TRANSPORTATION

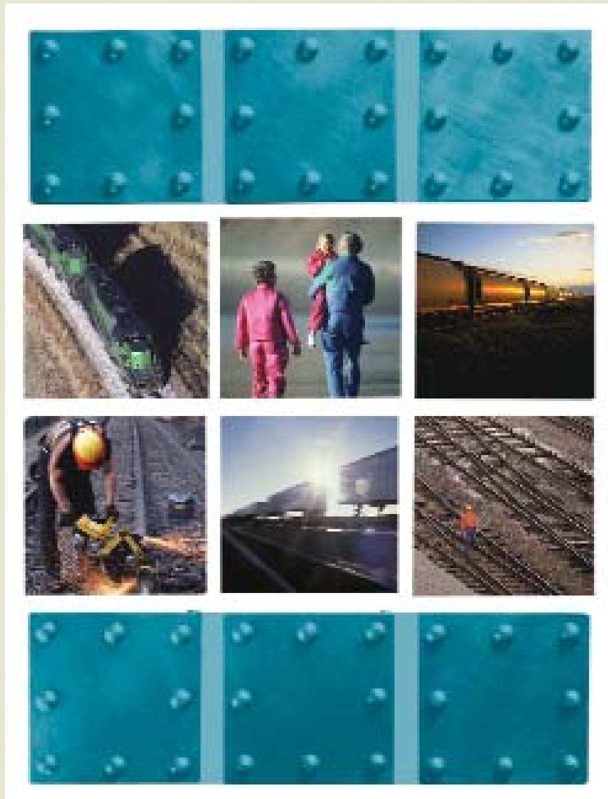
INVEST IN AMERICA

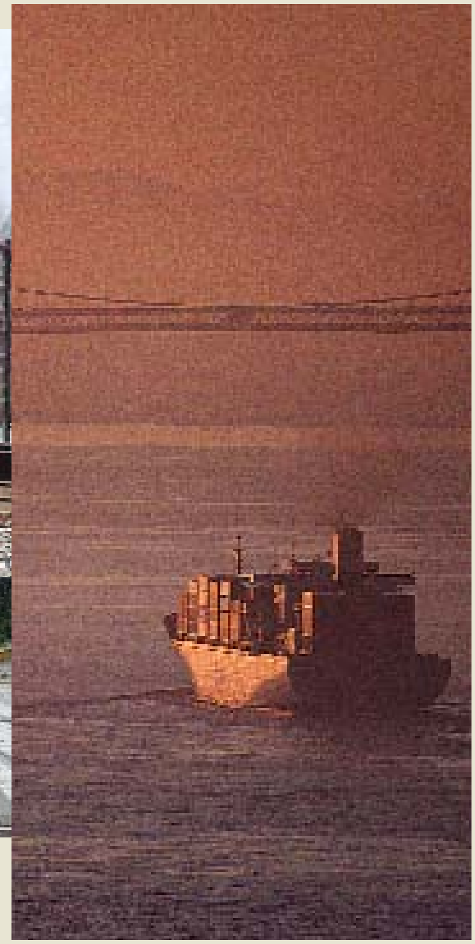


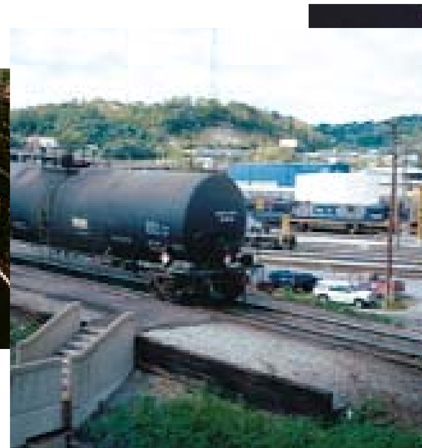



FREIGHT–RAIL BOTTOM LINE REPORT

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS






FOREWORD

This document presents AASHTO's views concerning the capacity of the nation's freight transportation system, especially the freight-rail system, to keep pace with the expected growth of the economy over the next 20 years. It describes the freight-rail industry, analyzes its benefits to the nation, estimates investment needs and the capacity of the industry to meet these needs, and quantifies the consequences of not investing in freight rail, including the impact on highway congestion and condition.

Currently, railroads carry a significant share of the nation's freight and make a substantial contribution to the national economy and to the economies of most states. Given the forecasts of substantial increases in freight over the coming years, it will be a challenge for the freight-rail industry to maintain its share of freight movement, and an even greater challenge to increase it.

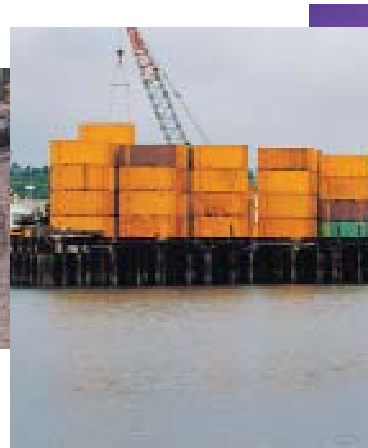
The U.S. has benefited from a succession of freight modes of transportation — ports developed in colonial times, inland waterways soon after, railroads in the 19th and early 20th centuries, highways and trucking in the mid and late 20th century. No comparable revolution is on the horizon. Now and into the future, each mode must be modernized and made more efficient, and all modes must be made to work better together, otherwise the nation will pay a high price.

Decisions made by the private sector and by federal, state, and local governments will determine how well the challenge is met. This report can be an important resource for making these decisions. It is one of a "family" of reports on the investment needs of the transportation modes that AASHTO is preparing, including:

- Highway and Transit Bottom Line Report documents investment needs to maintain and improve performance.
- Intercity Passenger Rail Report documents investment needs for existing and planned intercity passenger rail corridors.
- Aviation Bottom Line Report estimates future investment needs to maintain and expand the air transportation system.
- Water Transportation Bottom Line Report documents the investment needs for the nation's ports and waterways.

AASHTO is pleased to offer these reports for the use of those who are committed to making sure that the United States continues to have the best transportation system in the world.

John Horsley
Executive Director
American Association of State Highway and Transportation Officials


ACKNOWLEDGEMENTS

This report is the result of the efforts of many people. It was initiated by the AASHTO Standing Committee on Rail Transportation (SCORT), which is chaired by Joseph H. Boardman, Commissioner of the New York State Department of Transportation. Commissioner Boardman provided the leadership and determination that made the report possible and guaranteed its quality. At critical junctures, SCORT's Vice-Chair Richard Peltz, Deputy Secretary for Local and Area Transportation for the Pennsylvania Department of Transportation, contributed his energy, enthusiasm, and wide experience to the process.

Steven Slavick, Director of the Intermodal Program for the New York Department of Transportation, developed the initial scope of work, which was refined by the SCORT Executive Committee. Slavick, David Ganovski, Director of Rail Freight Services for the Maryland Department of Transportation, and Louis Jannazo, Acting Administrator of the Rail Development Commission in the Ohio Department of Transportation, formed the project management group that directed and oversaw the work of the consulting team.

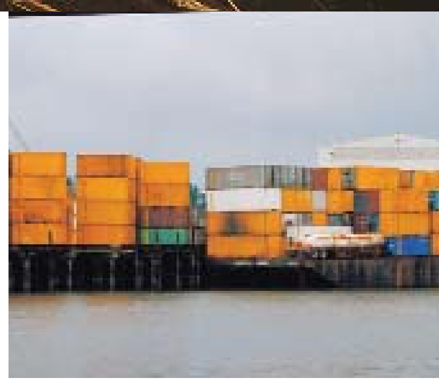
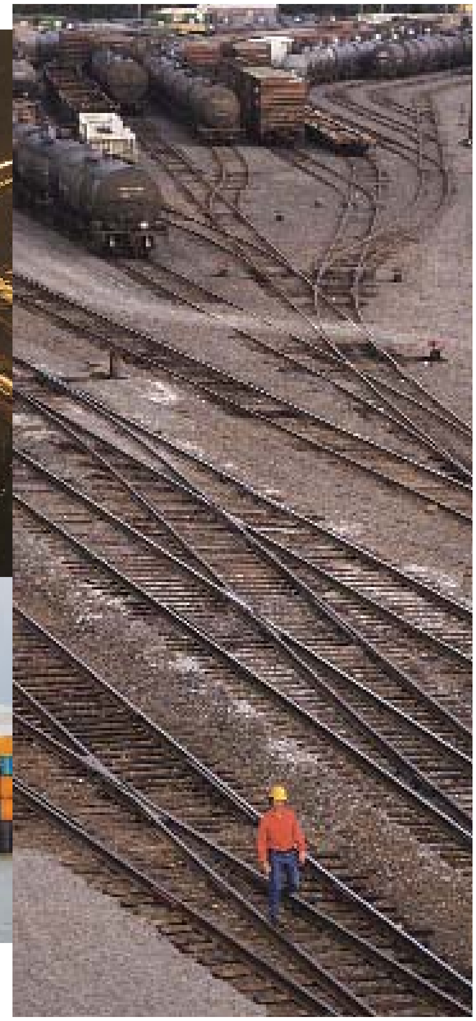
In addition, many other SCORT members commented on drafts of the report and provided material that is included. SCORT member states demonstrated their belief in the importance of this report through funding commitments that provided the necessary resources.

The report was prepared under a contract with Cambridge Systematics, Inc., by a consulting team led by Lance R. Grenzeback, Senior Vice President, and Alan Meyers, Senior Associate. The team also included Joseph G. Bryan and Bengt Muten, President and Executive Officer-Products, respectively, of Reebie Associates, and Carl D. Martland of MIT.

A number of knowledgeable professionals were consulted, including representatives of the Association of American Railroads and the Federal Railroad Administration, who provided valuable advice on the initial scope and direction of the investigation. Their contribution is much appreciated but they should not be held responsible for any of the report's findings or conclusions.

Graphic Design

Melinda Appel, Appelgrafix

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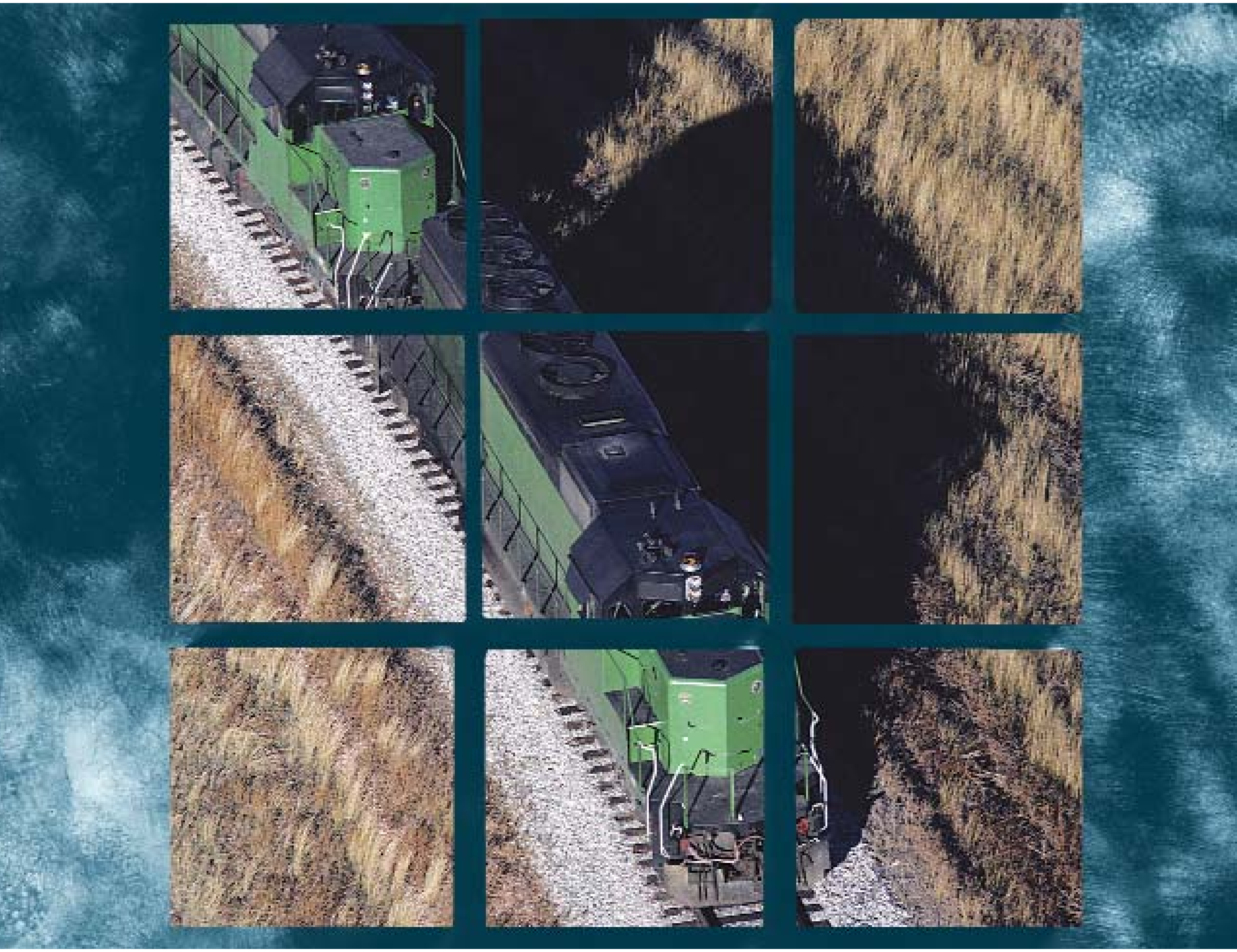


EXECUTIVE SUMMARY

ABOUT THIS REPORT

This report describes the nation's freight-rail system, its issues, and its needs. It is one of a "family" of AASHTO Bottom Line reports that deal with all of the major modes of freight and passenger transportation. The report addresses concerns about the capacity of the nation's freight transportation system, especially the freight-rail system, to keep pace with the expected growth of the economy over the next 20 years. The report finds that relatively small public investments in the nation's freight railroads can be leveraged into relatively large public benefits for the nation's highway infrastructure, highway users, and freight shippers.

As part of its family of Bottom Line Reports, AASHTO has published an investment needs report for highways and transit and a report on intercity passenger-rail benefits and investment needs. The cost estimates for freight-rail investment presented in this report were developed independently of those presented in the passenger-rail report. Taken together, these reports provide a comprehensive picture of the benefits of surface transportation to the nation and the value of strategic transportation investments to facilitate freight and passenger movement.

SUMMARY OF FINDINGS

Trucks move most of the nation's freight and will continue to do so, but freight rail is critical to the freight transportation system, the competitiveness of many industries, and the economies of most states. The following are public benefits of the freight-rail system.

■ Transportation System Capacity and Highway Cost Savings

The freight-rail system carries 16 percent of the nation's freight by tonnage, accounting for 28 percent of total ton-miles, 40 percent of intercity ton-miles, and six percent of freight value. If all freight-rail were shifted to trucks tomorrow, it would add 92 billion truck vehicle-miles-of-travel (VMT) to the highway system and cost federal, state, and local transportation agencies an additional $64 billion for highway improvements over the next 20 years. This $64 billion is a conservative figure that does not include the costs of improvements to bridges, interchanges, local roads, new roads or system enhancements. If these were included, the estimate could double.

■ Economic Development and Productivity

Freight rail provides shippers with cost-effective transportation, especially for heavy and bulky commodities, and can be a critical factor in retaining and attracting industries that are central to state and regional economies. If all freight-rail were shifted to trucks tomorrow, it would cost current rail shippers an additional $69 billion this year alone — or $1.4 trillion over the next 20 years — causing significant changes in business and consumer costs.

■ International Trade Competitiveness

Freight rail, in partnership with the trucking industry, provides intermodal transportation connecting U.S. seaports with inland producers and consumers. Freight rail also carries 16 percent of the nation's cross-border NAFTA trade. Intermodal freight-rail service is crucial to the global competitiveness of U.S. industries.

■ Environmental Health and Safety

Freight rail is fuel-efficient and generates less air pollution per ton-mile than trucking. Rail also is a preferred mode for hazardous materials shipments because of its positive safety record.

■ Emergency Response

Freight rail is vital to military mobilization and provides critically needed transportation system redundancy in national emergencies.

At issue is the capacity of the freight-rail system to grow with the economy and continue to provide these public benefits.

The U.S. economy is growing, and with it the demand for freight transportation services. With moderate growth in the economy — about three percent per year — domestic freight tonnage will increase by 57 percent by 2020 and import-export tonnage will increase by nearly 100 percent.

Today trucks and the highway system carry 78 percent of domestic tonnage, the freight-rail system carries 16 percent, and barges and coastal shipping carry six percent. By 2020, the highway system must carry an additional 6,600 million tons of freight (an increase of 62 percent), and the freight rail system must carry an additional 888 million tons (an increase of 44 percent). However, the highway system is increasingly congested, and the social, economic, and environmental costs of adding new highway capacity are prohibitively high in many areas. State departments of transportation are asking if expanding the capacity of the freight-rail system in some cases might be a cost-effective way of increasing the capacity of the total transportation system.

The freight-rail system was a triumph of 19th century America. It freed business and industry from the need to locate near sea, river, and canal ports. It opened up domestic east–west trade corridors and underpinned the development of the United States as an industrial power. But the freight-rail system was eclipsed in the 20th century by trucking and highways, which freed business and industry again, this time from the need to locate near rail lines and terminals. Long-haul trucking, which provided reliable, door-to-door service, captured a large share of east–west freight traffic from the railroads and much of the north–south freight traffic from coastal steamers and river barges. Much of the railroad industry slid into bankruptcy in the mid-1900s.

The government deregulated the railroad industry in 1980. The mergers and reorganization that followed restructured the industry. System mileage was cut in half, from 380,000 miles of track at its peak in 1920 to 172,000 miles today. Ownership was consolidated into seven Class I railroads that today originate 84 percent of the traffic and generate 91 percent of railroad revenue, and 551 regional and short-line railroads that operate 30,000 miles of track, originate 16 percent of traffic, and generate nine percent of railroad revenue. Freight-rail productivity was increased; ton-miles handled per railroad employee have nearly quadrupled since 1980. Rates were dropped, service was improved, and market share was stabilized at 28 percent of total domestic ton-miles and about 40 percent of intercity ton-miles.

However, the productivity gains and competitive rates have not been sufficient to rebuild market share and increase revenue. Railroad revenues have continued to drop. The industry's return on investment has improved from about four percent in 1980 to about eight percent in 2000; however, it is still below the cost of capital at 10 percent. Most of the benefits of railroad reorganization and productivity improvements have accrued to shippers and the economy in the form of rate cuts, rather than to the railroads and their investors.

This is a major problem for the railroad industry because it is extraordinarily capital-intensive. Railroads spend about five times more to maintain rail lines and equipment than the average U.S. manufacturing industry spends on plant and equipment. Wary of the gap between the railroads' capital needs and their income, investors have backed away from railroad stocks. This has reduced the amount of money available to railroads to invest in the freight-rail system, forcing the railroads either to borrow money to maintain and expand infrastructure or defer maintenance and improvements.

The rail industry today is stable, productive, and competitive, with enough business and profit to operate but not to replenish its infrastructure quickly or grow rapidly. Market forces will continue to pressure the rail industry to streamline and downsize, to maximize revenues, and to minimize capital costs. The freight-rail system's possible futures are as follows:

■ No Growth

With minimal Class I investments accomplished by the railroads from revenue alone and from investments in short-line improvements and safety enhancements, the freight-rail system could carry the same volume of freight in 2020 as it carries today, but little more. Freight that could not be handled by the railroads, much of it heavy commodities, would move to trucks and the highway system. This would shift almost 900 million tons of freight and 31 billion truck VMT to the highways, costing shippers $326 billion, costing highway users $492 billion (in travel time, operating, and accident costs), and adding $21 billion to highway costs over the 20-year period. This $21 billion is a conservative figure that does not include the costs of improvements to bridges, interchanges, local roads, new roads, or system enhancements. If these were included, the estimate could double. This scenario illustrates how insufficient investment in our nation's freight-rail system could negatively impact highways and the overall transportation system.

■ Constrained Investment

With additional investment — approximately what the Class I railroads can afford today from their revenue plus borrowing — the freight-rail system could handle additional traffic, but could not keep pace with growing demands for freight movement. It could handle around half of its "fair share" of forecast growth in freight-rail tonnage. The balance would likely shift to trucks and the highway system. This would transfer almost 450 million tons of freight and 15 billion truck VMT to the highways, costing shippers $162 billion, costing highway users $238 billion (in travel time, operating, and accident costs), and adding $10 billion to highway costs over the 20-year period. Inclusion of costs for bridges, interchanges, etc., could double this estimate.

■ Base Case

With a higher level of investment, the freight rail system could maintain its current share of commodity-lane traffic, and accommodate its "fair share" of forecast growth in freight-rail tonnage. Funding would come from a combination of railroad investments (above and beyond what currently can be funded from revenues and borrowing) and public-sector participation. In this scenario, the highway system would still shoulder the full forecast growth in truck-freight tonnage and truck VMT.

■ Aggressive Investment

With a still-higher level of investment, the freight rail system could increase its share of freight traffic, capturing more than its base case share of forecast growth, and relieving some of the anticipated truck and congestion pressure on the nation's highway system. Funding needs would be met by greater railroad investments and increased public-sector participation. This would allow freight rail to carry a larger percentage of freight tonnage in 2020 than it carries today (17 percent in 2020 compared to 16 percent today). It would shift 600 million tons of freight and 25 billion truck VMT off the highway system, save shippers $239 billion, save highway users $397 billion, and reduce highway costs by $17 billion. Inclusion of costs for bridges, interchanges, etc., could double this estimate.

To simply keep up with freight rail's share of the forecast demand — the base case scenario — the freight-rail system needs substantial capital investment. The precise amount has not been determined, but can be generally estimated from a variety of sources.[1]

Rail Safety Needs — $13.8 billion

The Institute for Transportation Research and Education at North Carolina State University surveyed state rail-safety needs, focusing on highway-rail at-grade crossings. This estimate includes costs for additional warning systems, grade separations, grade-crossing eliminations, and track relocations for both freight and passenger systems. These needs have usually been addressed by a combination of private and public investment.

Short-Line Improvements — $11.8 billion

The tracks and bridges of much of the nation's short-line system are inadequate to handle the newer 286,000-pound and 315,000-pound railcars coming into service. A study commissioned by the American Short-Line Rail Road Association estimated the cost of upgrading the nation's short-line system to handle 286,000-pound railcars at $6.9 billion. This estimate is consistent with the findings of the Railroad Shipper Transportation Advisory Council (White Paper III, April 2000), which was based on a 1999 survey by AASHTO. The council found a total capital need of $11.8 billion, of which $9.5 billion was unfunded. The council's estimate included deferred maintenance, safety and speed improvements, and weight improvements. In recent years, these needs have been largely addressed by public investment.

Class I Infrastructure Repair and Maintenance — $4 to $5 billion annually, or $80 to $100 billion over 20 years

Class I Infrastructure Improvements, above and beyond Repair and Maintenance — $3.5 billion annually, or $70 billion over 20 years

The Class I railroads currently are investing around $2 billion annually for improvements above and beyond repair and maintenance. This is not sufficient to meet the needs of the base case scenario, and is more consistent with the constrained investment scenario. Should this continue, it means that freight rail will lose market share, thereby increasing transportation and highway system costs over the next 20 years. Higher levels of investment will be needed to achieve either the base case scenario or aggressive investment scenario.

The total cost to achieve the base case scenario is estimated at $175 to $195 billion over 20 years. Railroads should be able to provide the majority of the funding needed (up to $142 billion dollars) from revenue and borrowing, but the remainder (up to $53 billion, or $2.65 billion annually) would have to come from other sources — including but not limited to loans, tax credits, sale of assets, and other forms of public-sector participation. Compared to the constrained investment scenario, the base case scenario removes 450 million tons of freight and 15 billion truck VMT from the highways, saves shippers $162 billion, saves highway users $238 billion, and saves $10 billion in highway costs over the 20-year period. Inclusion of costs for bridges, interchanges, etc., could double this estimate.

The total cost to achieve the aggressive investment scenario is estimated at $205 to $225 billion over 20 years. Up to $83 billion, or $4.15 billion annually, would have to come from sources other than railroad revenue and borrowing. Compared to the constrained investment scenario, the aggressive investment scenario removes 1,035 million tons of freight and 40 billion truck VMT from the highways, saves shippers $401 billion, saves highway users $635 billion, and saves $27 billion in highway costs over the 20-year period. Inclusion of costs for bridges, interchanges, etc., could double this estimate.

While these are preliminary estimates that should be confirmed by detailed benefit/cost studies, the conclusion is that relatively small additional investments in the nation's freight rail system can be leveraged to provide relatively large public benefits.

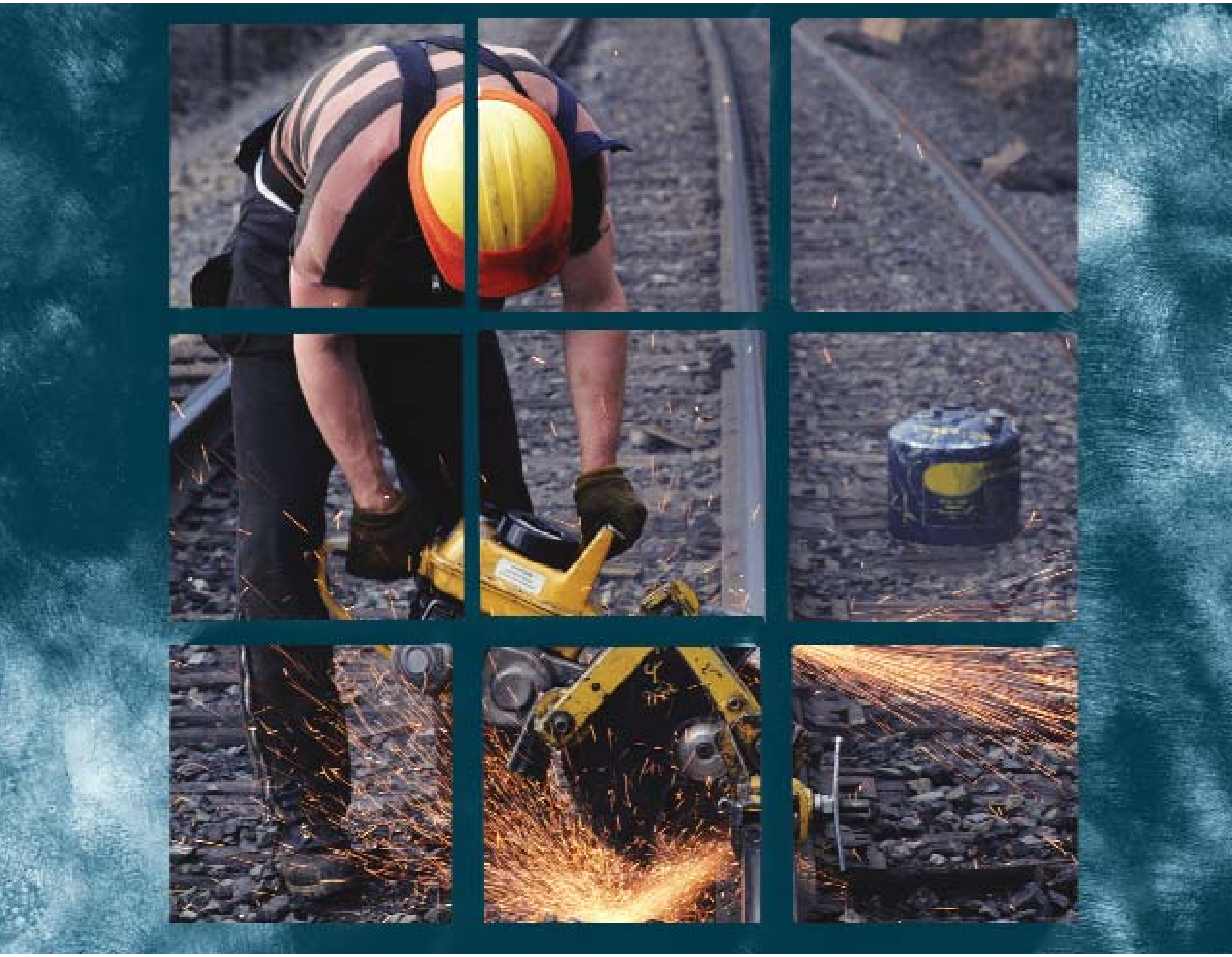
These investments must be made at the network level. Public participation in rail system investments has historically addressed the bottom of the system: grade crossings, branch lines, and commuter rail services. The present need is to treat the key elements at the top of the system: nationally significant corridor choke points, intermodal terminals and connectors, and urban rail interchanges. Investments at this level hold the most promise of attracting and retaining freight-rail traffic through improvements in service performance.

Broadly speaking, the choice for the nation's freight-rail system is between "market-driven evolution" of the freight-rail system and "public-policy-driven expansion" of the system. Market-driven evolution will accommodate some of the forecast freight growth, but relieve little of the forecast congestion on the highway system. A public-policy-driven expansion could produce a rail industry that provides the cost-effective transport needed to serve national and global markets, relieve pressure on overburdened highways, and support local social, economic, and environmental goals.

Many states have already taken steps consistent with a public policy-driven approach, by investing directly in their rail systems, and by forming public–private partnerships to implement specific projects. But making increased levels of investment and realizing the public benefits of a strong freight-rail system at a national level will require a new partnership among the railroads, the states, and the federal government.

This partnership must enunciate a clear national policy of improving freight system productivity; expanding state eligibility and flexibility to invest where freight-rail improvements have significant highway and public benefits; increasing loan and credit enhancement programs; and initiating innovative tax-expenditure financing programs, including accelerated depreciation, tax-exempt bond financing, and tax-credit bond financing. The partnership must extend beyond state boundaries to match the scale of the policy and investment decisions to the scale of today's freight-rail system.

The problems of the freight transportation sector, especially the challenges facing the freight-rail industry, and the consequences of not addressing them are clearer today than when ISTEA and TEA-21 were enacted, and they will sharpen in the coming years. The public sector and the private freight transportation community must advance public policy options that improve the capacity, productivity, and security of the freight-rail system as an integral part of the national freight transportation system.



INTRODUCTION

This report describes the nation's freight-rail system, its issues, and its needs. It is one of a "family" of AASHTO Bottom Line reports that deal with all of the major modes of freight and passenger transportation. AASHTO has also published an investment needs report for highways and transit and a report on intercity passenger rail benefits and investment needs. The cost estimates for freight-rail investment presented in this report were developed independently from those presented in the passenger-rail report. Taken together, these reports provide a complete picture of the benefits of the various surface transportation modes to the nation and the value of strategic transportation investments to facilitate freight and passenger movement.

The nation's freight transportation system — its highways, waterways, airways, and railways — offers the best service and rates in the world. It benefits producers and consumers and bolsters the competitiveness of U.S. industries in the global economy. However, significant capacity is not being added, and the freight system — domestic and intertnational — is increasingly congested. Performance is not improving at historic rates, and freight tonnage (domestic and international) is forecast to increase 67 percent by 2020, which will further stress the system.

This report responds specifically to increased public-sector attention to the issue of freight rail. Rail is critical to the competitiveness of many industries and the economies of many states. It provides the long-distance, line-haul component of truck-rail intermodal moves. It serves the nation's seaports and facilitates international trade. It strengthens national security by permitting rapid military mobilization. Finally, rail provides vital system redundancy when highway or aviation services are disrupted.

The nation's freight-rail system provides significant benefits, but it also faces major challenges. The 19th century route system must be adapted to serve a 21st century global economy, but railroad investment capital is limited. Freight-rail services must be expanded to relieve highway congestion and support economic development. And the public benefits of investment in the freight-rail system must be clearly enunciated.

This report is organized into three main sections. The first section presents an overview of rail's role in the nation's intermodal freight system. The second part discusses alternative futures for the freight-rail system and their implications. The third section of the report describes issues and choices to be faced in creating a freight-rail system to meet the nation's transportation needs into the 21st century.

These main sections are followed by six appendices. Appendix A presents a summary overview of private-sector rail issues. Appendix B offers an overview of public-sector rail programs. Appendix C lists potential public–private rail financing strategies. Appendix D provides state-by-state examples of public-benefit freight-rail projects that have been implemented. Appendix E examines selected freight corridors to illustrate the role of rail in addressing our nation's freight transportation needs. Appendix F presents as endnotes the references cited throughout this report.

RAIL'S ROLE IN THE INTERMODAL FREIGHT SYSTEM

This section examines:

- Evolution of the nation's freight transportation system;
- Goods movement today;
- Freight-rail services today;
- Public benefits of the freight-rail system; and
- Condition of the freight-rail industry.

Key findings presented in this section are as follows:

1. The freight-rail system is an important part of the nation's freight transportation system and is critical to the economy. Freight rail carries 16 percent of nation's freight by tonnage, accounting for 28 percent of total ton-miles, 40 percent of intercity ton-miles, and six percent of freight value.
2. The freight-rail system provides significant public benefits by providing cost-effective transportation that is vital to state economic development; reducing truck travel, congestion, and highway costs; providing a critical intermodal link for international trade; improving air quality and fuel efficiency; supporting military mobilization; and providing transportation-system redundancy during national emergencies.
3. The rail industry today is stable, productive, and competitive, with enough business and profit to operate, but not to replenish its infrastructure quickly or grow rapidly. Its capital cost for infrastructure and equipment is huge and relatively fixed. Competition among railroads and with trucking has driven rail rates down, benefiting shippers and the economy, but making it difficult for the railroads to attract the long-term investment needed to grow substantially and serve new markets. Market forces will continue to force the rail industry to streamline and downsize, to maximize revenues, and to minimize capital costs. Under current conditions, rail will continue to generate substantial public benefits, but will not live up to its full potential.

THE EVOLUTION OF THE NATION'S FREIGHT SYSTEM

Four eras describe the evolution of the nation's freight system. Three are characterized by the development and maturation of a single transportation technology, while the fourth is characterized by the emergence of information and communication technologies to manage and utilize all modes of transportation.

The "Sail Era" (18th Century)

The colonial economies of the 18th century were built on water transport. Figure 1 shows the major 18th century water-transportation routes. At the time of the American Revolution, it cost as much to move a ton of goods 30 miles inland as to move it across the Atlantic.[2] Two out of three settlers lived within 50 miles of the Atlantic coast. Coastal and Atlantic trade dominated the freight system.

The "Rail Era" (19th Century)

The introduction of rail technology in the mid-19th century freed business and industry from the need to locate near sea, river, and canal ports. Within a matter of decades, railroads opened much of the interior of the country. East–west rail routes were built to follow development of the Midwest, and after the Civil War, to solidify political and military control of the West. But north–south rail routes were slow to develop because the railroads could not compete effectively with water transport for coastal trade. Figure 2 shows the major rail corridors of the late 1800s. Dense urban centers grew at major inland rail hubs and at coastal cities that benefited from the new mode of transportation. Domestic inland trade dominated the freight system.

The "Truck Era" (20th Century)

The development of truck and highway technologies in the early 20th century freed business and industry again, this time from the need to locate near rail lines and terminals. An east–west and north–south interstate highway grid was built to connect cities and regional economies. Figure 3 shows the pattern of the Interstate Highway network. Production and consumption centers migrated outward from city centers, taking advantage of inexpensive land made newly accessible by the trucking and highway systems. Long-haul trucking captured a large share of east–west freight traffic from railroads and much of the north–south freight traffic from coastal steamers and river barges. While rail and water continued to serve some traditional markets, trucks were the only way to serve the new suburban and ex-urban markets, and trucking became the dominant mode of freight transportation.

The "Integration and Information Era" (21st Century)

The global economy of the 21st century is being built on information, telecommunications, and low-cost, long-haul transport by water, rail, and air. Containerization — first introduced in the 1950s — efficiently linked trucks, double-stack trains, and containerships, significantly reducing transport costs, cargo pilferage, and damage. The parallel development of information and communication technologies made it possible to manage global freight flows that were reliable, visible, reasonably secure, and cost-effective. The collapse of the communist bloc, the integration of the European Union, and the emergence of global initiatives such as the North American Free Trade Agreement reduced trade barriers. The result has been an explosion of global trade in all directions — north, south, east, and west — that continues unabated today. Figure 4 shows the growth in trade across U.S. borders. The graph traces the growth in the value of imports and exports from 1860 to 2000 by U.S. coast and border region. The accompanying map delineates the coastal and border areas included in the graph.

This simplified sketch of the evolution of the nation's freight system highlights the critical issues facing the nation's freight-rail system today. How does a freight-rail system, with routes designed originally to serve a 19th century economy oriented to east–west domestic trade, serve a 21st century global economy? Where does the freight-rail industry stand today, and where does it go from here?

Figure 1. Goods Movement in the "Sail Era"

Focused on Atlantic and Coastal Trade

Figure 2. Goods Movement in the "Rail Era"

Focused on East–West Corridors and Key Hubs

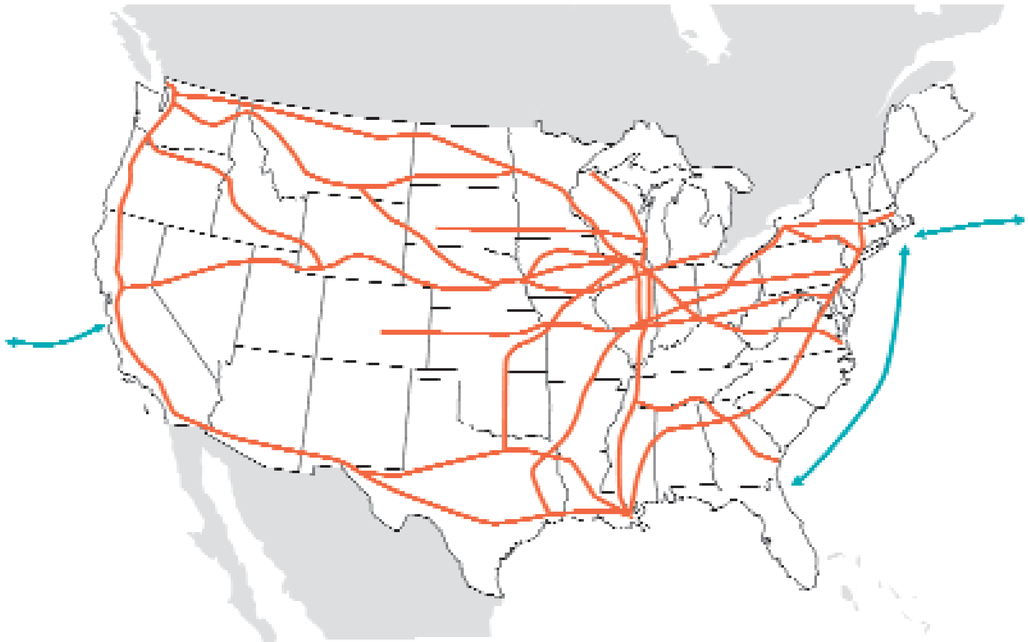


Figure 3. Goods Movement in the “Truck Era”

Grid-Based, not Hub-Based

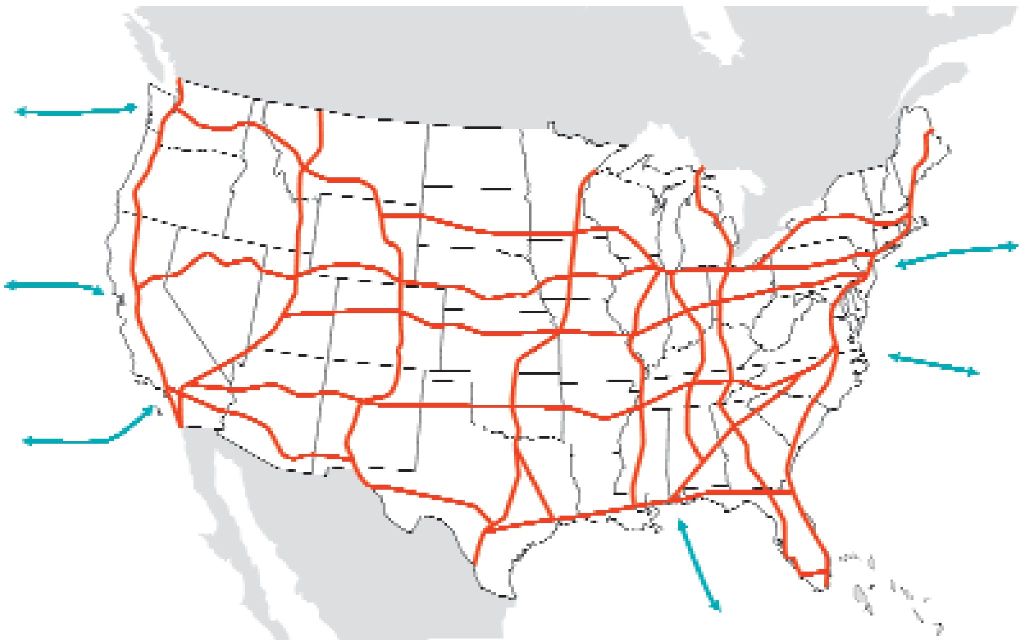
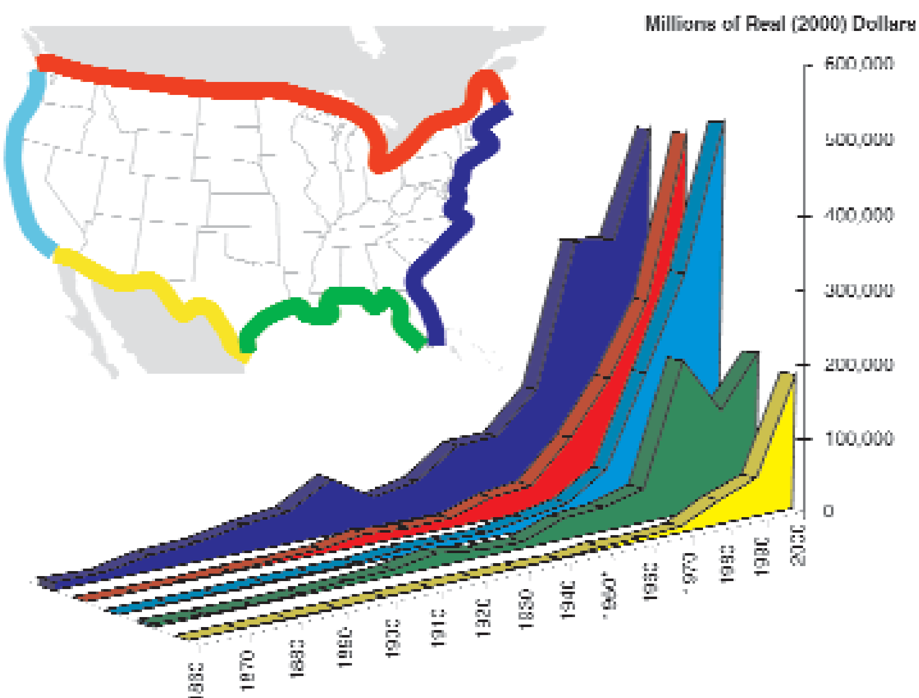


Figure 4. Goods Movement in the “Integration and Information Era”

Growth in Value of Imports and Exports from 1860 to 2000 by U.S. Coast and Border Region



GOODS MOVEMENT TODAY

There are several sources and types of freight data available to assess the performance of the goods movement system and its component modes. In this report, we have relied on the TRANSEARCH year 2000 database. The TRANSEARCH database includes all domestic moves by truck, air, rail, and water, and is linked to a set of commodity-specific future forecasts. According to TRANSEARCH:

- The nation's freight system moved 14 billion tons of domestic freight valued at $11 trillion over 4.5 trillion ton-miles in 2000. Figure 5 shows the share of tons, ton-miles, and revenue dollars for each mode.

- Trucks moved 78 percent of the nation's domestic freight tonnage, generated 60 percent of its ton-mileage, and accounted for 88 percent of its dollar value, the highest percentage in each category. Trucks moved 11 billion tons valued at $9.5 trillion over 2.6 trillion ton-miles in 2000. Figure 6 shows the density (in tons) of freight-truck traffic on the major roadways.

- Rail moved 16 percent of total domestic freight tonnage, second to truck. Rail moves tended to be longer in distance than truck moves and therefore accounted for a proportionately higher share (28 percent) of ton-miles. Rail moves also tended to involve lower-value commodities than truck, so rail represented a proportionately lower share (6 percent) of total domestic freight value. Rail moved two billion tons valued at $600 billion over 1.2 trillion ton-miles in 2000. Figure 7 shows the density (in tons) of freight-rail traffic on the major rail lines.

- Water (e.g., river barges, and coastal and lake steamers) moved six percent of tonnage, 15 percent of ton-miles, and one percent of value. These figures cover only domestic waterborne tonnage. Like rail, water moves tended to be longer in distance and lower in value than truck moves. Domestic shipping moved one billion tons valued at $138 billion over 540 billion ton-miles in 1998. Figure 8 shows the density (in tons) of inland and coastal water freight on the major water routes.

- Air represented a negligible share of tonnage and ton-miles, but a disproportionately high share of value, 5 percent. Air freight tends to be very light and valuable.

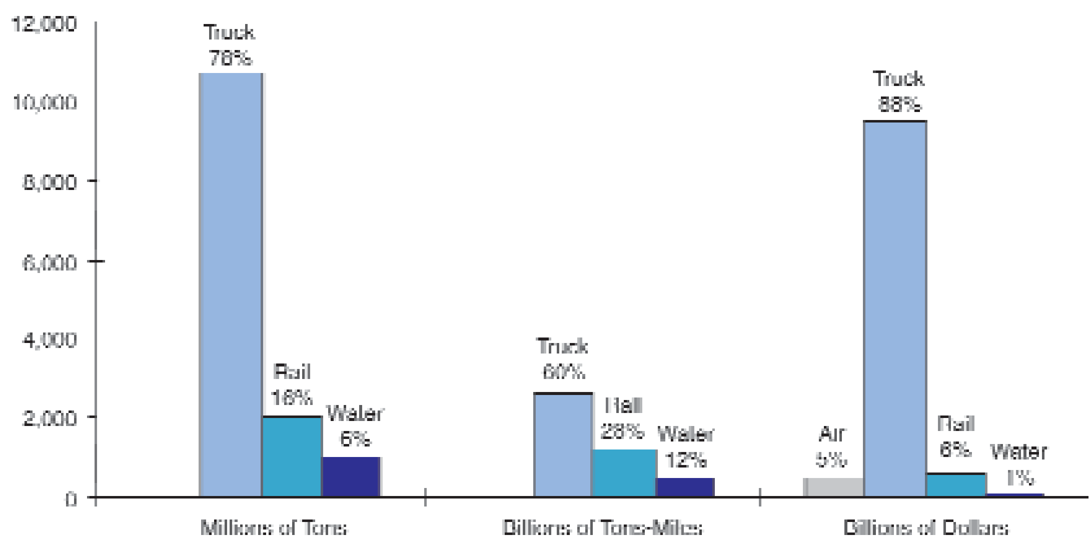
Another widely used set of freight statistics is published annually by the Eno Foundation in its "Transportation in America" series. The Eno data includes more modes — it covers pipelines, in addition to air, rail, water, and truck — but it reports only "intercity" tonnage (tonnage moving from one local area or commercial zone to another). By excluding tonnage that is not intercity in nature — which is predominantly handled by truck — the Eno data reports a lower share of tonnage, ton-mileage and value for trucking than the TRANSEARCH data. The Eno data is useful in comparing the performance of freight modes in terms of longer-distance services. Eno data suggests that, for intercity freight in the year 2000, rail was responsible for 41 percent of intercity ton-mileage, compared to 29 percent for trucks, 17 percent for pipelines, 13 percent for water, and less than one percent for air. This clearly highlights the critical role that rail plays in moving large quantities of freight over long distances.

Each freight mode offers certain advantages and disadvantages in terms of cost, speed, reliability, visibility, and security, with shippers buying freight services that best fit their specific shipping needs. Figure 9 shows the spectrum of freight transportation services with the approximate cost per pound and key service characteristics. For example, package and express shippers favor air and truck because these modes offer the fastest and most reliable door-to-door service for light-weight shipments. The cost is high, but customers are willing to pay for the high quality of service. In contrast, shippers of bulk commodities like coal, grain, and petroleum prefer to use water or rail. These modes offer less speed and reliability, but provide transportation at a far lower unit cost, which makes these commodities affordable across the nation. Figure 10 compares average trip length by mode. Figure 11 compares average value of cargo by mode.

In the "freight transportation service spectrum," rail occupies a place between and overlapping water transport and trucking. It competes with water transport for heavier, lower-value, less time-sensitive commodities. It competes with trucking for higher-value, often containerized, shipments moving over longer distances. And it is the preferred mode for a number of economically important, but heavy and bulky commodity groups, such as coal, farm products, and minerals. Figure 12 shows rail's top 10 commodities by tonnage and mode share compared to truck. Rail shares are shown for rail carload and rail intermodal service; truck shares are shown for truck trips under 500 miles and truck trips over 500 miles. Most railroad revenues are generated by moving coal, chemicals, farm products, and non-metallic minerals (see Table 1).

Figure 5. U.S. Domestic Freight Movement

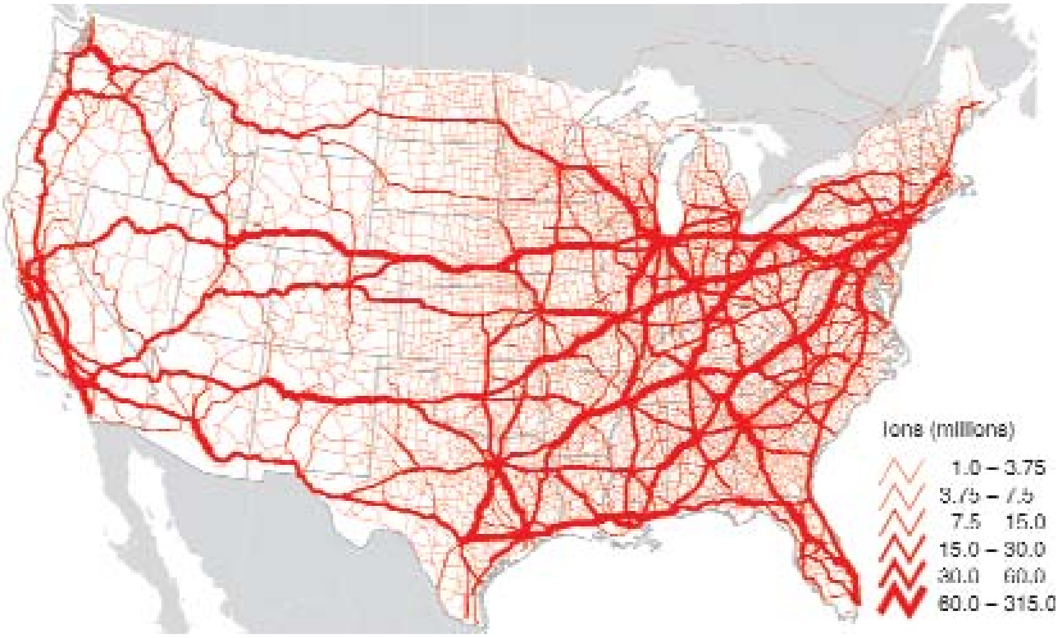
Year 2000



Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Figure 6. U.S. Domestic Freight-Truck Traffic

Year 2000



Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

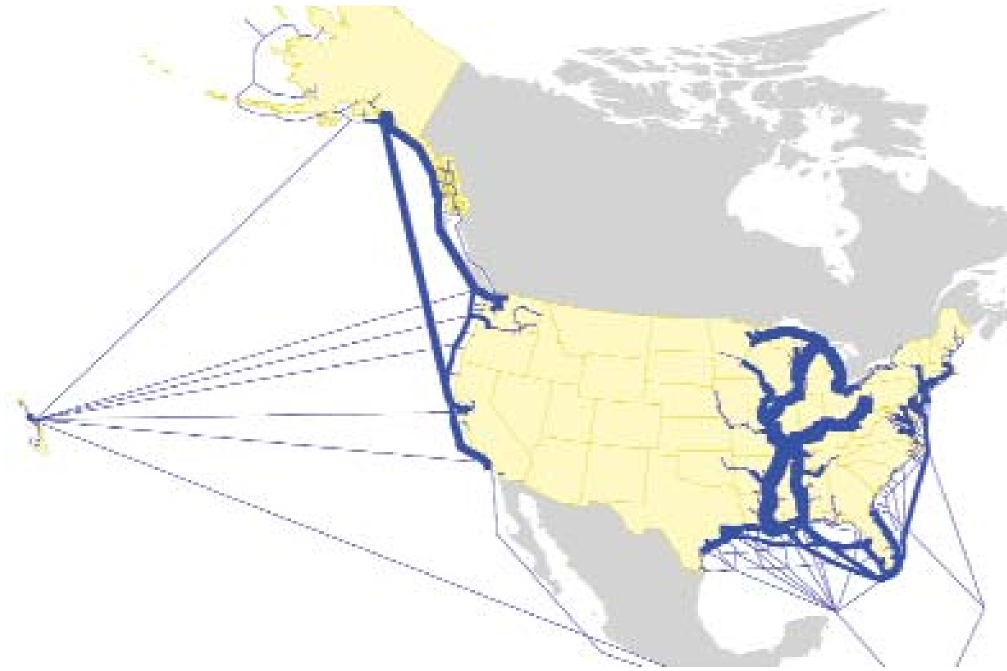
Figure 7. U.S. Domestic Freight-Rail Traffic

Year 2000

Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Figure 8. Inland and Coastal Water-Freight Flows

Year 2000



Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Figure 9. Freight Transportation "Service Spectrum"

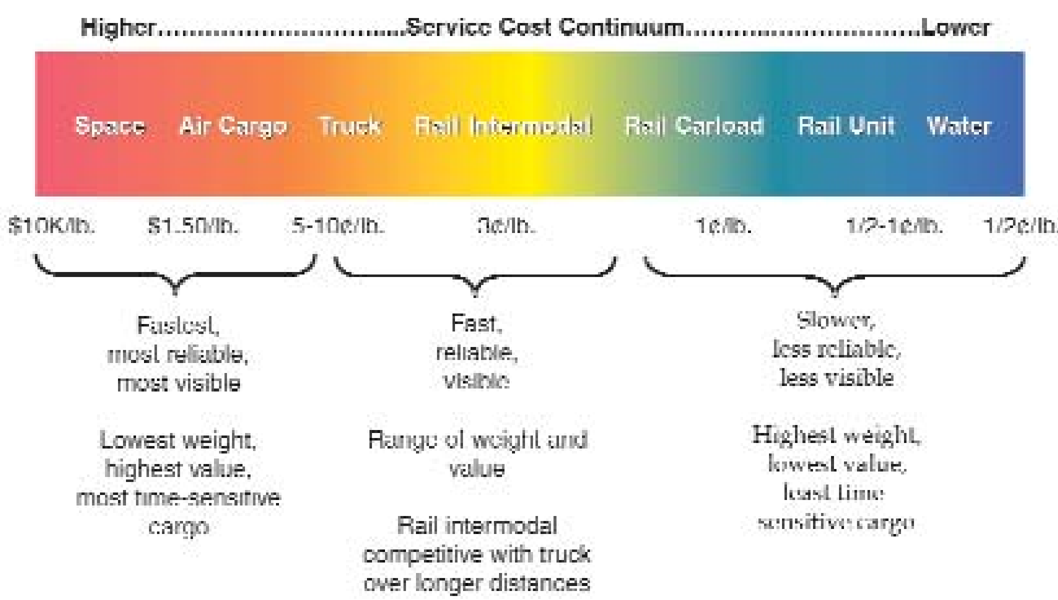
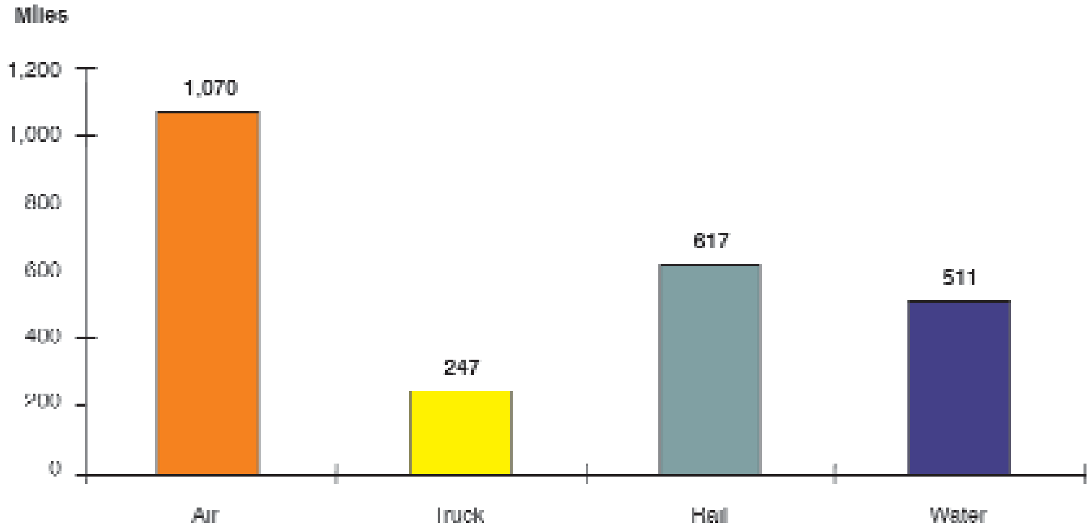


Figure 10. Average Length of Trip by Mode in Miles

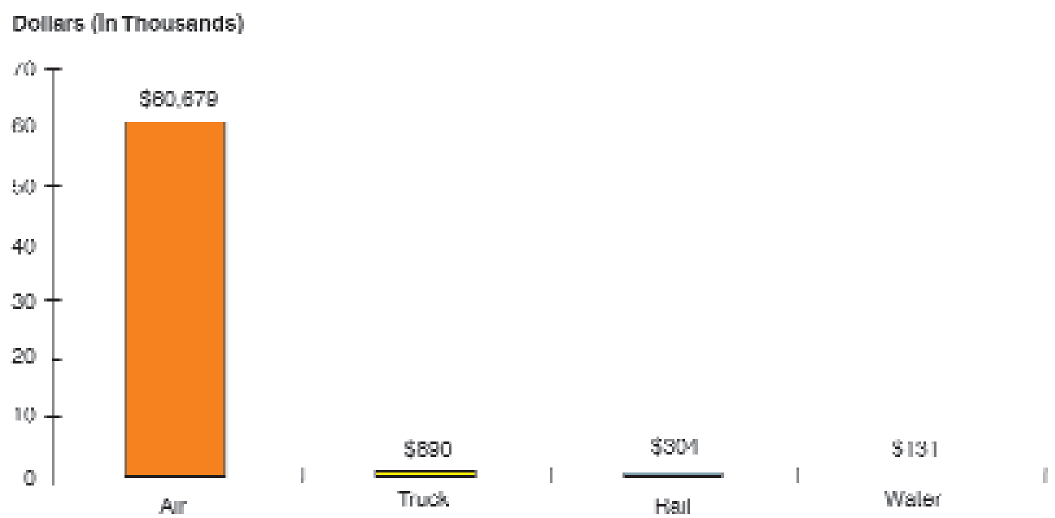
Year 2000



Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

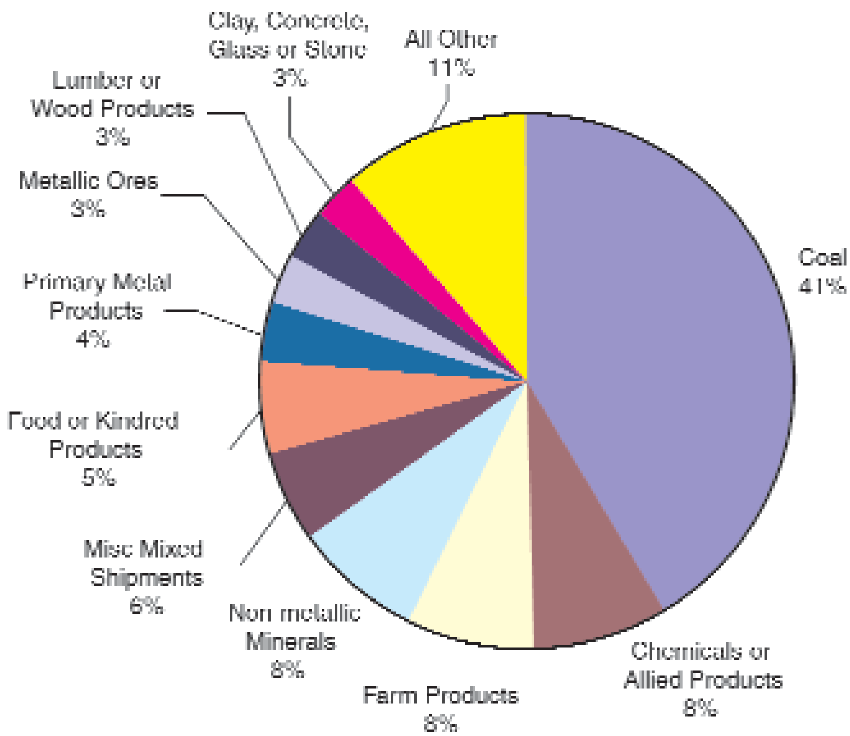
Figure 11. Average Value per Ton of Cargo

Year 2000



Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Figure 12. Rail's Top Ten Commodities by Tonnage



Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Table 1. Rail's Leading Commodities by Revenue

Example of Four Class I Railroads' Annual Reports

Norfolk Southern (2000)	CSX (2001)	Union Pacific (2001)	BNSF (2001)
23% Coal, Coke, and Iron	24% Coal, Coke, and Iron Ore	23% Energy	37% Consumer Products
18% Intermodal	16% Intermodal	19% Industrial Products	23% Coal
15% Automotive	13% Chemicals	18% Intermodal	23% Industrial Products
13% Chemicals	11% Automotive	15% Chemicals	17% Agricultural Products
11% Metals and Construction	9% Forest Products	14% Agricultural Products	
10% Paper, Clay, and Forest Products	7% Agricultural Products	11% Automotive	
10% Agriculture	6% Metals		
	5% Minerals		
	6% Other		

FREIGHT-RAIL SERVICES TODAY

Rail provides three basic types of freight service: bulk unit train, mixed carload, and intermodal (container, trailer, and automobile). These services differ in their markets, operations, and contributions to the nation's freight transportation system.

Bulk Unit Train

Bulk unit trains move very high volumes of a single commodity such as coal, grain, minerals, and waste. (Intermodal containers and specialized automobile carrier cars are frequently made up into unit trains; these are addressed in the discussion of intermodal service.) Figure 13 shows coal being transported in a bulk unit train. Commodity flows tend to be one-way; cars (usually hopper cars) move loaded from shipper to receiver and are returned empty from the receiver to the shipper. Commodity flows tend to be "door-to-door," moving from shipper to receiver entirely by rail.

Bulk unit train commodities are highly sensitive to transportation cost because they are heavy but, like coal and grain, relatively low in value. Unit trains provide the efficiencies needed to move these commodities cost-effectively. This is accomplished through:

- Long trains (up to one and one-half miles) of rail cars moving along mainline corridors, which allows economies of scale in operation (less handling cost, more efficient utilization of locomotives, greater fuel efficiency, etc.);
- Uniform composition (usually a single commodity and railcar type), which simplifies the collection and distribution of railcars along feeder lines; and
- Customers who tend to produce or consume large quantities of these materials, reducing the number of origins and destinations that need to be served.

Unit train flows tend to occur along well-defined, high-density corridors, rather than clustering at major urban rail hubs. Figure 14 shows the density (in tons) of unit train traffic on major rail lines. The highest-density traffic lines carry coal from production centers in Wyoming's Powder River Basin to Midwest power plants and barges on the Missouri and Mississippi rivers, and from production centers in Appalachia to cities and export terminals on the Atlantic coast.

In 2000, unit trains carried 1.027 billion tons over 582 billion ton-miles. This is the equivalent of 25.1 billion truck miles. Within the commodity groups served by unit train, rail handles a dominant 70 percent of the tonnage, compared to 30 percent for water and truck, indicating that rail is the preferred mode for these commodities.[3] Table 2 compares unit train, carload, and intermodal services. The table shows the tons, ton-miles, rail share compared to other modes, and equivalent freight-truck vehicle-miles-of-travel (VMT) for each type of rail service.

Mixed Carload

Mixed carload trains move a diverse range of commodities, including chemicals, food products, forest products, metals, auto parts, waste, and scrap. Rail carload equipment includes liquid-bulk tank cars, open flatcars, hopper cars, and traditional boxcars. (Intermodal containers and specialized automobile carrier cars can also be handled as carload traffic; these are addressed in the discussion of intermodal service.) Figure 15 shows a tank car moving through a railroad classification yard. Like bulk unit trains, carload traffic tends to be one-way — loaded to the receiver, empty back to the shipper.

Most carload traffic is door-to-door, although smaller customers without direct rail access or those who need less-than-carload quantities can be served by combined carload-truck services. "Transload" facilities accommodate the transfer of non-flowing materials (e.g., lumber, sheetrock, etc.) from carload to truck using conventional methods (e.g., forklifts, cranes, etc.). Similarly, "transflow" facilities accommodate the transfer of liquid or "flowing" materials (e.g., oils, plastic pellets, bakery flour, etc.) from carload to truck using very specialized pumping equipment. Transload and transflow commodities are moved from the shipper's factory to a rail yard or siding near the receiver, then moved the final miles by truck for "just-in-time" use by the receiver.

Carload generally serves heavy products that are sensitive to transportation costs. However, it can be more difficult to achieve economies of scale with carload traffic than with unit-train traffic because carload service involves a much higher degree of handling and management.

- Carload trains typically are not uniform in composition. They include a variety of railcar types, each of which must be collected from and distributed to specific customers. On a unit train, one hopper car full of coal is the same as any other. But on a carload train, each car is an individual shipment. Moreover, many cars are privately owned or in "sequestered" or dedicated service and therefore not interchangeable and available for use by other customers. The variety of car types and commodities increases administrative and physical-handling costs compared to unit train service.

- Carload train lengths vary greatly by intercity corridor and market, reflecting the different mixes and volumes of commodities moving between markets. The railroads collect many different types of cars from many different customers, classify and marshal them into long consists for the intercity move, and then break them into shorter consists for the final delivery. The railroads depend on a complex hub and spoke network to move consists and individual cars through the system. The shorter the intercity corridor and the more complex the mix of car and commodity types, the more difficult it is to achieve economies of scale in carload operations.

- Carload customers are more diverse than unit train customers. Carload users range from large customers generating hundreds of carload shipments a week to small customers receiving a handful of carload deliveries a month. The mix of large and small customers and the wide geographic distribution of origins and destinations make it difficult to handle all shipments profitably. For example, CSX estimates that it is three times more expensive on a per-car basis to serve a low-density customer than to serve a high-density customer.

Carload traffic flows are far more dispersed than unit train flows. Figure 16 shows the density (in tons) of carload traffic on major rail lines. The carload network is centered on the nation's key urban railroad hubs (e.g., Chicago, St. Louis, Kansas City, Memphis, Houston, and Dallas) with major corridors running north–south and east–west. Traffic densities on the major corridors are similar, but the mix of commodities varies (e.g., chemicals from Houston to Chicago; lumber from Portland to Chicago; and food products from the San Joaquin Valley to Chicago).

In 2000, carload trains carried 783 million tons over 236 billion ton-miles. This is the equivalent of 20.1 billion truck miles. However, within the commodity groups served by carload, rail captures just seven percent of the tonnage, compared to 93 percent for truck and water.[4] Rail continues to seek ways to grow its share of mixed carload business, but to compete more effectively with trucking, it will need to increase its door-to-door reliability, lower its operating costs, and increase its overall handling speed.

Intermodal (Container, Trailer, and Automobile)

Intermodal trains move truck trailers and containerized goods containing 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. For the purposes of this report, rail shipments of automobiles are also treated as intermodal traffic since they share many of the characteristics of intermodal merchandize (e.g., high-value, time-sensitive, etc.) and are handled in a similar manner. However, the railroads usually market and account for automobile traffic as a separate service. Figure 17 shows an intermodal train carrying double-stacked containers. Unlike unit train and carload traffic, intermodal traffic is typically two-way. Imported international containers may move inland from a seaport, be unloaded, then reloaded with export cargo (if available) or with purely 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.

Intermodal containers come in a variety of shapes and sizes. They range from 20-feet to 53-feet long and from 8-feet, 6-inches high to 9-feet, 9-inches high. International container volumes are measured in 20-foot equivalent units, or TEUs. A 20-foot container is counted as one TEU, and a 40-foot container is counted as two TEUs. The 40-foot container is the most common type used in waterborne transportation. Domestic containers typically are 48- or 53-feet long, and are modifications of standard over-the-road truck trailers. Standard truck trailers also appear in intermodal service in sizes ranging from 28- to 53-feet long. In the year 2000, 51 percent of intermodal traffic was in international containers, 23 percent in domestic containers, and 26 percent in truck trailers.[5] Truck trailers and containers are handled on railcars in a variety of ways:

■ Container-on-Flatcar (COFC)

Containers are placed directly on standard flatcars. A 90-foot flatcar will accommodate up to four TEUs.

■ Trailer-on-Flatcar (TOFC)

Over-the-road trailers or containers mounted on truck chassis are placed directly on flatcars. Standard flatcars accommodate one or two units; specialized spine cars take up to five.

■ Double-Stack

Containers are placed two-high, one on top of the other, in a special low-profile "well car." Well cars may accommodate as few as two containers, or as many as 10 containers depending on their length (e.g., 45-foot, 48-foot, or 53-foot containers can be stacked on top of two 40-foot or two 20-foot containers). By stacking the containers, railroads can double (or more than double) the number of containers carried on a train, improving productivity and effective capacity, and reducing unit costs.

Automobiles are generally carried in specialized railcars that accommodate either two or three levels of vehicles. The vehicles are driven onto and off of the railcars. Both the "bi-level" and "tri-level" auto carriers have high vertical profiles and require overhead clearances similar to double-stack container traffic. In one typical movement, autos are loaded at the production plant, taken to an unloading ramp where they are driven off and parked, and then are reloaded onto auto-rack trailers for final highway delivery by truck to dealerships. Another typical movement is movement between marine terminals and inland consolidation/distribution facilities or "mixing centers."

Intermodal service accommodates higher-value, lower-weight commodities than unit train or carload services. The service offers faster speeds, higher train frequency, better schedule reliability, and more visibility en route — albeit at a higher price — and is competitive with door-to-door trucking over longer distances (generally starting at 400 to 500 miles, depending on the equipment and corridor). The most efficient and cost-effective intermodal service is the unit train, which is the preferred method for serving high-volume corridors. Intermodal railcars can also be handled in combination with carload traffic, as part of mixed merchandise trains. Although this can be costly, especially on routes that provide overhead clearance for single-stack intermodal cars only, it allows intermodal service to reach lower-volume customers.

More than any other rail service, intermodal depends on partnerships with trucking companies, seaports, and others in the transportation logistics chain. Each container or trailer or set of automobiles is an individual shipment, and there are a vast number of origins and destinations to be served. In response, both railroads and truckers have recognized that the best approach to this market is to let each mode do what it does best. Railroads handle the long-haul movement of large quantities of containers and trailers between major hubs such as seaports and major population centers, while truckers handle the short-haul movement to/from the customer's "front door." For example, merchandise manufactured and packed in a container in China may be imported to the United States through the Port of Long Beach, trucked to the nearby intermodal container transfer facility, loaded onto a double-stack unit train, moved by rail to Chicago, transferred across town by truck from a western railroad to an eastern railroad, moved by rail to north Jersey, transferred to truck, taken to a nearby distribution center where the contents are transferred to smaller trucks, and finally delivered by van to a customer in Brooklyn. This type of international move, where rail is used to complete a journey begun via water, is loosely called a "landbridge" move.[6]

Much of intermodal traffic is in higher-value consumer products and in import-export traffic. This creates two distinct patterns: high demand for suitable railcar equipment leading up to and during seasonal shopping periods; and the concentration of intermodal rail traffic along a relatively few, high-density corridors connecting the nation's leading container ports and its primary consumer markets. Figure 18 shows the density (in tons) of freight-rail intermodal traffic on major rail lines. The most significant flows are from the west coast container ports of Long Beach, Los Angeles, Oakland, Portland, Tacoma, and Seattle through Chicago to New York and northern New Jersey.

In the year 2000, intermodal trains carried 199 million tons over 421 billion ton-miles. This is the equivalent of 16.2 billion truck miles. While not nearly as high as the figures for unit train and carload, these are significant numbers. Within the commodity groups served by intermodal, rail handles over 16 percent of the tonnage, which is twice the figure for carload, indicating a deeper penetration by rail into this market.[7] Intermodal has been one of the fastest-growing segments of the rail industry.

Figure 13. Example of Bulk Unit Train

Coal in Hopper Cars

Figure 14. Unit Train Traffic Flows

Year 2000

Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Figure 15. Example of Industrial Commodities/Carload Train

Liquid Bulk Tank Car Moving Through a Classification Yard

Figure 16. Carload Train Traffic Flows

Year 2000

Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Figure 17. Example of Containerized Merchandise/Intermodal Train

Double-Stack Train

Figure 18. Intermodal Train Traffic Flows

Year 2000

Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Table 2. Relative Performance of Unit Train, Carload, and Intermodal Rail Services

Year 2000

	Net Tons (Million)	Ton-Miles (Billion)	Rail Share Versus Other Modes	Equivalent Truck VMT (Billion)
Bulk Commodities/ Unit Train Service	1,027	582	70%	25.1
Industrial Commodities/ Carload Service	783	421	7%	20.1
Containerized Merchandise/ Intermodal Service	199	236	16%	16.2
Total	2,009	1,239	16%	61.4

Source: Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

FREIGHT-RAIL BENEFITS TODAY

Freight-rail services benefit the nation's economy, transportation system, and environment.

Economic Benefits

Rail provides shippers of heavy materials or large volumes of materials with a transportation option that can be significantly more cost-effective than truck. Depending on the density of the commodity, one railcar may move the same weight or volume as four or five trucks. Even industries that ship their finished products by truck may be dependent on rail. For example, poultry farmers ship finished chickens to supermarkets by truck, but most of the cost is in buying and moving feed, which is done by rail. For such shippers, rail is usually the low-cost option, and rail rates have been dropping. On average, it costs 29 percent less to move freight by rail today than in 1981.[8] The associated cost savings (in the billions of dollars annually) are vital to the viability of these businesses. The availability of rail service can be an important factor for states and municipalities interested in retaining and attracting these types of businesses.

Many states believe that freight-rail service is vital to their economies and have made freight-rail service, especially the retention of lower-density branch lines, a significant part of their economic development and transportation programs. The quote from the Idaho Department of Commerce, shown in Figure 19, reflects the importance of rail to many state departments of economic development, commerce, and agriculture. Rail service also can act as a catalyst for redeveloping urban corridors and underutilized rail-served brownfields as "integrated logistics centers" — concentrations of rail-served warehousing, distribution, and manufacturing — with efficient rail and truck service. Figure 20 shows a schematic of an "integrated logistics center" developed on brownfield industrial property adjacent to a highway and rail line.

To estimate the value of freight-rail service to the nation's shippers, a hypothetical case was examined: What if shippers in 2000 did not have access to rail and instead made the equivalent shipments by truck paying truck rates? The answer: $69 billion. Table 3 shows the hypothetical impact of shifting to truck the 1,239 billion tons of freight now carried by rail at $0.024 per ton for a total cost of $25 billion. If this same 1,239 billion tons of freight were carried by truck at the prevailing average cost of $0.080, the total cost to shippers would be $99 billion, an increase of $69 billion. This figure would increase annually as the total volume of freight increases with the growth of the economy and trade. The final cost to consumers would be significantly higher as the economic-multiplier effect of increased shipping costs rippled through other sectors of the economy. In practice, if the freight-rail system suddenly "went away," some of these shippers would use water, some would relocate, and others might not ship at all. However, this hypothetical case provides one illustration of the economic importance of rail within the overall transportation system.

The railroad industry also makes direct contributions to the nation's economy. U.S. freight railroads pay over $14 billion a year in wages and benefits to their 192,000 employees. Class I railroad capital expenditures in 2000 came to $6.1 billion. Class I railroads also paid more than $2.2 billion in payroll taxes, $382 million in federal income taxes, and $800 million in other taxes.[9]

Transportation System Capacity and Cost

In 2000, the freight-rail system handled 28 percent of all freight ton-mileage in the United States, a substantial share of the nation's overall freight capacity. The railroads help reduce pressure on the nation's highways. If everything moving by rail were to move instead by truck, an additional 61.4 billion truck VMT would be logged every year.

To estimate the value of freight-rail service to the nation's highway system, a second hypothetical case was estimated: How much additional highway funding would be needed between the year 2000 and the year 2020 if freight-rail service was unavailable and business and industry were forced to make the equivalent shipments by truck? The answer: $64 billion dollars.

The FHWA's Highway Economic Requirements System (HERS) model was used to estimate highway-needs costs.[10] A first approximation analysis found that combination-truck VMT would increase by 38 percent over the baseline combination truck VMT forecast in year 2020, and that cumulative highway-needs-costs to accommodate the increased VMT over the 20-year period would cost the nation $64 billion dollars. Table 4 shows the highway-needs-cost impact of adding enough truck VMT to the highway system to carry all the commodities carried by rail. In 2020, the highway system will carry an estimated 245 billion truck VMT. If all freight-rail tonnage were shifted to trucks, truck VMT would increase by 92 billion VMT to a total of 337 billion VMT. The incremental cost to the highway system would be $64 billion for a cumulative cost of $1,943 billion between 2000 and 2020.

This estimate is conservative. First, it is based on an assessment of a systemwide increase in truck VMT. In practice, the truck VMT increases would be realized on specific corridors. Many of these would be high-volume, high-congestion corridors, where the highway needs generated by increased truck VMT would be proportionately higher. Second, while HERS captures some major highway costs such as roadway resurfacing and widening of existing roadways, it does not capture others, such as improvements to bridges, interchanges, or local roads; investment in new roads; and system enhancements. It is estimated that HERS captures approximately 47 percent of total capital highway needs.

Many states are responding to increased pressure on their interstate and state highway systems by looking to rail system improvements. Rail is cost competitive for some kinds of intercity freight movements and handles more intercity ton-mileage than truck. In certain intercity corridors, it may be less expensive to boost capacity by improving the rail system than by adding or widening highways. Better rail service would attract and offset truck traffic, "creating" additional highway capacity for automobiles. Virginia has performed several studies of highway-rail improvements in the I-81 corridor to evaluate the public benefits of this approach. Another recent effort was the Mid-Atlantic Rail Operations Study, a joint effort of five states (New Jersey, Pennsylvania, Maryland, Delaware, and Virginia), the I-95 Corridor Coalition, and three railroads (NS, CSX, and Amtrak), which looked at rail infrastructure choke points and opportunities for improvements paralleling I-95, I-81, and other critical highway corridors. (These and other public-benefit rail projects are discussed in more detail in Appendix D.)

The nation's freight-rail system provides another critical transportation capacity benefit. It provides the infrastructure over which much of the passenger rail system operates. Except for the northeast corridor between Washington, D.C. and New York City (which is owned by Amtrak), Amtrak operates almost entirely on the freight-rail system. Many commuter railroads throughout the country also operate some or all of their service on the freight railroads' lines.

Intermodal Connectivity and International Trade

Freight-rail service provides a critical link in the nation's intermodal freight transportation system, serving the trucking and maritime shipping industries, and supporting the nation's international trade and global competitiveness.

The rail and trucking industries are competitors, but they are also partners. Unless a rail move is "door-to-door," it begins or ends with a truck move. This could involve the transfer of an intermodal container or the transfer of bulk and carload commodities via transload or transflow operations. Rail and trucking companies are partnering to provide integrated door-to-door intermodal services that optimize the relative strengths and efficiencies of each mode. The chairman of the nation's largest truckload carrier states, "Rail is low-cost where there is sufficient density on a lane. This is fundamentally a fact of life. Let's make [rail and truck] technologies work together and use them where appropriate. We have worked with our rail partners very effectively."[11] The Norfolk Southern Railroad estimates that 40 percent of its non-coal freight moves by truck.

Seaports rely on rail to provide them with connections to shippers and receivers of bulk, carload, and "hinterland" intermodal freight. Rail typically represents between 10 and 50 percent of a port's landside traffic by tonnage. Certain ports are especially dependent on rail. These include coal and grain ports (since unit train is the preferred method of moving these goods); ports handling high volumes of chemicals, oils, lumber, paper, and other carload commodities; and major container gateways that serve large inland markets via "landbridge" operations. These connections may be regional in nature (such as the rail link between the coal fields of Appalachia and the marine terminals in Hampton Roads, Virginia), or they may be national in nature (such as the rail link that allows containerized goods from the Far East to be imported through the ports of Los Angeles and Long Beach and moved across the country to the New York/New Jersey market).

Ports compete to attract the business of ocean carriers and major shippers. These carriers and shippers look very closely at the inland distribution costs associated with ports-of-call because inland transportation can account for half of the end-to-end cost of an overseas move. Ports that do not offer rail service or that cannot accommodate equipment such as double-stack container cars or heavy bulk cars on key routes are at a competitive disadvantage in attracting and retaining business.

As a result, many ports are taking the lead role in making rail access improvements. The most visible example to date is the recently opened Alameda Corridor, which serves the ports of Long Beach and Los Angeles. The ports, in cooperation with local, regional, and state governments, developed and implemented a $2.4 billion dollar plan to consolidate the operations of three freight lines and reduce local trucking between port and rail facilities. The result is a single, triple-tracked, fully grade-separated, 20-mile intermodal freight-rail corridor. About half the funding is derived from bonds secured by freight-rail revenues; the remainder is a combination of loans, grants, and tax proceeds. The public benefits of the project included strengthening the economic value of the ports, reducing truck traffic and engine emissions, eliminating congestion at rail-grade crossings, and reconnecting neighborhoods once divided by the rail lines.

By serving the nation's seaports, rail becomes a critical element in the nation's access to global markets and supports U.S. producers and consumers in the world economy. Rail also provides access across land borders to Canada and Mexico. While trucks sit in queues at borders awaiting inspection and clearance, trains that are pre-cleared and electronically tracked can cross the border at full speed without stopping. According to the U.S. Bureau of Transportation Statistics, surface trade with Canada and Mexico was valued at over $575 billion dollars in 2000. Rail was responsible for over $94 billion dollars or 16 percent of this trade. Just five border crossings — Port Huron, Michigan; Laredo, Texas; Buffalo-Niagara Falls, New York; Detroit, Michigan; and International Falls-Ranier, Minnesota — account for 80 percent of rail-borne international trade by value.

Environmental Benefits

Railroads provide significant environmental benefits.[12] The U.S. Environmental Protection Agency estimates that for every ton-mile, a typical truck emits roughly three times more nitrogen oxides and particulates than a locomotive. Related studies suggest that trucks emit six to 12 times more pollutants per ton-mile than do railroads, depending on the pollutant measured. According to the American Society of Mechanical Engineers, 2.5 million fewer tons of carbon dioxide would be emitted into the air annually if 10 percent of intercity freight now moving by highway were shifted to rail.

In 2000, railroads moved a ton of freight an average of 396 miles per gallon. If 10 percent of the freight moved by highway were diverted to rail, the nation could save as much as 200 million gallons of fuel annually. On average, railroads are three or more times more fuel efficient than trucks.

Rail is also a preferred mode for hazardous materials shipments. The nation's railroads handled 1.7 million carloads of hazardous materials in 2000. Just 35 accidents took place that resulted in spills or leaks of the materials.

Emergency Response

Over the past decade, transportation logistics managers have focused on increasing efficiency as a means of reducing the need for infrastructure. States and MPOs have adopted aggressive system-management, demand-management, and ITS strategies. Shippers have implemented just-in-time delivery strategies, centered on information and transportation system reliability, to reduce inventory and warehousing requirements. But as the terrorist attacks of September 11 illustrated, a transportation system at risk of disruption must provide an excess of capacity — some amount of "transportation redundancy" — or face the possibility of catastrophic breakdown.

The freight-rail system provides a critically needed alternative mode of transportation in the event of an emergency. In a paper for the FHWA Office of Freight Management and Operations (*Freight Transportation Security and Productivity*, April 11–13, 2002), Michael Wolfe articulates a paradox: "...overall logistics systems capabilities are growing simultaneously more robust and more fragile. Ironically, sophisticated JIT supply chains are more subject to delivery disruptions than older, less efficient models." Wolfe continues:

> "Well-tuned supply chain management systems excel in handling relatively small variations in supply or demand — variations within their competence and design capacity. Those systems cannot respond effectively to conditions far beyond their normal operating circumstances, such as large, sudden spikes in demand (a military surge) or plunges in supply (sudden imposition of tighter security controls). The events following September 11 may foreshadow future impacts of the paradox."

A nationwide rail network connecting U.S. cities, states, and seaports provides a measure of system redundancy that affords needed insurance against the loss of highway capacity for both freight and passengers.

Rail plays another critical emergency-related service role by providing efficient connections between military facilities, and by connecting these facilities with ports of embarkation during periods of overseas mobilization. The U.S. armed forces depend on rail as a critical element in the logistics chain. As the chief of the Military Traffic Management Command put it in recent testimony, "our nation's military goes to war on rails."[13]

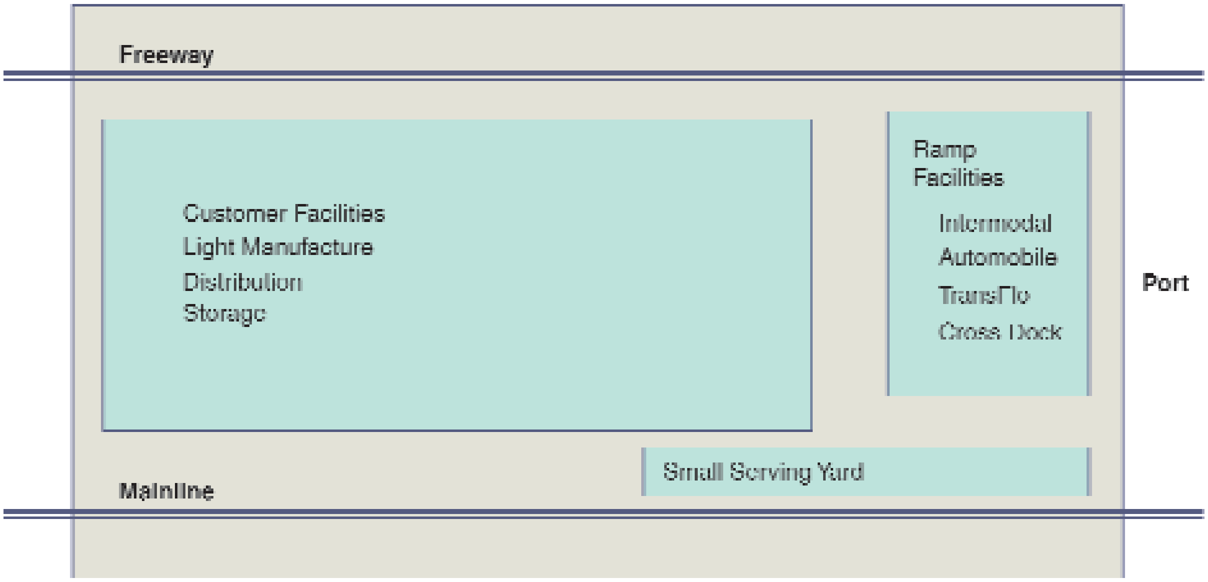
Figure 19. Importance of Freight Rail in Supporting State Economies by Providing to Markets and Retaining/Attracting Business

Idaho Example

> **" Idaho's economy, particularly in rural areas, relies heavily upon the freight-rail system to facilitate movement of the state's ... natural resources and manufactured products to local, national, and international markets.**
>
> **Most Idaho companies surveyed that ship by rail state that they could not exist without access to railroads."**
>
> **— Idaho Department of Commerce, March 2002**

Figure 20. Role of Freight Rail in Supporting State Economies by Redeveloping Historic Urban Cores and Brownfields

The Integrated Logistics Center Concept



Source: CSX Transportation

Table 3. Value of the Freight-Rail System to the Nation's Shippers

Year 2000

	Rail Ton-Miles, 2000	Rail Ton-Miles, 2000 Shifted to Truck	Shipper Cost in Year 2000
Rail Volumes	1,239 billion @ $0.024	None	$30 billion
If Rail Traffic Shifted to Truck	None	1,239 billion @ $0.080	$99 billion
Difference			$69 billion

Source: Reebie Associates' TRANSEARCH and Eno Foundation

Table 4. Value of the Freight-Rail System to the Nation's Highway System

Years 2000–2020

	Combination Truck VMT, 2020 (TRANSEARCH Diversion Estimate)	Highway Needs 2000–2020 (HERS Model, First Approximation)
Base Case Forecast	245 billion	$1,879 billion (1999 FHWA Condition and Performance Report, Maximum Investment Scenario)
Plus Trucks Added if All Rail Tonnage Moved by Truck	92 billion	$64 billion
Total	337 billion	$1,943 billion
Percent Change	38%	3%

Source: Cambridge Systematics based on Reebie Associates' TRANSEARCH and HERS Model, First Approximation

THE FREIGHT-RAIL BUSINESS TODAY

The Nation's Freight-Rail Network

Construction of the nation's rail network started in 1828. The system expanded rapidly in the late 1800s and early 1900s. System mileage peaked in the 1920s, at approximately 380,000 miles of track. Since that time, the rail network has been modernized, rationalized, and downsized to a core network whose route system is descended directly from its 19th century design. The Class I railroad system today has 172,000 miles of track, less than half the number of miles it had in the 1920s. Figure 21 traces the growth and contraction in the number of miles of rail line in the United States from the early 1800s through 2000.

The reduced size of the nation's freight-rail network is the result of two factors: competition with the trucking industry and deregulation. As private businesses face stiff rate competition from trucks and shareholder pressure to generate profits, the nation's major railroads have disinvested in lines and services with insufficient traffic density to adequately cover operating and maintenance costs. To improve productivity and profitability, they have invested in double-stack cars, larger hopper and tank cars, and higher boxcars and auto-rack cars, which in turn require investment in high-clearance tunnels, higher-weight-capacity track, and stronger bridges. The high cost of these improvements has limited railroads to upgrading only the highest volume and most profitable lines. Other lines have been downgraded or abandoned.

Abandonment also has occurred as a result of mergers and consolidations among railroads, which have led to duplicative or redundant lines. The merger trend began in the mid-19th century as railroads struggled to build networks and access profitable routes and markets. In the mid-20th century, when many of the railroads were spiraling into bankruptcy, the Staggers Act helped railroads continue the process of merging, restructuring, and reorganizing. Abandonments began in the 1920s and continued steadily up to 1980. Since deregulation, the pace has slowed as more lines have been sold to create short-line and regional railroads.

The result of these changes is a modern, efficient "core" network geared towards profitably serving today's freight-rail markets. But this efficiency has come at a cost. Railroad service has been withdrawn from many areas, forcing businesses to relocate or shift to truck service.

The Nation's Freight Railroads

Mergers and reorganization following the economic deregulation of the rail industry in 1980 restructured the industry. Today, there are seven Class I railroads (defined as railroads with revenues in excess of $261.9 million) and 551 regional and short-line railroads. The seven Class I railroads, all privately owned, are: Burlington Northern/Santa Fe; the Canadian National (which controls the merged Grand Trunk Western and Illinois Central); Canadian Pacific (which controls the Soo Line); CSX Transportation; Kansas City Southern Railway; Norfolk Southern; and Union Pacific. Two Mexican railroads — the Ferrocarril Mexicano and the Transportacion Ferrovaria Mexicana — would also qualify as Class I railroads if they were U.S. companies. The Kansas City Southern owns a substantial minority interest in Transportacion Ferrovaria Mexicana, while the Union Pacific has an interest in Ferrocarril Mexicano.

In 2000, these railroads originated 84 percent of national rail traffic and generated 91 percent of railroad revenue. They operated just over 100,000 miles of railroad, employed more than 168,000 workers at an average wage of over $57,000. Figure 22 shows the areas served by today's Class I railroads. (The Mexican Class I railroad lines are not shown in this figure.) Table 5 provides summary statistics that compare the Class I and regional/short-line railroads as groups.

The 551 regional and short-line railroads operated over 30,000 miles of their own railroad lines in 2000 and employed over 23,000 workers at an average wage of over $47,000. The regional and short-line railroads are 94.5 percent private- and 5.5 percent public-owned. They originate 16 percent of national rail traffic but generate nine percent of railroad revenue, despite operating more than 20 percent of total system mileage.

Regional and short-line systems have been formed from a combination of historic holdings and the pieces of the Class I system that were shed by the larger railroads. Many branch lines operate effectively in conditions where the Class I railroads cannot. The regional and short-line systems take advantage of different labor cost structures, different profitability targets and business models, and may also receive some level of public funding support.

Regional and short-line systems play two critical roles in the nation's freight-rail network. They are important partners for the Class I railroads because they often provide the first and last service miles in the "door-to-door" collection and distribution of railcars. This arrangement allows the Class I railroads to focus investment in higher-density, longer-distance line-haul business in key corridors. Regional and short-line systems also ensure rail service for shippers along their lines who rely on rail to move heavy or bulky commodities cost-effectively. Without regional and short-line rail service, these shippers might close or relocate, taking jobs and tax revenue with them.

The consolidation of the nation's railroads has triggered concern about competitive pricing of railroad services. Some shippers argue that with fewer railroads and rail lines available, they may be "captive" to a single railroad that has little incentive to price its services competitively. As a result, some states have requested, through the federal Surface Transportation Board, that a railroad allow its competitors to offer service over the railroad's own lines. The railroads, for their part, argue that they already price their services as close to cost as possible to compete with trucking, and that competitive access requirements can "split" small markets into ever smaller pieces that are even more difficult for them to serve cost-effectively. The long-term railroad price and revenue trends (discussed in the next section) suggest that the industry on the whole is operating under intense price pressure.

Railroad Productivity and Service

Railroad productivity has improved dramatically over the past two decades. Figure 23 shows the trend in rail productivity measures.

- Ton-miles handled per railroad employee have nearly quadrupled.
- Railroad improvements between 1965 and 1995 reduced costs by $25 billion.[14] Improvements included the following:

  — Introduction of unit and double-stack trains resulted in an annual savings of $7.5 billion in 1996 alone;

  — Improved track and network rationalization resulted in $7 billion savings in track costs over the period;

  — Investment in computers and communications resulted in $4.7 billion savings in labor costs;

  — Reduced crew consists resulted in $4.2 billion savings in labor costs; and

  — Improved fuel efficiency resulted in $1.3 billion savings in fuel costs.

Overall, these productivity improvements have generally translated into service improvements described in terms of shipper cost, visibility and reliability.

Cost

Rail prices have dropped over the past two decades relative to other modes. Competition among railroads and with trucking has reduced rail rates, benefiting shippers, consumers, and the economy. In 1980, rail was more expensive on an index basis than either truck or water; today, it is more economical than truck or water. Figure 24 shows the change from 1950 to 2000 in rail, truck, and water freight rates.

Visibility

Shipment visibility is far greater today than ever before. With advanced tracking technologies and web-based services, customers can follow their individual shipments in real-time and make rerouting decisions en route if necessary. The railroads track and report intermodal shipments effectively, but tracking and reporting consistently on carload shipments is still a challenge.

Reliability

Over the past decade, railroads have introduced scheduled intermodal services with guaranteed reliability (e.g., within 1.0 hours of schedule, 99 percent of the time). Some railroads claim 99 percent on-time performance for their top intermodal customers, but the industry, as a whole, does not yet meet this benchmark. Railroads have also begun to schedule carload train departures, but because these are lower-priority trains in the system than passenger or intermodal trains, the railroads' ability to meet arrival windows is substantially less.

With some exceptions, service quality as measured by average train speed (freight train-miles per train-hour) has not improved over the past decade. Average speeds are actually lower today than in 1991. Figure 25 shows average freight trains speeds over the last decade. Most shippers whose primary need is for speed will elect to use other modes. Rail speed is less of an issue for price-oriented bulk commodities than for intermodal and carload goods, where competition with trucking is stronger. However, equipment cycle time is a crucial requirement in bulk transport, and speed of transit is a major contributor to it.

Modern just-in-time logistics place a premium on visibility, reliability, and speed — areas where trucking has an advantage over rail. A critical challenge for rail is to increase its performance in each of these areas, and to do so at a competitive cost.

Freight-Rail Market Share, Revenues, and Capital Needs

The recent gains in productivity and service quality have slowed the precipitous decline of rail market share. Figure 26 shows the change since 1950 in market share (measured in ton-miles) for rail, truck, inland waterway carriers, air carriers, and pipelines. The figure accounts only for intercity freight-rail ton-miles (e.g., including freight-rail traffic between major city-pairs but excluding local, agricultural, etc., ton-miles). The railroads' full share of the freight market, measured as a percentage of ton-miles over the nation's freight system, has also stabilized at about 28 percent. However, productivity gains and lower rail rates have not been sufficient to bring about substantial gains in market share, and shares measured in tonnage and revenue terms have continued to drop.

Competitive pricing by the railroads has been a critical factor in rail's ability to stabilize and maintain its market share. The result has been a steady decline in rail revenues on a ton-mile basis. Figure 27 shows freight-rail revenues per ton-mile from 1970 to 2000. Revenue, whether measured in constant or current dollars, has dropped significantly. This has been offset to some extent by productivity gains, disinvestment in underperforming assets, and other business strategies. Overall, the railroad return on investment has actually improved somewhat, from around four percent in 1980 to around six percent in year 2000. Nevertheless, railroad return on investment has been well below the cost of capital (10 percent or more). Figure 28 shows the Class I railroads' return on investment since 1981 compared to the cost of capital. This gap indicates that most of the benefits of railroad reorganization and productivity improvements have accrued to the shipping community in the form of rate cuts, rather than to railroads and their investors.

This is a major problem for the railroad industry because it is an extraordinarily capital-intensive industry. In 1996, capital expenditures by the railroads amounted to 18.7 percent of revenues. Figure 29 lists capital expenditures as a percentage of revenue for various U.S. industries. In year 2000, Class I railroads invested 17.8 percent of their revenues in capital improvements, compared to an average of 3.7 percent for all manufacturing industries. Between 1991 and 2000, it is estimated that the railroads invested $54 billion in their systems: 67 percent for roadway and structures, and 33 percent for equipment.

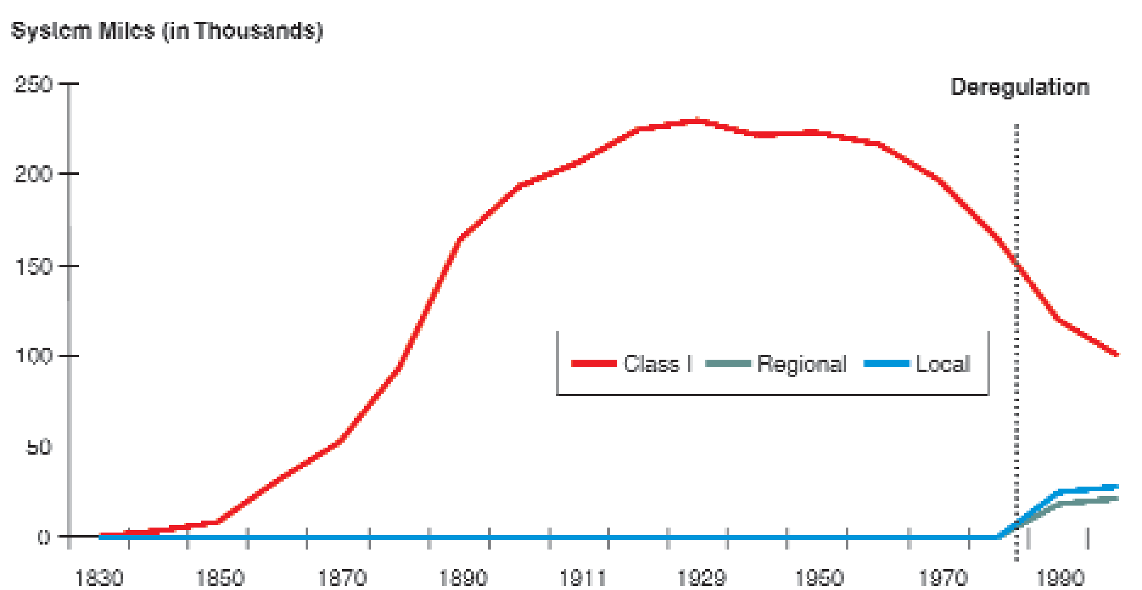
Wary of the gap between railroad capital needs and net operating income ($54 billion versus $31 billion between 1991 and 2000) investors have backed away from railroad stocks. Rail's stock market value compared to the S&P 500 is one-fifth of its 1980 size. Figure 30 shows the value of railroad stocks as a percentage of the Standard & Poor's 500. The percentage has dropped from over two percent in 1980 to under one-half percent in 2000.

This has reduced the amount of capital available for the railroads to invest, forcing them to borrow money to maintain and expand infrastructure, or to defer maintenance and improvements. The AAR estimates that the funds shortfall — the difference between capital expenditures and the amount the railroads can invest from their own revenues — is about $2 billion annually. Figure 31 graphs the shortfall for the period between 1981 and 2000.

State of the Rail Industry Today

The rail industry today is stable, productive, and competitive, with enough business and profit to operate, but not to replenish its infrastructure quickly or grow rapidly. Its capital cost for infrastructure and equipment is huge and relatively fixed. Competition among railroads and with trucking has driven rail rates down, to the benefit of shippers and the economy, but railroads are not attracting the long-term investment needed to grow substantially and serve new markets. Market forces will continue to force the rail industry to streamline and downsize, to maximize revenues, and to minimize capital costs.

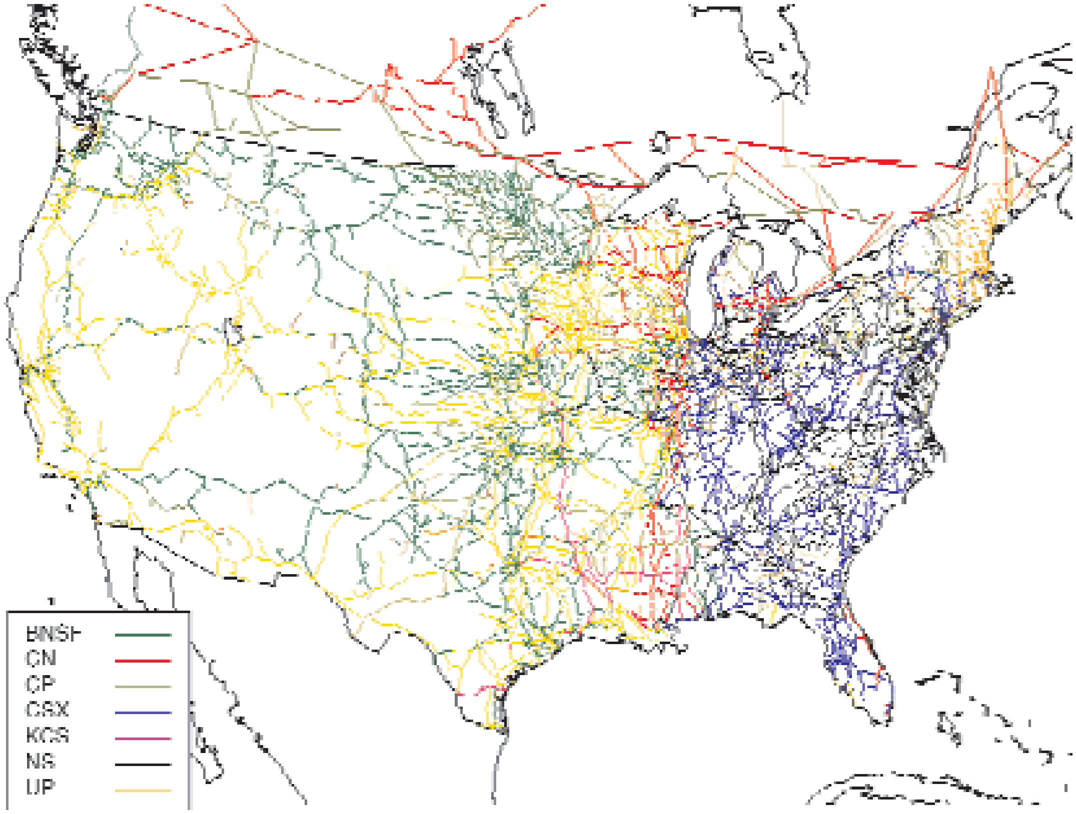
Figure 21 Miles of Rail Line in the United States



Source: Louis Thompson, World Bank

Figure 22. The Nation's Class I Railroad Network

Year 2000



Source: Reebie Associates

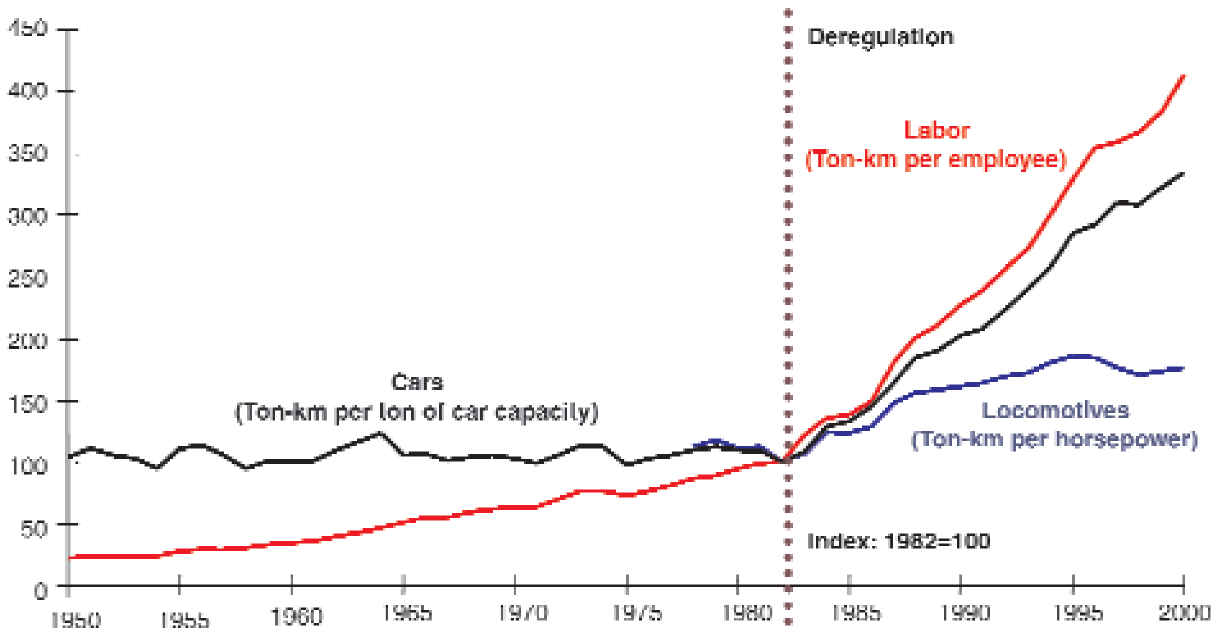
Table 5. Profile of U.S. Class I and Regional/Short-Line Railroads

Year 2000

	Carloads Originated	Revenues ($)	Miles Operated, Less Trackage Rights	Employees (Billion)
Class I (7)	27.8 B 84%	33.1 B 91%	99,250 69%	168,320 88%
Other (551)	5.2 B 16%	3.2 B 9%	45,535 31%	23,488 12%
Total	33.0 B	36.3 B	144,785	191,808

Source: AAR

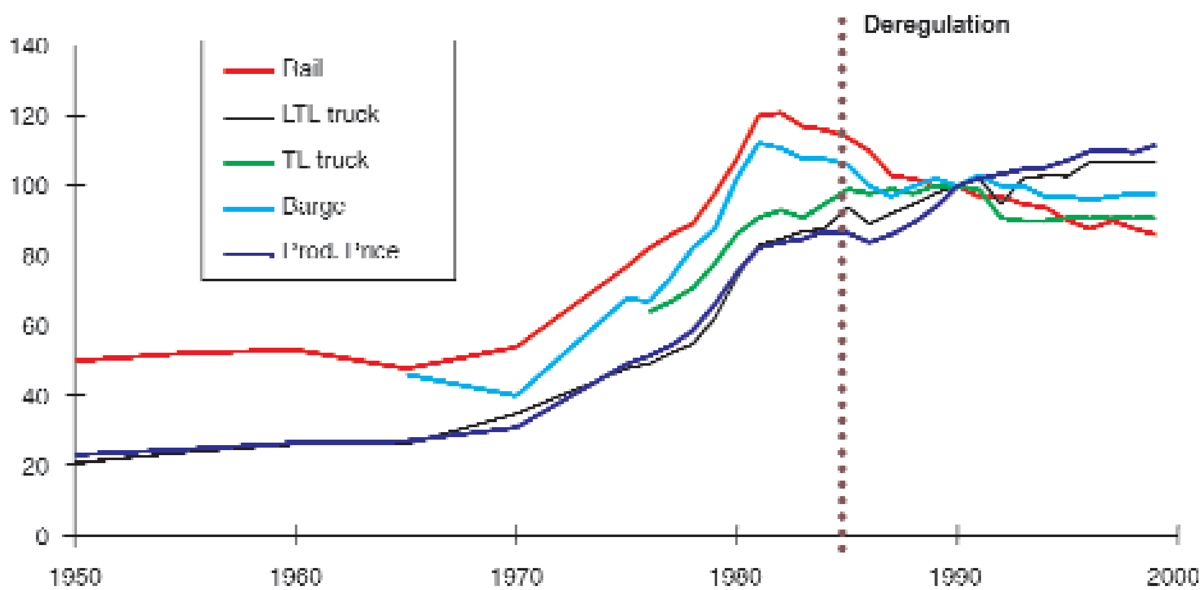
Figure 23. Railroad Productivity Is Increasing



Source: Louis Thompson, World Bank

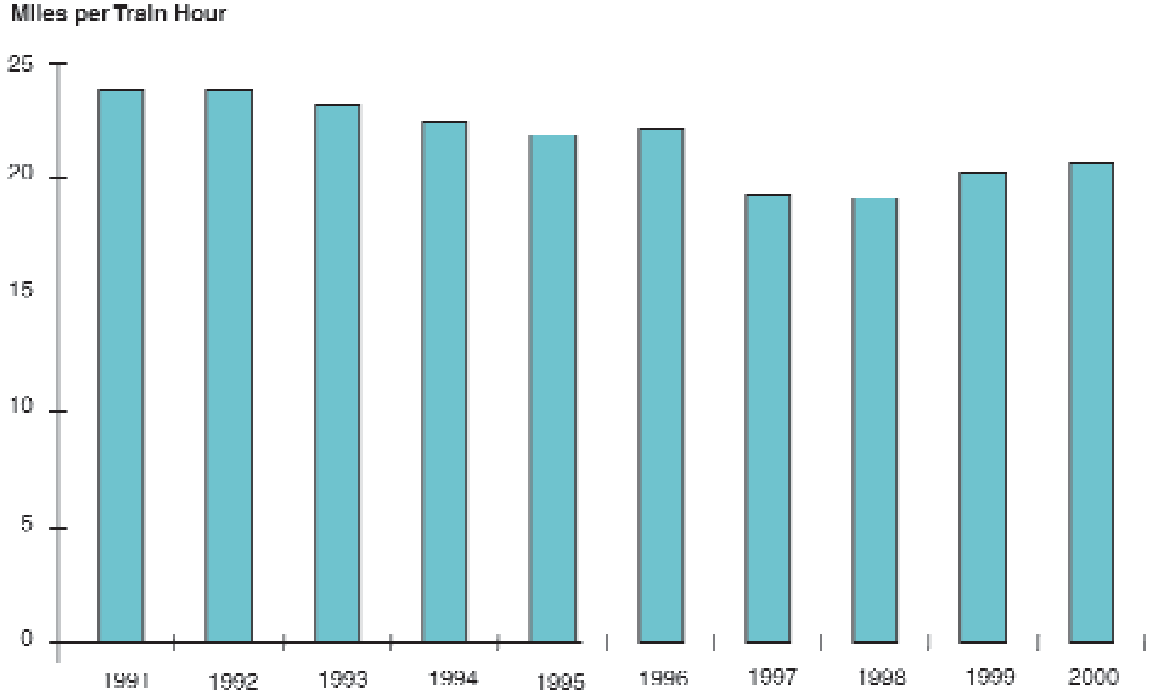
Figure 24. Decline in Rail Rates Versus Other Modes Following Deregulation

Average U.S. Freight Rates Index: 1990 = 100



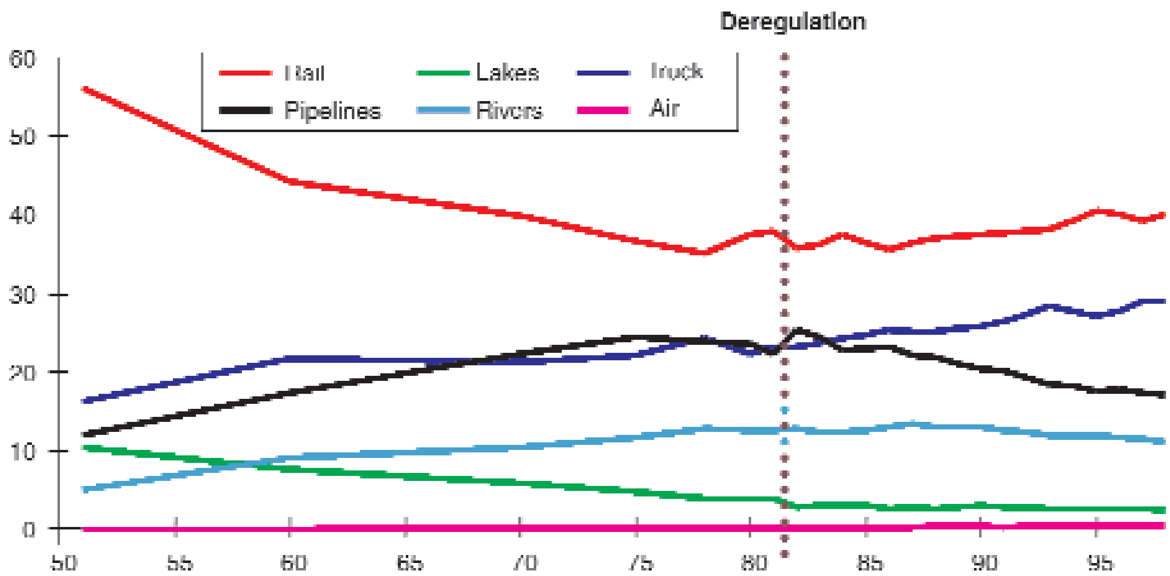
Source: Louis Thompson, World Bank

Figure 25. Rail Performance Measured in Travel Speed Has Not Improved



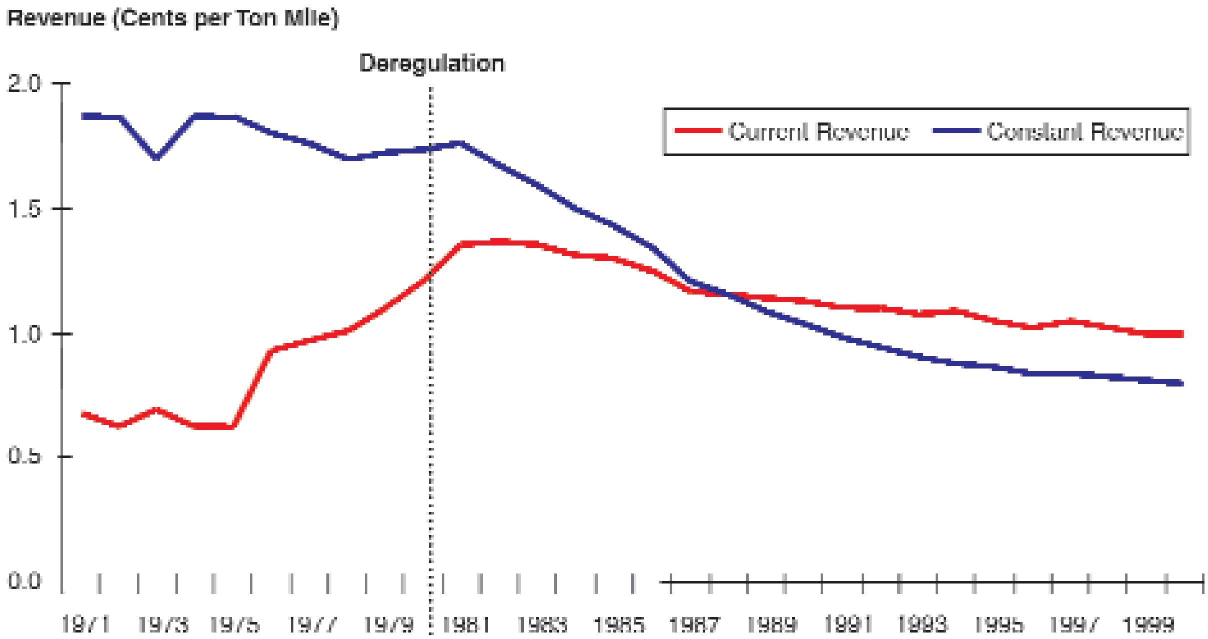
Source: AAR

Figure 26. Rail Market Share as a Percentage of Intercity Ton-Miles Has Stabilized



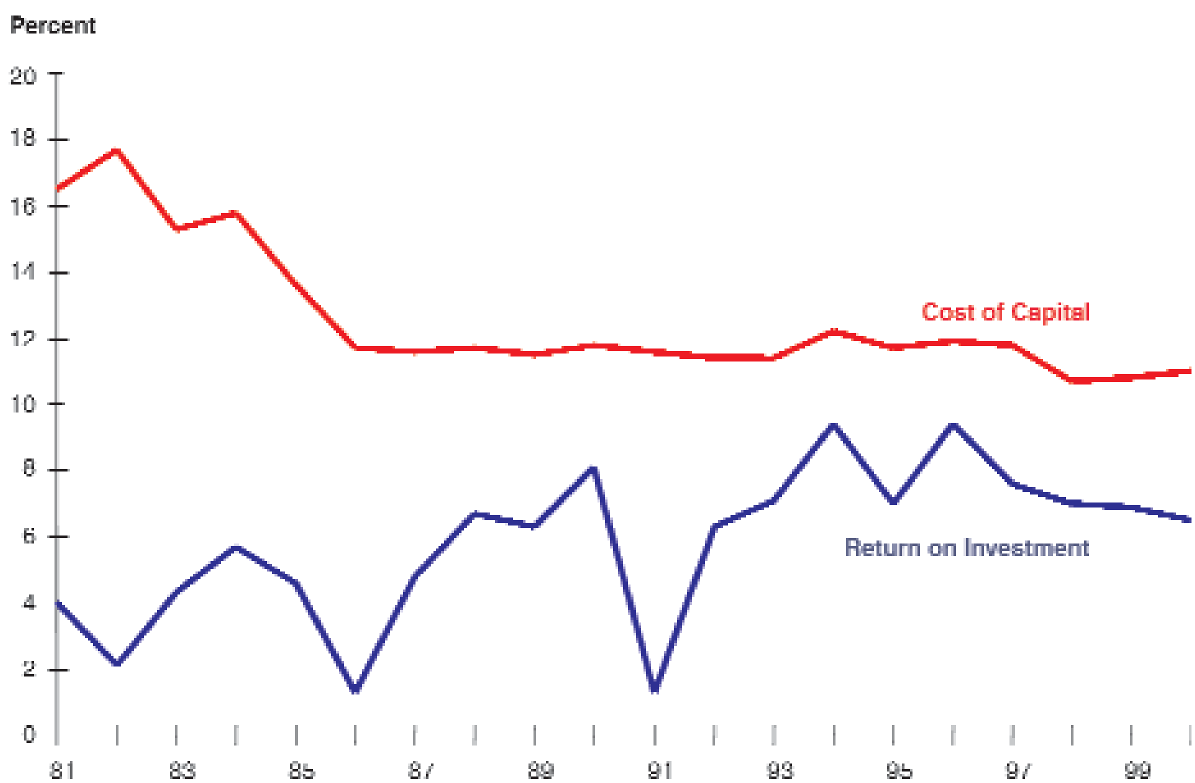
Source: Louis Thompson, World Bank

Figure 27. Declining Freight-Rail Revenue per Ton-Mile



Source: Louis Thompson, World Bank

Figure 28. Class I Railroad Return on Investment Versus Cost of Capital

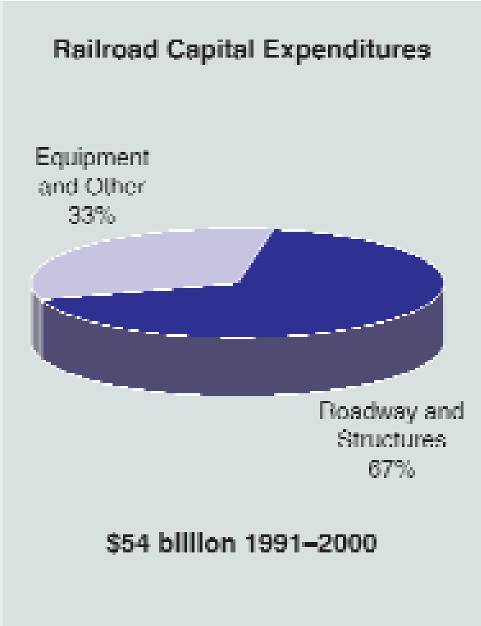


Source: Louis Thompson, World Bank

Figure 29. Railroad Capital Needs Are Far More Intensive Than Other Industries

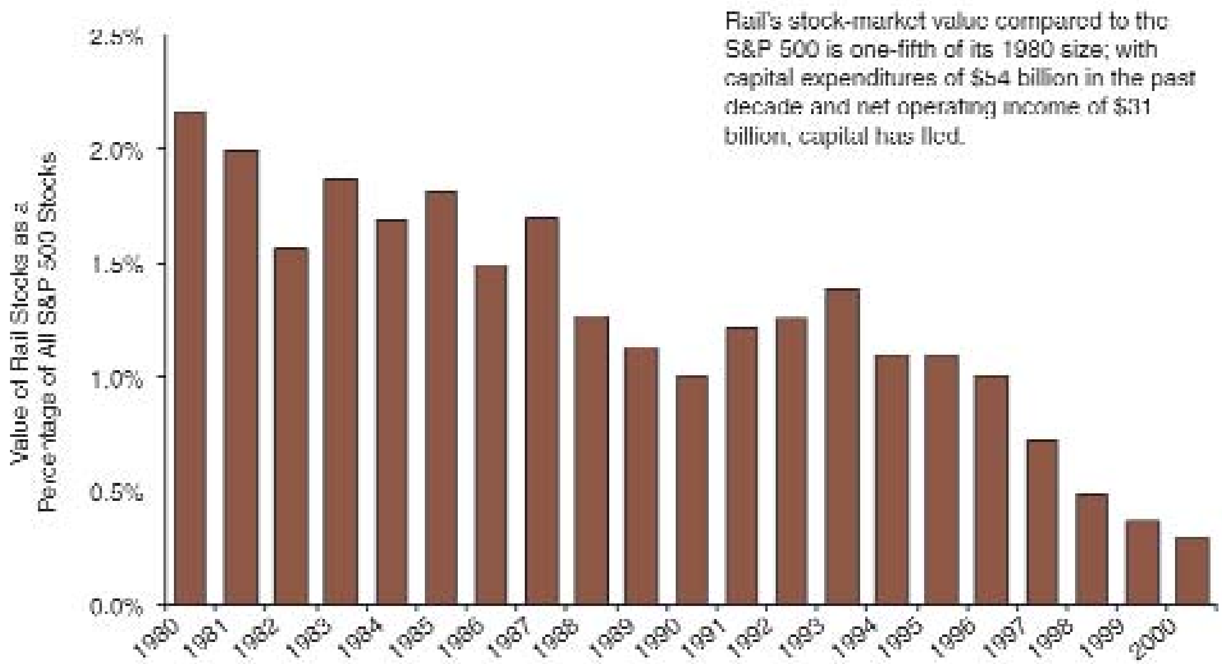
Capital Expenditures as a Percentage of Revenue for Various U.S. Industries: 2000

All manufacturing	**3.7%**
Petroleum and coal products mfg.	2.1%
Transportation equip. mfg.	2.6%
Food manufacturing	2.7%
Wood product mfg.	3.3%
Machinery mfg.	3.1%
Fabricated metal product mfg.	3.7%
Primary metal product mfg.	3.8%
Paper manufacturing	4.9%
Computer and electrical prod. mfg.	5.5%
Chemicals manufacturing	5.6%
Nonmetallic mineral prod. mfg.	6.2%
Class I Railroads	**17.8%**



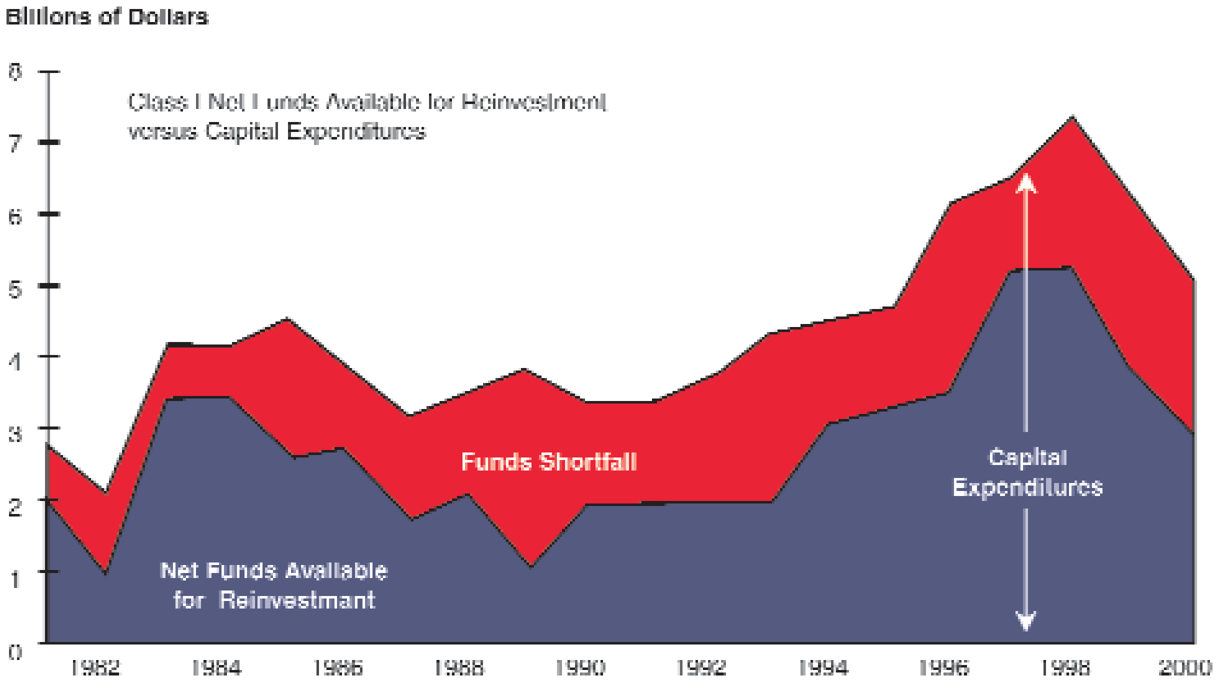
Source: U.S. Bureau of the Census, AAR

Figure 30. Rail's Stock Market Value Today Is Just 20 Percent of Its 1980 Value



Source: Morgan Stanley, Standard & Poors

Figure 31. Needed Capital Expenditures Exceed Class I Funds Available for Reinvestment



Source: AAR

ALTERNATIVE FUTURES FOR THE FREIGHT-RAIL SYSTEM

This section analyzes:

- Economic and logistic drivers of freight demand;
- Freight forecasts and transportation system impacts;
- Alternative freight-rail growth scenarios and their benefits and costs; and
- Corridor-level infrastructure needs.

Key findings presented in this section are as follows:

1. Total domestic and international freight tonnage will increase by 67 percent by 2020. At current investment levels, the railroad industry would have difficulty absorbing its share of this growth.
2. In the worst case, freight rail would carry the same volume of freight in 2020 as it carries today. This would shift almost 900 million tons of freight and 31 billion truck vehicle-miles-of-travel to the highways, costing shippers $326 billion, costing highway users $492 billion, and adding $21 billion to highway costs through 2020. In the best case, freight rail would carry a larger percentage of freight tons in 2020 than it carries today (e.g., 17 percent in 2020 compared to 16 percent). This would shift 600 million tons of freight and 25 billion truck vehicle-miles-of-travel off the highway system, saving shippers $239 billion, saving highway users $397 billion, and reducing highway costs by $17 billion.
3. There is an estimated unfunded annual need for $2.65 to $4.15 billion of additional freight-rail infrastructure improvements. This investment could benefit the public in many ways, including: reduced highway congestion and costs, lower freight rates, greater economic development opportunities, and less fuel consumption and air pollution.

ECONOMIC AND LOGISTIC DRIVERS OF FREIGHT DEMAND

In the past two decades, passenger and freight movement over the nation's transportation system has increased dramatically. Vehicle-miles-of-travel by passenger cars and trucks grew by 72 percent while road-lane-miles grew by only 1 percent.[15] Over the same period, ton-miles of freight moving over the nation's railroads increased by 55 percent while system mileage actually declined.[16] The factors that have driven this growth in freight movement in the past two decades are growth in population, domestic production, international trade, and transportation-intensive production and distribution logistics.

Between 1970 and 2000, the U.S. gross domestic product (GDP) increased from $3.5 trillion to almost $9 trillion — an increase of 250 percent. Over the three decades, growth in GDP averaged 3.2 percent per year. During this same period, international trade in goods and services increased from $350 billion (equivalent to 10 percent of GDP) to over $2.4 trillion (equivalent to 27 percent of GDP) — a sevenfold increase. Figure 32 shows the growth in the GDP (columns) and trade (line) from 1970 to 1999 in billions of 1996 dollars.

A dramatic drop in the cost of transportation has supported this strong growth in GDP and international trade. In 1981, total transportation logistics expenditures were 18 percent of GDP, but by 1993 this figure had dropped to about 10 percent of GDP. Figure 33 shows the trend in total logistic expenditures. The three components of total logistics expenditures shown in the figure are administrative cost (management, insurance, warehousing, etc.), transportation cost (purchase of transportation services), and inventory carrying cost.

This cost savings was the product of deregulation of the freight industry, a significant decline in interest rates, investment in capacity, and the adoption of new logistics strategies. Between 1978 and 1998, the government's economic regulation of the airline, trucking, railroad, and ocean shipping industries was reduced sharply. As competition increased, transportation firms were consolidated, merged, and restructured; operating networks were expanded; and freight rates were cut. Investments were made in larger trucks, double-stack trains, and mega-containerships; satellite communication and GPS vehicle-location systems were installed in trucks, trains, and ships; and new and better coordinated intermodal services were introduced.

Shippers took advantage of the lower freight rates and improved services to adopt new, **just-in-time** logistics strategies. Just-in-time operations allow businesses to substitute lower-cost transportation for high-cost inventory, achieving huge reductions in inventory carrying costs, and benefiting shippers, consumers, and the economy. Just-in-time logistics involves a shift from **push** to **pull** logistics systems — **from manufacture-to-supply** or inventory-based logistics to **manufacture-to-order** or replenishment-based logistics.

In a **push system**, suppliers push materials to a manufacturer, who pushes the completed product to a distributor, who supplies the retailer, who fills the customer's order. Each maintains an expensive inventory of parts and products as a buffer against fluctuations in supply and demand. Figure 34a illustrates the flow of freight in a push logistics system. The pie chart indicates the relative importance and investment in inventory, information, and transportation.

A **pull system** relies less on expensive inventory and more on accurate information and timely transportation to match supply and demand. Input materials are received just prior to production, and as little finished product as possible is maintained in inventory. Point-of-sale data are used to pull products through a system that may involve two or three tiers of suppliers; a manufacturer that has spun off design and marketing functions to other firms; and a third-party logistics provider who coordinates the movement of parts and products to distributors or directly to customers. Figure 34b illustrates the increasing complexity of freight and information flows in pull logistics system. The pie chart shows the change in the relative importance and investment in inventory, information, and transportation.

Where the push model places a premium on fixed assets such as warehousing, the just-in-time pull model places a premium on the reliability and timeliness of the transportation system and substitutes time spent in the transportation network for time spent in the warehouse. But warehousing and distribution centers still play a major role in pull logistics. Businesses such as Wal-Mart, Home Depot, Target, and K-Mart import huge amounts of cargo through international seaports, move them to major regional distribution centers, and then to satellite distribution centers and local outlets as needed. Mail order companies like Land's End maintain state-of-the-art warehouses containing a huge assortment of goods from which a specific customer's order can be "picked."

The big change has been in the efficiency of these warehousing operations, in terms of reduced inventory time, improved management and operations, and improved connections within the freight transportation network. The past decade has seen substantial growth in the development of very large warehousing centers on the urban periphery, far enough out that land is less expensive, yet near enough and well-served enough by highway and rail to effectively serve major population centers. For example, major warehousing clusters have emerged in central New Jersey (to serve the New York/North Jersey market) and in the Harrisburg/Lancaster area (which is well-positioned to serve New York, Philadelphia, Wilmington, Baltimore, and Washington).

E-commerce benefits pull systems because it allows customer orders to be communicated directly to distributors, manufacturers, and suppliers. Fulfillment of e-commerce and mail orders depends on door-to-door transportation of parcel and express packages directly to the customer, increasing demand for small shipments that would otherwise get picked up at a store by the customer. Business use of express delivery services such as Federal Express and UPS, which place a premium on reliability, speed and visibility, has also contributed to the explosive growth of package and parcel traffic. Federal Express and UPS maintain vast warehouse and distribution centers supporting their operations. They rely heavily on air and truck, although UPS also uses intermodal rail. Their success has made parcel delivery one of the fastest-growing segments of the trucking industry.

Pull systems are tremendously efficient. They can produce what the customer wants and deliver it when the customer wants. By reducing the time between manufacture and sale, businesses can be more certain about how much they should produce and the cost of carrying extra inventory of expensive parts and products. However, pull logistics systems place tremendous demands on the transportation system. Shippers operating manufacture-to-order and time-definite-delivery systems must have reliable, timely, and visible door-to-door freight transportation. Shippers increasingly send frequent, smaller shipments rather than fewer larger ones, multiplying the opportunity for something to go wrong. An accident, congestion, labor disputes, storms — even unanticipated spikes in supply and demand — can unravel these tightly strung systems. Overall logistics systems capabilities are growing simultaneously more robust and more fragile.

The armed forces also are adopting pull logistics techniques and integrating their logistics systems with commercial freight systems to reduce deployment time and cost. Under peacetime conditions, the military is just another very large shipper. But with its new doctrine of rapid response, future wartime military deployments will likely occur as short, sharp surges. Large-scale deployments will stress the freight transportation system and could disrupt the tightly strung logistics networks of civil commerce and defense industry production.

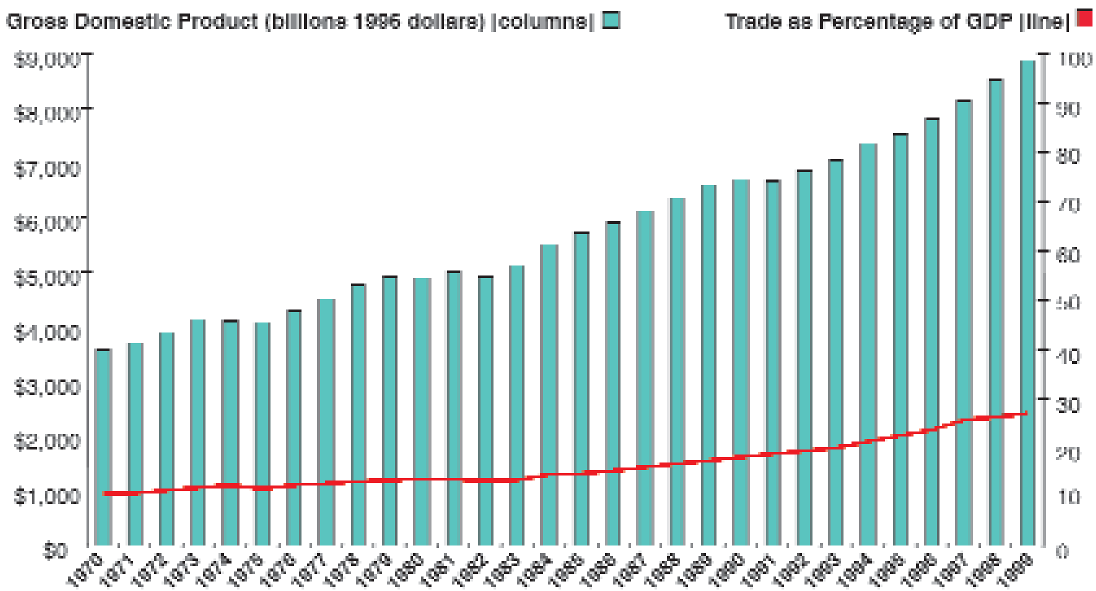
Shippers and the economy have benefited from these changes, but they are far more reliant on timely, reliable freight service than they were 20 or 30 years ago. The consequences of service failure today matter far more than they did in the past. Service failures today mean: depletion of critical materials and stocks; degraded product quality — from rapid (days) to immediate (hours); idled workers, equipment, and customers; loss of market share and profits; and an increasing risk that failures in one part of the chain will ripple through more than one firm and more than one business sector.

Therefore, it is not surprising that the freight transportation modes offering the highest levels of service are also growing the fastest. Figure 35 shows the compound annual freight-tonnage growth rates by mode from 1990 to 2000. Air cargo has grown by 17.9 percent annually; truck by 6.9 percent annually; and rail intermodal by 4.6 percent. Rail carload and bulk grew just 1.4 percent annually, while domestic waterborne trade declined by 0.5 percent annually.

However, the productivity returns from deregulation, the capacity investments made in the 1970s and 1980s, and the introduction of just-in-time logistics are diminishing. There are relatively few opportunities for further economic deregulation. Congestion is increasing; the impact is most noticeable in metropolitan areas where peak-period travel times have risen significantly and travel-time predictability has dropped. With the experience of the September 11, 2001, terrorist attacks, shippers are hedging their bets, retreating from just-in-time to "just-in-case" by adding inventory and increasing inventory-carrying costs. After two decades of improvement, total logistics costs appear to have stalled at 10 percent of GDP, and there are some indications that costs — especially wages, insurance, and fuel costs — are beginning to rise again.

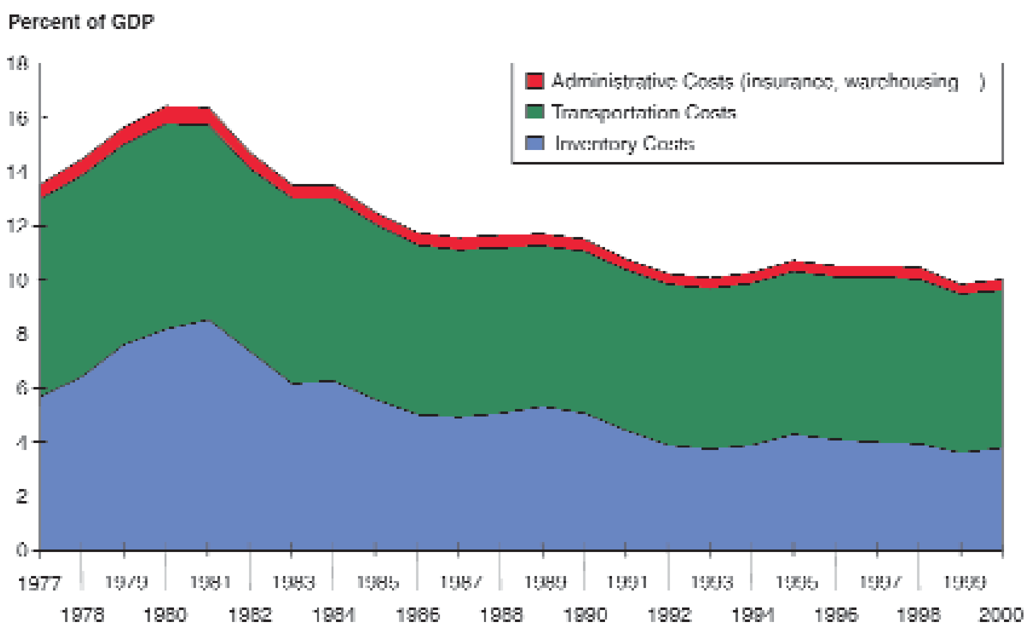
These trends are expected to continue into the coming decades, suggesting that it is time to think about new strategies to meet the nation's freight transportation needs in the 21st century.

Figure 32. U.S. GDP and Trade History



Source: Compiled from official statistics of the U.S. Department of Commerce, Bureau of Economic Analysis

Figure 33. Logistics Expenditures and GDP



Source: Cass/ProLogis 12th Annual State of Logistics Report, 2000

Figure 34a. Push Logistics

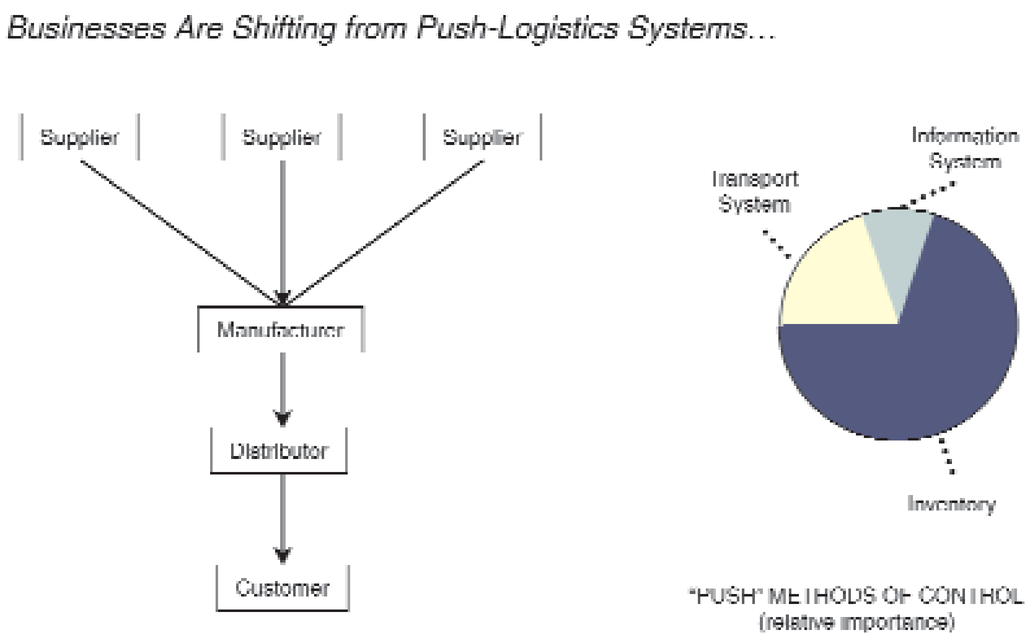


Figure 34b. Pull Logistics

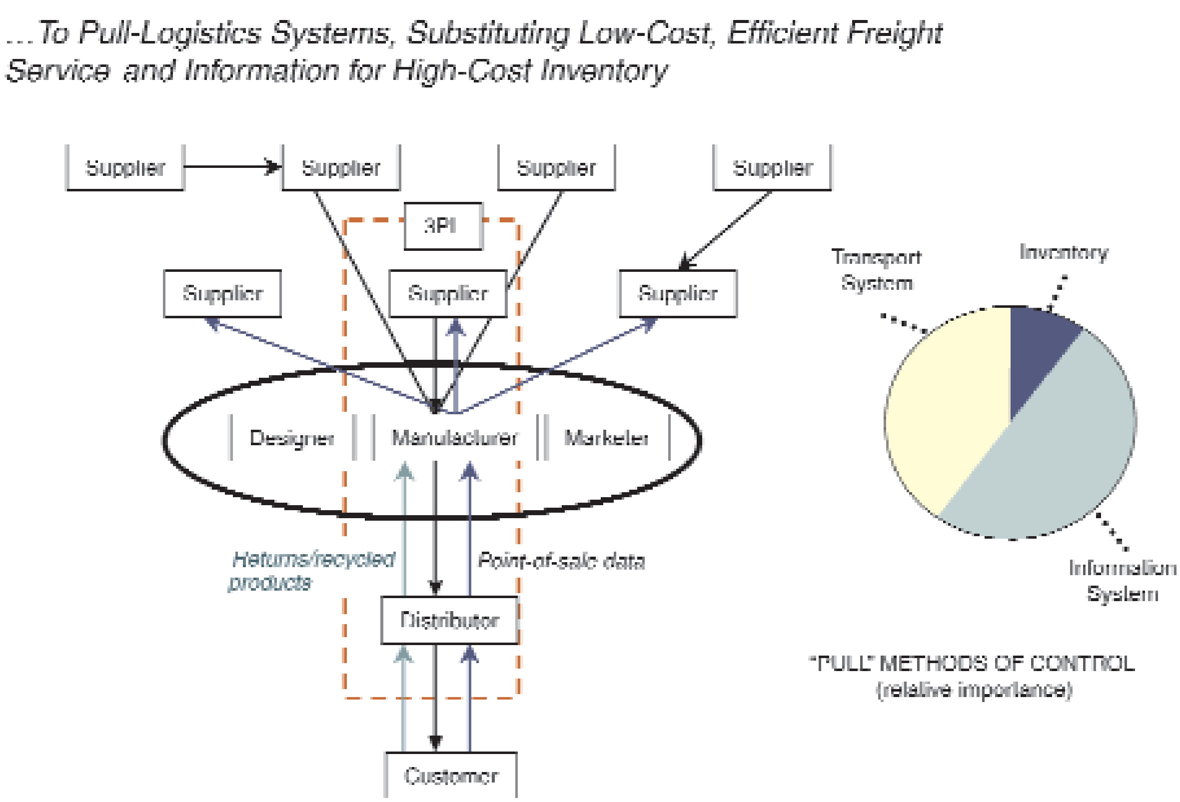
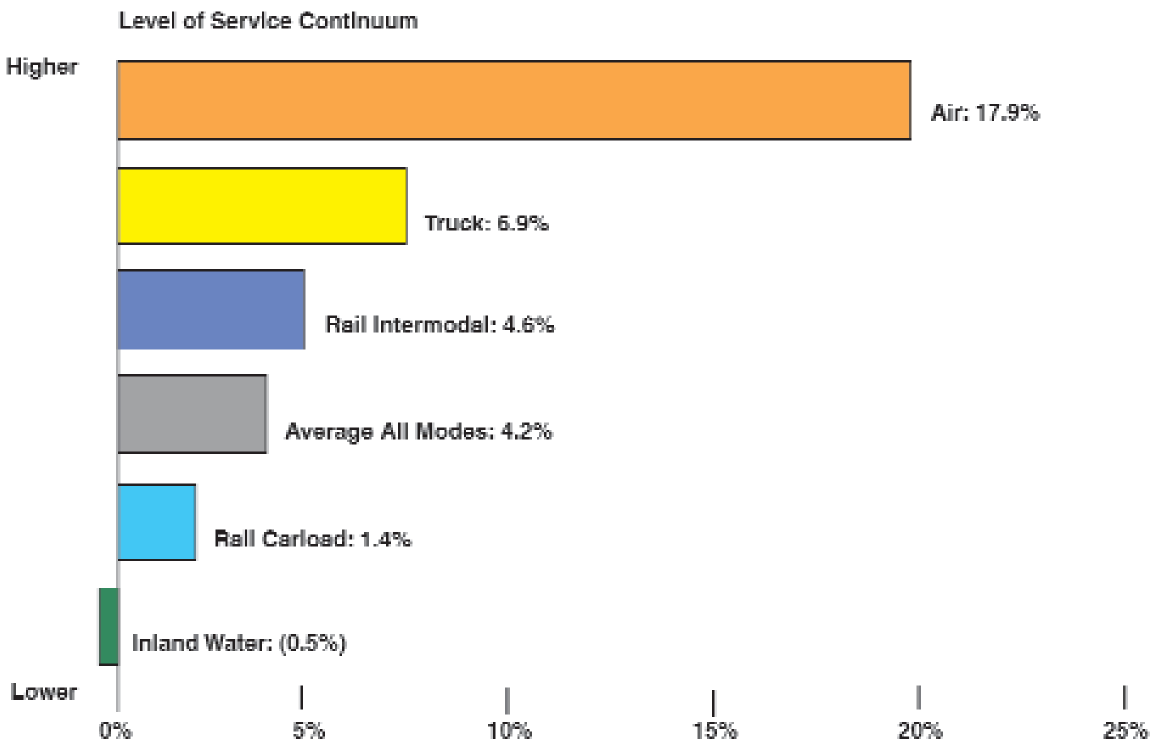


Figure 35. Compound Annual Freight-Tonnage Growth Rates by Mode, 1990–2000 — Highest Growth Rates Seen in Modes Offering the Highest Levels of Customer Service



Source: Reebie Associates

FREIGHT FORECASTS AND TRANSPORTATION SYSTEM IMPACTS

Baseline freight forecasts presented in this section are based on TRANSEARCH data for the year 2000 and on interim growth rates developed under the ongoing FHWA Freight Analysis Framework (FAF) project. Previously released Freight Analysis Framework forecasts have been modified for purposes of this report and final forecasts subsequently released under the FAF project may differ.

Figure 36 shows the forecasts for domestic and import-export freight tonnage for 2000, 2010, and 2020. These baseline forecasts indicate:

- With moderate economic growth, total freight tonnage will grow from 15.2 billion tons in 2000 to 24.5 billion tons in 2020, an increase of 67 percent.
- Domestic tonnage will rise from 12.6 to 21.7 billion tons, an increase of 57 percent.
- Import-export tonnage will grow from 1.4 to 2.8 billion tons, an increase of 99 percent. (These figures do not include tonnage associated with international waterborne shipment of crude petroleum, which is also expected to increase by 100 percent.)

Different regions of the country are growing at different rates and will experience corresponding differences in the rate of freight growth. Based on the adjustment of 1998 regional growth rates to the year 2000 base forecast, growth rates are forecast at 76 percent in the West, 71 percent in the South, 63 percent in the Central region, and 58 percent in the Northeast. However, the highest increases on a volume, rather than percentage, basis will occur in the Northeast and Central regions because these regions have a larger base and concentration of existing freight activity. Figure 37 shows the states within each region and the regional growth rates.

The baseline forecasts for each mode are driven by the growth in the commodities that they handle. Tables 6 and 7 show the freight forecasts for 2000 and 2020 by tonnage and ton-miles for each mode. For the "first approximation" forecasts, it was assumed that each mode would maintain its existing share of trade lanes in a given commodity type. The baseline forecasts do not attempt to consider transportation constraints or opportunities that might cause traffic in certain commodities to shift from one mode to another, nor do they anticipate the effects of evolving logistics strategies. (Such opportunities, as they pertain to freight rail, are discussed later in this report.) The baseline forecasts indicate:

- Trucking will grow from 10,700 million tons in 2000 to 17,296 million tons in 2020, an increase of 62 percent. Ton-miles will grow from 2,639 billion in 2000 to 4,174 billion in 2020, an increase of 58 percent.

- Rail will grow from 2,009 million tons in 2000 to 2,891 million tons in 2020, an increase of 44 percent. Ton-miles will grow from 1,239 billion in 2000 to 1,821 billion in 2020, an increase of 47 percent. This is an average for all rail markets. Forecasts for specific rail submarkets are described later in this report. Note that this base case forecast actually indicates that rail will not grow as fast as truck or air, and will lose some market share. Among rail-served commodities, rail retains its current market share, but these commodities are not forecast to grow as rapidly as the commodities that are predominantly handled by truck or air.

- Domestic waterborne commerce will grow from 1,054 million tons in 2000 to 1,470 million tons in 2020, an increase of 39 percent. Ton-miles will grow from 539 billion in 2000 to 617 billion in 2020, an increase of 14 percent.

- Air-freight will grow from nine million tons in 2000 to 25 million tons in 2020, an increase of 181 percent. Ton-miles will grow from nine billion in 2000 to 27 billion in 2020, an increase of 182 percent.

Growth in freight demand, combined with forecast growth in passenger movement, will contribute to increased congestion and reduced performance of the nation's transportation system. However, the impacts on each mode will be different.

Historically, air cargo has moved two ways: on dedicated cargo planes and as "belly cargo" in the holds of regularly scheduled passenger planes. Following the terrorist attacks of September 11, 2001, the loading of belly cargo was suspended, but has resumed with increased levels of inspection. However, some of this market has shifted to truck or air carriers that operate dedicated cargo planes. Dedicated cargo planes place less strain on congested runways and airspace than passenger planes because air cargo flights operate at off-peak periods when runway capacity is available. But because almost all air cargo moves on or off airport via truck, a primary constraint to the growth of air cargo is the adequacy of the air-truck connection — e.g., warehousing (transfer) capacity and ground access. This is a serious concern for air cargo hubs with frequent and severe congestion on their major truck access routes, such as JFK airport in New York City.

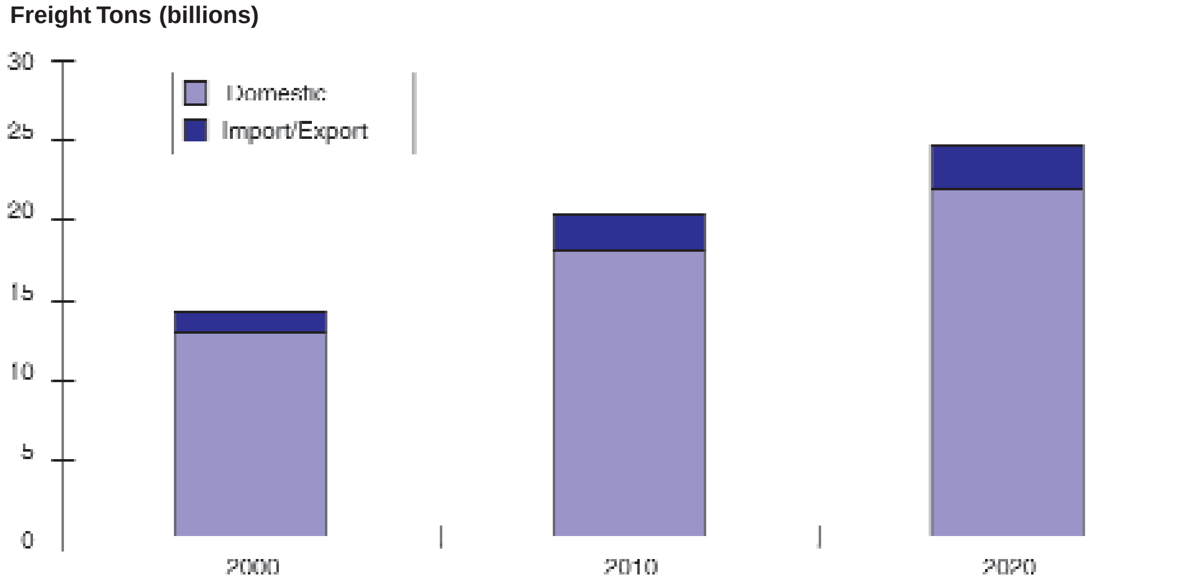
Waterways face a variety of pressures from the continued expansion of both domestic and international trade. Many ports are seeking deeper navigation channels to accommodate next-generation "mega-containerships." Now in service in the Pacific trades, these vessels need channel depths of 50 feet or more. Marine terminals also are facing shortages of land for the storage and transfer of containers and cargo, and many are being forced to operate at unprecedented levels of efficiency to compensate for their shortage of space. Landside access is increasingly problematic, as many ports must contend with congestion on their major truck access routes and inadequate or antiquated rail connectors.

Highway capacity also poses a challenge. Domestic freight tonnage will grow by about 70 percent in the next 20 years. About 60 percent of that tonnage will be loaded on trucks and carried on highways that already operate at or near capacity, adding to the potential for unacceptable levels of congestion and delay. Freight-truck traffic on the major corridors begins, ends, or passes through the nation's most densely populated metropolitan areas, contributing to congestion where highway capacity is already at a premium. Figures 38, 39, and 40 show the estimated highway "levels of service" for 2000, 2010, and 2020. The levels of service describe the volume-to-capacity ratio for a roadway. As the volume of traffic increases compared to the throughput capacity of the roadway, congestion increases and level of service decreases. Red indicates congested highway segments with low levels of service. The forecasts are based on average daily traffic volumes. Commodity-carrying trucks, which often move during off-peak or night hours, may be exposed to less congestion than peak-period commuters in their automobiles, but trucks will be exposed to more congestion and delay, forcing up logistics costs.

The railways have significant physical constraints, too. These are principally in the form of critical choke points: antiquated bridges, low-ceiling tunnels, "missing" connections, outdated signal systems that cannot accommodate both high-speed passenger trains and slow-speed freight trains, single track line without adequate sidings, bridges too weak to safely carry today's heavier rail cars, and inadequate terminal capacity. These choke points reduce the overall throughput capacity of the rail system. The rail network also has significant operational constraints: railroads must interchange traffic among themselves, share right-of-way with passenger rail, and cross highway traffic at grade. The railroads also have significant business requirements: in the face of limited profitability and capitalization, they must operate as bottom-line-oriented, for-profit businesses that live or die by quarterly profit statements and annual investment returns. However, there is also considerable unused potential in the nation's rail system, capacity that could be reclaimed and utilized to strengthen the national freight transportation system.

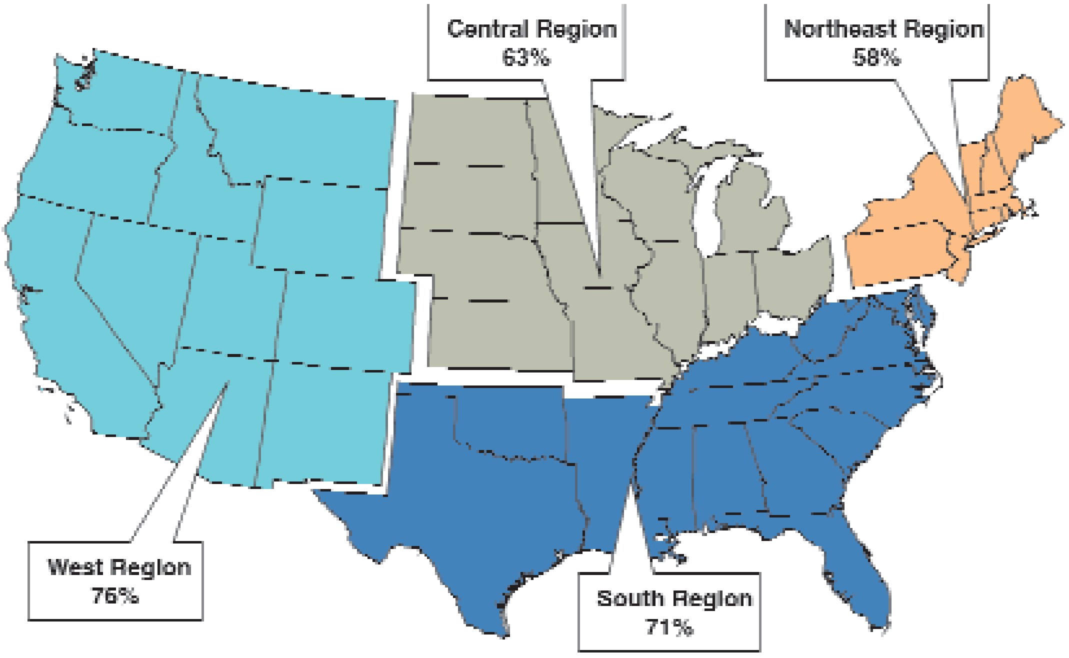
The nation must make improvements in each of its modal systems and at their points of interconnection to accommodate future growth in freight movement. Figure 41 shows the relative shares of new freight tonnage that must be accommodated by the nation's highway and freight-rail systems between 2000 and 2020. If improvements are not made in the freight-rail system, the nation's freight transportation system will weaken and shippers, highway users, and communities will pay the social, economic, and environmental costs.

Figure 36. U.S. Domestic and International Freight Tonnage Growth Forecast, 2000–2020



Source: DRI-WEFA, Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

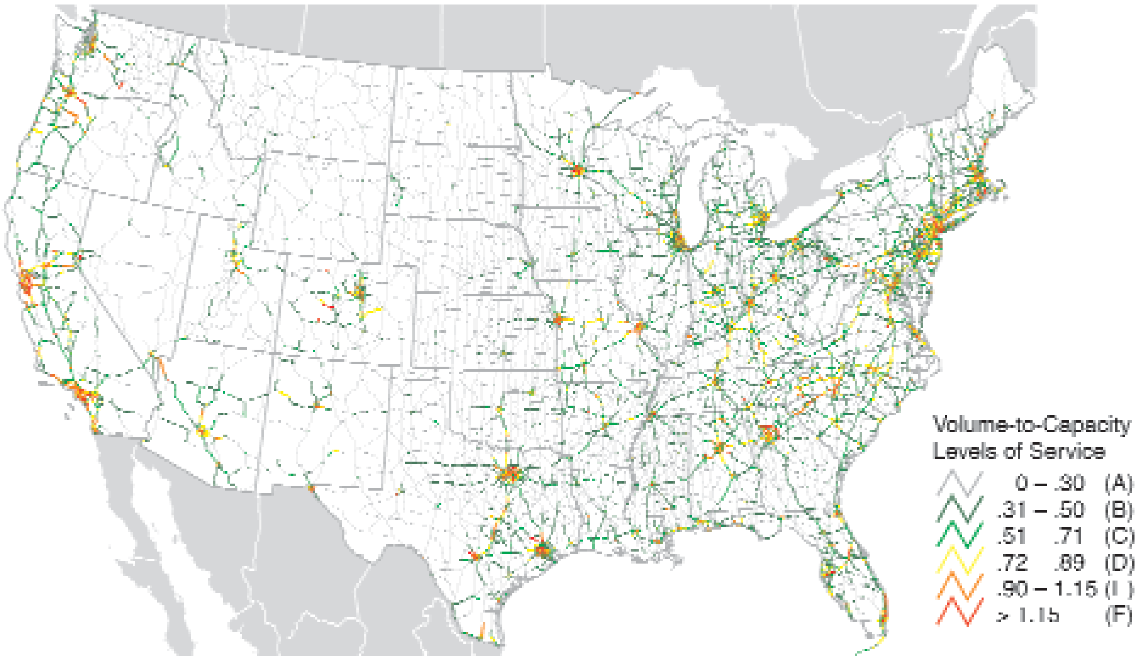
Figure 37. U.S. Domestic Freight Tonnage Growth Forecast, 2000–2020



Source: DRI-WEFA, Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Figure 38. Congested Highways, 2000

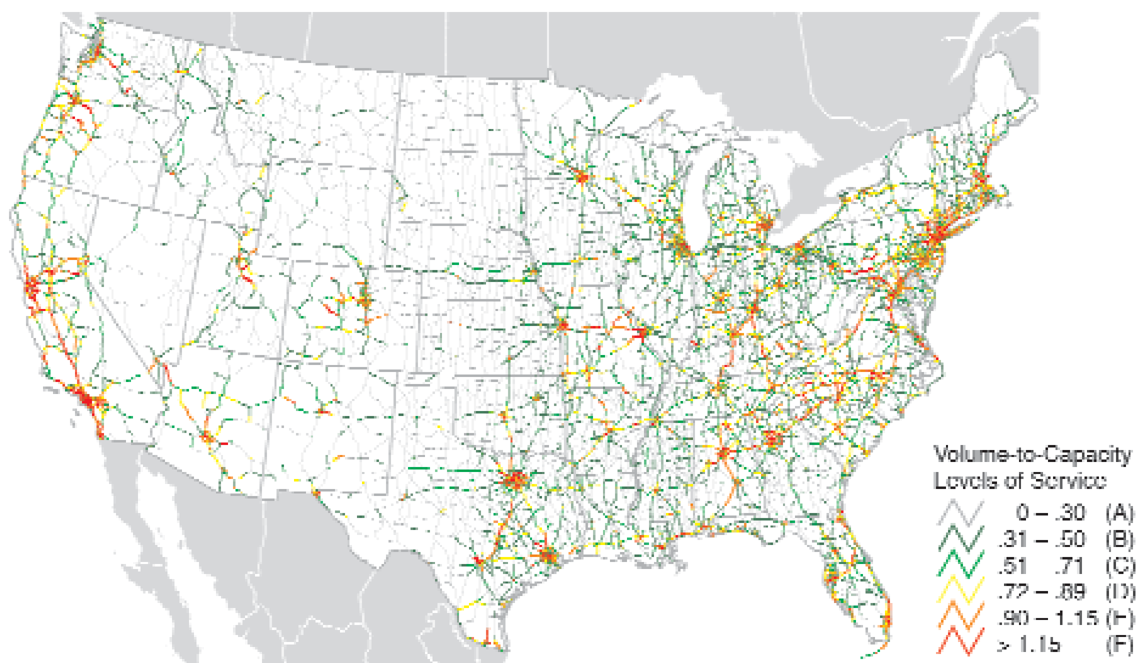
Congestion Disrupts Truck-Freight Service by Making Trips Slower, Less Reliable, and More Expensive



Source: U.S. DOT Freight Analysis Framework Project

Figure 39. Potential Congested Highways, 2010

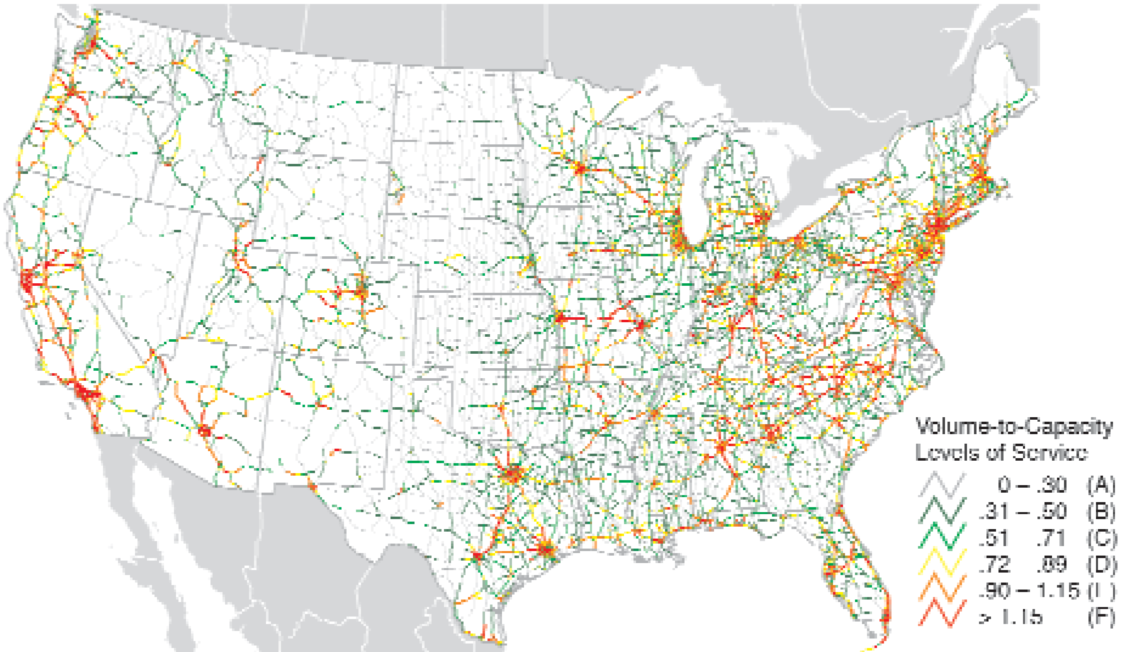
As Traffic Grows, Trucks Will Be Exposed to More Congestion



Source: U.S. DOT Freight Analysis Framework Project

Figure 40. Potential Congested Highways, 2020

Without Additional Capacity or Improved Productivity, Logistics Costs will Rise



Source: U.S. DOT Freight Analysis Framework Project

Figure 41. Freight and Public Policy Issues — Do Highway and Rail Have Enough Capacity to Absorb Growth? If Not, Where Is Public Investment Justified?

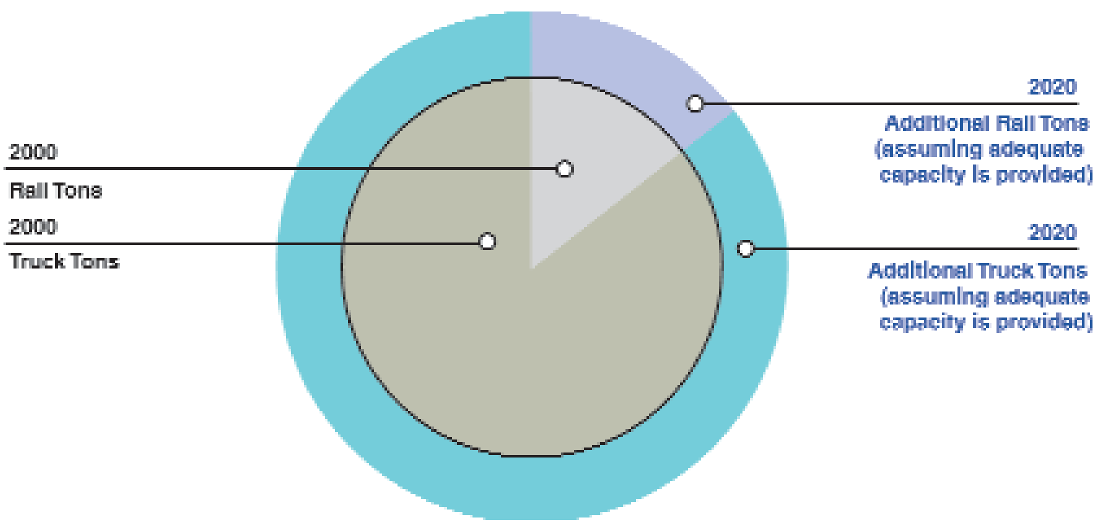


Table 6. U. S. Domestic Freight Tonnage Growth Forecasts by Mode, 2000–2020

	Tons (2000) (Millions)	Tons (2020) (Millions)	Change	CAGR
Truck <500 miles >500 miles	10,700 9,339 1,361	17,296 15,188 2,108	62% 63% 55%	2.43% 2.46% 2.21%
Rail	2,009	2,891	44%	1.9%
Water	1,054	1,470	39%	1.68%
Air	9	25	181%	5.31%
Total	13,772	21,682	57%	2.30%

Source: DRI-WEFA, Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

Table 7. U. S. Domestic Freight Ton-Mileage Growth Forecasts by Mode, 2000–2020

	Tons (2000) (Billions)	Tons (2020) (Billions)	Change	CAGR
Truck <500 miles >500 miles	2,639 1,241 1,398	4,174 2,046 2,128	58% 65% 52%	2.32% 2.53% 2.12%
Rail	1,239	1,821	47%	1.94%
Water	539	617	14%	0.68%
Air	9	27	182%	5.33%
Total	4,427	6,638	50%	2.05%

Source: DRI-WEFA, Reebie Associates' TRANSEARCH and U.S. DOT Freight Analysis Framework Project

ALTERNATIVE FREIGHT-RAIL GROWTH SCENARIOS

Four Scenarios

The future of the nation's freight-rail system will depend on a combination of factors: underlying economic growth, railroad investment and operating/business decisions, public participation strategies, availability and performance of alternative freight modes, and shipper/market acceptance of railroad services. For purposes of this report, four potential growth scenarios for freight rail were formulated and examined.

■ No Growth

This scenario assumes that the freight-rail industry makes only the minimum investment necessary to maintain current volumes; rail volumes do not increase; and rail loses substantial market share to other modes. In this scenario, rail moves 2,008 million tons over 1,239 billion ton-miles in 2020. Table 8 shows the estimated growth forecasts for unit train, carload, and intermodal services in tons, ton-miles, and market share. The table also provides an estimate of the truck VMT that would be generated if freight-rail were diverted to truck.

■ Constrained Investment

This scenario assumes that the freight-rail industry makes selected investments that allow the freight-rail system to grow, but not sufficiently to accommodate the 2020 base-case volume. Railroads fix choke points and provide service where there is a strong profit incentive to do so, but do not fix all choke points nor meet all demand for service, even if it means foregoing business that would use rail. This estimate assumes that freight rail absorbs only 50 percent of the base-case growth forecast. In this scenario, freight rail moves 2,451 million tons over 1,531 billion ton-miles in 2020. Table 9 provides the details of the forecast.

■ Base Case

This scenario assumes that the freight-rail industry maintains its current share of traffic lanes in specific rail-served commodities. Unit train, carload, and intermodal services grow at different rates reflecting different growth rates in their underlying commodities. The base case assumes that freight-rail investments are sufficient to provide the capacity needed to accommodate this demand. In this scenario, freight-rail moves 2,891 million tons over 1,821 billion ton-miles in 2020. Table 10 provides the details of the forecast.

■ Aggressive Investment

This scenario assumes that the freight-rail industry makes the investments and service improvements needed to meet and exceed the base-case forecast volume. It retains its existing share of total traffic and captures new business from truck and water freight. This estimate assumes that freight rail can attract an additional nine percent of intermodal traffic and an additional two percent of carload commodities that currently move by truck or water. Unit train traffic is assumed to be at maximum capacity in the base case and does not increase under this scenario. In this scenario, rail moves 3,486 million tons over 2,265 billion ton-miles in 2020. Table 11 show the breakout of the forecast by mode.

Highway Benefit Assessment

The FHWA's HERS model was used to determine the relative effects of the four rail scenarios on the nation's highway costs. Table 12 shows the forecast of combination-truck VMT on the highways and the corresponding increase or decrease in highway-needs costs for each rail scenario. The base case rail forecast corresponds to the HERS 2020 condition. Where rail was unable to accommodate its base-case volumes, the difference was converted to equivalent truck VMT and added to the highway network. Where rail provided capacity in excess of its base-case volumes, the difference was subtracted from the highway network. In practice, shippers that would prefer to use rail but cannot do so due to lack of service might shift to water or not ship at all, but for the purposes of this analysis it has been assumed that the traffic would shift to truck.

Under the no-growth and constrained scenarios, rail cannot accommodate its base-case volume, resulting in the diversion of freight from rail to truck and generating more truck VMT and higher highway costs. Conversely, under the aggressive-growth scenario, rail volume exceeds the base-case volume, resulting in diversion of freight from truck to rail and reducing truck VMT and highway costs. The results are as follows:

- **No Growth**

Combination-truck VMT of 276 billion (31 billion over base case); cumulative highway needs of $1,900 billion between 2000 and 2020 ($21 billion over base case).

- **Constrained**

Combination-truck VMT of 260 billion (15 billion over base case); cumulative highway needs of $1,889 billion between 2000 and 2020 ($10 billion over base case).

- **Base Case**

Combination-truck VMT of 245 billion; cumulative highway needs of $1,879 billion between 2000 and 2020.

- **Aggressive Investment**

Combination-truck VMT of 220 billion (25 billion under base case); cumulative highway needs of $1,862 billion between 2000 and 2020 ($17 billion under base case).

This analysis suggests that every one percent increase in truck vehicle-miles-of-travel adds approximately $1.6 billion to the nation's highway bill from 2000 to 2020. If the railroads are unable to meet their base case forecasts, the additional cost to the nation's highways from 2000 to 2020 would be between $10 billion (constrained scenario) and $21 billion (no-growth scenario). Conversely, if the railroads attract additional traffic from the highways, it would save the nation $17 billion over the same period. Table 13 summarizes these figures, and Figure 42 shows the increment of truck VMT added or subtracted for each scenario.

These cost estimates are conservative because they are based on a systemwide increase in truck VMT rather than VMT impacts in specific high-volume corridors. Also, while HERS captures some major highway costs such as roadway resurfacing and widening of existing roadways, it does not capture others such as bridges, interchanges, local roads, new roads, and system enhancements. Analysis of current highway expenditures suggests that HERS captures approximately 47 percent of total capital highway needs. In addition, a specific calculation has not been made for potential impacts on bridge costs of freight diverted from rail to trucks. These costs could be substantial since very heavy loads would be diverted to highways.

This HERS analysis also produced estimates of costs (travel time, operating, and accidents) accruing to highway users, and the results are far larger than the highway needs alone. If the railroads are unable to meet their base case forecasts, the additional cost to the nation's highway users from 2000 to 2020 would be $492 billion under the no growth scenario and $238 billion under the constrained scenario. Conversely, if the railroads attract additional traffic from the highways, it would save the nation's highway users $397 billion over the same period.

Shipper Benefit Assessment

Diverting freight to or from rail would have a significant impact on highway costs. However, substantially greater impacts would be felt by shippers and ultimately by consumers. Annual shipper costs in 2020 were estimated by comparing the truck ton-miles and rail ton-miles associated with the four scenarios and applying unit cost factors to calculate the probable change in transportation costs to shippers. As in the highway cost assessment, where rail was unable to accommodate base-case volumes, the difference was added to the highway network. Conversely, where rail provided capacity in excess of the base-case volume, the difference was subtracted from the highway network. This is a highly simplified approach, but it is useful in illustrating the potential magnitude of benefits and costs savings associated with the different scenarios.

■ No Growth

1,239 billion ton-miles by rail; an additional 582 billion ton-miles by truck (representing forecasted base-case rail traffic that cannot be accommodated by rail); total shipper costs of $76.3 billion in year 2020, $32.6 billion more than the base case. Over a 20-year period, this is approximately $326 billion more than the base case.

■ Constrained Investment

1,531 billion ton-miles by rail; an additional 290 billion ton-miles by truck (representing forecasted base-case rail traffic that cannot be accommodated by rail); total shipper costs of $59.9 billion in year 2020, $16.2 billion more than the base case. Over a 20-year period, this is approximately $162 billion more than the base case.

■ Base Case

1,821 billion ton-miles by rail; total shipper costs of $43.7 billion in year 2020.

■ Aggressive Investment

2,265 billion ton-miles by rail; a reduction of 444 billion ton-miles by truck (due to the ability of the railroad system to accommodate volumes in excess of the base-case forecast); total shipper costs of $18.8 billion in year 2020, $24.9 billion less than the base case. Over a 20-year period, this is approximately $239 billion less than the base case.

This analysis suggests that if the railroads are unable to meet their base case forecasts, the nation's rail shippers would pay an additional annual cost of between $16.2 billion (constrained scenario) and $32.6 billion (no-growth scenario) in 2020. These should be treated as maximum figures since some shippers, faced with the unavailability of rail service, might ship by water instead of truck or might not ship at all. Conversely, if the railroads are able to attract traffic from the highways, it could save the nation's shippers $24.9 billion in year 2020. The cumulative amounts over the period 2000 to 2020 would be approximately 10 times these amounts. Table 15 shows the annual cost impact on shippers for each freight-rail scenario. Table 16 shows the cumulative, 20-year cost impact on shippers for each freight-rail scenario.

Other Benefits

The quantification of other benefits related to rail improvements is beyond the scope of this study. However, to the extent that the rail system can be improved to handle greater levels of traffic, then the freight-rail system will generate proportionately greater levels of public benefits, including:

- Economic benefit multiplier effects as lower transportation costs trickle down through the economy;

- Reduced highway congestion, improved safety, and more reliable travel for highway users;
- Greater intermodal connectivity and support for international trade;
- Greater environmental benefits, including a reduction in fuel consumption and engine emissions; and
- Greater emergency response capability and system redundancy to respond to natural disasters and terrorism.

Cost Assessment

Long-term, system-wide cost estimates that are comparable to those developed for the highway and transit systems do not exist. The railroads and the states generate cost estimates for specific projects to calculate return on investment and estimate public benefits, but there is no program to systematically amass these costs estimates and forecast future investment levels. This need can and should be addressed by the railroads and the states in future Freight Rail Bottom Line Reports.

In the interim, a "first approximation" estimate of system-wide needs and costs was developed. The estimate is based on available studies, current and planned projects, railroad capital investment trends, industry advice, and professional judgment. Costs are divided into two categories: "railroad" (representing funds estimated to be available from revenues and borrowing) and "public/unfunded" (representing costs that would have to be met through public sector participation or other means). The estimate includes the following:

Rail-Safety Needs — $13.8 billion

The Institute for Transportation Research and Education at North Carolina State University surveyed state rail-safety needs, focusing on highway-rail at-grade crossings. They identified the following needs, covering freight and passenger rail lines:

— $2.4 billion to upgrade existing automatic warning systems using state-of-the-art technology;

— $4.2 billion to install new state-of-the-art automatic warning systems at passively signaled crossings;

— $4.5 billion for 1,154 grade separations;

— $0.7 billion for 6,727 grade-crossing closures over a 20-year period; and

— $2.0 billion for 45 track relocation projects.

These rail-safety investments were described for the most part as public-sector costs, with some limited participation by the railroads.

Short-Line Improvements — $11.8 billion

The tracks and bridges of much of the nation's short-line system are inadequate to handle the newer 286,000-pound and 315,000-pound railcars coming into service. The short-lines must upgrade the weight-bearing capacity of their tracks and bridges to handle these cars or risk losing a portion of their business. The American Short-Line Rail Road Association commissioned Zeta-Tech to estimate the cost of upgrading the nation's short-line system to handle 286,000-pound railcars. The estimated cost was $6.9 billion. This estimate is consistent with the findings of the Railroad Shipper Transportation Advisory Council (White Paper III, April 2000), which was based on a 1999 survey by AASHTO. The council found a total capital need of $11.8 billion, of which $9.5 billion was unfunded. The council's estimate included redress of deferred maintenance and safety, speed, and weight improvements.

- **Class I infrastructure repair and maintenance — $4 to $5 billion annually, or $80 to $100 billion over 20 years**[17]
- **Class I infrastructure above and beyond repair and maintenance — an additional $2 billion annually, or $40 billion over 20 years**[18]

These costs can be apportioned to the four freight-rail scenarios as follows:

No Growth

This includes the rail safety improvements, short-line improvements, and the Class I infrastructure repair and maintenance costs. The total cost is $105 to $125 billion over 20 years, or $5.3 to $6.3 billion annually. The public/unfunded share would be $23 billion, or $1.1 billion annually.

Constrained Investment

The Class I railroads are spending today about $2 billion annually on infrastructure, above and beyond repair and maintenance. These expenses support improvements to retain existing markets and capture new ones. At these investment rates, the Class I railroads are holding onto their market share of intercity ton-mileage, but are losing market share in terms of total tonnage and revenue. The inference is that the railroads are not investing enough to maintain parity with other modes. This situation most closely resembles the constrained investment scenario. Therefore, the constrained investment costs are defined as the no-growth costs plus this additional $2 billion — $145 to $165 billion over 20 years, or $7.3 to $8.3 billion annually. The public/unfunded share of this amount would remain at $23 billion, or $1.1 billion annually.

Aggressive Investment

To maintain their proportional share of freight traffic into the future (or increase their share), the railroads must increase their investment in rail infrastructure and systems. The recent, five-state Mid-Atlantic Rail Operations Study found that $6.2 billion in system improvements over and above planned expenditures were needed over the next 20 years to maintain and grow rail's market share. The improvements addressed the needs of both the intercity passenger and Class I freight railroads, which share many rail lines in the region. As an order-of-magnitude estimate, if the $6.2 billion cost were extrapolated to cover all states (excluding Hawaii), the estimated need would be about $60 billion over 20 years, or $3 billion per year. This represents investment over and above the constrained scenario. The estimated cost for the Aggressive Investment scenario would then total $205 to $225 billion over 20 years, or $10.2 to $11.2 billion annually. The public/unfunded share of this amount would be $83 billion, or $4.15 billion annually.

Base Case

If the base case is defined as the midpoint between the constrained investment and aggressive investment scenarios, then the estimated cost for the base case scenario would total $175 to $195 billion over 20 years or $8.8 to $9.8 billion annually. The public/unfunded share of this amount would be $53 billion, or $2.65 billion annually.

Table 17 summarizes these cost estimates.

Benefit/Cost Comparison

Table 18 provides a comparison of the benefit estimates and cost estimates. It suggests that an additional investment of $53 billion to "upgrade" from the constrained investment scenario to the base case scenario yields an estimated $410 billion in benefits over a 20-year period — $10 billion in reduced highway needs, $238 billion in reduced highway user costs, and $162 billion in reduced shipper costs. (As discussed earlier, the highway needs figure derived from HERS is considered very conservative.) Table 18 also suggests that an additional investment of $83 billion to "upgrade" from the constrained investment scenario to the aggressive investment scenario yields an estimated $1,063 billion in benefits over a 20-year period — $27 billion in reduced highway needs, $635 billion in reduced highway user costs, and $401 billion in reduced shipper costs.

Both the benefit estimates and the cost estimates presented in this report should be treated only as "first approximations" for purposes of illustration and discussion. Significantly greater efforts will be required to produce more solid and defensible numbers on both sides of the benefit/cost equation. The value of this analysis is less in its specific numbers, and more in its overall message — namely, that relatively small investments in the nation's freight railroads can be leveraged into relatively large public benefits for the nation's highway infrastructure, highway users, and freight shippers.

Major Improvement Needs

Major improvements are needed to upgrade the rail system infrastructure, rail operations, and rail business practice to achieve the benefits of the base case scenario or the aggressive investment scenario. Some of these require capital investments, while others require a willingness to embrace non-traditional operational and business models. A list of improvement needs would include the following:

■ System Issues

Mainline capacity; bridges and tunnels; heavier bearing capacity to support 286,000-pound railcars; height clearances to support double-stack intermodal railcars; terminal capacity; highway access and congestion at rail terminals; grade crossing control/elimination to enhance safety, railroad capacity and highway capacity; and environmental issues (noise, vibration, environmental justice, etc.).

■ Operational Issues

Electronic braking; positive train control; shared freight capacity by multiple railroads; crew size; remote control; information technology for incident response and traffic management; scheduled railroads; dedicated versus mixed services; efficient interchange; routing strategies; relationship between Class I and short-line railroads; intermodal partnerships; safety and security; emergency response and system redundancy; and shared operations with passenger rail.

■ Business Practice Issues

Class I railroad mergers and the drive to a unified network; future Class I business pressures; future short-line business pressures; changing customer service demands; perceptions of captivity; business retention and attraction; land use and development strategies; environmental regulation; open access alternatives; transnational ownership issues; and access to adequate capital.

These needs and issues are described in more detail in Appendix A.

Table 8. Rail Growth Forecast Through 2020 — "No-Growth" Scenario

	Unit Train	Carload	Intermodal	Total
2020 Tons (millions) Percent Change from 2000	1,027 +0	783 +0	199 +0	2,008 +0
2020 Ton-Miles (millions) Percent Change from 2000	582 +0	421 +0	236 +0	1,239 +0
2020 Market Share Percent Change from 2000	54.8% – 15.2%	4.2% – 2.9%	10.3% – 5.9%	9.8% – 6.3%
2020 Equivalent Truck VMT (billions) Percent Change from 2000	25.1 +0	20.1 +0	16.2 +0	61.4 +0

Source: Reebie Associates

Table 9. Rail Growth Forecast Through 2020 — "Constrained Investment" Scenario

	Unit Train	Carload	Intermodal	Total
2020 Tons (millions) Percent Change from 2000	1,294 +26%	844 +8%	313 +57%	2,451 +22%
2020 Ton-Miles (millions) Percent Change from 2000	697 +20%	463 +10%	371 +57%	1,531 +24%
Market Share Percent Change from 2000	69.0% – 0.9%	4.5% – 2.6%	16.2% 0.0%	11.9% – 4.2%
2020 Equivalent Truck VMT (billions) Percent Change from 2000	30.2 +20%	21.4 +7%	25.3 56%	76.9 25%

Source: Reebie Associates

Table 10. Rail Growth Forecast Through 2020 — "Base Case" Scenario

	Unit Train	Carload	Intermodal	Total
2020 Tons (millions) Percent Change from 2000	1,294 +26%	1,268 +62%	329 +66%	2,891 +44%
2020 Ton-Miles (millions) Percent Change from 2000	697 +20%	719 +71%	405 +71%	1,821 +47%
2020 Market Share Percent Change from 2000	69.0% – 0.9%	6.8% – 0.3%	17.0% +0.8%	14.1% – 2.0%
2020 Equivalent Truck VMT (billions) Percent Change from 2000	30.2 +20%	34.4 +71%	27.5 +69%	92.1 +50%

Source: Reebie Associates

Table 11. Rail Growth Forecast Through 2020 — "Aggressive Investment" Scenario

	Unit Train	Carload	Intermodal	Total
2020 Tons (millions) Percent Change from 2000	1,294 +26%	1,702 +117%	490 +148%	3,486 +74%
2020 Ton-Miles (millions) Percent Change from 2000	697 +20%	965 +130%	603 +154%	2,265 +83%
2020 Market Share Percent Change from 2000	69.0% – 0.9%	9.2% + 2.0%	25.3% +9.1%	17.0% +0.9%
2020 Equivalent Truck VMT (billions) Percent Change from 2000	30.2 +20%	46.2 +130%	40.9 +151%	117.3 +91%

Source: Reebie Associates

Table 12. Rail Growth Forecast Through 2020 — Comparison of Scenarios

	No Growth	Constrained	Base Case	Aggressive
2020 Tons (millions) Percent Change from 2000	2,008 0%	2,451 +22%	2,891 +44%	3,486 +74%
2020 Ton-Miles (millions) Percent Change from 2000	1,239 0%	1,531 +24%	1,821 +47%	2,265 +83%
2020 Market Share Percent Change from 2000	9.8% – 6.3%	11.9% – 4.2%	14.1% – 2.0%	17.0% +0.9%
2020 Equivalent Truck VMT (billions) Percent Change from 2000	61.4 0%	76.9 +25%	92.1 +50%	117.3 +91%

Source: Reebie Associates

Figure 42. Location of Incremental Rail Traffic Growth, 2000–2020 — “Base Case” Scenario

Source: Reebie Associates

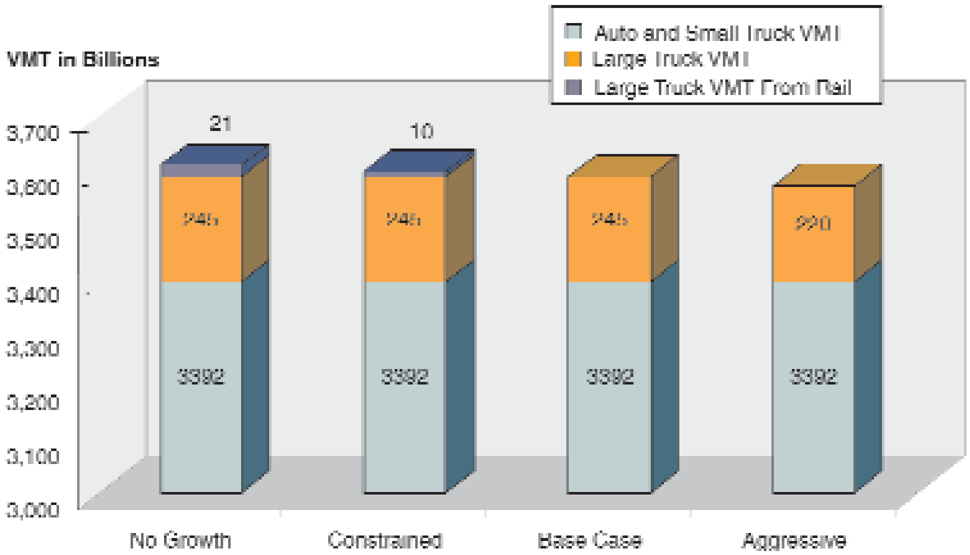
Table 13. Estimated Effect of Alternative Scenarios on Highway Needs and Highway User Costs

	Combination Truck VMT, 2020 (TRANSEARCH Diversion Estimate)	Highway Needs, 2000–2020			Highway User Costs
		Base Case	Additional Needs	Total	Additional Costs
No Growth	276 billion	$1,879 billion	$21 billion	$1,900 billion	$492 billion
Constrained	260 billion	$1,879 billion	$10 billion	$1,889 billion	$238 billion
Base Case	245 billion	$1,879 billion	$0 billion	$1,879 billion	$ 0 billion
Aggressive	220 billion	$1,879 billion	($17 billion)	$1,862 billion	($397 billion)

Source: Cambridge Systematics and Reebie Associates
Highway Needs Base Case: 1999 FHWA Condition and Performance Report, Maximum Investment Scenario
Estimated Additional Needs and Highway User Costs: HERS Model, First Approximation, Cambridge Systematics

Figure 43. Effect of Alternative Scenarios on Year 2020 VMT

Small Change Overall, but Measureable Benefit for Large Truck VMT



Source: Cambridge Systematics and Reebie Associates

Table 14. Estimated Effect of Alternative Scenarios on Annual Shipper Costs 2000–2020

	"Rail Commodities" on Rail, 2020			"Rail Commodities" on Truck, 2020			Annual Cost to Ship Rail Commodities (Billions)
	Ton-Miles (Billions)	Unit Cost (per Ton-Mile)	Rail Cost (Billions)	Ton-Miles (Billions)	Unit Cost (per Ton-Mile)	Truck Cost (Billions)	
No-Growth	1,239	$0.024	$29.7	582	$0.080	$46.6	$76.3
Constrained	1,531	$0.024	$36.7	290	$0.080	$23.2	$59.9
Base Case	1,821	$0.024	$43.7	0	$0.080	—	$43.7
Aggressive	2,265	$0.024	$54.4	(444)	$0.080	($35.5)	$18.8

Source: Cambridge Systematics and Reebie Associates

Table 15. Estimated Effect of Alternative Scenarios on Cumulative Shipper Costs, 2000–2020

	"Rail Commodities" on Rail			"Rail Commodities" on Truck			Cumulative Cost to Ship Rail Commodities (Billions)
	2000 Cost	2020 Cost	Average Annual Cost	2000 Cost	2020 Cost	Average Annual Cost	
No-Growth	$29.7	$29.7	$29.7	$0	$46.6	$23.3	$1,060
Constrained	$29.7	$36.7	$33.2	$0	$23.2	$11.6	$896
Base Case	$29.7	$43.7	$36.7	$0	—	—	$734
Aggressive	$29.7	$54.4	$42.1	$0	($35.5)	($17.3)	$495

Source: Cambridge Systematics and Reebie Associates

Table 16. "First Approximation" of Alternative Scenario Costs, 2000–2020

	Total 20-Year Cost (Billions)			Annual Average Cost (Billions)		
	Railroad Cost	Public/ Unfunded	Total	Railroad Cost	Public/ Unfunded	Total
No Growth	$82 – $102	$23	$105 – $125	$4.2 – $5.2	$1.1	$5.3 – $6.3
Constrained	$122 – $142	$23	$145 – $165	$6.2 – $7.2	$1.1	$7.3 – $8.3
Base Case	$122 – $142	$53	$175 – $195	$6.2 –$ 7.2	$2.6	$8.8 – $9.8
Aggressive	$122 – $142	$83	$205 – $225	$6.2 – $7.2	$4.0	$10.2 – $11.2

Source: Cambridge Systematics and Reebie Associates

Table 17. "First Approximation" Comparison of Incremental Benefits and Costs of Alternative Scenarios, 2000–2020

	20-Year Benefit (Billions)				20-Year Cost (Billions)		
	Change in Highway Needs	Change in Highway User Cost	Change in Shipper Cost	Total	Private Railroad Cost	Public/ Unfunded Cost	Total
No Growth	($21)	($492)	($326)	($839)	$83 – $102	$23	$105 – $125
Constrained	($10)	($238)	($162)	($410)	$122 – $142	$23	$145 – $165
Base Case	$0	$0	$0	$0	$122 – $142	$53	$175 – $195
Aggressive	$17	$397	$239	$653	$122 – $142	$83	$205 – $225
	Incremental 20-Year Benefit (Billions)				Incremental 20-Year Cost (Billions)		
Moving from Constrained to No Growth	($11)	($254)	($164)	($429)	($40)	($0)	($40)
Moving from Constrained to Base case	$10	$238	$162	$410	$0	$30	$30
Moving from Constrained to Aggressive	$27	$635	$401	$1,063	$0	$60	$60

Source: Cambridge Systematics and Reebie Associates

ASSESSMENT OF FREIGHT CORRIDORS

To further illustrate the role and potential of freight-rail in addressing total freight transportation system needs, this report examined five unique transportation corridors. While each corridor is of national significance, they differ in terms of the commodities they carry, and in terms of their relative reliance on truck and rail. It was not possible to examine every corridor of significance in this study — such as the many lower-volume corridors that have enormous economic impacts in their regions — but the selected corridors represent a useful "cross section."

The corridors examined included:

- I-5 from Washington to California;
- Southern California/Chicago/NYNJ;
- Northeast/Southeast Atlantic;
- Powder River Basin; and
- Detroit to Mexico.

Detailed results (including maps) are presented in Appendix E and summarized here. The results confirm that supporting the nation's freight-rail system in a manner that allows it to accommodate its year 2020 base case forecast volumes offers significant benefits in terms of reduced highway needs and congestion. The benefits differ by corridor — as do the probable costs of obtaining these benefits — but the benefits are clearly present in every case.

Example 1 — The I-5 Corridor, Washington to California

The I-5 West Coast Corridor extends 1,200 miles between Seattle, Washington, and San Diego, California. This important north–south corridor carries the majority of freight flows between the Pacific Northwest and the Pacific Southwest, as well as Canadian and Mexican cross-border traffic. The primary highway route is Interstate 5. The major rail carrier along the I-5 Corridor is the Union Pacific. The Burlington Northern Santa Fe has a competing route, but certain segments (notably Bieber-to-Stockton and Bakersfield-to-Mohave) use trackage rights on the Union Pacific. San Diego is served only by BNSF.

— Rail capacity along the I-5 Corridor is severely constrained due to California's mountainous terrain. East of Bakersfield, for example, a single track winds its way through the Tehachapi Mountains, up grades steeper than two percent. Not only is local traffic funneled through this narrow mountain pass, but also UP and BNSF traffic from the bay area and the central valley to the southeast. In Oregon, clearances for double-stack containers are lacking entirely. The Los Angeles to San Diego line is predominantly passenger service. Terminal facilities in all the metropolitan areas also must serve Midwest and East Coast traffic, and can be congested as a result.

— I-5 is one of our nation's most heavily used routes for both automobile and truck traffic. Absent improvements, the Highway Performance Monitoring System projections of year 2020 highway traffic for I-5 indicate level of service E and F for virtually the entire distance between San Diego and the Bay area, as well as for metropolitan Portland and Seattle/Tacoma.

— If rail volumes follow the no-growth forecast instead of the base case forecast, the result would be to shift 6.5 million tons from rail to truck in year 2020. This is the equivalent of 5.5 billion ton-miles, or 393 million truck vehicle-miles-of-travel.

Example 2 — Southern California/New York/New Jersey via Chicago

This corridor extends 3,000 miles between Southern California and the New York/New Jersey metropolitan area via Chicago. This east–west corridor connects the nation's three largest metropolitan areas and its two largest port complexes. It handles much of the nation's intermodal rail traffic, and is a vital link in "landbridge" services between Asia and the Northeast/Mid-Atlantic region. The primary highway route is along Interstate 15 (from California to Utah), Interstate 70 (Utah to Colorado), Interstate 76 (Colorado to Nebraska) and Interstate 80 (Nebraska to New York/New Jersey). The UP and BNSF compete in the Southern California–Chicago corridor, and the NS and CSX compete in the Chicago–New York/New Jersey corridor. For through traffic between Southern California and New York/New Jersey, the Eastern and Western carriers cooperate.

— The crossing through Chicago has traditionally been a barrier in rail transportation. Smaller flows suffer significant delay in the interchange between western and eastern Class I railroads, either in yards or through the unloading and trucking of trailers across town. There has been significant recent investment to enhance service in this corridor, including: construction of the Alameda corridor; triple-tracking of the UP in Nebraska; double-tracking of the CSX east of Chicago; and significantly upgraded NS intermodal terminals in Harrisburg and Bethlehem, Pennsylvania. The major constraints to growth in this service appears to be the capacity of, and truck access to, major intermodal terminals.

— The I-15/70/76/80 route is forecast to operate at generally acceptable levels of service over much of its length, although it is forecast to operate at levels of service E and F as it passes through major metropolitan areas — southern California, Denver, Chicago, Cleveland, and New York/New Jersey. This relatively good level of service is due at least in part to the fact that freight in this corridor is already heavily reliant on rail, rather than truck.

— If rail volumes follow the no-growth forecast instead of the base case forecast, the result would be to shift 20.0 million tons from rail to truck in year 2020. This is the equivalent of 32.4 billion ton-miles, or 2.3 billion truck vehicle-miles-of-travel.

Example 3 — Northeast/Southeast Corridor

This corridor extends roughly 1,500 miles between Maine and Florida, and passes through many of the nation's most urban centers — Boston; New York/New Jersey; Philadelphia; Baltimore; Washington D.C.; Charlotte; Atlanta; Jacksonville; and Miami. It accommodates cross-border traffic with Canada and provides access to major international seaports up and down the coast. The primary highway routes are I-95 (Maine to Florida) and I-81 (New York to Virginia). A variety of other interstate highways provide vital connections to these corridors throughout New England, the Mid-Atlantic and the Southeast. Rail service throughout the entire corridor is provided by the NS and the CSX, with portions also served by the CP and the CN. This analysis considers moves that originate in New England and Upstate New York and terminate in the Southeast, and vice versa. This is traffic that must run through the densely developed Mid-Atlantic corridor between New York City and Washington, D.C.

— When Conrail was split up between NS and CSX, one of the benefits expected was single-carrier service between the Northeast and the Southeast. CSX, which directly serves upstate New York and New England, instituted train services running through Northern New Jersey, while Norfolk Southern assisted Canadian Pacific in upgrading its Sunbury-to-Scranton line in return for access to Albany and New England. While the expected rail diversions have not yet lived up to their promise, there are expectations of growth as the economy returns, but impeding this growth are some significant capacity constraints. Rail traffic between New England and the Southeast must take a circuitous route through Albany due to the lack of Hudson River crossings further south. The CSX route passes through congestion in northern New Jersey and constricted tunnels under Baltimore, and shares trackage with Amtrak and commuter services (most significantly between Baltimore and Fredericksburg, Virginia). Norfolk Southern's route through the Shenandoah Valley is pure freight and avoids urban congestion, but is a single line route through hilly terrain, with speed restrictions. The Mid-Atlantic Rail Operations Study proposed a program of $6.2 billion in public and private investments to address these and other choke points affecting this corridor.

— Both I-95 and I-81 are among the most heavily used truck routes in the country and are forecast to be among the worst performing in year 2020. Virtually the entire length of I-95 between Portland, ME, to the South Carolina state line is forecast to operate at levels of service E or F. Similarly, I-81 is forecast to operate at levels of service E or F between the Pennsylvania Turnpike and the Tennessee state line, through the entire state of Virginia. This makes it critical to consider rail as a means of partially offsetting future truck traffic.

— If rail volumes follow the no-growth forecast instead of the base case forecast, the result would be to shift 3.8 million tons from rail to truck in year 2020. This is the equivalent of 4.0 billion ton-miles, or 288 million truck vehicle-miles-of-travel.

Example 4 — Powder River Basin

This corridor extends from the low-sulfur coal fields of the Powder River basin in northeastern Wyoming to power plants throughout the Midwest and South. In the 1980s, Chicago North Western (in cooperation with Union Pacific) and then Burlington Northern built access lines to the coal fields. The Dakota, Minnesota & Eastern is well on the way to passing all regulatory (though not necessarily capital) hurdles to build another line from the upper Midwest. Parallel highway service is provided by I-25 through Wyoming, I-80 through Nebraska, and a variety of interstate and state highways fanning out east and south of Nebraska. The volumes of coal now flowing from this region represent the single largest rail market in the country, and a steady stream of 13,000-ton trains flow out of Wyoming around the clock. This traffic is expected to grow as more power plants east of the Mississippi switch away from higher sulfur Appalachian coal.

— Because of the volume and profitability of this market, there are no significant rail capacity constraints. From the building of the Powder River line, to triple tracking where the corridor shares assets with transcontinental flows, to upgrading of lines to handle 286,000-pound and 315,000-pound cars, the railroads have made the necessary investments.

— Most of the highways paralleling these rail services are forecast to experience acceptable levels of service. Notable exceptions include: I-70 between Kansas City and St. Louis; I-80 through eastern Iowa; I-35 through Dallas and central Texas; and metropolitan Minneapolis, Chicago, and Memphis.

— If rail volumes follow the no-growth forecast instead of the base case forecast, the result would be to shift 77.4 million tons from rail to truck in year 2020. This is the equivalent of 72.8 billion ton-miles, or 3.3 billion truck vehicle-miles-of-travel.

■ Example 5 — Detroit to Mexico

This corridor extends from the automobile manufacturing facilities of Detroit to the Texas/Mexico border. As auto-related manufacturing has expanded in Mexico, the supply chains have been integrated with Michigan-based parts suppliers. Rail service is provided by multiple carriers. Union Pacific has a direct route in Laredo, Texas, and cooperates with Norfolk Southern and CSX with run-through services east of St. Louis. Burlington Northern Santa Fe also connects with the Eastern carriers, and participates with RoadRailers connecting to Norfolk Southern's Triple Crown network. Canadian National, through its alliances with KCS and others, provides access from Halifax to Mexico City. However, both the BNSF and KCS routes depend on trackage rights over Union Pacific for significant portions of their routes. The corresponding highway route from Detroit to the border is I-94 in Michigan; I-69 through Michigan and Indiana; I-70 through Indiana and Illinois; I-55 through Illinois, Missouri, and Arkansas; I-40 and I-30 through Arkansas; and I-35 through Texas.

— Capacity is limited at border crossing points, in the Houston terminal area, and at the interchanges between the Eastern and Western carriers (with the exception of the Union Pacific run-through trains at Salem and Saint Elmo). The corridor shares assets with the chemical flows from the Gulf Coast and transcontinental flows in the east.

— Levels of service E and F are forecast for portions of I-35 in Texas, as well as metropolitan Memphis, Indianapolis, and Detroit.

— If rail volumes follow the no-growth forecast instead of the base case forecast, the result would be to shift 0.2 million tons from rail to truck in year 2020. This is the equivalent of 366 million ton-miles, or 26 million truck vehicle-miles-of-travel.

CREATING THE 21ST CENTURY FREIGHT-RAIL SYSTEM

This section discusses:

- Choices and public benefits;
- Public–private partnership opportunity; and
- The bottom line.

Key findings presented in this section are as follows:

1. The nation's freight-rail system faces a choice between "market-driven evolution" of the freight-rail system and "public-policy-driven expansion" of the system. Market-driven evolution of the freight-rail system would accommodate some of the forecast freight growth, but relieve little of the forecast congestion on the highway system. A public-policy-driven expansion could produce a rail industry that provides the cost-effective transport needed to serve national and global markets, relieve pressure on overburdened highways, and support local social, economic, and environmental goals.
2. A public-policy-driven expansion would require network-level capital investment in nationally significant corridor choke points, intermodal terminals and connectors, and urban rail interchanges. A "first approximation" needs estimate suggests that the freight-rail system needs an additional capital investment of $2.6 to $4.0 billion annually.
3. Making these investments and realizing these benefits will require a new partnership among the railroads, the states, and the federal government to enunciate a clear national policy of improving freight system productivity; expand state eligibility and flexibility to invest where freight-rail improvements have significant highway and public benefits; increase loan and credit enhancement programs; and initiate innovative tax-expenditure financing programs, including accelerated depreciation, tax-exempt bond financing, and tax-credit bond financing. The partnership must extend beyond state boundaries to match the scale of the policy and investment decisions to the scale of today's freight-rail system.

CHOICES AND VISION

The nation's freight-rail system has a choice of futures. The U.S. economy is growing, and with it, the demand for freight transportation services. The railroads and the public sector must decide how much to invest in the freight-rail system to meet that demand. The growth forecasts and the potential impacts described in the preceding section help sketch the dimension and direction of the challenge facing the railroads and the public sector. The freight-rail system's futures are as follows:

- With minimal investment, which could be accomplished by the railroads alone, the freight-rail system would carry the same volume of freight in 2020 as it carries today, but little more.

Freight-rail capacity would not grow apace with the economy. Freight that could not be handled by the railroads, much of it heavy commodities, would move to trucks and the highway system.

- With constrained investment, approximately what the railroads can afford today from their revenue and borrowing, the freight-rail system would grow but not keep up with the economy. It would handle half or more of the forecast growth in freight-rail tonnage, but the balance would likely shift to trucks and the highway system.

- To keep up with the forecast demand, that is, for the railroads to maintain the same share (by commodity and traffic lane) of the freight market in 2020 that they hold today, additional investment by the railroads as well as strong financial support from the public sector would be required. The freight-rail system would handle all the forecast growth in freight-rail tonnage, but the highway system would still have to shoulder its full share of the forecast growth in truck-freight tonnage and VMT.

- To increase the freight-rail system's share, that is, to capture a larger portion of the forecast growth in freight demand (the aggressive growth scenario) and relieve some of the anticipated truck and congestion pressure on the nation's highway system, continued investment by the railroads and substantial investment by the public sector would be required.

The choice among these futures depends on the desired balance between **market-driven evolution** of the freight-rail system and **public-policy-driven expansion** of the system.

Market-driven evolution of the freight-rail system would likely produce a rail industry that is stable, profitable, and competitive in some segments. It would have sufficient capital and profit to operate and grow in higher-profit markets, but not enough capital and profit to reform its infrastructure forcefully, grow rapidly, or serve lower-profit markets effectively. The railroads would continue to invest a high proportion of their revenues in the maintenance and improvement of the freight-rail system, but the return on capital would be modest and the railroads' ability to borrow and expand would be constrained.

Market pressure would force the railroads to focus their own investments on unit train services, which generate most of today's freight-rail revenues and profits. It is likely that the railroads would hold onto most or all of the forecast growth in bulk commodities such as coal. The railroads also would invest in and contend for intermodal freight because it is a growing market. However, it is not a highly profitable market. The railroads compete closely with over-the-road truckers for intermodal business. Competition would likely force the railroads to focus on the highest-volume, long-haul lanes, and concede the remaining traffic to the truckers. The carload market would be at greatest risk in a market-driven evolution of the freight-rail system. Carload services are complex to manage and the unit operating costs are relatively high. A small percentage shift of industrial commodities away from rail would generate significant additional heavy-truck traffic on the highway system.

A public-policy-driven expansion could produce a rail industry that provides the cost-effective transport needed to serve national and global markets; relieve pressure on overburdened highways; and support local social, economic, and environmental goals. A policy-driven expansion could lift the freight-rail system sufficiently to meet the base case forecast, that is, to help ensure that freight rail carries the same proportion of freight tonnage in 2020 as it does today, perhaps more.

A policy-driven expansion would require network-level capital investment to enhance carload and intermodal service. Public participation in rail system investment has historically addressed the bottom of the system: grade crossings, branch lines, and commuter rail services. The present need is to treat the key elements at the top of the system: nationally significant corridor choke points, intermodal terminals and connectors, and urban rail interchanges. Investments at this level have the most promise for attracting and retaining freight-rail traffic through broad improvements in performance.

Expansion of the freight-rail system would require investment to minimize major corridor choke points. Examples would be building east coast north–south rail capacity to relieve and support the I-95 and I-81 highway corridors. The Mid-Atlantic Rail Corridor Study, sponsored by the I-95 Corridor Coalition, three railroads (Amtrak, CSX, and the Norfolk Southern), and the five mid-Atlantic state DOTs (New Jersey, Pennsylvania, Maryland, Delaware, and Virginia), identified $6.2 billion of public–private improvements needed over 20 years to ensure effective freight-rail and passenger-rail service throughout the corridor. Figure 44 shows the projects recommended for the five-year, near-term portion of the program, which includes $2.4 billion of bridge, clearance, capacity, and connector improvement projects. Other examples would be developing West Coast north–south rail capacity to relieve and support the I-5 highway corridor; and expanding Midwest/Southwest NAFTA rail-corridor capacity to connect North American manufacturing and population centers.

Expansion of the freight-rail system also would require investment in terminals and connectors. The leading example of this type of project on the west coast is the recently completed Alameda Corridor. On the East Coast, an example would be the Port Authority of New York and New Jersey's planned "port inland distribution network."

Finally, expansion of the freight-rail system would require the rationalization of the urban interchange networks that connect the Class I systems to the regional and short-line systems (collectors). The leading national example of this type of project would be the long-needed overhaul of Chicago's antiquated rail hub, which handles the massive, east–west interchange of intermodal and carload rail traffic.

Table 18 describes needed improvements to unit train, carload, and intermodal freight-rail services in the 21st century freight-rail system. Table 19 shows how physical improvements to the freight-rail system translate to operational improvements, and how, in turn, operational improvements could translate into better service performance and the ability to maintain and expand the market for freight rail.

The public benefits of these investments would be a much strengthened freight-rail system that contributes positively to the nation's economy, communities, and environment. Freight transportation is necessary for distributing the food, energy, building materials, clothing, and tools that are needed to maintain people, their homes, businesses, communities, and the nation. Freight transportation is the foundation of economic development and regional, national, and global trade. And to the extent that the freight-rail system is improved, the commuter- and passenger-rail systems also are improved and help relieve congestion on the highway system.

PUBLIC–PRIVATE PARTNERSHIP OPPORTUNITY

Making these investments and realizing these benefits will require a new partnership among the railroads, the states, and the federal government. This partnership must address the public benefits of systemwide freight-rail investments as well as local improvements. However, there is no ready model for that partnership.

Government involvement in national-scale freight transportation programs has typically come after decades of debate about strongly enunciated state and industry problems. The transcontinental railroad was developed to link the country together during its westward expansion after the Civil War. The catalyst for the Interstate Highway System was national defense and metropolitan development after World War II. The financial collapse of the railroad industry in the 1950s and 1960s triggered the economic deregulation of the commercial transportation industry. And rising public concerns about congestion and the environmental costs of overbuilding the Interstate Highway System were the major national concerns behind enactment of the landmark Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).

The partnerships driving these programs varied widely. The transcontinental railroad was built by the private sector in public–private joint venture with the federal government. The interstate highway system was built by the states in a public-public venture led by the federal government. To accomplish the deregulation of the commercial transportation industry, the federal government disengaged itself from the industry after almost 100 years of direct economic oversight. With ISTEA, the federal government redefined its relationship with the states, devolving control over most transportation decision-making to state and local government.

The strategies for funding these initiatives also varied widely. The federal and state governments provided credit support to the companies developing the transcontinental railroad, but did not directly finance construction. By contrast, the federal government took the lead in funding the Interstate Highway System through fuel taxes collected by the federal government and reapportioned to the states. The federal government also provided the political and legal structure for both deregulation and ISTEA, but after extending critical and successful support to the Northeast rail system, it left the issue of financing transportation improvements up to the private sector and state and local governments.

The public sector could sidestep the issue of a freight-rail program partnership entirely, allowing the market to continue to shape the freight-rail system. This would allow state departments of transportation to focus on their historic strength: building the highways and bridges that are the backbone of the nation's truck-freight system, for which they have an unquestioned mandate and financial backing. It would minimize the entanglement of public funds in private transportation networks, and it would avoid the contentious issue of funding a freight-rail program. However tempting, this approach will only defer and aggravate the need to find new, cost-effective transportation capacity and relieve highway congestion.

History suggests that the initiative to solve freight-rail needs, like the early turnpike movement to create the national highway system, must start with the states. States have the detailed knowledge of local transportation and economic development needs and a significant commitment to rail. Most states address freight rail, and many actively invest in freight-rail projects. Thirty state departments of transportation have staff dedicated to managing freight-rail and passenger-rail programs. Twenty state departments of transportation have staff dedicated specifically to freight rail. Twenty-two states have used state money to fund rail projects, which have included the purchase of branch lines and the banking of rights-of-way, grants and loans for rail-line rehabilitation and equipment, and construction of clearance and track improvements. Ten states have freight-rail budgets exceeding $1 million annually. Appendix B provides a brief listing of public-sector rail initiatives and programs.

State and federal expenditures on passenger and freight-rail transportation have been increasing steadily over the past 30 years. Figure 45 shows state and federal spending on passenger and freight-rail transportation from 1970 to 2000. (Separate data are not available for freight vs.

passenger improvements, and in many cases the investments fund benefits that accrue to both.) However, state and federal expenditures on passenger and freight rail are dwarfed by the public sector's expenditures on highways. In 1998, state and federal expenditures on highways were 33 times greater than their expenditures on passenger rail and freight rail: the public sector invested $108 billion in highways, $11 billion in transit, $9 billion in airways and airport, but just $3 billion in the nation's rail system, which was split between passenger and freight rail. Figure 46 shows total federal and state expenditures in 1998 by mode.

Of all investment in passenger and freight rail since 1980, the Eno Foundation estimates that the government has provided just 14 percent, and the Class I railroads 86 percent. Of the government share, most has been provided by the states and most has gone to passenger rail. Government has invested relatively little in the freight-rail system. Figure 47 compares government rail funding to the Class I railroads' investment in infrastructure and equipment.

The states and the federal government have three basic tools for investing in freight-rail improvements.

1. Grants from transportation programs. Existing programs such as the surface transportation program, the congestion management and air quality program, and state general transportation programs are heavily committed to the maintenance and preservation of the nation's roadway systems; however, expanded state eligibility and flexibility in the use of these funds is appropriate where freight-rail improvements have significant highway and public benefits. The states and the federal government may wish to consider establishing a separately funded rail program. Grants give states and the federal government the best control over the use of funds. Funds can be targeted to specific projects that solve freight- and passenger-rail needs.
2. Loan and credit enhancement programs such as the Rail Revitalization and Improvement Funding program (RRIF) and Transportation Infrastructure Finance and Innovation Act (TIFIA) program.
   - RRIF is a credit program. Current requirements governing credit risk assessment have discouraged use of the program, but Congress is debating changes that would make it more accessible and expand significantly the size of the program for both Class I and short-line railroads.
   - TIFIA provides loans, loan guarantees, and lines of credit for large projects. The program is modeled after a loan provided for the Alameda Corridor Transportation Project — truck and rail corridor project improving access to the ports of Los Angeles and Long Beach. To qualify for assistance under TIFIA, a project needs a source of revenue to cover debt service costs; the total project must be valued at over $100 million or 50 percent of the state's annual federal-aid highway apportionments, whichever is less; the federal TIFIA loan cannot exceed one-third of the total project cost; and the project's senior debt obligations must receive an investment-grade rating from at least one of the major credit rating agencies. These factors limit its applicability, and stand-alone rail projects are not eligible today; but TIFIA is an important tool that can be used for financing joint highway and rail projects that meet the program guidelines.
3. Tax-expenditure financing programs, including accelerated depreciation, tax-exempt bond financing, and tax-credit bond financing. A tax-exempt bond is an obligation issued by a state or local government where the interest received by the investor is not taxable for federal income tax purposes. Tax-credit bond financing is a new form of federally subsidized debt financing, where the investor receives a federal tax credit in lieu of interest payments on the bonds. From the borrower's perspective, it provides a zero-interest-cost loan. These programs can be used to

provide targeted, income tax benefits for investments made to improve the efficiency or increase the capacity of the freight-rail system. They have the potential to elevate the rail system's rate of return and simultaneously reduce its cost of capital.

A new partnership to improve the freight-rail system would want to use all of these tools, tailoring them to projects that produce public and systemwide benefits. The Alameda Consolidated Transportation Corridor, recently completed at a cost of $2.4 billion, is the bellwether for innovative public–private financing of highway and freight-rail infrastructure improvements. The project was funded through a combination of railroad revenues; port revenues; state, local, and regional funds; and federal loan guarantees. Appendix C lists additional freight-rail investment strategies.

A public–private partnership to improve the freight-rail system is not without risk. The public sector can invest in the freight-rail infrastructure, but it cannot provide effective and cost-competitive services that will attract and retain shippers. The railroads must do that. There is much that railroads are doing and can do to improve service and profitability, but there are an equal number of challenges — key among them being financing rail infrastructure, developing new business models for network ownership and operation, improving service reliability, and dealing with the possibility of another round of mergers. Similarly, the public sector cannot make business and industry use freight-rail services. Many shippers have moved away from freight rail, seeking the greater flexibility, reliability, and visibility of door-to-door trucking. There is no guarantee that the railroads and the public sector, even working together, will quickly reverse this trend.

But even with these risks — which are widely known and understood — many states have already taken significant steps towards these types of partnerships. Together, the states have already planned or committed to freight-rail expenditures totaling billions of dollars. Recent and planned freight-rail improvements sponsored and funded (at least in part) by the states are listed below; more detailed information on each of these projects is presented in Appendix D.

- Grade Separation Projects — eliminate up to 1,154 grade separations in 34 states
- Track Relocation Projects — 45 major track relocation projects in 14 states
- Mid-Atlantic Rail Operations Program — New Jersey, Pennsylvania, Delaware, Maryland, and Virginia
- Double-Stack Clearances from Columbus to Norfolk — Ohio, West Virginia, and Virginia
- Alameda Consolidated Transportation Corridor — Los Angeles and Long Beach, California
- "Alameda Corridor East" — Los Angeles, Orange, Riverside, and San Bernardino Counties, California
- Sandpoint Railroad Relocation — Idaho
- Washington State Freight-Rail Assistance Program, "FAST" Corridor, "Grain Train," and "Fruit Express" Programs
- Central Utah Rail Project
- Union Pacific "Overland Route" — Reno, Nevada
- Utah "Isolated Empire" Project
- Eastern Colorado Freight Mobility Strategies

- Gulf, Mobile, and Ohio Flyover — Chicago, Illinois
- Sheffield Flyover — Kansas City, Missouri
- Argentine Connection — Kansas City, Missouri and Kansas
- Missouri Short-Line Improvements
- Iowa "Clean Air" Projects
- South Dakota System Preservation
- Ohio Southern Railroad Improvements
- Georgia Short-Line Improvements
- Little Rock Port Authority Railroad — Little Rock, Arkansas
- Mississippi CSXT Mainline Relocation
- New York "Full Freight Access" Program and Cross-Harbor Tunnel
- Virginia I-81 Corridor Improvements
- "Shellpot Connection" — Delaware
- Maryland Short-Line Improvements
- Tioga Terminal Rail Project — Pennsylvania
- Conrail Double-Stack Project — Pennsylvania

The Alaska Railroad, though not part of the freight-rail system serving the contiguous 48 states, is a unique full-service railroad worthy of note for its approach to meeting the needs of Alaska's residents and businesses. Established in 1914 as a federal government enterprise until purchased by the State of Alaska in 1985, the Alaska Railroad moves nearly 500,000 passengers and nearly 8 million tons of freight on 525 miles of track.

Operating under adverse conditions in an area of widely dispersed communities, many not served by roads, the Alaska Railroad utilizes inventive and aggressive methods in fulfilling its mission to serve the public. One good example of its innovative approaches was the initiation in 2000 of barge service from the "Lower 48" to the railroad's dock in Whittier, where freight can then be distributed by rail throughout the state.

Finally, in building a new partnership, the states and railroads must make the partnership extend beyond state boundaries. The states and railroads can negotiate, finance, and implement freight-rail improvements where most of the benefits accrue locally. But it is more difficult for the states to justify investments in projects where the benefits accrue largely to other states and economic regions. The states and the railroads need multi-state forums to evaluate market demand and growth and set priorities for network-level freight-rail investments. With those in place, the states and the railroads need multi-state infrastructure corporations or banks to manage equitably the financing and repayment of investments. The Mid-Atlantic Rail Operations Study, which brought five state departments of transportation together with Amtrak, CSX, and Norfolk Southern under the auspices of the I-95 Corridor Coalition, is a promising start toward building a model for a regional partnership. Leadership, initiative, and financial support at the federal level will be important in helping establish and maintain such multi-state partnerships.

THE BOTTOM LINE

The U.S. economy is growing steadily, generating demand for more freight transportation. The growth will strain the nation's freight system, including its freight-rail system. The freight-rail system is confronted by congestion and capacity choke points along national corridors, at intermodal terminals, and at urban rail interchanges. The commuter and intercity-passenger railroads, which share these rail lines with the freight railroads, share these same challenges.

A market-driven evolution of the freight-rail system will accommodate some of the economic growth, but relieve little of the forecast congestion on the highway system. A public-policy-driven expansion of the freight-rail system supported by public sector investment is needed if the system is to maintain its share of forecast tonnage and help relieve pressure on the highway system. Without coordinated public and private action, congestion and capacity constraints will weaken the freight industry, the economy, local communities, and the environment.

Public-sector investment historically has treated the bottom of the system grade crossings, branch lines, and commuter rail services. The need today is to treat the top, the key elements of the national network — nationally significant corridors, intermodal terminals and connectors, and urban rail interchanges.

A first approximation suggests that the freight-rail system needs an additional investment of $2.6 to $4.0 billion annually. This investment can be shared among the railroads, the states, and the federal government, and portions of the public sector's investment could be paid back from long-term growth in the railroads' revenues.

The states have the experience to initiate and manage this program with the railroads, but it will be a challenge. The program must balance public demands for economic development, community, and environmental benefits against the risk of distorting the competition of the freight-transportation marketplace. Federal initiative and support will be needed to enunciate a clear national policy of improving freight system productivity; facilitate the creation of multi-state investment corporations or banks to coordinate network-level improvements; and help fund the program.

The problems of the freight transportation sector and the consequences of not addressing them are clearer today than when ISTEA and TEA-21 were enacted, and they will sharpen in the coming years. The public and private freight transportation community must advance public policy options that improve the productivity and security of the freight-rail system as an integral part of the national freight system.

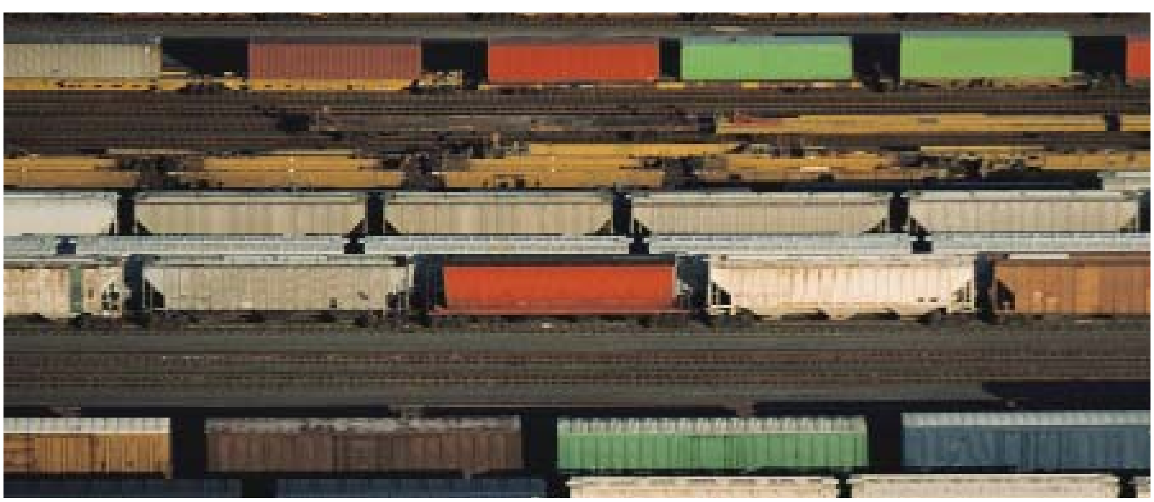


Table 18. Potential Improvements for the 21st Century Freight-Rail System

System Element	Unit Train	Carload	Intermodal
Speed	40–50 mph	40–50 mph	
Terminal and Yard Capacity	40–50 mph	*Larger/ Redesigned Ports*	50–70 mph *Additional/ Restructured Terminals*
Line Capacity	Spot	Spot	Sidings, Multi-Track
Heavy Axle Load	Raise	Support	
Bridges (weight and effective life)	*Sustain Network*	*Sustain Network*	Spot
Clearance			Expand Stack-Train Service
Grade Crossing Reduction	Improve Turnaround Time	*Improve Safety and Service*	*Improve Speed; Reduce Accidents*
Eliminate Gaps (coverage, connections, access)		*Improve Connections*	*Extend Market Reach*
Growth	Preserve	Strengthen (or wither)	*Grow*
Light Density Line Support		Feeders	

Note: Priority improvements in italics.

Table 19. Potential Rail Performance Effects of Freight-Rail Improvements

Program Improvement	Operational Effects	Service Performance Improvement
Clearances	Stack Train Introduction	Cost Reduction — Intermodal
Track and Bridges	Increase Axle Loads	Cost Reduction for Bulk and Carload
Signals	Improve Meet/Pass and Schedule, Increase Maximum Speed	Service Improvement, Cost Reduction
Sidings	Longer and/or More Frequent Trains, Improve Meet/Pass and Schedules	Service Improvement, Cost Reduction
Geometry	Increase Minimum Speed	Service Improvement, Cost Reduction and Safety
Multiple Tack	Increase Capacity, Reduce In-Transit Delay	Service Improvement, Cost Reduction
Terminals	Increase Capacity, Reduce In-Transit Delay	Service Improvement, Cost Reduction for Carload, Intermodal
Crossovers and Connections	Reduce In-Transit Delay Improve Schedules	Service Improvement, Cost Reduction
Grade Crossings	Reduce In-Transit Delay Improve Schedules	Service Improvement, Cost Reduction and Safety

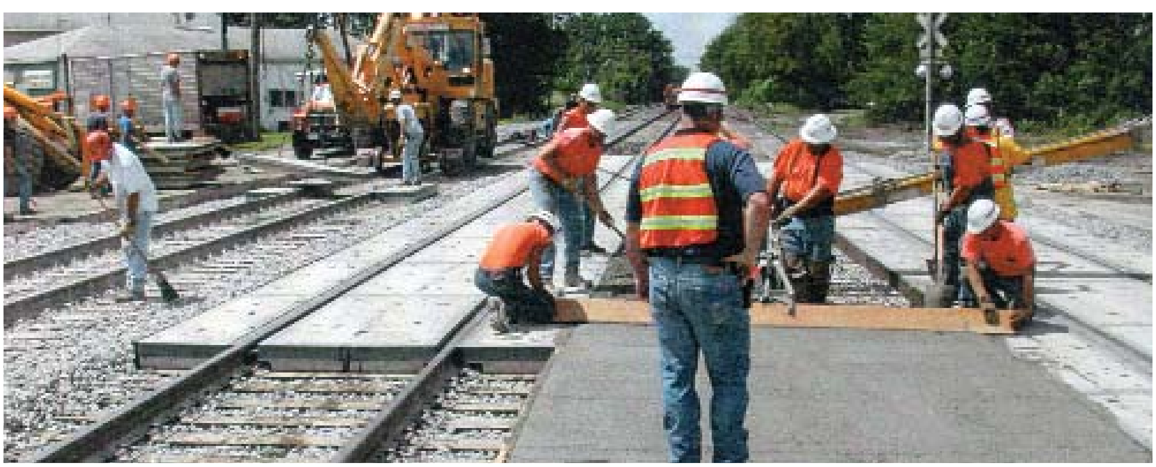


Figure 44. Mid-Atlantic Rail Near-Term Program

$2.4 Billion, Within 5 Years

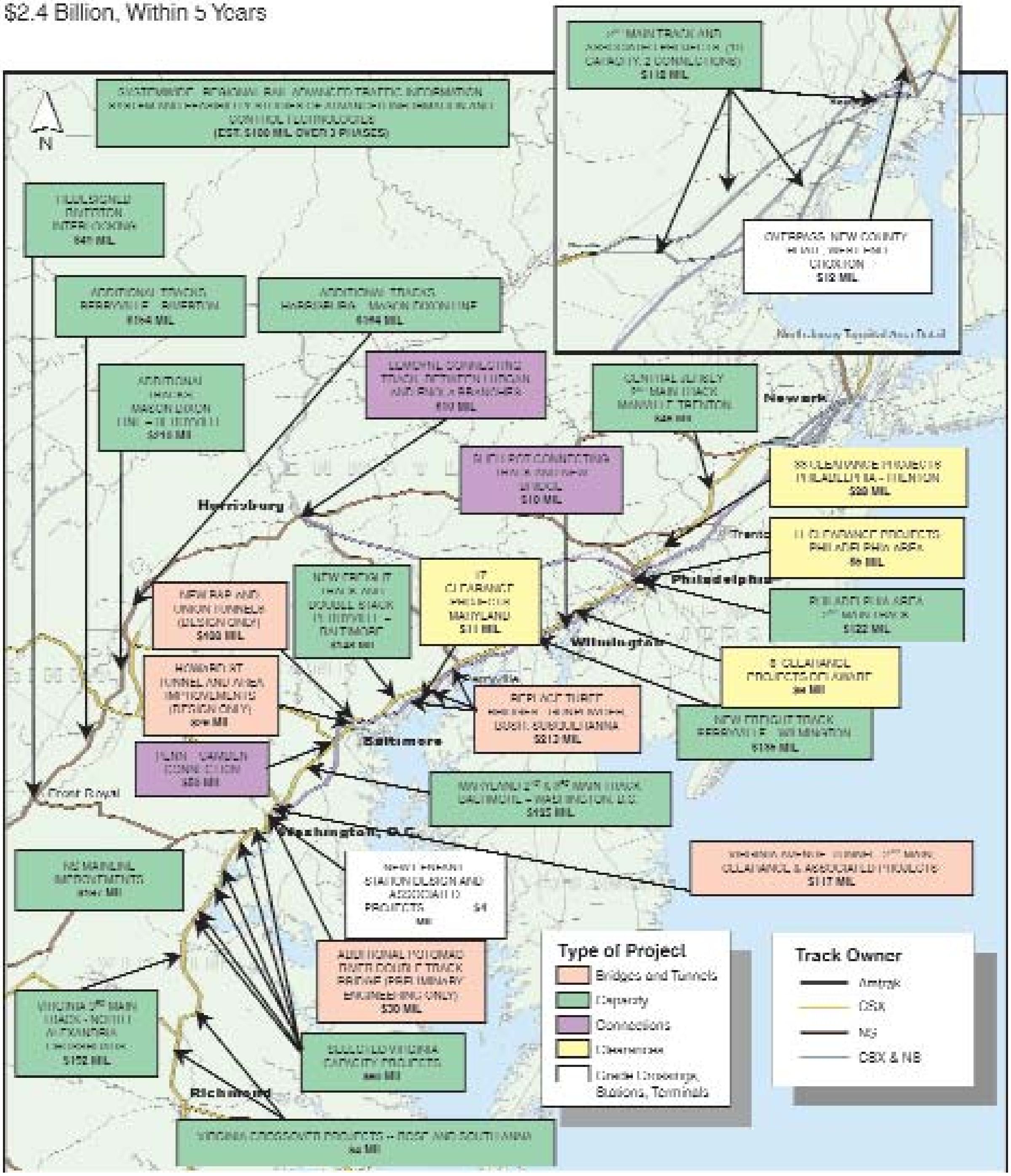
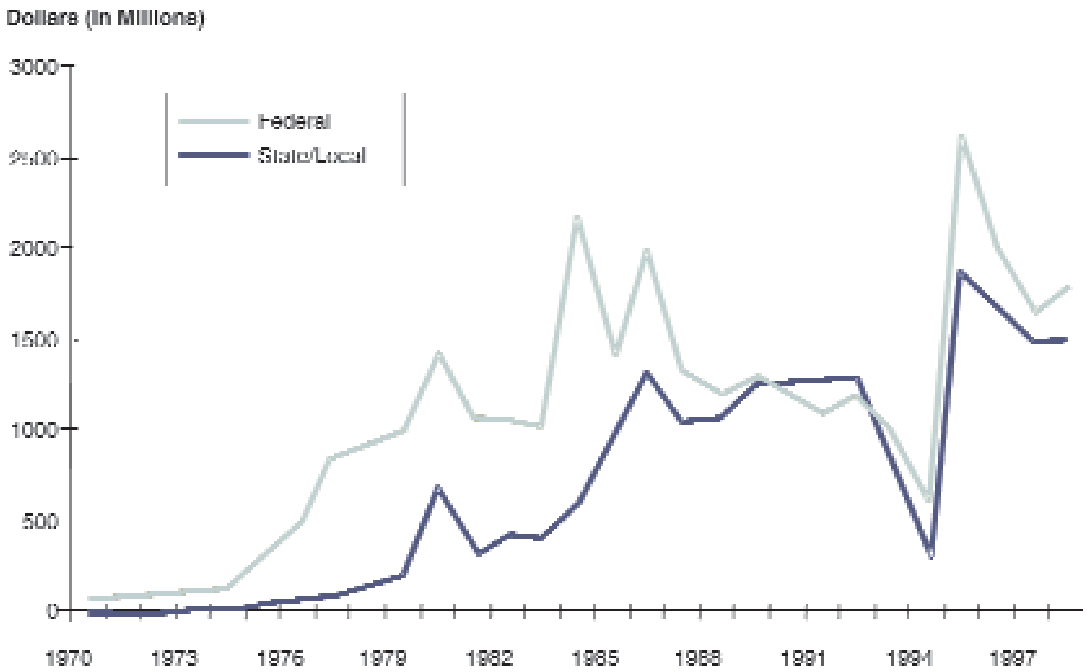


Figure 45. Federal and State Expenditures for Freight-Rail and Passenger-Rail Transportation

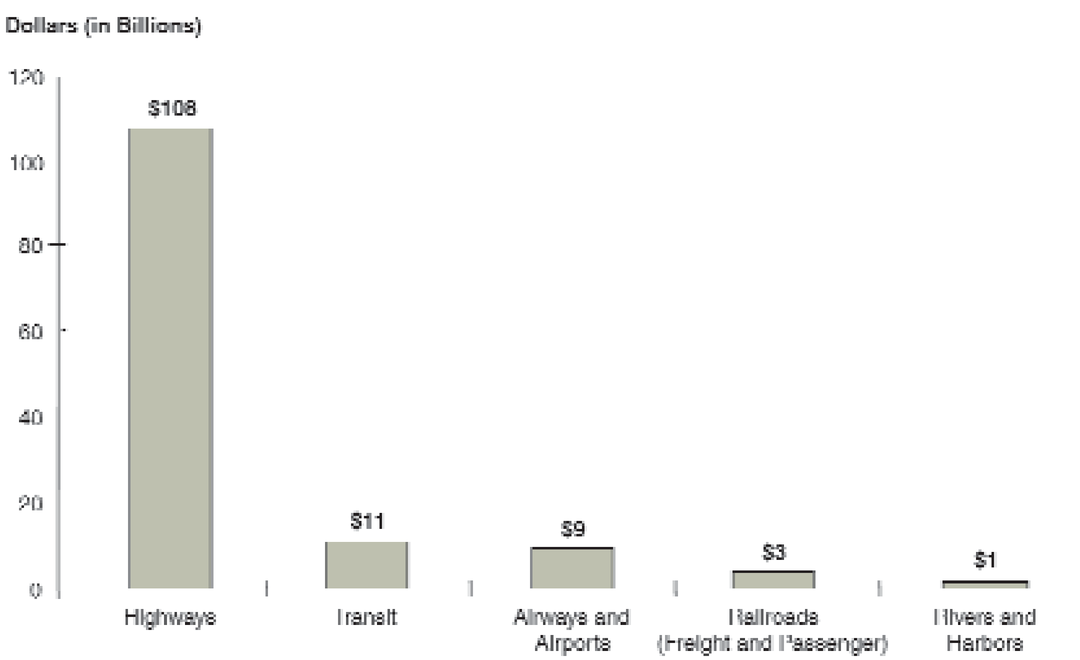
1970 to 1998



Source: Eno Foundation

Figure 46. Federal and State Expenditures for All Transportation Modes

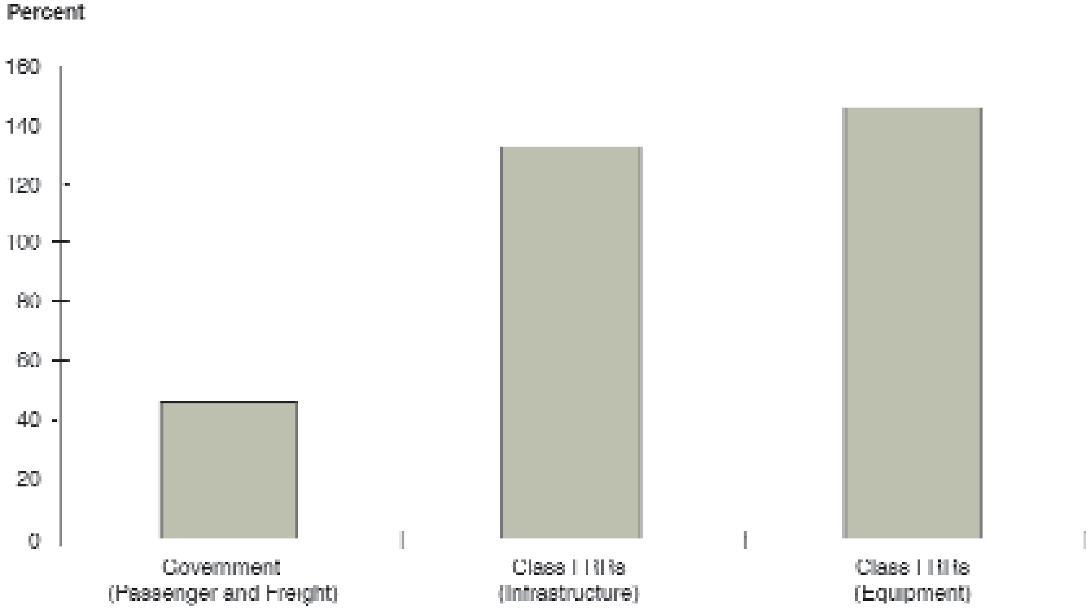
1998



Source: Eno Foundation

Figure 47. Public and Private Rail Funding

Since 1980, government has provided 14 percent of all rail funding, while Class 1 railroads have provided 86 percent. States have provided most public rail funding, and most public funding has gone to passenger rail.



Source: Eno Foundation

APPENDIX A

PRIVATE-SECTOR RAIL ISSUES AND CHALLENGES

SYSTEM INVESTMENT ISSUES

Mainline Capacity

Additional capacity gives railroads the ability to put more freight through a terminal or line. Adding more tracks (sidings, double tracking), processing more trains on a given track (signaling improvements, speed increases, electronic braking), expanding the capacity of a track (longer sidings), or increasing the capacity of each car (higher clearance, heavier-axle loads) provides additional freight throughput capacity. Operating improvements are critical to getting the best possible utilization from the available line capacity, but even with such improvements, there is often a critical need for additional mainline capacity, in the form of running tracks and/or passing sidings.

Bridges and Tunnels

Many of the nation's railroad bridges and tunnels were built in the 1800s and are in deteriorating condition. Nor were these bridges and tunnels intended for the sizes and weights of traffic that the nation's rail system currently needs to accommodate. Reconstruction and modernization of these antiquated bridges and tunnels represents a huge capital expense — billions of dollars at a national level. Given that these are assets with a very long life-span, they will generate benefits for decades. This is clearly an area where the railroads could benefit from public assistance in covering the gap between near-term capital expenditures and long-term revenue payback.

Heavier Axle Loads

One advantage railroads have, as the owners of their own right-of-way, is that they can make their own decision as to the operating cost benefit of heavier railroad cars versus the additional maintenance cost of the track from those heavier cars. Over the past decade, the industry has generally moved from 128-gross ton cars to 143.5-ton cars, with a significant part of the network ready for 157.5-ton cars. This has been done after research by the railroads individually and at the Transportation Technology Center. However, not all railroad cars are moving on their own right-of-way. About 30 percent of all freight is interchanged between Class I railroads, or between a Class I railroad and a short-line or regional railroads. One railroad's savings from increasing capacity without line investments may be another railroad's cost in carrying heavier cars. This is quite apparent for short lines, as they rarely have a capacity improvement, but are being pushed by their Class I partners to accept increasingly heavy cars.

Height Clearances

The nation's leading container ports depend on double-stack rail. Providing double-stack access for ports and for major domestic load centers will be crucial to expanding rail's share of the intermodal market.

Equipment

Railroads can carry higher and wider containers; railroads and trucks can carry a much greater variety of containers. Should we be considering better sets of containers that will result in better performance of the intermodal system?

Terminal Growth and Highway Access

Increasing line capacity is often a straightforward exercise, once the investment decision has been made. In many cases, it is a case of adding sidings or double track where excess track was removed earlier. If not, the investments are often made between cities, where land use and utilization are not major issues. However, increased rail terminal capacity will also be needed. Adding terminal capacity — particularly in urbanized areas — can be challenging. Urban area land for large facilities, such as intermodal terminals, is increasingly scarce. Congestion and other impacts on highway access routes may be critical issues. In recent years, this had led to new terminal construction relatively far from the urban areas.

As urban rail terminals handle increasing amounts of traffic, improvements to local access roads and regional truck routes will be needed. In recent years, the issue of effective truck connections between rail terminals and seaports has received particular attention. And as newer rail terminals developed outside of urban areas continue to grow, they will generate additional pressure on the highways that connect them with major population and production centers.

Environmental Justice

The impact on abutters and neighborhoods from new intermodal terminals must also be taken into account.

Grade Crossings

Grade crossings are a safety issue and a capacity issue. From a safety standpoint, the prevention of train-vehicle and train-pedestrian accidents is of paramount importance. The key strategies are: signage and control of intersections; education of pedestrians and vehicle operators; and elimination of grade crossings with higher-volume highways. From a capacity standpoint, lower speeds through grade crossings contribute to train delays, especially near terminals. Terminal operations sometimes result in backing trains across grade crossings, and even stopping trains on grade crossings. At-grade crossings of different railroad systems are also a significant problem. For example, the CSX and NS mainlines cross each other just outside Savannah, GA, and the schedule impacts are felt up and down the East Coast.

OPERATIONAL ISSUES

Electronic Braking

Trains use compressed air both for braking and for signaling brake action. In a long train, the compressed air signal can take several minutes to set the brakes in the whole train. By using a wire or radio electronic signal, brakes can be set instantly. The lowered stopping times can be used to make the distance between signals, and thus trains, shorter, and increase track capacity. A number of promising experiments have take place. However, unless the whole fleet is so equipped, it is hard to realize the improvements.

■ Positive Train Control (PTC)

By using Global Positioning Systems and continuous data communications, trains can be directly controlled as to speed and distance from other trains. This leads not only to safety improvements (elimination of some human factor failures), but also the improvements in capacity and fuel efficiencies. Trains are now spaced on a block system, where a train is given exclusive rights to occupy a piece of track, and another train is not allowed in until the first train has left. However, these fixed blocks lead to greater spacing than is necessary for safety. Fuel efficiencies are gained as a train can be signaled to slow down and follow, as opposed to stop, wait, and go.

■ Shared Capacity

A double track can handle much more than double the trains of a single track. Two competing railroads, each with a single track, can agree to each operate one way, allowing the other carrier in as a tenant railroad in the same direction. This has been done in a number of cases.

■ Crew Size

In many overseas countries, and in most passenger service in the United States, trains operate with a single crewmember in the engine. This is an area of collective bargaining, and has safety implications, especially if it is not used in conjunction with automatic train stop or positive train control. It has also been subject to state legislation.

■ Remote Control

In Canada and Europe, railroad switching is routinely done with a single remote control operator, on the ground or riding on the steps of a locomotive or car. Since the operator communicates directly with the locomotive, rather than with another crewmember, this has led to improvements in both productivity and safety.

■ Information Technology

Some of the greatest gains in the past decades have come from improvements in information technology. Most of the communication between shippers and railroads is by computer to computer (EDI), or of customer to railroad computer (World Wide Web). Freight cars are traced using transponders (Automatic Equipment Identification). However, while these have led to cost savings, they have not been taken into account in changing the way the railroad does business, by full extension to areas like yield management and asset optimization. Future improvements may come from positive train control (PTC), asset utilization programs, computer-aided dispatching (including the possibility of shared or common dispatching among multiple railroads) and real-time traffic and schedule information that could be shared among railroads to facilitate scheduling as well as incident response.

■ Scheduled Railroad

With Canadian National in the lead, the North American railroads are rediscovering scheduled service. In the second half of the 20th century, with heavy labor costs and no additional revenue from improved service, railroads minimized costs by waiting for a train to be at its full capacity before sending it out. However, this led to uncertainty in delivery times, which translated into unpredictable working hours, unknown system conditions during travel periods, and uncertain delivery windows for the customer. For higher-value intermodal traffic, which places a premium on reliable service, scheduled service and a high on-time percentage are absolute requirements to attract and keep business. The Class I's now schedule intermodal service arrivals and departures fairly closely and are aggressive in trying to meet these schedules. Many of the railroads also schedule the departure times of bulk and carload traffic, but the arrival times for these types of services continue to present a scheduling challenge.

Relationship of Service to Utilization and Cost

Maximum utilization of an asset requires it to be in continuous use, while maximum service requires that assets be available when desired. The railroads are experimenting with the balance between utilization and service through asset management and through peak pricing.

Dedicated Train Service

The railroads have differing philosophies on the use of dedicated facilities and trains to specific services, or achieving maximum economies of scale through joint use for different markets. Norfolk Southern is currently going through a cost-cutting exercise by exploiting opportunities for mixing services.

Efficient Interchange

For coast-to-coast traffic, the West Coast Class I's must interchange with the East Coast Class I's at Midwest rail hubs, the largest being Chicago. This involves switching railcars from one system to another and one crew to another, and in some cases, the interchange is accomplished using trucks to dray containers from one yard to another. Overall, the time delays and inefficiencies of this operation can be substantial. Through marketing agreements, trackage and haulage arrangements, and operating coordination, railroads have expanded the use of "run through" services that streamline the handoffs between Class I's. Interchanges between short-lines and Class I's also need improvement, although volume, network features, and operating practices can all be impediments.

Routing Strategies and the Role of Short-Lines

The nation's passenger airlines long ago discovered that the best way to make money, on the whole, was to concentrate as much traffic as possible between a limited number of points. They serve these high-density corridors with their most expensive equipment and their highest-priced labor, and rely on less-expensive labor and equipment (typically provided by partnerships with regional airlines) to collect or distribute traffic at/from key hub cities. The shipping industry is moving in the same direction, using "mega-containerships" for high-density linehauls between major global hubs, and a combination of modes (smaller feeder ships, barges, trucking, and rail) to consolidate and distribute traffic at critical load centers.

The railroads are moving toward this same sort of "hub and spoke" strategy. They are consolidating and improving their services in critical high-density, higher-profit corridors, and curtailing or eliminating their services in others. In some cases, this is due to the size of their markets, while in others it has more to do with the condition and cost of maintaining and upgrading their infrastructure. For example, to move grain out of the northern plains, BNSF has started using 110-car "shuttle trains" loading at a limited number of elevators. This replaces a system of shorter trains loading at more elevators, and places greater pressure on other modes (that is, trucking, short-line railroads, or Class I branch-line services) to pick up and deliver traffic over "the last mile." Another example is the NS intermodal network, where Harrisburg is being developed as a central terminus to serve Mid-Atlantic and Northeastern urbanized areas.

As a result, the role of short-lines will be even more critical in the coming decades. While short-lines generate only nine percent of railroad revenue, they originated or terminated over 11 million carloads of railroad traffic or about half of non-intermodal railroad shipments. While many short-lines are locally owned, increasingly they are part of national holding companies.

Intermodal Partnerships

The trucking and railroad industries are partners in providing intermodal services. Ports are increasingly involved in direct investments in rail access improvements. Railroads depend on trucking in many cases for shipping "the last mile" to their customers. All of this points the way to a more integrated future, in which the health and vitality of each mode depends largely on the health and vitality of others, and in which investments must be made to benefit the transportation system as a whole, not specific modes within it.

Safety and Security

Railroad fatalities have been steadily declining. A number of states have recently strengthened laws prohibiting people from walking along or crossing railroad tracks. Law enforcement is more aware of the need to protect railroad facilities in the wake of the September 11th terrorist attacks. Unique among the modes, railroads provide their own forces of sworn peace officers.

Emergency Response and System Redundancy

With their relatively good safety record, railroads have been regarded as ideal for hauling hazardous commodities. However, when an accident happens that leads to the release of hazardous materials, it is a major event. To reach economies of scale, the system is more concentrated, but also more vulnerable. The redundancies in lines that existed prior to deregulation increased the cost of railroad carriage, but they also provided alternatives in cases of service failures. As some of the system failures in conjunction with recent mergers have shown, the redundancy in facilities, equipment, and employees is no longer there. In contrast to public transportation assets, the decision to invest in additional capacity to provide for emergencies is purely a business decision, predicated on the risk of disruption to customer service.

Limits of Operating Efficiencies

Railroad profitability has increased in spite of dropping rates. This is a result of past productivity increases, including: shift to unit and stack trains, improved track and network rationalization, reduction in clerical and mid-management, reduced crew consists, and improved fuel efficiency. These improvements have cut railroad costs by $25 billion annually. The significant productivity gains of the past 25 years may be hard to replicate — advanced technologies and practices may provide benefits, but we should not plan with the assumption that recent rates of productivity improvement will be sustainable over the long term.

BUSINESS PRACTICE ISSUES

Mergers and the Drive to a Unified Network

After the last round of major mergers, the Surface Transportation Board issued new regulations governing these transactions. The bar has been raised, requiring improved competition, not just maintained competition. While not necessarily imminent, a new round of mergers, resulting in transcontinental systems, may be forthcoming. While the benefit in elimination of assets is not likely to be significant, the impact on service from the reduction of traffic interchange could have a positive impact, especially in intermediate-length markets. In addition, large, unified networks create significant improvement in equipment utilization and operating density, and intensify the competitive impact of fixed facilities. The experience of the past decade shows that integration issues can be very large, at times (but by no means always) leading to protracted service disruptions, and delaying merger benefits and planned investment by years. Experience also shows that competent managements eventually resolve their difficulties, and payoffs come back within reach. The promise of these payoffs, coupled with strategic considerations, probably will lead to new merger proposals — most likely in the form of end-to-end combinations — ultimately with North American scope.

Future of the Class I's

The seven largest railroads account for 84 percent of national rail traffic and 91 percent of railroad revenue. The four biggest railroads, Norfolk Southern, and CSX Transportation in the East, and Union Pacific and Burlington Northern Santa Fe in the West, all participants and products of mergers in the past decade, account for the majority of the traffic and revenue. Each railroad has certain differences in niches and operating philosophies, but for all major markets, they are served either directly by two of these railroads or by the two eastern carriers in combination with the two western carriers. In addition to the big four, the United States is served by the two major Canadian Railroads, Canadian National, with routes from Minnesota and Michigan through Chicago to the Gulf, and Canadian Pacific, with routes into Chicago, New York City, and Philadelphia. Kansas City Southern has a route from Chicago to the Gulf and the Mexican border, with a significant stake in the line to Mexico City.

Apart from mergers, in which any and all of these railroads may become involved, the future keys on bringing capital consumption, the cost of capital, and the rate of return into economic alignment. Most Class I's will continue to position themselves as wholesalers of line-haul transportation, either handling whole trainloads for unit train shippers, or relying on short-lines, steamship companies, motor carriers, and third parties to perform the retail function, and usually the pickup and/or delivery function. While this trend favors the bulk and intermodal businesses, it works against the carload. To increase profitability, and to adapt to capital and capacity constraints, railroads are examining market segments not just for their contribution, but for their lost opportunity costs as well, and are de-marketing the least attractive traffic. Some carriers are considering not only the elimination of unprofitable branch lines, but possible whole lines of business, and in both cases the carload traffic is the prominent target. There may be serious concerns for states that maintain short-line rail systems, which typically are carload operators, and for any state whose highways and environments may have to bear truck transportation of the traffic railroads shed.

There are a few counter-currents that could rise in significance. First is recognition that "intermediation" breeds "commoditization," and an attempt to offset the commoditizing effects of the wholesale strategy with value-added services (automotive mixing centers are an example of such a service). Some carriers retain retail intermodal products, and there is a resurgent interest in the carload business in some sectors, as well as the possibility of better carload service and productivity from new yard technology and design.

Future of the Short-Lines

Short-lines generate only nine percent of railroad revenue, yet they originated or terminated over 11 million carloads of railroad traffic, or about half of non-intermodal railroad shipments. While many short-lines are locally owned, increasingly they are part of national holding companies; the holding companies provide administrative and purchasing economies, but little or no operating economies. The short-lines are formed from competitive bids for track spun off by larger railroads, and the relatively high purchase prices that result can bring with them significant capital costs. In addition, the lines contend for traffic in mature markets against other rail as well as trucking alternatives. The central issues for the short-lines are two forms of dependence: on Class I connections for their market viability, and on carload traffic for their baseload volume. As Class I systems de-market the carload freight — or simply as its market share continues to decline — short-line roads are threatened with marginalization. Although creative marketing, efficient operation and financial support can help, the crucial requirement will be the profitable handling of carload traffic for the Class I roads.

Customer Service Pressures

Shippers require reliable pickup and delivery service at competitive speeds, coupled with low cost, product visibility, and varying degrees of cargo safety and security. As fast-cycle logistics systems have continued to spread through the world economy, U.S. railroads have responded with dedicated trainload services for bulk, TOFC/COFC, and automotive customers, whose on-time performance reaches well into the 90-plus percentage range. Information support is improving through applied technology, and fast trains worked in protected yards provide security from theft and asymmetric threats. Carload system performance (and some intermodal performance, outside high-density lanes) is far weaker, reportedly with transit times stretching into weeks, and on-time performance below 70 percent. Rail transportation costs normally are quite competitive with highway alternatives, but pickup and delivery transfers can eat up the cost advantage, and inadequate service will make the total logistics cost profile of rail unattractive to customers. Carriers are beginning to apply scheduled services as one kind of solution, yet one railroad that has long operated this way believes scheduling is necessary but insufficient, and recommends reservation systems (using information technology) as a way to raise both service and asset utilization. Because the carload problem is fundamentally one of intermediate handling for car block classification, terminal areas also will be part of the solution, with their design and technology forming critical components.

Suppliers

As the railroad industry has consolidated, so has the supplier industry. With a smaller customer base, the remaining suppliers are finding themselves increasingly at the mercy of the changing investment strategies of the carriers. As this sector finds itself increasingly strapped, the incentives and capital for R&D and new investment is diminishing.

Addressing Perceptions of Captivity

Railroad customers with large volumes and service only from a single carrier feel at a disadvantage compared to those that can shop around. While there are rate limitations from the STB, enforcement is difficult. A few have built second rail lines to introduce competition, while other lobby for regulatory or legislative change.

Business Retention and Attraction

Unit Train — The bulk business generally is strong because it plays to railroad strengths in dense, heavy-loading, unbalanced, low-value, and frequently long-haul traffic. Railroads carry 73 percent of U.S. coal production, with market share climbing as volume has continued to shift to the western coalfields. Total U.S. production grew 14 percent in the past decade, although it turned flat in the past few years and is affected by foreign trade. The fortunes of the coal industry are vital to railroads because this business is the system baseload and the foundation of carrier profits. Upturns and downturns have profound bottom-line effects, and the continuation of coal volumes is crucial to railroad survival. Railroads haul 28 percent of U.S. grain production (another market influenced by foreign trade). Tonnage has been moderately down since the western rail mergers, because of a loss of interest in the short-train gathering services favored by some of the pre-merger lines. Railroads have been and will remain effective at attracting, retaining, and financing unit train business; the key for the future is the vigor of the American bulk markets, and to a lesser extent their geographic patterns.

Carload Railroads hold an entrenched position for significant portions of the loose car traffic that they have been able to retain. This is a function of heavy loading, unbalanced, and often long-haul traffic, requiring specialized equipment for commodity markets. Nevertheless, market shares in many sectors are in long-term decline. Rail carriers handle 18 percent of U.S. chemical tonnage, with volume up 17 percent but share down from 28 percent 10 years before. This traffic is an important contributor to financial returns, and in the significant amount of hazmat carried on their rights-of-way, railroads are providing a public benefit. Food tonnage grew 16 percent in the last decade, yet market share fell from 14 percent to 10 percent; volumes and shares are both down in the lumber and paper business handled in carloads. A variety of factors contribute to this result — loss of direct on-rail access, changes in shipment size and commodity mix for some categories —but the central factor is the low level of railroad service for a business that cannot be tendered in trainload lots. Many shippers therefore turn to rail only when necessary, and seek ways to avoid it as new production comes on-line. With a few exceptions (such as paper in boxcars on the Wisconsin Central), railroads do not attract and cannot finance new carload business, and without substantial changes in methods and levels of performance, this will not change.

Intermodal — Railroads are effective competitors for intermodal traffic in dense, long-distance lanes. The TOFC/COFC business is the most readily susceptible to traffic diversion both to and from highway. Railroad volume grew in the 1990s and market share first climbed, then slipped from 9.6 percent in 1995 to 7.0 percent in 2000. In the key market over 500 miles, share slipped from 30 percent to 17 percent; this was caused by merger-related operational disruption during time of strong growth, among other factors. The equipment mix has continued to shift, with container volume surpassing trailers in recent years, due to growth in foreign trade, the inherent advantages of stack train operation, and motor carrier disappointment in service levels. On the automotive side, almost two-thirds of new vehicle volumes goes to market via rail, usually in dedicated train service from assembly plants to delivery ramps. Railroads starting in the 1980s successfully reversed new vehicle traffic losses to highway, using enclosed equipment, heightened clearance, and fast, direct service over long distances. Railroads have been and will remain competitive for long-haul segments of intermodal business, and can finance some improvements, but probably not large-scale growth.

Land Use Strategies

Railroads are increasingly interested in partnering for the development of integrated logistics centers, or "freight villages" (featuring warehouse and rail-served industrial tenants), at mainline-to-branch interchanges with good highway access.

Environmental Regulation and Effects on the Rail Industry

While the railroad industry is relatively benign to the environment, including lower emissions per ton-mile than trucking, it is becoming the subject to increasing regulation, which will require investment. The railroads are exceedingly dependent on coal to provide their baseline revenue. Coal is a major contributor to greenhouse gases. If the dependency on coal in power generation is significantly reduced, the baseline revenue will have to be alternatively funded to keep the industry viable.

Access Alternatives (European Experience, Canadian Model) and Quid Pro Quo

In Europe, EU directives require open access in international traffic, which has been implemented in countries such as the UK, Sweden, and Australia. The political implication of allowing access to a nationally owned system, or one that is being divested by a government, are of course different from requiring the opening of a privately owned system. Success can not only be measured in the reduction of rates paid by the shippers, but the sustainability of the system through reinvestment, both in infrastructure and operating assets.

The Canadian model — allowing existing carriers the right to operate over each others track for limited distances to reach customers not otherwise served — more closely resembles practice in the

United States. There are a number of cases where similar arrangements have been required or volunteered in order to maintain competition after a merger of U.S. railroads.

Transnational Ownership

With U.S.-based railroads operating in Canada and Mexico, with Canadian National reaching to the Gulf of Mexico, Canadian Pacific reaching across much of the upper mid-west, and U.S. holding companies with interests around the world, it may not be reasonable to talk about, and regulate, a U.S. railroad system.

Capital Access

The railroad industry is extraordinarily capital intensive. In 2000, Class I railroads invested 17.8 percent of their revenues in capital improvements, compared to an average of 3.7 percent for all manufacturing industries. Between 1991 and 2000, it is estimated that the railroads invested $54 billion in their systems: 67 percent for roadways and structures, and 33 percent for equipment. But the industry does not earn a sufficient rate of return to cover the cost of capital. Wary of the gap between railroad capital needs and net operating income ($54 billion versus $31 billion between 1991 and 2000) investors have backed away from railroad stocks. Rail's stock market value compared to the S&P 500 is one-fifth of its 1980 size. This has reduced the amount of capital available for the railroads to invest, forcing them to borrow money to maintain and expand infrastructure, or to defer maintenance and improvements. The AAR estimates that the funds shortfall — the difference between capital expenditures and the amount the railroads can invest from their own revenues — is about $2 billion annually.

APPENDIX B

PUBLIC-SECTOR RAIL PROGRAMS

TRADITIONAL PUBLIC-SECTOR INVOLVEMENT

■ Land Grants and Other Government Support

The level of government support for initial construction of early railroads ranged from none, to the extension of eminent domain, to actual investment, and in some cases, majority ownership. Most of these investments have long since been sold off, but exceptions such as the North Carolina Railroad remain. In order to encourage development in the west, the federal government developed the land-grant program, where qualifying railroads received title to half the land adjacent to the lines built in return for discounted transportation for government travel and shipments. While the benefit to the carrier is quite obvious, this was a win-win situation, since the remaining government-owned land more than doubled in value and the government received substantial savings in transportation costs. The railroads also benefited from the land they received and developed or resold, but much of the land granted to the railroads, especially in desert and mountain areas, was valueless because it could not be farmed or developed.

■ Interstate Commerce Commission

After various attempts at state regulation, the Interstate Commerce Commission (ICC) was established in 1887. At its peak, railroads were regulated with regard to entry, exit, pricing, and safety by the ICC. The ICC Termination Act of 1995 (ICCTA) terminated the Interstate Commerce Commission (ICC) effective December 31, 1995; eliminated various functions previously performed by the ICC; transferred licensing and certain non-licensing motor carrier functions to the Federal Highway Administration within DOT (now the Federal Motor Carrier Safety Administration); and transferred remaining rail and non-rail functions to the Board. Passage of this legislation represented a further step in the process of streamlining and reforming the federal economic regulatory oversight of the railroad, trucking, and bus industries that was initiated in the late 1970s and early 1980s.

■ United States Railway Administration

As railroads struggled to cope with the upswing of traffic during World War I, in 1918 the federal government took over control of the then highly fragmented railroad system. While the primary goal was to increase operating efficiency by running the railroads as a single system, the lasting results were standardization in procurement, a rundown capital plant, and a great reluctance among railroads to accept further government involvement in the operation or reorganization of the railroads.

■ Amtrak

The common carrier obligation of railroads historically required provision of both passenger and freight services. In the 1960s, unprofitable passenger traffic was becoming such a significant burden that it was affecting the financial ability of railroads to provide freight service. In 1971, the federal government formed the National Passenger Rail Corporation, known as Amtrak. Amtrak took over the intercity passenger service obligation of the railroads. The railroads were required to provide the right-of-way access to Amtrak at marginal cost for 25 years.

United States Railway Association

In the mid-1970s, almost all the railroads operating in the northeast were bankrupt, with no foreseeable hope of reaching profitability. The federal government formed the United States Railway Association (USRA) to create a new system. The USRA led to the formation of Conrail in 1976. After $10 billion in investment, a reduction of employment, and a reduction of route miles, the system was sold off on the open market, and the federal government withdrew from railroad ownership.

CURRENT PUBLIC SECTOR INVOLVEMENT

Taxes

As the sole major transportation mode that owns and maintains its own right-of-way, the railroad industry faces different tax liabilities than other freight transportation modes. The majority of the tax burden is fixed, based on assets, as opposed to variable, based on traffic. In 1999, the railroad paid $453 million in property taxes on their rights-of-way. Various states tax railroad property in different ways. For example, 31 percent of CSX's tax bill (around $20 million) goes to the state of New York, but only seven percent of CSX's track is located in New York. The New York State Legislature has passed a bill (currently awaiting the Governor's signature) that would reduce tax bills for the Class I's by about 45 percent. In return, CSX will invest $26 million in New York infrastructure projects, including upgrades for both freight and passenger service.

Deficit Reduction

Rail and barge operators pay 4.3 cents per gallon in diesel fuel taxes toward the general fund. In 1999, this amounted to $165 million. The railroads have proposed elimination of the tax. Others have suggested that the tax be dedicated to state-approved rail improvements.

Railroad Retirement

Railroad employees were the first to be covered by a federal retirement program. When Social Security was formed, railroad employees were not included. As part of a shrinking industry, the railroad retirement system supports more retirees per current employee than the social security system. The railroads argue that this places an unfair burden on the industry; others argue that this is a legitimate and long-standing social debt incurred by the railroads.

Regulation

While the level of economic regulation of the railroad industry has change markedly over the past 25 years, the Surface Transportation Board provides the remaining economic regulation. The Federal Railroad Administration regulates safety regulations and administers federal support programs.

STATE PROGRAMS

States have a significant commitment to freight-rail; most states address freight-rail in their planning process, and many actively fund freight-rail improvements. A 1997 survey of state DOTs by the University of Texas found the following.

Dedicated staff

Thirty state DOTs have staff dedicated to passenger-rail and freight-rail programs. Twenty state DOTs have staff dedicated specifically to freight-rail.

■ Dedicated budget

Ten states have freight-rail budgets exceeding $1 million annually.

■ Direct funding of rail improvements

Twenty-two states used state money to fund rail projects, which included purchase of branch lines and banking of right-of-way; grants and loans for rail line rehabilitation and equipment; and construction of clearance and track improvements.

FEDERAL PROGRAMS

■ Section 130 Rail-Highway Grade Crossing Program

Under this program, the entire cost of construction of projects for the elimination of hazards of rail-highway crossings can be funded. This includes separation or protection of crossings, the reconstruction of crossings, the relocation of highways to eliminate crossings, and (where more cost-effective) the relocation of rail lines to eliminate crossings.

■ National Highway System (NHS) Program

Provides funding to improve highway links on the NHS network, or designated as intermodal connectors, to accommodate intermodal movements, including truck and freight rail.

■ Surface Transportation Program (STP)

Provides funding for roadway improvements over any federal-aid highway, including improvements that benefit freight-rail movement such as lengthening or increasing vertical clearances on highway bridges, or improving at-grade crossings.

■ Congestion Mitigation and Air Quality (CMAQ) Improvement

Provides funding for transportation projects that improve air quality in designated non-attainment areas. Intermodal freight facility improvements are eligible, and funded projects have included railyards, branch lines, and clearance improvements.

■ Transportation Infrastructure Finance and Innovation Act (TIFIA)

Provides credit assistance (up to one-third of project cost) for major transportation investments of national significance, including international bridges and tunnels, intercity passenger rail facilities, and publicly owned intermodal freight-rail facilities on or adjacent to the NHS.

■ Railroad Rehabilitation and Improvement Financing (RRIF)

Provides credit assistance for public and private sponsors of intermodal and rail projects, including Class I and short-line railroads.

■ Projects can include acquisition, development, improvement, or rehabilitation of equipment or facilities.

National Corridor Planning and Development (NCPD) and Coordinated Border Infrastructure (CBI) programs provide funding for planning, project development, construction and operation of projects that serve border regions near Canada and Mexico and for high-priority corridors throughout the United States.

■ Transportation and Community and System Preservation Pilot Program (TCSP)

Provides funding for a wide variety of transportation and public policy initiatives to achieve locally determined goals. Has been used for rail realignment, overpass construction, and studies of grade separations and redevelopment of rail-served brownfields.

■ Transportation Enhancements (TE)

TE projects are funded from a 10 percent set-aside of STP funds. These support non-traditional transportation-related improvements, and have been used for rehabilitation of historic/cultural rail facilities and for branch line improvements.

APPENDIX C

PUBLIC–PRIVATE RAIL FINANCING STRATEGIES

Direct Funding out of Railroad Revenues

Pro: Railroads can make investments where they generate sufficient revenue to repay the investment and serve profitable markets.

Con: Limited railroad investment funds; railroads are not earning their cost of capital, making borrowing on the open market more difficult and expensive; railroads cannot afford to invest in lower-profit lines and services; unlikely to invest in projects in order to achieve public benefits.

Rail User Fees or Surcharges

Pro: User fees generate revenues to pay back construction bonds financed by the states or special purpose authorities. The leading, successful example is the recently opened Alameda Corridor.

Con: Requires stable and increasing volumes of traffic to generate revenue stream. The Alameda Corridor is a relatively unique situation. The corridor serves the high-volume container ports of Long Beach and Los Angeles; other locations may not have sufficiently stable and growing traffic to support user fees. Most manageable when applied to short, well-defined corridors or bridges and tunnels. More difficult to manage when multiple improvements must be made across a network and across a multi-state region.

Direct Federal Appropriations and Earmarks

Pro: Ensures targeted public investment in rail projects that have significant national, public benefits.

Con: Limited funds; requires lengthy public planning and review process; typically entails compliance with federal labor and other laws that are generally unacceptable to the railroads.

Congestion Mitigation and Air Quality (CMAQ) Program Grants

Pro: CMAQ grants have been used to fund transportation improvements that reduce congestion and engine emissions in regions that do not meet national air quality standards.

Con: Lack of explicit eligibility for freight rail; limited funding.

Transportation Infrastructure Finance and Innovation Act (TIFIA)

Pro: Provides loans and loan guarantees for large transportation projects.

Con: Lack of explicit eligibility for freight-rail and intermodal projects; requires revenue stream to pay back loans; high threshold for project eligibility.

Railroad Rehabilitation and Improvement Finance Program (RRIF)

Pro: Loan program specifically for rail improvements; congressional proposals would significantly expand funding for the program.

Con: Limited funding at present; FRA lacks authorization to fund the mandated project credit-risk analysis, so few projects have been initiated; funding focuses on investments with private, rather than public benefits; financially constrained railroads unlikely to invest in projects in order to achieve public benefits.

- **Borders and Corridors**

  Pro: Provides funds to states to plan and develop multi-state trade corridors serving international trade gateways.

  Con: Popular program but over-subscribed with limited funding, much of which has been earmarked to highway projects; rail projects are not explicitly eligible.

- **Section 130 Grade Crossing Program**

  Pro: Provides for use of highway funds to eliminate dangerous highway/rail grade crossings or improve existing grade separations.

  Con: Limited funding available; states and railroads are discussing expansion of the program but have not resolved concerns about assignment of liability for accidents at crossings.

- **Federal Tax-Credit Bond-Financing Programs**

  Pro: Tax credit financing might be used to generate funds for investment in rail infrastructure projects; funds could be distributed as grants, loans, or credit enhancements; could be targeted to specific types of businesses and improvements; does not impact discretionary portion of federal budget.

  Con: New program not easily understood; numerous details to be worked out; impacts revenue side of the federal budget.

- **Issuance of Tax-Exempt Debt for Railroad Infrastructure**

  Pro: Holders of debt would be exempt from tax on interest earned, resulting in reduced cost of funds; could be targeted to specific types of businesses and improvements; debt could be acquired by investors other than railroads; does not impact discretionary portion of federal budget.

  Con: Will likely require congressional action to increase ceiling on state per-capita debt limit, and to allow tax exempt debt for private activity; impacts the revenue side of the federal budget.

- **Use of Rail Share of Gas Tax for Dedicated Railroad Trust Fund**

  Pro: Would re-allocate 4.3 cent per gallon diesel-fuel tax paid currently by the railroads from the general fund to a dedicated railroad trust fund for rail infrastructure projects.

  Con: Railroad industry opposes the tax; generates a modest amount of funding ($160 million per year).

- **State-Based Loans and Infrastructure Banks**

  Pro: Would provide states with a mechanism to invest in rail improvements.

  Con: States require seed money for banks and programs.

- **Sale of Freight Assets for Rail Passenger Use**

  Pro: Generates cash, in-kind improvements, or state matching funds that states or railroads can use to invest in freight-rail service improvements.

  Con: Limited opportunities; primarily in high-density metropolitan rail corridors; states must have sufficient transportation revenues to support purchase of assets or access rights.

- **Relief from State Property Taxes on Rail**

  Pro: State property taxes on rail were estimated at $453 million in 1999; relief could be coupled with requirements that the funds be dedicated to rail improvements.

  Con: Would represent a loss of state revenues that would have to be made up from other taxes or fees.

APPENDIX D

EXAMPLES OF PUBLIC-BENEFIT FREIGHT-RAIL PROJECTS

The following are selected examples of public-benefit freight-rail projects identified in the preparation of this report. It is by no means a complete listing, but it does serve to illustrate the range of approaches that are being pursued by the public sector — often in partnership with the private sector — to achieve public benefits from freight-rail improvements.

NATIONAL SUMMARIES

- Grade Separation Projects — National (from Rail Safety Funding Survey by North Carolina State University)

  Project Description: Eliminate up to 1,154 grade separations in 34 states.

  Project Benefit: Improved safety, reduced highway congestion, improved train performance.

  Project Cost: Estimated at up to $4.5 billion.

- Track Relocation Projects — National (from Rail Safety Funding Survey by North Carolina State University)

  Project Description: Forty-five major track relocation projects in 14 states.

  Project Benefit: Improved safety, reduced highway congestion, improved train performance.

  Project Cost: Estimated at up to $2.0 billion.

MULTI-STATE CORRIDORS

- Mid-Atlantic Rail Operations Study — New Jersey, Pennsylvania, Delaware, Maryland, and Virginia

  Project Description: Planning study performed jointly by five states, the I-95 Corridor Coalition, NS, CSX, and Amtrak. Study identified a range of physical and operational improvements to rail corridors paralleling I-95 and I-81, including: reconstruction of antiquated bridges and tunnels; capacity enhancements; height and weight clearances; connections; and terminals.

  Project Benefit: Improved passenger and freight-rail system safety, speed and reliability; greater competitiveness with trucking to offset highway congestion on two of the nation's most-used truck corridors; economic benefits to region's shippers, businesses and passengers.

  Project Cost: Estimated at $6.2 billion over 20 years, to be funded through public–private partnership structures (currently under discussion).

- Double-Stack Clearances from Columbus to Norfolk — Ohio, West Virginia, and Virginia

  Project Description: Upgrade existing NS line between Columbus and Norfolk from TOFC/COFC-capable to double-stack-capable with tunnel improvements and other projects.

  Project Benefit: Increase intermodal traffic and reduce reliance on trucking in this congested multi-state highway corridor; provision of double-stack service to West Virginia shippers.

  Project Cost: Unknown.

STATE, REGIONAL, AND LOCAL INITIATIVES — WEST

- **Alameda Consolidated Transportation Corridor — Los Angeles and Long Beach, California**

  Project Description: Twenty-mile, triple-tracked, fully grade-separated rail corridor linking the Ports of Los Angeles and Long Beach to major intermodal railyards located near downtown Los Angeles. Project is completed and operating.

  Project Benefit: Consolidates three separate, aging at-grade rail lines (UP, SP, SF) into a single upgraded corridor with joint use by BNSF and UPSP; eliminates over 200 urban at-grade rail crossings to improve rail system capacity, speed, and safety, saving an estimated 15,000 person-hours per day of automobile delay and reducing diesel train emissions by 28 percent; ensures state-of-the-art rail access to international gateway ports of Los Angeles and Long Beach and reduces their dependence on trucking; supports regional and international economic development and competitiveness.

  Project Cost: $2.4 billion, funded through innovative multi-level public–private partnership: $1.16 billion in revenue bonds and $400 million in federal loans supported by a "toll" or surcharge of $15 per loaded TEU; $394 million from the Ports; $347 million from the LA Metropolitan Transportation Authority; $130 million from state and federal grants; and $400 million from federal highway funds for street and highway overpasses.

- **"Alameda Corridor East" — Los Angeles, Orange, Riverside, and San Bernardino Counties, CA**

  Project Description: Approximately 60 mile UP/BNSF rail trade corridor, extending from the Alameda Corridor through the Southern California counties of Orange, Los Angeles, San Bernardino, and Riverside. Elements of the corridor are under construction.

  Project Benefit: Facilitates the movement of both international (via the Ports of San Pedro) and domestic containers to major rail and intermodal hubs in the United States.

  Project Cost: $1.4 billion (approx).

- **Sandpoint Railroad Relocation — Idaho**

  Project Description: Relocate UP secondary mainline operations onto a BNSF branch line.

  Project Benefits: Eliminated 3.5 miles of track through the center of Sandpoint and 17 at-grade crossings, improving safety and mobility.

  Project Cost: $7.5 million, including $2.5 million in STP funds.

- **Washington State Freight-Rail Assistance**

  Project Description: Washington has an extensive program of freight-rail assistance, including grants and loans for track upgrades, equipment, bridges and tunnels, acquisition, and preservation; WSDOT identifies 19 past or pending assistance projects.

  Project Benefit: Maintain essential freight services, alleviate highway congestion, spur economic growth.

  Project Cost: Referendum 51 provides $94 million in funding.

- **Washington State "FAST" Corridor**

  Project Description: FAST stands for "Freight Action Strategy." It is a program of 15 priority freight projects between Everett and Tacoma, including rail-highway grade separations, railyard improvements, port access, and regional highway improvements. Construction underway on initial projects.

  Project Benefit: Improve overall freight movement efficiency and safety.

  Project Cost: Unknown. Twenty-seven percent federally funded, 73 percent other public and private funding; partnership includes the state, regional government, three ports, 12 cities, two counties, the BNSF, the UP, and the Washington Trucking Association.

Washington State "Grain Train" and "Fruit Express" Railcar Programs

Project Description: The "Grain Train" is a program to alleviate railcar shortages by purchasing grain cars with public funds; it started in 1994 and is financially self-sustaining. The "Fruit Express" is a just-in-time rail produce service provided by Amtrak trains; the state leased refrigerated rail express cars for the service. A pilot program has been completed.

Project Benefit: Maintain essential freight services, reduce dependence on just-in-time trucking.

Project Cost: $667,000 initial federal-state investment in Grain Train cars, being repaid from rental fees paid by the railroads; $500,000 in state funds for the Fruit Express.

Central Utah Rail Project

Project Description: Construct 45-mile short-line railroad from UP main line west of Levan, Utah to Salina, Utah near I-70. This restores service previously provided by the Marysville branch, which was closed by a landslide and flood in 1983.

Project Benefits: Provide cost-effective alternative to truck transport for existing industries; improve their connections to international seaports; improve their overall competitiveness and preserve jobs and tax revenues; reduce heavy truckloads on area highways; reduce pollution; and improve safety.

Project Cost: Unknown.

Union Pacific "Overland Route" — Reno, NV

Project Description: Construct trench through downtown Reno to accommodate UP mainline. Project is in the planning stage.

Project Benefit: Eliminates at-grade rail crossings.

Project Cost: Unknown.

Utah "Isolated Empire" Project

Project Description: Construct 100-mile rail link from phosphate mining center in Utah to the national rail system. Project is in the planning stage.

Project Benefits: Support economic development of mineral resources on remote land.

Project Cost: $300 million.

Eastern Colorado Freight Mobility Strategies

Project Description: Program of highway-rail grade crossing improvements, Class I capacity improvements, short-line track upgrades, and intermodal terminal improvements. Recommended increased state support for freight-rail investments.

Project Benefits: Improve capacity, safety, service, mobility, and associated economic benefits.

Project Cost: Unknown; mix of public and private investments.

STATE, REGIONAL, AND LOCAL INITIATIVES — PLAINS AND MIDWEST

Gulf, Mobile, and Ohio Flyover — Chicago, IL

Project Description: Elevation of the former Gulf, Mobile, and Ohio Chicago–St. Louis mainline through the Southwest Chicago. Project is in the planning stage.

Project Benefit: Eliminates five at-grade intersections with other railroads carrying freight and (as of 2003) Amtrak intercity traffic; improves freight train speed, safety, and reliability.

Project Cost: Estimated cost of $200 million; funding source unknown.

■ Sheffield Flyover — Kansas City, MO

Project Description: Elevation of a three-mile section of the east–west BNSF mainline and Kansas City Terminal Railroad (KCT) through downtown Kansas City. Project is completed.

Project Benefit: The flyover eliminated conflicts with UP and KCS mainlines — benefiting up to 250 train moves per day — and eliminated at-grade vehicular traffic conflicts.

Project Cost: $75 million. BNSF, KCT, and the state of Missouri formed a joint Transportation Corporation to issue construction bonds with state tax exemptions and Kansas City ad valorem tax relief. The bonds are to be repaid from railroad revenues.

■ Argentine Connection — Kansas City, MO, and KS

Project Description: Elevation of a two-mile section of the east–west BNSF mainline at Santa Fe junction, between the KCT mainline in Missouri and the BNSF Argentine Yard in Kansas. Project is in the planning stage.

Project Benefit: This east–west line is heavily used by BNSF and crosses other rail lines and streets at grade. The flyover would improve performance and safety for up to 80 BNSF train moves per day and eliminate at-grade vehicular traffic conflicts.

Project Cost: $60 million. A joint public–private transportation corporation has been formed to fund the project, similar to the corporation formed to fund the Sheffield Flyover.

■ Missouri Short-Line Improvements

Project Description: Construct rail spur in Pemiscot County to connect regional port facility and adjoining industries with the BNSF mainline; construct Columbia Terminal Railroad (COLT), owned and operated by the City of Columbia Water and Light Department, to ship coal from eastern Kentucky and support adjoining industries.

Project Benefits: Improved rail access for port and industries in economically depressed region of the state; improved intermodal connectivity and competitiveness; access to low-cost fuel with reduced need for trucking.

Project Cost: $1.9 million for the Pemiscot County short-line (combination of federal, state, and local funds); unknown for COLT.

■ Iowa "Clean Air" Projects

Project Description: Modify supports on a Mississippi River highway bridge to allow double-stack container clearance; construct wye track to allow diversion of train traffic out of downtown Iowa City; construct highway underpass below the UP tracks at Mason City.

Project Benefit: Improved freight-rail capacity, reduced rail impacts and highway congestion, and reduced rail transportation costs.

Project Cost: Total cost unknown; 70 percent of funding through clean air program.

■ South Dakota System Preservation

Project Description: Until 1980, the Chicago, Milwaukee, St. Paul, and Pacific Railroad provided most of South Dakota's rail service. When the Milwaukee went bankrupt, the state purchased most of its system in the state, upgraded key portions, and in 1981 entered into an agreement with the BN to operate part of the system. BN agreed to fund a portion of the state's debt for improving the mainline between Ortonville, Minnesota, and Terry, Montana, and in 1990 BN purchased the line.

Project Benefit: Maintaining and preserving rail access to rural rail shippers, and transitioning rail lines from state-owned to privately owned and self-supporting.

Project Cost: Unknown.

- Ohio Southern Railroad Improvements

  Project Description: Restoration of service on state-owned rail line between New Lexington and Zanesville by the Ohio Central Railroad and the state of Ohio.

  Project Benefit: Restoration of service supports new mining operation, improves access to an existing mine, and provides a bypass for NS around congested yards in Columbus.

  Project Cost: $10 million, including $2 million in state grants and $5.5 million in state loans.

STATE, REGIONAL, AND LOCAL INITIATIVES — SOUTH

- Georgia Short-Line Improvements

- **Project Description:** The state of Georgia funds freight-rail improvements through its Office of Intermodal Programs. Two recent projects include the construction of a rail loop to provide rail service to a feed mill in southeast Georgia, and the rehabilitation of the 180-mile state-owned rail line between Vidalia, Georgia, and Martha, Alabama (including track work and bridges).

  Project Benefits: Provide cost-effective rail service to rural industries; improve the safety and capacity of rail operations; allow for the introduction of passenger excursion service to promote tourism and related economic development.

  Project Cost: $400,000 for rail loop; $6.2 million for mainline; funded from state general funds.

- Little Rock Port Authority Railroad — Little Rock, AK

  Project Description: Rehabilitate state-owned Class III railroad providing switching services between Little Rock Industrial District shippers and two Class I railroads as well as direct intermodal connections for rail-to-barge transfers on the Arkansas River.

  Project Benefits: Avoid reduction or elimination of rail service for area shippers, who in some cases would have been forced to relocate; reduce transportation costs; aid in recruiting new industries; improve intermodal connectivity.

  Project Cost: Unknown.

- Mississippi CSXT Mainline Relocation

  Project Description: Relocate and upgrade existing CSX Transportation mainline along the I-10 Corridor serving the Gulf Coast from New Orleans to Pensacola. An EIS is in preparation.

  Project Benefits: Improve capacity and condition, upgrade access to Mississippi's ports, allow for upgraded passenger service, reduce highway conflicts, and provide right-of-way for potential highway improvements.

  Project Cost: Unknown.

STATE, REGIONAL, AND LOCAL INITIATIVES — NORTHEAST AND MID-ATLANTIC

- New York "Full Freight Access" Program and Cross-Harbor Tunnel

  Project Description: "Full Freight Access" is a set of capacity, clearance, and operational strategies coordinated by New York State DOT to facilitate north–south freight-rail movement through the state. A related study of a potential cross-harbor tunnel linking North Jersey to Brooklyn is being conducted by New York City (now in the EIS stage).

  Project Benefit: Increased NAFTA trade capacity, improved freight-rail service to New York City and the "downstate" region, reduced transportation costs, increased system redundancy, reduced truck traffic on severely congested bridges and tunnels in the downstate region.

  Project Cost: Unknown.

Virginia I-81 Corridor Improvements

Project Description: Improvements to the NS mainline in the I-81 corridor, coordinated with highway improvements to I-81.

Project Benefit: I-81 is one of the nation's most heavily used truck corridors, with truck percentages that can exceed 40 percent, much of which is long-haul combination truck traffic moving through the state between the Gulf/Southwest and the urbanized areas of the Northeast. With rail improvements and expected diversion of truck traffic to rail, highway investments are still needed, but their magnitude is reduced and a positive benefit is generated.

Project Cost: Unknown.

"Shellpot Connection" — Delaware

Project Description: Upgrade and reopen the Shellpot Bridge (a circa 1888 swing-span structure taken out of service in 1995 by Conrail) and mainline connections for freight and intercity passenger traffic.

Project Benefit: Greater rail passenger and freight capacity between Wilmington and Dover, DE; improved access to the Port of Wilmington and the region's industrial shippers; provides bypass of passenger station.

Project Cost: $13 million; capital cost funded by state ($5 million in grant appropriations and the remainder from bonds, to be repaid by NS out of "toll" surcharges on rail traffic over 20 years. Toll charges are on a sliding scale — initially $35 per car per year, reducing with volume.

Maryland Short-Line Improvements

Project Description: Over the past 23 years, the state has funded the acquisition and improvement of 220 miles of state-owned rail rights-of-way. A new six-year program is in place to upgrade weight capacities on these lines to 286,000 pounds where they feed into higher-weight NS lines.

Project Benefit: Preserve and improve rail access for rural shippers and industries.

Project Cost: Unknown.

Tioga Terminal Rail Project — Pennsylvania

Project Description: Provide direct rail service to marine terminal.

Project Benefits: Reduced levels of local drayage truck moves required for maritime/rail intermodal operations, reduced emissions and congestion in and around the Port of Philadelphia.

Project Cost: Unknown; the Delaware Valley Regional Planning Commission placed this project on their TIP as a CMAQ-funded project.

Conrail Double-Stack Project — Pennsylvania

Project Description: Double-stack Conrail mainline from Philadelphia to the Ohio state line; completed in 1996.

Project Benefits: Increased the economic competitiveness of the Port of Philadelphia by increasing the capacity of rail service; reduced the level of truck traffic and congestion, particularly in the Philadelphia region.

Project Cost: Approximately $100 million dollars; the Commonwealth provided $38 million in state General Fund support and the balance was provided primarily by Conrail with some limited local funding support.

APPENDIX E

ASSESSMENT OF FREIGHT CORRIDORS

To further illustrate the role and potential of freight-rail in addressing total freight transportation system needs, we examined five transportation corridors. While each corridor is of national significance, they differ in terms of the commodities they carry, and in terms of their relative reliance on truck and rail. It was not possible to examine every corridor of significance in this study — such as the many lower-volume corridors that have enormous economic impacts in their regions — but the selected corridors represent a useful "cross section."

For each corridor, we determined truck and rail tonnage under the year 2020 Base Case forecast, assigned the tonnage to the rail and highway systems using a model assignment procedure, and calculated the associated ton-mileages. Because many of these corridors include significant international traffic, this data also was included along with the domestic traffic. We defined "corridor traffic" to include all traffic originating in, terminating in, being imported into, or being exported from, selected business economic areas (or BEA). The data reflect only this selected traffic, and exclude other traffic using portions of the corridors.

EXAMPLE 1— THE I-5 CORRIDOR, WASHINGTON TO CALIFORNIA

The I-5 West Coast Corridor extends 1,200 miles between Seattle, Washington, and San Diego, California. This important north–south corridor carries the majority of freight flows between the Pacific Northwest and the Pacific Southwest, as well as Canadian and Mexican cross-border traffic. The primary highway route is Interstate 5. The major rail carrier along the I-5 Corridor is the Union Pacific. The Burlington Northern Santa Fe has a competing route, but certain segments (notably Bieber to Stockton and Bakersfield to Mohave) use trackage rights on the Union Pacific. San Diego is served only by BNSF.

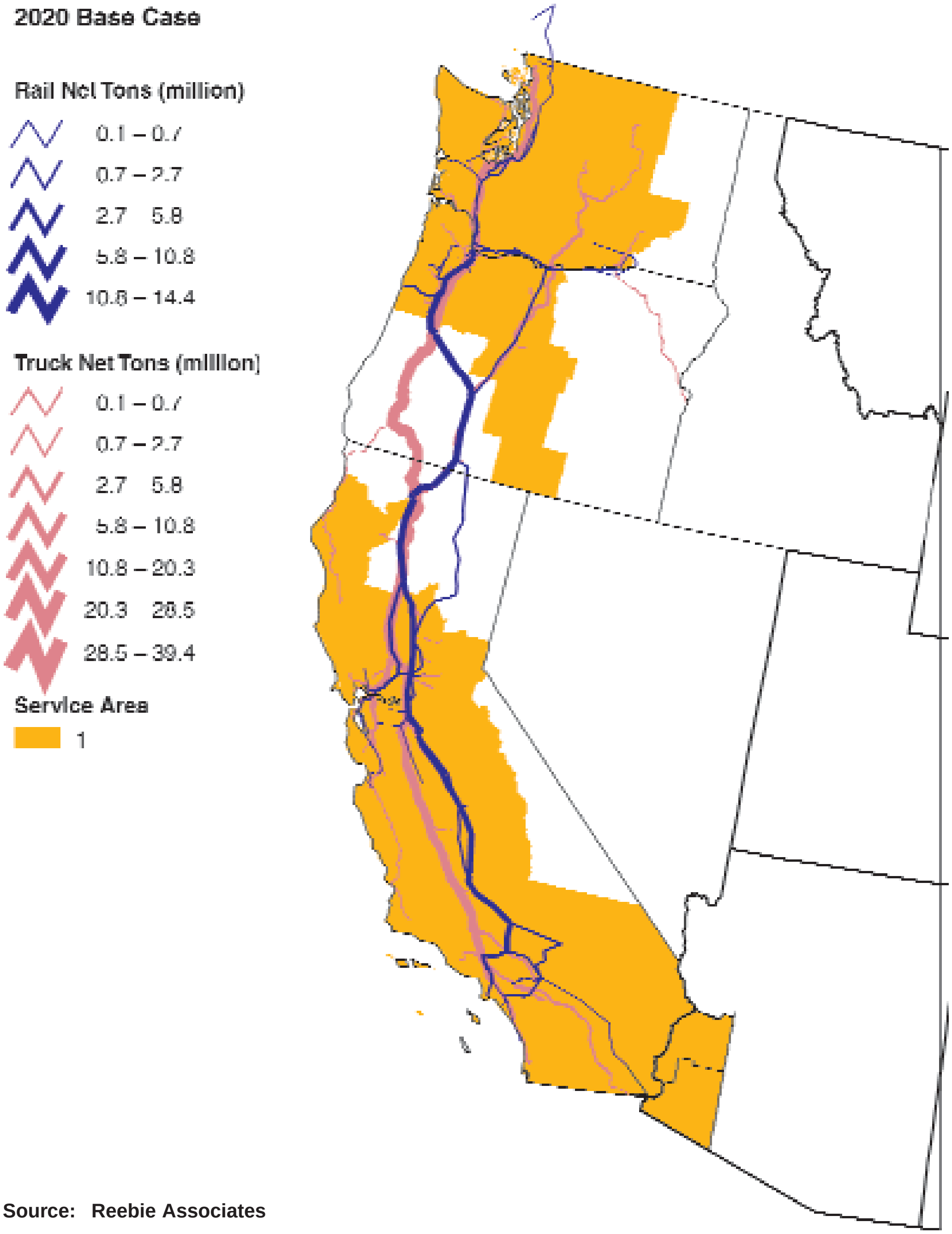
■ Modal Characteristics

By 2020, freight flows in this corridor will reach 57 million tons and over 52 billion ton-miles. Sixty-nine percent of tonnage and 72 percent of ton-miles will be by truck; 31 percent of tonnage and 28 percent of ton-miles will be by rail. Most of the rail traffic will be carload (18 percent of total tonnage), with seven percent intermodal, five percent international, and a negligible amount by unit train.

■ Commodity Flows

A diverse range of commodities move along the I-5 corridor — including food or kindred products, lumber and wood products, pulp and paper products, primary metal products, and farm products. Import/export traffic to and from Canada and Mexico accounts for 17 percent of total tonnage in the corridor. Rail's market share is strongest for pulp, mixed shipments, lumber, metal products, and chemicals, and is weakest for farm products.

Figure 48 I-5 Corridor Freight Flows



Source: Reebie Associates

Rail System Issues

Rail capacity along the I-5 Corridor is severely constrained due to California's mountainous terrain. East of Bakersfield, for example, a single track winds its way through the Tehachapi Mountains, up grades steeper than two percent. Not only is local traffic funneled through this narrow mountain pass, but also UP and BNSF traffic from the San Francisco Bay area and the central valley to the southeast. In Oregon, clearances for double-stack containers are lacking entirely. The Los Angeles to San Diego line is predominantly passenger service. Terminal facilities in all the metropolitan areas also must serve midwest and east coast traffic, and can be congested as a result.

Highway System Issues

I-5 is one of our nation's most heavily used routes for both automobile and truck traffic. Absent improvements, the Highway Performance Monitoring System projections of the year 2020 highway traffic for I-5 indicate level of service E and F for virtually the entire distance between San Diego and the bay area, as well as for metropolitan Portland and Seattle/Tacoma.

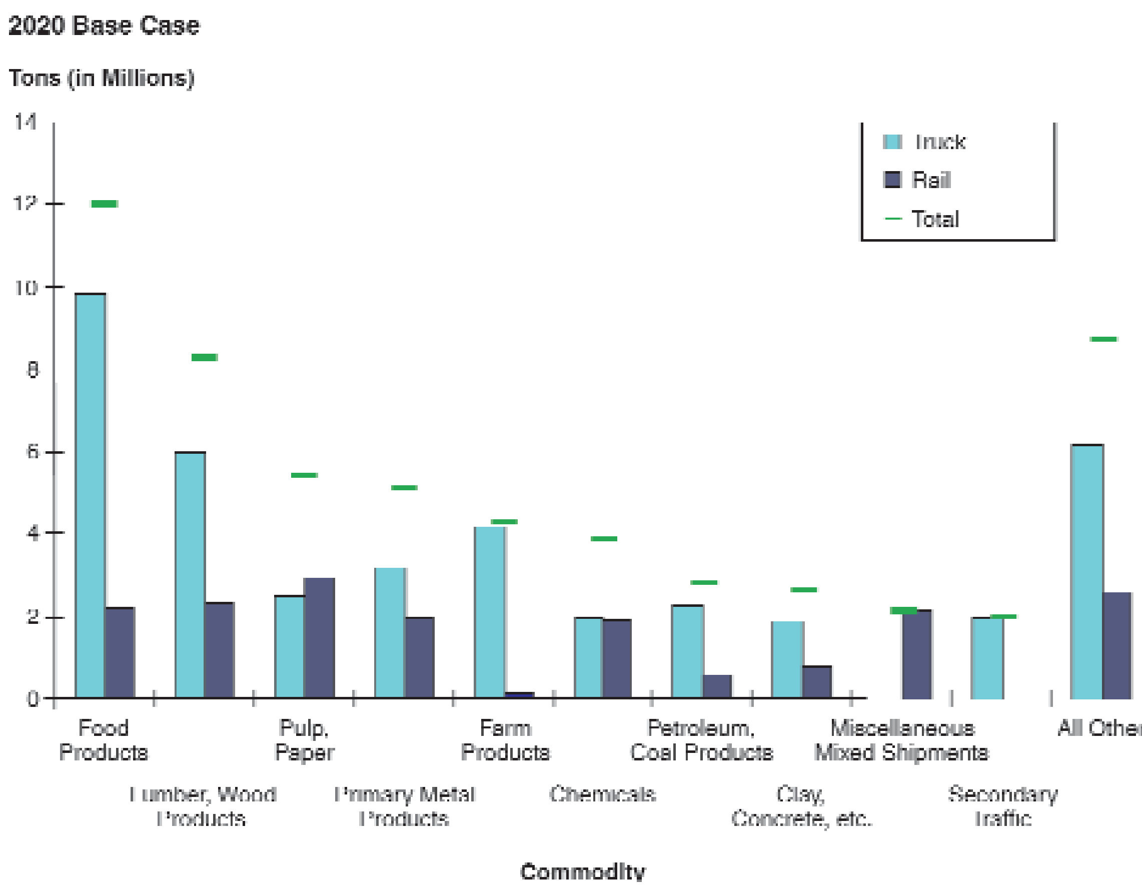
Intermodal Diversion Potential

The deteriorating condition of I-5 makes it even more imperative to consider strategies to improve the ability of the rail system to absorb freight traffic. The share of potential intermodal rail traffic actually captured by intermodal rail is 17 percent. While this is better than many corridors, the fact that the average length of a truck haul in the corridor is 936 miles — a distance at which rail intermodal is highly competitive with truck — suggests there is room to improve on this share.

Base Case Versus No-Growth Forecasts

Failing to achieve the base case forecast would reduce rail tonnage by up to 43 percent and increase truck tonnage by up to 19 percent between the selected origin-destination pairs. Truck traffic in the corridor would increase up to 6.3 billion ton-miles, or 451 million truck miles traveled, in the year 2020.

Figure 49. I-5 Corridor Tonnage by Commodity



Source: Reebie Associates

Table 20. I-5 Corridor Tonnage by Mode, 2020 Base Case

	Truck	Rail				
	All	Unit	Carload	Intermodal	International	Total
Tons (Mil) Share	39.8 69%	0.1 0%	10.6 18%	3.9 7%	3.0 5%	57.4 100%
Ton-Miles (Mil) Share	37,627 72%	14,810 28%				52,078 100%
Year 2000 Effect of "No-Growth" Instead of "Base Case" Scenario	+7.5 m Tons (+19%) +451 m VMT	– 7.5 m Tons (– 43%) – 6,313 m Ton-Miles				

Source: Cambridge Systematics and Reebie Associates

EXAMPLE 2 — SOUTHERN CALIFORNIA/NEW YORK/ NEW JERSEY VIA CHICAGO

This corridor extends 3,000 miles between Southern California and the New York/New Jersey metropolitan area via Chicago. This east–west corridor connects the nation's three largest metropolitan areas and its two largest port complexes. It handles much of the nation's intermodal rail traffic, and is a vital link in "landbridge" services between Asia and the Northeast/Mid-Atlantic region. The primary highway route is along Interstate 15 (from California to Utah), Interstate 70 (Utah to Colorado), Interstate 76 (Colorado to Nebraska) and Interstate 80 (Nebraska to New York/New Jersey). The UP and BNSF compete in the Southern California–Chicago corridor, and the NS and CSX compete in the Chicago–New York/New Jersey corridor. For through traffic between Southern California and New York/New Jersey, the eastern and western carriers cooperate.

Modal Characteristics

By 2020, freight flows in this corridor will reach 81 million tons and 135 billion ton-miles. Thirty-three percent of tonnage and 36 percent of ton-miles will be by truck; 67 percent of tonnage and 64 percent of ton-miles will be by rail. Most of the rail traffic will be intermodal (56 percent of total tonnage), with carload accounting for 10 percent and a negligible amount by unit train. Intermodal rail is clearly the dominant mode for freight moves between these origin–destination pairs.

Commodity Flows

Flows are dominated by miscellaneous mixed shipments, principally containerized goods of various kinds. These account for about three-quarters of the tonnage moving in the corridor. The remainder is a mix of food, chemicals, and various types of products. There is no cross-border traffic, but the flows include the landside component of import–export moves through the ports of Los Angeles/Long Beach and New York/New Jersey.

Rail System Issues

The crossing through Chicago has traditionally been a barrier in rail transportation. Smaller flows suffer significant delay in the interchange between western and eastern Class I railroads, either in yards or through the unloading and trucking of trailers across town. There has been significant recent investment to enhance service in this corridor, including: construction of the Alameda Corridor; triple-tracking of the UP in Nebraska; double-tracking of the CSX east of Chicago; and significantly upgraded NS intermodal terminals in Harrisburg and Bethlehem, Pennsylvania. The major constraints to growth in this service appears to be the capacity of, and truck access to, major intermodal terminals.

Highway System Issues

The I-15/70/76/80 route is forecast to operate at generally acceptable levels of service over much of its length, although it is forecast to operate at levels of service E and F as it passes through major metropolitan areas — Southern California, Denver, Chicago, Cleveland, and New York/New Jersey. This relatively good level of service is due at least in part to the fact that freight in this corridor is already heavily reliant on rail, rather than truck.

Intermodal Diversion Potential

This market has a concentration of appropriate commodities and length of haul that is more favorable to intermodal rail than any other corridor in the nation. The share of potential intermodal rail traffic actually captured by intermodal rail is 72 percent, which is extremely high, but further gains may be possible.

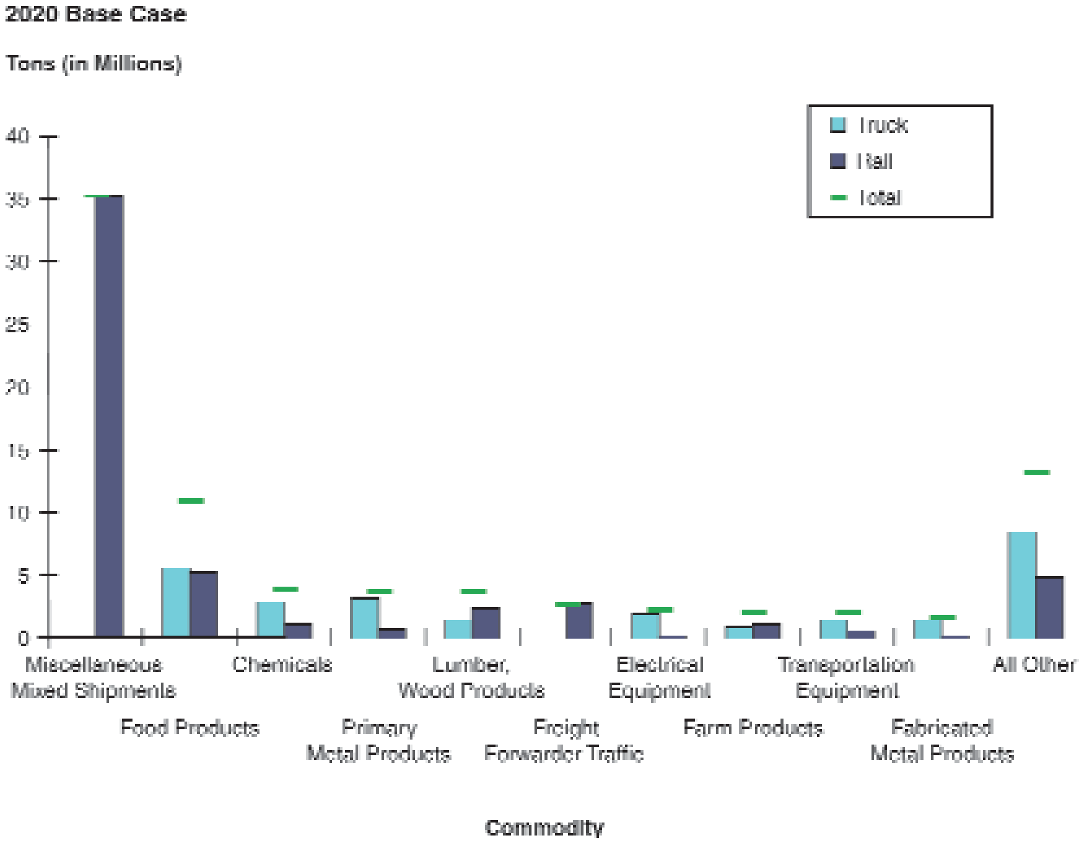
Base Case Versus No-Growth Forecasts

Failing to achieve the base case forecast would reduce rail tonnage by up to 38 percent and increase truck tonnage by up to 75 percent between the selected origin-destination pairs. Truck traffic in the corridor would increase up to 33 billion ton-miles, or 2,353 million truck miles traveled, in 2020.

Figure 50. Southern California/New York/New Jersey Corridor Freight Flows

2020 Base Case

Figure 51. Southern California/New York/New Jersey Corridor Tonnage by Commodity



Source: Reebie Associates

Table 21. Southern California/New York/New Jersey Corridor Tonnage by Mode, 2020 Base Case

	Truck	Rail				Total
	All	Unit	Carload	Intermodal	International	
Tons (Mil) Share	27.1 33%	0.0 0%	8.3 10%	45.4 56%	0.1 0%	80.9 100%
Ton-Miles (Mil) Share	48,255 36%	87,189 64%				135,444 100%
Year 2000 Effect of "No-Growth" Instead of "Base Case" Scenario	+20.3 m Tons (+75%) +2,353 m VMT	– 20.3 m Tons (38%) – 32,949 m Ton-Miles				

Source: Cambridge Systemics and Reebie Associates

EXAMPLE 3 — NORTHEAST/SOUTHEAST CORRIDOR

This corridor extends roughly 1,500 miles between Maine and Florida, and passes through the many of the nation's most urban centers — Boston; New York/New Jersey; Philadelphia; Baltimore, Washington, D.C.; Charlotte; Atlanta; Jacksonville; and Miami. It accommodates cross-border traffic with Canada and provides access to major international seaports up and down the coast. The primary highway routes are I-95 (Maine to Florida) and I-81 (New York to Virginia). A variety of other interstate highways provide vital connections to these corridors throughout New England, the Mid-Atlantic, and the Southeast. Rail service throughout the entire corridor is provided by the NS and the CSX, with portions also served by the CP and the CN. This analysis considers moves that originate in New England and Upstate New York and terminate in the Southeast, and vice versa. This is traffic that must run through the densely developed Mid-Atlantic corridor between New York City and Washington, D.C.

Modal Characteristics

By 2020, freight flows in this corridor will reach 37 million tons and 38 billion ton-miles. Seventy-four percent of tonnage and 74 percent of ton-miles will be by truck; 26 percent of tonnage and 26 percent of ton-miles will be by rail. Carload rail traffic accounts for 14 percent of total tonnage and international rail traffic for 10 percent, with a small amount of intermodal and unit train traffic.

Commodity Flows

Flows are very diverse, with no single type dominating. Leading commodity groups include lumber and wood products, clay/concrete/glass/stone, secondary traffic, pulp and paper products, and food. Major rail commodities include lumber and paper products and the clay used in their manufacture; these account for three-quarters of rail tonnage. Around 27 percent of the tonnage is cross-border NAFTA trade with Canada (principally lumber, pulp/paper, chemicals, and farm products). Commodity flows also reflect the landside distribution of import/export traffic through the international ports of Boston; Hampton Roads, VA; Charleston; Savannah; Port Everglades, Miami; and others.

Rail System Issues

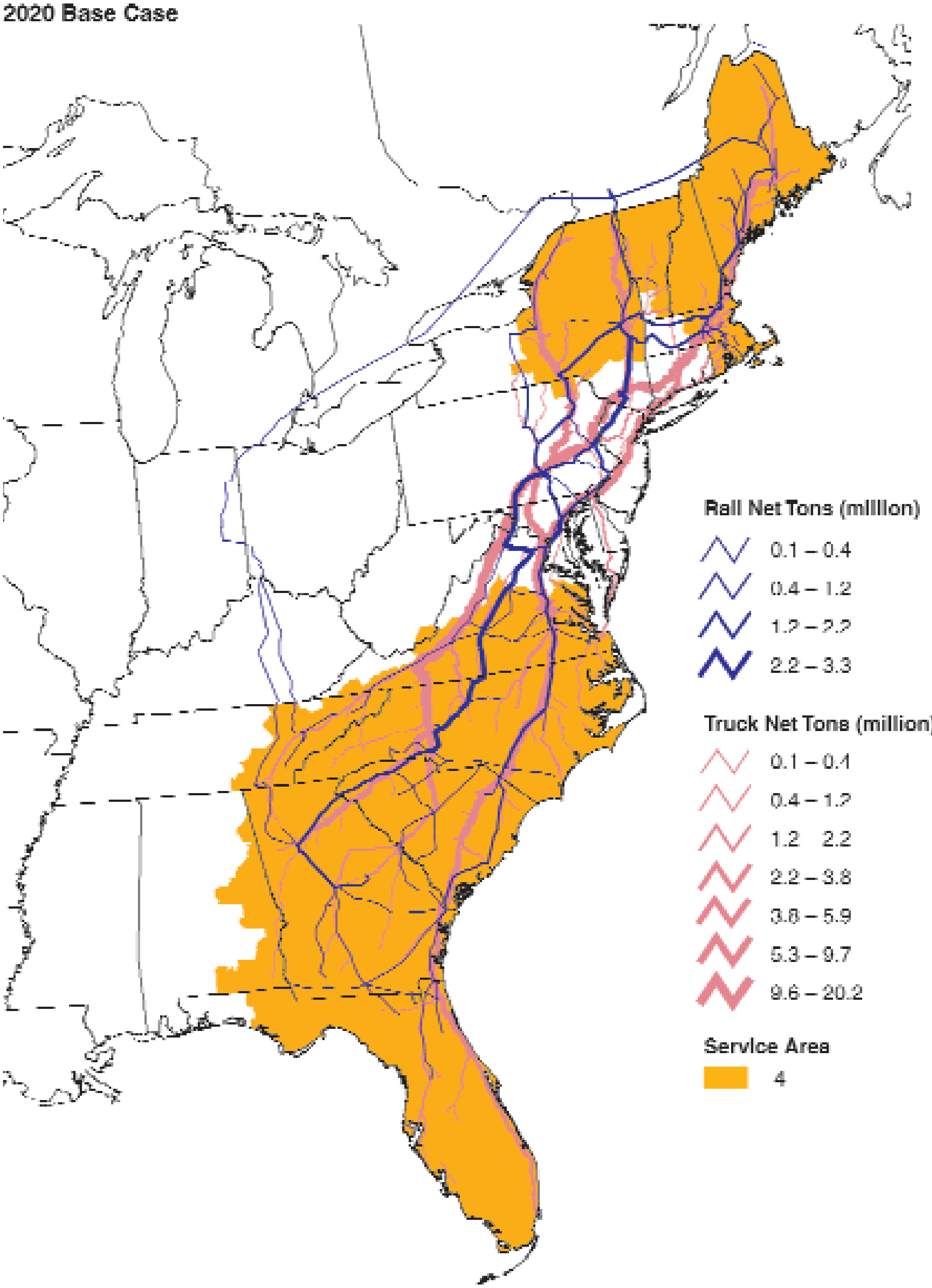
When Conrail was split up between NS and CSX, one of the benefits expected was single-carrier service between the northeast and the southeast. CSX, which directly serves upstate New York and New England, instituted train services running through Northern New Jersey, while Norfolk Southern assisted Canadian Pacific in upgrading its Sunbury-to-Scranton line in return for access to Albany and New England. While the expected rail diversions have not yet lived up to their promise, there are expectations of growth as the economy returns, but impeding this growth are some significant capacity constraints. Rail traffic between New England and the southeast must take a circuitous route through Albany due to the lack of Hudson River crossings further south. The CSX route passes through congestion in northern New Jersey and constricted tunnels under Baltimore, and shares trackage with Amtrak and commuter services (most significantly between Baltimore and Fredericksburg, Virginia). Norfolk Southern's route through the Shenandoah Valley is pure freight and avoids urban congestion, but is a single-line route through hilly terrain, with speed restrictions. The Mid-Atlantic rail operations study proposed a program of $6.2 billion in public and private investments to address these and other choke points affecting this corridor.

Highway System Issues

Both I-95 and I-81 are among the most heavily used truck routes in the country and are forecasted to be among the worst-performing in year 2020. Virtually the entire length of I-95 from Portland, ME, to the South Carolina state line is forecast to operate at levels of service E or F. Similarly, I-81

Figure 52. Northeast/Southeast Corridor Freight Flows

2020 Base Case



Source: Reebie Associates

is forecast to operate at levels of service E or F between the Pennsylvania Turnpike and the Tennessee state line, through the entire state of Virginia. This makes it critical to consider rail as a means of partially offsetting future truck traffic.

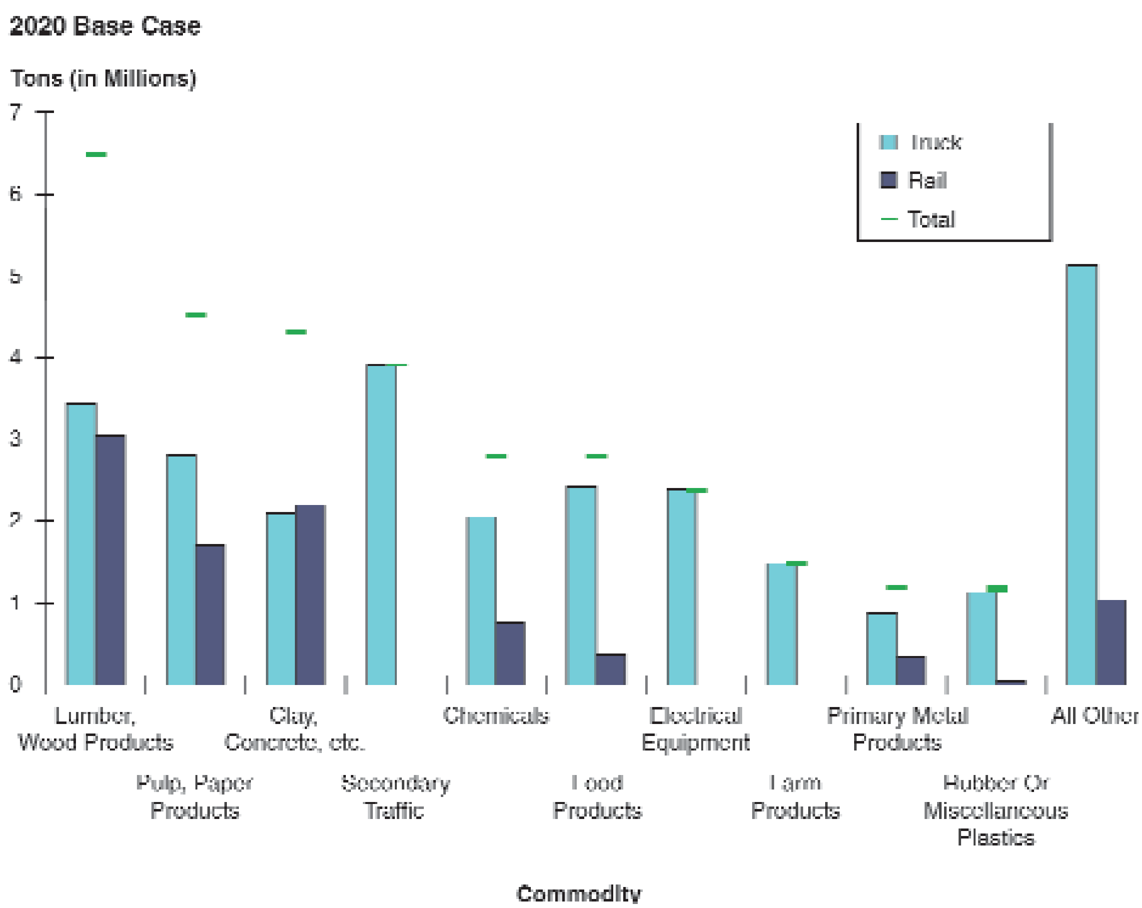
Intermodal Diversion Potential

The share of potential intermodal rail traffic actually captured by intermodal rail in this corridor is just two percent, which represents disappointing performance — especially compared to a highly developed intermodal service corridor like Southern California/New York/New Jersey, where this figure is 72 percent. Significant gains in intermodal rail's market share should be achievable, if appropriate infrastructure improvements are made.

Base Case Versus No-Growth Forecasts

Failing to achieve the base case forecast would reduce rail tonnage by up to 45 percent and increase truck tonnage by up to 15 percent between the selected origin-destination pairs. Truck traffic in the corridor would increase by up to four billion ton-miles, or 321 million truck miles traveled, in 2020.

Figure 53. Northeast/Southeast Corridor Tonnage by Commodity



Source: Reebie Associates

Table 22. Northeast/Southeast Corridor Tonnage by Mode, 2020 Base Case

	Truck	Rail				
	All	Unit	Carload	Intermodal	International	Total
Tons (Mil) Share	27.7 33%	0.1 0%	5.2 14%	.03 1%	3.8 10%	37.2 100%
Ton-Miles (Mil) Share	28,024 74%	10,052 26%				38,076 100%
Year 2000 Effect of "No-Growth" Instead of "Base Case" Scenario	+4.3 m Tons (+15%) +321 m VMT	– 4.3 m Tons (45%) – 4,496 m Ton-Miles				

Source: Cambridge Systemics and Reebie Associates

EXAMPLE 4 — POWDER RIVER BASIN

This corridor extends from the low-sulfur coal fields of the Powder River Basin in northeastern Wyoming to power plants throughout the Midwest and South. In the 1980s, Chicago North Western (in cooperation with Union Pacific) and then Burlington Northern built access lines to the coal fields. The Dakota and Minnesota and Eastern is well on the way to passing all regulatory (though not necessarily capital) hurdles to build another line from the upper Midwest. Parallel highway service is provided by I-25 through Wyoming, I-80 through Nebraska, and a variety of interstate and state highways fanning out east and south of Nebraska. The volumes of coal now flowing from this region represent the single largest rail market in the country, and a steady stream of 13,000-ton trains flow out of Wyoming around the clock. This traffic is expected to grow as more power plants east of the Mississippi switch away from higher-sulfur Appalachian Coal.

Modal Characteristics

By 2020, freight flows in this corridor will reach 418 million tons and 362 billion ton-miles. Sixteen percent of tonnage and nine percent of ton-miles will be by truck; 84 percent of tonnage and 91 percent of ton-miles will be by rail. Unit trains will represent 81 percent of these moves by tonnage, with carload accounting for three percent and a negligible amount of intermodal and international traffic.

Commodity Flows

Coal moving by unit train is the dominant commodity, with modest amounts of other commodities moving by truck or rail.

Rail System Issues

Because of the volume and profitability of this market, there are no significant rail capacity constraints. From the building of the Powder River line, to triple tracking where the corridor shares assets with transcontinental flows, to upgrading of lines to handle 287,000-pound and 315,000-pound cars, the railroads have made the necessary investments.

Highway System Issues

Most of the highways paralleling these rail services are forecasted to experience acceptable levels of service. Notable exceptions include: I-70 between Kansas City and St. Louis; I-80 through eastern Iowa; I-35 through Dallas and central Texas; and metropolitan Minneapolis, Chicago, and Memphis.

Intermodal Diversion Potential

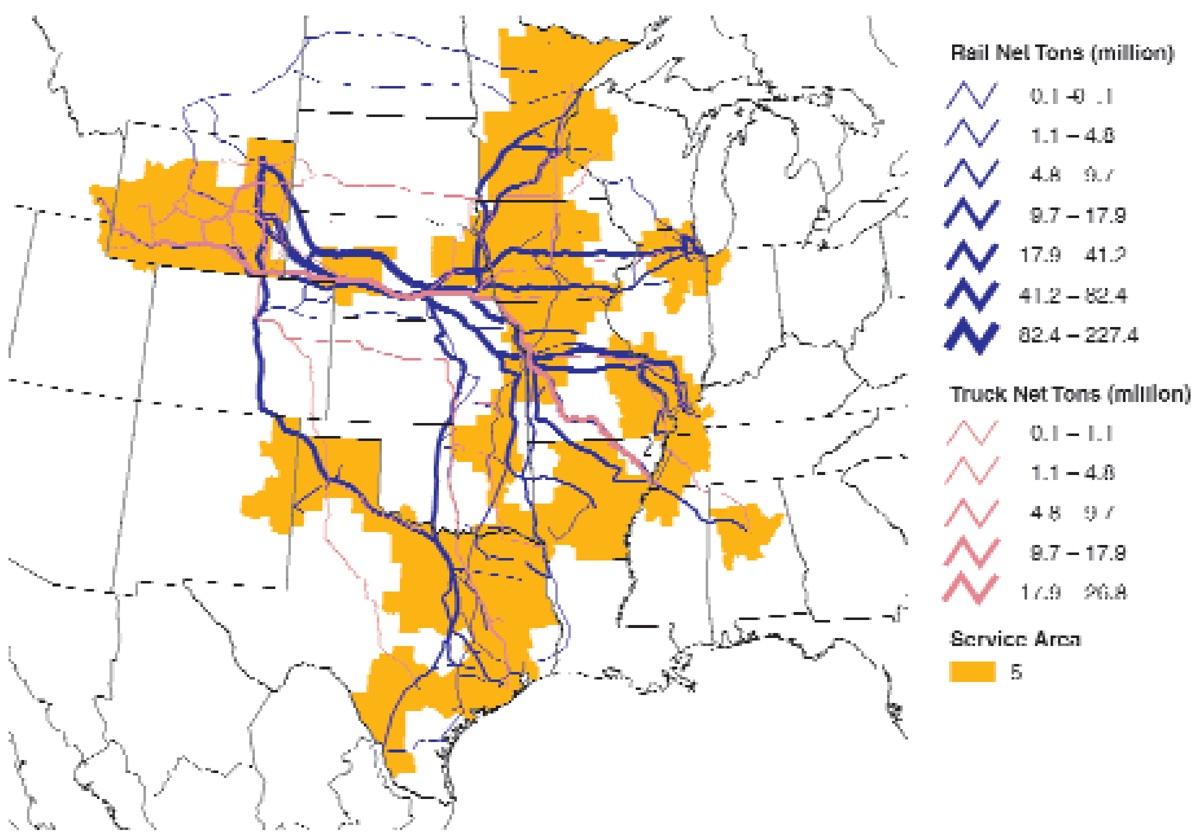
The share of potential intermodal rail traffic actually captured by intermodal rail in this corridor is just two percent, which represents poor performance. However, the intermodal market is a small piece of business compared to the coal traffic. Clearly, the primary benefit of this corridor is that it provides cost-effective rail transportation from the coal fields while keeping heavy bulk-carrying trucks off the road.

Base Case Versus No-Growth Forecasts

Failing to achieve the base case forecast would reduce rail tonnage by up to 17 percent and increase truck tonnage by up to 86 percent between the selected origin-destination pairs. Truck traffic in the corridor would increase by up to 55 billion ton-miles, or 3,908 million truck miles traveled, in 2020.

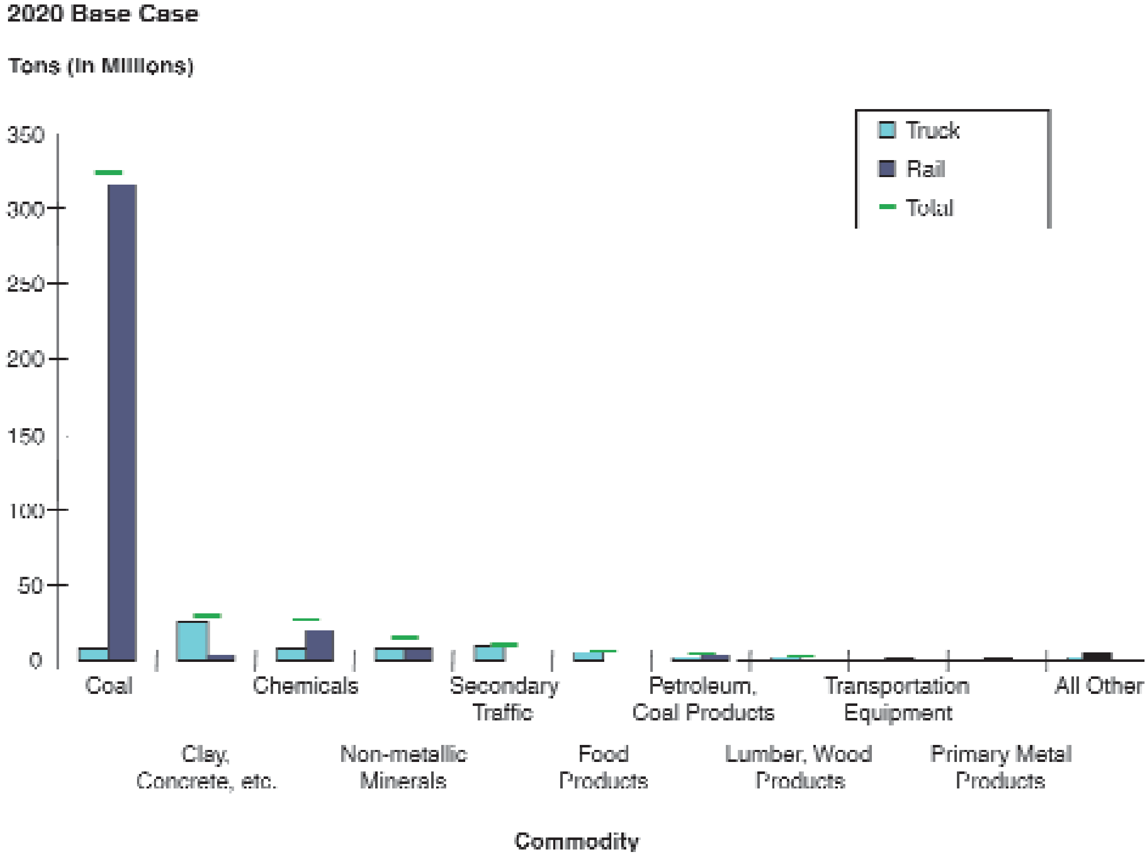
Figure 54. Powder River Basin Freight Flows

2020 Base Case



Source: Reebie Associates

Figure 55. Powder River Basin Tonnage by Commodity



Source: Reebie Associates

Table 23. Powder River Basin Tonnage by Mode, 2020 Base Case

	Truck	Rail				
	All	Unit	Carload	Intermodal	International	Total
Tons (Mil) Share	67.4 16%	336.3 81%	13.9 3%	0.1 0%	0.0 0%	417.7 100%
Ton-Miles (Mil) Share	32,800 9%	329,416 91%				362,217 100%
Year 2000 Effect of "No-Growth" Instead of "Base Case" Scenario	+58.2 m Tons (+86%) +3,908 m VMT	– 58.2 m Tons (–17%) – 54,716 m Ton-Miles				

Source: Cambridge Systematics and Reebie Associates

EXAMPLE 5 — DETROIT TO MEXICO

This corridor extends from the automobile manufacturing facilities of Detroit to the Texas/Mexico border. As auto-related manufacturing has as expanded in Mexico, their supply chains have been integrated with Michigan-based parts suppliers. Rail service is provided by multiple carriers. Union Pacific has a direct route in Laredo, Texas, and cooperates with Norfolk Southern and CSX with run-through services east of St. Louis. Burlington Northern Santa Fe also connects with the eastern carriers, and participates with RoadRailers connecting to Norfolk Southern's Triple Crown Network. Canadian National, through its alliances with KCS and others, provides access from Halifax to Mexico City. However, both the BNSF and KCS routes depend on trackage rights over Union Pacific for significant portions of their routes. The corresponding highway route from Detroit to the border is: I-94 in Michigan; I-69 through Michigan and Indiana; I-70 through Indiana and Illinois; I-55 through Illinois, Missouri, and Arkansas; I-40 and I-30 through Arkansas; and I-35 through Texas.

Modal Characteristics

By 2020, freight flows in this corridor will reach 16 million tons and 27 billion ton-miles. Forty-eight percent of tonnage and 48 percent of ton-miles will be by truck; 52 percent of tonnage and 52 percent of ton-miles will be by rail. International trains will represent 49 percent of these moves by tonnage, with three percent by carload and a negligible amount of intermodal and unit train.

Commodity Flows

Transportation equipment moving by rail and truck is clearly the dominant commodity move, with a mix of other lower-volume commodity types. About 84 percent of tonnage is generated by international trade moves.

Rail System Issues

Capacity is limited at border crossing points, in the Houston terminal area, and at the interchanges between the Eastern and Western carries (with the exception of the Union Pacific run-through trains at Salem and Saint Elmo). The corridor shares assets with the chemical flows from the Gulf Coast and transcontinental flows in the east.

Highway System Issues

Levels of service E and F are forecasted for portions of I-35 in Texas, as well as metropolitan Memphis, Indianapolis, and Detroit.

Intermodal Diversion Potential

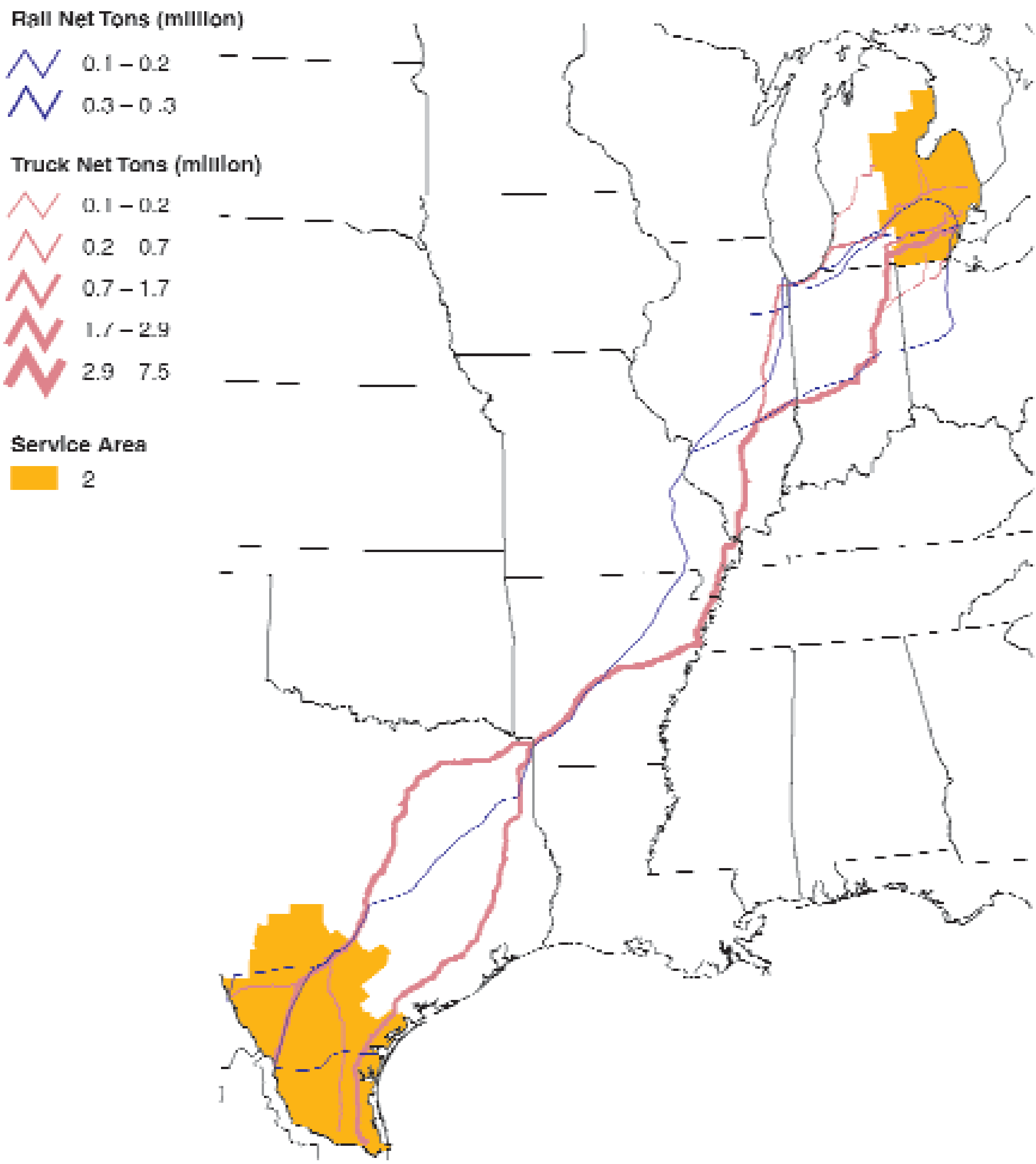
The share of potential intermodal rail traffic actually captured by intermodal rail in this corridor is barely above zero percent, which represents poor performance. However, this excludes international traffic, which is the major generator of rail and truck traffic. The primary concern is clearly to serve this international trade.

Base Case Versus No-Growth Forecasts

Failing to achieve the base case forecast would reduce rail tonnage by up to 31 percent and increase truck tonnage by up to 33 percent between the selected origin-destination pairs. Truck traffic in the corridor would increase by up to 4.3 billion ton-miles, or 306 million truck miles traveled, in 2020.

Figure 56. Detroit-to-Mexico Freight Flows

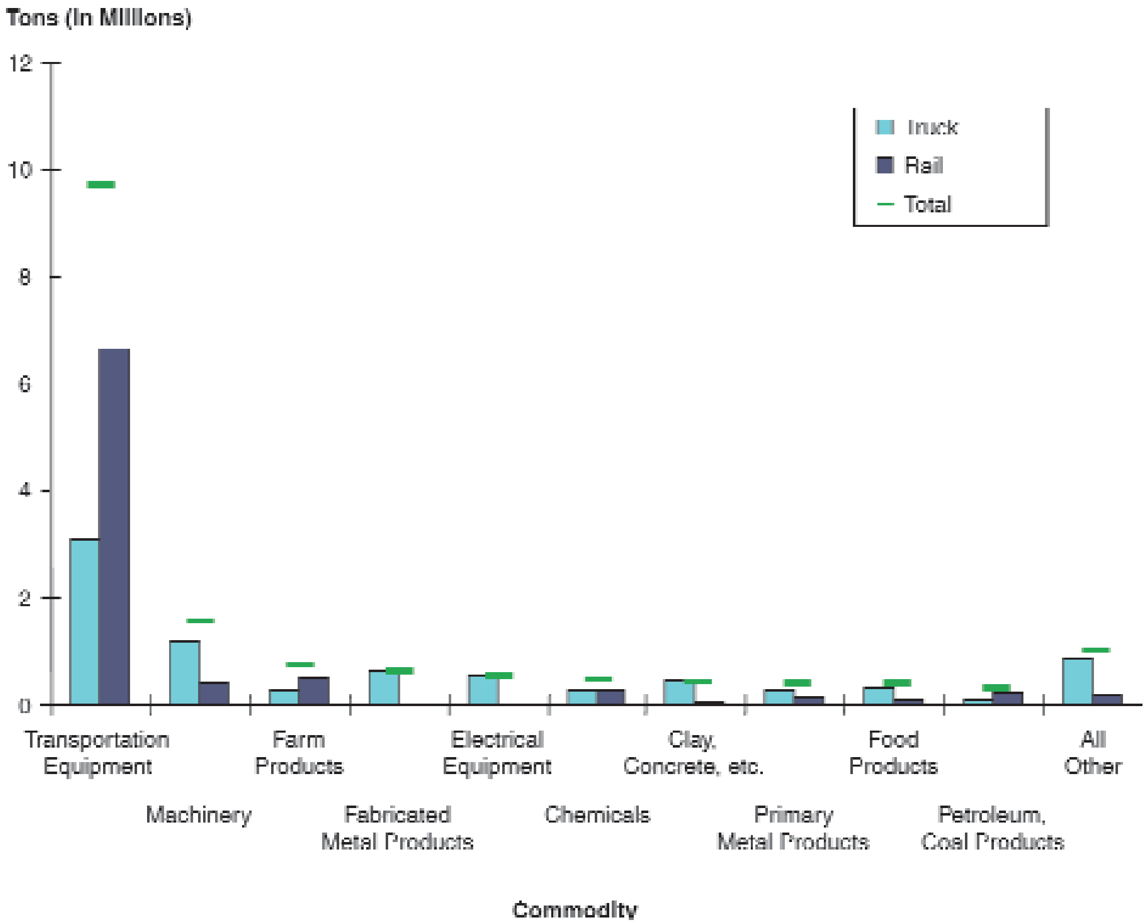
2020 Base Case



Source: Reebie Associates

Figure 57. Detroit-to-Mexico Tonnage by Commodity

2020 Base Case



Source: Reebie Associates

Table 24. Detroit-to-Mexico Tonnage by Mode, 2020 Base Case

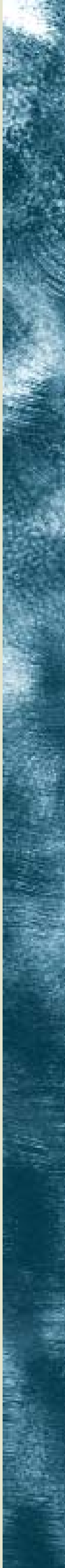
	Truck	Rail				Total
	All	Unit	Carload	Intermodal	International	Total
Tons (Mil) Share	7.9 48%	0.0 0%	0.4 3%	0.0 0%	8.1 49%	16.4 100%
Ton-Miles (Mil) Share	12,715 48%	13,822 52%				26,537 100%
Year 2000 Effect of "No-Growth" Instead of "Base Case" Scenario	+2.6 m Tons (+33%) +306 m VMT	– 2.6 m Tons (– 31%) – 4,282 m Ton-Miles				

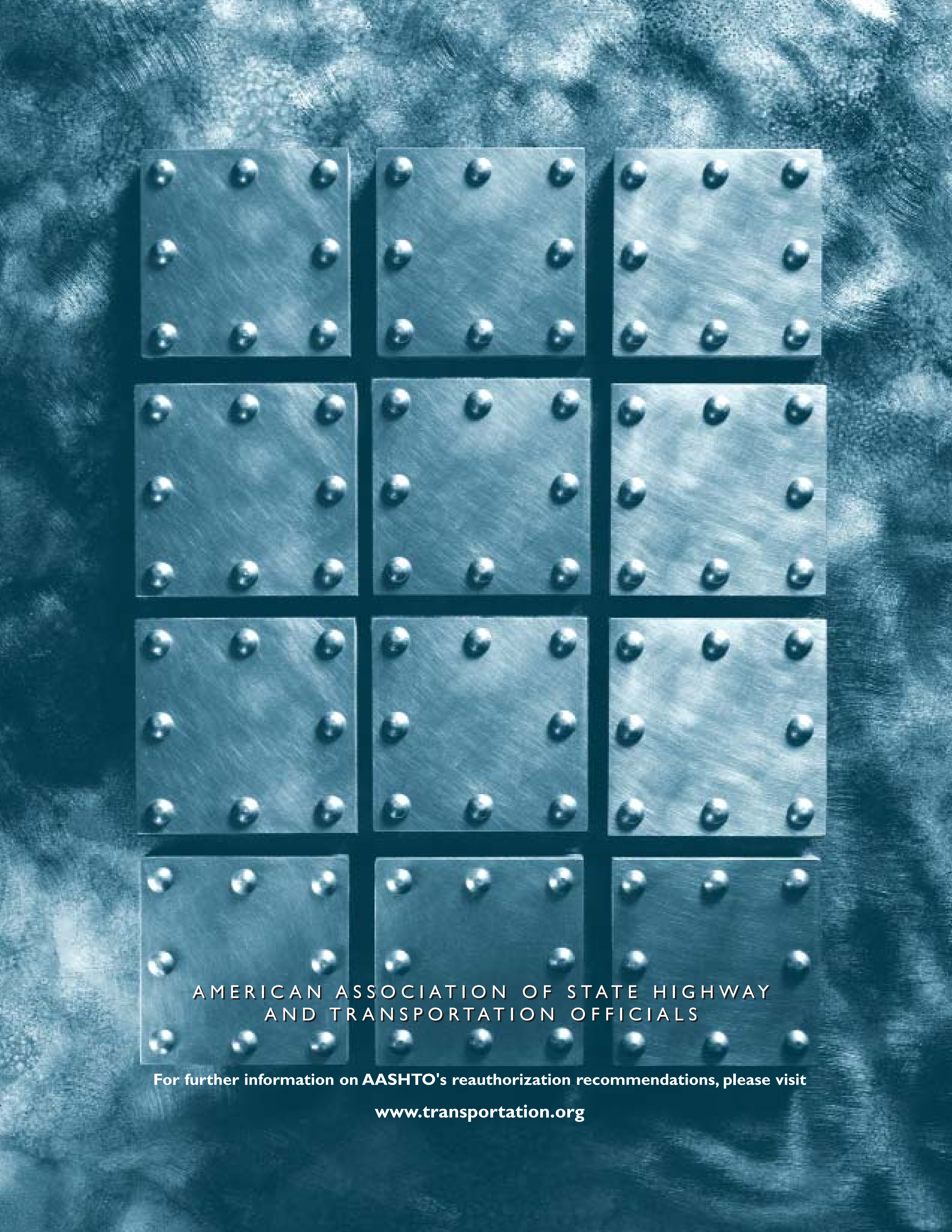
Source: Cambridge Systematics and Reebie Associates

APPENDIX F

ENDNOTES

1. This first approximation of freight-rail needs likely understates both the costs and the benefits. A comprehensive national assessment of freight-rail needs, comparable with highway and transit needs assessments, does not exist.
2. James M. McPherson, *The Battle Cry of Freedom: The Civil War Era*. Oxford University Press, New York and Oxford, 1988, p. 11.
3. Reebie Associates TRANSEARCH data and U.S. Department of Transportation Freight Analysis Framework Project.
4. Reebie Associates TRANSEARCH data and U.S. Department of Transportation Freight Analysis Framework Project.
5. IANA Rail International Traffic Report, Fourth Quarter 2001.
6. Technically, a landbridge runs from port to port and links two marine movements. The example described is actually a "mini-landbridge," but this distinction is often dropped in practice.
7. Reebie Associates TRANSEARCH data and U.S. Department of Transportation Freight Analysis Framework Project.
8. American Association of Railroads.
9. American Association of Railroads.
10. HERS is a simulation model that can estimate the benefits and costs of highway investments on the federal-aid highway system, currently 958,000 miles of roadways that serve most of the nation's traffic. HERS uses benefit-cost analysis to determine the most cost-effective investments to make for a sample of highway segments that are representative of the highways in each state. HERS evaluates several types of highway improvements for each segment, including pavement rehabilitation, roadway widening, and reconstruction. HERS aggregates its estimates of improvement costs and various user-benefit measures to all federal-aid highways. HERS can provide estimates of the costs of highway programs to maintain or reduce current user costs, to maintain or reduce travel-time costs, or to make all economically justified investments. HERS utilizes the Highway Performance Monitoring System (HPMS) data sets prepared by the states. The HPMS data include current and forecast information that indicate highway conditions, capacity, and vehicle-miles-of-travel. HERS is used by the United States Department of Transportation as the basis for its reports to the U.S. Congress on highway investment needs.
11. Don Schneider of Schneider National, quoted in *trafficWORLD*, 11/19/01.
12. American Association of Railroads.
13. Testimony before the Surface Transportation Board 3/7/2000, quoted in TRANSLOG, May 2000.
14. Carl Martland, *Journal of the Transportation Research Forum*, Vol. 38, No. 1, 1999.
15. Federal Highway Administration.
16. Eno Foundation.
17. American Association of Railroads.
18. American Association of Railroads.
19. ITS projects must be valued at over $30 million to qualify for a TIFIA loan.





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www.transportation.org