes will come a significant increase in demand for freight transportation to support businesses, households, and government services.

The national and regional economies are weathering a major recession today that has reduced demand across all freight transportation modes, but the eventual economic recovery will quickly return the freight system in the Mid-Atlantic (and the nation as a whole) to where it was in 2007 and early 2008—in the early stages of a capacity crisis. The current fiscal climate encourages state transportation agencies and the railroads to put off challenging questions and long-term investment in favor of addressing short-term needs. But without coordinated planning and additional investment, significant congestion can be expected in the future on both the rail and highway systems. This is especially true for the region's rail system.

Today, 88 percent of freight rail corridor miles in the MAROps region operate below capacity (at levels of service A, B, or C) and three percent operate above capacity (at level of service F). Without further improvements to the rail system, by 2035 only 43 percent of rail corridor miles in the MAROps region are projected to operate below capacity (at levels of service A, B or C), while 30 percent will operate above capacity (level of service F).

Implementing the full MAROps program, estimated to cost about $12 billion over the 30 year period (up from $6.2 billion in 2002 MAROps Phase I study, largely because of the increases in energy and material costs), would maintain the capacity of the system. The program would involve implementation of 217 projects, including 110 projects to add mainline capacity and 81 projects to provide doublestack clearance. There would also be projects to expand terminal capacity, remove or rebuild grade crossings, replace or rehabilitate outdated bridges and tunnels, and add new communication and technology to improve safety and the coordination of train movements.

Increasing the capacity of the network has the potential to increase the share of freight captured by rail. The rail share of freight transportation in the Mid-Atlantic region is between one and two percent lower than the national average. Conservative estimates of the potential to shift freight from truck to rail suggest that rail could capture the equivalent of 13 to 55 additional trains per day. This would remove a moderate amount of truck traffic from the region's highways, relieving some of the congestion pressure on the highways.

The additional traffic would—as intended—absorb some of the capacity provided by the MAROps improvements. With implementation of the full MAROps program and a "high" increase in rail mode share, 70 percent of the rail corridor miles in the region are projected to operate below capacity by 2035 and 6 percent would operate above capacity.

Implementing only the 150 priority MAROps improvements—the projects judged by railroad managers and state DOT officials to be critical path projects that would yield the highest near-term benefits—would reduce the cost of the program from $12 billion to $6 billion. The rail system would not have as much capacity to attract and absorb new traffic as it would with the full MAROps program, but it would still have sufficient capacity to capture a moderate amount of new freight traffic. Implementing the priority projects only and assuming a "low" increase in rail mode share, 57 percent of the rail system would operate below capacity and 19 percent would operate above capacity.

Implementing the full MAROps program would contribute $1.3 billion in business output and 9,800 jobs to the five-state region each year. Shippers would see a modest reduction in transportation costs (around 1 percent), railroads would carry additional freight, increasing their revenue, and freight operators would see overall net reductions in costs of $40 and $52 million per year in operating costs.

The benefit/cost ratio of implementing the full MAROps program and achieving a high increase in rail mode share is estimated at 1.86. The benefits include traveler benefits, shipper benefits, and societal economic benefits.

The benefit/cost ratio of implementing only the priority MAROps improvements and achieving a low increase in rail mode share is estimated at 2.9. The ratio is greater because implementing only the priority MAROps improvements would defer several of the highest-cost and most complex improvement projects. Both programs would generate economic growth in all five states and the three major metropolitan areas within the region.

The findings of the MAROps Phase II study reinforce the conclusions of the Phase I study, which found that cooperative action between the states and railroads is critical to improving the system. The MAROps rail network covers five states and serves three major metropolitan areas, each its own jurisdictional roles and responsibilities. However, the network is operated as a system. Improvements in one state alone, while beneficial, would simply shift choke points upstream or downstream and would not necessarily improve overall corridor capacity and travel times. A coordinated program of state- and railroad-funded improvements is needed across the network if rail capacity is to be increased and freight traffic shifted from truck to rail.

The MAROps Phase II study also confirms the need for a national support for major rail improvement projects. The MAROps projects range in complexity from relatively simple fixes to extremely complicated and costly projects such as the multi-billion-dollar Baltimore rail tunnel improvements. The states and railroads can address many of the smaller, less costly projects over time, but national action will be required to accomplish the major projects.

The major projects will benefit the region, but they also will improve rail freight and Amtrak passenger rail operations between the Mid-Atlantic and the Midwest, the Southeast, and the West Coast. The full set of MAROps improvements will encourage long-haul truck traffic to shift to improved rail intermodal service. This will reduce logistics costs for shippers and highway congestion across the country, not just within the MAROps region.

In summary, without concerted action to implement the MAROps improvements, the capacity of the rail system will lag behind population and economic growth. Rail freight will be shed to trucks, adding congestion to the region's already overloaded highway system. The cost of freight transportation in the region generally, and the cost of rail freight transportation specifically, will increase. This will drive up the cost of living and cost of doing business in the region, reducing the economic competitiveness of the region in national and global markets. The Mid-Atlantic is one of the nation's largest and most important population and economic regions. It must have balanced and cost-effective freight and passenger transportation system. For these reasons, its is recommended that the I-95 Corridor Coalition, its member states, and the railroads advance the MAROps program and look for opportunities to accelerate implementation of the projects.

1.0 Introduction

The objective of Mid-Atlantic Rail Operations (MAROps) Phase II study is to update the findings and recommendations of the 2002 MAROps Phase I study on the condition and performance of the rail network in the Mid-Atlantic region. The 2002 study was an initiative of the I-95 Corridor Coalition, five Mid-Atlantic states (Delaware, Maryland, New Jersey, Pennsylvania, and Virginia), and three railroads (Amtrak, CSX, and Norfolk Southern) to understand the impact of rail choke points on rail freight transportation and the economy of the region.

The MAROps Phase I study took a bottom up look at the regional rail system, identified critical rail choke points; defined the improvements needed from a system perspective; and developed a strategic, phased implementation program. The MAROps I study concluded that rail improvements were needed to keep pace with demand, and it recommended a 20-year, $6.2 billion program of 71 rail capacity and operational improvements.

The MAROps I study demonstrated that it was possible to investigate the regional rail network as a system and address systemwide issues across jurisdictional boundaries. The study made clear the need to manage system capacity, build system-oriented institutional relationships, and develop system-responsive funding strategies.

The MAROps Phase I study also demonstrated that states and railroads will invest to improve regional rail capacity. Sixteen individual rail projects have been built since the study was completed, and another seven are partly completed or funded for completion over the next five years.

The study and these investments represent a fundamental shift in the approach that state departments of transportation (DOTs) take to freight rail—one that is pro-active, forward looking, and focused on the economic and environmental benefits of expanding rail freight transportation as a key element in the larger portfolio of freight transportation services. MAROps is one of several studies (including federal efforts to provide data for multimodal freight planning, national research on freight, and other state and regional efforts) to draw attention to the important role that rail can play in an overall freight system and the potential benefits for the highway system and the general public from investing in rail.

Since the completion of MAROps Phase I study, the national and regional economies have weathered a major recession. Although the recession has reduced demand across all freight transportation modes, the eventual economic recovery will quickly return the freight system in the Mid-Atlantic (and the nation as a whole) to where it was in 2007 and early 2008—in the early stages of a capacity crisis. The current fiscal climate encourages state transportation agencies and railroads to put off challenging questions and long-term investment in favor of addressing short-term needs. However, without additional investments, significant congestion can be expected in the future on both the rail and highway systems.

The MAROps Phase II study builds upon the success of the Phase I effort to update and renew the commitment to improving the region's freight transportation system challenges. It is an opportunity to identify the longer-term needs, opportunities, and investment strategies that are vital for the economy to continue to grow.

2.0 Background

2.1 Mid-Atlantic Region

The MAROps study is part of an initiative by the I-95 Corridor Coalition to assess the freight transportation capacity of the Mid-Atlantic region, which for the purposes of this study includes New Jersey, Pennsylvania, Delaware, Maryland, and Virginia. The initiative addresses:

- Rail freight transportation through:
  - Mid-Atlantic Rail Operations Phase I Study (MAROps I), which identifies rail choke points across the region, recommends a systemwide improvement program, and estimates regional benefits; and
  - Mid-Atlantic Rail Operations Phase II Study (MAROps II), the subject of this report, which updates the 2002 MAROps I program based on projected economic growth and freight demand through 2035, and estimates public benefits for the region, the individual states, the metropolitan areas, and the major rail corridors.
- Highway freight transportation through:
  - Mid-Atlantic Truck Operations Study (MATOps), which identifies major highway bottlenecks for freight trucks, estimates the cost of delay to carriers and shippers, and recommends a program of highway improvements paralleling the rail improvements; and
- Marine freight transportation through:
  - Short Sea Shipping Study, which examines the feasibility of increasing freight transportation capacity along the "marine highway" paralleling I-95 by expanding intermodal barge services for containers and truck trailers.

Freight transportation capacity in the Northeast megaregion's Mid-Atlantic core is important because it provides businesses and residents access to regional, national, and global goods, which are critical to region's economic well being. The Northeast megaregion is among the most densely settled areas of the United States. Figure 2.1 shows the density of development and the interconnectedness of the megaregion by mapping the night-time light intensity of the region. With only small gaps, development blankets the region from Boston to Richmond. If the megaregion were a separate country, it would be the fourth largest economy in the world.

Figure 2.1 Northeast /Mid-Atlantic Megaregion

Source: Regional Plan Association, *America 2050: A Prospectus*, New York, NY, November 2007, page 8. http://www.rpa.org/pdf/Northeast_Report_sm.pdf

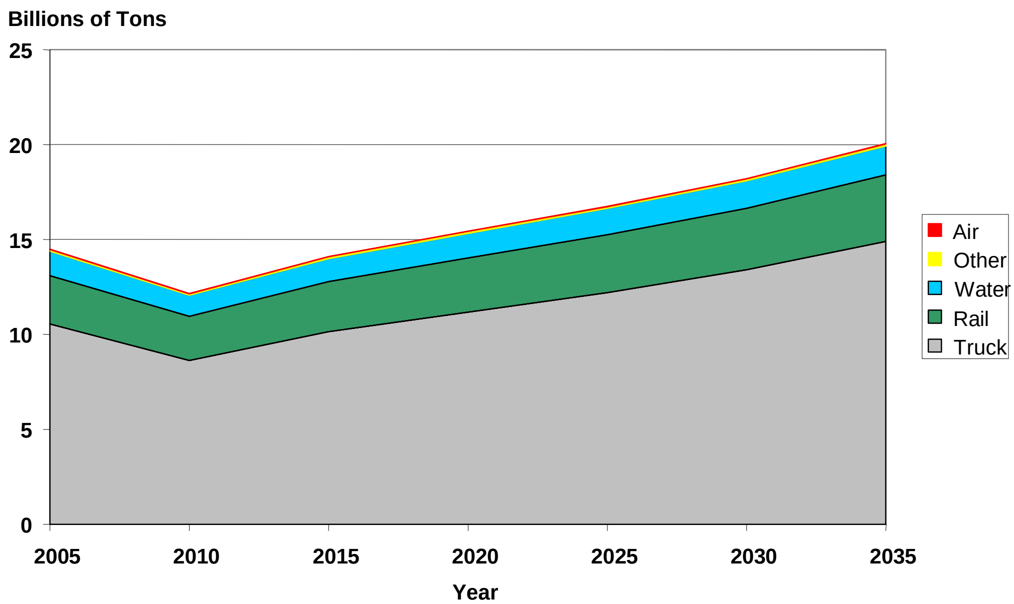
Over 23 million people live in the five-state Mid-Atlantic region, accounting for 12 percent of the U.S. population, but just 2 percent of its land area. The region has shifted from a 1950s-era goods-producing economy based on manufacturing and trade to a 2000s-era goods-consuming economy based on finance, services, health care, high-tech manufacturing, and related fields. Today, 2.3 billion tons of goods are shipped into, out of, and within the region, with the majority of freight terminating in the region.

In this economy, cost-effective freight transportation is critically important in keeping down the cost of doing business and the cost of living. Without cost-effective freight transportation, the increasingly high-tech and high-value goods and services produced in the region will be less competitive in national and global markets, and the economic development of the region will slow.

2.2 Freight Transportation Supply and Demand

With economic recovery, national freight demand is projected to grow, driven by population, economic activity, new logistics patterns, and trade. Figure 2.2 plots the projected national demand for freight transportation in tonnage at five-year intervals through 2035. The figure shows the sharp contraction of the economy in 2009 and 2010, and the anticipated growth in truck, rail, water, and air freight transportation demand as the economy recovers.

Figure 2.2 National Freight Transportation Demand, 2005 to 2035

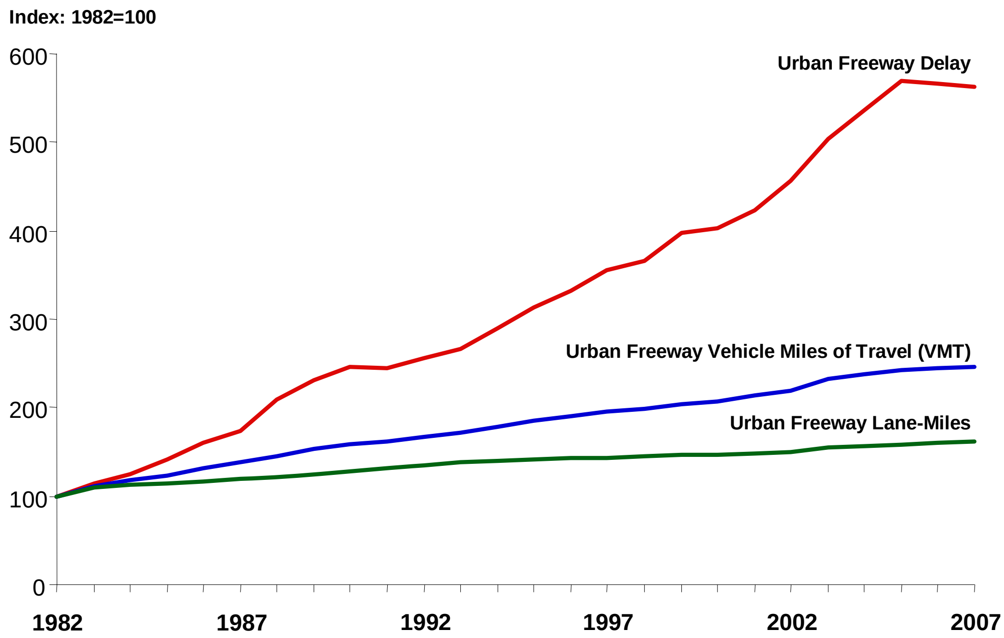


Source: IHS-Global Insight, Inc., based on 2007 TRANSEARCH data and 2009 economic projections.

The renewed demand for transportation will press the capacity of the nation's transportation systems, especially its critical highway and rail freight transportation infrastructure. On the highway system, lane-miles of urban freeway in the Mid-Atlantic region increased by 60 percent between 1982 and 2007, but vehicle-miles of travel on those roadways grew by 145 percent. As demand outpaced the supply, vehicle-hours of delay grew by 460 percent.

Figure 2.3 shows the widening gap between urban freeway lane-miles, vehicle-miles of travel, and hours-of-delay incurred by drivers.

Figure 2.3 Mid-Atlantic Region Highway System Capacity, 1982 to 2007



Sources: Federal Highway Administration, *Highway Statistics, 1982 to 2007*; and Texas Transportation Institute, *The 2009 Urban Mobility Report*.

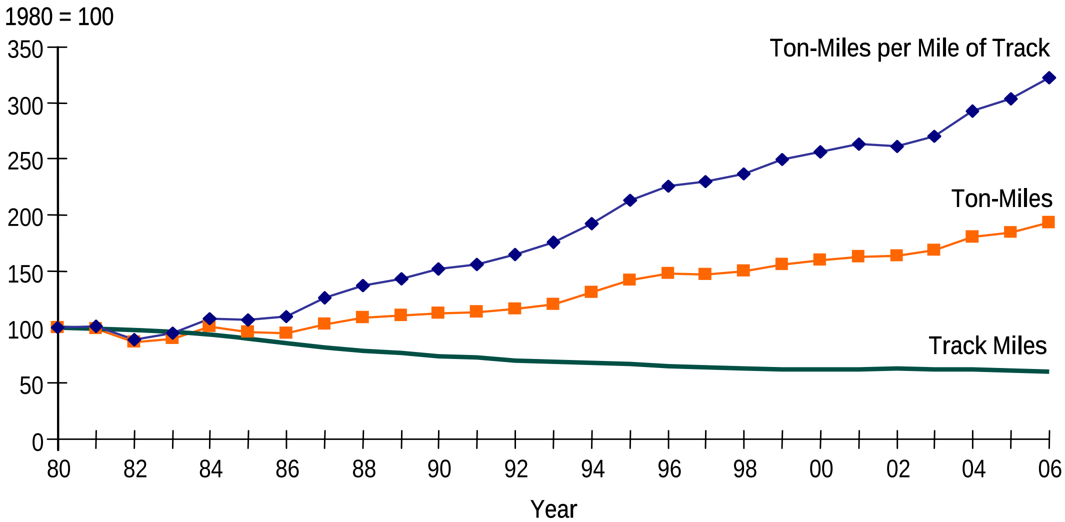
The result has been increased costs for highway users. The U.S. DOT estimates that the cost of congestion nationally across all modes of transportation could be as high as $200 billion per year if direct costs, productivity losses, costs ociated with cargo delays, and other economic impacts accruing to auto drivers, freight carriers, businesses, consumers, and the general public are included.[1]

As the cost of highway congestion has increased, public policy-makers at all levels of government have started looking to the railroads to carry more freight to relieve truck and highway congestion, and to help conserve energy, reduce engine emissions, and improve safety. Shippers, too, have started looking to railroads to carry more longer-distance shipments, especially as the costs of truck fuel and labor have increased.

[1] U.S. Department of Transportation, *National Strategy to Reduce Congestion on America's Transportation Network*, Washington, D.C., March 2007. See http://www.fightgridlocknow.gov/docs/conginitoverview070301.htm.

However, the growing demand for freight transportation is also pressing the capacity of the nation's rail freight system. Ton-miles of rail freight carried over the national rail system have doubled since 1980, and the density of train traffic—measured in ton-miles per mile of track—has tripled since 1980. (One ton of freight moved one mile counts as one ton-mile.) Figure 2.4 illustrates the widening gap between ton-miles of rail travel and track miles.[2]

Figure 2.4 Freight Ton-Miles and Track Miles, Class I Railroads, 1980 to 2006



Source: AAR and Annual Report Form R1.

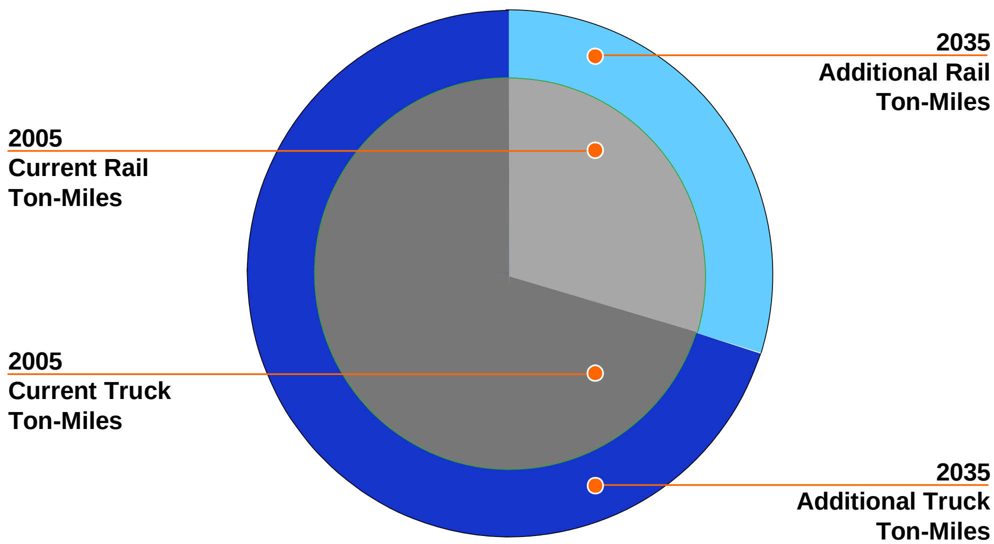
At issue is whether the rail freight system has the capacity to handle the growing volume of freight. As illustrated in Figure 2.5, trucks account for almost two-thirds of the ton-miles of freight transported in the Mid-Atlantic region today. Their share is represented by the dark gray center portion of the pie chart, with rail accounting for the balance shown in light gray.

With no change in mode share, by 2035, trucks and the highway system must find the capacity to absorb the additional ton-miles represented in dark blue, and rail must find the capacity to absorb the additional ton-miles represented in light blue. If rail capacity cannot keep pace with population and economic growth, then the railroads will shed freight to an already congested highway system. Conversely, if rail can keep pace with economic growth and increase its share, it could provide some relief to the highway system. However, with both freight transportation systems pressing capacity, the public and private sectors must invest carefully to ensure that they get the most cost-effective freight

[2] Association of American Railroads data and Annual Report Form R-1.

transportation service to meet the region's and the nation's economic, social, and environmental goals.

Figure 2.5 Freight Transportation Capacity Challenge

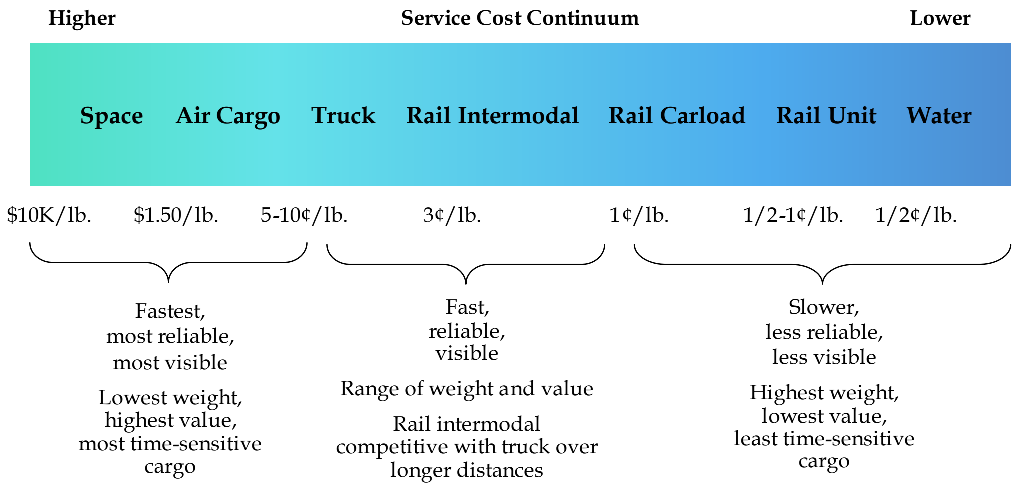


2.3 Role of Rail in Freight Transportation

Investment in rail capacity is important because rail is a critical component of the region's freight transportation system. Air, truck, rail, and water freight transportation make up a competitive and cooperative spectrum of freight transportation services, as shown in Figure 2.6. Each mode offers advantages and disadvantages in terms of cost, speed, reliability, visibility, security, and safety. Businesses try to use each mode to its greatest advantage when designing supply chain networks to ship and receive products.

At the high end of the spectrum is air cargo, which provides fast reliable service at a high price. At the low end of the spectrum is waterborne transportation, which offers slower service but at a lower price. In general, the value and weight of the goods determines the mode of transportation, with lower-weight, higher-value, and more time-sensitive shipments using the faster, more expensive transportation modes, and higher-weight, lower-value per pound, and less time-sensitive commodities using the slower, less costly transportation modes. Rail spans the middle of the freight transportation spectrum, providing cost-effective service for both moderate- and lower-value freight moving long distances.

Figure 2.6 Freight Transportation Service Spectrum



Source: IHS-Global Insight, Inc., TRANSEARCH database, and U.S. Department of Transportation Freight Analysis Framework data.

Rail services fall into three distinct categories:

- Bulk rail service. Bulk services are dedicated unit trains hauling a single bulk commodity such as coal moving from mines to power plants or grain moving from farms to ports. Commodity flows tend to be one-way, with cars (usually hopper cars) moving loaded from shipper to receiver and returning empty from the receiver to the shipper. The flows are typically "door-to-door," moving from shipper to receiver entirely by rail. Unit trains operate along well-defined, high-density corridors. Bulk commodities are highly sensitive to transportation cost because they are heavy and like coal relatively low in value per pound. Unit trains provide the efficiencies needed to move these commodities cost-effectively. Bulk services represent the lower-price end of rail service. Rail competes with water transport for this freight transportation business.
- General merchandise/carload rail service. General merchandise or mixed carload trains move a diverse set of commodities, including chemicals, food products, forest products, metals, auto parts, waste and scrap using boxcars, gondolas, tank cars, and other specialized rail equipment. Most carload traffic moves door-to-door, although smaller customers without direct rail access or those who need less-than-carload quantities can be served by combined carload-to-truck services, known as transload and transflow services.[3]

[3] "Transload" facilities handle the transfer of non-flowing materials (e.g., lumber, sheetrock, etc.) from carload to truck using conventional forklifts and cranes. "Transflow" facilities manage the transfer of liquid or "flowing" materials (e.g., oils, plastic pellets, bakery flour, etc.) from carload to truck using specialized pumping

Footnote continued

- Intermodal rail service. Intermodal services, as defined by the rail industry, are trains hauling international and domestic containers and trailers. Intermodal trains move trailers and containers packed with finished consumer goods, refrigerated foods, parts and tools for manufacturing, raw materials, post-consumer scrap—almost anything that can be packed into a container or truck trailer. Unlike unit train and general merchandise/carload traffic, intermodal traffic is typically two-way. Imported international containers move inland from a seaport, are unloaded, then reloaded with export cargo (if available) or with domestic cargo (taking advantage of discounts offered by the railroads and container owners) for the backhaul. Similarly, auto trains may arrive at a port with export vehicles and depart with import vehicles. Premium intermodal rail service competes directly with the trucking industry for long-distance freight transportation. It represents the fastest growing segment of rail service.

Shippers select among air, truck, rail and water freight transportation services—and among bulk, carload, and intermodal rail freight transportation services—based on many factors, but the four most important are:

- Shipment characteristics, including the volume of the commodity, the nature of commodity, and the frequency of shipments;
- Access to the rail network, either directly from a plant rail siding, or indirectly by way of a transload or intermodal terminal;
- Service requirements such as travel time, reliability, and frequency; and
- Cost, including transport cost and related charges such as equipment leasing, transloading, warehousing, and administration.

For rail to maintain or grow its market share, it must be accessible to shippers and offer services that are appropriate and cost-effective compared to competing truck and water freight transportation services. For the purposes of this study, rail capacity is used as a broad proxy for the ability of the rail system to meet shipper needs and continue to attract freight as the economy grows.

2.4 MAROps Phase I Study

This is the second of two Mid-Atlantic Rail Operations studies. The MAROps Phase I study examined rail choke points and their impact on the capacity of the rail system serving the Mid-Atlantic region. It was an initiative of the

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equipment. Transload and transflow commodities are moved from the shipper's facility to a rail yard or siding near the receiver, then moved the final miles by truck for just-in-time use by the receiver. General merchandise or carload service falls between the slow bulk unit trains and the faster intermodal services in terms of price and service levels, competing with some trucking services.

I-95 Corridor Coalition, five Mid-Atlantic states (Delaware, Maryland, New Jersey, Pennsylvania, and Virginia) and three railroads (Amtrak, CSX, and Norfolk Southern). Its objective was to investigate the regional rail network as a system and address systemwide issues across state boundaries.

The MAROps Phase I study took a bottom up look at the regional rail system; identified critical rail choke points (done by railroad and state planning and rail operations experts); defined the improvements needed from a system perspective; and developed a strategic, phased implementation program.

The MAROps I study concluded that rail improvements were needed to keep pace with demand. It recommended a 20-year, $6.2 billion program of 71 rail capacity and operational improvements. The projects are mapped and described in Figure 2.7. The projects are color-coded by type (e.g., bridges and tunnels, capacity, connections, clearances, and grade crossings/stations/terminals).

The study estimated the public benefits to the region at $12.8 billion, suggesting a positive benefit-cost ratio for the program. The benefits came from direct cost savings to freight shippers, based on the difference between truck and rail freight rates; direct cost savings to highway users from reducing the number of truck-miles of travel on the region's highways; and broad regional economic benefits from increasing freight transportation productivity and reducing the cost of doing business.

MAROps I helped initiate and support interest in investing in the freight rail system in the Mid-Atlantic and nationally. Since its completion, the railroads and the states have advanced projects to improve a number of major rail corridors, which are shown in Figure 2.8. These corridors include:

- Norfolk Southern Crescent Corridor. The Crescent Corridor is a network of rail lines stretching from the Gulf Coast and Memphis to Harrisburg, Philadelphia and New York. Norfolk Southern is making infrastructure improvements to move more freight faster and more reliably along the 2,500-mile network. Crescent Corridor projects include straightening curves, adding passing tracks, improving signal systems, and building new terminals. Altogether, nearly $2.5 billion in Crescent Corridor projects have been identified. Norfolk Southern plans to implement the Crescent Corridor initiative through a series of public-private partnerships. When the Crescent Corridor initiative is fully implemented, Norfolk Southern projects that more than one million truckloads of freight will be shifted from the highways to the rails annually, saving more than 170 million gallons of fuel per year.
- Norfolk Southern Heartland Corridor. The Heartland Corridor project is a three-year engineering effort to increase intermodal freight capacity by raising vertical clearances in 28 tunnels on their rail line between the port of Hampton Roads, VA and central Ohio. The Heartland Corridor crosses Virginia, through southern West Virginia and north through Columbus, Ohio with connections to Chicago. The first phase of the tunnel work began in October 2007. When the project is completed in early 2010, the rail route

between the East Coast and the Midwest will accommodate containerized freight moving on double-stack trains, be more direct (by about 200 miles), and faster (by about a day's transit time). Currently, double-stack trains must take longer routes by way of Harrisburg, PA, or Knoxville, TN.

- CSX National Gateway. The National Gateway will create more efficient rail routes from the East Coast ports of Baltimore, MD, Wilmington, NC, and Charlotte, NC to Midwestern markets by raising bridges and removing other overhead clearance constraints that limit the use of double-stack intermodal trains and by upgrading tracks, equipment, and facilities. The Gateway program will improve three existing rail corridors that run through Maryland, Virginia, North Carolina, Pennsylvania, Ohio, and West Virginia: the I-70/I-76 Corridor between Washington, D.C. and northwest Ohio via Pittsburgh; the I-95 Corridor between North Carolina and Baltimore via Washington, D.C.; and the Carolina Corridor between Wilmington and Charlotte, NC.
- Federal Railroad Administration (FRA) Baltimore Rail Tunnel Improvement Study. The existing Howard Street Tunnel in Baltimore, a single-track tunnel, serves CSX's main north-south line and is a significant choke point on the MAROps rail network. In 2005, the FRA completed an initial study of alternative improvements to the CSX Howard Street tunnel and the Amtrak B&P and Union tunnels in response to the tunnel fire in 2001 that shut down rail traffic for months and underscored the importance of the Howard Street Tunnel as a nationally and regionally significant rail link. The FRA and the Maryland DOT are now conducting a follow-up study to provide detailed engineering analyses of alternative alignments.
- CSX Baltimore to Miami Mainline. As part of longer-term look at improving rail service along the I-95 corridor and relieving truck traffic pressure on I-95 itself, CSX modeled the capacity and operation of the CSX mainline from Baltimore, MD to Florence, SC.

Figure 2.7 MAROps Phase I Recommended Projects

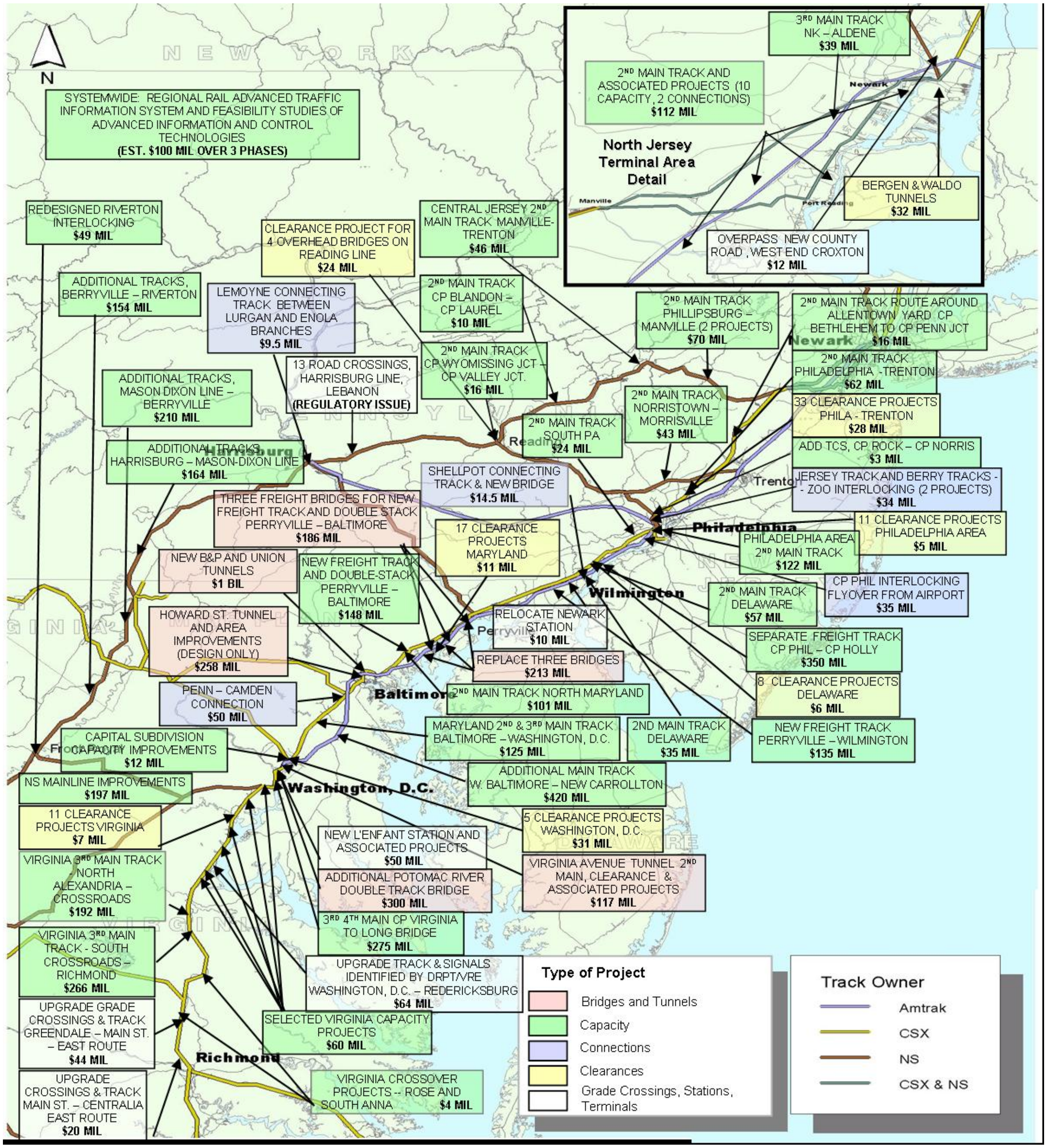
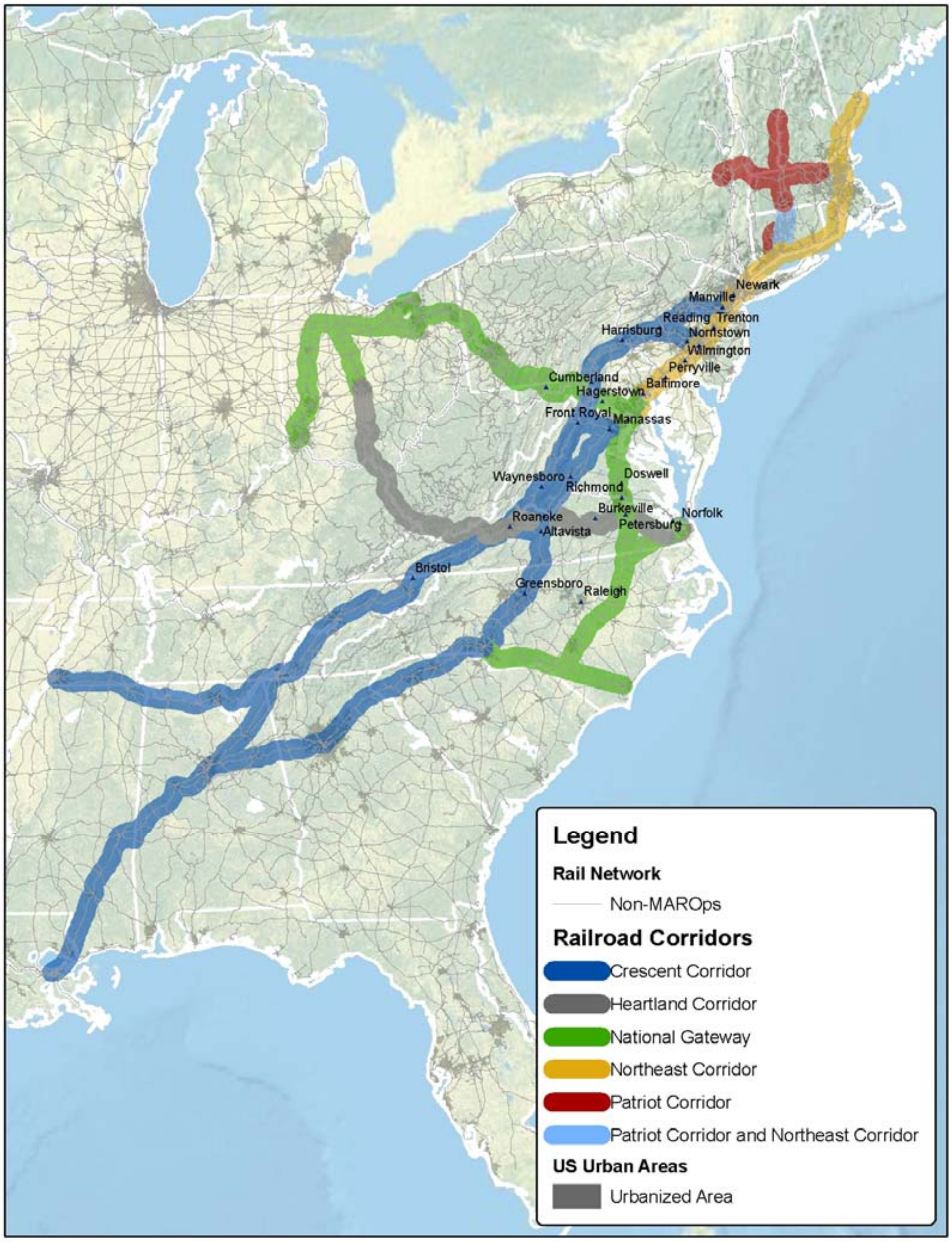


Figure 2.8 Rail Corridor Initiatives



2.5 MAROPS PHASE II STUDY

The recession has dampened freight demand and congestion, but as the recession eases, the region will find itself facing many of the same freight transportation issues, including:

- Increasingly congested highways;
- Limited freight and passenger rail capacity;
- Proposals to expand commuter rail, intercity, and high-speed rail services to relieve highway congestion;
- Shifts in distribution centers and freight flows as a result of changes in trade patterns and logistics practices (e.g., more all water shipping through the Panama and Suez canals to PANYNJ, Philadelphia, Wilmington, Baltimore, Norfolk, etc.);
- Rising energy costs;
- Regulatory actions to reduce greenhouse gases (CO2) and mitigate climate change; and
- Revenue pressure on transportation agencies and carriers to do more with less.

MAROps II was initiated to update the Phase I findings and prepare for these post-recession challenges.

The participants in the MAROps Phase II study are the I-95 Corridor Coalition, five Mid-Atlantic states (Delaware, Maryland, New Jersey, Pennsylvania, and Virginia) and three railroads (Amtrak, CSX, and Norfolk Southern)

The study updates the information on the current condition and performance of the rail and highway networks (supply), economic and freight growth projections for the region (demand), rail improvements (accounting for completed, revised and new projects) and the benefits for corridors, states, and regions.

The study focuses on the capacity of the regional freight rail system. It recognizes, but does not address in detail, the following important issues:

- **Passenger rail.** The Amtrak Northeast Corridor (NEC) is the most heavily traveled passenger rail corridor in the United States. Although used primarily by passenger trains, freight trains use some segments of the NEC to make connections between different sections of the freight rail network. Amtrak is currently developing a NEC master plan, which will identify improvements to the NEC to provide improved passenger service for Amtrak and the commuter railroads. To avoid duplication, the MAROps Phase II study focuses on freight improvements in the NEC; however, the Amtrak and MAROps reports have been closely coordinated because Amtrak is a partner in the MAROps studies. Several projects appear in both the

MAROps and the Amtrak programs because they are mutually beneficial. These projects are noted as such in the findings and recommendations of this report.

- **State of Good Repair.** The MAROps II study does not include regular maintenance and replacement projects except where these projects would significantly increase the capacity of the rail system. Examples of these exceptions are replacement of bridges to handle heavier train weights, and the reconstruction or replacement of tunnels that would make possible the introduction of doublestack intermodal rail service where none exists today. The MAROps study assumes that freight railroads and Amtrak have in place or are working toward plans to ensure that their networks remain in a state of good repair. State of good repair is defined as: "A condition in which the existing physical assets, both individually and as a system, (a) are functioning as designed within their "useful lives," and (b) are sustained through regular maintenance and replacement programs; state of good repair represents just one element of a comprehensive capital investment program that also addresses system capacity and performance."[4]
- **Local access.** The MAROps II study focuses on regional freight movements and rail lines, not local freight movements and rail lines. Similar to the Intestate highway system, the regional rail network constitutes the major arteries of the national rail system. Local freight lines provide the connections between these major arteries and the region's many ports and industrial customers. With a few exceptions, the MAROps II study does not identify improvements to local rail lines.

[4] Mary E. Peters, Secretary of the U.S. Department of Transportation, Letter to Congressional Committees, July 25, 2008.

3.0 Technical Approach

3.1 Overview

Analysis Process

The MAROps II study analyzes the benefits of implementing rail corridor improvements in the Mid-Atlantic region. Benefits are estimated for the MAROps region as a whole and individually for the five states, three major metropolitan areas, and the major rail corridors. This section describes the study's technical approach. Sections 4.0 through 8.0 report the key findings of the analysis, and Section 9.0 reports the study's conclusions and recommendations.

The technical analysis process is diagrammed in Figure 3.1. The technical approach examines four elements:

- **Demand.** The demand analysis looks at the demand for freight transportation generally and rail freight transportation specifically. The demand projections use 2005 as the base year and 2035 as the planning year. The analysis investigates how economic growth and structural changes in the Mid-Atlantic region's economy may affect the demand for rail freight transportation. It also estimates how changes in rail capacity may affect rail mode share; i.e., the percentages carried by truck and rail, respectively. It translates the demand projections (measured in commodity tonnage moving between origins and destinations) into carloads and trains by type of train (e.g., intermodal, bulk, carload, and passenger).
- **Supply.** The supply analysis looks at the supply of rail service, measured by the number of tracks, the types of signal systems, and the types of train services (e.g., intermodal, bulk, carload, and passenger) using each rail segment. The analysis identifies four sets of improvements: MAROps Phase I improvements that have been completed; railroad and state DOT improvements underway today; railroad and state DOT improvements programmed for implementation in the near future; and improvements proposed under the MAROps program through 2035.
- **Capacity.** The capacity analysis compares demand to supply, using a volume-to-capacity (V/C) ratio as a measure of level of service (LOS) and a general proxy for rail system capacity and performance. The capacity analysis estimates the impact of increasing demand from population and economic growth and the impact of increasing the rail mode share on freight rail capacity in the MAROps region.
- **Benefits.** The benefits assessment estimates the benefits of improving the capacity of the MAROps region rail system. It focuses on the public sector

benefits at the regional, corridor, state, and metropolitan levels, but also approximates the direct benefits to shippers and carriers. The benefits assessment attempts to answer the question: Do the results warrant advancing the MAROps program?

Demand, supply, and capacity are analyzed for five scenarios:

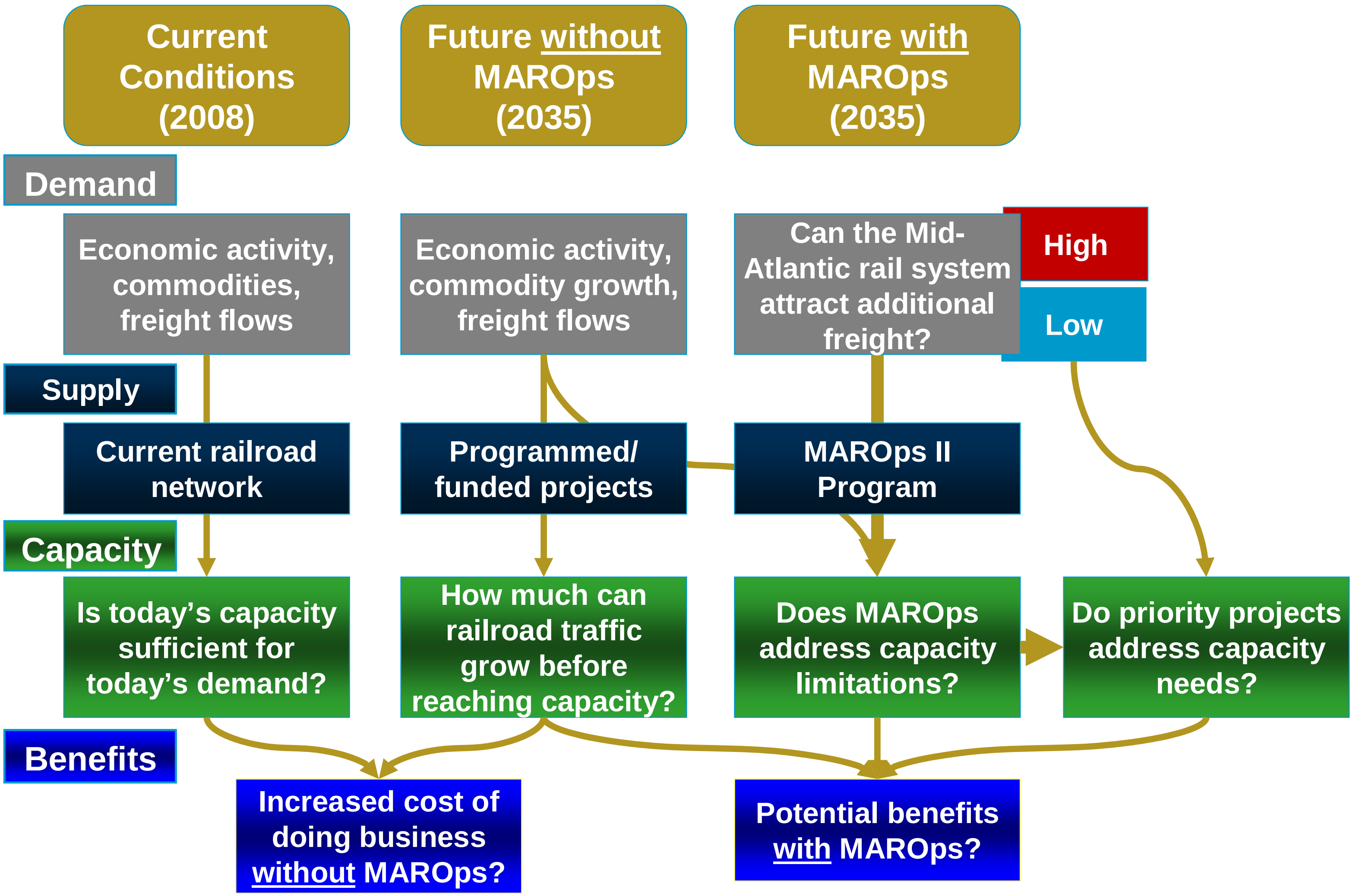
- **Current conditions (2007/2008).** This scenario estimates the current levels of service for each corridor and rail line segment given today's rail demand and supply. It is used to calibrate the model (i.e., Does the model accurately identify existing rail traffic and choke points?) and create a baseline for comparison with the future conditions.
- **Future conditions <u>without</u> MAROps improvements and <u>no</u> increase in rail mode share (2035).** This scenario estimates the future level of service for each corridor and rail line segment assuming that demand for rail freight transportation increases because of population growth, economic development, and trade, but the supply of rail service does not increase significantly. The scenario assumes that the highway and rail networks are maintained in a state of good repair, but that state DOTs and railroads make no significant improvements to the network beyond those are already underway or funded. The scenario assumes that there is no increase in the rail mode share (i.e., the proportions of freight tonnage carried by rail and truck remain the same as total demand grows). This scenario represents an unlikely worst case scenario, but provides information for analyzing choke points and targeting improvements.
- **Future conditions <u>with</u> MAROps improvements and <u>no</u> increase in rail mode share (2035).** This scenario estimates the future levels of service for each corridor and rail line segment assuming that the full MAROps program is implemented. It uses the same demand projections as the <u>without</u> MAROps scenario and also assumes there is <u>no</u> increase in rail mode share. The scenario addresses the question: How well do the MAROps improvements meet project demand assuming no freight traffic is shifted from truck to rail? This scenario represents a possible, albeit very conservative, future condition. Its primary function is to serve as a base line for estimating the capacity of the rail system to carry a larger share of freight.
- **Future conditions <u>with</u> MAROps improvements and a <u>high</u> increase in rail mode share (2035).** This scenario estimates the future levels of service assuming that the full MAROps program is implemented and that the added capacity and service attract a relatively large amount of additional freight traffic from truck to rail (i.e., "high" increase in rail mode share).
- **Future conditions with <u>priority</u> MAROps improvements and a <u>low</u> increase in rail mode share (2035).** The project steering committee of freight and passenger railroad and state transportation officials used the results of the prior scenarios, especially the "future scenario with MAROps improvements and high increase in rail mode share" and their best professional judgment to

identify a set of priority projects. These projects were judged to be critical path projects that would yield the highest near-term benefits. This scenario estimates the future levels of service assuming that only the priority projects in the MAROps program are implemented and that the added capacity and service attracts a relatively small amount of additional freight traffic from truck to rail (i.e., "low" increase in rail mode share).

Benefits are estimated for two scenarios:

- **Future conditions with MAROps improvements and a high increase in rail mode share (2035).**
- **Future conditions with priority MAROps improvements and a low increase in rail mode share (2035).**

Figure 3.1 MAROps Technical Approach



Limitations of the Technical Approach

The analysis process has three important limitations. First, the analysis does not use a railroad operations model such as Berkeley Simulation Software's Rail Traffic Controller (RTC) model, which simulates the minute-by-minute movement of trains over sections of a rail network. The railroads use the RTC and other simulation models to estimate the potential return on investment from specific investments in locomotives, rail lines, switches, signal systems, and dispatching and control systems. Given the size of the MAROps region and the scale of network under analysis, the steering committee determined that developing such a model would be prohibitively expensive for the current study.

Second, the parametric modeling approach used for the study does not replace detailed engineering studies by the railroads and states before they commit to improvements. The study's modeling approach is appropriate for long-range policy and program development. It is effective at approximating corridor-level needs and building a picture of capacity at a multi-state regional scale. However, it is less effective at assessing specific projects and alternative project designs.

Finally, the cost estimates used in the study are the best, readily available estimates and have been reviewed by the steering committee; however, all cost estimates should be treated as first approximations. Detailed project cost estimates were used where available. Where detailed cost estimates were not available, order-of-magnitude estimates were developed based on comparable projects, industry rules of thumb, and best professional judgment. The estimates assume average conditions (i.e., average right-of-way costs and availability, normal terrain conditions, etc.).

The next sections provide a brief summary of the data and procedures used to the analyze demand, supply, capacity, and benefits across the scenarios.

3.2 Demand Projections

The demand for freight transportation is estimated by examining macro-economic projections of population and economic growth and forecasting commodity demand by industrial sector. This information is used to extrapolate current demand for rail and truck freight transportation to the 2035 planning year. The primary data sources are as follow:

- **Economic activity and commodity demand.** Macro-economic data for 2005 and forecasts for the nation and the Mid-Atlantic region in 2035 were generated by IHS-Global Insight, Inc. These data were supplemented by data on population and employment trends from Woods & Poole. The data were used to identify the critical growth industries in the MAROps region and develop estimates of production value, total employment, consumption input (tonnage) by type of commodity, and production output (tonnage) by type of commodity.

- **Rail freight demand.** 2007/2008 railroad rail traffic data were used to describe current rail freight demand, and 2005 Surface Transportation Board (STB) Carload Waybill Sample Data were used to define goods flows by county-of-origin, county-of-destination, and type of commodity. The 2005 STB Carload Waybill Sample Data, 2007/2008 railroad rail traffic data, and IHS-Global Insight TRANSEARCH data projections were used to extrapolate the current freight demand to the 2035 planning year. These data were translated into network flows by assigning them to a rail network.
- **Truck freight demand.** Current truck freight demand and flows were developed using publicly available truck counts by highway segment available from the Federal Highway Administration's (FHWA) Freight Analysis Framework (FAF2) data base. The flows were reverse engineered to create a truck trip table using an origin/destination matrix estimation procedure and then assigned to the I-95 Corridor Coalition's Integrated Corridor Assessment Tool (ICAT) highway network.[5] Woods & Poole county-level employment projections for 2035 were used to estimate future economic activity and generation and attraction of freight truck trips. The future truck trips were assigned to the ICAT network to approximate future truck traffic volumes.

The economic forecasts prepared for the study reflect higher rates of economic growth than are currently projected because work on the study began before the recent recession. Long-range macro-economic forecasts such as the 30-year forecast used for this study typically assume that there will be periods of recession and expansion within the forecast period, but do not try to predict them on a year-by-year basis. Instead, the forecasts anticipate the average performance over the forecast period.

However, the recent recession was significantly more severe than recessions over the past 30 years. New forecasts indicate that the recession has both lowered the current level of demand and dampened the rate of growth in the future. As a consequence of the lower base of economic activity and the growth rate, it could take five to eight years or more for freight transportation demand to reach 2035 levels used in this report.

It is likely that the supply of new rail capacity will also lag five to eight years or more because the recession has also slowed investment by the railroads and the states in their transportation networks. If this proves true, the level-of-service estimates and benefits reported will be reasonably accurate but occur later than the 2035 planning year. Section 5.0, which reports the details of the rail and truck freight demand projects, includes a comparison of the pre- and post-recession forecasts.

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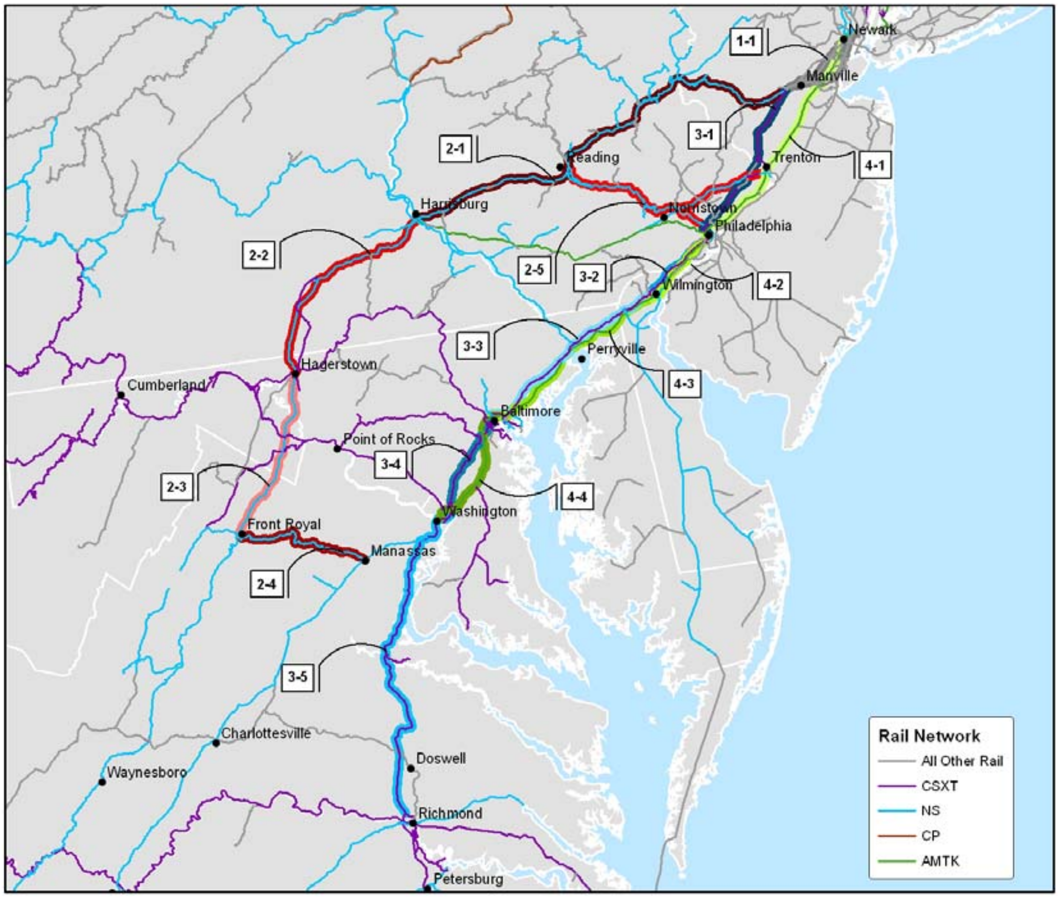
[5] http://ags.camsys.com/icat/. To be transferred in late 2009 to www.i95coalition.org.

3.3 SUPPLY INVENTORY

The number of tracks in operation in each rail corridor and the primary signal system in use (e.g., automatic blocking system, centralized traffic control, traffic control system, warrants, or no control) were identified using track charts and data supplied by Amtrak, CSX, and Norfolk Southern. The rail corridors and segments covered by the study are mapped in Figure 3.2. For convenience in locating and analyzing improvement projects, each rail corridor and major rail segment within a rail corridor was assigned a number. The corridors and their designations are:

- **New Jersey Terminal, designated as Corridor 1 and Segment 1-1**. The New Jersey Terminal is a shared asset area, operated by Conrail on behalf of CSX and Norfolk Southern. The rail lines in the New Jersey Terminal area provide common access for CSX and Norfolk Southern to the ports, intermodal terminals, and rail yards across the New York/Northern New Jersey metropolitan region.
- **Norfolk Southern I-81 Corridor, designated as Corridor 2 and Segments 2-1 to 2-4.** The I-81 Corridor or Crescent Corridor runs south from Newark through Harrisburg and Hagerstown to Front Royal where it splits into parallel lines with one branch running to Charlotte, Atlanta, and Birmingham and the other branch running to Roanoke, Chattanooga, Birmingham, and then on to New Orleans. This corridor provides connections from the Mid-Atlantic to the Memphis and New Orleans rail hubs and also links the region to Norfolk Southern's East-West line from Harrisburg to Chicago and the West.
- **CSX's I-95 line, designated as Corridor 3 and Segments 3-1 to 3-5.** The CSX I-95 line runs south from Newark through Philadelphia, Wilmington, Baltimore, Washington D.C., and Richmond on its way to Florida. This route provides a coastal connection from the Mid-Atlantic to the Southeast. It also provides connections to CSX's several East-West routes.
- **Amtrak's Northeast Corridor (NEC), designated as Corridor 4 and Segments 4-1 to 4-4.** The NEC connects Boston, New York and Washington, D.C., with services north to Portland, ME and south to Richmond, VA. The most heavily traveled sections are between New York and Washington, DC, within the Mid-Atlantic region. Many segments of the NEC are used for local rail freight movements; however, the most heavily used segment for long-distance rail freight is between Philadelphia and Baltimore. Most of these trains are operated by Norfolk Southern and CSX during nighttime hours.

Figure 3.2 MAROps Rail Corridors and Segment Designations



3.4 Capacity and Level of Service Analysis

The information on railroad supply and demand is used to estimate the levels of service (LOS) of the rail system, following a procedure that parallels the Highway Capacity Manual LOS analysis and designations commonly used by state DOTs and other transportation agencies. The LOS analysis examines the number of trains using or projected to use a section of rail network and compares it to the available capacity on that segment.

Capacity

The capacity is estimated using a parametric model developed by Cambridge Systematics for the American Association of Railroads (AAR) as part of the National Rail Freight Infrastructure Capacity and Investment Study.[6] The

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[6] Association of American Railroads, *National Rail Freight Infrastructure Capacity and Investment Study*, prepared by Cambridge Systematics, Inc., September 2007.

Footnote continued

description of the model presented here is adapted from that report. Three primary variables are used in the model:

- **Number of tracks** of mainline, not including sidings;
- **Control System**. Different signal systems impact the spacing of trains on the track and are grouped into three major types:
  - No Signal and Track Warrant Control (NS/TWC);
  - Automatic Block Signaling (ABS); and
  - Centralized Traffic Control/Traffic Control System (CTC/TCS).
- **Mix of Train Types.** The mix of train types determines the speed and spacing of trains on a track. Different types of trains operate at different speeds and have different braking capabilities. A corridor that serves a single type of train will usually accommodate more trains per day than a corridor that serves a mix of train types. Trains of the single type can be operated at similar speeds and with more uniform spacing between the trains because they have similar braking capabilities. This increases the total number of trains that can traverse the corridor per day. When trains of different types—each with different length, speed, and braking characteristics—use a corridor, greater spacing is required to ensure safe braking distances. As a result, the average speed drops, reducing the total number of trains that can traverse the corridor per day. For the study, trains were grouped into three types based on their operating characteristics:
  - Auto and Intermodal Train Service. This group includes intermodal trains and multilevel auto carriers hauling assembled automobiles. These trains tend to operate at higher speeds because they are lighter than merchandise and bulk trains and run to more exacting schedules.
  - Bulk and General-Merchandise Train Service. This group includes merchandise/carload trains and bulk coal and grain trains. These trains tend to haul heavier, bulkier commodities such as coal, grain, gravel and phosphates, and operate at slower speeds.
  - Passenger Train Service. This group includes Amtrak's intercity passenger rail trains and metropolitan commuter rail trains.

  Table 3.1 shows the capacity parameters used in the national AAR model for railroads operating east of the Mississippi. Somewhat different numbers were used for this study, especially for CSX, based on consultation with the railroads involved in this study about the conditions of the corridors in the Mid-Atlantic region. The specific capacity parameters are confidential and

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http://www.aar.org/~/media/Files/National_CAP_Study_docs/natl_freight_capacity_study.ashx (accessed 9/14/2009).

not presented here, but, in general, the capacities used are more conservative than those in the national AAR study.

Table 3.1 Capacities of Typical Rail-Freight Corridors

		Trains per Day	
Number of Tracks	Type of Control	Practical Maximum If Multiple Train Types Use Corridor*	Practical Maximum If Single Train Type Uses Corridor**
1	N/S or TWC	16	20
1	ABS	18	25
2	N/S or TWC	28	35
1	CTC or TCS	30	48
2	ABS	53	80
2	CTC or TCS	75	100
3	CTC or TCS	133	163
4	CTC or TCS	173	230
5	CTC or TCS	248	340
6	CTC or TCS	360	415

Source: Class I railroad data aggregated by Cambridge Systematics, Inc. Table reproduced from the Association of American Railroads, *National Rail Freight Infrastructure Capacity and Investment Study*, prepared by Cambridge Systematics, Inc., September 2007.

Key: N/S-TWC – No Signal/Track Warrant Control.; ABS – Automatic Block Signaling.; CTC-TCS – Centralized Traffic Control/Traffic Control System.

Notes: * For example, a mix of merchandise, intermodal, and passenger trains.
** For example, all intermodal trains.
The table presents average capacities for typical rail freight corridors. The actual capacities of the corridors were estimated using railroad-specific capacity tables. At the request of the railroads, the detailed capacity numbers were not included in the report to protect confidential railroad business information.

One significant difference between the use of parametric capacity model for the national AAR rail capacity study and the MAROps Phase II study was the treatment of passenger trains, generally, and the Amtrak NEC, in particular. Because the NEC serves very high volumes of passenger rail trains, freight trains are restricted to a narrow window of operations, typically six hours each night (although Amtrak has allowed operations outside of this freight window in certain circumstances through direct negotiation with the freight railroad operator). When the freight window is closed, freight trains continue to arrive throughout the day at a few key NEC access points and queue up for the operating window to open. Delay at the access points is not captured by the parametric model.

In addition, Amtrak conducts maintenance and rehabilitation work during these hours, effectively limiting freight train movements to a single track (although the specific number of operating tracks varies across the network). For the purposes of examining freight capacity on Amtrak's NEC using the parametric model, it is assumed that freight trains are limited to six-hour, one-track service for the entirety of the NEC.

The freight window concept was also applied to freight rail segments with significant commuter rail operations—such as Virginia Railway Express (VRE) service on the CSX mainline in Virginia and the Maryland Area Regional Commuter (MARC) service on the CSX mainline in Maryland. For these rail segments, it was assumed that freight trains operate only when commuter rail trains do not. A freight window was defined for each corridor based on commuter rail schedules. Typically, commuter rail trains operate in the morning and evening peak periods and freight trains use the corridor at other times (generally between 18 and 20 hours per day).

Level of Service

Corridor volumes were compared to current corridor capacity to assess congestion levels. This was done by calculating a volume-to-capacity (V/C) ratio expressed as a level of service (LOS) grades. The LOS grade are listed in Table 3.2.

Table 3.2 Volume-to-Capacity Ratios and Level of Service Grades

LOS Grade	Description		Volume/Capacity Ratio
A	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.0 to 0.2
B			0.2 to 0.4
C			0.4 to 0.7
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents	0.7 to 0.8
E	At Capacity	Very heavy train flow with very limited capacity to accommo-date maintenance and recover from incidents	0.8 to 1.0
F	Above Capacity	Unstable flows; service break-down conditions	> 1.00

Source: Association of American Railroads, *National Rail Freight Infrastructure Capacity and Investment Study*, prepared by Cambridge Systematics, Inc., September 2007.

Rail corridors operating at LOS A, B, or C are operating below capacity; they carry train flows with sufficient unused capacity to accommodate maintenance work and recover quickly from incidents such as weather delays, equipment failures, and minor accidents. Corridors operating at LOS D are operating near capacity; they carry heavy train flows with only moderate capacity to accommodate maintenance and recover from incidents. Corridors operating at LOS E are operating at capacity; they carry very heavy train flows and have very limited capacity to accommodate maintenance and recover from incidents without substantial service delays. Corridors operating at LOS F are operating above capacity; train flows are unstable, and congestion and service delays are persistent and substantial. The LOS grades and descriptions correspond generally to the LOS grades used in highway system capacity and investment requirements studies.

3.5 Capacity Improvements

The MAROps Phase II study builds on the Phase I program which identified 71 projects to reduce rail choke points and increase capacity. The MAROps Phase I projects were identified by the freight and passenger rail operators and state DOT officials. For Phase II, the Phase I projects were reviewed and amended to reflect all changes since the publication of the Phase I report. The study team met with each railroad and state to:

- Identify completed projects from the MAROps I program and remove them from the Phase II project list;
- Identify projects that are planned, funded, and programmed, but not yet built;
- Identify refinements to existing projects;
- Identify new projects not considered in MAROps I;
- Discuss the relative priority of projects; and
- Gather current cost information for the projects.

The information was compiled as a draft Phase II program and reviewed by the steering committee.

3.6 Rail Mode Share Estimation

Changing the capacity and level of service of the rail system has the potential to shift the behavior of the freight system's customers—the shippers. The current rail market share is influenced by the demand for freight transportation and individual decisions that shippers and customers make based on the following key factors:

- Cost of shipping;
- Time it takes for goods to get to their destination (travel time);
- Ease of accessing rail terminals (i.e., locations of terminals relative to the shipper's and receiver's location); and

- Reliability of the service provided (i.e., the likelihood that unforeseen events will delay shipments).

Typically, railroads carry goods that are less expensive, have lower pipeline inventory cost, are less time sensitive, involve large quantities being shipped from fixed points, and have the ability to tolerate delays.

As the capacity of the rail system is expanded, each of these variables will change and rail could become a competitive shipping option for rail-ready commodities that are currently shipped by truck. For example, the introduction or improvement of doublestack intermodal rail service can increase rail competitiveness in long-distance and heavily traveled market corridors, especially where increased capacity allows for faster travel times and greater travel time reliability.

The study estimates how much additional freight traffic might travel by rail if the MAROps II program were implemented, creating more capacity and allowing from faster travel times and greater travel time reliability. The model uses a shift-share approach that compares the rail share in freight markets in the Mid-Atlantic region to the rail shares in other U.S. freight markets.

Two cases are estimated. The first assumes that rail market share will grow with the prevailing growth in regional demand for goods currently carried by rail and that there will be no change in proportions of freight carried by truck and rail. This future is described in the scenario, "Future conditions <u>without</u> MAROps improvements and <u>no</u> increase in rail mode share (2035)."

The second assumes that the Mid-Atlantic region will experience a shift in rail market share based on local rail capacity improvements. The model estimates the potential for a shift in share for each major Mid-Atlantic market by assessing its potential based on the observed rail market share of similar markets throughout the U.S. (The model does not attempt to predict a precise absolute or percentage change in volume of rail and truck movements that might result from an individual project. To do so would require a detailed operational analysis of each project.)

A market is defined as a paired origin and destination for freight moving by rail or truck, typically, between two cities. A Mid-Atlantic market is similar to a national market if the markets are alike in the following factors:

- Gross truck and rail volume by type of commodity;
- Type of equipment, as a proxy for commodity type (e.g., intermodal, carload, bulk; truckload, less-than-truckload, etc.);
- Distance between markets, typically city pairs;
- Directness of non-intermodal rail travel (i.e. direct service versus service requiring rail interchanges);
- Directness of intermodal travel; and

- Ratio of rail-to-truck travel time to account for the greater circuity of rail line compared to highway routes.

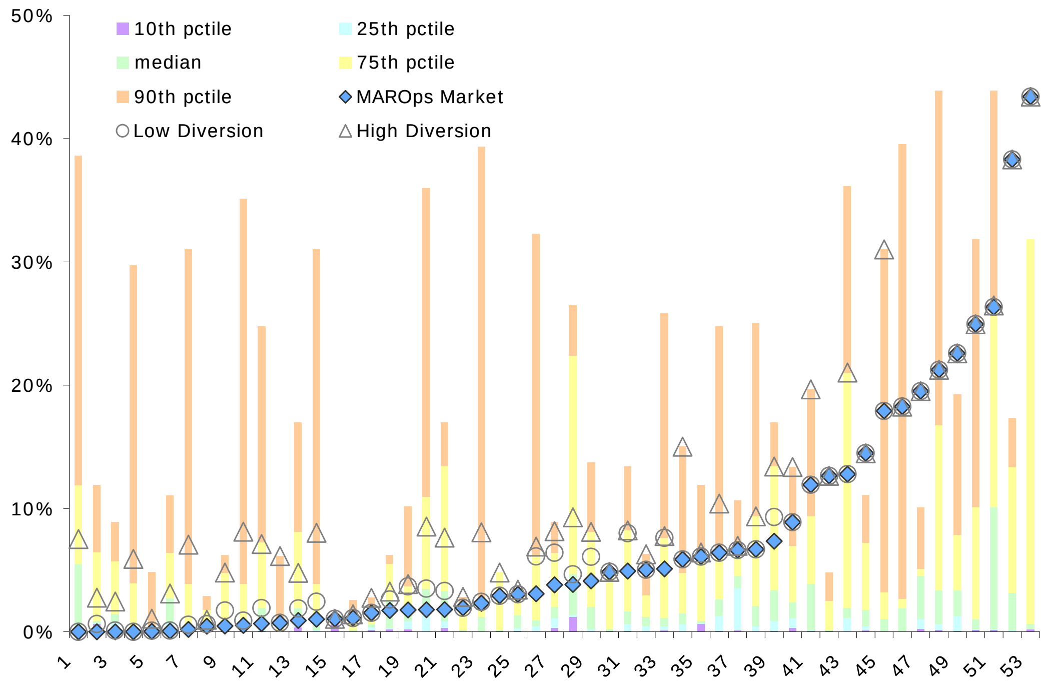
The steps in the mode share analysis are as follows:

- **Identify Mid-Atlantic rail market pairs.** The rail market pairs are defined by Bureau of Economic Analysis [BEA]-zone origin-destination pairs, and equipment type for both rail carload and rail intermodal service (auto, bulk, dryvan, flat car, refrigerated, and tank).
- **Identify comparable rail market pairs in other geographic areas.** For each of the MAROps carload and intermodal markets, a set of closely comparable markets are identified as matches from a database representing all rail markets pairs in the United States. To be considered a match, comparable markets must have same number of junctions and be within 20 percent of the MAROps market value of density ratio, rail mileage ratio, and rail circuity ratio. The variables are described below:
  - *Number of junctions:* When a railcar reaches a junction, it must be separated and attached to a different railroad's train. This process can add nearly a day to the total delivery time for a shipment. By comparison, a direct-line rail market may provide much faster service;
  - *Density ratio*: The relative volume, measured in tons, between the comparable and MAROps markets. If the ratio is more than one, then the comparable market has more traffic than the MAROps market;
  - *Rail mileage ratio*: The relative rail mileage between comparable and MAROps markets. If the ratio is more than one, then the comparable market has more mileage than the MAROps market; and
  - *Rail circuity ratio*: The relative circuity between comparable and MAROps pairs.[7] If the ratio is more than one, then the comparable market is more circuitous for rail travel than the MAROps market.
- **Identify possible mode share range.** The rail mode share in each MAROps market is compared to the rail mode share in the matched and comparable markets and a potential rail mode share is established for the MAROps market. Figure 3.3 shows an example of the analysis results. A total of 284 market pairs (i.e., origin and destination market pairs served by rail) were analyzed. The figure shows the first 50 market pairs, which are predominately intermodal traffic lanes. The blue diamonds are the current MAROps rail share in the market pair (i.e., rail share as a percentage of total

[7] Rail circuity is the ratio of rail distance compared to highway distance. In many market pairs, rail travel is more circuitous than highway travel, which gives trucks a time and cost advantage because the distance is shorter. If the ratio is more than one, then goods shipped by rail travel a longer distance than those shipped by truck.

truck and rail freight tonnage moving between the markets). The columns show the distribution of rail shares (again, percentages) in comparable markets across the United States. The column colors correspond to the percentile ranges as labeled; the green section represents the median market share in the comparable markets (i.e., half of rail mode shares in the comparable markets are higher and half are lower). For each market, a possible high and low market share are then calculated. These are represented by the open circles and triangles.

Figure 3.3 Rail Mode Share Estimates for MAROps Intermodal Market Lanes



- **Apply decision rules to define a potential rail mode share.** Each market and the possible high and low rail modes share are examined and decision rules applied to define a potential rail mode share from among the possible rail modes shares. The decisions rules, which are described below, are conservative. If the existing mode share is above the median, then no increase was assumed, regardless of the calculated possible high and low shares. The guidelines decision guidelines are:
  - If the rail share of MAROps market pair is above the median share for rail in other matched comparable markets, then there will be no growth in the mode share in MAROps because the MAROps market already has a higher than average mode share. (Although there may be no growth in rail mode share, there may be absolute growth in rail and truck traffic between market pairs because of population and economic growth.)

- If the rail share of MAROps market pair is between the 25th percentile and the median for rail in other matched markets, then the rail share in the MAROps market could grow to a level between the median (low mode share potential) and the 75th percentile (high mode share potential) of the matched comparable markets; and
- If the rail share of MAROps market pair is below the 25th percentile of the matched markets, then the rail share in the MAROps market could growth to a level between the 25th percentile (low mode share potential) and the median (high mode share potential) of the matched comparable markets.

The possible mode shares are not based on specific MAROps projects. Rather, increased mode shares answer the question: If MAROps rail service were to improve significantly, what is the potential for increase in MAROps rail market share? The analysis techniques and available data are not sufficient to quantify the level of "significant improvement" required to effect a shift in rail market share.

3.7 Benefits Assessment

The benefits assessment estimated two types of benefits: changes in travel costs for truck and rail; and economic impacts, including changes in business activity (e.g., business output, and value added) and changes in employment (e.g., jobs and wage income).

Travel cost savings accrue to shippers through less expensive shipping costs for those who shift from truck to rail; faster rail operations for those who continue to ship by rail; and faster truck operations for those who continue to ship by truck. The construction of MAROps improvements increases business activity by creating construction jobs, and those construction jobs increase spending in other sectors throughout the economy. The cumulative effect on the economy is measured by the increase in business activity and employment.

The analysis does not directly link the MAROps improvements to travel time savings, to economic growth, and the benefits assessment. The models used for capacity analysis, economic growth, and economic impact are independent models with logical links, but no direct or feedback links. For the purposes of the study, it was assumed that:

- Implementation of the full MAROps program would create enough new capacity and service improvements to significantly reduce rail travel time savings and enable a substantial increase in rail mode share (e.g., a high rail mode share increase). The benefits of this scenario were analyzed as "future conditions with MAROps improvements and a high increase in rail mode share (2035)."

- Implementation of the priority MAROps projects would create sufficient capacity and service improvements to moderately reduce rail travel time savings and enable a limited increase in rail mode share (e.g., a low rail mode share increase). The benefits of this scenario were analyzed as "future conditions with priority MAROps improvements and a low increase in rail mode share (2035)."

Travel Time and Cost Benefits

Changes in rail and truck travel costs are estimated by multiplying the per-hour operating cost for each mode (including wage costs, operations and maintenance costs, etc.) by the change in total travel time for each mode. Truck travel time savings are estimated based on modeled results from the ICAT network and rail travel times are estimated based on estimates of the impact of the MAROps projects on rail travel times.

Rail travel time changes are estimated at a project level and aggregated to corridors and segments for three classes of improvement projects:

- **Major choke point projects**. These projects address specific choke points by improving connections between existing railroad mainlines, increasing route speeds, making more efficient routing possible by adding switching equipment and operations, and improving yard access and egress. These projects have a significant impact on railroad operations and travel times.
- **Capacity projects**. These projects add mainline track or sidings, update signals, and otherwise add capacity without fundamentally changing railroad operations. These projects provide benefits by increasing the railroads' ability to route traffic over their network, thereby reducing congestion and delay, but the primary effect is to allow the railroad to carry more freight on more trains. These projects have a direct impact on the rail LOS measures. Most of MAROps II projects are in this category.
- **Clearance projects**. These projects increase the overhead clearance on rail lines so that doublestack intermodal container trains can operate over the lines. This is done by raising bridges that cross over rail lines, increasing the height of tunnels, and repositioning catenary lines and overhead signal equipment to allow safe passage of doublestack container trains. These projects are generally not expected to improve railroad travel times, but do allow for improved intermodal movements, a fast growing segment of the rail market that is an important rail service for ports and international trade. This category includes other similar projects that have limited direct impact on travel time.

Although all improvements provide for more fluidity in rail movements, only the major choke points are expected to have significant impacts on train travel times for rail movements. Table 3.3 lists the expected improvements to travel time that would result from each type of project.

Table 3.3 Travel Time Benefit Assumptions by Project Type

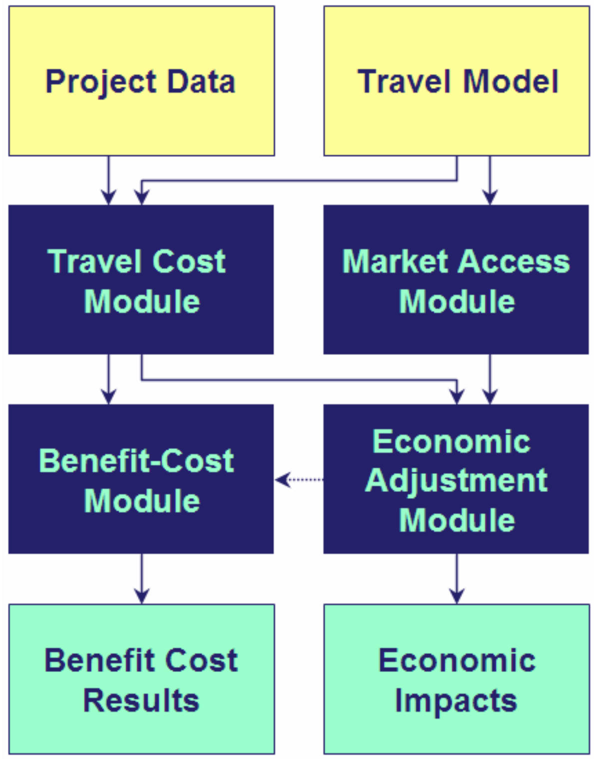
Project Type	Travel Time Improvement Assumptions
Capacity	15 seconds per mile of new mainline 12 seconds per mile for traffic control systems (TCS)
Clearance/other	No direct travel time benefit captured
Major Choke point	Benefits estimated for each specific project in consultation with railroad and state DOT officials

Economic Benefits

Economic benefits, including changes in business activity (e.g., business output, and value added) and changes in employment (e.g., jobs and wage income), were estimated using the Transportation Economic Development Impact System (TREDIS) developed by the Economic Development Research Group.[8] TREDIS is a web-based economic impact and benefit-cost analysis tool for transportation projects and programs. It evaluates data across all modes of passenger and freight transportation, including highway, rail, marine and air travel, and all types of intermodal terminals and facilities. It provides detailed estimates of freight and passenger costs and benefits, including the value of improving transportation reliability, access, and system connectivity. The TREDIS model estimates the benefits and costs of transportation investments, including the impacts of congestion, evaluating improved access to markets, and other related questions. The key elements of the TREDIS model are shown in Figure 3.3.

[8] See www.edrgroup.com/; www.edrgroup.com/products/transportation-tools/; and http://www.tredis.com/.

Figure 3.4 TREDIS Model Elements



Source: Economic Development Research Group.

The TREDIS model requires three types of inputs:

- MAROps program costs;
- Travel model information
  - Market and access data for each mode, including local market size, regional market size, and average drive times to terminals and international gateways;
  - Travel demand characteristics such as vehicle trips, vehicle miles, hours of travel, hours of congested travel, average number of crew members per vehicle (1.1 for freight trucks and 2.0 for freight trains), average load (15 tons for freight trucks and 2,500 to 5,800 tons for freight trains, depending on commodity mix), toll charges, etc.

- Economic value assumptions:
  - Economic value factors such as cost per crew member ($22.13 for freight trucks and $25.03 for freight trains),[9] freight logistics costs per hour per ton ($1.52 for freight trucks and $0.39 for freight trains),[10], and reliability valuation. These factors are used to describe the value of different types of trips (e.g., freight, journey to work, passenger rail, etc.); and
  - Vehicle cost factors such as operating cost per mile ($1.15 for freight trucks and $178.23 for freight trains),[11] safety costs ($5.1 million per fatality, $60,000 per injury, and $8,300 per damage collision),[12] and environmental costs per-mile ($0.11 for freight trucks and $5.05 for freight trains).[13]

In addition to TREDIS, the pavement maintenance models within the FHWA's Highway Economic Requirements System (HERS) were used to estimate the change in pavement maintenance costs associated with changing truck vehicle miles of travel.

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[9] Calculated by averaging wages, weighted by total state employment, for the region. Wages from Bureau of Labor Statistics, *2007 Mean Wages.*

[10] Values estimated by EDR and provided with the model. The estimates are based on published data in Federal Highway Administration's *Freight Analysis Framework* describing the value of freight carried by each mode.

[11] Truck operating cost calculated based on data from Federal Highway Administration's *Highway Economic Requirements System* and rail cost calculated based on an assumption of the average tons per train in the Mid-Atlantic in 2005 (5,500) and Norfolk Southern and CSX Surface Transportation Board filings, "Table R-1," 2007.

[12] U.S. Department of Transportation, "Treatment of the Economic Value of a Statistical Life in Departmental Analyses," February 2008.

[13] Based on calculations from Bureau of Transportation Statistics, "Issue Brief Number 2: Transportation Energy Efficiency Trends in the 1990s," April 2003 (for truck fuel consumption); Environmental Protection Agency, "Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder", March 2007 (for rail fuel consumption); Federal Highway Administration, *Assessing the Effects of Freight Movements on Air Quality at the National and Regional Level*, prepared by ICF Consulting, 2005 (for truck and rail emissions factors); Richard Tol, "The Social Cost of Carbon," Economics; Vol. 2 2008-25, August 12, 2008 (for CO2 costs); and Federal Highway Administration's *Highway Economic Requirements System (*for other emissions costs).

4.0 Current Conditions

This section describes the current demand, supply, and capacity of the rail network in the MAROps region.

4.1 Demand – A Consuming Region

In 2008, over 36 million people (12 percent of the nation's population) lived in the five-state MAROps region. There were approximately 23 million jobs in the region. The economic structure of the Mid-Atlantic region has changed significantly over the last 50 years, with manufacturing declining and newer industries such as services, health care, finance, and high-tech manufacturing becoming more prominent. Although these changes continue today, the retrenchment of heavy manufacturing is nearly complete. As a result, freight movements in the Mid-Atlantic are increasingly driven by consumption patterns rather than by manufacturing.

In 2007, approximately 2.3 billion tons of goods were shipped into, out of, or within the Mid-Atlantic region by all freight transportation modes, accounting for approximately 5 percent of the total U.S. freight traffic by weight and about 7 percent by value.[14]

In 2005, the freight railroads moved nearly 375 million tons of freight in the region: 155 million inbound tons; 103 million outbound tons; 67 million through tons; and 50 million internal tons (i.e., rail movements among Delaware, Maryland, New Jersey, Pennsylvania (East of Harrisburg), and Virginia), as shown in Table 4.1.

The largest share of rail movements (more than 40 percent) was inbound, reflecting the quantity of goods that are required for this part of the United States to sustain itself. Outbound and internal trips each account for less than 30 percent of total movements because this region consumes significantly more goods than it produces.

[14] Calculated from Federal Highway Administration's Freight Analysis Framework: 2007 Provisional Database.

Table 4.1 Freight Rail Tonnage by State and MAROps Region, 2005

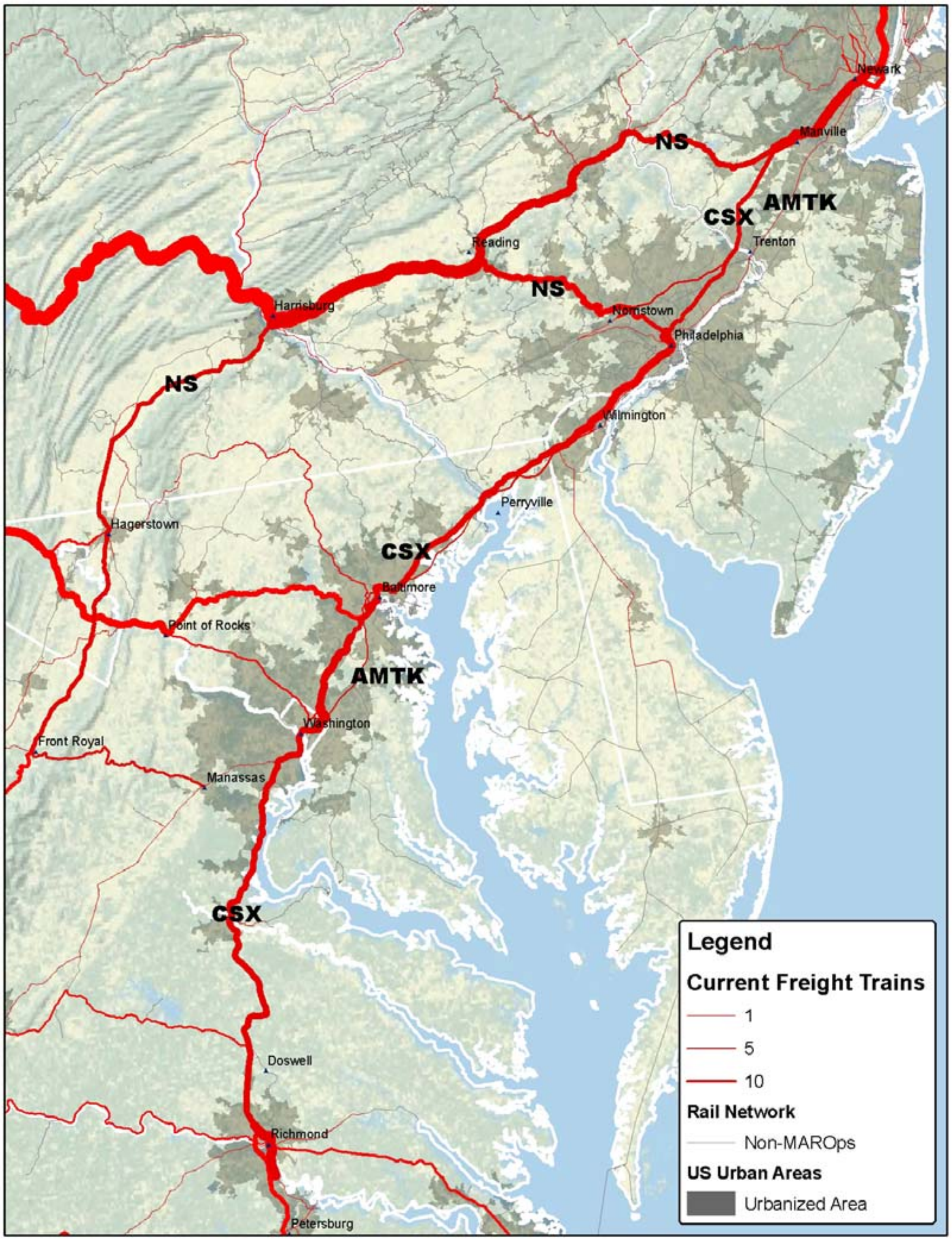
By State	Inbound	Outbound	Through	Internal
Delaware	6,064,364	1,286,712	16,293,730	28,832
Maryland	27,508,104	8,376,860	42,971,870	1,794,849
New Jersey	22,801,472	13,258,008	7,696,881	390,700
Pennsylvania (Phila.)	31,922,485	30,240,852	58,574,843	7,626,497
Virginia	66,309,737	49,543,877	83,217,376	21,004,576
MAROps Region	**Inbound**	**Outbound**	**Through**	**Internal**
	154,606,162	102,706,309	67,483,659	49,860,895

Source: 2005 STB Waybill Sample

Note: Internal flows are either inbound or outbound;
*Note that the study area through and internal tons cannot be calculated by summing the individual state 'through' and 'internal' tons. The study area is treated as one geographic region, so there are fewer 'through' trips than when each state is treated individually, and more 'internal' trips.

Figure 4.1 maps the current volume of rail freight movement measured in trains per day over the MAROps rail network. The total number of freight trains on the rail segment is proportional to the thickness of the red lines. There is a significant amount of traffic on Norfolk Southern's East-West route through Harrisburg, serving the Philadelphia and New York markets from the Mid-West; on Norfolk Southern's North-South route through Point of Rocks serving the Baltimore and the DelMarVa peninsula from the Gulf Coast; and on CSX I-95 North-South route serving the Mid-Atlantic markets from the Gulf Coast and Southeast.

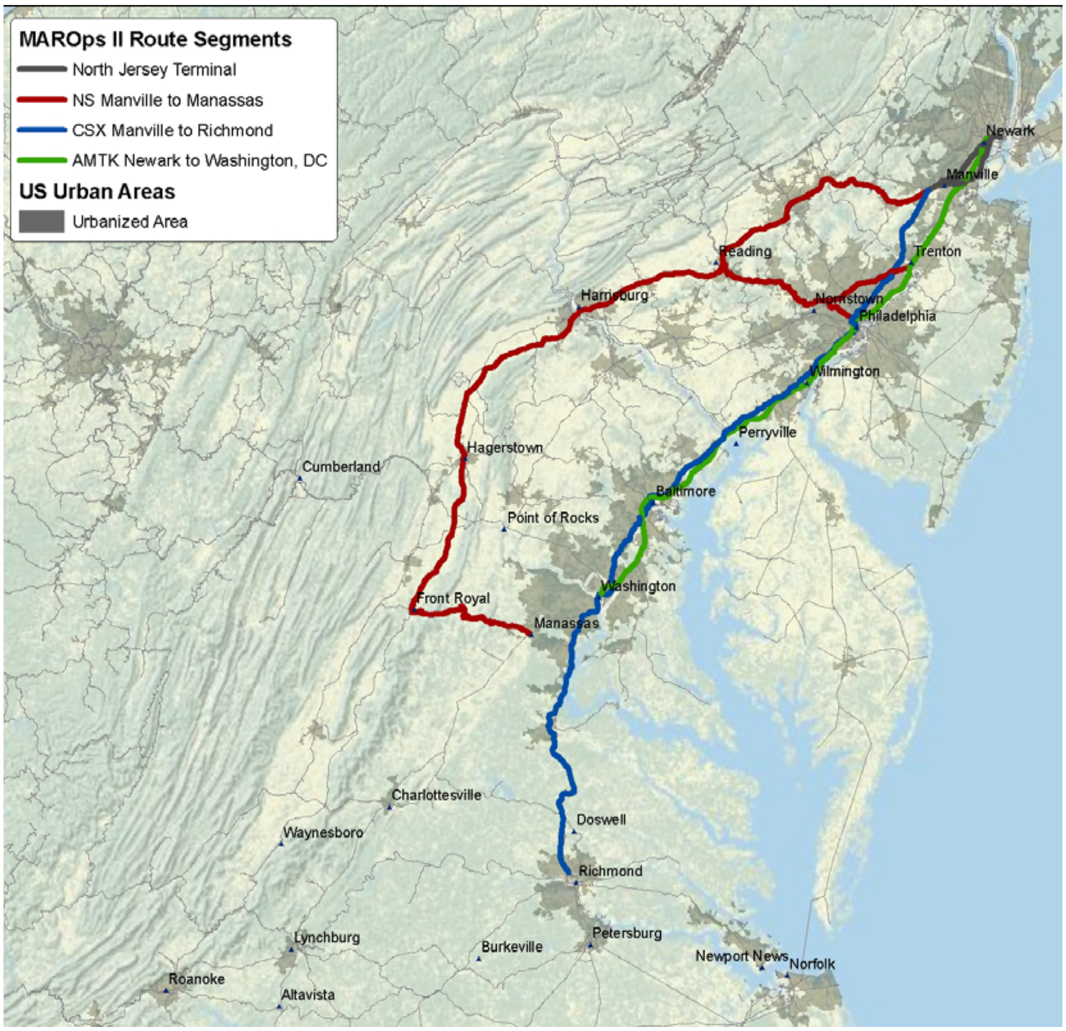
Figure 4.1 Current Freight Train Volumes on the MAROps Network



4.2 Supply

Figure 4.2 shows the location of the major rail lines in the MAROps region. The grey lines represent the North Jersey Terminal (MAROps corridor 1); the red lines represent Norfolk Southern's I-81 corridor from Manville, NJ to Manassas, VA (MAROps corridor 2); the blue lines represent CSX I-95 corridor from Manville, NJ to Richmond, VA (MAROps corridor 3); and the green lines represent Amtrak's Northeast Corridor from Newark, NJ to Washington, DC (MAROps corridor 4).

Figure 4.2 Mid-Atlantic Rail Routes



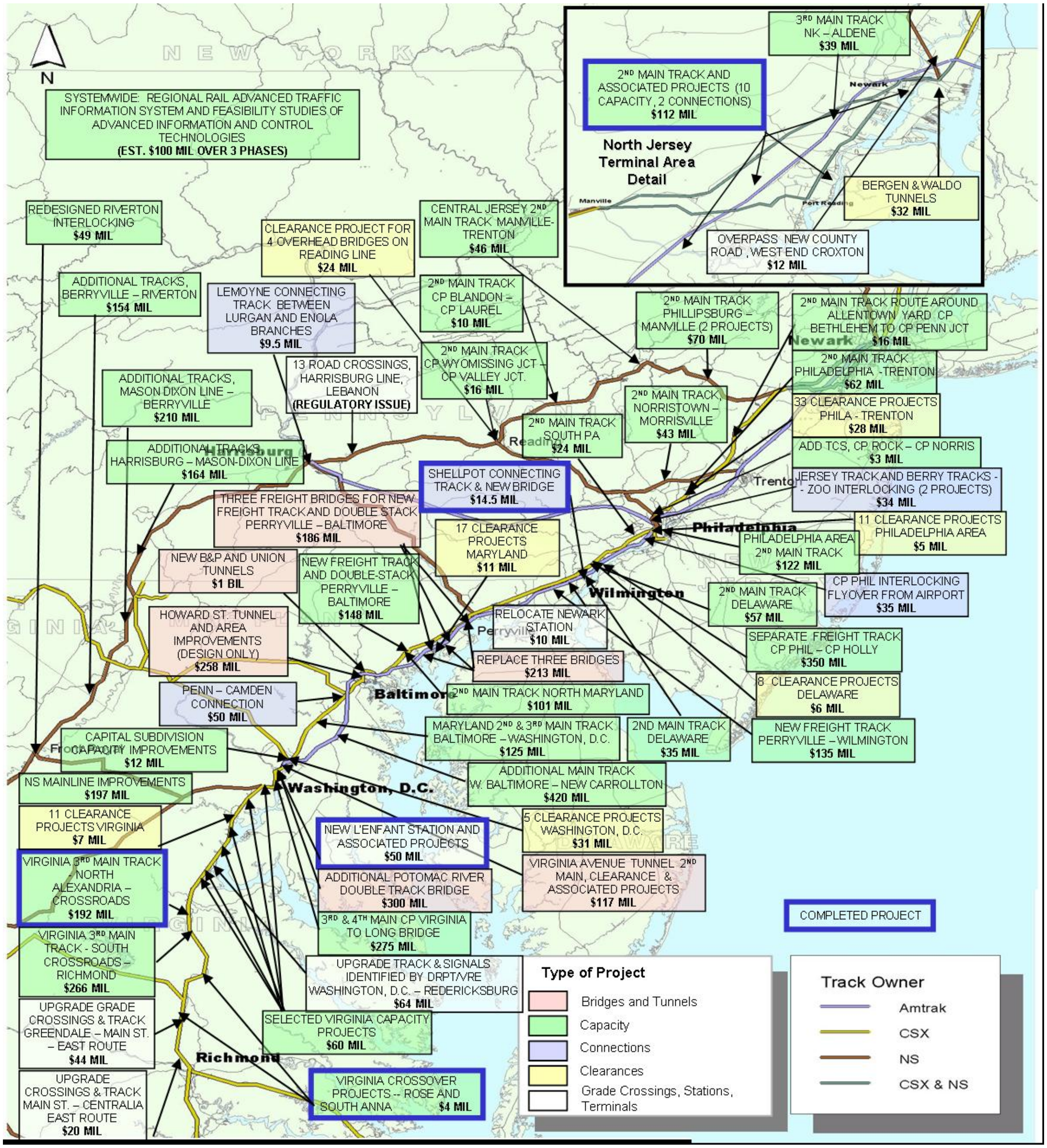
Since the publication of the MAROps Phase I Report in 2002, the participating states and railroads have completed nine improvement projects identified in the MAROps Phase I as critical to increase the capacity of the MAROps network. Table 4.3 lists the completed projects, and Figure 4.3 maps their locations. The completed projects are indicated by blue borders around the project description boxes. The completed projects represent significant progress in improving the rail network in the Mid-Atlantic region.

Table 4.2 Completed MAROps Phase I Projects

Railroad	Description of Project	Project Type
Conrail	Doubletrack Lehigh Line connecting track	Capacity
Conrail	TCS P&H Branch segment	Capacity
Conrail	Double track 10.7 mile segment of Lehigh Line	Capacity
Conrail	Double track 1.5 miles of single track to reach the Chemical Coast from the Lehigh Line	Capacity
NS	New vehicular overpass to eliminate at-grade crossing	Grade Crossings, Stations, and Terminals
CSX	Build a connection in the southeast quadrant for a connection to the Delair Branch (Engleside Connection QA 0.3)	Connection
NS	Rebuild Shellpot Connection, improve clearances; separate passenger station from freight operations; replace the bridge	Bridges and Tunnels
Amtrak	Third track segments Landlith to Ragan; high speed crossovers	Capacity
CSX	Triple track 5.1 mile segment Carroll to St Denis; upgrade storage track to create 4th main between West Baltimore and St Denis. Retire Halethorpe interlocking and replace with new interlocking at St. Denis	Capacity
CSX	Realign connection from Alexandria extension to Capital Subdivision to offer higher speeds; reconfigure south end of Benning Yard to create second main; Double track 1.4 miles from New Jersey Ave to Maine Ave	Connection, Capacity
CSX	Triple track, RO to SRO, SRO to Ravensworth, AF to RW, new double track Quantico River Bridge	Capacity
CSX	New interlockings at Arkendale and Elmont (replaced South Anna and Rose)	Connection
CSX	Add auto track bridge extension at Lorton; Add layover track for VRE equipment in Alexandria	Capacity

Note: Some of the projects have other components that are not yet complete. The information is for the completed segments. Funded, but not completed projects, are described in the next section.

Figure 4.3 Completed MAROps Phase I Projects



Note: Map shows completed projects. Currently funded, but not completed projects, are shown in the next section.

4.3 Capacity and Level of Service

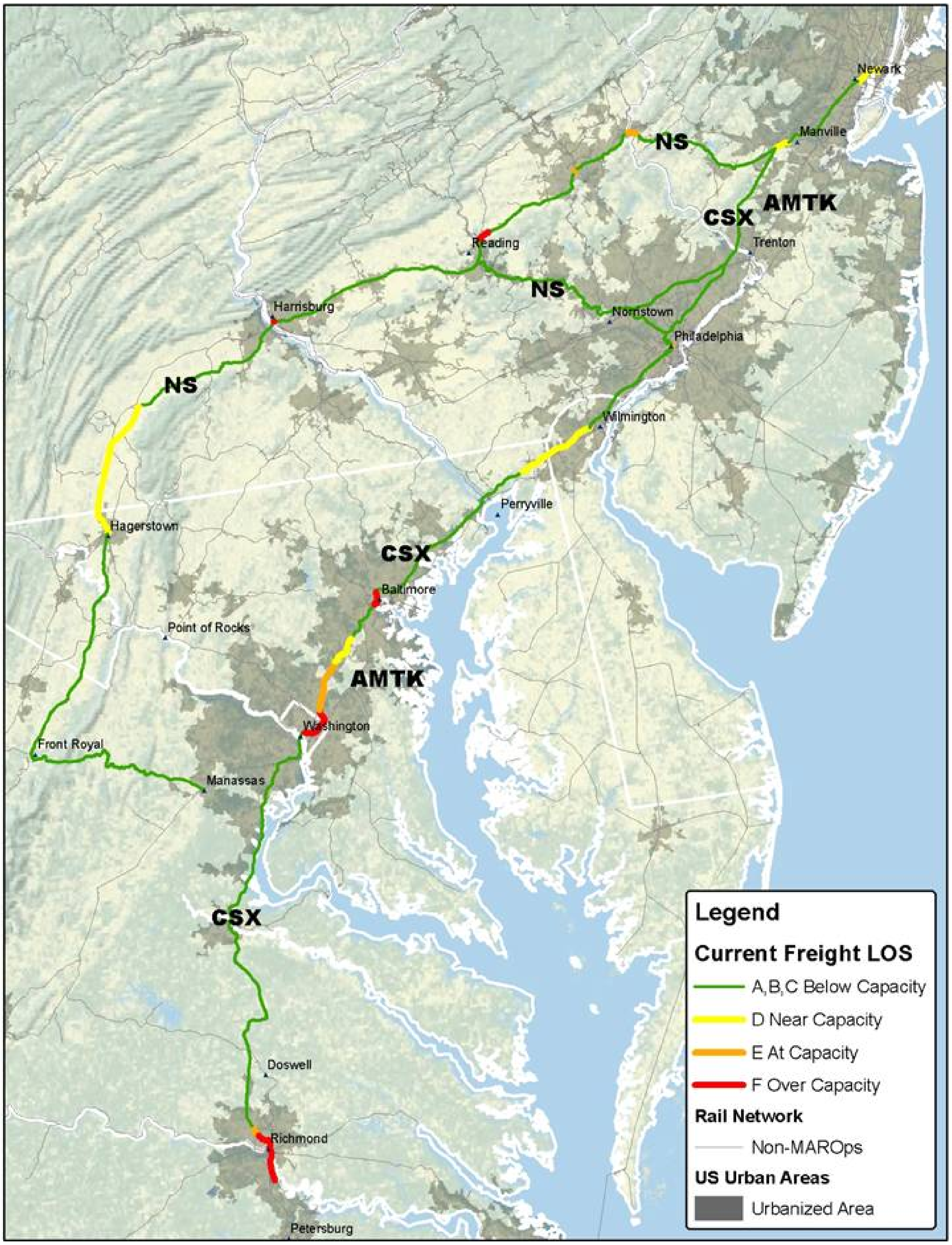
Currently, 88 percent of corridor freight rail miles in the MAROps region operate below capacity (at LOS A, B, or C) and three percent operates above capacity (at LOS F). Table 4.4 shows the number of corridor miles by corridor and level of service. Figure 4.4 maps the same information. Some of the notable capacity limitations are:

- **Howard Street Tunnel in Baltimore and the Virginia Avenue Tunnel in Washington, D.C.** Around 8 percent of the CSX I-95 corridor miles operate above capacity (LOS F) according to the model, and another 14 percent operate near or at capacity (LOS D or E). The primary congestion points are at the Howard Street Tunnel in Baltimore, MD and the Virginia Avenue Tunnel in Washington, D.C;
- **CSX Acca Yard in Richmond, VA.** CSX experiences significant congestion at the Acca Yard in Richmond, VA because all trains pass through the busy rail yard;
- **Norfolk Southern I-81 at Reading, PA.** Only 1 percent of the Norfolk Southern I-81 corridor mile operates above capacity; however, 11 percent of the corridor miles are at or near capacity, primarily in Reading, PA area, where the configuration of the network causes circuitous train movements;
- **New Jersey Terminal area, the Norfolk Southern lines north of Hagerstown, and the CSX line between Wilmington and Baltimore.** These segments operate near capacity today and are likely to see more intense congestion as rail volumes grow.
- **Amtrak Northeast Corridor.** All of the freight operations on the Northeast Corridor, which occur during a six-hour window and on one track, operate below capacity according the model; however, this does not account for the delays accruing to trains queuing and waiting for access to the NEC.

Table 4.3 Current Freight Rail Level of Service by Corridor

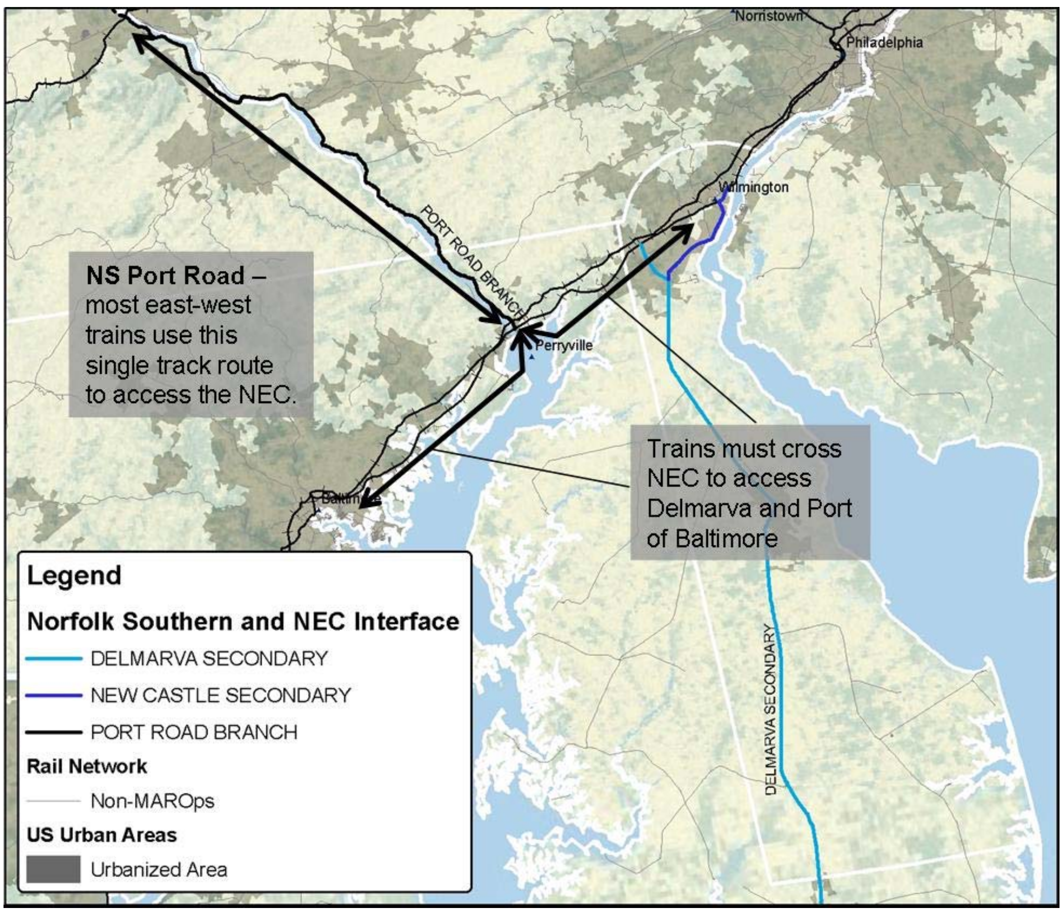
	Corridor 1 – New Jersey Terminal	Corridor 2 – NS I-81 Corridor	Corridor 3 – CSX I-95 Corridor	Corridor 4 – Amtrak Northeast Corridor	Overall
LOS A, B, C Below capacity	86%	88%	79%	100%	88%
LOS D Near capacity	14%	10%	9%	0%	7%
LOS E At capacity	0%	1%	5%	0%	2%
LOS F Above capacity	0%	1%	8%	0%	3%
Total Corridor Miles	*49*	*324*	*304*	*217*	*895*

Figure 4.4 Current Freight Rail Levels of Service, NS and CSX Corridors



In much of the rest of the country, Amtrak operates long-distance passenger service over freight lines; however, in the Northeast Corridor, the freight railroad operate over what is now primarily a passenger rail line. The most intensive freight operations are between Philadelphia and Baltimore. Norfolk Southern routes trains over the NEC from the Port Road Branch line (near Perryville, MD) to the Delmarva and Newcastle Secondary (in Delaware) and the Port of Baltimore. The rail lines are shown in Figure 4.5. Currently, Norfolk Southern is limited to a six-hour operating window on the NEC and must use a single track to accommodate Amtrak's maintenance and repair of the NEC line during that six-hour window. Operating delays frequently cause Norfolk Southern traffic to queue on Port Road as they wait for the freight operating window on the NEC to open. Although the model currently shows the entire Northeast Corridor operating at an acceptable level of service for freight (i.e., with enough capacity on one-track in a six-hour window to handle the freight traffic), the limited operating window is equivalent of having an 18-hour red light at an intersection, with traffic arriving (and queuing) all day.

Figure 4.5 Norfolk Southern Access to Delmarva and Port of Baltimore via the Northeast Corridor



5.0 Future of the Region Without MAROps Improvements and No Increase in Rail Mode Share

This scenario estimates the future levels of service for each rail corridor and rail line segment assuming that demand for rail freight transportation increases because of population growth, economic development and trade, but the supply of rail service does not increase significantly. The scenario assumes that the highway and rail networks are maintained in a state of good repair, but that state DOTs and railroads make no significant improvements to the network beyond those are already underway or funded for construction. The scenario assumes that there is no increase in the rail mode share (i.e., the proportions of freight tonnage carried by rail and truck remain the same as total demand grows). This scenario represents an unlikely worst case scenario, but provides information for analyzing choke points and targeting improvements.

5.1 Demand – Regional Growth

Growth in Employment and Population

Population in the Mid-Atlantic is expected to grow by 24 percent, from 36 million in 2008 to nearly 45 million in 2035. The population in the MAROps region is projected to grow at a rate of four-fifths of one percent per year, slightly slower that the rate of growth of the total U.S. population, which is projected to grow by about one percent per year. Employment in the MAROps region is projected to grow at one and one fifth of one percent per year, from 23 million jobs in 2008 to nearly 31 million jobs in 2035. Table 5.1 shows the population and employment forecasts by state and for the Mid-Atlantic region.

Table 5.1 Population and Employment Trends

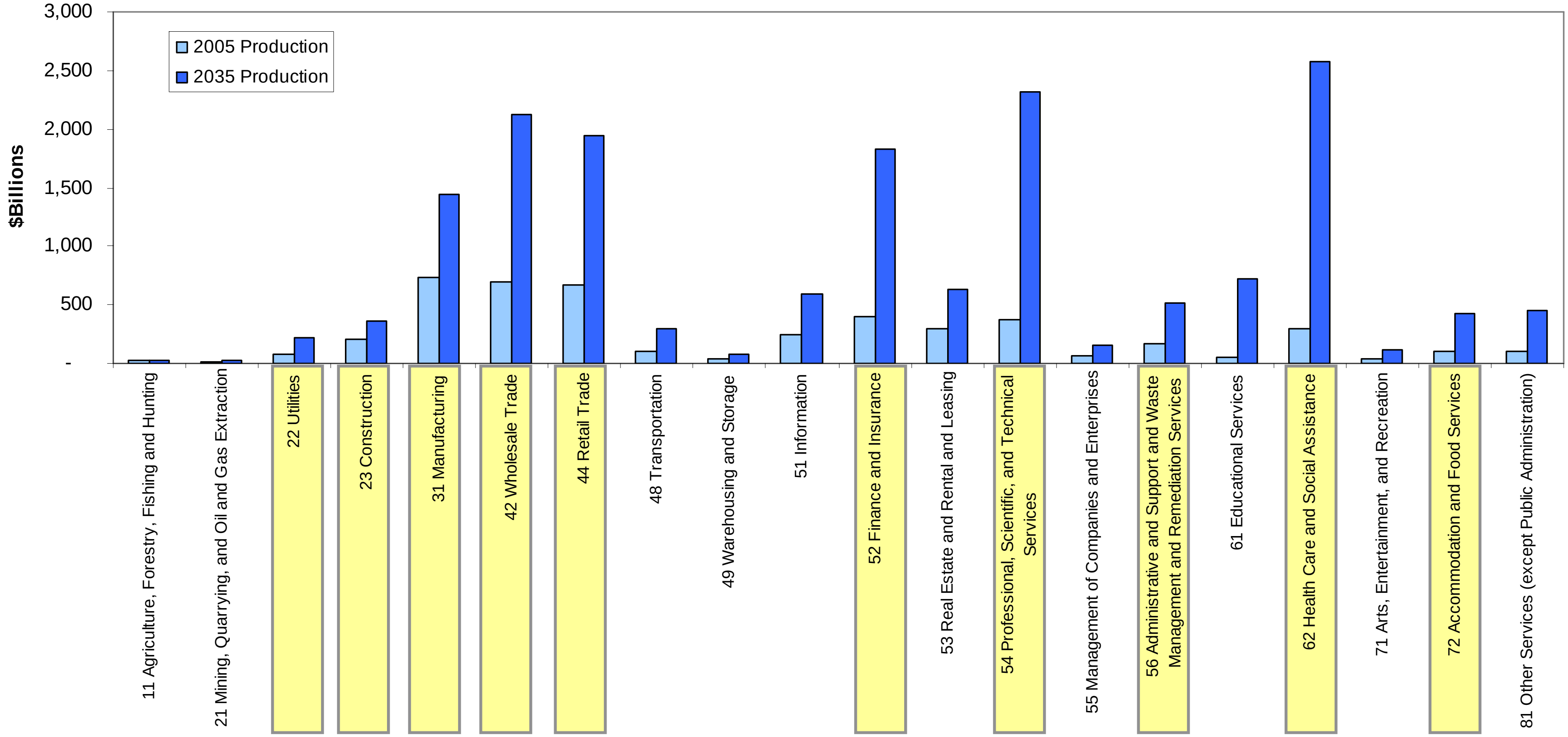
	Population			Employment		
State/US	2005 (thousands)	2030 (thousands)	Average Annual Growth (%)	2005 (thousands)	2035 (thousands)	Average Annual Growth (%)
Delaware	832	1,060	0.97%	376	513	1.04%
Maryland	5,637	7,287	1.03%	2,109	2,827	0.98%
New Jersey	8,765	10,466	0.71%	3,415	4,219	0.71%
New York	19,355	21,548	0.43%	7,108	8,570	0.63%
Pennsylvania	12,441	13,687	0.38%	5,039	5,991	0.58%
Virginia	7,567	10,033	1.13%	3,062	4,577	1.35%
Mid-Atlantic	54,597	64,082	0.64%	21,109	26,698	0.79%
Total U.S.	297,153	378,547	0.97%	174,176	252,435	1.24%

Source: Woods & Poole, 2008.

Growth by Industry

While the Mid-Atlantic will continue to experience growth, the types of industries that will grow in the future will be different than those that were prominent in the past. Figure 5.1 compares the region's major economic sectors, their current production value, and their expected future production value. Production value describes the contribution of a particular industry to the Gross Domestic Product (GDP) and defines its importance to the regional economy. The key industries (in terms of economic growth and freight transportation) are highlighted in yellow. Employment is not projected to grow as fast as the value of economic production because of automation and other productivity improvements.

Figure 5.1 Production Value Projections for Mid-Atlantic Industries, 2005 and 2035



Source: IHS-Global Insight, Inc., Business Demographics, 2008

The key industries in the region, described in approximate order of their expected contribution to the growth of the Mid-Atlantic economy over the next 30 years, are:

- **Health Care and Social Assistance** – An aging and growing population will create growth in demand for Health Care and Social Assistance industry. Dentists, doctors, hospitals, home health care, mental health, day care, and homeless shelters will need inbound shipments of supplies. These shipments will be relatively small in size compared to the demands or a more freight driven industry like manufacturing.
- **Professional, Scientific and Technical Services** – Growth in the Professional, Scientific, and Technical Services industry will be driven by the Computer Systems & Design Services sector. Revenue is projected to grow at 6.2 percent per year with employment growing at 2.2 percent per year. Increases in revenue and employment in this industry will require additional inbound shipment of supplies and equipment, but far less inbound shipments than manufacturing industry.
- **Wholesale Trade** – Durable Goods Wholesale growth will be driven by the Lumber & Construction Material; Hardware, Plumbing, and Heating Equipment, and Motor Vehicle Parts sectors. As a whole, revenue will grow at 3.8 percent per year but similar to the story of other key growth industries, the employment will grow at 0.5 percent per year due to productivity improvements. Increase in durable wholesale trade will increase inbound freight volumes of durable goods like autos, motor vehicles, motor vehicle parts, computers, photographic equipment, hobby goods, etc.
  - Non-durable Goods Wholesale growth will be driven by the Farm Products and Drug & Druggists Sundries industries. Revenue will grow at 3.7 percent with employment will grow at 0.46 percent per year. Increase in non-durable wholesale trade will increase inbound freight volumes of non-durable goods like food, beverage, and tobacco products, apparel, or chemical products.
- **Retail Trade** – Retail Trade growth will be driven by population growth. As the population grows, there will be more demand for consumer goods, groceries, etc. Growth in the retail trade industry will increase inbound freight volumes of all kinds of consumer goods.
- **Finance and Insurance** – Growth in the Finance and Insurance industry will be driven by Insurance Carriers & Related Activities and the Funds, Trusts, & Other Financial Vehicles sectors. The only industry that will beat national growth rates, revenue is forecasted to grow at 5.3 percent per year. The industry will not demand or produce much freight, requiring only inbound shipment of supplies and equipment.
- **Manufacturing** – There are three main types of manufacturing that are key to the continued growth of the Mid-Atlantic region – Food Product

Manufacturing; Petroleum & Coal Product Manufacturing, and Chemical Product Manufacturing. The Animal Food Manufacturing and the Grain & Oilseed Manufacturing sectors will drive growth in the Food Product Manufacturing industry. As a whole, the Food Product Manufacturing industry will experience revenue growth of 2.1 percent per year while productivity improvements will mean that employment will grow at 0.1 percent per year. The finished food products are shipped to grocery store and market warehouse and distribution centers throughout the country.

- The Petroleum & Coal Manufacturing industry will experience 2.4 percent revenue growth per year but will lose employment at the rate of 1 percent per year due to significant improvements in productivity per employee. Petroleum makes a significant contribution to distribution freight traffic volumes.
- The Agricultural Chemical Manufacturing (fertilizers) and Pharmaceutical & Medicine Manufacturing sectors will drive growth in the Chemical Manufacturing industry. Revenues will grow 3.45 percent per year, faster than either Food or Petroleum Manufacturing industries, but will experience employment loss of 1.4 percent per year due to significant employee productivity improvements.

Other industries that are expected to growth moderately, but generate substantial demand for freight transportation services are:

- **Administrative Support and Waste Management and Remediation** – Growth in the Administrative and Waste Management industry revenue will be driven by sectors like employment services, investigation and security, pest control, landscaping, waste collection, and waste treatment. Revenues will grow at a rate of 3.7 percent per year. The waste centers, specifically, produce a lot of truck traffic.
- **Accommodation and Food Service** – Growth in the Accommodation and Food Service industry will be driven by growth the Accommodations sector. Revenue will grow a 4.7 percent per year with lower employment growth due to increase in per employee productivity. The hotels, RV parks, places offering room and board, restaurants, and bars, will require inbound shipments of supplies and consumer goods in relatively small quantities.
- **Construction** – The Construction industry is driven by population growth. Construction industries, like building construction, bridge construction, or building equipment contractors, rely on shipments of masonry, pipes, beams, and wood products to build the region's homes, retail outlets, offices and infrastructure.
- **Utilities** – The Utilities industry is driven by population growth. As the population grows, there will be more homes to heat, more water to distribute, and more computers to power. Some utilities, like coal fired

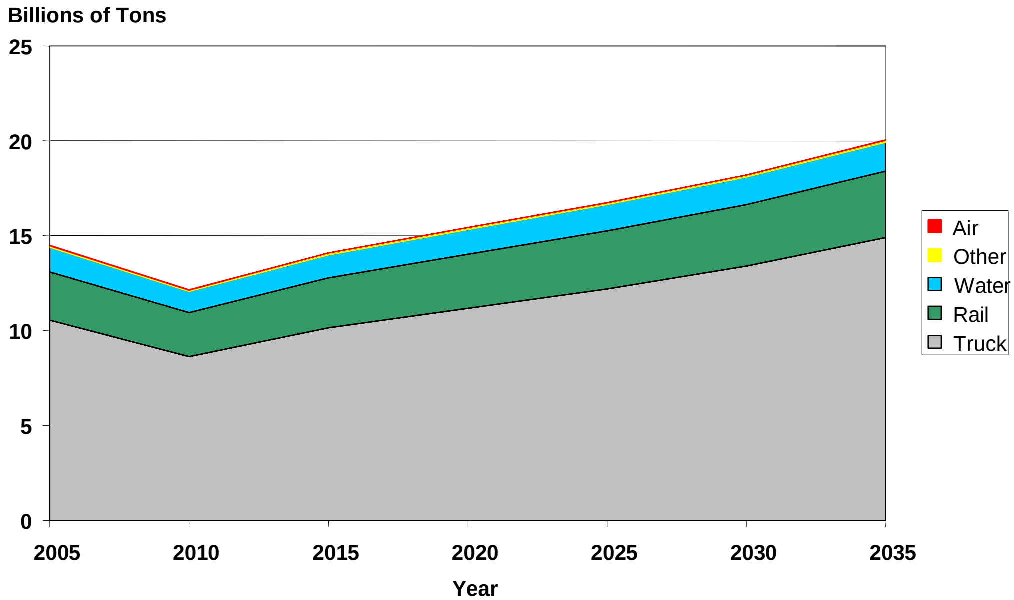
power plants, require significant inbound freight shipments for power generation.

The Impact of the Recession on Freight and MAROps Benefits

Population and economic growth in the Mid-Atlantic and the national economy will drive up the demand for freight transportation. In general, the volume of freight transportation tracks the growth in Gross Domestic Product (GDP). At the time the economic projections were prepared for this study, the GDP was expected to grow at an compound average annual rate of about 2.8 percent per year, slightly below the average of about 3 percent experienced over the previous 30 years. Total freight demand, measured by tonnage, was expected to grow by 63 percent between 2002 and 2035 with the value of goods shipped expected to grow by 186 percent during the same period.

However, since 2008, the nation has been suffering through a major recession. Economic growth and the demand for freight transportation have slowed. The economy is expected to recover beginning in late 2009 and 2010. The current expectation is that the economy will grow at rates of between 3 percent and 4 percent between 2010 and 2014, then track at an average growth rate of about 2.6 percent through 2035. This would result in a lower long-term demand for freight transportation than the initial forecast prepared for the study, which anticipated a longer-term growth rate of about 2.8 percent. Figure 5.2 shows the current projections for freight demand by tonnage in five-year increments from 2005 to 2035. The figure shows the sharp contraction of the economy in 2009 and 2010 and the anticipated growth in truck, rail, water, and air freight transportation demand as the economy recovers.

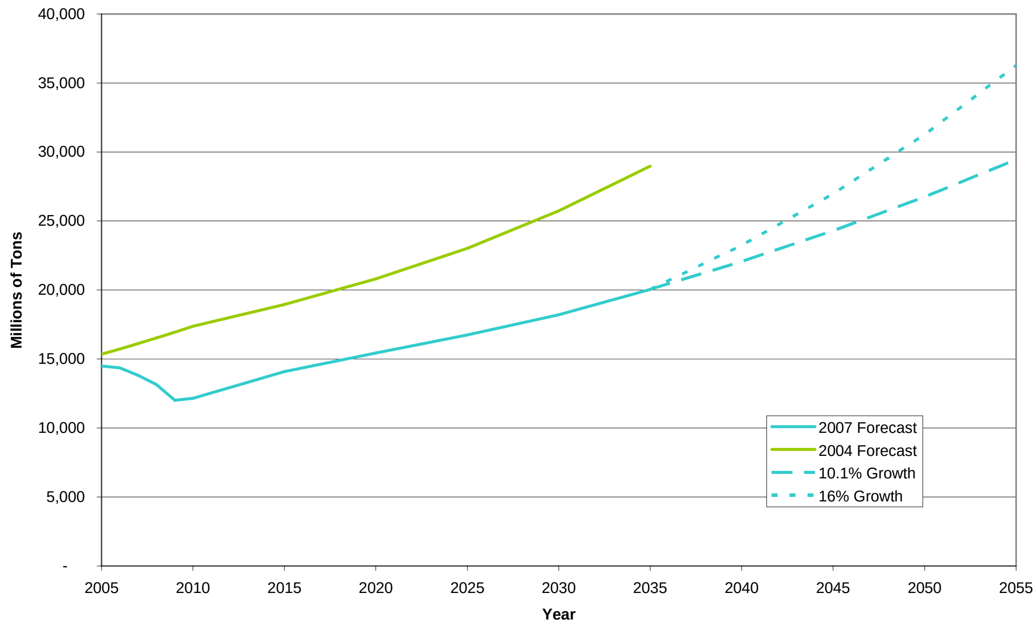
Figure 5.2 Projected Freight Transportation Demand, 2005 to 2035



Source: IHS-Global Insight, Inc., based on 2007 TRANSEARCH data and 2009 economic projections.

Figure 5.3 compares the initial freight demand projections prepared for the study using pre-recession data with more recent projections based on actual freight flow data through 2007 and early-2009 economic forecasts. The dashed lines show the effects of different assumptions about overall recovery rates. The comparison is very approximate, but suggests that it may be five to eight years or more before freight demand reaches the levels projected initially for 2035 for this study.

Figure 5.3 Projected Freight Transportation Demand, 2005 to 2035 and Beyond



Source: IHS-Global Insight, Inc., 2007 TRANSEARCH data and 2009 economic projections.

The recession has slowed growth in freight demand, but it has also slowed investment by the railroads and the states in their transportation networks. It is likely that the supply of new rail capacity will also lag. If this proves true, the LOS estimates and benefits reported will be reasonably accurate but will occur later than the 2035 planning year.

Impact of the Changing Economy on Rail Freight

MAROps economic projections indicate that rail freight demand is expected to grow more slowly than truck freight demand by 2035 in the MAROps region, leading to a decline in rail mode share to 10 percent. This decline is not the result of congestion or changes in the quality of rail service. Instead, it reflects the structural change in the economy of the Mid-Atlantic region, which is producing less heavy, lower-value commodities suited to rail transportation and more light-weight, higher-value commodities suited to truck transportation. The freight forecasts assume no shift in mode by commodities, so as the volume of heavy, lower-value commodities declines, so does the rail share. In practice, mode shares will shift if rail capacity, costs, and service reliability improve, making rail freight transportation more competitive with trucking.

The impact of population and economic growth and the shifts in trade patterns and trade flows are translated into commodity tonnage flows, then to equivalent rail carloads and trains. Table 5.3 lists the projected number of trains per day by

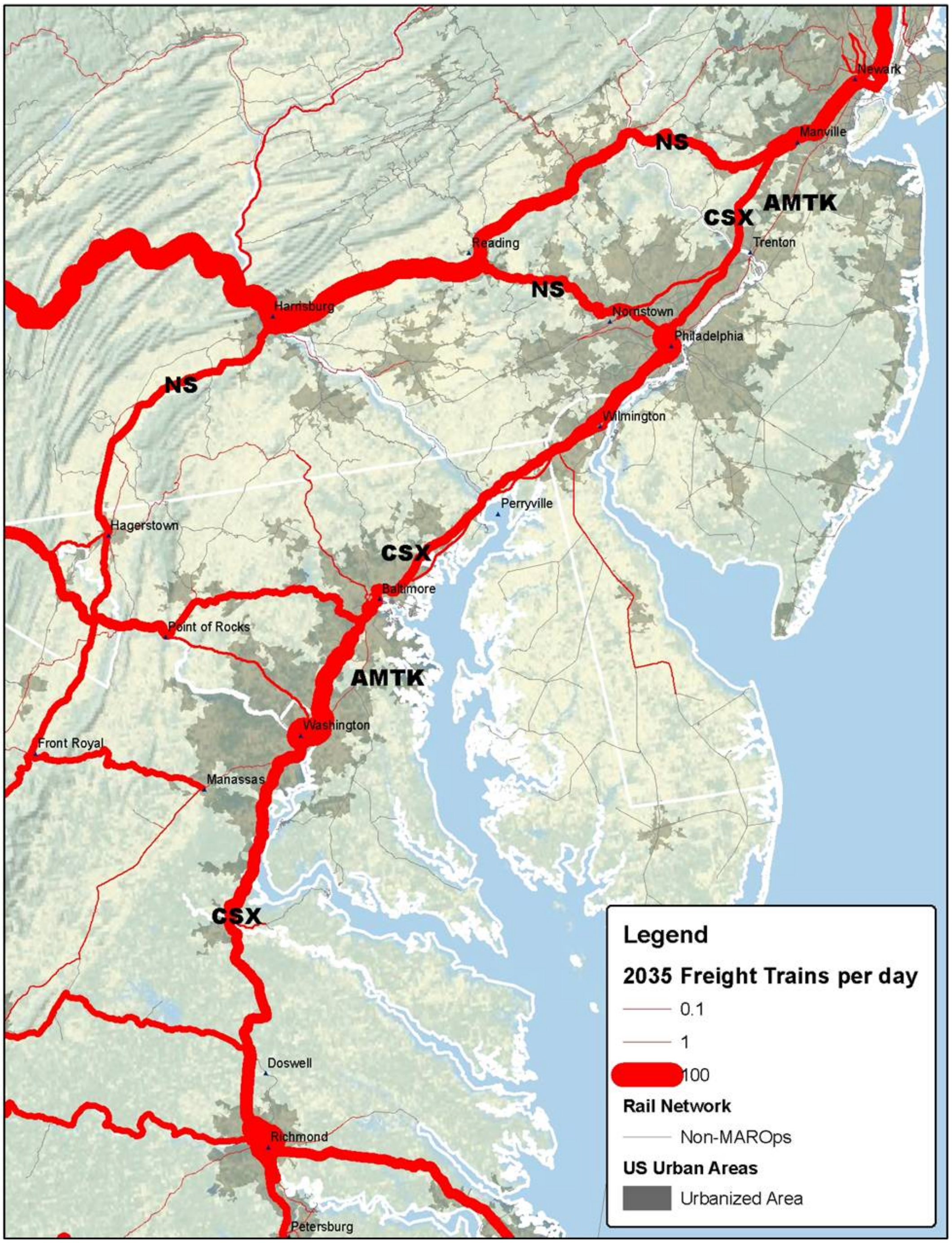
MAROps rail corridor and segment needed to accommodate the anticipated freight demand in 2035. Figure 5.4 maps the projected train volumes by corridor. The total number of freight trains on the rail segment is proportional to the thickness of the red lines.

Table 5.2 Average Trains per Day by MAROps Corridor, 2035

Segment (Corridor Number)	Average Trains per day (Segment)	Average Trains per day (Corridor)*
North Jersey terminal (1)	22	22
NS Newark-Harrisburg (2)	53	38
NS Harrisburg-Hagerstown (2)	33	
NS Hagerstown-Riverton Jct (2)	30	
NS Riverton Jct-Manassas (2)	25	
NS Philadelphia-Harrisburg (2)	21	
CSX Newark-Philadelphia (3)	35	47
CSX Philadelphia-Wilmington (3)	48	
CSX Wilmington-Baltimore (3)	34	
CSX Baltimore-Washington (3)	58	
CSX Washington-Richmond (3)	53	
Amtrak NEC Newark-Philadelphia (4)	0	7
Amtrak NEC Philadelphia-Wilmington (4)	21	
Amtrak NEC Wilmington-Baltimore (4)	12	
Amtrak NEC Baltimore-Washington (4)	1	

* The Average Trains per day (corridor) are calculated as the trains per day on each segment, weighted by the length of each segment.

Figure 5.4 Estimated Freight Train Flows in 2035



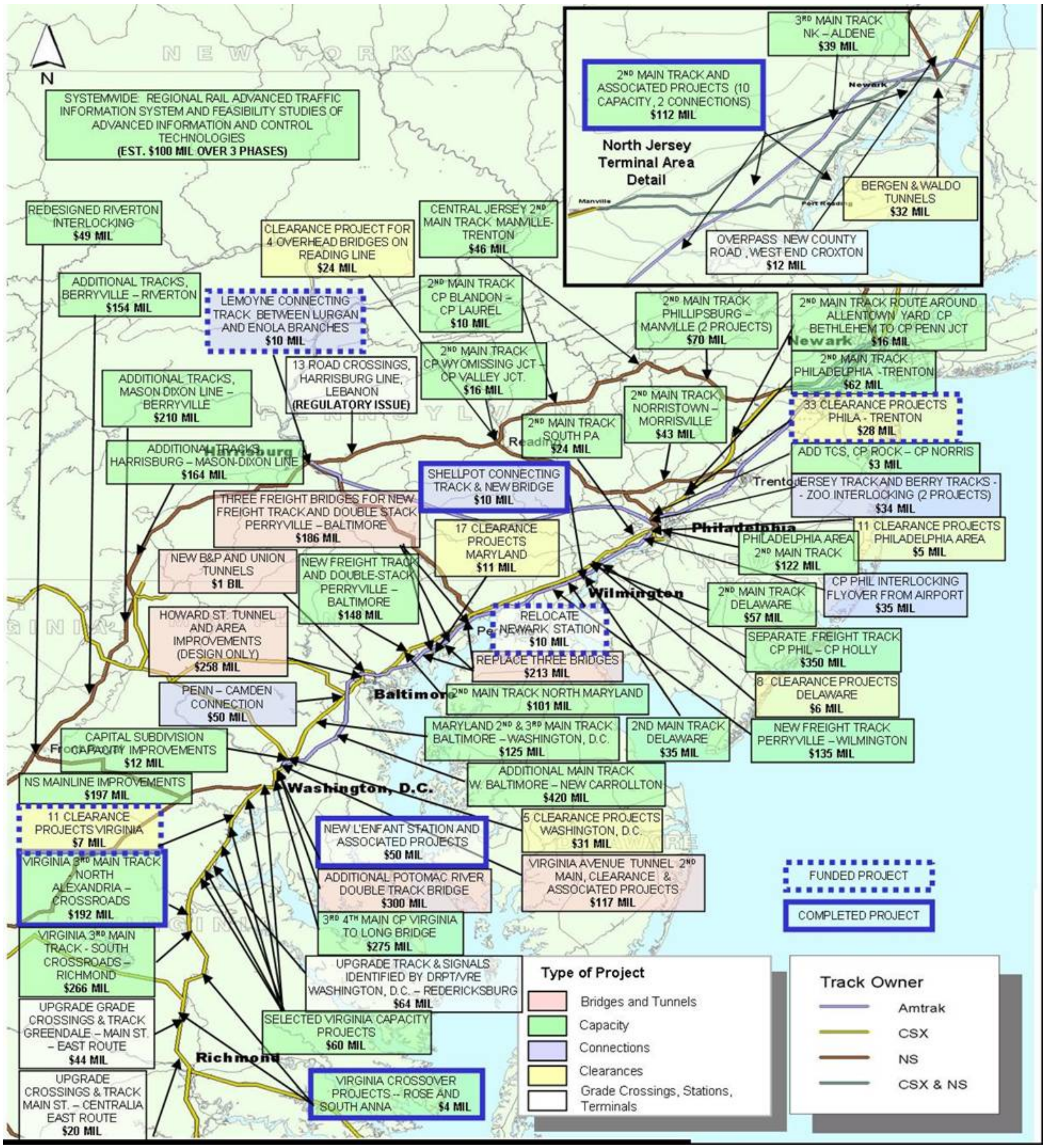
5.2 SUPPLY – PLANNED RAIL IMPROVEMENTS

In addition to the MAROps I projects completed through 2008 from the, five additional projects have been programmed by the MAROps states. These projects have dedicated funding and are expected to be constructed in the next five years. These projects do not impact the performance of the system today, but will impact it in the future and the analysis of the future MAROps system without the MAROps program assumes that these projects will be completed by 2035. Table 5.3 lists the projects that are included in current state transportation improvement programs or planned for construction by the railroads. Figure 5.5 maps all completed and programmed projects from the MAROps Phase I program with the projects programmed for implementation shown boxed with dotted blue lines.

Table 5.3 Funded (not yet completed) MAROps Phase I Projects

Railroad	Project Description	Project Type	Timeline
Conrail	Connect siding to Trenton Line to provide for opposing trains through Port Reading Jct.	Capacity	Near
CSX	33 clearance projects between SEPTA Woodbourne bridge (QA 26.53) and signal bridge at QA 6.3	Clearance	Near
NS	New connection between Hagerstown line and Enola Branches	Connection	Near
Amtrak	Additional sidings and relocate passenger station	Grade Crossings, Stations, and Terminals	Mid
Amtrak	Add third track segments; realign tracks; add high-speed crossovers; modify bridges along NEC	Capacity	Long
CSX	Third main, AF to RW , FB to HA	Capacity	Near
CSX	11 Clearance projects in Virginia	Clearance	Mid

Figure 5.5 Completed and Funded (not completed) MAROps Phase I Projects, 2009



5.3 Capacity and Level of Service

The freight level of service (LOS) on each corridor and segment is calculated assuming that all programmed projects are completed and rail demand increases as projected over the next 30 years. Table 5.4 summarizes the number of rail corridor miles by LOS for each corridor. Figure 5.6 maps the LOS for each rail line. Without improvements, the LOS across the MAROps rail network will deteriorate significantly. Some of the highlights include:

- Currently, 88 percent of corridor rail miles in the MAROps region operate below capacity (at LOS A, B, or C) and three percent operate at or above capacity (at LOS F). With the MAROps improvements, 43 percent of corridor rail miles in the MAROps region will operate below capacity (at LOS A, B, or C) and 30 percent will operate at or above capacity (at LOS F).
- The CSX I-95 route will become significantly congested, with only 20 percent of corridor miles along this route operating below capacity and 58 percent operating above capacity.
- Norfolk Southern's Harrisburg I-81 route will become more congested, but relatively less of its network will be above capacity (15 percent). The route from Newark to Reading shows some areas that are at or above capacity segments, but most of the corridor is expected to operate within capacity.
- Norfolk Southern's Hagerstown to Harrisburg line on NS is projected to be operating over capacity; and
- Freight movement on the Amtrak Northeast Corridor will be significantly congested in the heavily used sections between Philadelphia and Baltimore, with almost 20 percent of the network above capacity and another 27 percent at capacity. Given the hour of use restrictions for freight service on the NEC, even relatively modest increases in freight traffic on the route will result in significantly worse levels of service for freight trains.

Table 5.4 Freight Rail Level of Service by Corridor for Future Without MAROps Improvements and No Increase in Rail Mode Share, 2035

	Corridor 1 New Jersey Terminal	Corridor 2 NS I-81 Corridor	Corridor 3 CSX I-95 Corridor	Corridor 4 Amtrak Northeast Corridor	Overall
LOS A, B, C Below capacity	74%	53%	20%	55%	43%
LOS D Near capacity	19%	29%	0%	0%	12%
LOS E At capacity	0%	3%	22%	27%	15%
LOS F Above capacity	7%	15%	58%	18%	30%
Total Corridor Miles	*49*	*324*	*304*	*217*	*895*

Figure 5.6 Freight Rail Levels of Service by Corridor for Future Without MAROps Improvements and No Increase in Rail Mode Share, NS and CSX Corridors, 2035

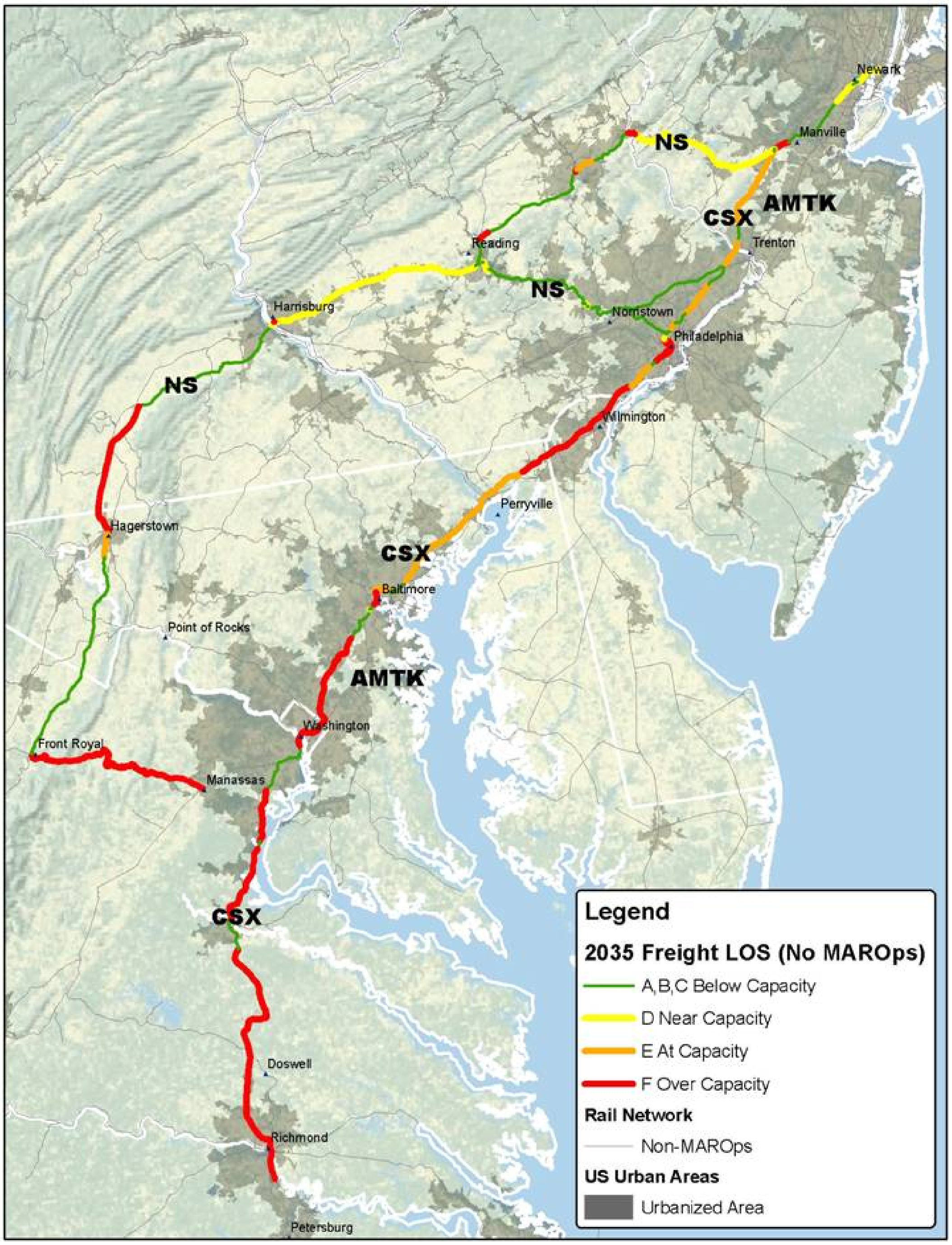
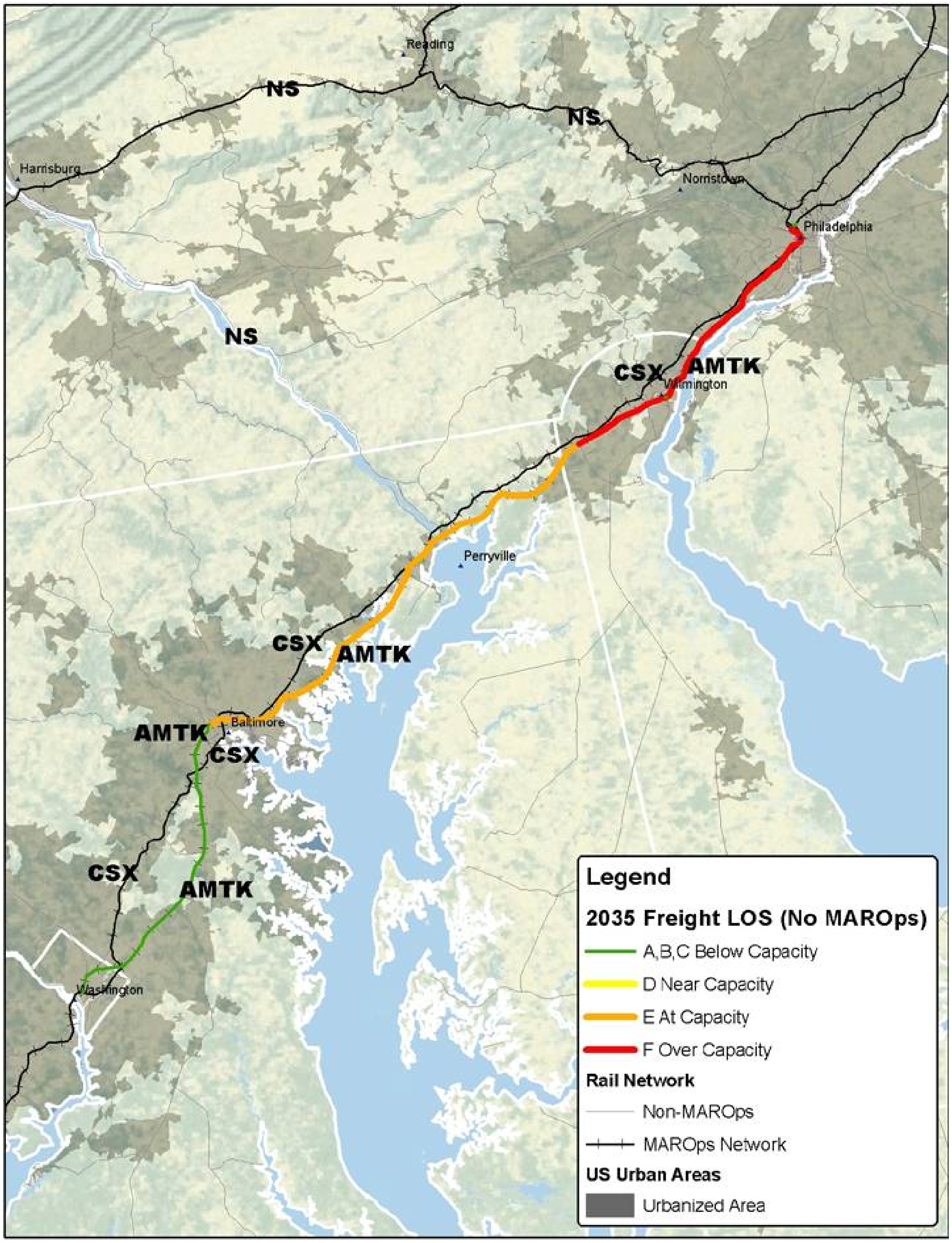


Figure 5.7 Freight Rail Levels of Service by Corridor for Future <u>Without</u> MAROps Improvements and <u>No</u> Increase in Rail Mode Share, NEC Freight Only, 2035

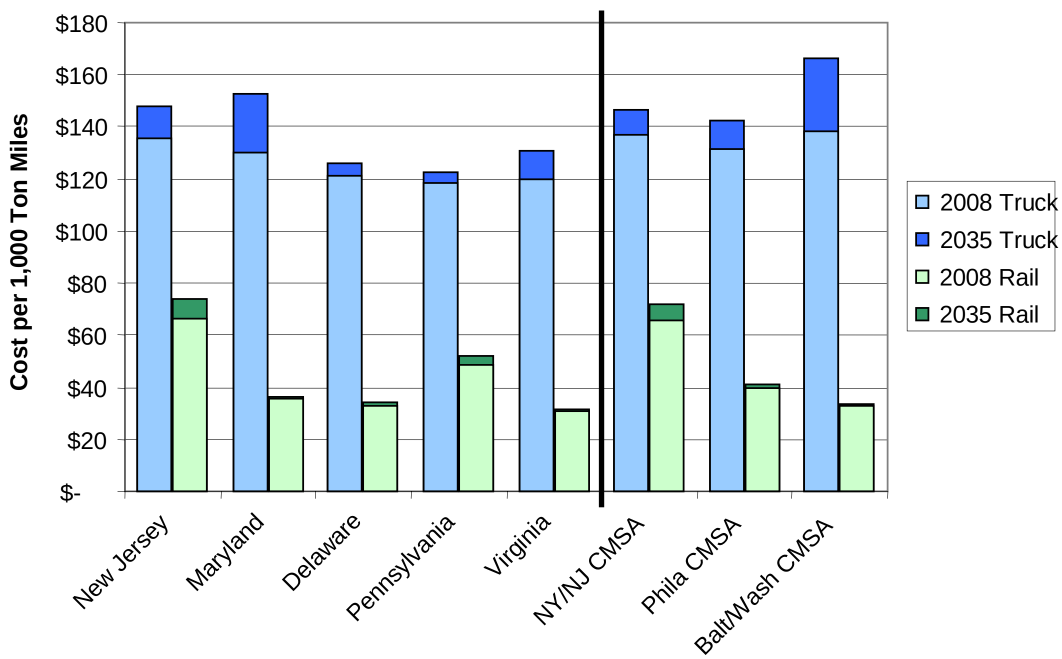


5.4 TRAVEL TIME BENEFITS

Freight traffic is projected to grow significantly by 2035. If only funded and planned projects are constructed, the rail network capacity constraints will cause significant delay to growing volumes of freight rail traffic. The additional delay will decrease the reliability of rail and increase average travel times. At the same time, increased shipment of goods by truck will increase roadway congestion and overall costs will rise accordingly.

For both truck and rail modes, increased traffic will increase the cost of doing business for operators and, as a result, for shippers. Figure 5.8 shows the change in the cost of doing business between 2008 and 2035 according to the TREDIS model outputs. The costs are based on changes in travel costs (e.g., crew costs and vehicle operating costs) per 1,000 ton miles for each of the five states and three major metropolitan areas in the study area. The results are expressed in thousands of ton miles to capture the relative cost of shipping goods.

Figure 5.8 Change in Travel Costs for Truck and Rail, from Current to Future Without MAROps Improvements and No Increase in Rail Mode Share



Across the board, shipping costs for both truck and rail are expected to increase. Truck costs increase somewhat faster than rail costs (8 percent compared to 5 percent). The largest increases in truck shipping costs are in Maryland (17 percent), and the Baltimore/Washington CMSA (20 percent). The largest increases in rail shipping costs are in New Jersey (11 percent) and the New York/New Jersey CMSA (10 percent).

6.0 Future of the Region With MAROps Improvements and No Increase in Rail Mode Share

This scenario estimates the future levels of service for each rail corridor and rail line segment assuming that the full MAROps program is implemented. It uses the same demand projections as the without MAROps scenario and assumes there is no increase in rail mode share. The scenario addresses the question: How well do the MAROps improvements meet project demand assuming no freight traffic is shifted from truck to rail? This scenario represents a possible, albeit very conservative, future condition. Its primary function is to serve as a base line for estimating the capacity of the rail system to carry a larger share of freight.

6.1 Demand – Regional Growth

This scenario assumes the same level of population and economic growth, the same total demand, and the same mode shares for truck and rail freight transportation in 2035 as the without MAROps scenario described in Section 5.0.

6.2 Supply – MAROps Improvements

The list of improvements proposed in the MAROps Phase I program was reviewed and updated. Railroad and state DOT officials identified completed and programmed (funded) projects, which were removed from the MAROps II program, and new or revised projects, which were added to the MAROps II program. A total of 217 projects were identified for the updated MAROps II program. They include 110 projects to add mainline capacity and 81 projects to provide doublestack clearance. There are also projects to expand terminal capacity, remove or rebuild grade crossings, replace or rehabilitate outdated bridges and tunnels, and add new communication/technology projects.

Included in the list are several projects that are also included in Amtrak's Master Plan for the Northeast Corridor. The Amtrak plan focuses on projects that will improve the capacity and level of service for intercity passenger and commuter rail operations while the MAROps study focuses primarily on projects that improve freight capacity and level of service. However, several projects are identified by both studies as mutually beneficial for freight and rail capacity. These include:

- Adding 8.5 miles of track from Perryville, MD north to Bacon to provide Norfolk Southern connections from the Port Road to the Northeast Corridor. This project would permit more frequent freight use of the Northeast Corridor than is allowed in the current freight window;
- Adding 21 miles of mainline track from Bacon to Iron, allowing more frequent freight use of the Northeast Corridor in this segment;
- Adding mainline track from Perryville to Baltimore, allowing more frequent freight use of the Northeast Corridor;
- Replacing the Gunpowder, Susquehanna, and Bush River rail bridges, and addressing clearance and limited track for freight operations (in Amtrak Long Term Capital Program);
- Improving or replacing the B&P and Union tunnels, which provide access to Amtrak's Penn Station in Baltimore. The Federal Railroad Administration (FRA) study of the Baltimore tunnels suggests providing combined freight operations for CSX and Norfolk Southern in a replacement tunnel for the Howard Street tunnel. The passenger tunnel replacement for the B&P and Union tunnels would have grades and curves that would not accommodate freight trains.
- Adding a 4th track on segments of NEC from Baltimore to New Carrollton, including Halethorpe to Baltimore Washington International Airport and Bowie to New Carrollton; reconfigure the existing four tracks west Baltimore to Halethorpe; and construct a new station at BWI with platforms on all tracks.

These projects were included in MAROps to improve the functioning of freight on the Northeast Corridor. They also are expected to have benefits for passenger trains (both intercity and commuter). In addition to these projects, there are significant additional investments being identified as part of the Amtrak Master Plan that are needed to meeting the goals for expanded and improved passenger service on the Northeast Corridor.

Closely related projects are grouped and their locations shown in Figure 6.1. Table 6.1 summarizes the estimated cost of the MAROps projects by corridor and segment.

Figure 6.1 MAROps Improvements

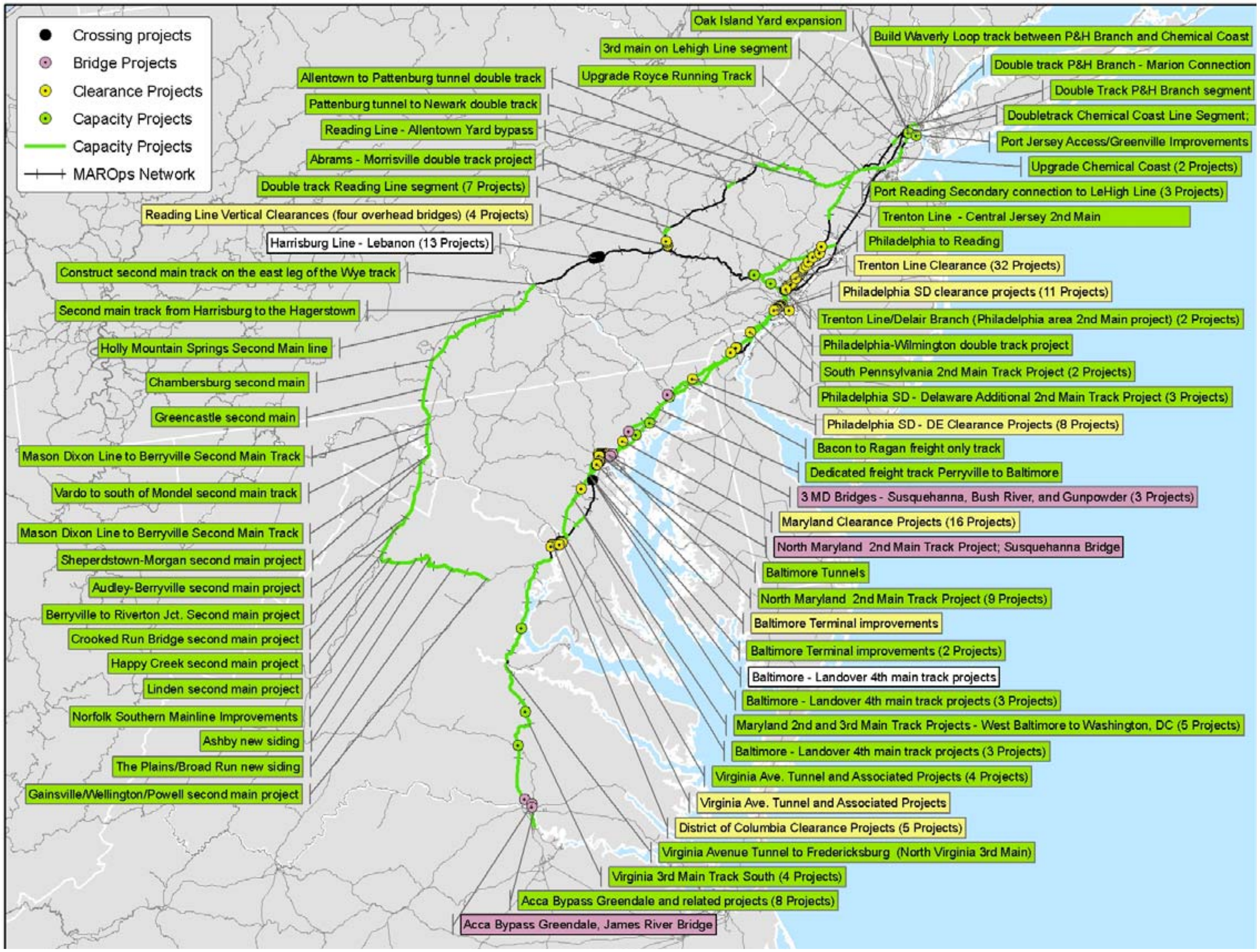


Table 6.1 MAROps Estimated Project Costs by Corridor and Segment

Segment (Corridor Number)	Clearance Projects ($ millions)	Other projects ($ millions)	Segment Total ($ millions)	Corridor Total ($ millions)
New Jersey terminal (1)	$206	$0	$0	$206
NS Newark-Harrisburg (2)	$189	$40	$0	
NS Harrisburg-Hagerstown (2)	$349	$0	$3	
NS Hagerstown-Riverton Jct (2)	$738	$0	$0	$1,818
NS Riverton Jct-Manassas (2)	$421	$0	$0	
NS Philadelphia-Harrisburg (2)	$78	$0	$0	
CSX Newark-Philadelphia (3)	$382	$47	$0	
CSX Philadelphia-Wilmington (3)	$134	$17	$0	
CSX Wilmington-Baltimore (3)	$1,168	$28	$0	$4,802
CSX Baltimore-Washington (3)	$421	$19	$0	
CSX Washington-Richmond (3)	$1,868	$51	$667	
Amtrak NEC Newark-Philadelphia (4)	$52	$0	$4	
Amtrak NEC Philadelphia-Wilmington (4)	$583	$0	$0	$5,172
Amtrak NEC Wilmington-Baltimore (4)	$1,995	$175	$0	
Amtrak NEC Baltimore-Washington (4)	$699	$0	$1,664	
Technology and Operations Improvements		$0	$0	$166
Totals	$9,282	$378	$2,505	$12,164

Note: Capacity projects are those that add mainline capacity; clearance projects remove clearances. Other projects include bridges and tunnels, grade crossing, technology, and communication projects.

Most of the projects are targeted to increase mainline capacity. Table 6.2 summarizes the number of added miles of track by corridor and segment. Over 660 miles of tack would be added as part of the MAROps program, including 30 miles in the New Jersey Terminal area, 330 miles on the Norfolk Southern route along I-81, 244 miles on the CSX route along I-95, and 58 miles on the Amtrak Northeast Corridor.

Table 6.2 Miles of Added Track by Corridor and Segment, 2035

Segment (Corridor Number)	Total (miles)	Corridor Total (miles)
New Jersey terminal (1)	29.7	29.7
NS Newark-Harrisburg (2)	49	
NS Harrisburg-Hagerstown (2)	94.3	
NS Hagerstown-Riverton Jct (2)	104.7	330.4
NS Riverton Jct-Manassas (2)	55.9	
NS Philadelphia-Harrisburg (2)	26.5	
CSX Newark-Philadelphia (3)	36.3	
CSX Philadelphia-Wilmington (3)	22.8	
CSX Wilmington-Baltimore (3)	60.9	244
CSX Baltimore-Washington (3)	36.9	
CSX Washington-Richmond (3)	87.1	
Amtrak NEC Newark-Philadelphia (4)	0.5	
Amtrak NEC Philadelphia-Wilmington (4)	17	
Amtrak NEC Wilmington-Baltimore (4)	30	57.8
Amtrak NEC Baltimore-Washington (4)	10.3	
Totals	661.9	661.9

6.3 Capacity and Level of Service

Implementing the MAROps projects will significantly improve the levels of service in 2035 compared to the without MAROps scenario. Table 6.3 shows the number of rail corridor miles by level of service (LOS) for each corridor. Figure 6.2 maps the levels of service for each rail line.

The improvements address most of the future capacity challenges identified in the without MAROps scenario. Overall, 81 percent of the network operates below capacity, compared to 43 percent without the MAROps improvements. However, even with the full set of MAROps improvements, there are capacity constraints at several locations, including the Howard Street Tunnel, the Washington, DC area, sections of the NEC near Wilmington, and in the Philadelphia area.

The LOS on the Howard Street Tunnel line reflects conservative assumptions by CSX about the number of trains that can be operated on that rail line. Ongoing FRA and Maryland DOT studies will provide more detailed information about the capacity of the rail line and tunnel segment.

The freight projects on Amtrak's NEC reduce a significant amount of the congestion compared to the without MAROps scenario. But, as is the case on the Norfolk Southern and CSX networks, there are specific locations where there are capacity shortfalls. These capacity shortfalls are located in densely populated urban areas in Baltimore, Wilmington, and Philadelphia where capacity expansion is difficult and expensive. Figure 6.3 maps the freight levels of service for each NEC rail line.

Table 6.3 Freight Rail Level of Service by Corridor for Future With MAROps Improvements and No Increase in Rail Mode Share, 2035

	Corridor 1 – New Jersey Terminal	Corridor 2 – NS I-81 Corridor	Corridor 3 – CSX I-95 Corridor	Corridor 4 – Amtrak Northeast Corridor	Overall
LOS A, B, C – Below capacity	96%	83%	68%	93%	81%
LOS D – Near capacity	4%	16%	10%	0%	9%
LOS E – At capacity	0%	0%	10%	1%	4%
LOS F – Above capacity	0%	1%	12%	5%	6%
Total Corridor Miles	*49*	*324*	*304*	*217*	*895*

Figure 6.2 Freight Rail Levels of Service by Corridor for Future With MAROps Improvements and No Increase in Rail Mode Share, NS and CSX Corridors, 2035

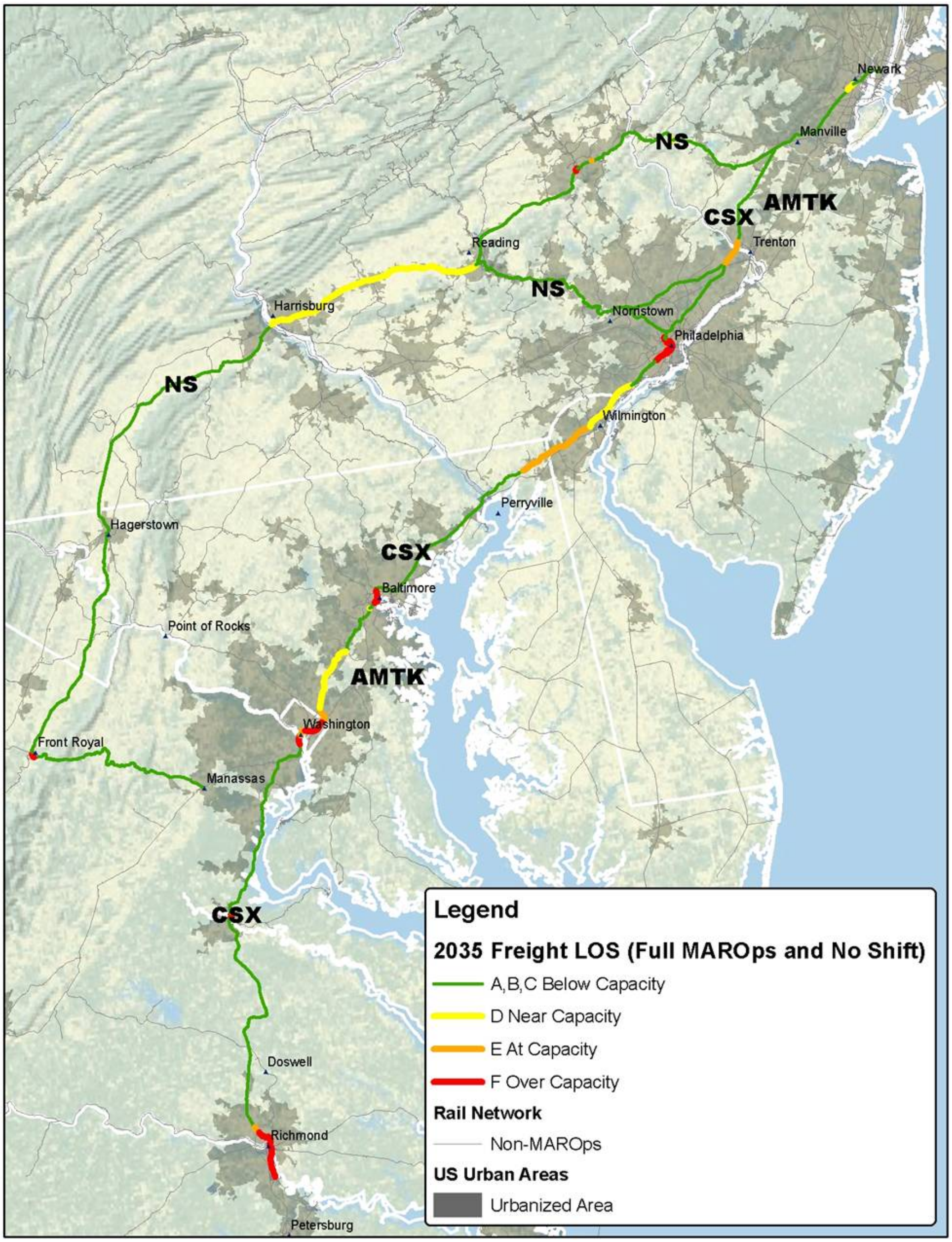
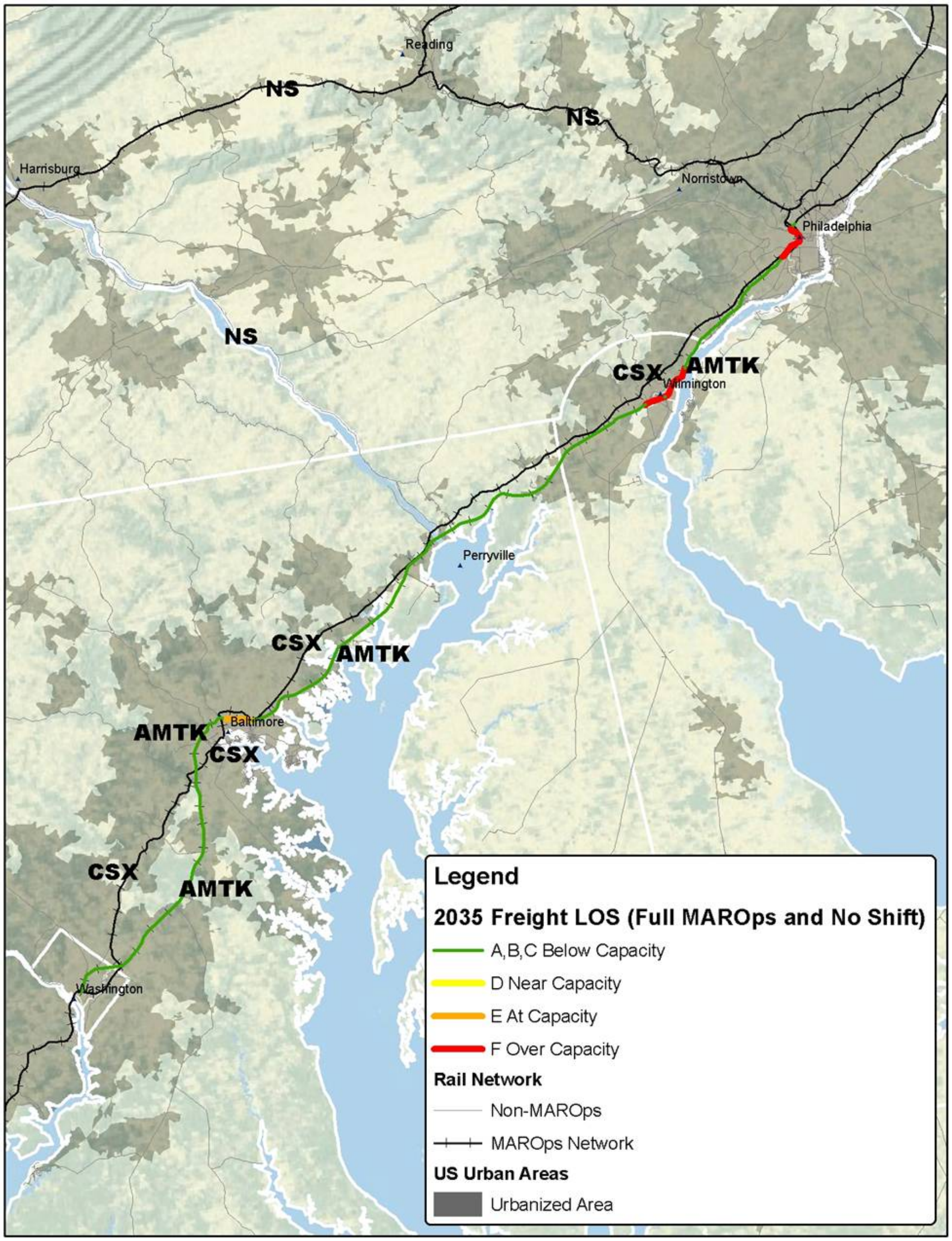


Figure 6.3 Freight Rail Levels of Service by Corridor for Future With MAROps Improvements and No Increase in Rail Mode Share, NEC Freight Only



6.4 Travel Time Benefits

The MAROps improvements will result in travel time improvements at major rail choke points. Table 3.2 lists the estimated travel time benefits for the major choke point projects. These estimates were reviewed by the freight railroad. The estimates reflect best professional judgments and could be refined by future operational simulation studies.

Table 6.4 Estimated Travel Time Benefits of Major Choke Point Reduction Projects

Project	Estimated Travel Time Benefits (Minutes per train)
Build Waverly Loop track between P&H Branch and Chemical Coast	10
Port Reading Secondary connection to Lehigh Line	3.2
Harrisburg Line – Lebanon, increase speed from 25 MPH to 40 MPH	2.4
Realign the mainline to eliminate the reverse curve at CP Ship	2
Virginia Avenue tunnel, upgrade track and bridge structures for 40 MPH	2
In Baltimore Terminal, convert HT switch to power switch South Baltimore Industrial Track TO in #1 Main at Clifford (BA 1.6 Curtis Bay Br).	10
B&P Tunnel-Union Tunnel replacement*	15
Howard Street Tunnel replacement*	15

Note: The current plan for replacement of the Howard Street, B&P and Union Tunnels anticipates combined NS and CSX freight operations in one tunnel and passenger operations in a separate tunnel. These tunnels would have different grades and depths and would not permit shared freight/passenger operations.

7.0 Future of the Region With MAROps Improvements and a High Increase in Rail Mode Share

This scenario estimates the future levels of service assuming that the full MAROps program is implemented and that the added capacity and service attracts a relatively large amount of additional freight traffic from truck to rail (i.e., a "high" increase in rail mode share).

7.1 Demand – Regional Growth with a High Increase in Rail Mode Share

Increasing the capacity of the network has the potential to increase the share of freight captured by rail service in 2035. As described in Section 3.0, potential mode share shifts were estimated by comparing current rail shares by commodity and market pairs (i.e., city pairs) in the MAROps region with similar rail market pairs nationally. Table 7.1 summarizes the results of the rail mode share analysis by MAROps rail corridor and segment. The table shows the estimated number of trains with and without the MAROps improvements. The number of trains is based on the potential increase in rail freight tonnage by commodity and market pair.

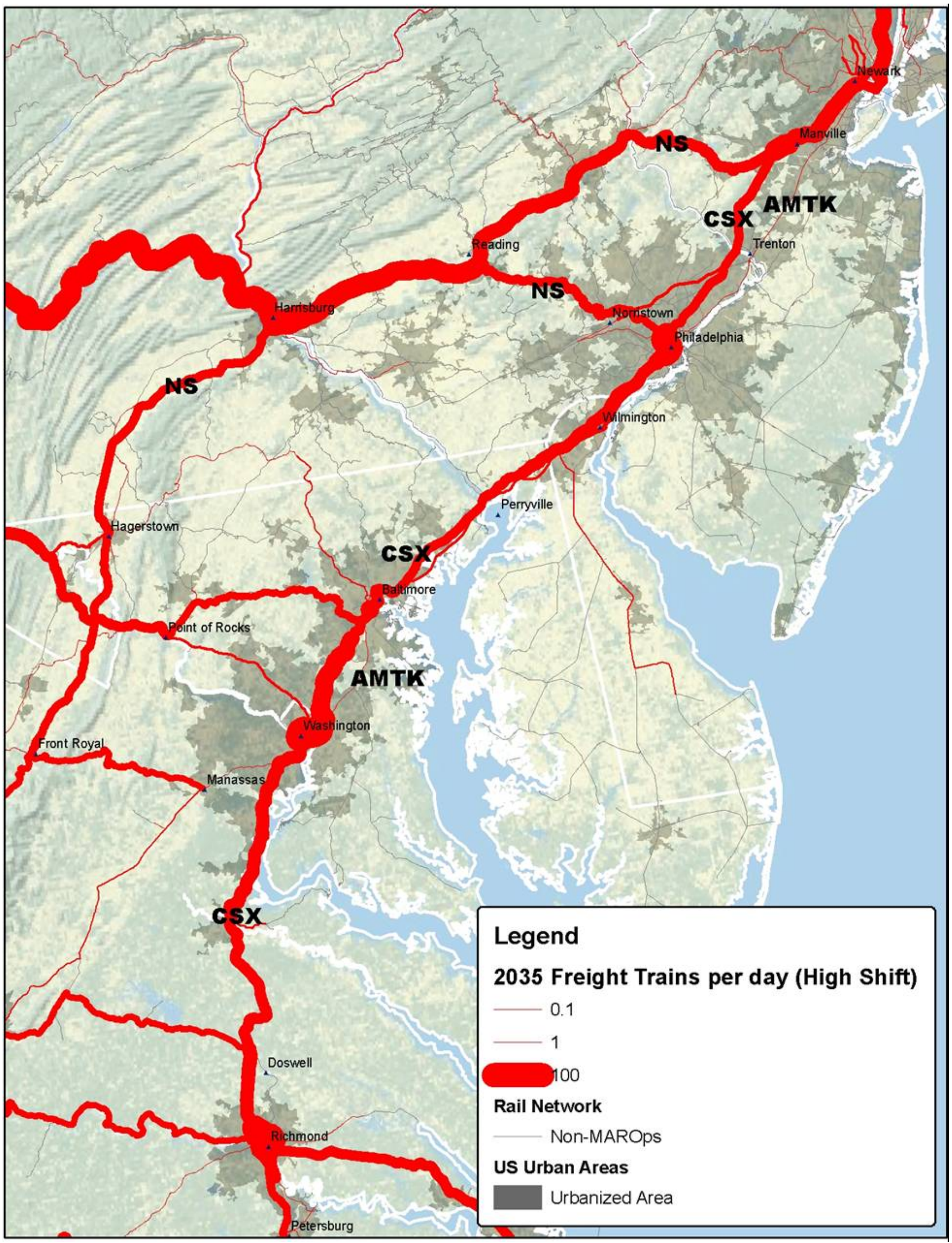
Table 7.1 Projected Number of Trains by Corridor for Future With MAROps Improvements and High Increase in Rail Mode Share, 2035

Segment (Corridor Number)	Average Trains per Day, 2035	
	Without MAROps	With MAROps and High Mode Shift
New Jersey terminal (1)	22	25
NS Newark-Harrisburg (2)	53	61
NS Harrisburg-Hagerstown (2)	33	37
NS Hagerstown-Riverton Jct (2)	30	34
NS Riverton Jct-Manassas (2)	25	26
NS Philadelphia-Harrisburg (2)	21	26
CSX Newark-Philadelphia (3)	35	40
CSX Philadelphia-Wilmington (3)	48	57
CSX Wilmington-Baltimore (3)	34	43
CSX Baltimore-Washington (3)	58	62
CSX Washington-Richmond (3)	53	56
Amtrak NEC Newark-Philadelphia (4)	0	0
Amtrak NEC Philadelphia-Wilmington (4)	21	21
Amtrak NEC Wilmington-Baltimore (4)	12	12
Amtrak NEC Baltimore-Washington (4)	1	1
Totals	446	501

According to the market share analysis, both the Norfolk Southern and CSX mainlines show the potential for additional growth. The segments with the largest potential growth are the Norfolk Southern line from Philadelphia to Harrisburg (17 percent increase in the Mid-West to Mid-Atlantic market share), the CSX line between Philadelphia and Wilmington (15 percent increase), and the CSX line between Wilmington and Baltimore (19 percent increase because double stack clearance allows CSX traffic between the Mid-West and Mid-Atlantic cities to move more directly to the region rather routing through Albany, NY). Most of the increase in mode share comes in intermodal traffic.

Figure 7.1 maps the projected number of trains by corridor for future with MAROps improvements and a high increase in rail mode share.

Figure 7.1 Projected Number of Freight Trains per Day by Corridor for Future With MAROps Improvements and High Increase in Rail Mode Share, 2035



7.2 Supply – MAROps Improvements

This scenario assumes the same level of MAROps improvements in 2035 as the with MAROps improvements and no increase in rail mode share described in Section 6.0.

7.3 Capacity and Level of Service

Table 7.2 summarizes the number of rail corridor miles by level of service (LOS) for each corridor for the future scenario with MAROps improvements and a high increase in rail mode share by 2035. For comparison, the lower half of the table reports the LOS percentages for the future scenario with MAROps and no increase in rail mode share. Figure 7.3 maps the LOS by corridor and segment.

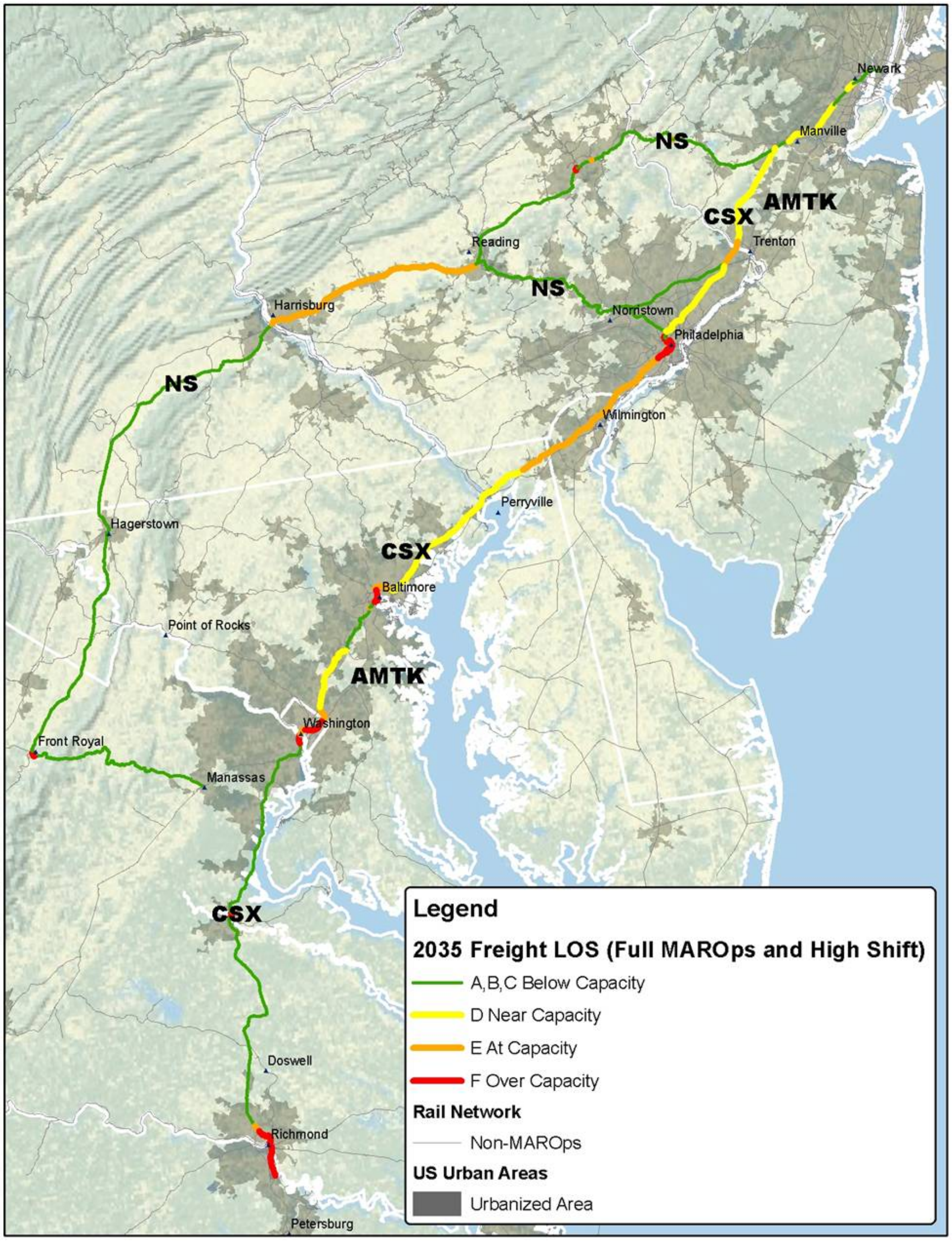
The analysis shows that 70 percent of the system operates below capacity (at LOS A, B or C) and six percent above capacity (at LOS F). The findings suggests that the MAROps rail system could accommodate a significant amount of additional traffic with the MAROps investments. With the additional traffic, several locations would still operate at or near capacity:

- For CSX, the route between Philadelphia and Wilmington reaches capacity and the overall utilization of the line increases: with no increase in rail mode share, 20 percent of the line operate at or near capacity (at LOS D or E); with a high increase in rail mode share 48 percent operates at or near capacity. Most of the capacity constraints are within the urban areas of Washington, Baltimore, Wilmington, and Philadelphia;
- For Norfolk Southern, the segments between Reading and Harrisburg, MD show growing congestion: the 16 percent of network that was operating near capacity (at LOS D) now operates at capacity (at LOS E); and
- In the Northeast Corridor, there is no increase in rail mode share and no change in the capacity constraints compared to the with MAROps and no increase in rail mode share scenario).

Table 7.2 Freight Rail Level of Service by Corridor for Future With MAROps Improvements and High Increase in Rail Mode Share

	Corridor 1 New Jersey Terminal	Corridor 2 NS I-81 Corridor	Corridor 3 CSX I-95 Corridor	Corridor 4 Amtrak Northeast Corridor	Overall
High Mode Shift					
LOS A, B, C Below capacity	65%	83%	40%	93%	70%
LOS D Near capacity	35%	0%	29%	0%	12%
LOS E At capacity	0%	16%	19%	1%	13%
LOS F Above capacity	0%	1%	12%	5%	6%
No Mode Shift					
LOS A, B, C Below capacity	96%	83%	68%	93%	81%
LOS D Near capacity	4%	16%	10%	0%	9%
LOS E At capacity	0%	0%	10%	1%	4%
LOS F Above capacity	0%	1%	12%	5%	6%
Total Corridor Miles	49	324	304	217	895

Figure 7.2 Freight Rail Levels of Service by Corridor for Future With MAROps Improvements and High Increase in Rail Mode Share, NS and CSX Corridors, 2035



7.4 Economic Benefits

The benefits of the future scenario with MAROps and a high increase in rail mode share are measured as changes in:

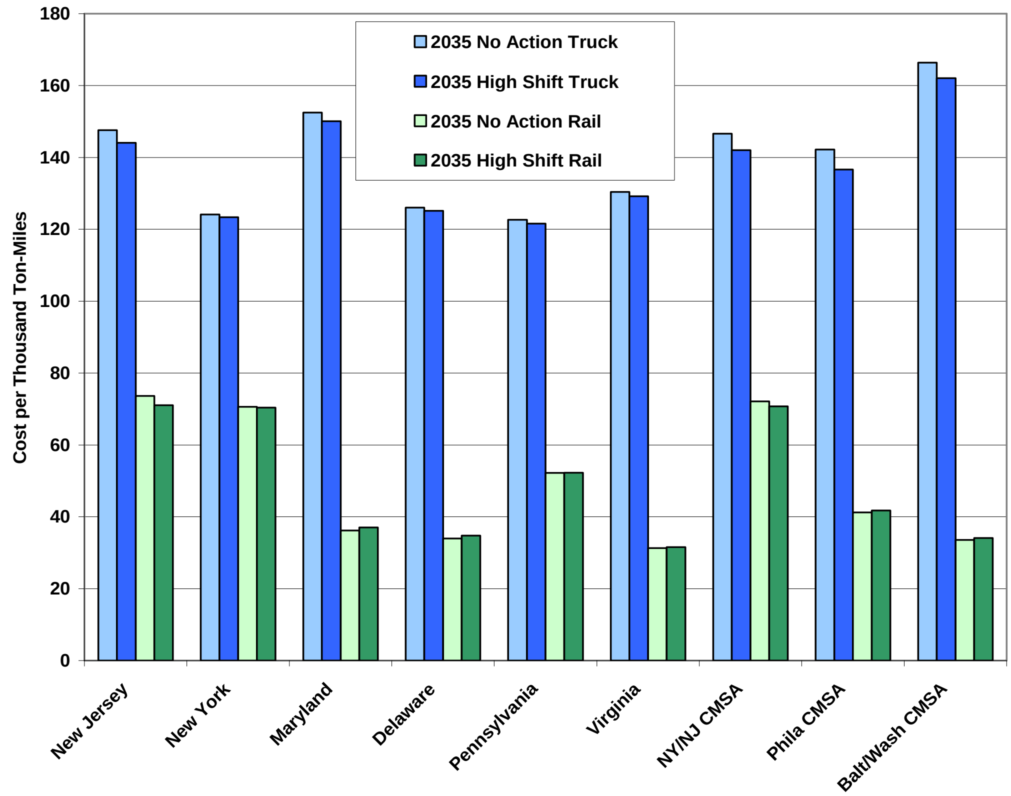
- Transportation costs (i.e., shipper costs) for use of the rail and truck networks; and
- Impacts on business output, job creation, and related factors.

Table 7.3 shows the percentage change in rail and truck costs per thousand ton-miles from the future without MAROps (no action) to the future with MAROps and high increase in rail mode share. The table shows the percentages by state and major metropolitan area. With the full MAROps program implemented, most states and regions experience a decline in shipping costs by truck, but some see increases in shipping costs by rail. Total truck shipping costs decline more than rail because of a shift of goods from truck to rail. The average cost of shipping declines because of the relatively higher costs (and consequently the relatively higher cost savings) of shipping by truck. The increase in cost for rail in some areas reflects structural changes in the economies of those areas, the increase in rail mode share, and the decrease in congestion from the implementation of the MAROps program. Figure 7.5 shows the corresponding absolute changes in rail and truck cost per thousand ton-miles.

Table 7.3 Change in Rail and Truck Costs from Future Without MAROps Improvements to Future With MAROps Improvements and High Increase in Rail Mode Share, 2035

State/Region	Change in Truck Cost per 1000 Ton-Miles	Change in Rail Cost per 1000 Ton-Miles	Change in Average Cost/ per 1000 Ton-Miles
New Jersey	-2%	-4%	-3%
Maryland	-1%	0%	0%
Delaware	-2%	2%	-1%
Pennsylvania	-1%	2%	0%
Virginia	-1%	0%	-1%
NY/NJ CMSA	-1%	1%	-1%
Philadelphia CMSA	-3%	-2%	-3%
Baltimore/Washington CMSA	-4%	1%	-3%

Figure 7.3 Change in Travel Costs for Rail and Truck from Future Without MAROps and No Increase in Rail Mode Share to Future With MAROps and High Increase in Rail Mode Share, 2035



The impacts of the MAROps program on business output, employment growth, and wage income come from construction expenditures and improved accessibility to regional and local markets. Table 7.4 summarizes the projected change in business output, employment growth, and wage income by state and major metropolitan area between a future without MAROps improvements and no increase in rail mode share and a future with MAROps improvements and a high increase in rail mode share. Table 7.5 shows the corresponding percentage change in business output, employment growth, and wage income by states.

Implementing the full MAROps program is projected to contribute $1.3 billion in business output and 9,800 jobs to the five-state region each year. Benefits accrue to all five states and the three major metropolitan area within region. Maryland and Pennsylvania are projected to see the largest absolute benefits, followed closely by Virginia, reflecting large construction investments, greater anticipated population and economic growth, and significant savings from mode shifts in those states.

Relative to the existing economic base, Delaware and Maryland are expected to experience the most significant percentage growth in business output, value added, and jobs, with Virginia not far behind.

The benefits for the major metropolitan areas (CMSAs) are greater than for the states because employment and business is projected to continue to shift from exurban and rural parts of the states to metropolitan areas.

Table 7.4 Estimated Economic Benefits of Future With MAROps Improvements and High Increase in Rail Mode Share, 2035

State/Region=	Business Output ($ million/year)	Value Added ($ million/year)	Jobs (per year)	Wage Income ($ million/year)
Delaware	$75	$36	583	$28
Maryland	$371	$202	2,913	$152
New Jersey	$203	$110	1,314	$75
Pennsylvania	$349	$190	2,836	$134
Virginia	$272	$143	2,226	$106
Total for States	$1,269	$681	9,873	$495
NY/NJ CMSA	$358	$204	2,398	$139
Philadelphia CMSA	$355	$189	2,490	$134
Baltimore-Washington CMSA	$528	$290	4,066	$218

Table 7.5 Percentage Change in Estimated Economic Benefits for Future With MAROps Improvements and High Increase in Rail Mode Share, 2035

State	Business Output	Value Added	Jobs	Wage Income
Delaware	8.0%	2.6%	3.3%	0.9%
Maryland	6.3%	2.3%	2.6%	1.1%
New Jersey	2.1%	0.7%	0.8%	0.3%
Pennsylvania	0.4%	0.0%	0.0%	0.0%
Virginia	4.3%	1.6%	1.8%	0.6%

Table 7.6 shows the distribution of economic benefits (measured by business output) by MAROps rail corridor. The table shows the benefits for the future with MAROps improvements and a high increase in rail mode share scenario.

Table 7.6 Estimated Business Output (in millions of dollars annually) by Rail Corridor for Future With MAROps Improvements and High Increase in Rail Mode Share, 2035

	Corridor 1 New Jersey Terminal	Corridor 2 NS I-81 Corridor	Corridor 3 CSX I-95 Corridor	Corridor 4 Amtrak Northeast Corridor
Delaware	$259	$1,331	$550	$99
Maryland	$1,050	$4,191	$5,075	$811
New Jersey	$2,101	$2,433	$1,522	$25
Pennsylvania	$2,104	$4,841	$3,314	$221
Virginia	$620	$3,290	$3,649	$591
State Totals	*$6,135*	*$16,086*	*$14,110*	*$1,748*
NY/NJ CMSA	$3,824	$3,923	$2,980	$25
Philadelphia CMSA	$812	$6,522	$3,229	$77
Baltimore-Washington CMSA	$1,069	$5,309	$7,691	$1,761

The Norfolk Southern and CSX corridors contribute the greatest overall benefits to the program, which is explained by the substantially larger number of projects along these two routes compared the number of improvements within the New Jersey Terminal or along the Amtrak Northeast Corridor. Delaware, New Jersey, and Pennsylvania accrue benefits from the Norfolk Southern corridor improvements because these states are expected to experience a relatively larger reduction in truck travel from the Norfolk Southern improvements compared to other states. Conversely, Maryland and Virginia benefit from the shift in truck traffic triggered by the CSX corridor improvements.

The approximate benefit/cost (B/C) ratio of implementing the full MAROps program is 1.86. This calculation includes traveler benefits/costs (A), shipper logistics costs (B), and societal benefits (C) as summarized in Table 7.7.

Table 7.7 Benefit/Cost Ratio for Future With MAROps Improvements and High Increase in Rail Mode Share, 2035

Category	Definition*	Present Value of Benefits	Present Value of Costs	Net Present Value (Benefits - Costs)	Benefit/Cost Ratio
Traveler Benefits	A	$13,760	$8,413	$5,347	1.64
Traveler and Shipper Benefits	A+B	$15,247	$8,413	$6,834	1.81
Total (Traveler, Shipper, and Societal) Benefits	A+B+C	$15,615	$8,413	$7,202	1.86

* Key to Definitions: A = Traveler benefits; B = Shipper logistics benefits; C = Societal benefits

8.0 Future of the Region With Priority MAROps Improvements and a Low Increase in Rail Mode Share

This scenario estimates the future levels of service assuming that only the priority projects in the MAROps program are implemented and that the added capacity and service attracts a relatively small amount of additional freight traffic from truck to rail (i.e., a "low" increase in rail mode share). The project steering committee of freight and passenger railroad and state transportation officials used the results of the prior scenarios, especially the "future scenario with MAROps improvements and high increase in rail mode share" and their best professional judgment to identify a set of priority projects (also described as Tier I projects). These projects were judged to be critical path projects that would yield the highest near-term benefits. This scenario assumes that only the priority projects are implemented.

8.1 Demand – Regional Growth with a Low Increase in Rail Mode Share

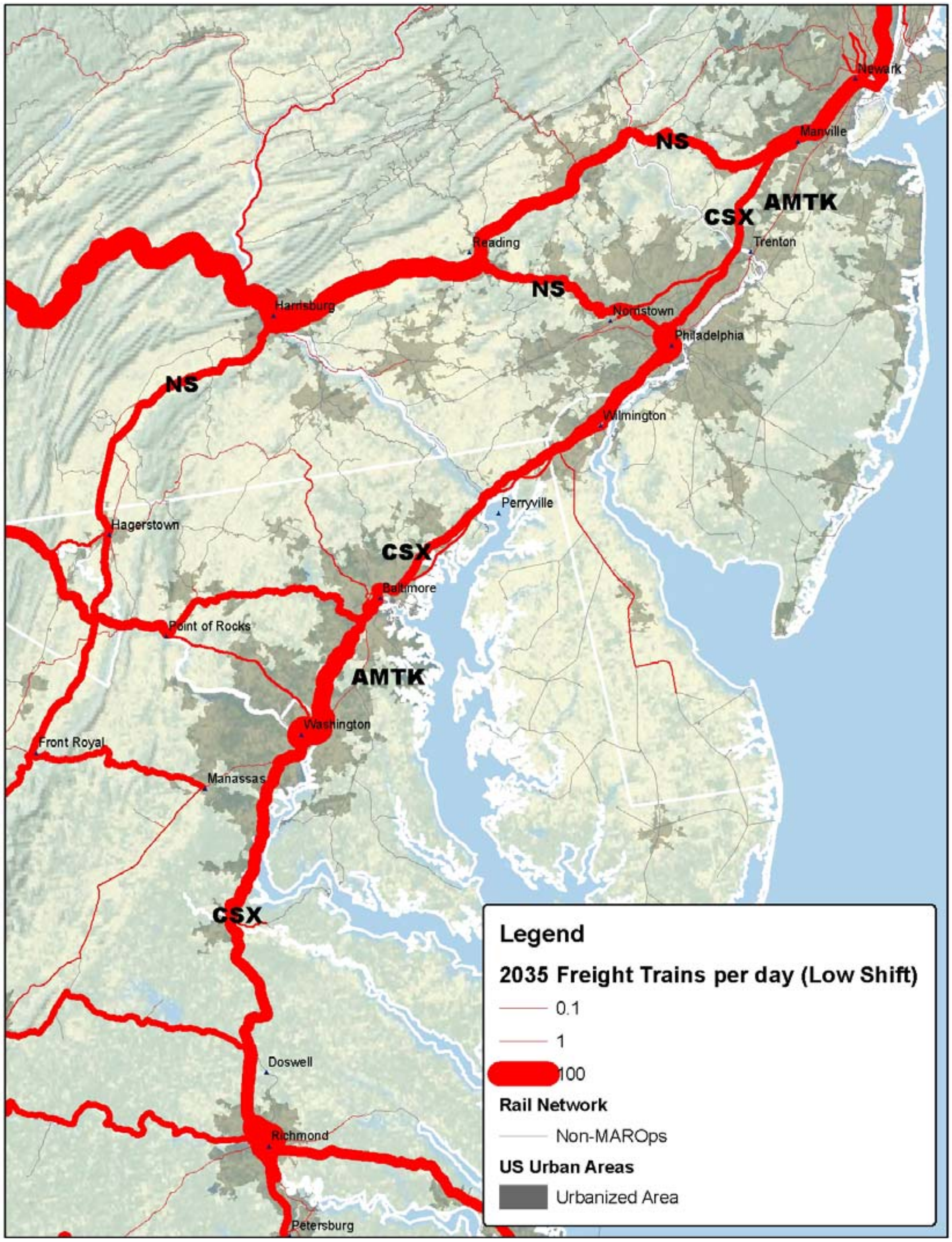
This scenario assumes the same level of population and economic growth as the previous scenario, but with a low increase rail mode share. Implementation of the priority MAROps projects will increase capacity and reduce congestion, but are assumed to support less growth in rail mode share than full implementation. Table 8.1 lists the projected number of trains for the priority MAROps projects and a low increase in rail mode share scenario.

Table 8.1 Projected Number of Trains by Corridor for Future With Priority MAROps Improvements and Low Increase in Rail Mode Share, 2035

Segment (Corridor Number)	Average Trains per Day, 2035	
	Without MAROps	With Priority MAROps and Low Mode Shift
New Jersey terminal (1)	22	23
NS Newark-Harrisburg (2)	53	55
NS Harrisburg-Hagerstown (2)	33	34
NS Hagerstown-Riverton Jct (2)	30	31
NS Riverton Jct-Manassas (2)	25	25
NS Philadelphia-Harrisburg (2)	21	22
CSX Newark-Philadelphia (3)	35	36
CSX Philadelphia-Wilmington (3)	48	50
CSX Wilmington-Baltimore (3)	34	36
CSX Baltimore-Washington (3)	58	59
CSX Washington-Richmond (3)	53	54
Amtrak NEC Newark-Philadelphia (4)	0	0
Amtrak NEC Philadelphia-Wilmington (4)	21	21
Amtrak NEC Wilmington-Baltimore (4)	12	12
Amtrak NEC Baltimore-Washington (4)	1	1
Totals	446	459

In this scenario, the majority of new rail traffic comes from bulk commodities. Railroads are already competitive with trucks in these commodity markets and the priority MAROps improvements are judged to have the most impact in shifting these commodities from truck to rail. Figure 8.1 maps the projected number of trains by corridor for future with priority MAROps improvements and a low increase in rail mode share.

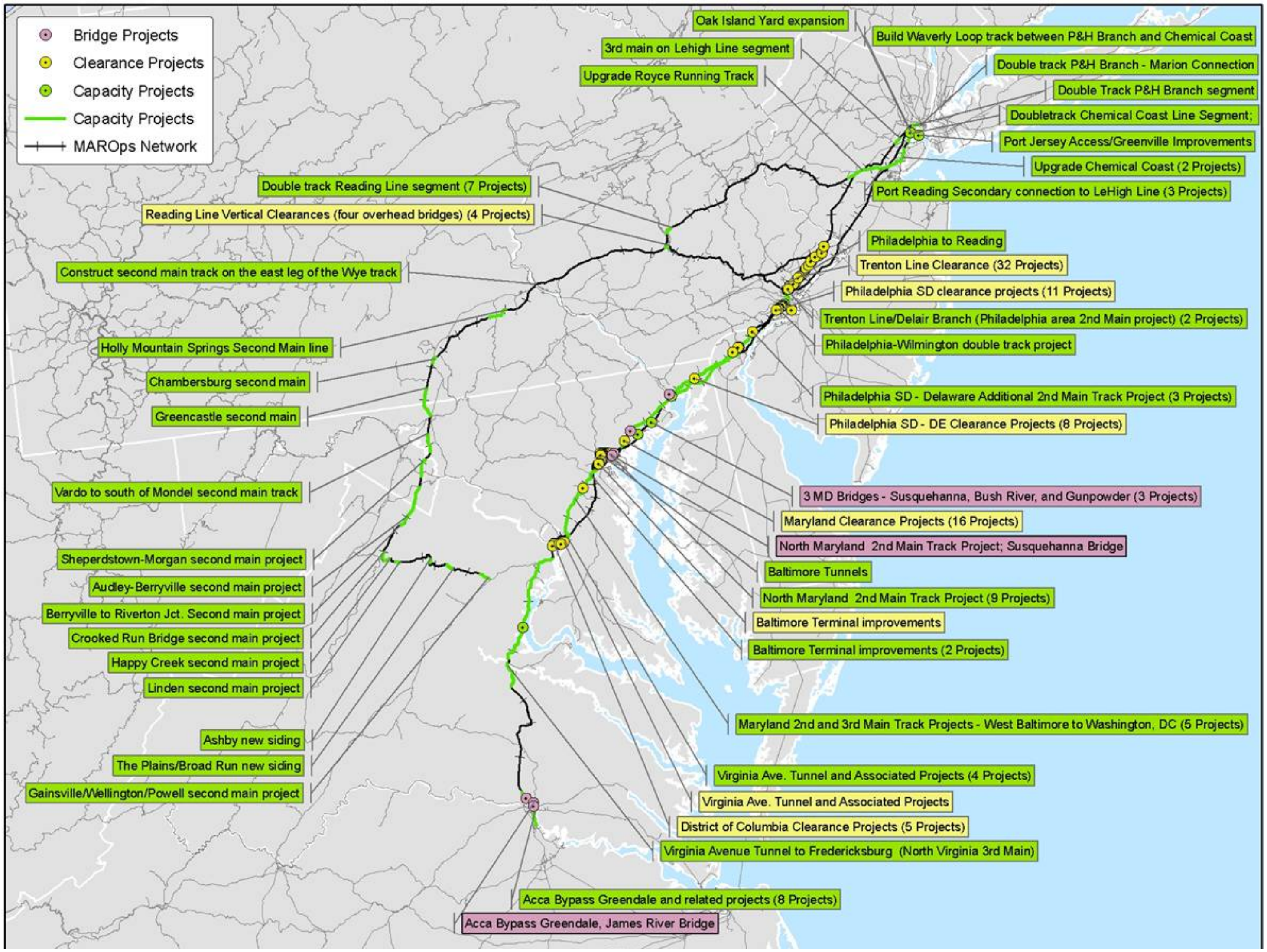
Figure 8.1 Projected Number of Trains per Day by Corridor for Future With Priority MAROps Improvements and Low Increase in Rail Mode Share, 2035



8.2 Supply – Priority MAROps Improvements

The project steering committee of freight and passenger railroad and state transportation officials used the results of the prior scenarios, especially the "future scenario with MAROps improvements and high increase in rail mode share" and their best professional judgment to identify a set of priority projects. These projects were judged to be critical path projects that would yield the highest near-term benefits. Figure 8.2 maps the 150 projects identified as priority projects, including 67 capacity projects, 76 clearance projects, and 7 bridge, tunnel, and other projects. The estimated cost of the priority projects is approximately $6 billion compared to $12 billion for the full program.

Figure 8.2 Priority MAROps Improvements



8.3 CAPACITY AND LEVEL OF SERVICE

Table 8.2 compares the levels of service across the MAROps system assuming implementation of the priority MAROps projects and low increase in rail mode share. For comparison, the lower half of the table reports the LOS percentages assuming implementation of priority MAROps projects and no increase in rail mode share. Implementing just the priority projects results in modest improvements in capacity and LOS by 2035. The findings suggests that the MAROps rail system could accommodate moderate amounts of additional traffic with the priority MAROps investments.

The figures provide the corresponding maps of capacity under the two priority scenarios. Figure 8.4 maps the LOS for the priority MAROps with low rail mode shift and Figure 8.3 maps the LOS for the priority MAROps with no rail mode shift.

Overall, 18 percent of the network is above capacity with priority MAROps and no mode shift, and 19 percent is above capacity with priority MAROps and a low mode shift. This suggests that with just the priority projects, the MAROps region rail system could keep pace economic growth and a low increase the share of freight carried by rail in 2035. However, even with the priority improvements and no mode shift, there would significant challenges in the MAROps region that cannot be fully addressed, including:

- The CSX I-95 route has 32 percent of route miles above capacity with the priority MAROps improvements and low rail mode shift. Capacity problems exist in the major urban areas and on the track north of and entering into the Acca Yard in Richmond, VA;
- The Norfolk Southern I-81 route has relatively less track above capacity (9 percent), but substantial amount of track near capacity (29 percent). The most significant capacity problems are from Front Royal to Manassas and from Harrisburg to Hagerstown. However, Norfolk Southern has prioritized segments in these stretches for physical and operational; and.
- On the NEC, the priority projects do not include several expensive projects to allow for 24-hour freight access between Baltimore and Philadelphia. Adding these projects would address capacity issues for Norfolk Southern accessing the Port of Baltimore and the Newcastle and Delmarva secondary lines, but there may be other solutions to address at least some of these choke points.

Table 8.2 Freight Rail Level of Service by Corridor for Future With Priority MAROps Improvements and Low Increase in Rail Mode Share, 2035

	Corridor 1 New Jersey Terminal	Corridor 2 NS I-81 Corridor	Corridor 3 CSX I-95 Corridor	Corridor 4Amtrak Northeast Corridor	Overall
Low Mode Shift					
LOS A, B, C Below capacity	93%	61%	48%	57%	57%
LOS D Near capacity	7%	29%	8%	0%	14%
LOS E At capacity	0%	1%	10%	25%	10%
LOS F Above capacity	0%	9%	34%	18%	19%
No Mode Shift					
LOS A, B, C Below capacity	93%	61%	48%	57%	57%
LOS D Near capacity	7%	29%	8%	0%	14%
LOS E At capacity	0%	1%	12%	25%	11%
LOS F Above capacity	0%	9%	32%	18%	18%
Total Corridor Miles	49	324	304	217	895

Figure 8.3 Freight Rail Levels of Service by Corridor for Future With Priority MAROps Improvements and Low Increase in Rail Mode Share, NS and CSX Corridors, 2035

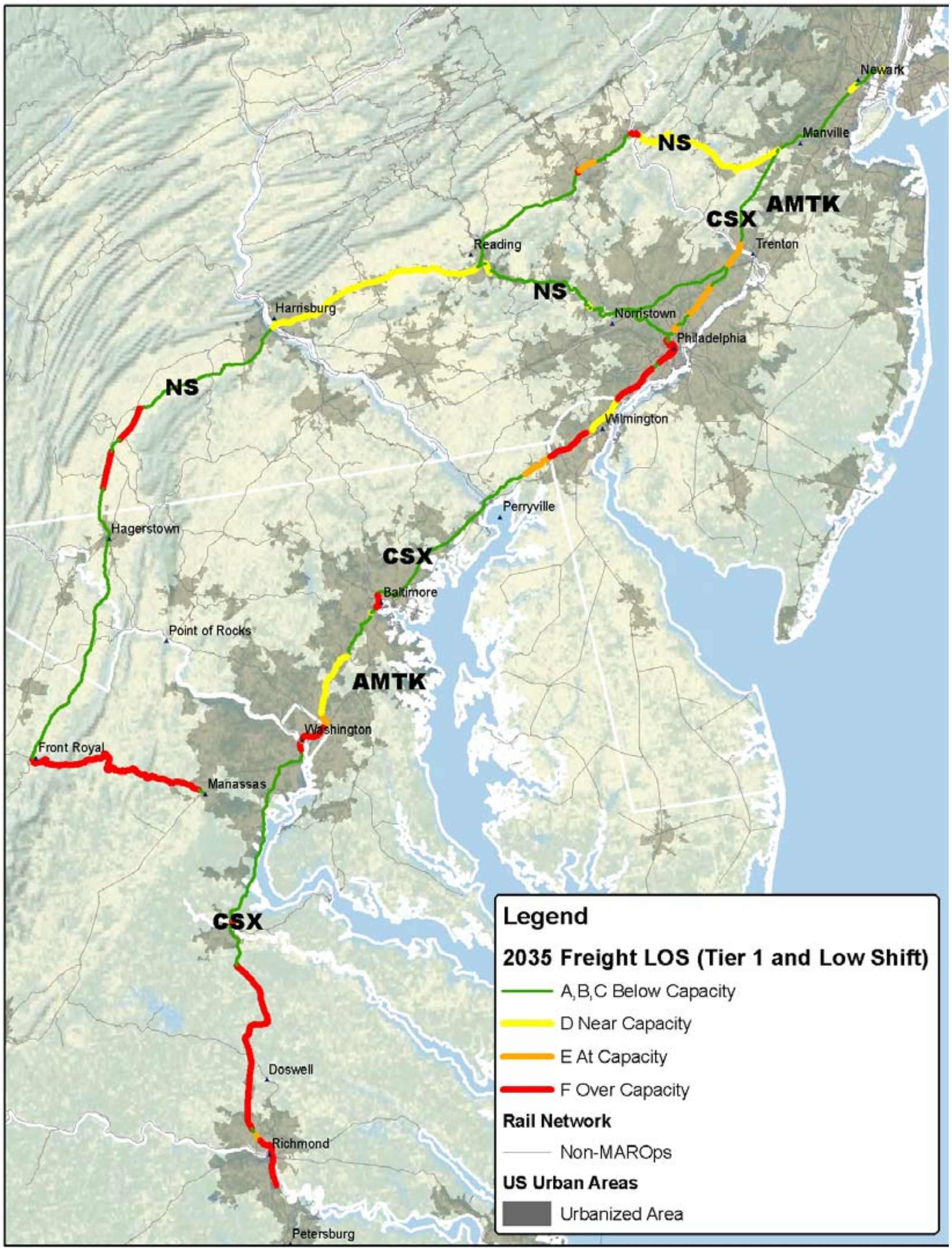
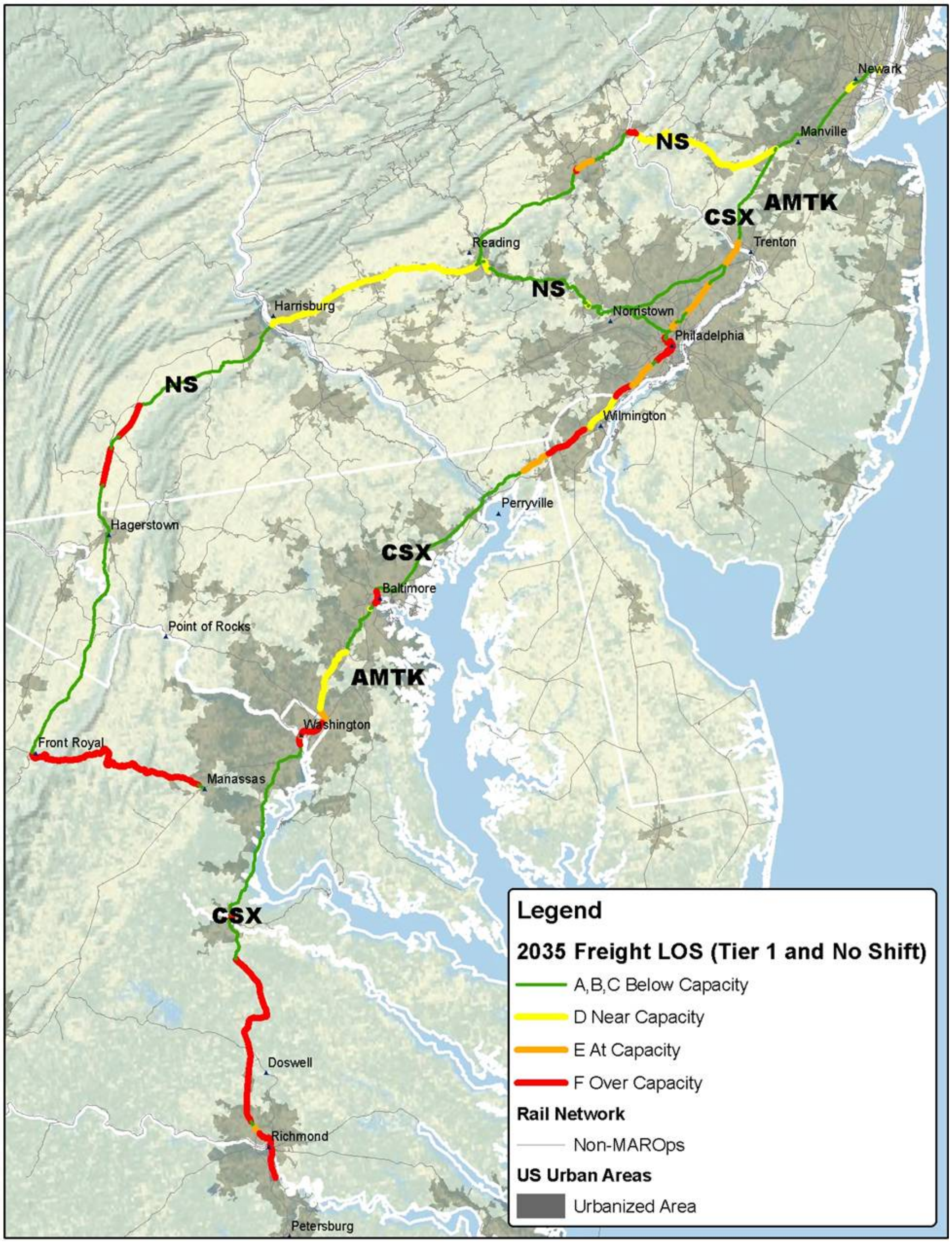


Figure 8.4 Freight Rail Levels of Service by Corridor for Future With Priority MAROps Improvements and No Increase in Rail Mode Share, NS and CSX Corridors, 2035



8.4 ECONOMIC BENEFITS

Implementing priority MAROps improvements only and assuming a low increase in rail mode share results in changes to rail and truck costs that are similar to, but slightly less than, the changes with the full MAROps program and a high increase in rail mode share.

Table 8.3 presents the relative change from the future without MAROps to the future with priority MAROps improvements and a low increase in rail mode share. With the priority projects implemented, most states and regions experience a decline in both truck and rail costs, but the declines are modest—one or two percent.

Table 8.3 Change in Rail and Truck Costs from Future Without MAROps Improvements to Future With Priority MAROps Improvements and Low Increase in Rail Mode Share, 2035

State/Region	Change in Truck Cost/1000 Ton Miles	Change in Rail Cost/1000 Ton Miles	Change in Average Cost/1000 Ton Miles
New Jersey	-2%	-2%	-2%
Maryland	-1%	0%	0%
Delaware	-2%	0%	-1%
Pennsylvania	-1%	0%	-1%
Virginia	-1%	-2%	-1%
NY/NJ CMSA	-1%	0%	-1%
Phila CMSA	-3%	-1%	-2%
Balt/Wash CMSA	-4%	-1%	-3%

The impact on business output, industry value added, employment growth, and wage income from implementing only the priority MAROps projects come—as with the full program—from construction expenditures and improved accessibility to regional and local markets. Table 8.4 summarizes the benefits by state and major metropolitan area (CMSA) in the MAROps region.

Table 8.4 Estimated Economic Benefits of Future With Priority MAROps and Low Increase in Rail Mode Share, 2035

State/Region	Business Output ($ million/year)	Value Added ($ million/year)	Jobs (per year)	Wage Income ($ million/year)
Delaware	$20	$10	152	$7
Maryland	$244	$133	1,921	$99
New Jersey	$162	$88	1,041	$59
Pennsylvania	$190	$101	1,470	$70
Virginia	$191	$100	1,546	$73
Total for States	$808	$432	6,130	$309
NY/NJ CMSA	$320	$182	2,127	$124
Philly CMSA	$219	$116	1,511	$80
Baltimore-Washington CMSA	$382	$212	2,947	$156

Implementing only the priority projects contributes $800 million (compared to $1.3 billion for the full program) and 6,100 jobs (compared to 9,800 jobs for the full program). Economic growth is seen in all five states and the three CMSAs within the study area. Maryland, Pennsylvania, and Virginia see the largest growth, with New Jersey not far behind. Delaware experiences somewhat less economic growth.

Table 8.5 shows the percentage change in business output, industry value added, employment growth, and wage income between 2009 and 2035, relative to their 2006 base. Maryland is expected to experience the most significant growth in business output, value added, and jobs, with Virginia, Delaware, New Jersey, and Pennsylvania seeing modestly lower increases.

Table 8.5 Percentage Change in Estimated Economic Benefits for Future With Priority MAROps Improvements and Low Increase in Rail Mode Share, 2035

State	Business Output	Value Added	Jobs	Wage Income
Delaware	2.1%	0.7%	0.9%	0.2%
Maryland	4.2%	1.5%	1.7%	0.7%
New Jersey	1.7%	0.6%	0.6%	0.2%
Pennsylvania	1.7%	0.6%	0.6%	0.2%
Virginia	2.4%	0.8%	1.0%	0.4%

Table 8.6 shows the distribution of economic benefits (measured by business output) by MAROps rail corridor. The table shows the benefits for the future with priority MAROps improvements and a low increase in rail mode share scenario.

Table 8.6 Estimated Business Output (in millions of dollars annually) by Rail Corridor for Future With Priority MAROps Improvements and Low Increase in Rail Mode Share, 2035

	Corridor 1 New Jersey Terminal	Corridor 2 NS I-81 Corridor	Corridor 3 CSX I-95 Corridor	Corridor 4 Amtrak Northeast Corridor
Delaware	$64	$347	$185	$5
Maryland	$578	$2943	$3,148	$666
New Jersey	$1,717	$2,166	$989	$0
Pennsylvania	$1,130	$2,635	$1,797	$146
Virginia	$402	$2,440	$2,533	$366
State Totals	*$3,891*	*$10,531*	*$8,652*	*$1,183*
NY/NJ CMSA	$3602	$4,167	$1,823	$0
Philadelphia CMSA	$516	$3,735	$2,284	$29
Baltimore-Washington CMSA	$723	$3,839	$5,646	$1,265

The overall benefit/cost ratio for the priority MAROps projects is 2.9, a full point higher than the B/C ratio for the full program. The benefit/cost ratios are shown in Table 8.7. The full program includes a number of major projects that will take significant resources to implement. Although the benefits of the priority projects are lower than all projects, the costs are also significantly lower, yielding an improved benefit/cost ratio.

Table 8.7 Benefit/Cost Ratio for Future With Priority MAROps Improvements and Low Increase in Rail Mode Share, 2035

Category	Definition*	Present Value of Benefits	Present Value of Costs	Net Present Value (Benefits - Costs)	Benefit/Cost Ratio
Traveler Benefit	A	$10,322	$3,829	$6,494	2.7
Full User Benefit	A+B	$10,935	$3,829	$7,106	2.86
Total Benefit	A+B+C	$11,086	$3,829	$7,258	2.9

* Key to Definitions: A = Traveler benefits; B = Shipper logistics benefits; C = Societal benefits

From the perspective of the major metropolitan area in the MAROps region, the benefits are even greater for the priority projects, with a benefit/cost ratio of 5.68. Again, the shifting of employment and businesses within the study area creates greater benefits for metropolitan areas.

9.0 Conclusions and Recommendations

The MAROps Phase II study examines the condition and performance of the regional rail system, updating the findings of the 2002 MAROps Phase I work. The study finds that the Mid-Atlantic region faces clear challenges to moving freight in the future. The population of the five-state area is projected to grow from 36 million in 2008 to nearly 45 million in 2035 and employment is expected to grow from 23 million jobs to 31 million jobs. With these changes will come a significant new demand for freight transportation to support businesses, households, and government services.

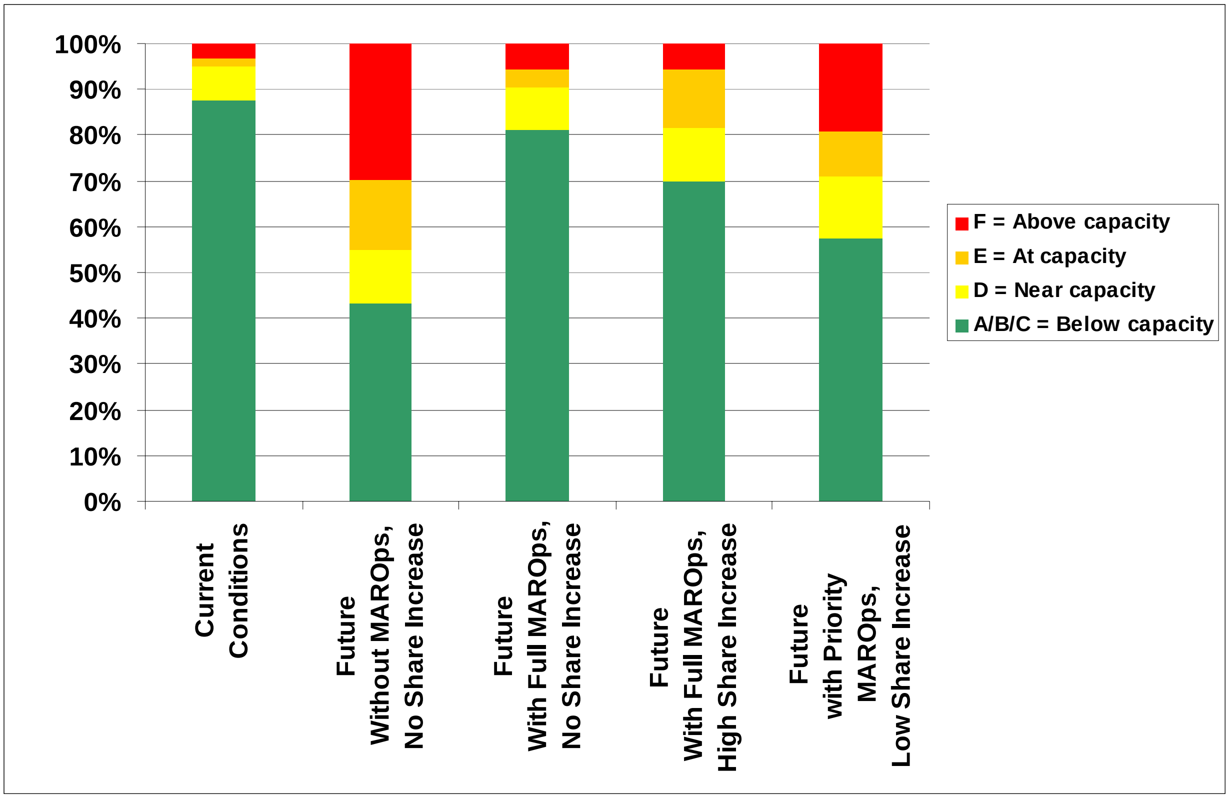
The key industries that are expected to generate new jobs, higher business and household income, and more tax revenue for the region—health care; professional, scientific, and technical services; finance; wholesale and retail trade, and manufacturing—all depend directly or indirectly on fast, cost-effective, and reliable freight transportation. Without improvements to the rail freight transportation system that add capacity and reduce delays, the costs of feeding, housing, and clothing the population and the costs of supporting the region's growth industries will go up.

Today, 88 percent of rail corridor miles in the MAROps region operate below capacity (at levels of service A, B, or C) and three percent operate above capacity (at level of service F) as shown if the leftmost column in Figure 9.1. The column colors represent the percentage of rail corridor miles operating at the different service grades: green represents levels of service A, B, or C (below capacity); yellow represents level of service D (near capacity), orange represents level of service E (at capacity), and red represents level of service F (above capacity).

Without further improvements to the rail system, by 2035 only 43 percent of rail corridor miles in the MAROps region are projected to operate below capacity (at levels of service A, B or C), while 30 percent will operate above capacity (level of service F). This scenario is represented by the second column from the left in the figure. It is an unlikely but possible worst case scenario.

Implementing the full MAROps program, estimated to cost about $12 billion over the 30 year period, would maintain the capacity of the system. The program would involve implementation of 217 projects, including 110 projects to add mainline capacity and 81 projects to provide doublestack clearance. There would also be projects to expand terminal capacity, remove or rebuild grade crossings, replace or rehabilitate outdated bridges and tunnels, and add new communication and technology to improve safety and the coordination of train movements. This scenario is represented by the third column from the left in the figure.

Figure 9.1 Percentage of MAROps Freight Rail Corridor Miles by Level of Service Grade and Scenario



Increasing the capacity of the network has the potential to increase the share of freight captured by rail. The rail share of freight transportation in the Mid-Atlantic region is between one and two percent lower than the national average. Conservative estimates of the potential to shift freight from truck to rail suggest that rail could capture the equivalent of 13 to 55 additional trains per day. This would remove a moderate amount of truck traffic from the region's highways, relieving some of the congestion pressure on the highways.

The additional traffic would—as intended—absorb some of the capacity provided by the MAROps improvements. With implementation of the full MAROps program and a "high" increase in rail mode share, 70 percent of the rail corridor miles in the region are projected to operate below capacity by 2035 and 6 percent would operate above capacity. This scenario is represented by the fourth column from the left in the figure.

Implementing only the 150 priority MAROps improvements—the projects judged by railroad managers and state DOT officials to be critical path projects that would yield the highest near-term benefits—would reduce the cost of the program. The rail system would not have as much capacity to attract and absorb new traffic as it would with the full MAROps program, but it would still have sufficient capacity to capture a moderate amount of new freight traffic. Implementing the priority projects only and assuming a "low" increase in rail mode share, 57 percent of the rail system is projected to operate below capacity and 19 percent would operate above capacity. This scenario is represented by the rightmost column in the figure.

Implementing the full MAROps program would contribute $1.3 billion in business output and 9,800 jobs to the five-state region each year. Benefits would accrue to all five states and the three major metropolitan area within the region. Shippers would see a modest reduction in transportation costs (around 1 percent), railroads would carry additional freight, increasing their revenue, and freight operators would see overall net reductions in costs of $40 and $52 million per year in operating costs. There would also be a reduction of $3 to $7 million in freight logistics costs (i.e., the extra cost of having goods in the pipeline to satisfy inventory needs), and $2 to $5 million a year in safety and environmental costs.

The benefit/cost ratio of implementing the full MAROps program and achieving a high increase in rail mode share is estimated provisionally at 1.86. The benefits include traveler benefits, shipper benefits, and societal economic benefits. The program would generate economic growth in all five states and the three major metropolitan areas within the region.

A priority-projects-only program would generate an estimated $800 million in economic benefits each year (compared to $1.3 billion for the full program) and 6,100 jobs (compared to 9,800 jobs for the full program). The priority program also would generate economic growth in all five states and the three major metropolitan areas within the region. A more detailed analysis would likely find alternative combinations of priority projects, some of which might be equally of more cost-effective with substantial public and private sector benefits. The benefit/cost ratio of implementing only the priority MAROps improvements and achieving a low increase in rail mode share is estimated at 2.9.

The findings of the MAROps Phase II study reinforce the conclusions of the Phase I study, which found that cooperative action between the states and railroads is critical to improving the system. The MAROps rail network covers five states and serves three major metropolitan areas, each its own jurisdictional roles and responsibilities. However, the network is operated as a system. Improvements in one state alone, while beneficial, would simply shift choke points upstream or downstream and would not necessarily improve overall corridor capacity and travel times. A coordinated program of state- and railroad-funded improvements is needed across the network if rail capacity is to be increased and freight traffic shifted from truck to rail.

The MAROps Phase II study also confirms the need for a national support for major rail improvement projects. The MAROps projects range in complexity from relatively simple fixes to extremely complicated, multi-billion dollar projects such as the Baltimore rail tunnels. The states and railroads can address many of the smaller projects, but national action is required to accomplish the major projects. The major projects would benefit the region, but they would also improve rail freight operations between the Mid-Atlantic and the Midwest, the Southeast, and the West Coast. It is long-haul truck traffic that is most likely to shift to improved rail intermodal service, reducing truck traffic and costs for shippers and motor carriers and reducing highway congestion across the country not just within the MAROps region.

In summary, without concerted action, the costs of freight transportation in the region generally, and the cost of rail freight transportation specifically, will increase. This will drive up the cost of living and cost of doing business in the region, reducing the economic competitiveness of the region in national and global markets. For these reasons, its is recommended that the I-95 Corridor Coalition, its member states, and the railroads advance the MAROps program and look for opportunities to accelerate implementation of the projects.