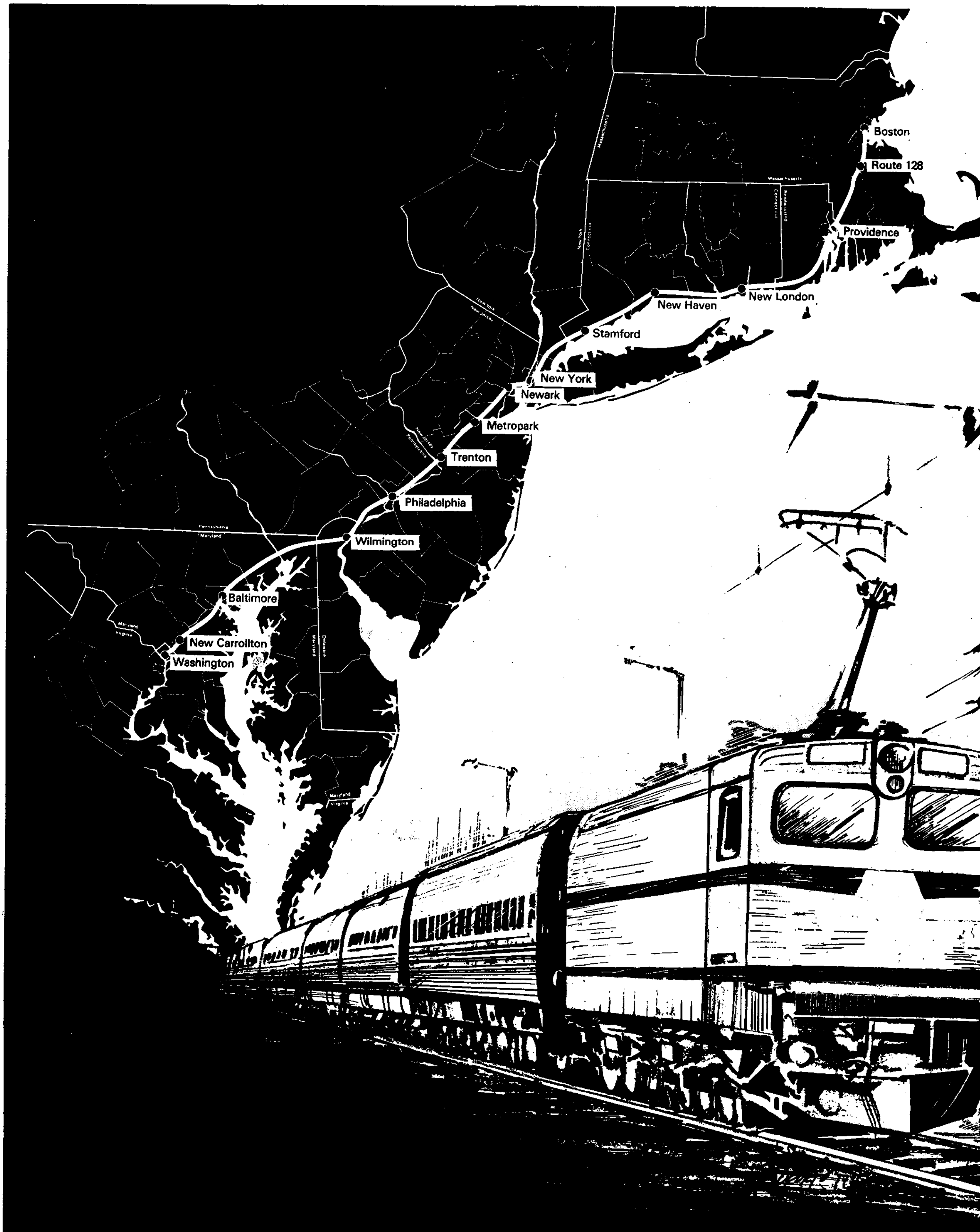
TWO-YEAR REPORT ON THE NORTHEAST CORRIDOR



U.S. DEPARTMENT OF TRANSPORTATION
FEBRUARY 1978

TWO-YEAR REPORT MANDATE

The following is an extract from Railroad Revitalization and Regulatory Reform (4R) Act of 1976, PL 94–210.

Section 703. The Northeast Corridor Improvement Project shall be implemented by the Secretary in order to achieve the following goals:

(1) *Intercity Rail Passenger Services. . .*

(E) Within 2 years after the date of enactment of this Act, the submission by the Secretary to the Congress of a report on the financial and operating results of the intercity rail passenger service established under this section, on the rail freight service improved and maintained pursuant to this section, and on the practicability, considering engineering and financial feasibility and market demand, of the establishment of regularly scheduled and dependable intercity rail passenger service between Boston, Massachusetts, and New York, New York, operating on a 3-hour schedule, including appropriate intermediate stops, and regularly scheduled and dependable intercity rail passenger service between New York, New York, and Washington, District of Columbia, operating on a 2 1/2-hour schedule, including appropriate intermediate stops. Such report shall include a full and complete accounting of the need for improvements in intercity passenger transportation within the Northeast Corridor and a full accounting of the public costs and benefits of improving various modes of transportation to meet those needs. If such report shows (i) that further improvements are needed in intercity passenger transportation in the Northeast Corridor, and (ii) that improvements (in addition to those required by subparagraph (A) (i) of this paragraph) in the rail system in such area would return the most public benefits for the public costs involved, the Secretary shall make appropriate recommendations to the Congress. Within 6 years after the date of enactment of this Act, the Secretary shall submit an updated comprehensive report on the matters referred to in this subparagraph. Thereafter, if it is practicable, the Secretary shall facilitate the establishment of intercity rail passenger service in the Corridor which achieves the service goals specified in this subparagraph.

SUMMARY AND CONCLUSIONS

The Two-Year Report on the Northeast Corridor (NEC) analyzes the Northeast Corridor Improvement Project (NECIP), a major public investment in improved intercity rail passenger transportation service between Boston, Mass., and Washington, D.C. The report presents the results of the National Railroad Passenger Corporation (Amtrak) operations in the NEC in 1976 and 1977, describes the physical components supporting NECIP service goals, and discusses Amtrak projections for the NEC during the period of construction. The balance of the report establishes and applies a conceptual framework for comparing service options after NECIP completion, describes the social and economic implications and public costs and benefits of still further improvements in NEC transportation beyond the NECIP, and evaluates possible rail responses to such additional transportation needs.

GENERAL PERSPECTIVES

The Federal investment in rail passenger facilities in the NEC is very large. It includes both a large investment in capital facilities owned by Amtrak and a substantial commitment to Federally financed commuter rail facilities owned by local transit authorities from Boston to Washington, D.C. In addition to this huge capital investment, the Federal Government provides millions of dollars annually in operating subsidies to Amtrak for intercity rail operations and in Urban Mass Transportation Administration subsidies for commuter operations along the NEC. As for freight, the Consolidated Rail Corporation (Conrail), which operates over Amtrak NEC trackage, has received Federal loans and other financial assistance. These massive Federal investments are justified not only by the high-population density and ridership levels — both present and projected — along the NEC, but also by the rail network's important economic benefits to the northeastern region of the country.

To protect the Federal investment in rail passenger and freight transportation and to guarantee the system's future economic performance, all these facilities must be operated in a coordinated fashion. There must be due regard for the specialized goals and needs of each separate service, but there must also be a recognition of the interdependence created by the facilities themselves. Thus, if future transport in the NEC is to reach its full potential, intercity, commuter, and rail freight transportation improvements should be coordinated to reinforce each other, to insure that the investments made in the NEC bring optimum benefits to the intercity traveler, the commuter, and the shipper.

This represents a considerable change in the concept of the NECIP. Most of the constituent elements, such as track work, electrification, and maintenance facilities, are certain to be a part of the final improvements; but there will be some changes in NEC planning that will place a greater emphasis on service to users and on the resolution of potential conflicts between intercity, passenger, commuter, and freight operations.

Funds for improving rail passenger service in the NEC are limited, and there is no assurance at this time that there will be any increase in the NEC budget beyond the $1.75 billion already authorized. Nevertheless, current planning will assure that the doors are not closed on future options.

To achieve substantial completion of the NECIP by February 1981, original NECIP planning was carried out under the assumption that project funding would peak at slightly over $600 million in FY 1979, with the remainder of the total authorization to be budgeted for FY 1980. In developing a detailed program plan for FY 1979, however, it became evident that selected project elements, such as vehicle maintenance facilities, signaling, train control, and electrification, would substantially benefit from further coordination with user agencies, including Amtrak, Conrail, and commuter operators. Accordingly, these elements will be delayed, with FY 1979 track, bridge, and tunnel work proceeding on schedule, and grade-crossing eliminations accelerating within the $455 million called for in President Carter's FY 1979 budget. This action has two additional implications for NECIP. First, the completion date for portions of the NECIP construction will be delayed, although the introduction of some service meeting the trip-time goals is still a possibility by 1981. The prolonged NECIP construction activities will also result in higher costs; however, this delay is necessary to insure that the NECIP decisions do not adversely affect the other NEC users.

COMPARISON OF ALTERNATIVE NEC OPERATIONS AFTER NECIP COMPLETION

This report examines, at varying cost and demand levels, a range of individual options for intercity passenger train service, type of equipment, and fare structures. Since the range of some of these variables requires further definition, more detailed examination is necessary before final decisions are made. Nevertheless, the work performed so far provides valuable indications of the significance of each variable studied.

Each option, with variations, was subjected to financial analysis based on demand forecasts, capital cost assumptions, and operating cost-estimating relationships to give a yearly surplus or deficit. A net present value calculation measured the total results for the period until the year 2000.

IMPROVEMENTS IN INTERCITY PASSENGER TRANSPORTATION

The report examines the direct and indirect social, economic, and environmental costs of expanding various modes to bring about intercity transportation improvements.

Intense urban development surrounding existing airport sites, environmental and financial constraints, and citizen opposition make significant airport expansion problematical. The same factors would limit the development of any new airport system. Development of new or expanded highways would be similarly expensive and involve substantial environmental and community impacts. Costs for constructing the 452-mile I-95 in the NEC have averaged $6.5 million per mile, and for sections in urban areas, the costs are considerably higher. The general public has displayed a marked resistance in recent years to building new transportation facilities as opposed to improving and fully utilizing existing facilities. The rail mode in the NEC offers the most potential for improved utilization to accommodate substantial increases in travel demand.

The NECIP will lead to an improved rail mode within an integrated transportation system; moreover, in conjunction with improved management of existing airports and highways, improved rail service will help to alleviate the congestion, environmental degradation, and social costs associated with transportation. Consistent with national policies on energy conservation, environmental quality, and urban development, rail improvements coordinated with other modes will contribute in a socially beneficial manner to the revitalization of urban centers — both physically, through upgraded stations, and economically, through intensified commercial activity in the vicinities of the stations. Intercity rail improvements will afford many groups a convenient opportunity to travel and give them greater choice among modes. Thousands of productive jobs and many contracting opportunities in the Northeast, including work opportunities for minority groups, will also be provided through investment in intercity rail.

Some gains in rail ridership in the NEC have occurred over the past 7 years, but as the public perceives major improvements in convenience, frequency, reliability, comfort, and reduced travel time, rail patronage is expected to increase substantially. By 1990, at least twice as many intercity riders are likely to be carried each year as in 1977.

POSSIBLE RAIL IMPROVEMENTS BEYOND THE NECIP

In addition to the work authorized under the NECIP, rail improvements in three categories may merit consideration as future transportation needs become apparent.

The first group comprises potential "post-NECIP improvements" that would offer still higher levels of system capacity, operating economy, and passenger service quality without affecting scheduled running times significantly. These possible additional investments have not been included in the NECIP because preliminary studies have indicated that they would return fewer benefits for the costs involved than the items included in the program. Nevertheless, ongoing engineering economy studies within the NECIP could conceivably lead to some interchange between the NECIP and the potential post-NECIP improvements exemplified in this report.

The second group includes measures required to meet the possible further reduction in trip times specified in the Railroad Revitalization and Regulatory Reform (4R) Act: 3 hours, Boston to New York; 2 hours, 30 minutes, New York to Washington, D.C. Such reductions could be achieved in several ways, separately or in combination: service options alone; additional fixed-plant investments; or tilt-body vehicles. A financial analysis of these alternatives has been performed.

The third group comprises possible items of work on the feeder lines — the Inland Route (Boston—New Haven via Springfield), Albany—New York City, and Harrisburg—Philadelphia.

CONCLUSIONS

- When the NECIP is complete, the success of NEC operations will depend on the rail service options offered, the cost levels achieved, and the sophistication with which schedules and fare levels are manipulated to provide the best combination of ridership and revenues within each of the rail markets.

- If NEC transportation demand develops so as to require additional capacity, selected improvements to the rail system beyond the NECIP would appear to offer a socially beneficial and environmentally sound approach to expansion of intercity capacity, as compared to air and highway expansion.

- During the NECIP construction period, it will be essential to minimize the delays and congestion to all services using the NEC. To this end, the Operations Review Panel, established under section 702 of the 4R Act of 1976, should be employed fully to resolve any problems arising out of the diverging interests of freight, commuter, and intercity passenger operations. In addition, the establishment of a steering group representing all major rail transport interests in the NEC is underway under the chairmanship of the Federal Railroad Administrator.

- Funding of NECIP fixed-plant components and of Amtrak vehicle purchases is fragmented. All related capital investment programs for the intercity service should be considered together and funded in a compatible manner to encourage and reflect comprehensive economic analysis. Moreover, Federal investments in commuter facilities and services along the NEC require coordinated planning and funding with the intercity improvements to achieve optimal solutions and full flexibility of passenger movement.

- In accordance with section 704(c) of the 4R Act, all transportation programs related to the NEC should be examined to insure integration and consistency with the implementation of the NECIP.

• The sample financial comparisons in this report yield the following conclusions.

(1) In a given year, there is a wide range between the low cost projections (based on consultants' studies) and the high cost projections (based on current Amtrak experience). In most cases, this range tips the balance between an operating surplus and a deficit.

(2) On the basis of the variables included in this analysis, comparisons among service options and between Metroliner and non-Metroliner equipment alternatives are not conclusive. The equipment decisions would appear to depend more on such factors as NECIP completion schedules, equipment acquisition leadtimes, passenger comfort, and relative wear-and-tear on the track.

(3) The demand forecasting model indicates that the fare elasticity of the NEC rail services is low. Thus, overall financial results would improve as average fare levels increase and would worsen as average fare levels decrease, and more passengers choose rail. This conclusion suggests that the joint objectives of profitability and maximum ridership require a sophisticated fares policy. Such a policy is now in the early stages of development.

• The alternatives evaluated show a wide range of financial achievement according to cost and demand assumptions. Some cover operating costs immediately or within a few years, while others remain in deficit. Nevertheless, all options show improvement in the net annual financial position year by year.

• Since prudent public policy requires accurate projections of possible future subsidy requirements, every element of the forecasting methodology developed for this report deserves careful scrutiny, amplification, and refinement. For example, there is an urgent need for detailed market analysis to establish a firm base for ridership and revenue projections under a wide variety of service options. Also, the range of operating and maintenance costs must be narrowed to reflect accurately the cost levels that will prevail on the NEC after NECIP completion.

• The financial analysis of alternatives to achieve further trip-time improvements as required by the 4R Act suggests that a fixed-plant-intensive approach would be costly. If the tilt vehicle is proven technically feasible, it would achieve the trip-time goals and thus warrant closer examination as a possible alternative.

• The feeder lines via Springfield, from Albany and from Harrisburg, serve important centers of population, contribute somewhat to travel on the NEC main line, and may lend themselves to incremental levels of improvement. The same analytical approach applied in this report to the NEC main line should be used for the feeder lines so that fixed facility and service upgrading options can be compared.

• It is essential to determine the shortest schedule for introducing into service a new lightweight, high-speed locomotive and the annual rate at which it could be produced. Only then will it be possible to specify and to select from the full range of fleet composition alternatives for the NEC to be ready for operation on the completed NECIP.

Actions taken on the basis of the above conclusions would enable Amtrak and the Department of Transportation to establish NEC operations on a sound economic footing while providing improved service to the widest possible cross-section of the traveling public.

CONTENTS

CHAPTER 1. INTRODUCTION

The purpose of this report is not only to fulfill the explicit requirements of the Railroad Revitalization and Regulatory Reform Act but also to provide the Congress and the public with a solid conceptual framework for establishing national policy toward Northeast Corridor (NEC) transportation investments. While the rail mode receives particular attention, the economic, social, and environmental costs and benefits of improving all modes of transportation in the NEC are evaluated.

The report uses the following approach. In chapter 2, the financial results and performance of National Railroad Passenger Corporation (Amtrak) NEC operations in 1976 and 1977 are presented. These results provide a glimpse of the present rail passenger system in the NEC, the base upon which the improvements are to be built. Chapter 3 describes the elements of the Northeast Corridor Improvement Project (NECIP). Chapter 4 contains projections of ridership, revenues, performance, and operating results for the NEC operation in fiscal years 1978 through 1982. Since the NECIP is not merely a construction project but also—and principally—an integrated, federally sponsored transportation service improvement program, chapter 5 describes rail passenger service options over a completed NECIP system.

Such service options appear solely for the purpose of establishing bases for analyses that explore what the return on the significant public investment in the NEC will be. Although some of those options reflect current Amtrak thinking, they should not be construed either as guarantees of future service, or as limitations on the scheduling or fare-setting freedom of the operator. Instead, service options are presented as examples to highlight rail policy questions. The financial results of NEC service options after NECIP completion are also projected in order to permit a comparison and to provide a baseline against which to evaluate the financial feasibility of possible further improvements in trip-time and service levels.

Chapter 6 discusses the needs for improvements in intercity passenger transportation in the NEC in the years 1982 to 1990 and the economic and social costs and benefits of improving various modes of transportation to meet those needs. This section also evaluates the potential rail patronage (market demand) that forms the basis for the rail economic projections and the social and economic benefits and costs of the NECIP and possible further improvements.

Chapter 7 examines conceivable improvements beyond NECIP to achieve still further system capacity, operating economy, and passenger service quality as well as to effect the 3-hour (Boston—New York) and 2 1/2-hour (New York—Washington, D.C.) trip times suggested by Congress. There is more than one way to further reduce trip times; this section presents these methods from an engineering viewpoint and then presents a net present value summation for these options. Finally, opportunities to upgrade the feeder lines to Harrisburg, Albany, and Springfield are discussed.

Appendix A discusses the effect of NECIP on freight service.

CHAPTER 2.
NEC EXPERIENCE IN RECENT YEARS

OVERVIEW OF TRAFFIC OPERATIONS AND TRENDS

The Northeast Corridor (NEC) from Boston, Mass., to the District of Columbia is the most densely populated region in the United States, with six major metropolitan areas of more than 2 million people each, including New York with more than 9 million people in its Standard Metropolitan Statistical Area. Fourteen percent of the U.S. population is concentrated in this region on only 2 percent of the land.

Although it encompasses only 2 percent of the National Railroad Passenger Corporation (Amtrak) nationwide track system, the NEC provides nearly 60 percent of the passenger-trips and 30 percent of the passenger-miles traveled on Amtrak trains. Almost 12 percent of the intercity trips in the NEC are by rail as compared to only about 1 percent in the Nation as a whole. Figure 2–1 depicts the traffic density on the NEC main line, showing the mix of freight, commuter, and intercity trains. Figure 2–2 shows the distribution of intercity trips among transportation modes.

Ten years ago, the intercity passenger service on the NEC between Boston, New York, and Washington, D.C., had reached an all-time low in schedule frequency, service, and ridership. Since the inception of the Metroliner in 1969 and the formation of Amtrak in 1971, there has been a marked and well-maintained increase in patronage, as shown in table 2–1.

The Metroliner high-speed service between New York and Washington, D.C., originally undertaken as a demonstration project, continues to attract substantial riders even though conventional locomotive-hauled trains are gaining passengers lost in the early days to the Metroliners. Ridership of the conventional trains continues to increase, primarily because trains have been equipped with new Amfleet cars, and their on-time performance is more dependable than the Metroliners. North of New York, the modest experiment with high-speed turbo trains was not successful, mainly because of equipment failures, infrequent service, and poor on-time performance. However, following the introduction of new fare policies adopted by Amtrak in the early 1970's, traffic north of New York is rising year by year.

OPERATING RESULTS, FY 1976-FY 1977

On April 1, 1976, the same day that the rail properties of Penn Central and other bankrupt roads reorganized by the U.S. Railway Association were conveyed to the Consolidated Rail Corporation (Conrail), the NEC right-of-way previously owned by Penn Central was conveyed to Amtrak. Amtrak's assumption of these properties required the assumption of new responsibilities for train dispatching of intercity passenger, freight, and commuter services and maintenance of the NEC right-of-way, and the increase of the total number of Amtrak employees.

OPERATIONS

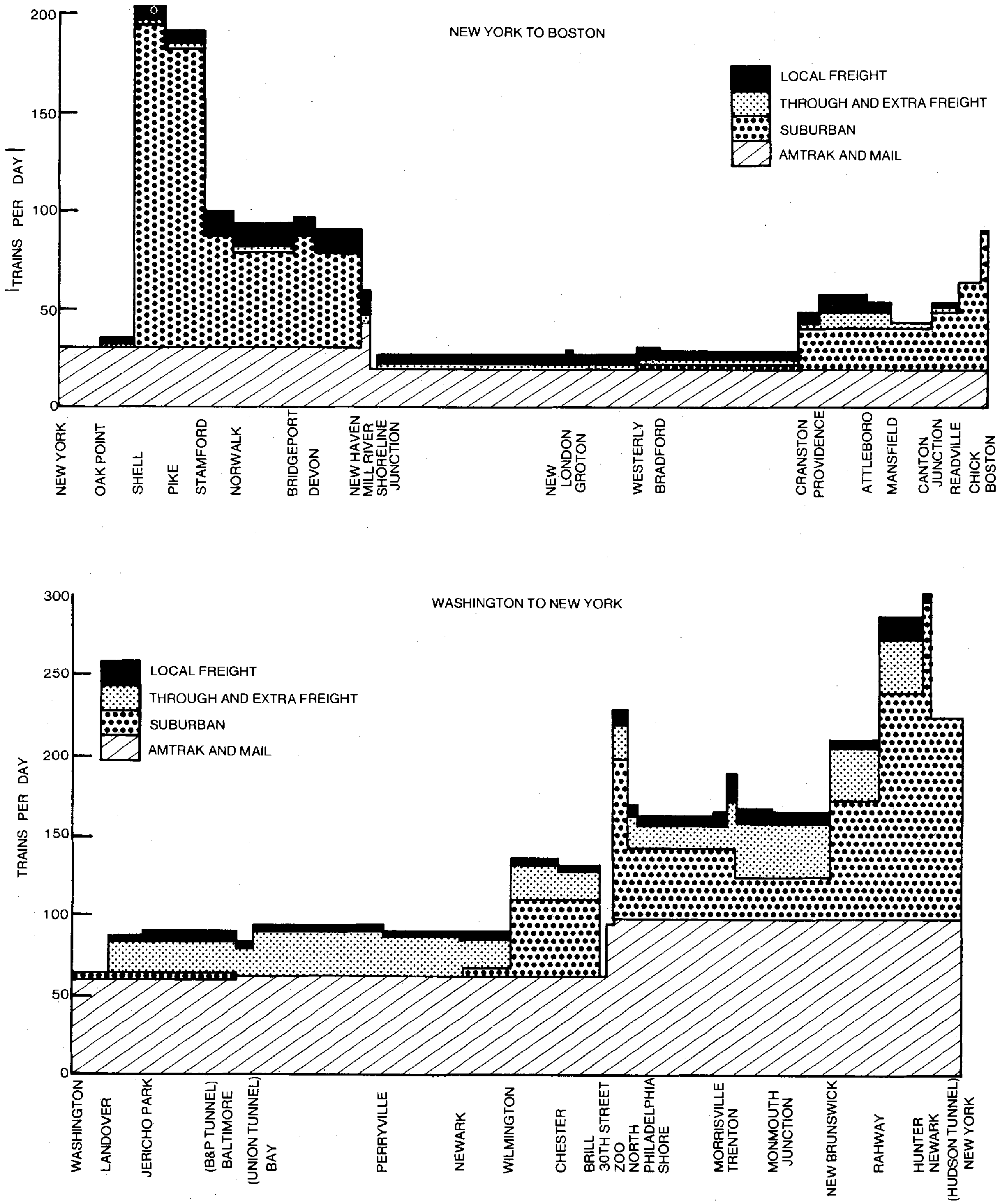
Train frequencies (the number of trains scheduled) are heavier along the NEC than along any other segment of railway in the country. In the Washington, D.C., to New York market, Metroliner service is offered hourly on weekdays between 6 a.m. and 7 p.m.; locomotive-hauled trains operate hourly at peak travel hours and otherwise at about 2-hour intervals beginning early in the morning and continuing throughout the day until 10 p.m. Additional locomotive-hauled train frequencies are offered between Philadelphia and New York, primarily during commuting hours. Frequencies on the New York to Boston run are markedly less than in the southern portion of the NEC. All service in this market uses locomotive-hauled equipment and is scheduled at 2-hour intervals, with many trains continuing through New York or originating south of New York.

Conventional train-miles were up slightly, but, for Metroliners, this index showed a decline attributable to the cuts in frequency (see table 2–2).

Capacity on the Metroliner service was affected by very poor availability. Monthly averages show about one-third of the cars out of service.

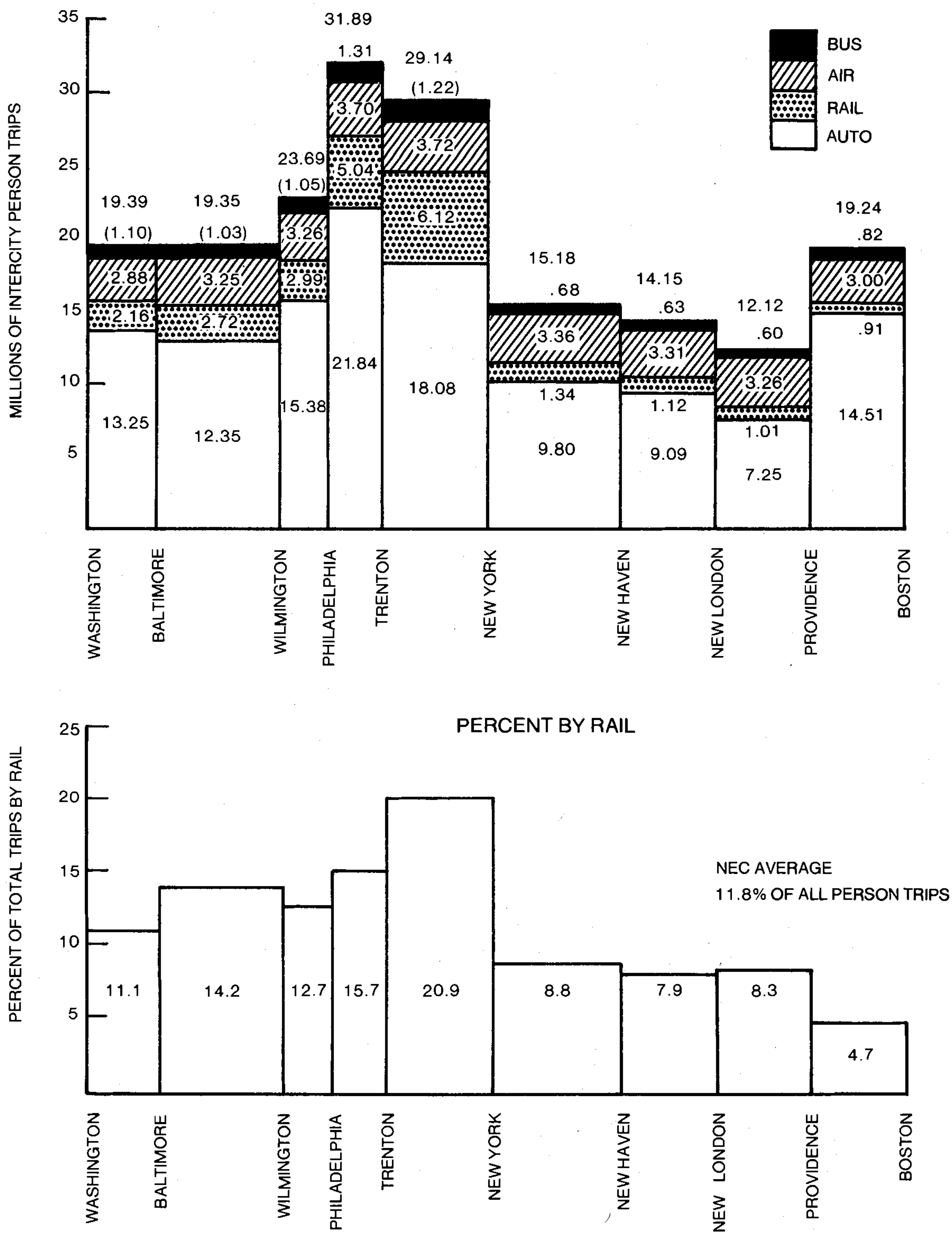
ON-TIME PERFORMANCE

On-time performance is an important factor for public acceptance and selection of a travel mode.



SOURCE: Department of Transportation, NECIP Draft Programmatic Environmental Impact Statement, Vol. 1, p. 1-24, Aug. 1977.

FIGURE 2-1. RAIL TRAFFIC DENSITY ON THE NEC, 1974.



SOURCE: Department of Transportation, Federal Railroad Administration, Planning and Analysis Division, unpublished projections of intercity travel demand in the NEC, May 1977.

FIGURE 2-2.1975 TOTAL INTERCITY PERSON-TRIPS BY ALL MODES (TOP) AND PERCENT BY RAIL (BOTTOM).

TABLE 2-1. NEC RIDERSHIP IN TWO KEY CITY-PAIRS, 1968-1976
(Thousand)

Year	Washington—New York/Newark			Boston—New York	Total
	Metroliner	Conventional	Total	Total	
1968	NA	576	576	339	[a]915
1969	255	558	812	308	1,120
1970	388	339	727	256	983
1971	452	268	720	219	939
1972	547	307	854	346	1,200
1973	585	396	980	456	1,436
1974	668	497	1,165	634	1,799
1975	600	470	1,070	574	1,644
1976	547	671	1,218	595	[a]1,813

[a]change from 1968-1976 = plus 98%.
NOTE: NA = not applicable.
SOURCE: Department of Transportation, Federal Railroad Administration, Staff Paper, Examination of Ten Years of Air-Train Data in the Boston to New York Passenger Market, May 1977.

TABLE 2-2. NEC PASSENGER TRAIN-MILES
(Thousand)

Type	FY 76	FY 77	Net change (%)
Metroliner	2,262	2,011	-11.1
Conventional	4,199	4,265	1.6
Total	6,461	6,276	-2.9

SOURCE: Northeast Corridor Office.

For Metroliners, arrivals within 15 minutes of published schedules occurred less than half the time and for conventional trains, less than 8 trips in 10.

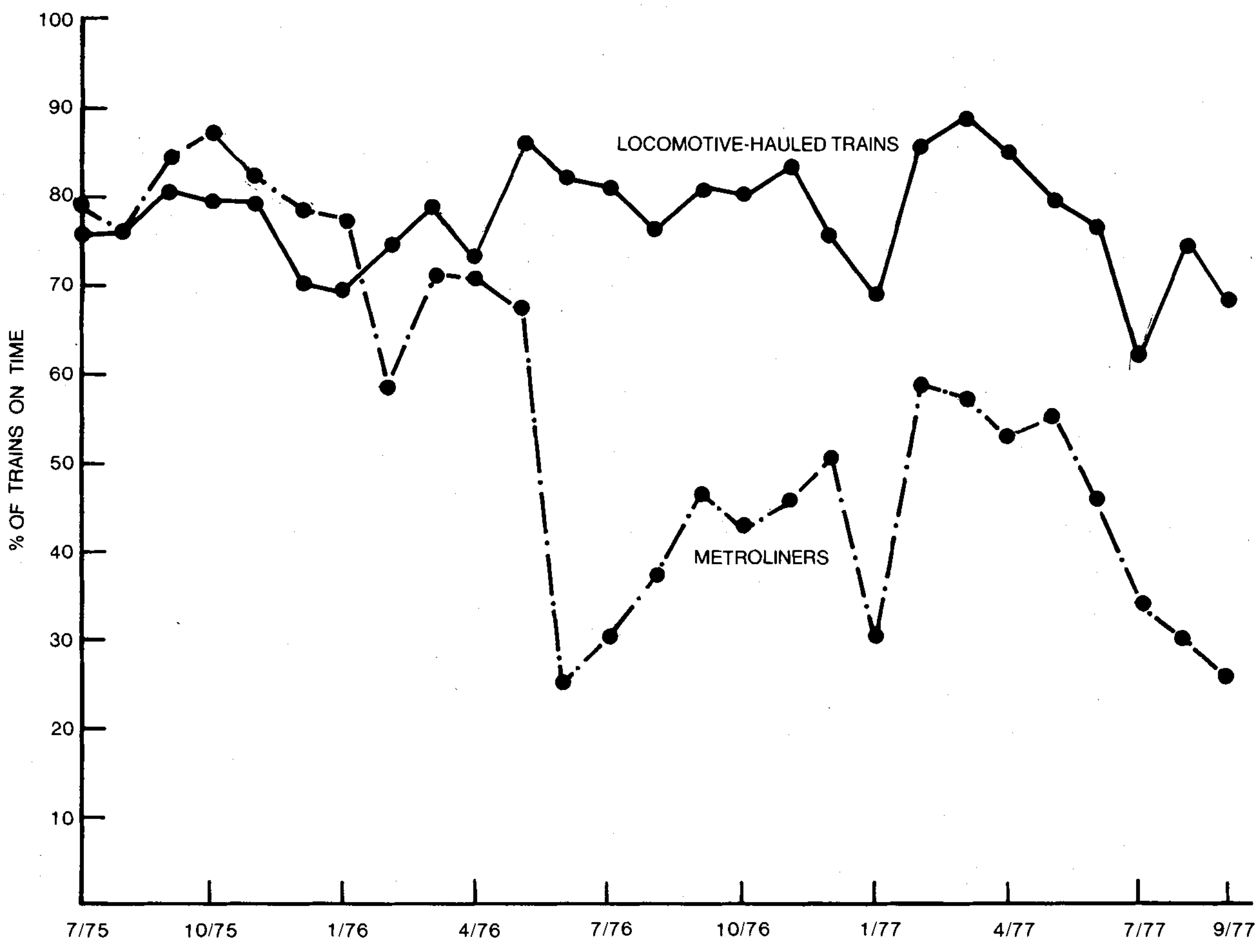
During April and May 1976, Amtrak imposed speed restrictions, for safety reasons, over major track segments between Washington, D.C., and New York. In most instances, speeds were limited to 80 mph, not a significant constraint on conventional trains that rarely exceeded such speeds, but a severe restriction on the Metroliners. Prior to the restrictions, Metroliners had traveled at speeds in excess of 100 mph over much of the track. The restrictions covered 185 miles of track, nearly double the speed-restricted mileage imposed by Penn Central, the previous owner of the NEC. The increased number of restrictions were necessary for Amtrak to correct track deficiencies that had developed as a result of poor maintenance under past ownership. As a consequence of slow orders, Metroliner on-time performance dropped to 25 percent for June 1976. Figure 2–3 portrays NEC on-time performance in 1976–77.

With only 25 percent of the Metroliners arriving on time, in contrast to the nearly 75 percent that had arrived on time during the 3 months immediately preceding June 1976, ridership fell off immediately. Patronage data for the transition quarter and for total FY 1977 show steady decline in spite of some recent, albeit modest, improvement in train on-time performance.

FINANCIAL RESULTS, FY 1976-FY 1977

Table 2–3 presents a summary of operating and financial results of Amtrak NEC service in FY 1976 and 1977, both in actual and constant prices. In FY 1977, 400,000 more passengers were carried than in 1976. Conventional trains accounted for the increase, counterbalancing a 5-percent decrease in Metroliner patronage. Passenger-miles were up 8 percent over the period. On the average, the passenger in FY 1977 traveled a greater distance than did the passenger in FY 1976.

At constant 1977 dollars, overall revenue decreased slightly, and this has been more than offset by the reduction in costs. As a result, the deficit per passenger-mile was reduced by 1 cent, and the operating ratio improved significantly.



SOURCE: Amtrak On-Time Performance Reports.

FIGURE 2-3. NEC ON-TIME PERFORMANCE TRENDS, FY 1976 THROUGH FY 1977.

TABLE 2-3. OPERATING AND FINANCIAL SUMMARY OF AMTRAK NEC SERVICE, FY 1976 and 1977

Category	FY 1976 (FY 1976$)	FY 1976 (FY 1977$)	FY 1977 (FY 1977$)
Statistics:			
Passengers (millions):			
Metroliner	2.2	2.2	2.1
Conventional	7.1	7.1	7.6
Total	9.3	9.3	9.7
Passenger-miles (millions):			
Metroliner	321.7	321.7	295.1
Conventional	730.9	730.9	852.7
Total	1,052.6	1,052.6	1,147.7
Train-miles: (millions)			
Metroliner	2.26	2.26	2.01
Conventional	4.20	4.20	4.27
Total	6.46	6.46	6.28
Revenue (million $):			
Metroliner	40.1	42.1	36.9
Conventional	47.4	49.8	51.5
Total	87.5	91.9	88.4
Total operating costs (million $):			
Metroliner	53.8	58.4	49.8
Conventional	111.1	120.5	122.7
Total	164.9	178.9	172.5
Surplus/deficit on operating costs (million $):			
Metroliner	-13.7	-16.3	-12.9
Conventional	-63.7	-70.7	-71.2
Total	-77.4	-87.0	-84.1
Derivatives:			
Operating ratio:			
Metroliner	134	139	135
Conventional	234	242	238
Total	188	206	195
Revenue/passenger-mile ($):			
Metroliner	.125	.131	.125
Conventional	.065	.068	.060
Total	.083	.087	.077
Revenue/train-mile ($):			
Metroliner	17.74	18.63	18.36
Conventional	11.29	11.86	12.06
Total	13.54	14.22	14.08
Operating costs/passenger-mile ($):			
Metroliner	.167	.181	.169
Conventional	.152	.165	.144
Total	.157	.170	.150
Operating costs/train-mile ($):			
Metroliner	23.81	25.84	24.78
Conventional	26.45	28.69	28.74
Total	25.53	27.69	27.47
Surplus/deficit/passenger-mile ($):			
Metroliner	-.042	-.050	-.044
Conventional	-.087	-.097	-.084
Total	-.074	-.083	-.073

SOURCES: Amtrak Five-Year Plans for 1976 and 1977. Interstate Commerce Commission, *Effectiveness of the Act.*

CHAPTER 3.
NECIP DESCRIPTION

As set forth in the Railroad Revitalization and Regulatory Reform (4R) Act of 1976, the Northeast Corridor Improvement Project (NECIP) must create a dependable train service linking Boston to New York in 3 hours, 40 minutes, and linking New York to Washington, D.C., in 2 hours, 40 minutes, with appropriate intermediate stops in each segment.

Like any major publicly funded transportation enterprise, NECIP must be a prudent investment; it must maximize revenue and ridership by providing passengers with a high quality of service in trains and at stations; at any given ridership level, it must likewise minimize operating and maintenance costs through judicious selection of capital projects. This chapter describes the physical improvements undertaken by NECIP and summarizes progress thus far. The Annual Report to Congress under section 703(1)(D) of the 4R Act contains further details on NECIP progress to date.

PROGRAM CONTENTS

The 4R Act set a Federal funding limit of $1.75 billion for improvements to the NEC main line rail system. This amount was the total of two subcategories: (1) improvements to be fully federally funded up to a limit of $1.6 billion, and (2) an additional $150 million of Federal funds available to match each State/local dollar committed to nonoperational station improvements and right-of-way fencing. Within that authorization, substantial improvements to the physical plant of Northeast Corridor (NEC) will take place.

The following is a description of the capital improvements currently proposed by the Federal Railroad Administration (FRA) for the NECIP. The project as a whole still has the status of a proposal; no irreversible decision or commitment of resources will be made until applicable environmental laws have been complied with. Moreover, the Draft Implementation Master Plan, upon which this description is based, is subject to change as detailed engineering work provides new insight into the economic justification of proposed program elements.

TRACK

The NECIP would rehabilitate or upgrade most of the track between Boston and Washington, D.C. The upgraded tracks must adhere to rigorous geometrical tolerances to assure complete safety and a high level of riding comfort. Improvement work on NEC track structures would include the following major items.

- Replacement of jointed rail with continuous welded rail on designated high-speed passenger tracks
- Track undercutting and ballast cleaning
- Tie replacement and track surfacing with wood ties or concrete ties, as appropriate
- Improved shoulders and drainage
- Renewal of turnouts and switch ties in interlockings where slow orders are currently imposed
- Improvement of interlockings to speed train movements from one track to another

CURVE REALIGNMENTS

Train speeds are influenced by track alignment and the amount of banking on curves (superelevation), as well as by many other factors.

Each of the 415 curves between Boston and Washington, D.C., has been evaluated according to its degree of curvature, length of transition spiral, amount of superelevation, existing speed limit, and the proposed design speed limit over the track section in which the curve is located. The NECIP would realign the most time-sensitive, cost-effective curves. Most realignments requiring costly real estate acquisition and bridge and catenary relocations would be avoided.

BRIDGES

The bridge program would completely replace certain bridges. In addition, the bridge program would include the rehabilitation or major repair of other bridges, as necessary, to improve their structural integrity and reduce speed restrictions. The track connections between movable and fixed portions of drawbridges would be modernized to allow higher speeds.

TUNNELS

The NECIP would include the following tunnel rehabilitation projects: Baltimore and Potomac Tunnel, Baltimore, Md.; Union Tunnel, Baltimore, Md.; North (Hudson) River Tunnel, New York, N.Y.; East River Tunnel, New York, N.Y.; and East Haven Tunnel, Conn. Present speed limits through these tunnels would be increased by eliminating deferred track maintenance, reestablishing drainage, and rebuilding a stable track to close tolerances on the original design gradient and alignment conditions. Equally important is the establishment of a clean, well-drained, and stable track structure to eliminate moisture problems that have adversely affected the tunnel signal systems over the past decade. Other specific tunnel activities would address ventilation, lighting, structural repair, and fire protection, as appropriate.

GRADE CROSSINGS

The NECIP would eliminate all remaining public and private grade crossings on the NEC, with the exception of certain crossings in New London, Conn.

ELECTRIFICATION

Between Boston, Mass., and New Haven, Conn., the NECIP would construct a new 25-kV, 60-Hz electric traction power system. Between New Haven, Conn., and New Rochelle, N.Y., the 12.5-kV, 60-Hz system would be modernized, upgraded, and endowed with a 25-kV capability. (Since the New Haven Line commuter cars would not be converted from 12.5-kV to 25-kV as part of the NECIP, the switch to 25kV over this segment would be deferred.) Between New Rochelle, N.Y., and Washington, D.C., the existing 11-kV, 25-Hz system would be modernized and upgraded to 25-kV, 60-Hz. As part of the NECIP, modern commuter cars operated by the New Jersey Department of Transportation and the Southeastern Pennsylvania Transportation Authority would be converted for 25-kV, 60-Hz capability. The commuter authorities would apply to the Urban Mass Transportation Administration for funding to replace older commuter cars that cannot be economically converted to the new voltage and frequency. The Consolidated Rail Corporation (Conrail) would be responsible for converting or replacing its own fleet of electric freight locomotives.

As part of this electrification program, the NECIP would construct new substations, switching stations, and transmission lines to the specific utility providing power. New transformers and circuit breakers would be installed at substations. New equipment would be installed for the switching stations between the power substations. The rehabilitation of the present catenary system would include catenary supports, conductor systems, power-feeding and connecting assemblies, and insulators. Catenary poles from Washington, D.C., to New Rochelle, N.Y., would be relocated, as required by curve realignments. New catenary poles north of New Haven would be installed to accommodate the new electrification. Due to deterioration, catenary from Pennsylvania Station, N.Y. to New Haven, Conn., would be restrung.

SIGNALING, TRAFFIC CONTROL, AND COMMUNICATIONS

Rehabilitation of the signaling, traffic control, and communications systems would provide for safe operations at 120-mph speeds and compatibility with the 25-kV, 60-Hz electrification. The signaling system would accommodate the diverse NEC services, with their differing speeds and performance characteristics.

Reverse signaling would be installed at selected locations to permit trains to move normally in either direction on a given track, thus increasing effective capacity. Additional safety devices to detect hot boxes, dragging equipment, and high/wide loads would be deployed. Centralized traffic control (CTC) equipment would be installed at Philadelphia, Pa., and New Haven, Conn. This CTC system would cover the Corridor south of Wilmington and east of New Haven. The NECIP would include new voice and data transmission equipment, including coaxial cables and microwave transmission towers. The improved communications system would replace the current trunk distribution cable system of 1915–35 vintage.

Signal block length would be adjusted, as necessary, to provide safe stopping distances at high speeds. To reduce vandalism and maintenance costs, wayside signals would be eliminated (except at interlockings where they are required by statute) and replaced with a modern multiple aspect cab signal system with automatic overspeed control.

SERVICE FACILITIES

Service facilities for NEC locomotives and cars would be suitable to perform routine maintenance. In addition to vehicle maintenance facilities, new maintenance-of-way bases would provide support for maintenance of the NEC fixed plant.

STATIONS

The NECIP would address 15 passenger stations at the following locations: Boston, Mass. (South Station); Route 128, Mass.; Providence, R.I.; New London, Conn.; New Haven, Conn.; Stamford, Conn.; New York, N.Y. (Pennsylvania Station); Newark, N.J.; Metropark, N.J.; Trenton, N.J.; Philadelphia Pa. (30th Street Station); Wilmington, Del.; Baltimore, Md. (Pennsylvania Station); New Carrollton, Md.; and Washington, D.C.

As permitted by the 4R Act, operational and some safety-related improvements would be entirely funded by the NECIP while the improvements of nonoperational portions of stations and related facilities would be funded on a 50–50 basis between NECIP and State or local authorities. The FRA expects to publish soon a regulation that will provide guidance in classifying particular station improvements into the categories set forth above.

Depending on funding and individual station characteristics, currently proposed plans provide for improvements to platform areas to expedite access to and egress from trains; installation of elevators and escalators to reduce congestion and accommodate the handicapped; and enhancements to ticketing areas, concourses, public address systems, and other station components such as signs and graphics related to the efficient movement of travelers.

In addition, the proposed NECIP station program would rehabilitate the basic structures and utilities at selected stations to assure the longevity and, where possible, the architectural integrity of station buildings. These improvements could include the upgrading of heating, ventilation, plumbing, electrical and communication systems; refurbishment of public restrooms and other services; and repair of exterior surfaces, lighting, and fire protection systems, especially where necessary to return station buildings to compliance with applicable codes and standards.

FENCING/BARRIERS

Safety-related fencing work proposed for total Federal funding includes the following.

- Installation of fence barriers along the perimeter of the right-of-way in areas where a high incidence of trespass and vandalism has been recorded.

- Fencing edges of overhead bridges to eliminate the throwing or dropping of objects.

- Fencing the perimeters of maintenance-of-way bases, repair shops, and yards.

Nonsafety-related fencing may be included in the NECIP, subject to the cost-sharing limitations.

PROGRAM PROGRESS TO DATE IN KEY AREAS

Since the passage of the 4R Act in 1976, the NECIP has accomplished the following major items.

- Within FRA, an NEC Project office (NECP) was set up to direct the NECIP in accordance with the 4R Act.

- In October 1976, the Department of Transportation (DOT) awarded an architectural/engineering contract to DeLeuw, Cather/Parsons and Associates. This firm provides support to NECIP in the following areas: systems, engineering, and design; components and facilities engineering and design; implementation planning; environmental assessment support; engineering management; data management; and procurement support.

- With regard to the NECIP, a relationship has been established between DOT and the National Railroad Passenger Corporation (Amtrak) that places Amtrak in a dual role. First, Amtrak is the owner/operator of the railway and, as such, will dispatch all trains and will participate in project development, construction oversight, testing, and acceptance. Its second role is to serve as a construction contractor to the FRA/NECP by initiating and managing all construction assigned to it by FRA/NECP.

- Both DeLeuw, Cather/Parsons and Amtrak work forces grew rapidly in FY 1977. By September 1977, the architect/engineer program had reached a level of 856 persons, or approximately 80 percent of planned peak in 1978. The total Amtrak force assigned to the project reached 1,601 full-time persons. During the same period, 739 Amtrak workmen were trained in contract classes for NEC work. As part of its general mobilization activities, DeLeuw, Cather/Parsons entered into, with FRA/NECP concurrence, 17 subcontracts.

- Early in FY 1977, a thorough and continuing environmental impact assessment was begun. It included the program as a whole and those particular sites where the impact is expected to be the greatest. A draft Programmatic Environmental Impact

Statement was published in autumn 1977. No irreversible project decisions will be made until this document becomes final (expected sometime in 1978).

- In preparation for NECIP, Amtrak work forces began long-deferred maintenance-of-way rehabilitation, including the following performed during FY 1977.

  — 140,768 wood ties replaced
  — 40 track-miles of welded rail placed
  — 80 miles of ballast renewed by cleaning or undercutting
  — 2,570 rail joints eliminations and insulated joint renewals

  In addition, Amtrak was funded for the design, construction, and study activities during FY 1977 of the following projects.

  — Design for repairs to bridge over Pelham Bay, N.Y.
  — Electrical work on Philadelphia 30th Street Station
  — Repairs to Woonasquatucket Bridge, R.I.
  — Communication and signaling preparation
  — Electric traction study
  — Catenary pole painting
  — Fencing
  — Station refurbishment
  — Access roads
  — Right-of-way cleanup

- During FY 1977, funds were made available to Amtrak for the purchase of ballast cars, a welding plant, track machinery, ties, rail, and other track material.

CHAPTER 4.
AMTRAK PLANS DURING NECIP CONSTRUCTION PERIOD

NORTHEAST CORRIDOR CONSTRUCTION IMPACTS ON OPERATIONS

During the Northeast Corridor Improvement Project (NECIP) construction period, intercity passenger trains, suburban commuter trains, and freight trains using the Northeast Corridor (NEC) system will experience congestion delays as individual tracks will be temporarily closed in order to make improvements to track structures, bridges, and tunnels and to effect electrification. It is not now possible to predict the exact nature of the delays, as they will vary according to construction. Construction will be scheduled to minimize delays as much as feasible, but all intercity passenger trains will experience some delays as system capacity is reduced. For example, the National Railroad Passenger Corporation (Amtrak) anticipates its trains will be delayed up to 15 to 20 minutes between Washington, D.C., and New York and 10 to 15 minutes between New York and Boston during the height of the construction effort. Commuters will experience shorter average delays [1]. Amtrak will keep passengers informed about expected delays through schedule notices, the reservation system, station announcements, and appropriate signs. Passenger service will logically receive operating priority, but if freight trains can be scheduled to use available time slots, most delay problems can be alleviated.

When faced with construction-induced operational delays, the Consolidated Rail Corporation (Conrail) may find diversion of through freight away from the NEC attractive. The impact of any extensive delays will be reflected in increased operating costs and potential losses in intercity and commuter rail revenue or freight traffic. Steps are being taken by the Department of Transportation (DOT) to discuss the consequences of construction activity and possible mitigating actions with Conrail and commuter agencies.

Although the entire length of the system will remain continuously operational throughout the construction period, there will be occasional, unavoidable shutdowns of certain segments. The longest complete shutdowns anticipated are 1 1/2 to 2 days, and these will occur on weekends. In such extreme cases, Amtrak may be required to use alternate routes, where available, or to bus passengers around short segments when track segments are shut down [2]. Appendix B presents further details of the NECIP construction impact on rail traffic.

With regard to NECIP construction impacts on highway and water traffic, precautions will be taken to avoid or reduce tieups of auto traffic as a result of improvements to bridges, stations, grade crossings, and route realignments. Almost all railway bridges over navigable waters are scheduled for repairs or upgrading. During this construction, it is possible that channels may be closed temporarily to waterborne commerce and recreational boating.

As a result of construction activity, however, such closures are not expected to exceed several hours to 1 day in length, and any such closings will be coordinated with the U.S. Coast Guard.

PROJECTED NON-NECIP IMPROVEMENTS TO AMTRAK SERVICE

Counterbalancing the temporarily adverse impacts of NECIP construction, the *Amtrak Five-Year Corporate Plan* includes certain improvements intended to have a positive impact on ridership [2].

Vehicles

To meet the trip-time goals of NECIP, Amtrak is assembling a fleet of vehicles that is expected to provide more attractive service. The exact composition of the new fleet and the services it will perform will depend on the results of an investigation underway by Amtrak and the Federal Railroad Administration.

Stations

To improve operational efficiency and to provide a minimum level of service, Amtrak, in its Five-Year Corporate Plan, is planning to make improvements, as needed, to 14 stations in the NEC that are not slated for funding under NECIP. At the same time, Amtrak will continue efforts to obtain State and city participation in funding station rehabilitation. Station improvements will include repair of platform surfaces and canopied structures to eliminate hazards for passengers; platform extensions to eliminate double stops; provision of ramps and elevators to serve the elderly and the handicapped; parking facilities; repair of toilet/washroom facilities; consolidation of ticketing and baggage facilities to reduce operating costs; emergency station repairs; installation of basic station signs and highway signs directing passengers to stations; lighting improvements on platforms, parking lots, walkways, and in stations; general repairs to elevators, stairways, public address systems, doors, windows, and mechanical systems.

In addition to these improvements, Amtrak capital will be required at major NEC stations to make repairs that will not be funded under the NECIP, such as those necessary to accommodate the needs of the Amtrak long-distance trains and NEC trains more than eight cars in length.

An important component of increased rail patronage in the NEC is the improved accessibility of rail stations. Table 4–1 shows details of intermodal connections presently available at NEC stations. Appendix C discusses NEC rail stations in greater detail.

In contrast to the ready availability of local buses, intercity bus connections are currently available only at Pennsylvania Station in Newark and at Trenton Station. However, the cities of Boston, Mass., Providence, R.I., New London, Conn., New Haven, Conn., Baltimore, Md., and Washington, D.C., have plans to develop their rail stations into multimodal terminals

TABLE 4-1. INTERMODAL CONNECTIONS AT 15 STATIONS UNDER NECIP

	Rail		Bus			Taxi	Dedicated service	Car rental
	Intercity	Commuter	Transit	Local	Intercity			
South Station, Boston, Mass.	X	X	X	X		X		
Route 128, Dedham, Mass.	X	X		X		X		
Union Station, Providence, R.I.	X	X		X		X		
Union Station, New London, Conn.	X			X		X		
Union Station, New Haven, Conn.	X	X		X		X		
Stamford Station, Stamford, Conn.	X	X		X		X		X
Pennsylvania Station, New York, N.Y.	X	X	X	X		X		
Pennsylvania Station, Newark, N.J.	X	X	X	X	X	X	X	X
Metropark, Iselin, N.J.	X	X				X		
Trenton Station, Trenton, N.J.	X	X		X	X	X		X
30th Street Station, Philadelphia, Pa.	X	X	X	X		X		X
Wilmington Station, Wilmington, Del.	X	X		X		X	X	
Pennsylvania Station, Baltimore, Md.	X	X		X		X		
New Carrollton Station, New Carrollton, Md.	X			X		X		
Union Station, Washington, D.C.	X	X	X	X		X		X

that would include intercity bus service. Amtrak has made through-ticketing and baggage-checking agreements with Bonanza Bus Co. for services that continue from Providence to Cape Cod and with Greyhound Bus Co. for services from Boston to upper New England. Generally, however, operations between buses and trains are not well integrated.

Emergency Repairs and Tools

In its Five-Year Corporate Plan, Amtrak has budgeted approximately $4.5 million for emergency repairs and tools for FYs 1978–80.

Pollution Control Improvements

Amtrak's recently acquired railway maintenance facilities had no pollution control equipment or procedures. Thus, Amtrak intends to finance improvements in these maintenance facilities in order to avoid fuel spills into waterways and to bring the facilities into compliance with provisions of the Federal Water Pollution Control Act Amendments of 1972 (PL 92–500) as further amended in 1977 (P.L. 95–217).

On-Board Service Support Facilities

The support facilities necessary for provision of food and other supplies inherited from the railway are seriously deteriorated and do not meet current standards for sanitation. According to its Five-Year Plan, Amtrak intends to make improvements in Boston, in New York City at Penn Station and Sunnyside Yard, in Washington, D.C., and in Albany, N.Y., for more efficient provision of food and other supplies. (See table 4–2.)

TABLE 4-2. AMTRAK FIVE-YEAR CORPORATE PLAN FOR IMPROVEMENTS
(Million $)

Year	Capital expenditures		
	Stations	Pollution control	On-board service support
1978	3.6	1.341	4.36
1979	4.2	1.65	2.95
1980	4.2	(a)	(a)
1981	3.9	(a)	(a)
1982	4.1	(a)	(a)

[a]No expenditure planned.

NEC Right-of-Way

In accordance with Amtrak's responsibility under the Railroad Revitalization and Regulatory Reform Act and agreements with DOT and to comply with State and local building and fire codes, Amtrak intends to commit $18.7 million over the next 5 years to correct plant deficiencies and acquire necessary maintenance equipment for track and structures.

NEC Feeder Line Rehabilitation Program

The lines now owned by Amtrak between Philadelphia and Harrisburg, Pa., and between New Haven, Conn., and Springfield, Mass., are in poor condition. However, no funding for repairs is available under the NECIP. Both lines carry substantial volumes of freight and passenger traffic. Because of the predominance of freight traffic, the Amtrak Board has instructed Amtrak to pursue a possible transfer of the lines to Conrail with the concurrence of the U.S. Railway Association and DOT. Regardless of ownership, to prevent further deterioration and safety hazards on these lines, Amtrak estimates that restoration to the original as-built condition would involve capital costs of $126 million and annual maintenance costs as high as $12 million, according to the Five-Year Plan. The Harrisburg line's speeds would then be restored to up to 80 mph, and the track improvements on the Springfield main line will permit a 60-mph speed. Further feeder line discussions will appear in later sections of this report.

OTHER FACTORS AFFECTING AMTRAK PERFORMANCE OVER THE CONSTRUCTION PERIOD

These factors include economic growth and changes in the level of competition.

ECONOMIC GROWTH

Between 1976 and 1982, according to data from the Economic Report of the President, January 1977, there will be about an 18-percent increase in total personal disposable income in the United States. It is expected that growth in the NEC will be well below the Nation as a whole. Since demand for travel is a function of the number of people served and the income available for spending on transportation, it could be expected that while travel in the NEC will grow, growth will be at a lower rate than in other parts of the Nation.

The economic outlook through 1989, based on the Wharton Long-Term Industry and Economic

Forecasting Model, is one of short-term optimism, moving to greater caution over the longer term. Short-term growth through 1979 will be stronger than previously expected due to Congressional action on tax incentives to spur employment and tax cuts to stimulate consumer spending. Over the longer term, growth will not be sustained at the 1978–79 rate—principally due to the fading effects of stimulation efforts and escalating fuel costs. Thus, through 1989, moderate economic growth is expected, with declining unemployment but relatively high inflation.

CHANGES IN THE LEVEL OF COMPETITION

This section discusses the air and the highway modes.

Air

It is unlikely that substantial improvements in trip time will be realized. In-flight travel times are already quite short, and improvements in airport access times are difficult to achieve. As a marketing technique, the air carriers offer discounts, such as the current weekend NEC (off-peak) excursion air fare (approximately equal to the Metroliner round-trip fare). Air patronage may also be attracted by a new, more convenient air shuttle terminal to be constructed at La Guardia Airport. It is conceivable that wide-body jets, such as the air bus, could be introduced into the NEC, if found to be economic for short-haul trips. In addition, Eastern Airlines is planning to expand its Newark service by adding 40 percent more seats between Newark and Washington, D.C., and 10 percent more seats between Boston and Newark. Furthermore, the completion of transit connections to Philadelphia International and to Washington National Airports should make access easier for air passengers. These systems will also improve rail connections.

Highway

The bus companies have reacted to changes in railway fares and rail improvements by encouraging the introduction of bus subsidies. In addition, they have introduced more express buses and kept the bus fare below the Amtrak fare. Trailways and Greyhound have recently put into effect fare reductions of approximately 50 percent between principal city-pair markets in the NEC: New York—Boston; Boston—Washington, D.C., and New York—Washington, D.C. These fares are experimental and are scheduled to remain in effect for only a short period. Continued experiments with bus fares can be expected in this highly competitive transportation environment.

As for the automobile, the price of gasoline to date has had little effect on the number of miles driven. Although gasoline prices more than doubled in the past 7 years, gallons consumed and miles driven are still increasing. Several sections of the north-south interstate spine, I-95, now under construction, will be completed by 1982, which could make travel by car and bus somewhat easier, particularly at off-peak times. However, trip-time improvement will be constrained by the 55-mph speed limit.

Market Research

According to results of research conducted over the past several years, Amtrak has found that although on-time performance is most important to travel needs, patronage tends to increase when the following improvements are perceived, either separately or in combination.

- On-time performance
- Frequency increases—more trains attract more passengers
- Improvements in trip time
- Price changes
- Introduction of new equipment (Amfleet experience appears to show that new equipment can increase ridership.)

Amtrak plans to capitalize on this information in its marketing efforts, as it attempts to capture an increased share of the market, particularly from the automobile. Amtrak has budgeted $40 million on nationwide marketing for FY 1978 and 1979. Of this sum, $10 million is for advertising, and about $4 million is for use in the NEC. Experiments with off-peak fares will continue, and Amtrak is considering some modification of the USA Rail Pass for use in the NEC. However, current ticketing procedures are complex and time consuming, and it is difficult for the system to assimilate special fares. A revised ticketing system will probably be necessary as the volume of passengers increases. In addition to ticketing and trip-time improvements, however, improvements must occur in station information and design and intermodal connections to increase the traveler's convenience, comfort, and security at journey's end. Signage is still limited; it is often unclear where connections can be found, and even directions within stations are frequently inadequate.

Fare Levels

Detailed projections of fare levels for the NEC for fiscal years 1978—1981 are speculative. However, based upon future marketing analyses, Amtrak will use a flexible approach to fares in order to adapt to the effects of the NECIP, as well as to any possible external factors. Such factors might include changes in the supply and cost of energy and in the fares charged on competing modes of transportation.

Financial Forecasts 1978–1982

The *Amtrak Five-Year Corporate Plan* (summarized in table 4–3) at constant 1978 prices, envisioned a difficult period in 1978 and 1979, with ridership adversely affected by construction work. This will be followed by a period when construction work will be reduced, and performance will progressively improve so that ridership will be increased. Train-miles will increase from 1980 until the full new service starts. At constant 1978 dollars, revenue is predicted to rise by 42 percent. Costs will increase each year, because of the extra maintenance required for improved track and the extra trains introduced under NECIP plans.

The general picture is one of static revenue and rising costs during the heavy construction period in 1978 and 1979. Thereafter, revenue increases strongly as ridership increases, and unit costs of transportation are reduced as the new train services are phased in.

The deficit per passenger-mile will improve as the new services are introduced, according to the Five-Year Corporate Plan assumptions. Table 4–3 presents operating and financial projections in the NEC from 1978 to 1982, in constant 1978 dollars.

REFERENCES

[1] *Draft Programmatic Environmental Impact Statement,* Vol. 1, Department of Transportation, Federal Railroad Administration, Washington, D.C., Aug. 1977.

[2] *Amtrak Five-Year Corporate Plan,* Fiscal Years 1978–1982, Washington, D.C., Oct. 1977.

TABLE 4-3. OPERATING AND FINANCIAL PROJECTIONS OF AMTRAK NEC SERVICE, 1978 TO 1982 (1978 $)

Category	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982
Statistics:					
Passengers (millions):					
Metroliner	2.2	2.1	2.2	2.5	.2.7
Conventional	8.9	8.9	9.2	10.5	12.1
Total	11.1	11.0	11.3	13.0	14.8
Passenger-miles (millions):					
Metroliner	309.0	308.5	323.3	375.9	397.8
Conventional	931.4	936.1	991.4	1,152.1	1,391.0
Total	1,240.4	1,244.6	1,314.7	1,528.0	1,788.9
Train-miles: (millions)					
Metroliner	2.02	2.02	2.02	2.22	2.30
Conventional	4.15	4.15	4.15	5.34	5.84
Total	6.17	6.17	6.17	7.56	8.14
Revenue (million $):					
Metroliner	41.3	41.3	43.3	50.4	53.3
Conventional	69.5	71.4	74.4	86.8	104.5
Total	110.8	112.7	117.7	137.2	157.8
Total operating costs (million $)					
Metroliner	58.5	62.2	63.7	64.3	66.6
Conventional	131.4	140.8	144.3	169.0	184.9
Total	189.9	203.0	208.0	233.3	251.5
Surplus/deficit on operating costs (million $):					
Metroliner	-17.2	-20.9	-20.4	-15.9	-14.9
Conventional	-61.9	-69.4	-69.9	-82.2	-80.4
Total	-79.1	-90.3	-90.3	-97.3	-95.3
Derivatives:					
Operating ratio:					
Metroliner	142	151	147	130	129
Conventional	189	197	194	195	177
Total	171	180	177	171	161
Revenue/passenger-mile ($):					
Metroliner	0.134	0.134	0.134	0.134	0.134
Conventional	0.075	0.076	0.075	0.075	0.075
Total	0.089	0.090	0.090	0.090	0.088
Revenue/train-mile ($):					
Metroliner	20.45	20.45	20.45	22.70	23.17
Conventional	16.75	17.20	17.92	16.25	17.89
Total	17.96	18.26	19.08	18.15	19.39
Operating costs/passenger-mile ($):					
Metroliner	.189	.201	.197	.171	.167
Conventional	.141	.150	.146	.147	.133
Total	.153	.163	.158	.153	.141
Operating costs/train-mile ($):					
Metroliner	28.96	30.79	31.53	28.96	28.96
Conventional	31.66	33.93	34.77	31.66	31.66
Total	30.78	32.90	33.71	30.86	30.90
Surplus/deficit/ passenger-mile ($):					
Metroliner	-.055	-.067	-.063	-.037	-.033
Conventional	-.066	-.074	-.071	-.072	-.058
Total	-.064	-.073	-.068	-.063	-.053

SOURCES: Amtrak, *Five-Year Corporate Plan*, and Amtrak Marketing Department statistics.

CHAPTER 5. ALTERNATIVE NEC OPERATIONS AFTER NECIP COMPLETION

This chapter defines and compares alternative Northeast Corridor (NEC) services after completion of the Northeast Corridor Improvement Project (NECIP) and examines sample cases.

A wide variety of train services could be run to advantage on the improved NEC. The following analyses have been designed to test possible alternatives for a number of factors that influence ridership and financial results. Some factors have been excluded from these analyses as being secondary at this stage. For example, the demand forecasting model (discussed in app. D) indicates that frequencies greater than two trains per hour between New York and Washington, D.C., will have only a small effect on ridership. These factors, including detailed investigation of local rail services, would be included in the comprehensive examination that must precede any final choice of train service.

Each factor is considered in isolation and thus indicates the general direction to be followed if the better alternatives are used together. It should not be assumed, at this stage, that where differences are small, any particular option is preferred.

SERVICE CONCEPTS

Comprehensive rail corridor planning requires the establishment and evaluation of train service options. Composed of a complete set of schedule, fare, equipment, and associated assumptions, each service option must reflect an underlying concept of the markets to be served. From this concept, particulars regarding schedules, fares, and equipment can flow and combine in different ways.

The service options explored in this report elaborate on two basic concepts that exemplify, but by no means exhaust, the available concepts for passenger business in the NEC. Prerequisite to any explanation of the service concepts and options after NECIP completion is a discussion of the existing NEC marketing approach.

EXISTING SERVICE CONCEPT IN THE NEC

National Railroad Passenger Corporation (Amtrak) NEC operations now respond to three distinct markets. The first market consists, essentially, of time-sensitive travelers — many attracted from airlines — who require speed, frequency, and reliability, and for whom money is less important. Business travel forms the bulk of this market, which is served only in the New York—Washington, D.C., segment and not between Boston and New York. The second market includes travelers who are price conscious above all and for whom time is secondary. A third market consists of daily commuters using multiple-ride discount tickets, mainly in the New York—Philadelphia area. Comparing the three markets now served by Amtrak in the NEC, table 5-1 suggests that the commuter market produces a yield (revenue per passenger-mile) equivalent to 28 percent of the Metroliner yield, and 54 percent of the price sensitive (noncommuter) yield. Because of the public policy issues involved in such indications, the commuter market deserves a separate, intensive study exploring the relationship between commuter services provided by Amtrak and locally provided services. Such a study should carefully scrutinize the assumptions and conclusions of table 5-1; should precisely quantify any incremental operating and capital costs incurred by Amtrak because it accepts multiple-ride commuter tickets; and should explore alternative institutional structures for accommodating these 2 million yearly passenger trips.

For the three NEC markets, Amtrak provides two separate services. The time-sensitive market has its own distinctive equipment and schedules, whereas the price-sensitive and commuter markets share the same trains. Served exclusively by self-propelled Metroliners, the time-sensitive travelers enjoy a scheduled 3-hour trip time between New York and Washington, D.C. (with proportional times between intermediate points). Metroliners provide hourly service for this market, and each train makes four or five intermediate stops: Baltimore and Philadelphia, always; Capital Beltway, Wilmington, Trenton, Metropark, and Newark, at frequent intervals. As of FY 1977, fares for time-sensitive passengers were 64.5 percent higher than those for the price-sensitive (noncommuter) market.

TABLE 5-1. COMPARISON OF AMTRAK NEC MARKETS, 1976

Category	Time-sensitive	Price-sensitive (noncommuter)	Commuter
Passengers (million):	2.2	5.1	2.0
% of total	23.7	54.8	21.5
Passenger-miles (million)	321.7	614.9	116
% of total	30.6	58.4	11
Transportation revenue/ passenger-mile (1976 $)	.125	.065	.035
Total operating cost/ passenger-mile (1976 $)	.167	.152	.152
Deficit/passenger-mile (1976 $)	.042	.087	.117

NOTE: Data for the time-sensitive (Metroliner market) and for the combined price-sensitive and commuter markets come from the Amtrak *Five Year Corporate Plan* of 1976 and from Amtrak Marketing Department statistics. The distinction between price-sensitive and commuter data is based on an Interstate Commerce Commission publication, *Effectiveness of the Act,* March 15, 1977. Passenger-miles for commuters assume an average journey length of 58 miles (New York to Trenton). Revenue per passenger-mile for commuters has been estimated by algebra, on the basis of a 55/45 commuter/noncommuter split on New York—Philadelphia trains with noncommuters paying $0.065 per mile. The average yield for these trains is $0.0486 per mile (with both markets combined.) Total operating costs per passenger-mile for commuters are assumed to be equal to those for Boston—Washington, D.C. Amfleet trains.

By contrast, Amtrak serves the price-sensitive and commuter markets with locomotive-hauled trains composed of Amfleet and older cars. These locomotive-hauled trains provide travel times of approximately 4 hours, 50 minutes, between Boston and New York; 1 hour, 40 minutes, between New York and Philadelphia; and 3 hours, 50 minutes, between New York and Washington, D.C. Among the Boston, New York, and Washington, D.C., endpoints, locomotive-hauled train frequencies range from one train every 2 hours to one train once every hour. Between Philadelphia and New York, additional trains raise the average frequency to every half-hour during the rush-hour peaks and to every hour throughout the rest of the day. Commuters comprise 55 percent of the ridership on the additional New York—Philadelphia trains, whereas all other locomotive-hauled services carry approximately 9 percent of their riders on commuter tickets [1].

SERVICE OPTIONS FOR ANALYSIS

As a basis for the financial projections for the NEC after NECIP completion, this report has defined two typical service options for analysis. The first, called "dual service," would continue the existing service concept: separate trains for the time-sensitive and price-sensitive markets. The second option, "single service," is defined to embody the concept of a single set of trains and schedules for both the time-sensitive and the price-sensitive markets, with market differentiation achieved by a fare policy. If properly designed, such unified service could give each component market at least as much, or more, service than now and reduce substantially the journey times between major stations, thus generating more ridership. Beyond these two options, which are described more fully below, there are numerous permutations and combinations of service variables, many of which deserve careful scrutiny, and some of which merit experimentation. In further analysis, for example, a dual service option could be redefined to include many of the attributes ascribed here to the single service and vice versa.

Dual Service

Between Boston and New York, this option would offer hourly service. Half these trains would make 5 stops and would complete the run in 3 hours, 40 minutes; the other trains would make 11 stops and would require approximately 4 hours, 5 minutes, for the run. Between New York and Washington, D.C., service would be every half hour; half the trains would make the run in 2 hours, 40 minutes, with 5 stops and would be restricted to the time-sensitive market at a premium fare. The other New York—Washington, D.C., trains would make nine stops, would require approximately 3 hours, 10 minutes, between endpoints, and would handle the price-sensitive clientele. Superimposed between Philadelphia and New York would be four trains per day in each direction, making five stops, and taking about 90 minutes for the trip. The dual service option explored here assumes that train lengths would vary throughout the course of the day to match demand fluctuations (see app. E).

Demand for this dual service is estimated to be 16 million passengers and 1,842 million passenger-miles in 1982, growing to 19.5 million passengers and 2,216 million passenger-miles in 1990 (see app. D). The growth from 1982 to 1990 stems largely from yearly population changes and income increases in the NEC.

Single Service

This option, between Boston and New York, would offer hourly service with five stops at the 3-hour, 40-minute, trip time. Between New York and Washington, D.C., there would be half-hourly service, in which half the trains would meet a 2-hour, 40-minute trip time with five stops, and the rest of the trains would make the run in 2 hours, 30 minutes, with only two stops—Philadelphia and Baltimore. Table 5–2 and figure 5–1 show the rationale behind the two-stop service between Washington, D.C., and New York, which would offer improved service to city-pairs that now account for over 50 percent of the passenger-miles and most of the urban population in the NEC. Superimposed over the above services would be 10 daily local trains each way between New York and Philadelphia at trip times of approximately 90 minutes, as well as 2 local trains geared to the small towns between New Haven and Boston. The single service option would be compatible with, and is assumed to reflect, peak/off-peak pricing, in which all travel during the rush hours would be at a premium fare. If successful, this control of traffic peaks by fare incentives might permit the adoption of constant train consists (see app. E), which are as-

TABLE 5-2. AMTRAK RIDERSHIP DATA RANKING BY CITY-PAIRS, 1976

	City-Pair	% of NEC passenger-miles	Cumulative % of NEC passenger-miles	% of NEC passengers
1	New York (Penn.) — Washington, D.C.	21.8	21.8	10.9
2	New York (Penn.) — Philadelphia (30th St.)	16.4	38.2	20.4
3	Boston (South) — New York (Penn.)	9.5	47.7	4.6
4	Philadelphia (30th St.) — Washington, D.C.	8.0	55.7	6.7
5	New York (Penn.) — Baltimore	3.4	59.1	4.6
6	New York (Penn.) — Wilmington	2.9	62.0	2.8
7	New York (Penn.) — Trenton	2.7	64.7	5.2
8	Providence — New York (Penn.)	2.7	67.4	1.6
9	New York (Penn.) — New Carrollton	2.5	69.9	1.3
10	Boston (South) — Washington, D.C.	2.4	72.3	0.6
11	Newark — Washington, D.C.	2.0	74.3	1.1
12	Boston (South) — Philadelphia (30th St.)	2.0	76.3	0.7
13	Philadelphia (30th St.) — Baltimore	1.9	78.2	2.3
14	Trenton — Washington, D.C.	1.5	79.7	1.0
15	New London — New York (Penn.)	1.4	81.1	1.2
16	Newark — Philadelphia (30th St.)	1.4	82.5	2.0
17	New Haven — New York (Penn.)	1.3	83.8	1.9
18	Wilmington — Washington, D.C.	1.3	85.1	1.2
19	Route 128 — New York (Penn.)	1.2	86.3	0.6
20	New Haven — Washington, D.C.	1.1	87.4	0.4
21	New York (Penn.) — Philadelphia (N. Philadelphia)	1.0	88.4	1.3
22	Boston (South) — New Haven	1.0	89.4	0.7
23-47	25 city-pairs less than 1% but at least .1% each, totaling 10.2%, averaging .4% each (percentages are passenger-miles)		99.6	
48-311	264 city-pairs less than .1%, totaling .4% each, averaging .0015% each (percentages are passenger-miles)		100.0%	

NOTE: This table excludes multiple-ride commuters on Amtrak NEC trains who account for approximately 11% of total passenger-miles and 21% of total passengers.
SOURCE: Calculated from Amtrak Matrix System.

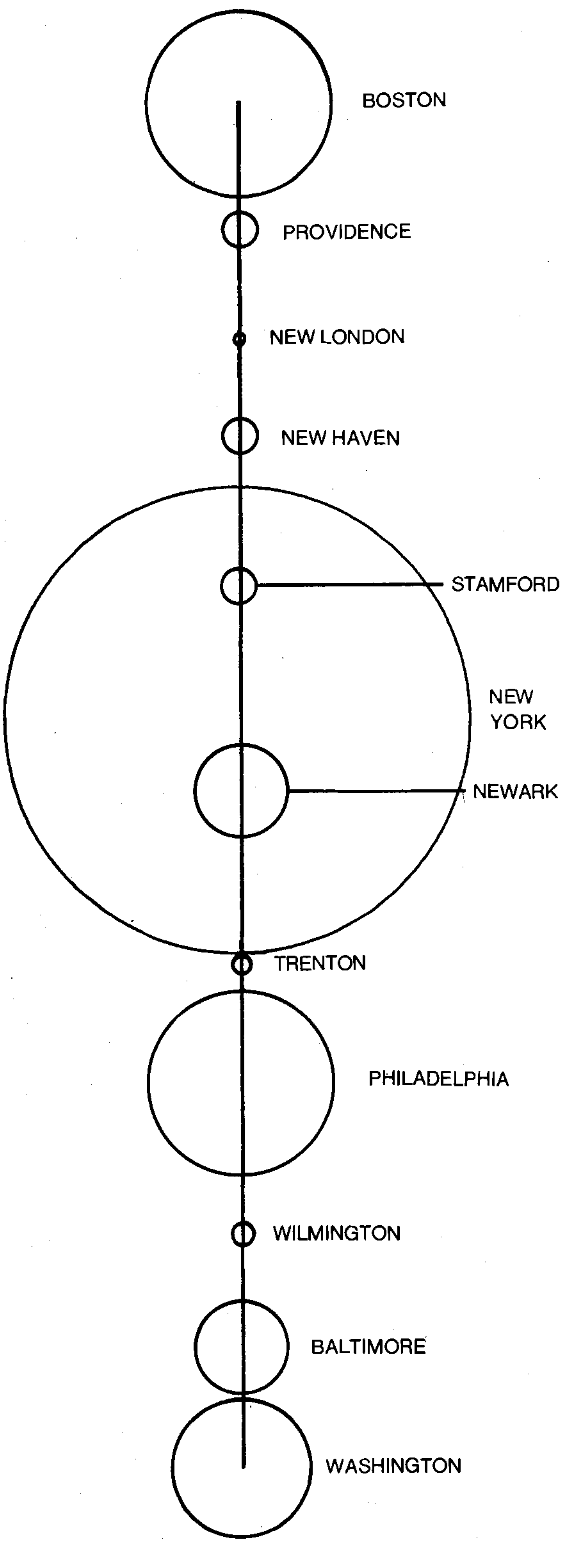


FIGURE 5-1. RELATIVE POPULATIONS OF NEC URBAN AREAS.

sumed in this single-service analysis. (Skip-stop service, peak/off-peak pricing, and constant train consists exemplify the attributes that the single service includes in this analysis but which could be applied to a dual or other service concept in future research.)

Demand for the single service is projected at 17.9 million passengers and 2,063 million passenger-miles in 1982, and 21.8 million passengers and 2,482 million passenger-miles in 1990.

Local Service Options

For the purposes of analysis, this report has developed dual and single service options based primarily on express trains between major cities. Nevertheless, the final train schedules developed for the NEC after NECIP completion must fully address the service needs of the 289 city-pairs accounting for 10.6 percent of the passenger-miles (see table 5–2). Furthermore, to the extent that commuter service operated for State and regional authorities can be integrated with Amtrak NEC services from scheduling and marketing points of view, many additional city-pairs will be opened up for exploitation by the intercity service. Also, as noted above, the commuter services offered by Amtrak itself require study and thorough integration into the operating fabric of the NEC.

COST ASSUMPTIONS

Appendix F shows in detail the assumptions made for costing purposes. Those of major significance are discussed in the following paragraphs.

CAPITAL COSTS

The fixed plant provided under the NECIP is assumed as given and is excluded from all calculations. Existing vehicles, such as the 61 Metroliner cars and 317 Amfleet cars now in use, have also been excluded until they need further expenditures. New vehicles have been treated in table 5–3.

OPERATING COSTS

No generally accepted operating cost-estimating relationships exist for the post-1982 era of NEC operations because many of the conditions influencing future costs are now uncertain and as a prudent recourse, this report has adapted existing Amtrak cost levels [2] to the increased service levels after 1982 and has designated them as "high" costs. High costs assume that — despite the large pending in-

TABLE 5-3. CAPITAL COST FACTORS FOR NEC VEHICLES

Vehicle	Price/unit (Million $)	Life-years	Subsequent use
New locomotives	2.6	15	Renew at 35% capital cost.
New Amfleet cars	0.6	10	Renew at $100,000.
Upgraded Metroliner cars	1.06	15 or 10	Scrap at 5% capital value.

vestment in fixed plant and vehicles — Amtrak will not be able to effect any significant operating efficiencies in the NEC. In certain expense categories — station services, marketing and reservations, and operating support — high costs do assume, optimistically, that Amtrak will be able to avoid a future cost increase despite the growth in patronage and train frequency.

To provide a range of operating expenses reflective of the potential efficiencies that the NECIP may bring, this analysis also includes a set of theoretical cost-estimating relationships developed over the past decade in NEC studies by consultants to the Department of Transportation. These theoretical formulas provide the low cost levels, which amount in a given year to approximately 70 percent of the high costs. This large discrepancy between high and low costs points to the need for an intensive NEC cost analysis program, fully incorporating not only the expected impact of the NECIP but also the institutional conditions within which Amtrak must work (e.g., labor agreements) and the cost implications of intricate service decisions.

Appendix F provides complete details on the development of the high and low cost levels.

FINANCIAL ANALYSIS

The objective of this financial analysis of NEC operations after NECIP completion is to evaluate the effect of service variables on future capital investment and operating subsidy requirements. Neither the level of revenues nor the level of costs alone dictate financial planning for NEC services; rather, the difference between revenues and costs and the economic soundness of capital investments must govern. Therefore, this report incorporates a methodology for estimating the sensitivity of NEC operating subsidies and net present value (NPV) to a host of variables including: operating-cost levels; service options; fleet composition; fare levels; and demands. The method is conceptually simple. For a given case, trip times, frequencies, and fare levels are fed into the demand model, which produces ridership and revenue projections. These results dictate the facility and production requirements — fleet size, car-miles, train-miles, and the like. The cost-estimating relationships convert all these data into operating costs that when subtracted from revenues yield the yearly surplus/deficit. Similarly, the capital cost factors, when applied to fleet size requirements, dictate the yearly investment and salvage values. The NPV for the case under consideration can then be easily calculated. While every element of the method and supporting data could benefit from further refinement, the approach at least provides a framework for preliminary, but comprehensive, financial analysis of the NEC after NECIP completion.

Figure 5–2 portrays the hierarchy of comparisons that have undergone analysis. The results appear below in table 5–4. Appendix G provides detailed tabulations. All projections are in FY 1978 dollars.

COMPARISON: HIGH- VERSUS LOW-COST LEVELS

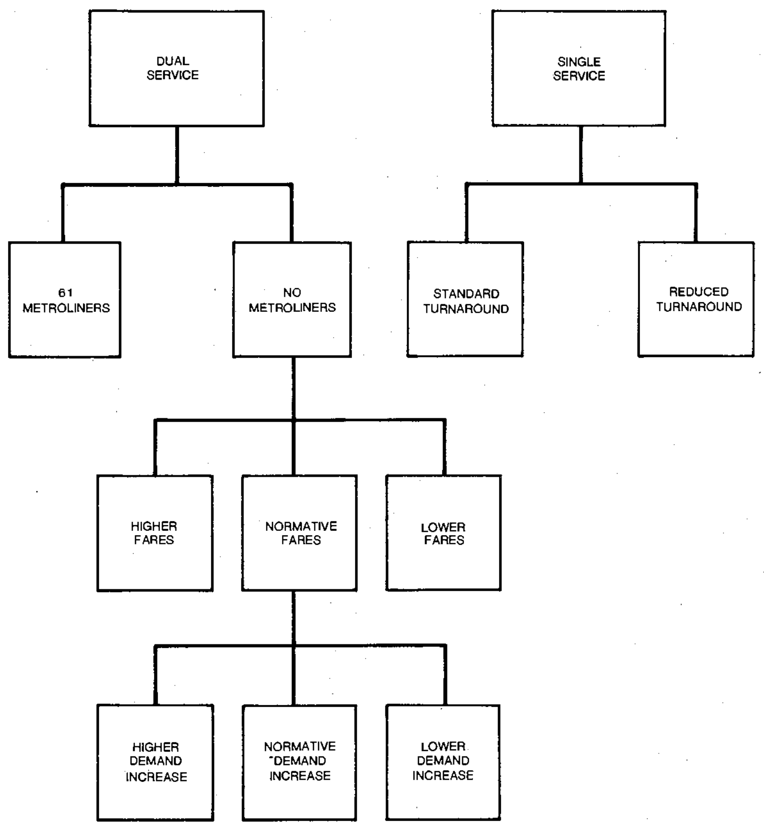
For each case evaluated, the analysis provides results under both the high- and low-cost levels. In general, under high-cost assumptions, operating deficits appear from the beginning of the service (1982) and continue until the growth in revenues outstrips the slower rise in costs (in the late 1990's). The early deficits account for the difference in NPV (10-percent discount rate) between high- and low-cost cases. For the dual service, the NPV is minus $467 million at high costs and minus $28 million at low costs.

COMPARISON: DUAL VERSUS SINGLE SERVICE

Table 5–4 compares the operating results and NPV of the dual service with those of the single service. Since the two service options, as defined here,

TABLE 5-4. COMPARISONS AMONG NEC SERVICE OPTIONS, 1986
(Constant FY 1978 $)

Category	Dual vs. Single Service		Single Service: Standard vs. reduced turnaround	
	Dual	Single	Standard	Reduced
Passengers (million)	17.66	19.78	19.78	19.78
Passenger-miles (million)	2,020.10	2,262.51	2,262.51	2,262.51
Revenue (million $)	207.0	231.8	231.8	231.8
Total operating cost (million $):				
High	255.1	275.4	275.4	273.8
Low	183.3	201.1	201.1	199.6
Surplus/deficit (million $):				
High	-48.1	-43.5	-43.5	-42.0
Low	23.7	30.7	30.7	32.3
Operating ratio:				
High cost	123	119	119	118
Low cost	89	87	87	86
NPV 10% discount, 1978-2000 (million $):				
High cost	-467.3	-474.5	-474.5	-410.6
Low cost	-28.2	-21.1	-21.1	-42.3
Reference table	G-3	G-4	G-4	G-5



NOTE: Each option has been evaluated under both high- and low-cost assumptions.

FIGURE 5-2. HIERARCHY OF COMPARISONS: NEC SERVICE OPTIONS AFTER NECIP COMPLETION.

Dual Service									
Metroliners vs. No Metroliners		Fare variation			Demand gain variations				
61	0	High	Normative	Tapered low	100%		Normative		50% lower
17.66	17.66	14.86	17.66	19.86	23.19		17.66		14.92
2,020.10	2,020.10	1,649.12	2,020.10	2,326.43	2,668.39		2,020.10		1,715.20
207.0	207.0	211.9	207.0	199.0	272.2		207.0		175.0
254.7	255.1	250.3	255.1	259.2	264.9		255.1		250.5
183.0	183.3	176.5	183.3	188.7	202.4		183.3		174.1
-47.7	-48.1	-38.4	-48.1	-60.2	7.2		-48.1		-75.5
24.0	23.7	35.4	23.7	10.3	69.7		23.7		0.9
123	123	118	123	130	97		123		143
88	89	83	89	95	74		89		99
-475.2	-467.3	-340.9	-467.3	-555.3	-113.2		-467.3		-619.1
-35.9	-28.2	112.6	-28.2	-122.3	263.2		-28.2		-149.7
G-2	G-3	G-7	G-3	G-6	G-8		G-3		G-9

NOTE: See table 5-4 for dual and single service options, note change in year, however.

produce roughly equivalent NPV, neither emerges as clearly preferable. Further analysis over a much wider spectrum of service concepts would be necessary to achieve a proper selection.

COMPARISON: STANDARD VERSUS REDUCED TURNAROUND

A crucial determinant of vehicle fleet size is the length of time a given train must remain at its terminus before being released for a return trip. (See app. E.) This required "turnaround" time at termini depends on such factors as the standard procedures for changing the direction of coach seating; the necessity to break up the train; car-cleaning and equipment-servicing standards and methods; and system on-time performance. As turnaround time decreases, fleet size requirements and fleet capital costs should decrease. As long as corresponding terminal capital and operating costs remain constant (an assumption requiring much further research), the NPV of any given service option should improve as turnaround times diminish. Using the single service option as an example, table 5–4 estimates the NPV improvement stemming from a turnaround time reduction to approximately two-thirds of the current "standard" turnaround.

COMPARISON: METROLINERS VERSUS NO METROLINERS

The NEC fleet after NECIP completion may comprise 61 Metroliners plus locomotive-hauled trains; locomotive-hauled trains only; or some intermediate option. For analytical purposes, this comparison projects the financial results of dual service with and without Metroliners. (In reality, a certain number of Metroliners will be in the post-1982 fleet as a result of Amtrak's ongoing Metroliner upgrading program.) The results are inconclusive, since the NPV differences depend more on salvage value and service-life assumptions (discussed in app. F) than on the operating costs incorporated in this analysis. Thus, factors external to this analysis would appear to govern the choice of fleet composition; such factors might include NECIP completion schedules, equipment acquisition leadtimes, passenger comfort, and relative wear-and-tear on the track (a factor that diminishes in importance to the extent that freight trains are permitted on passenger-dedicated tracks).

COMPARISON: HIGH AND LOW FARES

This comparison tests the sensitivity of operating results and NPV to high-, low-, and normative-fare levels. The high-fare level represents an initial increase of 20 percent in 1982, which is allowed to rise by about 1 percent per year until 2000. The normative-fare level reflects current Amtrak fares. The low-fare level represents an equation that lowers the per mile charge as distances increase, for a net reduction in the average fare per passenger-mile. The results suggest that for the selected excursions under dual service overall financial performance would tend to improve with a higher fare and to worsen at lower fare levels. Conversely, ridership is less at the higher fare and greater at the lower fare. Further analysis and operational experience might verify or refute such a relationship, which may have a bearing on future levels of profitability or subsidies. (App. D provides further tests of the relationships between fare levels, demand, and revenues.)

COMPARISON: HIGH- VERSUS LOW- DEMAND INCREASE

To test the sensitivity of the financial results to errors in the demand forecasts, this comparison analyzes the dual service at normative fares with two variations: an assumed 100-percent increase in the predicted ridership gain between 1980 and 1982 from the NECIP, and a 50-percent deficit in that gain. The higher demand produces favorable results, since at the normative fare, the revenue increase (plus 31 percent) far outstrips the cost increase (plus 3.8-percent high, plus 10.4-percent low— high costs have a larger fixed component). On the other hand, with lower demand, the decrease in revenue (minus 36 percent) far outstrips the cost economies (minus 1.8-percent high, minus 5-percent low), thus producing the worst operating deficit of any option studied.

SUMMARY OF FINANCIAL PROJECTIONS OF NEC ALTERNATIVES

From these analyses, as summarized in table 5-4, come the following indications.

- High costs exceed low costs by approximately 40 percent. This wide range determines whether the yearly operating outcome is positive or negative; since the yearly outcome could constitute a continuing need for subsidies, careful scrutiny, amplification, and refinement of NEC cost-estimating relationships must take place. Otherwise, there will be no way to predict on a sound basis any future operating subsidy requirements.

- The analyses to date are inconclusive with respect to dual versus single service and in regard to Metroliner versus non-Metroliner equipment options. Further examination, incorporating refinements in the existing methodology and variables and encompassing new factors, might well yield more definitive results.

- Under a given service option, shorter equipment turnaround times provide better results than longer turnarounds. This improvement stems from a decrease in vehicle capital costs but does not allow for any higher terminal capital and operating expenses to accommodate the quicker turnarounds. Such related terminal costs merit careful investigation.

- This study suggests that overall financial results could improve as fares increase (and ridership decreases), and could worsen as fares decrease (and ridership increases). Again, further analysis coupled with operating experience might confirm or contradict this conclusion.

- At the normative fares, if demand levels exceed expectations, the financial results should improve; if demand levels fail to meet the projections, deficits would grow.

REFERENCES

[1] Interstate Commerce Commission, *Report to the President and the Congress, Effectiveness of the Act, March 15, 1977, Amtrak.*

[2] Amtrak Financial Planning Department, "Statement of Northeast Corridor Financial Operations For the Year Ended September 30, 1977," NEC Spine, Nov. 1977.

CHAPTER 6.
IMPROVEMENTS IN INTERCITY PASSENGER TRANSPORTATION

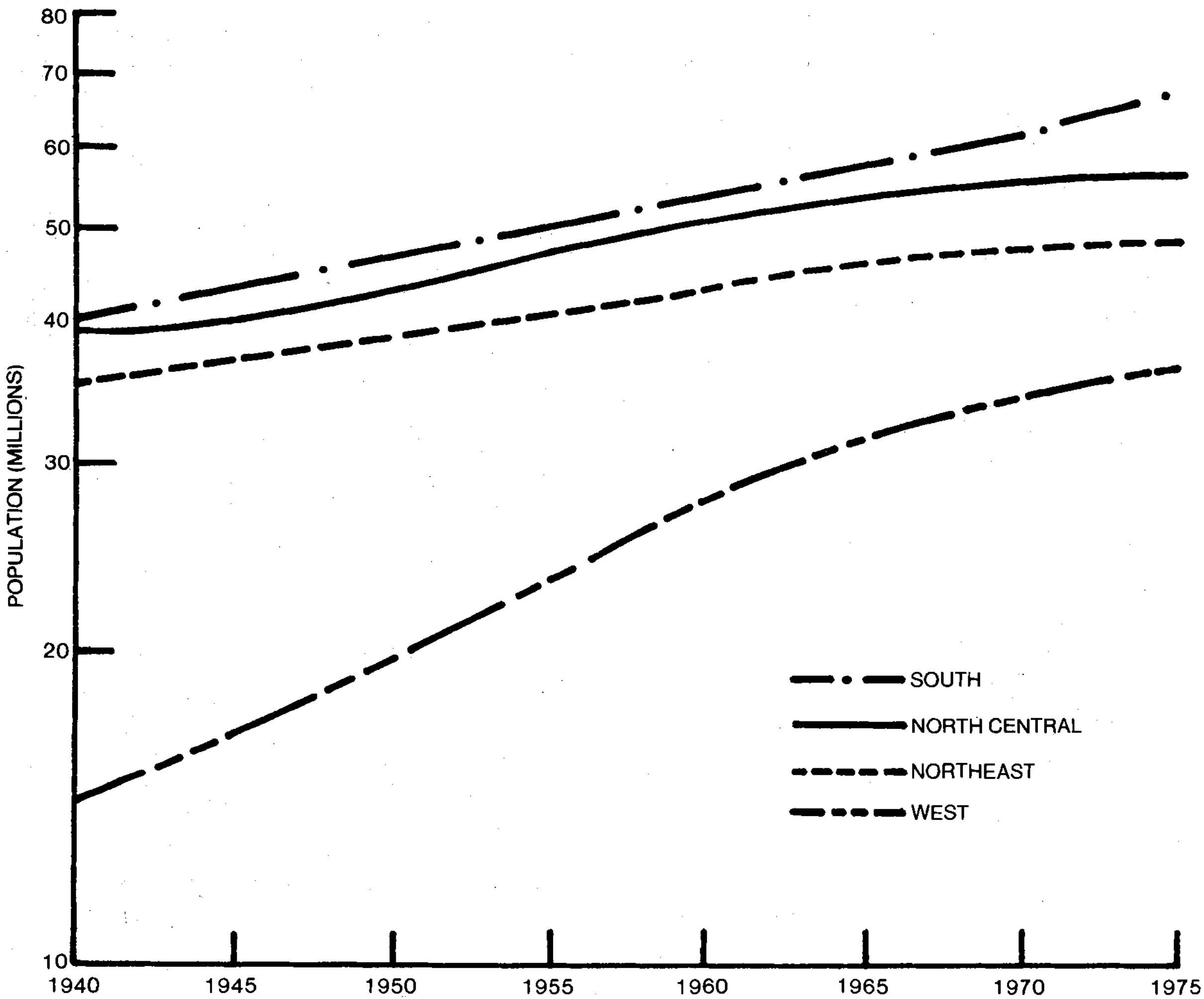
Over the past 7 years, population growth rates in suburban areas and in other regions have been greater than those in the central cities of the Northeast. (See table 6–1 and fig. 6–1.) As a result of high costs of labor, transportation, and energy in the Northeast, much manufacturing has shifted to other parts of the Nation. Wealth has moved out, taking along the tax base to suburban areas. And highway development, housing subsidies, and Federal assistance and construction programs have encouraged development to move outside the central cities. Yet, as a Nation, we have made a substantial investment over the past several hundred years in these cities. The oldest in the Nation, they are rich in cultural heritage and continue to support the heaviest concentrations of population in the United States. For their own populations, their metropolitan areas and regions, and the Nation as a whole, these cities represent major centers of commercial, industrial, financial, artistic, and intellectual life.

Although these Northeast centers have experienced some economic decline relative to other

TABLE 6-1. POPULATION OF CENTRAL CITIES AND SUBURBS IN THE NORTHEAST, 1900, 1930, 1960, 1970, 1973
(Thousands)

	1900		1930		1960		1970		1973	
	cc	occ	cc	occ	cc	occ	cc	occ	cc	occ
Bridgeport, Conn.	71	17	147	64	156	181	156	232	148	234
Hartford, Conn.	80	73	164	147	162	387	158	505	148	522
Washington, D.C.	279	133	487	219	763	1,312	756	2,104	733	2,219
Baltimore, Md.	509	209	805	264	939	864	905	1,164	877	1,250
Boston, Mass.	561	760	781	1,387	697	1,898	641	2,112	618	2,122
Springfield, Mass.	127	75	250	126	288	205	280	249	272	261
Worcester, Mass.	118	61	135	77	186	142	176	167	170	177
Jersey City, N. J.	206	180	317	374	276	334	260	348	255	343
Newark, N.J.	246	277	442	807	405	1,284	382	1,474	357	1,483
Paterson, N.J.	139	95	248	419	279	907	282	1,076	277	1,077
Albany, N.Y.	185	209	296	224	278	378	256	465	250	493
Buffalo, N.Y.	352	156	573	339	532	774	462	886	425	919
New York, N.Y.	3,437	376	6,930	1.045	7,781	2,912	7,894	3,677	7,646	3,763
Rochester, N.Y.	163	171	328	219	318	413	296	586	276	611
Syracuse, N.Y.	108	172	209	192	216	347	197	439	184	458
Philadelphia, Pa.	1,294	598	1,951	1,186	2,002	2,340	1,948	2,869	1,861	2,944
Pittsburgh, Pa.	452	632	670	1,353	604	1,801	520	1,881	479	1,885
Providence, R.I.	236	172	330	347	357	464	342	557	330	593
Mean	476	243	840	488	902	941	884	1,156	851	1,184
Standard deviation	793	213	1,577	452	1,771	818	1,800	1,005	1,744	1,030

NOTE: cc denotes central cities, occ denotes suburbs.
SOURCE: Advisory Council on Intergovernmental Regulations *Trends in Metropolitan America*, Feb. 1977, p.11.



SOURCE: Department of Commerce, Bureau of the Census. *Historical Statistics of the United States: Colonial Times to 1970*, Washington, D.C., Department of Commerce, Bureau of the Census, "Population Profile of the United States, 1975," Series p. 20, No. 292, Current Population Reports, Washington, D.C.

FIGURE 6-1. TOTAL POPULATION OF THE UNITED STATES BY REGION, 1940-1975.

parts of the country, travel within the region continues to grow. At peak travel times, streets and highways are more crowded than ever and airport access roads are congested. Flight delays are caused by weather conditions and overcrowded airspace at periods of high demand. Although intercity travel in the Northeast Corridor (NEC) is a relatively small proportion of total travel, prudent transportation investments are still needed to alleviate the significant delays frequently experienced by intercity travelers. For, if overall travel in, around, and between NEC cities increases as anticipated and further relief in some form is not provided, intercity travel will continue to be a frustrating experience for hundreds of thousands of travelers. Combined with other investments in the cities, improved transportation will place the region in a better position to attract and maintain a viable economic base and to stimulate improved business and social exchange along the NEC. It is important to consider in each case whether such improvements contribute environmental enhancement, vitality, energy efficiency, and social benefits to the communities served and do not detract from investments already made in their substantial physical, cultural, economic, and community resources.

THE NEEDS AND THE COSTS

IMPROVING THE AIR MODE

Currently, many air travelers encounter congested access routes to and from the major NEC airports, particularly during peak periods that coincide with rush-hours for local traffic. Although there are various mass transit projects and programs designed to alleviate the situation, if there is an expanded use of wide-body jets and an increased number of airport operations (as shown in table 6–2), there is likely to be even greater congestion on the roads to the airports than is being experienced today; and unless ground commuter traffic is substantially reduced and many more air travelers make use of mass transit, congestion will continue to worsen. Community opposition makes the construction of new access routes unlikely. Congestion experienced on access routes, at terminals, and in takeoffs and landings will have the greatest relative impact on travel time for short-distance travelers.

TABLE 6-2. AIRCRAFT OPERATIONS FOR THE MAJOR METROPOLITAN AREAS, NEC, FY 1975 AND FY 1990
(Thousands of operations)

Comparison values	Boston	New York	Washington, D.C.
FY 1975	267	865	490
FY 1990	380	1,270	667
Change (%)	+42	+47	+36
Average annual % change	2.4	2.6	2.1

SOURCE: Federal Aviation Administration, Terminal Area Forecasts, 1978-1988, Jan. 1977.

It is the runway system, which is the least susceptible to changes, that has the greatest impact on airport operations. A Federal Aviation Administration (FAA) analysis of runway conditions at 24 major airports experiencing delays found that Boston, New York, and Philadelphia aircraft delays are likely to increase over the next 15 to 20 years [1]. Strategies such as improvements in air traffic control and the use of quotas and higher landing fees at peak hours could provide relief under these circumstances; and if rail passenger service within the NEC continues to improve with an increased ability to draw airline passengers to rail, airport expansion or new construction could conceivably be avoided for some time.

New York

In the New York area, no major airport expansion programs (beyond existing airport boundaries) are likely because of environmental constraints and the extent of urban development surrounding each of the airport sites.

The development of a surplus military field, Stewart Field in Orange County at Newburgh, N.Y., for commercial operations as a fourth air carrier airport to serve the New York metropolitan region has been considered, but community opposition and distance have made the existing proposal infeasible. Alternatives for increasing air carrier capacity at Kennedy, La Guardia, and Newark include the diversion of remaining general aviation flights to reliever sites, the possible diversion of international flights to other eastern seaboard or inland airports, and the increased use of regional reliever airports for selected short-haul air carrier operations.

Boston

The Massachusetts Port Authority (MASSPORT), a State transportation agency, owns and operates Logan International Airport.

The physical expansion of Logan by land acquisition is not feasible because of adjacent bodies of water and the extent of built-up areas close to the airport site. According to MASSPORT's current planning and forecasting activities, Logan has the capacity to meet projected air carrier demands through 1990. Nevertheless, the concept of a second major air carrier airport in the Boston area has been advanced for a number of years, but no feasible proposals have resulted. Any further effort, in the near future, to select a site for a second major air carrier airport in the highly developed Boston/eastern Massachusetts area will encounter environmental constraints, political sensitivities, demand constraints, and financial restrictions.

Philadelphia

Philadelphia International Airport (PHL) is the major airport for the Philadelphia metropolitan area and an extended area encompassing southern Pennsylvania, southern New Jersey, and most of Delaware. Any expansion of PHL through land acquisition could have significant adverse environmental impacts and require relocation of some of the existing facilities.

Although the probable need for a new air carrier airport by the end of the century is recognized by Philadelphia airport planners, no site selection efforts are underway or proposed for the near future. The soon-to-be-completed airport systems plans for Pennsylvania and New Jersey are not expected to recommend the construction of a major jet airport in the Philadelphia vicinity. Alternative options to the construction of a new air carrier airport in the Philadelphia area have been suggested in previous studies. Any future jetport site selection efforts in the Philadelphia area will undoubtedly encounter the following obstacles: unavailability of suitable land areas, political sensitivities, financial restrictions, environmental constraints, and general citizen opposition. Strong citizen opposition in 1971 aborted plans for a new general aviation airport in nearby Delaware County, Pa.

Table 6–3 shows construction costs for new airports that could serve the incremental demand over saturation at Boston, New York, and Philadelphia airports for the year 2000. Other NEC airports are expected to have sufficient capacity without major new construction.

THE HIGHWAY

Forecasts indicate that intercity highway travel in the NEC will increase by at least 48 percent in the period between 1975 and 1990. The congestion encountered on the highways by intercity travelers can be attributed, primarily, to two factors: (1) congestion of freeways near and within metropolitan areas; and (2) The sharp peaking character of highway travel.

TABLE 6-3. NEW AIRPORT INCREMENTAL CAPITAL COSTS AT SELECTED SITES FOR THE YEAR 2000

Item	Boston	New York	Philadelphia
New runways	1	1	1
Airport capital costs (million 1976 $):			
Construction	99.4	150.6	110.6
Building	90.0	150.5	92
Land	82.5	45.6	82.5
Total	271.9	346.7	285.1

SOURCE: Federal Aviation Administration. Establishment of New Major Public Airports in the United States, Aug. 1977.

One-third of intercity auto and bus trips must bypass one or more metropolitan area and confront heavy urban traffic at the beginning and end of the journey. Without basic changes in the way people presently travel—primarily on the road—28 percent of the rural interstate mileage and 53 percent of the urban interstate mileage nationwide will experience traffic demand exceeding design capacity in 1990[2]. According to Federal Highway Administration (FHWA) traffic data, capacity on certain segments of I-95, the major north-south route between Boston and Washington, D.C., will be exceeded substantially in 1990.

As highway capacity is saturated, the frustrated intercity traveler is likely to: experience a reduction in speed; transfer to other highway routes; travel at less congested times, if possible; divert to other modes; and, as other modes approach capacity limits, divert to other destinations, or simply not travel. To relieve highway congestion for all travelers, several potential strategies are described below.

New Construction

(1) Construct a new north-south highway. The 1971 report, "Recommendations for Northeast Corridor Transportation," proposed a bypass highway spine, consolidating and improving existing highways into a new north-south route bypassing major metropolitan areas [3]. A highway route information system, costing around $86 million in 1978 dollars would warn intercity travelers of congestion ahead and give directions on how to get from I-95 to the alternate spine. To avoid the big cities, the route would be 100 miles inland from I-95, a relatively long distance to travel to avoid intracity traffic, and likely to add so much mileage that it would attract only long-distance travelers. However, it is unlikely that the unbuilt portions of the spine could be constructed. Construction of sections of I-95 and other routes up and down the NEC has encountered intense community opposition. Costs for constructing the 452-mile I-95 have averaged $6.5 million per mile. However, costs range up to $848 million for 4.9 miles, including the Fort McHenry Tunnel in Baltimore [4].

(2) Add lanes to beltways. The intercity traveler can find trip time lengthened by as much as 40 percent if he is caught in a traffic-choked beltway where the intrametropolitan area traffic spills on to the interstate system. Two 3.9-mile lanes were added in

each direction on route I-495 in Maryland to provide relief at a cost of $10,329 million. Other sections including interchanges could be far more costly, but a billion dollars spent eliminating bottlenecks could improve travel time by 15 minutes or more. However, new capacity on the beltway tends to encourage new development, which then clogs the new highway lanes almost upon completion.

(3) Expand the interstate spine. The costs for enlarging tunnels, cuts, and fills, or constructing new structures, such as bridges, could be so large in urban areas that interstate lane expansion in some sections might not be feasible [2]. Furthermore, every new lane adds more noise to the affected area. Noise barriers and drainage basins for the new lanes could also drive costs up.

More Efficient Management of Existing Facilities

(1) Install freeway surveillance and control systems for congested facilities. This is currently being applied in the form of ramp metering and/or closure in various parts of the country. In 1978 dollars, this would cost $52 million.

(2) Implement differential pricing for parking, bridges, tunnels, and entering the central business district to discourage peak-hour driving.

(3) Divert intercity passengers and freight to other modes where capacity is underutilized. The railway has large excess capacity for intercity freight and passenger traffic. With greater use of transport of truck trailers on flatcars, heavy truck traffic could be reduced on the highways. With an improved rail system, many auto travelers should become train travelers thereby relieving some congestion on the highway. It is also possible that some drivers will switch to the bus as well as the train if a severe fuel shortage occurs.

(4) Within the city and on its fringes, better public transportation and paratransit facilities might induce drivers to leave their cars at home. Restricted parking and greater use of the auto-restricted-zone concept in central cities in conjunction with special provisions for mass transit will make more efficient use of existing streets and highways and improve the community environment.

THE INTERCITY BUS

At present, intercity bus traffic accounts for 5 percent of all intercity trips of less than 250 miles in the NEC, and 3 percent of trips between 250 miles and 500 miles [5]. Bus riders are attracted primarily by lower fares and flexible service. Growing congestion on the urban segments of intercity expressways, the 55-mph speed limit restriction, and rising fuel prices (with rising fares) are all contributing to an erosion of the intercity bus lines ability to attract more passengers from other modes. Improvement potential for the bus could include: (1) improving terminal locations in cities so that bus terminals could be integrated with railway stations, where appropriate; (2) exclusive busways and other operational improvements to existing highways; (3) operating subsidies that would allow increased frequency of service and/or lower fares; and/or (4) additional highway capacity dedicated for bus use if strategies (1) (2) (3) are insufficient. Although the bus offers advantages over air and auto with respect to air quality and energy efficiency, any capacity improvements dedicated for use by buses could place additional burdens on the roads in the most densely populated and traveled portions of urban areas. Operational improvements that do not involve new highway construction are being actively encouraged by the Department of Transportation (DOT).

THE RAILWAY

Rail has large, underutilized capacity in its system. The expansion of air service with its speed advantage and the development of the interstate highway system for the convenient and ever increasing number of automobiles have been the underlying causes of the decline in rail ridership from the peak levels achieved at the end of World War II. Furthermore, as traffic has declined, railroad corporations came to believe that passenger service was incapable of becoming profitable, and that it would continue to be a drain on freight earnings. With the establishment of the National Railroad Passenger Corporation (Amtrak) in October 1970, Congress recognized the need to relieve the Nation's railroads from the burden of providing intercity rail passenger service as well as the need for Federal funding to assist Amtrak.

Along the NEC, the demonstration of high-speed rail service and the marketing efforts of Amtrak have shown that with ridership in 1977 at twice the level of the late 1960's, the downward trend in patronage can be reversed. The Northeast Corridor Improvement Project (NECIP) will take another long step in the direction of providing a restored rail system in the NEC, capable of moving large numbers of people efficiently. Further improvements to the rail system are discussed in detail in chapter 7.

BENEFITS OF IMPROVEMENTS: A CHOICE AND AN OPPORTUNITY

Better management of all modes can achieve improved intercity transportation with reduced congestion. However, at the stage that additional capacity is needed to reduce congestion, rail capacity can be increased without the adverse environmental impacts that expansion of air and highway facilities would involve. Consistent with national energy conservation and environmental quality goals, rail improvements will contribute to the vitality, strength, and revitalization of NEC cities and towns; and thousands of productive jobs will be created.

With completion of the NECIP, the traveler will have a real choice among modes and a greater opportunity to travel. With improved train frequency, the rail system should be convenient, permitting travelers freedom to depart according to their own schedules. Traveling comfortably from center city to center city without the tension of coping with traffic congestion, or the time taken by security checks or takeoff and landing delays, the intercity traveler should find the rail trip safe, relaxed, and reliable; and as the train travels on its own right-of-way, it will be far less subject to operational hazards in foggy, rainy, or snowy weather than the auto, bus, or plane.

It is conceivable that with improvements to feeder lines, intermodal connections, stations, tracks, and equipment to achieve more efficiency, comfort, reliability, and still shorter trip times, present users will benefit, and more travelers should find it convenient and preferable to shift to the train. The congestion, environmental stress, and social costs of other modes should then be reduced as well as the need to construct new or expanded air and highway facilities.

Some of these benefits are discussed in more detail below.

IMPROVED SOCIAL MOBILITY

There are millions of people in cities of the Northeast who do not own automobiles or are unable to drive because they are either too young or too old or because a handicap prevents them from driving. In 1970, in the Northeastern Standard Metropolitan Statistical Areas, 32 percent of the population were without automobiles compared with 19 percent nationwide. For the central cities, where most trips begin and end, the percentages are greater. Even among those who do own cars, there are many who might drive for short trips in town but prefer not to endure the congestion and stress of freeway driving or the confinement of bus travel for longer intercity trips. For many of the growing number of people living alone, a convenient rail system is often more appealing than driving. For many older people and people with low and moderate incomes, transportation is a major problem, limiting them from participating in the life around them [2]. With off-peak fare discounts, the rail system can offer the elderly, the young, the handicapped, and the low-income person the opportunity to travel by train at an affordable price. A system attractive to higher paying riders is more likely to afford such discounts. Without such a system, the choice for everyone is more limited.

In addition to those who cannot or will not drive, there are some who would rather not take a trip than bear the costs, or hazard the anxiety they associate with flying.

For all these groups, an improved passenger rail system expands mobility and provides opportunities for congenial, comfortable, and pleasant travel as cities are brought closer together with shorter trip times. The region becomes more socially and economically integrated with more efficient and convenient rail service.

EMPLOYMENT

Reducing unemployment is one of the goals of title VII of the Railroad Revitalization and Regulatory Reform (4R) Act. The NECIP is anticipated to create a total of 38,250 person-years of labor throughout the NEC as the program is implemented [5]. Table 6–4 estimates man-years of employment by State and year. The figures noted represent only construction-related jobs and do not include jobs generated through manufacture and transportation of construction materials and employment induced in other sectors of the economy by NECIP; thus, if these factors are considered, the total number of jobs created during the construction period would be around 100,000. Further improvements would, of course, generate more construction-related jobs.

Another goal of the 4R Act is to encourage minority employment and to contract with minority businesses for construction projects. A goal of NECIP is

TABLE 6-4. MAN-YEARS OF EMPLOYMENT BY STATE AND YEAR FOR TOTAL NEC IMPROVEMENT[a]
(Fiscal years)

State	1977	1978	1979	1980	Total
Massachusetts	358	858	1,460	1,102	3,778
Rhode Island	262	749	1,163	985	3,159
Connecticut	534	1,698	2,912	2,610	7,754
New York	242	582	1,094	592	2,510
New Jersey	423	1,158	1,774	1,486	4,841
Pennsylvania	369	901	1,393	1,135	3,798
Delaware	239	894	1,193	656	2,982
Maryland	658	1,704	3,300	2,194	7,856
Washington, D.C.	73	371	793	335	1,572
Total, annual	3,158	8,915	15,082	11,095	38,250
Total, cumulative	3,158	12,073	27,155	38,250	

[a]Figures represent equivalent man-years of employment on the NEC improvement program and exclude those involved in peripheral areas related to final material preparation (e.g., manufacturing, processing, transportation, etc.).
SOURCE: Department of Transportation, NECIP, Draft Programmatic Environmental Impact Statement, Aug. 1977.

to ensure that minority business firms are employed throughout project implementation. The DOT has established a Minority Business Resource Center in FRA to assist in reaching the minority-hiring goals for employment that have been set for construction contractors. With the help of the National Urban League, minority-training programs for construction skills will be developed through local, public, and private agencies concerned with assuring equal opportunity employment.

A more permanent effect of rail improvements will be the increased levels of Amtrak employment throughout the NEC. New jobs created in order to accommodate the growth in ridership are estimated to bring a 5-percent increase over total 1975 railway employment in the eight NEC States and the District of Columbia by 1990. Jobs in the two largest employment categories—maintenance-of-way and maintenance-of-equipment—will be divided among maintenance facilities and several repair shops.

The reduction of travel on other modes will reduce somewhat the number of jobs they provide. The major transfer from road will not result in any significant loss of auto-related employment. However, some airline and bus company jobs that would have been created by 1990 if rail service were not improved will not be needed. With the NECIP and any further improvements in rail service, as many as 4,000 net, new, permanent jobs could be created by 1990 [5]. In addition to the direct creation of jobs, improved rail will stimulate development around stations and business and service activity. The employment opportunities created should be a welcome assist towards improving the area's economy.

LAND USE

As discussed earlier, it has become increasingly difficult to construct new or expanded highways or airports in the NEC. Already more than 30 percent of the land in major cities is used for roads and parking facilities. A new highway can remove from the tax base as much as 36 acres per mile and 200 to 300 acres for a single interchange. Up and down the NEC, communities have rejected long-planned freeways in favor of mass transit as the adverse effects of new roads on the character of neighborhoods and the countryside have become apparent. Furthermore, highway construction often spurs new development on the urban fringe, requiring costly new services and community facilities, and draining strength from older communities.

As for the air mode in the NEC, it has been almost impossible to locate an airport site accessible to airport users that would not have adverse effects on existing communities. New airports in the NEC would require at least 5,000 to 10,000 acres to construct. On the other hand, most rail rehabilitation and renovation will take place on preexisting railroad right-of-way, requiring no relocation or demolition. Handsome stations will be restored, and travelers arriving at these stations in the central city should make use of city facilities and create a market for the development of shops, hotels, residences, restaurants, and offices nearby. Such is likely to be the case in Boston, Providence, New London, New Haven, Newark, Wilmington, Baltimore, and Washington, D.C., where improved rail should stimulate investments that add new dollars to the tax base without incurring the need for large increases in services such as water, sewer, and fire protection. These investments in rail, in stations, and in associated facilities would be made at a time when people in greater numbers are coming back to the older neighborhoods in town, attracted by their architectural and community character, their space, and their convenient location.

ENERGY

Electric utilities and transportation are the greatest energy consumers, using about 25 percent and 24 percent, respectively, of all energy in the NEC. Transportation uses more than half the Nation's annual petroleum consumption [2]. At present, nearly half our consumption is based on imported oil. If energy consumption continues to increase at the present rate, oil imports will be likely to increase substantially, with the automobile consuming more than half of total imports. The cost of oil will continue to rise, and our balance of payments position will be even less favorable than it is today.

In the NEC, petroleum is the basis of most of the energy used for transportation. Gasoline accounts for 75 percent, jet fuel accounts for almost 10 percent, and electricity is used for less than 0.5 percent, according to the Federal Energy Administration 1977 Computer Data Bank. Each travel mode can be compared in terms of fuel consumption per passenger-mile and the assumed number of persons per trip (load factor). (See table 6–5.) Rail is energy efficient—much more so than automobile or aircraft—and is almost on a level with the intercity bus. However, reduction of overall fuel consumption in the NEC as a result of an improved rail system will be slight because intercity transportation uses only 1.3 percent of the total Btu consumed for all transportation in the NEC States. It is still significant in dollar terms.

With the complete electrification of the rail system, assuming that oil-fired electric boilers are converted to coal, hydroelectric, or perhaps some other source of energy at some stage, and diversion of passengers from other modes using petroleum-based fuels, the consumption of gasoline, diesel, and jet fuels will decrease. As much as 360,000 barrels of oil and $8.3 million per year could be saved with the NECIP program. An additional 92,000 barrels of oil and $2.1 million could be saved annually with the rail system improved to achieve the 2 1/2-hour and 3-hour trip times. If highway and air improvements were made instead of improvements to rail, more energy would be consumed; rail patronage and its viability would be likely to decline; and the possibility of flexibility for a power source for essential transportation would be lost. If, on the other hand, highway and air travel becomes more congested, fuel more costly, and far more intercity travelers are diverted to rail, oil savings would, of course, increase, and our dependence on foreign oil would be further lessened.

TABLE 6-5. BTU PER PASSENGER-MILE BY MODE

Mode	NEC load factor (%)	Btu/ passenger-mile
Rail (1975):		
Electric	43	1,308
Diesel		2,125
Turbine		2,344
Electric:		
1982	56	1,035
1990	61	931
Bus	51	819
Air	55	8,500
Auto:		
1975	35	4,116
1982	35	3,125
1990	35	2,315

SOURCE: Department of Transportation, Federal Railroad Administration, Draft Programmatic Environmental Impact Statement, p. 3-75, Aug. 1977.

AIR QUALITY

The operation of airplanes, buses, and automobiles produces carbon monoxide (CO), hydrocarbons, nitrogen oxides (NOX), and particulates. In addition to these pollutants, the generation of electricity for electrified rail produces particulates and sulfur dioxide (SO_2). The adverse effects of these pollutants have been long recognized. With the diversion of intercity trips from road and air to rail and with the electrification of the track north of New Haven, under the NECIP, there will be a small reduction in total pollutants along the NEC. Table 6–6 shows the ef-

TABLE 6-6. TOTAL AIR POLLUTANT EMISSIONS CHANGES IN THE NEC, 1990
(Tons)

Pollutant	Auto	Bus	Air	Electrification, north of New Haven	Utility plant max.	Total
CO	-7,008	-44	-356	-215	+40	-7,583
HC	-876	-19	-102	-38	+12	-1,023
NO_x	-511	-220	-213	-443	+720	-667
Particulates			-9		+639	+630
SO_2				-77	+3,035	+2,958
Total suspended particulates				-34		-34
Aldehydes				-7		-7
Organic acids				-9		-9
Total	-8,395	-283	-680	-823	+4,446	-5,735

SOURCE: Federal Railroad Administration calculations (Office of Policy and Program Development) based on data from the NECIP Draft Programmatic Environmental Impact Statement, Aug. 1977.

fect of the NECIP on pollutant levels, assuming conversion of oil-fired electric-generating plants to coal. The increase in fuel consumption due to the increase in electrical power generated for movements along the NEC will increase certain air pollutants. The emissions resulting from electrical energy generation for NECIP are also shown in table 6–6. The SO_2 emissions would be negligible compared to total electricity emissions projected in 1990. However, SO_2 can cause severe effects on public health if not adequately controlled. With more efficient control by equipment in smokestacks, or if low-sulfur coal is burned, there will be much fewer rail-related SO_2 emissions at the power station.

Increased rail patronage on NEC trains and a concomitant reduction of passengers on the other forms of intercity transportation would further reduce the amount of CO, hydrocarbons, and NOX but will have little effect on the amount of electrical energy generated and the pollutants produced by the generation. Insofar as improved rail passenger transportation in the NEC will benefit the region with improved air quality, it will contribute to the goals set by the Clean Air Amendments of 1977, P.L. 95–95.

NOISE

Rail improvements will reduce noise for both the traveler and the NEC environment. In the operation of trains on the NEC, the following factors will affect the noise decibel (db) level.

Continuous welded rail. . . . . 5dB less
Curve realignment. . . . . .3dB less
Bridges. .some reduction
Electrification . . . . 4dB-10dB less
Extra speed, 80 to 120 mph. . . . . . .5dB more

These improvements will provide for a 28-percent decrease in the Equivalent Noise Impact by 1990 according to the *Draft Programmatic Environmental Impact Statement,* prepared for NECIP [5].

To put this noise level assessment in the proper perspective, one must consider the noise in other modes of intercity travel. Noise is a major social cost of flight. Extensive airport operations at Kennedy, La Guardia, Newark, Philadelphia, Logan (Boston), and National (Washington, D.C.) have resulted in severe noise impacts on surrounding residential communities. Takeoff and landing noise creates annoying interruptions in schools, business offices, and residential areas.

Noise suits are pending in several cities. For example, in East Boston approximately 2,200 people (1970 census data) reside within the Noise Exposure Forecast 45 noise contour of Logan Airport, and several legal actions have resulted from adverse noise impacts. MASSPORT has initiated extensive measures to reduce adverse noise impacts associated with landings and departures, including rigid adherence to Federal Aviation Regulation

(FAR) 36 noise levels, preferential approach and departure routes, and restriction warm-ups [1].

In the highway mode, noise levels continue to be a problem due to the dense urban environment of the NEC. The sight of new housing developments backed up to the interstate is a familiar one to the rider on the NEC. For urban areas, the noise levels are far above Federal Highway Administration (FHWA) design noise levels.

SAFETY

The NECIP will provide a generally safer environment in which all trains can operate at higher speeds. The grade-crossing elimination program will segregate rail traffic from vehicular and pedestrian movements; and the selective fencing of the right-of-way along the NEC will prevent most train accidents resulting from vandalism, foreign material, pedestrians, or animals on the tracks.

In the NEC, as in the rest of the Nation, motor vehicle accidents are the leading cause of deaths and a major cause of accidents. In 1975, an estimated 46,000 persons nationwide died in motor vehicles and nearly 2 million disabling injuries were reported [2]. Table 6–7 compares fatalities and accidents per million passenger-miles for various modes. Rates shown are comparative fatality rates based upon the rail rate. As can be seen, bus, plane, and rail accidents are neglible relative to auto.

With the NECIP, 10 fatalities per year valued at $4 million and 7,031 accidents valued at $10.3 million will be avoided as 6.5 million auto passengers divert to rail. With further improvements in rail and more passengers diversion, one additional fatality per year could be avoided, and there could be an annual reduction of 724 persons injured in accidents. The National Highway Traffic Safety Administration has estimated the average social costs of a highway fatality or injury. These costs include such factors as loss of earnings, cost of hospitalization, property loss, and funeral expense. Based on a value of $400,000 per fatality and $1,600 per accident, around $14.8 million per year in social cost would be avoided with the NECIP and an additional $1.56 million cost would be avoided each year with further improvements beyond the NECIP.

TABLE 6-7. COMPARISON OF FATALITIES AND ACCIDENTS
(Per million passenger-miles)

Mode	Fatalities	Ratio	Accidents
Auto (personal)	.0140	20.00	9.3
Bus (intercity)	.0008	1.14	NDP
Plane	.0012	1.7	NDP
Rail (intercity)	.0007	1.00	NDP

NOTE: NDP = no data provided, but the amount is considered insignificant relative to auto accidents.
SOURCE: Department of Transportation, summary of National Transportation Statistics Annual Report.

PUBLIC TRANSIT

Public transit will derive direct benefits from improved rail service in the form of increased demand for its services. Because most rail stations are located in the center city, business and pleasure travelers usually have ready access to public transportation to the station and, on arrival, find good transit connections to their final destinations. As further rail improvements increase ridership and intercity transit schedules and intercity bus connections are coordinated with rail, the demand for public transit in the NEC should increase. Furthermore, improvements in the efficiency and attractiveness of stations will benefit commuters as well as intercity travelers.

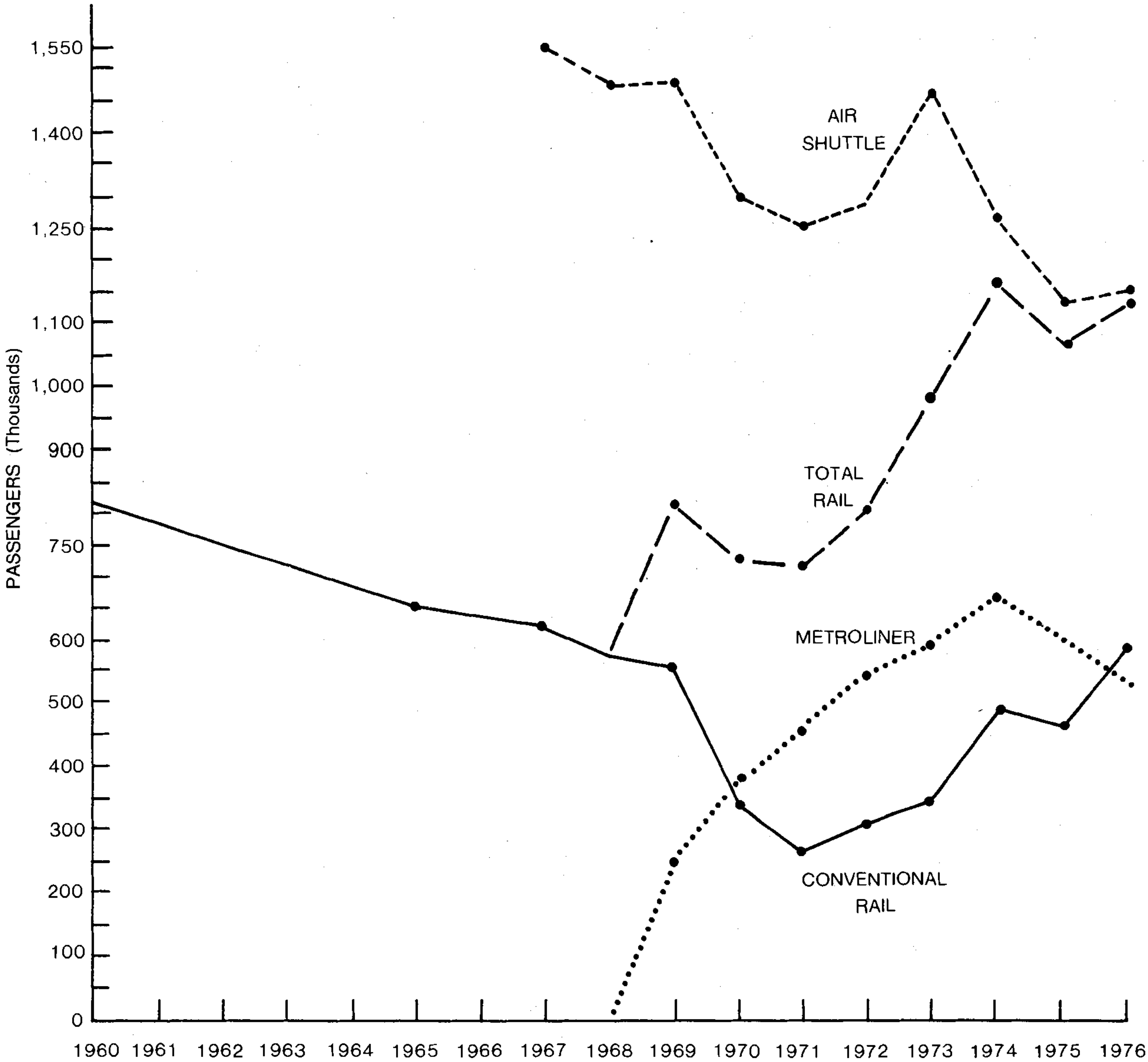
THE RAIL POTENTIAL (MARKET DEMAND)

Presently, the rail mode is underutilized. In the NEC, rail could easily carry many times the number presently carried.

THE HISTORICAL CONTEXT

In 1944, 75 percent of the people who traveled between cities in the United States by common carrier chose trains. According to *Transportation, Facts and Trends, July 1976,* 565 million passengers were carried by first-class railway nationwide in 1944 [6]. Although no actual figures are available specifically for the NEC, it is estimated that between 56 and 80 million riders were carried. By 1969, more than 90 percent of commercial intercity travelers nationwide used planes or buses; fewer than 8 percent rode trains [7].

By the late 1960's, the rail passenger business in the NEC had been allowed to run down. In the period after World War II, the vastly increased use of the automobile and the rapid development of commercial air services were responsible for a substantial and continuing reduction in the number of intercity rail passengers. The railways compounded the situation by disinvesting in passenger services, leaving the rolling stock antiquated and in need of repair. Moreover, disheveled stations wearily greeted passengers persistent enough to chance uncertain departure and arrival times and shabby trains. Nevertheless, in 1969, conventional trains between New York and Washington, D.C., carried about 5 million passengers a year. But the advent of the Metroliners was the first serious attempt in more than 20 years to provide any improvement for passengers. The experiment demonstrated that if trains are clean, modern, convenient, and on time, people will ride. The Metroliner successfully established a new rail image in the age of the automobile and the airplane. It carried more than 2 million passengers in its first 2 years of operation, and in the first year of its operation, ridership increased by 8 percent [7].



SOURCE: Robert L. Winestone, "Staff Paper, Ten Years of Train-Air Data in the New York to Washington Passenger Market," Department of Transportation, Federal Railroad Administration, Office of Federal Assistance, Rail Passenger Programs Division, May 1977.

FIGURE 6-2. NEW YORK—WASHINGTON,D.C., RAIL AND AIR SHUTTLE PASSENGER DATA. (Thousands)

THE MARKET ATTRACTED: SHIFTS IN MODES

As Metroliners increased in frequency, air travelers were attracted to its downtown-to-downtown service. The rail share of total air and rail passengers for the New York—Washington, D.C., city-pair increased from approximately 25 percent in 1965 to 40 percent in 1976. Rail passenger traffic peaked at 45 percent of the total combined travel during May 1977. Whereas in 1968 the air shuttle carried over twice as many passengers as rail, in 1976, it was virtually equal in passenger loads to rail with about 1.1 million journeys per year [8]. Figure 6–2 shows the pattern of ridership on the trains and the air shuttle in the NEC in recent years. Use of both the shuttle and the Metroliner has declined, in part, as a result of the decline in the economy.

Although the Metroliners sparked the rail revival, conventional trains have been gaining ridership. When rail fares on conventional trains were reduced in 1972, ridership increased on these trains. In March 1976, when new locomotive-hauled Amfleet cars were introduced for conventional service, ridership on Amfleet trains rose 11 percent, while the increasingly less comfortable and often late Metroliner attracted about 11 percent fewer riders [9]. The additional riders on the Amfleet cars indicate a possible shift from Metroliners to conventional trains or simply a shift from Metroliners to other modes. Some polls show that a number of automobile users are shifting to trains. Total NEC ridership increased 5 percent from December 1975 to December 1976 and grew from 9.7 million riders in December 1976 to 10.6 million by September 30, 1977, according to the *Amtrak Five-Year Corporate Plan,* October 1977 [10]. Although ridership continues to climb, the poor on-time record, particularly for Metroliners, is a deterrent to many travelers. Recent reports from Amtrak show that in the first 9 months of 1977, Metroliner ridership was down 8 percent, but ridership on other trains in the NEC has increased by 6 percent.

WHO IS RIDING?

In autumn 1975 and spring 1976, Amtrak conducted on-board surveys of passengers to determine who is currently riding their trains in the NEC. (See table 6–8). About 67 percent of trips on the Metroliner and 43 percent on Amfleet cars were for business purposes. Table 6–8 shows, however, that the current market for both services draws a wide cross section of the population, with a tendency for the more affluent patrons to ride the Metroliner and the more cost-conscious travelers to use Amfleet.

TABLE 6-8. CORRIDOR PASSENGER PROFILES IN 1976

Demographic profile	Rail passengers	
	Metroliner (%)	Amfleet (%)
Sex:		
Male	70	53
Female	30	47
Age:		
Under 18	1	6
18-24	15	21
25-34	32	25
35-44	27	16
45-54	13	13
55-64	9	12
Over 65	3	7
Median	39	33
Marital status:		
Married	65	49
Single	28	39
Widowed	2	5
Divorced	4	5
Other	1	2
Annual family income ($):		
Under 5,000	2	9
5,000-9,999	6	10
10,000-14,999	10	15
15,000-19,999	13	15
20,000-24,999	15	13
25,000 over	54	38
Highest level education attained:		
Grades 1-8	1	2
Some high school	1	4
High school graduate	5	12
Some college	17	28
College graduate	25	24
Some graduate work	12	9
Graduate degree	39	21
Trip purpose:		
Business	67	44
To/from school	7	10
Shopping	5	1
Personal	10	16
Vacation/recreation	6	11
Visit friends/relatives	10	18
Occupation:		
Professional & technical	35	29
Managers & administrators	27	15
Sales workers	3	5
Clerical	12	3
Blue collar and service workers	2	5
Homemaker	6	13
Retired	3	6
Student	10	20
Unemployed	2	4

SOURCE: Amtrak Marketing Department.

An Amtrak survey in 1976 showed that there are significant differences between ridership on Metrocoach and Metroclub. Seventy-five percent of all Metroclub passengers were professionals or managers compared to two-thirds (66.3 percent) of those on Metrocoach. Eighty-five percent of all passengers using Metroclub had household incomes over $25,000. In both categories, on-time performance was most important to passengers, while quality of food and courteous service were important considerations. All passengers felt that the fares paid were worth the services offered. The results indicate that there is a strong market for high-income business travelers when first-class services are offered.

WHO WOULD RIDE?

According to a 1972 nationwide market survey, prepared for Amtrak by Louis Harris & Associates, Inc. (table 6–9), there is a clear and strong public interest in providing, continuing, and improving intercity passenger train travel in the United States. The survey found that the mobile section of the population, whether traveling by car, bus, rail, or air, was primarily composed of young people under 30, people with a college education, and people earning $15,000 and over in 1972 dollars. Dissatisfaction was expressed about station locations, parking, the quality of food and service, and the interest of the railroad in keeping the service alive. Among the three most mobile groups, a substantial minority, or more than three times the number currently riding are likely to be attracted to ride the trains as improvements in train travel and marketing are made [11].

No analysis of potential ridership by elderly passengers, groups, or singles appears to have been made in the survey. However, personal comfort, safety, the ability to look out and see interesting scenes enroute, to obtain refreshments on board and to move around in transit blend into a single theme that adds up to a special personal freedom and comfort unique to train travel for all age groups. This combination cannot be matched by other forms of transportation. Sixty-five percent of those surveyed felt that there is something exciting about taking a trip by train. In other words, traveling by train can be a pleasurable experience. The survey found that more of the public would ride trains if trains ran on time, were new, and kept clean; if train attendants were friendly and attentive to needs; if train terminals were modern, efficient, and located at convenient places. With NECIP terminal improve-

TABLE 6-9. PUBLIC OPINION REGARDING IMPROVED TRAIN TRAVEL

Louis Harris Questionnaire	A great deal of difference (%)	Only some difference (%)	No difference at all (%)	Not sure (%)
If trains almost always ran on time	61	25	12	2
If the time of a train trip were reduced by 50%	56	23	15	3
If trains were new and were kept sparkling clean	56	30	13	1
If train attendants were friendly and attentive to your needs	54	30	13	3
If train terminals were modern and efficient	53	31	13	3
If there were a terminal located at a place convenient to where you live	52	27	19	2
If overnight trains had showers and modern up-to-date bathroom facilities	50	30	18	2
If long-distance trains provided facilities for carrying automobiles so that you could take your car with you	43	20	34	3
If low-cost rental cars were available to you when you arrived at your destination	35	29	33	3
If there were new railroad cars with modern, stylish decoration	31	34	34	1
If there were three classes of travel—first class, coach, and economy	29	33	34	4
If trains offered more entertainment such as new movies	23	29	46	2
If you could purchase tickets by using any major credit card	22	20	52	6
If trains had telephones so that you could make calls along the way	18	24	57	1
If attendants wore colorful, new uniforms	14	24	60	2

SOURCE: A survey of public mandate for the current passenger market and the potential market for intercity rail passenger travel in the U.S., Louis Harris and Associates, Inc., June 1972, p.1.

ments, upgraded track and equipment, and better parking facilities at most stations, in combination with service improvements on the part of Amtrak, some of these concerns will be satisfied.

The Competitive Situation

The frequency of air service on major routes in the NEC is already so high that any increases in frequency would not add significantly to the convenience of air. On the other hand, it cannot be expected that air frequencies will be reduced to such a low level as to eliminate its competitive position with regard to rail—except perhaps in the Philadelphia—New York market. Air speed is not likely to increase in the NEC, but time consumed in airport access and parking and air space congestion will increase. For the bus or car, travel time will not be reduced, but smaller, energy-saving cars may affect comfort, particularly for long-distance trips.

The automobile will continue to provide the most convenient and flexible way to reach many destinations. However, as rail service improves in time, comfort, and convenience, for many intercity travelers, it can become an increasingly sensible, inviting, and sociable alternative to congested highways, the stress and boredom of driving, and the frustrating search for a place to park in city centers.

Further improvements achieved in rail would be made in a receptive climate. Recent changes in living patterns may work in favor of public transportation—both intracity and intercity. Smaller families, two adults' earnings, and more singles make travel more affordable and possible; and as the costs of land and housing continue to rise and a number of persons shift from single-family detached housing to apartments, townhouses, and in-town living, public transportation becomes more attractive. As in-town stations serve the city dweller or worker, improved beltway stations may increase the draw from the suburbs to rail.

Fares

To bring new riders into the system, fare policies will have to be attractive. It is possible to make more efficient use of the equipment available and to spread the passenger loads more evenly by discounts for riders at off-peak times. The business traveler is likely to pay a premium price to travel at peak hours on the deluxe Metroclub-type service or on the time-competitive Metroliner coach. Auto and bus travelers, generally traveling for personal purposes, are less sensitive to time and more influenced by cost.

Table 6–10 shows fare and time comparisons on the various modes and includes access connections. It is possible that a fare closer to the air fare could be charged for Metroliner coach travel and still gain significant transfer of passengers from air to rail where journey times are comparable. For similar distances in the United Kingdom, with journey times around 2 hours, 30 minutes (London to Manchester, Liverpool, and Leeds), British rail has been able to increase its first-class fares to the level of the airplane fare and on occasion, somewhat above it, without appreciable retransfer to air [12]. Discount fares at off-peak times have been highly successful in the United Kingdom. Students, the elderly, families, and groups traveling together (such as school, special interest, etc.) can be offered special rates. In addition to such special discounts, lower fares at off-peak hours could increase use of high-speed rail for lower income groups. With an expanded market, the social benefits of the Federal investment would be extended to a wider cross section of the American public.

Public Information

To publicize the new and better service, television and radio advertising appears to be most effective in reaching a broad market—although well-placed posters and newspaper and magazine advertisements also have benefits. Good information from a toll-free telephone call and clear signs and directions in and near stations will instill confidence in the system. If a simplified ticketing and reservation system is used and if the rail traveler can walk on without a reservation as the airline customer can, a trip by train becomes natural and convenient, and total trip time is reduced.

Stations and Access

From the middle of the 19th century to the middle of the 20th century, the railroad station was at the central position in the American community. As cities prospered, the railroad station became a grand entrance, representing the cultural and commercial achievements of the city or town in which it stood. Today, in the NEC, stations are often larger than necessary for train service. However, they readily lend themselves to adaptive uses for restaurants, shops, and museums that can complement the rail use. If the station is to be adapted in part for other uses, it will be particularly important to assist the traveler or user in finding his way to the train.

TABLE 6-10. FARE AND TIME COMPARISONS BY MODE, NEW YORK CITY–WASHINGTON, D.C., JANUARY 1978

Mode	Line haul, 1 way ($)	Total fare, line haul + access ($)	Travel time (h. min): Line haul	Access connection	Total
Rail:					
Metroliner:					
Coach	25.50	29.50 w/taxi	3.00	1.00	4.00
Club	38.00	42.00 w/taxi	3.00	1.00	4.00
Conventional:					
Coach	20.50	21.40 w/publ. trans.	3.00	1.40	5.30
Club	30.50	33.90 w/publ. trans.	3.50	1.40	5.30
Round trip, off peak	[a]15.50	16.40 w/publ. trans.	3.50	1.40	5.30
Air:					
Shuttle	40.00	55.00 w/taxi	.50	1.40	2.30
		45.75 w/publ. trans.	.50	2.30	3.20
Round trip, weekend	[a]24.50	39.50 w/taxi	.50	1.40	2.30
		30.25 w/publ. trans.	.50	2.30	3.20
Bus:					
Express	15.00	15.90 w/publ. trans.	4.20	1.40	6.00
Round trip excursion, 30-day	[a]15.00	15.90 w/publ. trans.	4.20	1.40	6.00

[a]For all round-trip options, fares and times are shown one-way.

A well-planned station will welcome the traveler with clear directions to the ticket office, restrooms, information booths, train platforms, restaurants and snackbars, and connecting trains. Arrival and departure times will be visually displayed at convenient places throughout the stations and perhaps even outside; signs will include such useful information as intermediate stops and whether refreshments are available on board. Well-lighted, comfortable seating areas near arrival and departure information signs will help to create a relaxed and secure feeling while waiting. Well-lighted station platforms with the station name clearly marked will reassure the passenger that the system is functioning and ready for use. Once on board, if the ride is comfortable and relaxed, if cars and washrooms are well maintained, and if reasonably good food is available, the traveler will feel welcome and assured that basic needs can be met with train travel and is likely to return again and again. As parking, taxis, and connecting mass transit improvements are made and schedules publicized, the rail trip will become more convenient. Poor performance in these aspects would be a deterrent to rail travel.

THE UNIQUENESS OF RAIL

It can be assumed that the train is a distinctive mode attracting its own patrons just as the bus, the car, and the plane. The plane serves mostly longer distance trips; the automobile is a short-distance, door-to-door carrier that provides cheap transportation for families and groups traveling together and is useful for trips with widespread and random destinations; the bus attracts most of its riders for relatively short distances where the confined passenger space is no problem. The intercity train is intermediate and has a distinct sector in which it excels. Furthermore, it will be performing in a new and improved way. There is evidence to show that when a new mode, or a dramatically improved mode, is introduced, new traffic is generated. British Rail experiences with London to Manchester and Glasgow service showed that when trip time was reduced, traffic volume increased substantially; the largest element of gain was in new traffic generated [12]. As the railway is restored and renewed and the public perceives major improvements in convenience, frequency, reliability, reduced travel time, and comfort, it can be assumed that people will ride in greater numbers.

FURTHER ANALYSIS OF THE MARKET

It is generally recognized that the market for rail has not been sufficiently surveyed; and even if the market were clearly identified, it has not been determined how best to attract and serve it.

More research is needed on travel patterns, geographical areas served, trip purposes, and attitudes regarding the relative importance of price, time, frequency, service quality, express and local service, and reserved and unreserved arrangements. Furthermore, it will be important over the next 5 years and especially when the NECIP is in place to test the effect of various marketing techniques, service types, patterns and fares, and related offerings such as station and access improvements, provision of accommodations, and rental cars. Cost-benefit analyses should also be conducted to determine what improvements can be made to better serve the the following: the New York suburban market that does not have easy access to Penn Station; the feeder lines from Harrisburg to Philadelphia and from Albany to New York City; and connecting Boston to New Haven and New York by way of Springfield, Mass. Other possible extensions, such as Washington, D.C.—Richmond, Va., should be examined. The cost-benefit analysis should consider whether it is possible to improve passenger volumes and revenues for these feeder lines in order to contribute to the overall financial performance of the total NEC operation. Most important, in order to make the most of this environmentally sound and energy-efficient mode, public investments in other forms of transportation and community development should work to reinforce the investments made in rail and not to reduce the effectiveness of such investments.

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CHAPTER 7. POSSIBLE RAIL IMPROVEMENTS BEYOND NECIP

The Northeast Corridor (NEC) main line may be able physically to accommodate investments beyond the Northeast Corridor Improvement Project (NECIP) outlined in chapter 3. Such further improvement ideas would require careful scrutiny from the standpoint of cost-effectiveness, since they would be competing not just against each other but also against broader Federal-funding needs in transportation and nontransportation fields. In that light, this chapter categorizes concepts for railroad improvements beyond NECIP and indicates how cost-benefit analyses could be applied within each category. The concepts fall generally into the following groups.

- Post-NECIP improvements that would not significantly affect scheduled running times.

- Post-NECIP trip-time reductions to achieve trip times on the NEC spine of 3 hours from Boston to New York. Two hours, 30 minutes, from New York to Washington, D.C., would already be achievable after NECIP completion through appropriate service options, exemplified in chapter 5; thus, any post-NECIP trip-time reductions south of New York would serve merely to expand the spectrum of service options under which 2 1/2-hour timings would be possible.

- Improvements to the feeder lines via Springfield, from Albany, and from Harrisburg.

Each of these major categories is analyzed in turn.

POST-NECIP IMPROVEMENTS

In selecting among investments, a railway management must constantly compare the stream of benefits with the capital costs to be gained from each and must, on that basis, establish a priority list. Investments with the highest ratio of benefits to costs would be performed first. In this respect, the NEC resembles any other railway; it will receive those improvements that promise the greatest benefits for the money spent. (Because the NECIP is a national enterprise, benefits may encompass not only financial but also public benefits, as discussed in ch. 6.) Any possible improvements beyond NECIP would, by definition, reflect a lower proportion of benefits to costs than would those included in the NECIP.

What follows, then, is a listing of possible post-NECIP improvements for additional system capacity, further operating economy, and still higher passenger service quality. These possible investments now have a lower priority than the NECIP components outlined in chapter 3. Nevertheless, ongoing engineering economy analyses within the NECIP could conceivably lead to some interchange between the NECIP described in chapter 3 and the potential post-NECIP improvements exemplified below and in appendix H.

SAMPLE INVESTMENTS FOR ADDITIONAL SYSTEM CAPACITY

The NEC handles a wide variety of trains (intercity passenger, commuter, through freight, and local freight), traveling at different speeds and exhibiting different operating characteristics. Should the number of trains grow, congestion may occur at certain locations. There are two generic ways to relieve such congestion: first, by adjusting operating procedures and schedules to avoid tieups by taking full advantage of the existing physical plant (one example of this could be the imposition of rigorous schedules on all freight movements, many of which are now unscheduled); second, after feasible avenues under the first approach have been exhausted, by expanding track capacity at bottlenecks. After NECIP completion, therefore, NEC operations should benefit from a series of noncapital-intensive adjustments as congestion among trains increases, until prior simulations or actual operating experience will have revealed that the need for capital investment can no longer be avoided.

At that point, available track capacity investment opportunities would require evaluation and rank ordering along such parameters as the following.

- Capital cost per passenger-minute (or ton-minute) of delay avoided

- Capital cost per percentage-point increase in system on-time performance (can be applied to any service or segment thereof)

- Capital cost per dollar saved through operating-cost reduction (every congestion delay has some cost, if only the energy cost of additional train stops and starts)

- Capital cost per dollar gained in revenue (would require intensive research into correlation of demand with on-time performance)

- Return on investment, calculated on the basis of the future stream of net benefits (revenue gains plus operating-cost savings) versus expenses (capital cost plus any short-term operating-cost penalties during construction)

The above parameters would apply to such potential capacity investment opportunities as the following.

Baltimore Tunnels

Owing to freight car clearance problems, the Baltimore and Potomac (B&P) Tunnel, in Baltimore, has an effective single-track capacity, and, therefore, is an especially congested area. The Department of Transportation, the State of Maryland, and Baltimore City have developed many alternative solutions to this problem, (as summarized in app. H),some of which address restructured operations rather than construction.

Additional Tracks, Flyovers, and Interlockings

Numerous locations exist where additional tracks (passing and siding) would reduce congestion and avoid delays, particularly to freight trains. Flyovers (grade-separated rail junctions) at Lane, N.J., and at Harold and New Rochelle, N.Y., have been suggested as offering congestion relief and improved dependability. Interlockings are strategically spaced locations where trains can move from one track to another. Improvements here can include the provision of new interlockings and the reconfiguration of old ones to afford more operating flexibility or to allow for higher speeds on diverging movements between tracks.

SAMPLE INVESTMENTS FOR FURTHER OPERATING ECONOMY

Having introduced all feasible operating economies through improved procedures, streamlined organization, and effective use of personnel, a railway may be able to reduce future operating and maintenance costs through judicious capital investments. Thus, numerous investment opportunities for cost reduction may be available on the NEC beyond the NECIP. Such potential improvements would require careful evaluation and comparison through the use of cost-benefit measurements (e.g., return on investment). Typical post-NECIP improvements for operating economy might be the following.

Completion of Centralized Traffic Control

The NECIP incorporates centralized traffic control (CTC) south of Wilmington and east of New Haven. The installation of CTC between Wilmington and New Haven could produce eventual operating economies through the elimination of manned interlocking towers.

Additional Bridge Rehabilitation

There are 771 undergrade bridges in the NEC which, by inspection, have been assigned to one of three categories depending on their structural condition: critical, questionable, or adequate. All bridges in the critical category and some in the questionable and adequate categories would be included in the NECIP, which will assure the structural integrity of NEC bridges for the speeds and loadings envisioned after NECIP completion. However, the NECIP bridge program will not fully correct decades of deferred maintenance on the property; in consequence, maintenance costs for bridges after 1982 would be higher than would be normal on a fully rehabilitated railway. To lower these annual maintenance costs, further capital projects for bridges would be possible.

SAMPLE INVESTMENTS FOR FURTHER ENHANCED PASSENGER SERVICE QUALITY

In choosing among modes, the traveler considers not just fares, trip times, and frequencies, but also the overall quality of the passenger experience. Thus, as the service quality of intercity rail improves, ridership (hence, revenues) can be expected to increase. In addition to the many noncapital-intensive service quality improvement possibilities, the NEC beyond the NECIP would present many competing opportunities for capital investments in service quality. Examples would be the following.

Improving Curves for Better Riding Comfort

Although NECIP will make some improvements to the alignment of the railway to meet the trip-time goals, there would remain certain curves that could benefit from realignments for still smoother ride quality.

Additional Station Improvements

Beyond the NECIP, further operational station improvement possibilities have been identified at several stations. For example, in New York and Philadelphia, such additional operational improvements might include the rehabilitation of existing station utility, heating, ventilation, and air conditioning systems for enhanced long-term viability of the station buildings. Also, beyond the 15 stations originally considered in the NEC engineering studies of 1974–76, several other locations may merit investigation from the viewpoints of marketing, train operations, overall economics, and community development. Examples of these possible locations would be Back Bay Station, Boston, Mass.; Bridgeport, Conn.; Rye, N.Y.; and Cornwells Heights, Pa.

POST-NECIP TRIP-TIME REDUCTIONS

The Railroad Revitalization and Regulatory Reform (4R) Act requires an examination of possible post-NECIP trip-time reductions resulting in schedules of 3 hours from Boston to New York, and 2 hours, 30 minutes, from New York to Washington, D.C., with appropriate intermediate stops in each segment. This section analyzes the market demand, the engineering feasibility, and the prospective financial results of such schedules. (All capital costs, operating costs, and revenue figures in this section are in constant FY 1978 dollars.)

MARKET DEMAND FOR SHORTENED SCHEDULES

With the sole exception of Boston—New York—Washington, D.C., trip times, the dual and single service options discussed in chapter 5 remain intact for the purposes of this analysis. Assumed to be introduced in 1986, further reduced trip times are as follows.

Dual Service

Between Boston and New York, half the trains achieve 3-hour schedules with 5 stops; the balance make the run in 3 hours, 30 minutes, with 11 stops. Between New York and Washington, D.C., half the schedules are at 2 hours, 30 minutes, with five stops; the other half, 3 hours with nine stops. Demand is projected to be 21.8 million passengers in 1990 (see app. D).

Single Service

Between Boston and New York, standard trip times are 3 hours with five stops. Between New York and Washington, D.C., half the trains achieve a 2-hour, 30-minute, timing with five stops; the balance make the run in 2 hours, 20 minutes, with stops in Philadelphia and Baltimore. Demand is estimated at 24.4 million passengers in 1990.

ENGINEERING FEASIBILITY

The post-NECIP trip-time reductions proposed in the 4R Act would be attainable in more than one way. Solely through service options, the 2-hour, 30-minute, trip time from New York to Washington, D.C., will be available upon NECIP completion; thus, any further trip-time reductions will (as the single service option demonstrates) merely expand the markets to which the shorter schedule may be offered. North of New York, however, service options — however innovative — will not suffice to lower the schedule to 3 hours.

To enhance the service option flexibility at 2-hour, 30-minute, timings south of New York and to permit 3-hour timings north of New York, the following sample alternatives have been developed and analyzed.

Fixed-Plant-Intensive Alternative

One way to achieve post-NECIP trip-time reductions would be to raise speed limits over 135.1 route-miles to 150 mph and to perform related curve realignments, signaling modifications, and track center modifications, as well as certain incremental improvements on the New Rochelle—New Haven segment. The total estimated cost of these fixed-plant improvements would be $890 million. Appendix J provides further details on the ingredients of this alternative. (Further track capacity additions may become necessary as a result of the higher speeds under this alternative if frequencies warrant and all other means of congestion relief are exhausted.) Although requiring an intensive fixed-plant investment, this alternative would also include the purchase of new vehicles to achieve and sustain the 150-mph speeds.

In the financial analysis, the fixed-plant expenditures flow in equal amounts over a 4-year period, 1982–85. As for vehicles, Bechtel-18 [1] estimates a $71,000-per-vehicle surcharge to provide 150-mph trucks. Thus, new locomotives would cost $2.671 million and new coaches would cost $671,000. Under both service options, it is assumed that only half the fleet will require replacement with the higher performance vehicles. These capital costs do not include any element for greater traction performance, nor do the annual costs include the additional fuel requirements for higher speeds. Although this analysis assumes, for costing convenience, a locomotive-hauled rather than a multiple-unit configuration for the theoretical 150-mph service, the technical and economic feasibility of such high-speed locomotives for NEC applications remain unproven.

It is further assumed that all the new vehicles would be purchased in equal amounts in FYs 1984 and 1985, and that the displaced vehicles would remain in the NEC fleet until their normal "salvage" date, the rest of the national rail system being unable to absorb the sudden influx of secondhand vehicles so quickly. This fleet of excess vehicles could constitute an "energy reserve" for the NEC and other corridors.

Vehicle-Intensive Alternative

Dating from the 19th century, the alignment of the NEC spinal main line suffers from scores of curves, many of them severe—particularly in the New York—Boston section. These curves have corresponding speed restrictions; it is for this reason that the fixed-plant-intensive alternative proposes so thorough a curve realignment program. On curves, the speed restrictions stem not from vehicle safety limitations — the vehicle-track system is so stable as to permit centrifugal forces far in excess of those allowed under the curve speed limits — but from considerations of passenger comfort. In short, the vehicles and the track can absorb far greater forces, hence far greater speed limits through curves, than the passengers can. If speed limits can be raised on existing curves, thereby taking advantage of the capabilities of equipment and track, while passenger comfort is protected, then trip times can be significantly reduced with a sharply reduced investment in curve realignments.

This is the essence of the tilt-body vehicle concept. As a tilt-body vehicle enters a curve, an active suspension system provides additional banking within the cars to protect passengers from excessive centrifugal forces. While attractive in theory, the concept has yet to be proven in 120-mph electrified railway passenger service on a regular basis.

In-service testing of representative examples of tilt vehicles will be underway in Europe during the coming year. In addition, the National Railroad Passenger Corporation (Amtrak) will be testing Canadian tilt-body equipment in the Pacific Northwest in 1979, in regular service. Such sustained revenue service would help to resolve the question: Will the basic concept work and meet with passenger acceptance at acceptable levels of maintenance and operating costs, with performance up to specifications and with complete safety?

If the technology were to prove successful in practical use, the next question would be: Would the application of tilt-body vehicles in the NEC achieve or approach the reduced trip times proposed in the 4R Act? Train performance calculations performed on computers with theoretical tilt vehicles indicate that the answer here may be "yes"—a properly working tilt vehicle might indeed meet the further reduced trip-time goals of 2 hours, 30 minutes/3 hours. Bechtel-9 [2] demonstrated that at a maximum 120 mph, the theoretical tilt vehicle could achieve significant journey time reductions in comparison to existing equipment in the NEC.

In the financial analysis, the fixed-plant capital costs for this alternative are estimated at $89 million for a possible incremental upgrading of the New Haven—New Rochelle link. Vehicle costs — incremental to achieve active tilt — are estimated, on a preliminary basis, to amount to $71,000 per 120-mph vehicle. For the purpose of this analysis, it is again assumed that half the vehicle fleet under both service options would be replaced with tilt vehicles in FYs 1984 and 1985, but the displaced vehicles would remain in the NEC fleet.

Although operating cost-estimating relationships are held constant before and after these post-NECIP trip-time reductions, it is conceivable that a tilt-body train could — by its design and performance characteristics — engender significantly reduced maintenance and energy unit costs. For example, experience on one European railway suggests that a tilt train now under development could reduce energy costs by 4 percent, and maintenance costs by 11 percent from current levels for high-speed trains. Because these savings are speculative, they are not included in the financial analysis.

Fixed Plant Plus Tilt Vehicles

Another alternative would be to combine the fixed-plant improvements with the tilt vehicle to achieve minimal journey times. Under this theoretical option, Boston—New York could conceivably enjoy 2-hour, 30-minute, service, which would be fully within the range of competition with air carriers. (To evaluate this alternative, the single-service option was modified to afford Boston—New York average trip times equal to those between New York and Washington, D.C., with corresponding demands.)

FINANCIAL ANALYSIS OF ALTERNATIVES

Table 7–1 summarizes the results (tabulated in app. K) of the financial projections for post-NECIP reduced trip times. The following conclusions can be drawn from these projections.

- A reduction in trip times through service options south of New York with no reduction north of New York has a net present value (NPV) far superior to that of the fixed-plant-intensive alternative. It is therefore difficult to justify implementation of the fixed-plant-intensive alternative on grounds of railway economy.

- By contrast, the vehicle-intensive alternative — if technically feasible — shows a NPV superior to that of alternatives having longer trip times. From the standpoint of railway economy, this alternative merits further verification, investigation, and comparison with the service options alluded to in chapter 5.

- While an alternative combining fixed-plant improvements with tilt vehicles would show the best operating results projected by this study, such an approach does not appear to be justifiable (from the standpoint of railway economy) in view of its relatively inferior NPV.

CORRIDOR FEEDER LINES

The 4R Act authorized NECIP to improve rail facilities along three feeder lines that extend from the NEC main line. The feeder lines are: Boston to New Haven via Springfield, Mass. (the Inland Route); Albany to New York City (N.Y.); and Harrisburg to Philadelphia (Pa.). Improvements to these lines are to "facilitate compatibility with improved high-speed rail service" on the main line. Funding for such improvements under the 4R Act is authorized only after the main line has been upgraded to meet the trip-time goals set by the Act.

TABLE 7-1. COMPARISON OF ALTERNATIVES FOR POST-NECIP TRIP-TIME REDUCTIONS, 1990
(Constant FY 1978 $)

Category	No further trip-time reductions, dual service	2:30 service option, no further reduction north of New York single service	Fixed-plant intensive		Vehicle intensive		Fixed plant plus tilt vehicle, single
			Dual	Single	Dual	Single	
Passengers (million)	19.50	21.84	21.80	24.42	21.80	24.42	26.00
Passenger-miles (million)	2,215.90	2,481.80	2,582.20	2,892.80	2,582.20	2,892.80	3,259.36
Revenue (million $)	227.3	254.6	262.5	294.0	262.5	294.0	332.5
Total operating cost (million $):							
High	258.1	279.0	263.6	281.9	263.6	281.9	293.3
Low	189.3	208.1	199.3	216.0	199.3	216.0	229.7
Surplus/deficit (million $):							
High	-30.8	-24.4	-1.1	12.1	-1.1	12.1	39.2
Low	38.0	46.5	63.2	78.0	63.2	78.0	102.8
Operating ratio:							
High	114	110	100	96	100	96	88
Low	83	82	76	73	76	73	69
NPV, 1978-2000, 10% discount (million $):							
High	-467.3	-474.5	-934.8	-879.0	-438.9	-383.2	-783.7
Low	-28.2	-21.1	-513.5	-446.0	-17.6	49.8	-360.3
Reference table	G-3	G-4	K-2	K-3	K-4	K-5	K-6

All three feeder lines serve State capitals (Albany, Harrisburg, and Hartford) and each is positioned to produce the same kinds of social benefits that spurred the NEC main line improvements. Many of the markets retain strong commercial, industrial, and financial ties to the major cities of the Northeast that are served by the NEC main line. Each line has retained a level of service, over time, sufficient to have kept the rail travel option from slipping completely from public awareness.

This section summarizes the opportunities presented by the feeder lines for rail service upgrading. What is needed for each line, however, is a detailed economic analysis similar to that which this study has undertaken for the main line.

INLAND ROUTE

Two important rail lines link New York, New Haven, and Boston: the Inland Route via Springfield and the Shore Line via Providence. Although (for reasons summarized in the NECIP Programmatic Environmental Impact Statement) the Shore Line has been selected for intensive upgrading to meet the 3-hour, 40-minute, New York-Boston trip time, the Inland Route could serve a higher population at intermediate points, and therefore has a potential market for improved rail passenger service.

At present, Amtrak owns the Springfield—New Haven portion (62 miles) of the 161-mile Inland Route through Connecticut and Massachusetts. The line from Springfield east to Framingham is Consolidated Rail Corporation (Conrail) property with the Massachusetts Bay Transportation Authority owning the 21 miles from Framingham to Boston.

Areas considered important rail markets are New Haven, Wallingford, Meriden, Hartford, Springfield, Worcester, and the region west and north of Boston. Patronage for the 10 trains operating each way daily from Springfield to New Haven is approximately 270,000 per year, for an average journey of 39 miles.

A first level of work on the Inland Route could be the proposed Amtrak program to correct deferred maintenance between Springfield and New Haven. Such a program would not address the Springfield—Boston segment and would not include the institution of through service from Boston to New Haven or New York via Springfield.

Other possible levels of improvement could upgrade the entire Boston—Springfield—New Haven line and provide potentially attractive service for Worcester, Springfield, and Hartford. Such further levels of improvement could also result in providing certain suburban communities to the north and west of Boston with access to the Inland Route that would prove more convenient than present access to the main line.

ALBANY

Terminating at Grand Central Terminal (GCT) (N.Y.), the Albany line lacks a direct connection to the NEC main line. For this reason, the Albany line is a feeder of the NEC in theory only; any significant development of through-passenger travel across New York would depend on improvements to connections between GCT and Penn Station.

Nine trains operate daily each way on the 141-mile Grand Central to Albany line, which is owned by Conrail north of Croton-Harmon and by Penn Central Trustees south of that point. Of these, five continue beyond Albany to Buffalo, Montreal, and other points. Extensive commuter service from GCT to Croton-Harmon, with limited additional service to Poughkeepsie, is provided by the Metropolitan Transportation Authority (MTA). It is the only one of the three feeder lines that is equipped with centralized traffic control.

Intercity rail markets exist in New York City, Croton-Harmon, Poughkeepsie, Rhinecliff (Kingston), Hudson, and Albany.

Ongoing improvements to the Albany feeder include the track, station, and signal work being performed for the State of New York. These improvements are projected to reduce trip times. In addition, major commuter-related projects funded by MTA south of Poughkeepsie might have a positive impact on Amtrak trip times.

This line has particular station problems at both terminals. At Albany, the present station is located away from major concentrations of population and economic activity, with difficult highway and street access.

Lack of rail connection between this feeder line and the NEC is an important issue in consideration of improvement possibilities. Patronage feeding the NEC could be encouraged by either a possible West

Side connection to Penn Station or better information on connecting transit service at GCT. Alternatively, a creative fare policy (with reductions for cross-New York transfers) could conceivably overcome the impediment to travel that is inherent in the need to change stations.

HARRISBURG

The rail line from Harrisburg to Philadelphia traverses a generally rural area until it reaches Lancaster, a major agricultural center. From Lancaster east, the area served becomes more urbanized until it reaches the suburbs of Philadelphia. By 1990, it is estimated that population immediately along this line will exceed 900,000, with an additional 700,000 people close enough to the line to avail themselves of it. Currently, 11 daily Amtrak trains in each direction connect Harrisburg and Philadelphia. Two additional trains in each direction connect the Harrisburg line with the NEC at North Philadelphia and continue to New York. Southeastern Pennsylvania Transportation Authority commuter trains run between downtown Philadelphia and Paoli, 20 miles distant. In 1976, the Amtrak Harrisburg line carried 778,270 passengers an average distance of 55 miles.

Presently, the Harrisburg line, like the NEC, is electrified at 11 kV 25 Hz and could benefit from modification for full compatibility with planned NEC power (25 kV 60Hz). Conversion of Silverliner equipment to dual-power capability would postpone the need for Harrisburg line reelectrification. Generally, tracks and bridges are in fair-to-poor condition along this line. Despite this, Silverliners between 30th Street Station and Harrisburg average nearly 55 mph, the highest average speed attained on any NEC feeder line. Freight traffic along this line is heavy. For the 12 months, September 1976 through August 1977, over 1.9 billion ton-miles of freight traversed the line, nearly four times the amount of freight on the Springfield to New Haven branch, the other feeder line owned by Amtrak. Because of the heavy freight volume, the Amtrak Board has recommended that the corporate staff investigate the possibility of conveying this line back to Conrail.

Several theoretical levels of work may be postulated for the Harrisburg line. One level would incorporate the proposed Amtrak program and would correct decades of deferred maintenance without significantly improving the inherent capabilities of the line. This first level of work would restore maximum speeds to 80 mph wherever the alignment permits. Other levels, on the other hand, would incorporate further upgrading to raise maximum speeds and achieve trip-time reductions over present capabilities. At present, the best trip time over the branch is 1 hour, 47 minutes.

REFERENCES

[1] Bechtel, Inc., *Task 18—Support Services: Engineering, Economics, and Cost Estimating,* Final Report to FRA—Northeast Corridor Project, July 1976. Bechtel's figures are escalated to 1978 dollars per appendix F.

[2] Bechtel, Inc., *Task 9—Technical and Economic Analysis of Vehicle/Right-of-Way Systems,* Final Report to FRA—Office of the Northeast Corridor Development, Aug. 1975; appendix IV.

APPENDIX A. FREIGHT SERVICE IN THE CORRIDOR

For passenger transportation analysis, the Northeast Corridor (NEC) is an identifiable market. Most trips originate and terminate on the main line; four stations (New York, Washington, D.C., Philadelphia, and Boston) generate over 55 percent of the passenger-miles. This simplicity does not prevail in freight service for several reasons.

First, the NEC is not a closed system for freight to the extent that it is for passengers. Most carloads traversing portions of the National Railroad Passenger Corporation (Amtrak) NEC main line either originate or terminate outside the NEC; in fact, if national averages hold, approximately half the NEC freight originates or terminates outside the Consolidated Rail Corporation (Conrail) system, which provides all freight service on the NEC main line under trackage rights from Amtrak [1].

Second, even within the NEC, freight car pickup and delivery takes place at hundreds of individual sidings and team tracks rather than at a limited number of stations. In Baltimore, Md., alone, Conrail lists 44 freight station accounting codes (origin/destination points for waybill purposes).

Third, physical, if not institutional, alternatives exist for handling much freight traffic to, from, or via the NEC; there is bypass trackage around the NEC for through freight, and much of the local freight to NEC cities can be handled in a variety of routings. Conrail itself owns a parallel route for through freight between Philadelphia, Pa., and northern New Jersey; while not convenient for through trains, physical interchanges exist between Conrail and its competitors at certain points. Such interchanges offer a degree of flexibility. For these reasons, the freight traffic pattern is far more complex than the passenger traffic pattern.

This complexity has important implications for NEC freight service. In the Conrail network and in connecting and competing lines, the level and costs of services to the NEC shippers follow more closely the trends in the Nation, rather than in the NEC per se. This situation has developed because of the various distances and the multitude of origins and destinations. Freight rates and divisions, for example, are established, or adjusted, on national, territorial, commodity-specific, or origin/destination-specific bases, without regard to any artifically defined "NEC territory."

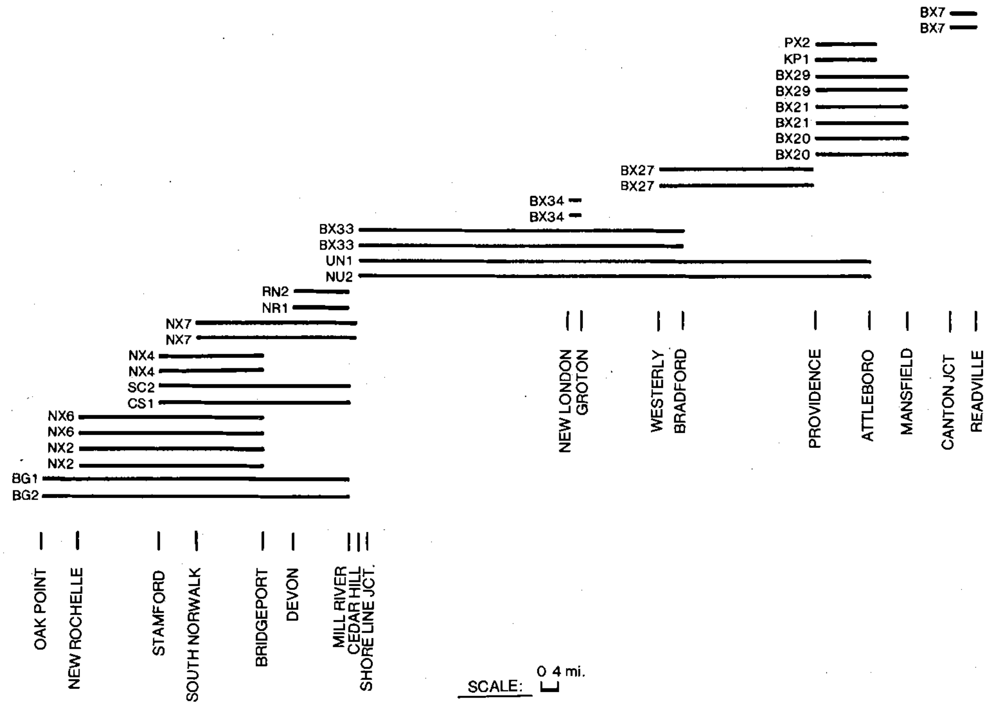
Similarly, service reliability — shown by a Massachusetts Institute of Technology (MIT) study to relate largely to switching, train blocking, and dispatching policies — depends far more on what happens at local yards, on other lines, and at interchange points outside the NEC main line, than on NEC-specific operations [2]. In summary, maintenance and improvement of all freight service located on, or adjacent to, the NEC (as required by the Railroad Revitalization and Regulatory Reform (4R) Act of 1976) will be a depend largely on operational strategies of Conrail and other carriers.

Although there is no demonstrable basis for isolating the NEC main line as an identifiable freight market, it is still possible to categorize and quantify the kinds of freight services performed by Conrail on the Amtrak main line property. The services include the following.

- Through freight—approximately 100 daily movements, of which 70 percent are scheduled.

- Local freight, providing pickup and delivery at local industries—approximately 35 daily movements, of which 80 percent are scheduled [3]. The movements handle approximately 6.1 million net tons of cargo annually [4].

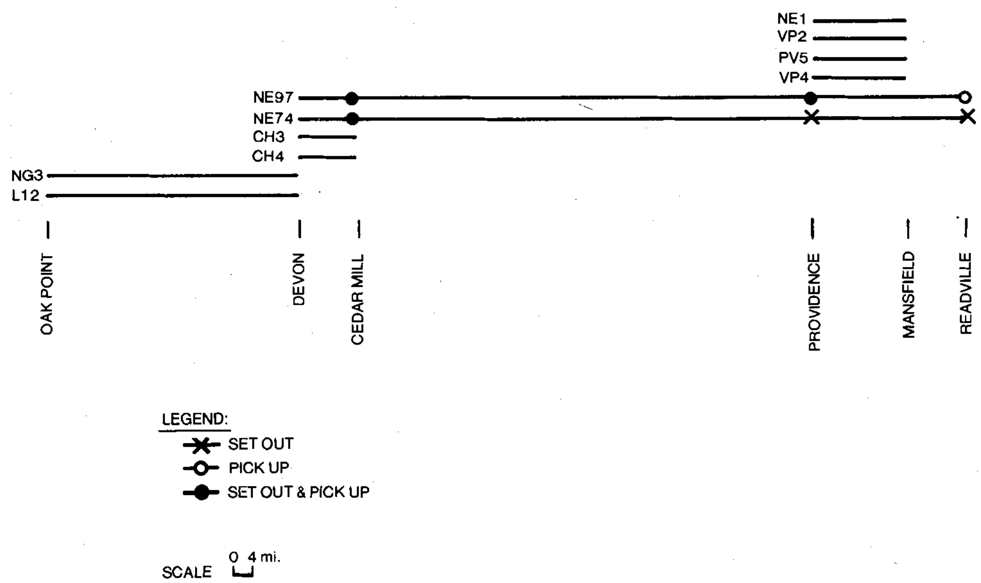
Figure 2-1, in chapter 2, depicts the importance of through and local freight movements with regard to total NEC traffic density. Figures A-1 through A-4 portray the scheduled through and local freight service in the NEC in 1974 and provide a general idea of volumes and major flows. The large number of freights entering or leaving the NEC at Perryville, Md., and Morrisville, Pa., are using bypass routes to and from Harrisburg. The total volume of local and through freight transportation performed by Conrail



NOTE: Each heavy line represents a train with its number preceding.

SOURCE: Department of Transportation, Federal Railroad Administration, Task 4 — Scenario Development and System Simulation, Final Report, Aug. 1975.

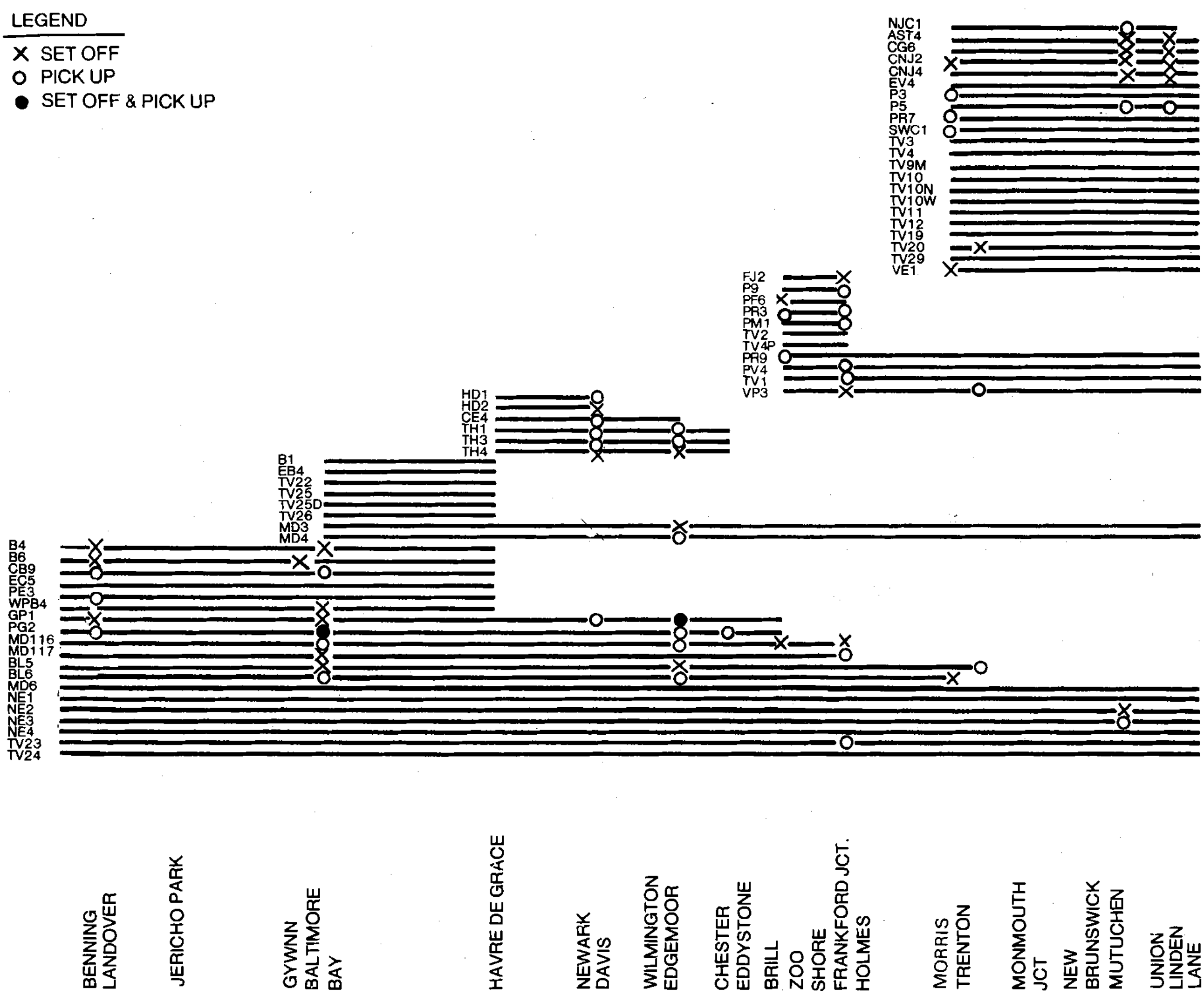
FIGURE A-1. WORK SEGMENTS: SCHEDULED THROUGH FREIGHT TRAINS IN THE NEC, 1974. (Boston — New York)



NOTE: Each heavy line represents a train with its number preceding.

SOURCE: Department of Transportation, Federal Railroad Administration, Task 4 — Scenario Development and System Simulation, Final Report, Aug. 1975.

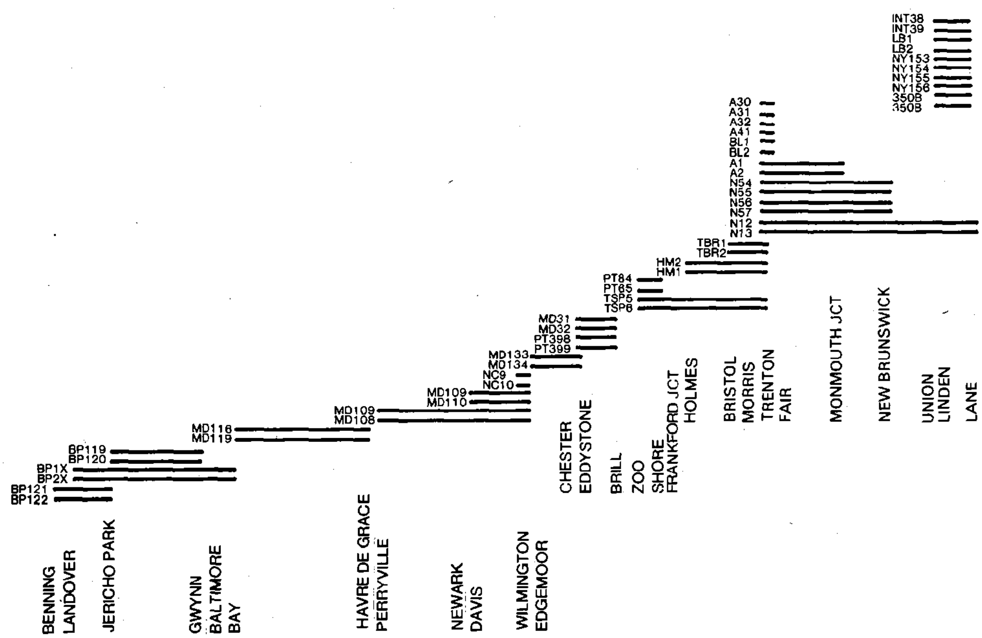
FIGURE A-2. WORK SEGMENTS: SCHEDULED LOCAL FREIGHT TRAINS IN THE NEC, 1974. (Boston — New York)



NOTE: Each heavy line represents a train with its number preceding.

SOURCE: Department of Transportation, Federal Railroad Administration, Task 4 — Scenario Development and System Simulation, Final Report, Aug. 1975.

FIGURE A-3. WORK SEGMENTS: SCHEDULED THROUGH FREIGHT TRAINS IN THE NEC, 1974.
(New York—Washington, D.C.)



NOTE: Each heavy line represents a train with its number preceding.

SOURCE: Department of Transportation, Federal Railroad Adminstration Task 4 — Scenario Development and System Simulations, Final Report, Aug. 1975.

FIGURE A-4. WORK SEGMENTS: SCHEDULED LOCAL FREIGHT TRAINS IN THE NEC, 1974.
(New York — Washington, D.C.)

on the NEC main line was approximately 6.57 billion net ton-miles in FY 1977 [5].

Predictions for future freight traffic on the NEC vary widely and must be treated with extreme caution. In a demand analysis report for the Federal Railroad Administration (FRA), Bechtel projected an increase in freight carloadings between 1973 and 1990 of from 35 percent (low growth) to 100 percent (high growth) [6]. The report does not distinguish between through and local traffic in the application of the multipliers, that were deduced from regional traffic and economic growth trends.

By contrast, an unpublished 1976 report, Local Freight Service Analysis, by Transportation and Distribution Associates, Inc. (TAD), inductively developed carload data for 1968 and 1974 for all local freight trains using the NEC main line, and made projections for local traffic in 1990 [4]. The TAD study showed an 11.3-percent decline in net tons handled by NEC local freight trains between 1969 and 1974 and projected a further 29-percent drop between 1974 and 1990 [7]. Thus, for local service, the two most salient studies appear to produce diametrically opposed results.

Because of the uncertainties surrounding both future NEC freight service and NEC intercity passenger schedules (service options for 1982 are still under investigation; in 1990, frequencies south of Philadelphia could remain as in 1982), the long-term impact of the Northeast Corridor Improvement Project (NECIP) on freight operations eludes quantification at this time. In the short term, of course, the impact will be largely negative; appendix B presents the expected construction effects of the NECIP; chapter 3 describes the proposed NECIP electrification system, which would require Conrail to fund the replacement and modification of its entire electric locomotive fleet.

In the long term, many physical plant improvements proposed by the NECIP would benefit both freight and passenger service. The improved track structure, the rehabilitated bridges, the reconfigured interlockings, the modernized power supply, and the improved signaling/communications/ failure detection systems should have a positive impact on Conrail operating costs, reliability, and flexibility. On the other hand, safety considerations stemming from adjacent high-speed passenger and freight operations could force Amtrak to impose on Conrail more stringent mechanical inspection requirements for equipment entering the main line. Similarly, reliability considerations could lead to a reduction of freight train length limits from 125 cars to less than 100; both the MIT study and recent railway experience have suggested that longer freight trains are more prone to failures and serious delays [8]. Initially at least, Conrail might perceive such restrictive measures as unfavorable consequences of the NECIP. Moreover, increases in intercity and commuter train frequencies, or schedule changes could someday create, or exacerbate, congestion at specific locations and impair freight train performance. Beyond the allowance incorporated in the NECIP implementation master plan for bottlenecks (the NECIP design simulations assume a 30-percent increase in freight traffic from 1982 to 1990), numerous remedies will be available. As chapter 7 indicates, operational changes, including more rigorous and inclusive freight train scheduling, would be applied until no further advantages can be gained; at that point, numerous possible capital investments for congestion relief would become available.

REFERENCES

[1] A. L. Kornhauser, "Development of an Interactive-Graphic Computer Model for the Nationwide Assignment of Railroad Traffic," Final Report, FRA Contract DOT-FR-75225, Sept. 30, 1977.

[2] A. Scheffer Lang, et. al., *Studies in Railroad Economics,* MIT, 1970.

[3] Data extracted by FRA-NECP from the Amtrak "Summary of Conrail Freight Movements in the NEC," maintained at Amtrak's NEC Operations Office, Philadelphia, Pa.

[4] Transportation and Distribution Associates (TAD), "Local Freight Service Analysis," unpublished report to FRA, Feb. 9, 1976. Carload figures for 1974 have been multiplied by the average net tons per carload, Eastern District, 1974 (=56.2), from Association of American Railroads, *Yearbook of Railroad Facts* (AAR Yearbook), 1977.

[5] Carloads extracted by FRA-NECP from the Amtrak "Summary of Conrail Freight Movements," then multiplied by average net tons per carload, Eastern District, 1976 (=57.8), per AAR Yearbook, 1977.

[6] Bechtel, Inc. *Task 1—Demand Analysis,* Final Report, FRA Contract DOT-FR-40027, Apr. 1975.

[7] TAD projections are in carloads; these percentages assume an average 52.1 net tons per carload in 1969; 56.2 in 1974; and 57.8 in 1990, per AAR Yearbook.

[8] As reported in Robert H. Leilich, *A Study of the Economics of Short Trains,* Peat, Marwick, Mitchell, and Co., June 1974. The volume cited from MIT is A. S. Lang and R. Reid, *Railroad Car Movement Reliability: A Preliminary Study of Line Haul Operations.*

APPENDIX B.
IMPACT OF NECIP CONSTRUCTION PROGRAM ON FREIGHT AND PASSENGER SERVICE

In order to set the stage for the following discussion of operational planning for the Northeast Corridor Improvement Project (NECIP), a current general plant and operation description from Boston, Mass., to Washington, D.C., is in order. Except where otherwise stated, the Northeast Corridor (NEC) is owned by the National Railroad Passenger Coroporation.

Boston, Mass., to New Haven, Conn., a distance of 156 miles, is primarily a two-track railroad with limited sections of three and four tracks. The right-of-way is owned by the Massachusetts Bay Transit Authority (MBTA) in Massachusetts. The signal control is single direction automatic block. Twenty-five interlockings, where trains move from one track to another track, have obsolete control mechanisms. The switch movements in some of the interlockings are operated mechanically. The train operation is by diesel locomotive. Freight and intercity passenger trains operate over this section and share the facilities between Providence, R.I. and Boston, Mass., with commuter trains. The NECIP and a major MBTA project in Boston will share the same right-of-way for 3–1/2 miles upon completion. For the duration of its construction, the Southwest Corridor Project will require the rerouting of NEC traffic to the Dorchester Branch from Readville, Mass., to Boston, Mass.

New Haven, Conn., to New Rochelle, N.Y., a distance of 56.6 miles, is a four-track railway. The railway in Connecticut is under a long-term lease to the Connecticut Department of Transportation from the Penn Central Trustees: the New York portion is owned by the Metropolitan Transit Authority. The operation is primarily electric. The traffic consists of intercity passengers, freight, and a major commuter movement to Manhattan's Grand Central Terminal.

New Rochelle, N.Y., to Penn Station, N.Y., a distance of 16.5 miles, is primarily a two-track intercity passenger railway. The Bay Ridge freight branch serving Queens and Brooklyn, N.Y., parallels this section and enters the NEC at Pelham Bay (Baychester), N.Y., and freight jointly uses the two tracks to New Rochelle, N.Y. From Harold interlocking in Long Island City, N.Y., the facilities are jointly used by the Long Island Railroad commuter operations and intercity passenger service into Penn Station.

Penn Station to Newark, N.J., a distance of 10 miles, is a two-track, passenger-only railway with an automatic block signal system and electric operation. This line is heavily used by both intercity and commuter trains. A major related project is proposed for this area. The direct access of a Conrail (formerly Erie Lackawanna) commuter line to Penn Station would require track and related facility connections. If the connection were built, the impact of added traffic on planned operations would have to be provided for.

Newark, N.J., to Wilmington, Del., a distance of 106.5 miles, is a four- to six-track railroad carrying intercity and commuter passengers and freight traffic. Train control is by automatic block with some bidirectional areas. The operation is electric. Commuter trains are operated by Conrail for both the New Jersey Department of Transportation and the Southeastern Pennsylvania Transportation Authority.

Two major related projects are proposed in this area. A Port Authority Trans-Hudson extension to Plainfield, N.J., would parallel the NEC from Newark, N.J., to Elizabeth, N.J. The proximity of construction might impact NEC operations. The Philadelphia Airport Line, as designed, would operate jointly on the NEC for approximately 1 1/4 miles south of Philadelphia, Pa. This project would require interlocking configuration changes and planning for the added traffic in this area.

Wilmington, Del., to Washington, D.C., a distance of 109.3 miles, is primarily a three-track railway with areas of two and four tracks. The signal system is automatic block with bidirectional control in some areas. The operation is electric. The traffic is intercity passenger and freight trains, with a small number of commuter trains.

Within the NECIP, components that impact operations are those that require the removal of a section of track from operations between two points to construct or improve the track or the supporting facilities. The outstanding components that impact operations during construction or improvement are: track structure; realignment of the railway; changes in interlocking configuration; tunnels; a portion of the bridge work; station track or facilities near the track, such as passenger platforms; signal changes or improvements, when implemented or tested; electric traction systems south of New Haven, Conn., (which are "live" and will require a cutoff of the power when being worked on); and any other work that may endanger the safe operation of the railroad.

Complex scheduling is required to complete the NECIP. To minimize the impact on train operation, the NEC has been segmented into 11 Railroad Development Projects (RDP), the boundaries of which were selected to enable the diversion of trains around work in the segment. General agreement has been reached for the taking of a portion of a track out of service in each of the 11 RDPs. Within each of these projects are several interlockings that provide for the movement of trains from one track to another. The general agreement provides that a given track, between two consecutive interlockings in any one or all of the 11 RDPs, may be out of service for the necessary project time. There are practical considerations that must also influence the planning, such as balancing the train diversions for the south- or westbound and north- or eastbound trains so any delays to trains are equally distributed. In other words, a train traveling from Boston to Washington, D.C., may experience five or six diversions from the normal route (tracks) it traverses. These crossover moves are made at lower speeds, causing some train delays. Amtrak may wish to consider temporary modifications to the published schedules in order to reflect the delays due to construction.

The present construction planning is based on scheduling for the improvements to the track structure. The other component improvements are then scheduled to coincide with, or fit, openings in the RDP schedule. As more definite project time requirements are determined, this strategy will be reassessed with possible scheduling planned around the project requiring the most track occupancy. For example, if a track is out of service, it could be moved to a new alignment, and the rail and tie work between the two consecutive interlockings can be performed at the same time.

Based on the 11 RDPs and the present planning, there could be as few as 11 and as many as 66 projects affecting operations at any one time in the NEC.

As detailed schedule requirements are determined, the impact on train operations will continually be assessed by the application of a track access evaluation simulation model. This model replicates the existing NEC operating conditions and the planned construction scheduling. It then simulates the traffic at that time to identify any problem area that may require schedule changes to minimize train delays.

The simulation model will be used for more than preplanning. It will allow for identified schedule problems to be analyzed and necessary steps to be taken to plan around the problem.

With the work so structured and scheduled, delays to passenger and freight transportation can be anticipated. The delays will reach a maximum during the most intense construction period and then diminish as completed improvements reduce train-running times.

APPENDIX C. NORTHEAST CORRIDOR RAIL STATIONS

INTERMODAL CHARACTERISTICS AND RELATED DEVELOPMENTS

The Northeast Corridor Improvement Project (NECIP) proposes to selectively rehabilitate and upgrade 15 stations in whole or in part (see fig. C-1). These improvements are directed at accommodating and promoting high-speed rail patronage through extensive station renovation and construction of supporting transportation improvements. They will include parking at most stations, if matching funds are provided by non-Federal entities.

Most stations are located either in central business districts or are immediately adjacent to them in areas undergoing redevelopment. The NECIP is, therefore, directed at incorporating the station as an attractive and compatible element of these redevelopment plans. However, the general level of improvement at each station will depend on the station's particular condition and needs. The type of improvements identified for each station is subject to further refinement due to the continuing and flexible planning and design process, as well as agreements to share funding by local agencies for nonoperational station improvements. For example, the proposed number of parking spaces must be regarded as an estimate of the potential magnitude of the parking requirements at each station where improved service is introduced. These estimates were derived from an analysis and evaluation of system-

LOCATION	TYPE	OWNER	CONSTRUCTION COMPLETED	NATIONAL REGISTER LISTING	CONSTRUCTION ALTER	CONSTRUCTION EXPAND	CONSTRUCTION NEW	1990 NEC INTERCITY PATRONAGE ANNUAL (THOUSANDS) ANNUAL	1990 NEC INTERCITY PATRONAGE ANNUAL 10TH BUSIEST DAY
BOSTON, SOUTH STATION	★	BOSTON REDEVELOPMENT AUTHORITY	1889	★			★	1,441	5,337
BOSTON (SUBURBAN), ROUTE 128	+	MASS. BAY TRANSPORTATION AUTHORITY	1965				●	694	2,570
PROVIDENCE, UNION STATION	●	STATE OF R.I.	1898	●	●			858	3,117
NEW LONDON, UNION STATION	+	UNION STATION TRUST (PRIVATE)	1887	●		●		447	1,655
NEW HAVEN, UNION STATION	●	PENN CENTRAL TRUSTEES	1920	●	●			1,720	6,370
STAMFORD, STAMFORD STATION	+	TRANSPORTATION PLAZA ASSOCIATES (PRIVATE)	1895				●	884	3,274
NEW YORK, PENNSYLVANIA STATION	★	AMTRAK	1968		★			12,586	46,614
NEWARK, PENNSYLVANIA STATION	●	AMTRAK	1935		●			4,309	15,959
ISELIN, METROPARK	+	STATE OF N.J.	1971				●	981	3,633
TRENTON, PENNSYLVANIA STATION	●	STATE OF N.J.	1971			●		2,435	9,018
PHILADELPHIA, 30TH STREET STATION	●	AMTRAK	1934		★			10,229	37,885
WILMINGTON, PENNSYLVANIA STATION	★	AMTRAK	1905	●	●			1,580	5,851
BALTIMORE, PENNSYLVANIA STATION	★	AMTRAK	1911	★		★		2,963	10,974
WASHINGTON, DC (SUBURBAN) NEW CARROLLTON	+	AMTRAK AND WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY	1969				●	1,803	6,677
WASHINGTON, DC UNION STATION	★	TERMINAL REALTY PENN. CO., AND TERMINAL REALTY BALTIMORE CO.	1908	★	★			6,150	22,777

LEGEND

★ MAJOR URBAN

+ SUBURBAN

● SECONDARY URBAN

FIGURE C-1. GENERAL STATION INFORMATION.

wide patronage projections and modal access requirements for 1990, and they are subject to further site-specific feasibility analysis, environmental impact studies, and discussions with local public agencies that will share the cost of constructing new parking facilities.

Improvements to be undertaken by NECIP at the selected Northeast Corridor (NEC) stations will undoubtedly serve as major catalysts for other transportation and related commercial developments utilizing private as well as additional public sector funding sources.

UNION STATION: WASHINGTON, D.C.

Washington, D.C., is the southern terminus for NEC intercity rail service. The station, completed in 1908, was designed as a gateway to the Nation's Capital and is an impressive, monumental railroad terminal, with an imposing white granite facade and vaulted interior spaces. The downtown site is close to offices, institutions, and residences. It contains connections to long-haul and commuter rail services, intracity and visitor tour buses, and the Washington Metropolitan Area (WMATA) subway. The current station is leased from the Terminal Realty Baltimore Co. and the Terminal Realty Penn System and operated by the Washington Terminal Co. It was renovated by the U.S. Department of the Interior to house the National Visitor Center. All rail uses were relocated in a replacement station.

The original terminal is listed in the National Register of Historic Places. The existing station can be remodeled to handle increased NEC rail demand. The proposed improvements include relocating and expanding the intercity rail facilities into the west wing and concourse of the original station and reconfiguring the replacement station to lengthen the tracks and platforms. The National Visitor Center would probably remain in the main hall and east wing. Completion of a 1,200-car parking garage and construction of additional on-site roadways are also included in the recommended program. Future plans call for development of a full intermodal terminal, accommodating intercity bus facilities. Although the downtown site is convenient to business, Government, and local residents, development plans for the surrounding area indicate that only nominal changes will be undertaken in the near future.

NEW CARROLLTON STATION: PRINCE GEORGE'S COUNTY, MD.

The Capitol Beltway Station was constructed as a temporary demonstration station project in 1969. This interim structure is to be relocated to New Carrollton, which serves as a terminal station on the Washington, D.C., subway system. Construction of the subway element of this joint-use station is to be completed in late 1978. It is a suburban station, owned by WMATA, that will serve the Washington, D.C., metropolitan area.

The proposed development program for New Carrollton Station includes construction of a below-track station, a new high-level platform, a passenger-staging area, and a 1,000-car parking garage.

Major commercial development is being planned for the Ardmore Triangle immediately adjacent to the New Carrollton Station, and the infrastructure is already under construction by Shell Oil Co. This particular station is already encouraging related development as a result of the anticipated direct interface with the Washington, D.C., subway system and the high-speed rail system.

PENNSYLVANIA STATION: BALTIMORE, MD.

Pennsylvania Station, erected in 1911, is an impressive four-story structure, featuring a two-story main lobby with marble walls and a ceiling composed of three stained-glass domes. The station is listed in the National Register of Historic Places and is bordered by the central business district and the residential communities of Mount Royal/Mount Vernon. Pennsylvania Station is owned by National Railroad Passenger Corporation (Amtrak) and currently serves conventional and Metroliner intercity rail, commuter rail, and intracity buses. Future plans of the Baltimore City Planning Council call for the establishment of a multimodal transportation center to include light-rail transit and intercity bus facilities. There is presently no additional development planned for the surrounding areas. However, the station upgrading is expected to provide an identity symbol for the neighborhood which could develop greater community cohesion and stimulate related housing and commercial developments.

The NECIP-proposed improvements include interior renovations and concourse expansions. In addition, parking facilities are proposed for 1,000 vehicles, with on-site improvements to accommodate intracity bus, taxi queuing, auto drop-off/pickup, and short-term parking facilities.

WILMINGTON STATION: WILMINGTON, DEL.

Wilmington Station, owned by Amtrak, was designed by the firm of Furness, Evans and Co. and completed in 1905. The station was recently added to the National Register of Historic Places. The brick structure is sound but has fallen into disrepair, and significant refurbishment will be required in order to upgrade Wilmington Station. Present users include intercity and commuter rail passengers. Local buses and taxis also serve the station. Wilmington Station is located in an older industrial and warehouse section of the city, and much of the area is scheduled for extensive redevelopment. Therefore, rehabilitating the station could serve as a catalyst for upgrading the surrounding neighborhood and provide an opportunity to develop an urban setting that could be conducive to pedestrian movements between the new civic center, central business district, and the station complex.

The proposed NECIP improvements include extensive remodeling of Wilmington Station to increase capacity access to the overhead platforms. Future plans call for incorporation of intercity bus and construction of a 1,000-vehicle parking garage. In general, these improvements are consistent with the city's Riverfront Plan and will be compatible with proposed redevelopment of the area.

30TH STREET STATION: PHILADELPHIA, PA.

This station is located west of the central business district in a predominantly business and institutional area. Although the immediate environment is not particularly attractive, it is strongly anchored by substantial and varied economic activity on several sides. The station, owned by Amtrak, is a multimodal center, providing connections to Metroliner and long-haul intercity rail, commuter rail, local bus, and rapid transit. The station also contains a number of office floors that serve as administrative facilities for the Consolidated Rail Corporation (Conrail) and Amtrak. The structure, built between 1927 and 1934, is of monumental scale with a grand high-ceiling concourse and is a significant city landmark. It may be eligible for the National Register of Historic Places.

Thirtieth Street Station is of adequate size to accommodate the 1990 patronage, and major alteration is not required. Since the station has been a community landmark, it will continue to be so, and planned improvements in the surrounding area are not major. Proposed NECIP improvements include rehabilitation of basic utility systems and expanded ticketing facilities. Future plans call for the addition of a 600-vehicle parking garage. Southeastern Pennsylvania Transportation Authority is developing the final design phases of a program that will extend the existing rail system to provide direct rail access to Philadelphia's commercial airport.

TRENTON STATION: TRENTON, N.J.

Trenton Station, renovated in 1971, is a one-story modern, steel-framed structure. The station is owned by the State of New Jersey and is used by intercity and commuter rail and intercity and commuter buses. The location is one-half mile from the central business district, and the predominant land use in the vicinity of the station is surface parking. The areas surrounding the parking lots are lower income residential neighborhoods.

Trenton Station building is in good structural condition and proposed NECIP improvements will be limited to cleaning and replacing unserviceable elements. Future plans call for the construction of a 1,280-car parking structure. Upgrading access and parking facilities has the potential to foster neighborhood stability and promote commercial development opportunities in an underdeveloped area of the city.

METROPARK STATION: ISELIN, N.J.

The Metropark Station is a modern 1,300-square-foot facility erected in 1971 as a beltway station at the interchange of the Garden State Parkway and State Route 27. The present owner is the State of New Jersey, and Metropark Station is currently served by intercity and commuter rail. Local bus service to the station, though not presently offered, is planned for the future. The Metropark Station site is compatible with existing development plans at the county level. Although local development plans are not known at this time, the station is in a high-growth corridor and can play a role in encouraging and attracting additional commercial activity in the Iselin area. Since Metropark Station is in satisfactory condition and adequate for its current primary functions, NECIP improvements will be limited to replacement of unserviceable elements. Future plans call for the construction of a 1,500-vehicle parking structure and improvements to vicinity roadway networks.

PENNSYLVANIA STATION: NEWARK, N.J.

Newark's Pennsylvania Station was designed by McKim, Mead, and White and was constructed between 1932 and 1935. Owned by Amtrak, it serves as a fully integrated multimodal facility containing connections to intercity and commuter rail, rapid transit, light rail, and local and intercity buses. The station is located on the edge of the central business district adjacent to a mixture of new and older business and commercial buildings. Future plans for the immediate area include highway improvements, a coliseum, and additional office buildings. The improved station and current planned development should provide the inducement for further commercial development in this area. The station is considered of historic quality and is proposed for inclusion in the National Register of Historic Places.

The NECIP improvements at Newark's station include circulation improvements within the station, modernization of mechanical systems, expansion of passenger-processing services and general cleaning, painting, and maintenance work. Future plans also call for additional short-term parking and a new parking garage for approximately 1,400 vehicles. The State plans to extend the existing Port Authority Trans Hudson rail service to Plainfield from this station, thus further enhancing its intermodal aspects.

PENNSYLVANIA STATION: NEW YORK, N.Y.

Pennsylvania Station's new facilities were completed in 1968 and are located in the lower level of Madison Square Garden/Penn Plaza office building complex in Manhattan. The station, the busiest in the country, is a multimodal facility served by intercity and commuter rail, rapid transit, local buses, and taxis. Pennsylvania Station, owned by Amtrak, is also a major departure/arrival point for commuters and passengers traveling outside the NEC. The improvements proposed by the NECIP are designed to upgrade passenger circulation by reorganizing space and providing new stairs, escalators, and elevators to improve platform access. Parking improvements or additional commercial developments are not recommended because of the highly urbanized location of this station. The Port Authority of New York and New Jersey has plans to develop a rail link connecting this station directly with J. F. Kennedy International Airport. The Port Authority also proposes to run some former Erie Lackawana commuter services into Penn Station instead of into Hoboken.

STAMFORD STATION: STAMFORD, CONN.

The existing station at Stamford is over 80 years old but is not architecturally distinctive and does not appear to be eligible for inclusion in the National Register of Historic Places. The facility and site are owned by private developers, Transportation Plaza Associates. The owners have had plans to demolish the structure and build a high-rise office complex incorporating rail-handling facilities at the plaza level. Currently, the site is served by intercity and commuter rail, local buses, and taxis.

Proposed improvements include construction of a new station, upgrading access roads, track realignments, platform improvements, bridge modifications, and parking provision for approximately 1,500 vehicles. Stamford Station is close to a major redevelopment area and adjacent to the existing central business district. The reconstructed station complex will continue to encourage additional high-intensity commercial development on adjacent parcels of land.

UNION STATION: NEW HAVEN, CONN.

Built in 1920, Union Station is listed in the National Register of Historic Places. It is owned by the Trustees of Penn Central and leased with a purchase option to the State of Connecticut. Union Station is located just south of the central business district, in an area undergoing residential, commercial, and institutional redevelopment. The main station building has not been in use since 1968. The station functions are housed in an existing, deteriorated passageway. Union Station is currently served by intercity rail and commuter rail and taxis. It is structurally sound but requires extensive renovation.

The proposed improvements for Union Station include structural and architectural renovation of the main terminal building, new utility systems, improvements to the platforms and canopies, and upgrading vehicular access facilities. Future plans call for the provision of a new parking facility for approximately 1,300 cars and a consolidated intercity bus and limousine terminal. Union Station improvement plans will also provide for renovation of commercial office space on the upper floors to anchor the area and give a more secure and viable commercial complex to the city.

UNION STATION: NEW LONDON, CONN.

Union Station was built between 1885 and 1887, designed by H. H. Richardson, and is listed on the

National Register of Historic Places. It was recently renovated by the owner, Union Station Trust, Inc., and includes office and commercial rental space. Amtrak presently leases about one quarter of the building's 29,000 square feet. Union Station is served by intercity rail and taxis. The site is located along the waterfront and is adjacent to the central business district, a 600-car municipal parking garage, a temporary intercity bus terminal, and harbor-related transportation facilities, including auto ferry services. The NECIP program calls for limited improvements to the passenger-handling facilities and upgrading the platforms. Site improvements may include pedestrian overpasses from the existing parking garage to the station and waterfront development.

The city also has plans for extensive development of the harbor area in the station vicinity for commercial, residential, and marina-related facilities.

UNION STATION: PROVIDENCE, R.I.

This station was built between 1896 and 1897 and has been placed on the National Register of Historic Places. Union Station is the focal point of a major urban park in the center of the city and is part of an extensive downtown redevelopment program that includes its renovation as a multimodal terminal.

The State and city are negotiating to turn Union Station complex over to a private developer, Textron, who will undertake the development of the two pavillion buildings and an existing office building for commercial and office purposes. The city also has an interest in enhancing the intermodal aspects of the station through incorporation of additional local/regional bus facilities and upgraded commuter rail services. A relatively new intercity bus terminal is one block from the station complex. Currently, the station is served by intercity and commuter rail, commuter buses, and taxis.

Proposed NECIP improvements include complete renovation of the main station building, a new pedestrian passageway under the tracks, new platforms and related structures, and accommodations for parking approximately 1,000 vehicles.

ROUTE 128 STATION: DEDHAM, MASS.

The existing station at Route 128 was built in 1965 and is a single-story, 2,500-square-foot brick structure. This suburban station presently serves intercity and commuter rail passengers and is located adjacent to Route 128, one mile from Interstate 95. Route 128 Station and its 690-car surface-parking facility are owned by the Massachusetts Bay Transportation Authority (MBTA). The site is bounded by transportation, industrial, and open space uses. Density of current development is such that continued growth can occur but would be subject to certain restrictions due to physical terrain and conservation easements.

The NECIP proposed improvements include several components. The size of the existing station facility is not adequate to accommodate projected 1990 patronage. Construction of a new station with associated platforms is proposed. A new parking structure with approximately 2,200 spaces is also proposed and will be connected directly to the station. Vehicular access improvements include new on-site roadways and signalization improvements.

This station is readily accessible to densely populated suburban residential and commercial centers; full development of the complex will encourage related industrial and commercial development in the vicinity. Further extensions of MBTA commuter and rail transit facilities would also enhance the intermodal characteristics of Route 128 Station.

SOUTH STATION: BOSTON, MASS.

South Station, which serves as the northern terminus of Amtrak NEC rail services, is located at the eastern edge of Boston's downtown area and is owned by the Boston Redevelopment Authority (BRA). The headhouse section, constructed in 1896, is on the National Register of Historic Places and is in need of major interior repairs and infrastructure rehabilitation. The BRA development plans for the station site include a multimodal terminal, new parking garage, and commercial office space. South Station is now served by commuter and intercity rail, commuter and intracity bus, and rapid transit subway.

Proposed NECIP improvements for Boston South Station involve major station renovation, new platforms and track structures, vehicular access improvements, and air rights parking facilities for approximately 600 vehicles. These proposed improvements are intended to be compatible with local plans for the site and will expand existing rail facilities to accommodate the projected increase in annual patronage levels.

The MBTA has recently been designated developer of the station to assure implementation of the full complement of local and intercity rail transportation facilities. A part of the MBTA agreement with BRA includes air rights provisions, parking for an additional 1,500 cars, construction of an office tower, and a hotel complex. The station is immediately adjacent to the central business district and is an integral part of a major commercial redevelopment area of downtown Boston.

APPENDIX D. DEMAND ASSUMPTIONS

This report uses 1982 and 1990 demand projections produced by, or derived from, the Aerospace Corporation model developed under contract to the Federal Railroad Administration. Two series of demand estimates are of concern. The first, predating this report, exhaustively analyzed demand sensitivity to a wide range of external factors (socioeconomic variables, fuel prices, and the like) and variations in rail service. While this first series does not reflect the service options analyzed here, it does present valuable insights into the dynamics of rail demand. The second series of demand estimates produced the ridership and revenue results for the dual service and all variations, as described in chapters 5 and 7 and tabulated in appendixes G and K. Demand projections for the single service option are derived from the second series of Aerospace estimates.

DESCRIPTION OF THE AEROSPACE MODEL

Obvious factors that affect estimates of future rail demand forecasts are: rail characteristics (e.g., time, fare, and frequency) in conjunction with the service offered by the competitive modes (i.e., air, auto, and bus); and sociodemographic/economic conditions (e.g., population and income) in the Northeast Corridor (NEC). Such quasi-independent variables must themselves be estimated to forecast transportation demand and modal split.

PHILOSOPHY AND METHODOLOGY

The computer model utilized here provides an estimate of annual ridership by each mode (i.e., rail, air, bus, and auto) between city-pairs within the NEC.

The methodology simulates the process by which the individual traveler selects the mode of travel to get from origin to destination that will minimize his perceived cost of the total trip. Time elements are converted to cost by the individual's value-of-time, which is a function of income level, purpose of trip, and specific origin-destination pair. This value-of-time characteristic and other traveler factors, such as party size, trip duration, auto availability, exact location within an urban area, and propensity to travel, were utilized in generating the specific proportion and nature of all trips and were developed using historical data, particularly the 1972 Census of Transportation.

In selecting the appropriate path a traveler will choose, a calculation is made of total door-to-door times and costs based on the following elements: access to mode terminal, parking at terminal, processing at terminal, average waiting time between departures (i.e., frequency of service), line-haul trip portion, and terminal to destination time. The access/egress trip times and costs are evaluated by mode (e.g., taxi, bus, and rapid transit) for both peak and off-peak periods. Intercity and urban auto travel is explicitly considered and includes tolls.

Other important variables that determine the total number of trips forecast are: urban population; median family income levels; and distance between urban areas.

This methodology was calibrated to simulate actual historical data from selected available periods between 1960 and 1975. Once estimates are made on independent variables in the future (e.g., population, income, trip times, frequencies and fares, access/egress characteristics, etc.), total demand by each mode can be estimated. The methodology is quite flexible and can accommodate such important issues as energy costs (e.g., oil) by converting such projections directly into the line-haul and/or access/egress aspects of each possible mode choice for a trip.

SCENARIO DEVELOPMENT — BOTH SERIES

The demand model described in the foregoing methodology subsection was used to forecast travel for two selected target years—1982, the projected first full year of service; and 1990, a reasonable planning horizon. Patronage estimates for intermediate years were estimated by interpolation. It was assumed that there will be a surge of demand over a period of time, possibly up to a year, after improved rail service is implemented. Thereafter, the rate of growth in patronage will become reduced to the level dictated by population and income trends. Any significant changes in mode characteristics would cause a change in the trend.

The Department of Transportation will continue to examine the issues and trends that influence NEC passenger transportation and will update forecasts accordingly. For both series 1 and series 2 of demand model runs, the following key factors were selected for evaluation and analysis.

• Urban Area Population. This factor directly affects the total number of passenger trips by any mode. Examination of various recent forecasts (National Planning Association, Bureau of the Census, etc.) resulted in an overall range of population change between now and 1990 from no-growth (pessimistic) to about 1 percent per year (an optimistic estimate based on a report in 1972 by the Office of the Bureau of Economic Research). A growth of 0.2 percent per year has been used generally, but sensitivity up to 1 percent has been tested.

• Urban Area Median Family Income. This factor directly affects people's inclination to travel and their mode preference. Based on forecasts from such sources as Data Resources, Inc. (for the Federal Energy Administration (FEA)) and the National Planning Association, the range of real income growth selected was from 1 percent per year to 2.4 percent per year.

• Energy (Oil) Costs. This factor has a significant impact on the cost of travel, particularly for cars and airplanes. The procedure was to forecast the cost of crude oil prices, which, in turn, was translated into operating fuel costs. The forecast ranges were based on studies conducted by FEA, Central Intelligence Agency, and others and show the following. In 1982, a barrel of oil is forecast to cost between $14.34 and $16.40; in 1990, the forecast range will be from $14.56 to $22.10 per barrel (all cost estimates in app. D are factored to FY 1977 dollars).

In translating oil costs into air fares, projected fuel efficiency of aircraft engines was incorporated in the analysis. For comparison purposes, the percentage of real increase in air fares over 1976 for the selected oil cost baseline is shown in table D-1. Since bus fuel costs are such a small part of bus-operating costs, it was concluded that the oil cost scenarios would have little impact on bus fares.

TABLE D-1. BASELINE OIL COSTS AND AIR FARE INCREASES, 1982 AND 1990

Year	Baseline oil costs ($/bbl)	Air fare increase over 1976 (%)
1982	14.56	4
1990	17.92	6

• Fuel Efficiency. This factor affects the cost of a trip and is considered particularly significant for auto and air modes. The estimates are as follows in table D-2.

TABLE D-2. COMPARISON OF FUEL EFFICIENCY, FOR AIRCRAFT AND AUTOS, 1982 AND 1990

Year	Air fuel efficiency over 1976 (%)	Auto average mpg (55 mph)
1982	104	17.9
1990	116	24.3

Little fuel efficiency changes are forecast for buses. Rail energy costs were deliberately removed from this analysis for several reasons. First, there is no direct correlation between oil costs (which is a recognized critical issue for scenario analysis) and electric rail energy costs. Second, the energy costs prorated to passengers are so small as to have but a negligible impact on fares. Third, studies are necessary to examine rail operating and maintenance costs in detail.

FIRST SERIES — SCENARIOS AND RESULTS

The first series model runs, which predate this report and do not reflect the dual and single service options analyzed here, show the sensitivity of rail demand to numerous factors.

Scenarios for the First Series

In addition to addressing the external variables discussed above, the first series of demand runs addressed rail service variations as follows.

• Rail Fares. Rail fare variation around current fares was examined within the range of plus or minus 45 percent to determine the impacts on ridership and revenue. In addition, several selected differential fare strategies were investigated.

• Rail Frequencies. Baseline frequencies for 1982 of 27 trains per day each way between Washington, D.C., and New York, 39 between Philadelphia and New York, and 15 between New York and Boston were used in the analysis. Train frequencies for 1990 were assumed as 30, 45, and 15. Sensitivity was tested within ranges of minus 67 percent to plus 100 percent. Baseline frequencies for 1982 were based on the National Railroad Passenger Corporation (Amtrak) proposed schedules. Baseline service for 1990 was based on increased frequencies to provide improved service. Some selected schedule options were also investigated.

• Rail Times. Section 703(1) (A)(i) of the Railroad Revitalization and Regulatory Reform (4R) Act calls for 2-hour, 40-minute, to 3-hour, 40-minute, trip service by "regularly scheduled" and dependable trains with "appropriate" stops. Thus, a certain proportion of the trains were assigned to make the trip-time goals with an "appropriate" number of stops. The operating scenario chosen was that all stations will receive at least the same frequency of service as presently offered and that the south Corridor will provide premium service with the same frequency between New York and Washington, D.C., as Metroliner service today (essentially hourly). In the north, a premium service of every 2 hours between New York and Boston was defined as the operational goal. Additional trains can make various combinations of skip-stop service at many intermediate stations. (There are 26 stations in the NEC receiving service, and 15 have been addressed under the Northeast Corridor Improvement Project (NECIP)).

Beyond the NECIP, the 4R Act directed an examination of trip-time goals of 2 hours, 30 minutes, to 3 hours. Thus, this scenario was examined along with variations of trip times in the range of plus or minus 30 percent to evaluate the sensitivity of demand to time.

A value for each variable within the range was selected to represent the "baseline" or best judgmental value for that parameter. Most of the scenarios were developed around the baseline for 1982 and 1990 by varying one or several parameters and evaluating the resulting demand estimates.

In most cases, only a single factor was varied in order to understand its impact independent of other factors. However in some cases, several variables were varied concurrently, either because it was believed that they vary together (e.g., income and population) or an upper or lower bound was desired under very optimistic or pessimistic conditions for rail travel.

Results for the First Series

Tables D-3 and D-4 summarize the key first series results for 1982 and 1990, respectively. The baseline ridership estimates are 15.5 million in 1982 and 21.8 million in 1990. For comparison, current FY 1976 ridership is 9.6 million, and current trends with-

TABLE D-3. FIRST SERIES, 1982 SCENARIO RESULTS
(Aerospace model forecasts)

Scenario No.	Comment	Rail mode split (%)[a]	Total passengers (thousand)	Total passenger-miles (thousand)	Total revenue[b] (thousand $)	Revenue/per passenger-mile ($)[b]	Revenue/per passenger ($)[b]	Average trip length (mi)
1	1976 fares	19/14	14.7	1,747.4	126.5	.072	8.63	119
2	Revised freq	20/15	15.5	1,765.4	127.4	.072	8.22	114
3	Revised 1976 fares	22/17	17.4	2,040.4	124.3	.061	5.79	117
4	#3 fare, -20%	25/18	19.9	2,372.3	115.3	.049	5.79	119
5	#3 fare, -10%	24/18	18.6	2,204.4	120.7	.055	6.49	119
6	#3 fare, +10%	21/16	16.4	1,904.8	127.8	.067	7.79	116
7	#3 fare, + 20%	20/15	15.3	1,763.8	129.4	.073	8.46	115
8	#3 fare, +40%	17/13	13.5	1,522.1	130.6	.086	9.67	113
9	#3 freq, -10%	22/17	17.1	2,006.8	122.2	.061	7.15	117
10	#3 freq, +10%	22/17	17.7	2,065.7	125.9	.061	7.11	117
11	#3 freq, +20%	23/18	17.9	2,093.7	127.6	.061	7.13	117
12	#3 freq, +30%	23/19	18.1	2,116.0	129.1	.061	7.13	117
13	#3 time, -10%	25/19	19.5	2,355.2	142.7	.061	7.32	121
14	#3 time, +10%	20/15	15.6	1,774.1	108.7	.061	6.97	114

[a]The first figure, in the column below, refers to 17 key city-pairs; the second figure refers to all 32 city-paris addressed in the model.
[b]1973 constant dollars. Multiply by 1.33 to convert to 1977 dollars.

TABLE D-4. FIRST SERIES, 1990 SCENARIO RESULTS
(Aerospace model forecasts)

Scenario No.	Comment	Rail mode split (%)[a]	Total passengers (thousand)	Total passenger-miles (thousand)	Total revenue[b] (thousand $)	Revenue/per passenger-mile ($)	Revenue/per passenger ($)[b]	Average trip length (mi)
21	Base freq & fare (2:40/3:40)	19/15	17.4	2,059.1	150.0	.073	8.62	118
22	High freq/rev fare	24/18	21.8	2,528.4	154.8	.061	7.10	116
23	High pop., income	25/19	25.1	2,901.5	178.0	.061	7.09	116
24	Fuel conservation (Lower car speeds)	27/20	23.2	2,720.4	166.3	.061	7.17	117
25	High income and very high pop.	25/19	27.1	3,153.4	193.7	.061	7.15	116
31	Base freq & fare (2:30/3:00)	21/16	19.3	2,376.2	171.6	.072	8.89	123
32	#31 fare, +15%	19/14	17.3	2,106.6	175.1	.083	10.12	122
33	#31 fare, +30%	17/13	15.6	1,872.6	176.3	.094	11.30	120
34	#31 fare, +45%	16/12	14.2	1,669.5	175.9	.105	12.39	118
35	#31 fare, -15%	23/18	21.4	2,689.2	164.5	.061	7.69	126
36	#31 fare, -30%	26/20	24.0	3,056.9	153.7	.050	6.40	127
37	#31 fare, -45%	29/22	27.0	3,464.1	136.7	.039	5.06	128
38	#31 with differential fare	26/20	23.8	3,027.5	174.7	.058	7.34	127
39	#31 Freq, +33%	22/17	20.4	2,507.2	180.7	.072	8.86	123
40	#31 freq, +67%	23/17	21.2	2,594.4	186.9	.072	8.82	122
41	#31 freq, +100%	24/18	21.9	2,668.9	192.2	.072	8.78	122
42	#31 freq, -33%	19/15	17.5	2,170.6	156.5	.072	8.94	124
43	#31 freq, -67%	15/12	13.7	1,714.3	123.6	.072	9.02	125
44	#31 time, -15%	25/19	22.8	2,928.2	209.8	.072	9.20	128
45	#31 time, -30%	29/22	27.1	3,638.0	259.0	.071	9.56	134
46	#31 time, +15%	18/14	16.4	1,936.6	140.4	.072	8.56	118
47	#31 time, +30%	15/12	14.0	1,588.4	115.9	.073	6.82	113
48	High frequency	23/18	21.2	2,512.3	182.1	.072	8.60	119
49	High fuel, incl. pop. & freq	23/18	23.6	2,958.4	212.8	.072	9.02	125
50	High fuel, incl. pop.	24/19	24.9	2,946.8	214.0	.073	8.60	118
51	Base fare & freq (2:30/3:00)	26/20	24.1	2,907.8	176.7	.061	7.33	121

[a]The first figure, in the column below, refers to 17 key city-pairs; the second refers to all 32 city-pairs addressed in the model.
[b]1973 constant dollars. Multiply by 1.33 to convert to 1977 dollars.

out any improvements indicate that rail ridership in 1982 would be approximately 10.3 million.

A discussion follows concerning the estimated impacts of various factors on rail demand.

Rail Fares

A modification of the basic 1976 fare equation showed a possible 18-percent increase in rail demand with only a slight (2-percent) reduction in revenue for a 1982 scenario. The fare was modified to create a constant revenue per passenger-mile, as in 1976, and it results in a higher fare for short trips and a lower fare for long-haul trips. Another fare variation was conducted for 1990, with the purpose of smoothing out demand over the links. The result was a 23-percent increase in demand and a 2-percent increase in revenue. Finally, a series of sensitivity runs were made by changing fares across the board with the results shown in table D-5.

Demand is sensitive to rail fares, with the relative impact much greater on passengers than on revenue. For example, a 10– to 15-percent increase in fares increases revenue by only 2 to 3 percent, whereas demand drops between 6 and 11 percent.

TABLE D-5. FIRST SERIES, RAIL FARE VARIATIONS 1982 AND 1990
(Aerospace model forecasts)

Fare change (%)	Demand change (%)	Revenue change (%)
	1982	
- 20	+14.4	- 7.2
- 10	+ 6.9	- 2.9
+10	- 5.7	+ 2.8
+20	- 12.1	+ 4.1
+30	- 22.4	+ 5.0
	1990	
- 45	+39.9	- 20.3
- 30	+24.4	- 10.4
- 15	+10.9	- 6.2
+15	- 10.4	+ 2.0
+30	- 19.2	+ 2.7
+45	- 26.4	+ 2.5

Rail Frequencies

The impact of frequency of service is much more complex to analyze on a system basis since individual city-pair frequencies vary from 15-minute intervals to periods of several hours. Nevertheless, it is interesting to indicate total impacts due to frequency sensitivity runs as summarized in table D-6.

TABLE D-6. RAIL FREQUENCY VARIATIONS 1982 AND 1990
(Aerospace model forecasts)

Frequency change (%)	Demand change (%)	Revenue change (%)
	1982	
+ 30	+ 4.0	+ 3.9
+ 20	+ 2.9	+ 2.6
+ 10	+ 1.7	+ 1.3
- 10	- 1.7	- 1.7
	1990	
+100	+13.5	+12.0
+ 67	+ 9.8	+ 8.9
+ 33	+ 5.7	+ 5.3
- 33	- 9.3	- 8.8
- 67	- 29.0	- 28.0

Due to the already high frequency of service provided in the NEC, a 30-percent increase in frequency only results in an approximately 5-percent increase in demand and revenue. Also, the model indicates that a 10-percent reduction in frequency shows little impact (i.e., 2 percent) but reducing frequencies by two-thirds results in an approximately 30-percent reduction in demand. On a systemwide basis, there appears to be little total impact, but in analyzing specific city-pairs, a reduction of service for those already receiving "little" service will be much more dramatic.

Rail Times

Varying rail trip-time results are shown in table D-7.

Again, as predicted by the Aerospace model, demand and revenue are very sensitive to changes in rail trip times. The elasticity is close to one near the baseline times.

TABLE D-7. RAIL TIME VARIATIONS
1982 AND 1990
(Aerospace model forecasts)

Time change (%)	Demand change (%)	Revenue change (%)
	1982	
+10	-10.3	-12.6
-10	+12.0	+14.8
	1990	
+30	-27.5	-32.5
+15	-15.0	-18.2
-15	+18.1	+22.3
-30	+40.4	+50.9

One of the key scenarios being examined for 1990, as suggested in the 4R Act, is the investigation of improving trip times from 2 hours, 40 minutes/3 hours, 40 minutes to 2 hours, 30 minutes/3 hours. Holding all other factors constant, this resulted in an 11-percent increase in demand and a 14-percent increase in revenue.

Socioeconomic Scenarios

For all the above discussions, population, income, and energy costs were held constant at the forecast baseline values. One selected scenario was labeled the "fuel conservation" scenario in which oil costs are at the high end and auto speed limits are reduced and enforced, resulting in a 6-percent increase in demand. In another scenario, high estimates for population and income were forecast along with high-energy costs, resulting in a 15-percent increase in rail demand over the baseline forecast.

The many comparisons and interrelationships of factors are quite complex. Table D-8 presents an estimate of the likely range of ridership.

SECOND SERIES — SCENARIOS AND RESULTS

The second series of Aerospace demand model runs provided the patronage, passenger-mile, and revenue estimates for the dual service, as described in chapters 5 and 7 and tabulated in appendixes G and K. From these projections, demands for the single service were calculated.

Second Series Scenario

Model runs were performed to establish demand estimates under dual service for the years 1982 and 1990, with NECIP trip times, and 1990 with post-

TABLE D-8. FORECAST RANGE OF ANNUAL RAIL PASSENGERS
(Million)

Range	1982 (2:40/3:40)	1990 (2:40/3:40)	1990 (2:30/3:00)
Low	13.0	15.5	17.5
Intermediate (most likely)	14.7	21.8	24.1
High	19.5	27.0	29.0

NECIP trip-time reductions. Chapters 5 and 7 describe in detail the rail service options. Assumptions used for external variables are listed in table D-9.

TABLE D-9. EXTERNAL VARIABLES IN DUAL SERVICE ANALYSIS

Category	1982	1990
Population growth (%/yr)	.2	.2
Income growth (%/yr)	1.7	1.7
Energy cost (1977 $/bbl):	14.50	17.92
Auto fuel efficiency (mpg)	21.7	29.4
Air fuel efficiency (1976=100)	104.2	116.3

For dual service in 1990 under both trip-time assumptions, it must be noted that the frequencies fed into the demand model (thus forming the basis for ridership and revenue projections) were higher than those used to calculate the operating costs. Based on the frequency elasticity results in table D-6, the estimated maximum net effect of this discrepancy would be to reduce 1990 revenues by 8 percent or $18.2 million, for which the net present value in 1978 dollars would be $5.8 million. The relative results of service options and variations would not be affected by this difference, since it remains constant throughout the analysis.

Second Series Results

Results for the second series of demand model runs appear in chapters 5 and 7 and in appendixes G and K. Demand projections used in this report for the single service option were not produced directly by the Aerospace model but were estimated from the Aerospace single service results by applying a factor. Passengers, passenger-miles, and revenues from the single service are calculated to be 12 percent higher than the counterpart figures in the dual service. This percentage takes into account the reduction in average trip time, the time elasticity of demand (from table D-7), and the overriding importance of the major towns in the total travel.

APPENDIX E.
EQUIPMENT CONSIDERATIONS

Within each service option, rolling stock alternatives are of paramount concern. If the Railroad Revitalization and Regulatory Reform (4R) Act trip-time requirements are to be met, only two kinds of equipment now appear to be available.

- Upgraded Metroliners. Having achieved sustained revenue service at 120 mph in the late 1960's, these cars with a complete overhaul incorporating numerous improvements, could meet the trip-time goals of the 4R Act. Nevertheless, only 61 Metroliners exist, enough to provide for only limited high-speed service. Even if the Metroliners are upgraded, unfulfilled motive power needs will remain if longer trains are required to meet additional demand.

- Lightweight electric locomotives hauling Amfleet cars. The available Amfleet equipment—317 cars already in the Northeast Corridor (NEC)—should be suitable for 120-mph trailer coach operation. (All components have been tested at 120 mph and higher.) Since the E-60 electric locomotive has not been approved for speeds above 90 mph on the NEC, and since the old GG-1 electric locomotives would be made obsolete by the conversion to 25 kV, 60 Hz under the Northeast Corridor Improvement Project (NECIP), a new lightweight electric locomotive will have to be purchased to haul the Amfleet cars.

Train performance calculations, using typical performance capabilities of advanced lightweight electric locomotives, suggest that there is a better-than-50-percent probability that such a locomotive with four cars will meet the trip-time goals. Nevertheless, it has not been conclusively proven that such a lightweight locomotive, operating alone, would meet the trip-time goals with trains of eight or more cars. For the purposes of analysis, this report assumes that one lightweight locomotive can meet the trip-time critical requirements with 4 or 5 cars; two locomotives with 7 to 11 cars; and three locomotives with 12 to 14 cars. To the extent that one lightweight locomotive exhibits performance superior to that assumed here, overall financial results for NEC service will benefit.

Given these assumptions, the major variables within the equipment component are: fleet composition (number and kind of locomotives, Metroliner cars, and coaches); consist policy (how each train is to be organized); turnaround times (allowances at endpoints for servicing, inspection, and schedule protection); and equipment availability (percentage of time a given equipment type is out of the shop and ready for service). As for fleet composition, this report has considered fleets including 61, 34, and 0 Metroliners in addition to locomotives and Amfleet cars. Train consists may be either fixed (constant throughout the year) or variable, with locomotive placement either at the head of the train or (in the case of multiple locomotives) at either end.

Traditionally, NEC trains have operated with a variable, single-ended consist (i.e., locomotive at the head of the train). However, it would be possible to use two locomotives for each train, locating one at each end of the Amfleet cars. This would produce a train capable of being driven from each end and thus able to achieve much shorter turnaround times. Extra capital costs for the locomotives might be offset by much higher utilization of the Amfleet cars. This approach would assume a standard, fixed train consist. There are advantages of flexibility in use, much higher utilization of locomotives and cars, ability to absorb increases in demand by larger train size without extra train mileage, reduction in switching costs, and a reduced need to take trains out of terminal stations at turnaround points. The disadvantages include the inability to match train size to demand and, on occasion, the hauling of unnecessary cars. Without a complementary fare policy to dampen the peaks and raise the valleys in daily demand, a poor-load factor could result with fixed-consist, double-ended trains.

A key to sizing the required fleet is the establishment of turnaround-time assumptions at major terminals. The National Railroad Passenger Corporation has indicated the following preferred assumptions, reflective of its operating experience. As a sensitivity test for further research and evaluation, reduced turnaround times have been posited and analyzed. If operational and terminal investment considerations permit, such reduced turnaround times might have a beneficial effect on fleet size, hence on net present value. Table E-1 shows these turnaround-time assumptions.

TABLE E-1. TURNAROUND TIME VALUES

Route	Standard (h.min)	Reduced (h.min)
Washington, D.C.—Boston	3 h	2 h
New York—Boston	3 h	1 h 30 min
New York—Washington, D.C. (trip-time critical)	1 h 20 min	1 h
Philadelphia—New York	1 h 30 min	1 h

APPENDIX F. COST FACTORS AND ASSUMPTIONS

This appendix describes in detail the capital and operating cost factors and assumptions underlying the railway economic projections. All capital cost, operating cost, and revenue estimates in chapters 5 and 7 are in fiscal 1978 dollars. All costs have been escalated (see table F-1) as far as 1976, on the basis of Association of American Railroads statistics [1] plus an assumed 8.5-percent yearly cost inflation rate from 1976 through FY 1978 in accord with the National Railroad Passenger Corporation (Amtrak) 8– to 9-percent cost increase projections [2].

TABLE F-1. COST ESCALATION INDEX

Year	Index
1974	186.8
1975	212.6
1976	234.1
1977	253.9
1978 (FY)	275.5

NOTE: The index for the years 1974-76 is escalated on the basis of statistics from the Association of American Railroads. For FYs 1977-78, the index reflects an assumed 8.5 percent yearly cost increase.

For the purpose of the financial analysis of the Northeast Corridor (NEC) after the Northeast Corridor Improvement Project (NECIP), the authorized fixed-plant improvement program at the $1.75-billion level is assumed as given and omitted from all calculations. The analysis of the post-NECIP trip-time reductions will address any investments over the authorized amount.

For each type of vehicle in the analysis, key capital cost factors are calculated as follows.

- The initial capital cost for each vehicle and the history of vehicle purchases (particularly important in a time-value-of-money calculation such as this)
- The service life and scrap value of each vehicle type. (Scrap is defined to mean the value of the vehicle at the end of its service life, whether for alternate "cascaded" uses or for scrap metal.)

Operating and maintenance costs, the other key elements of cross-vehicle comparisons, are discussed later in this appendix.

The assumptions for each capital cost factor by vehicle type are the following.

INITIAL CAPITAL COSTS AND PURCHASE DATES

Locomotives. Amtrak plans to purchase a fleet of 53 new lightweight electric locomotives at total price of $137.5 million, equivalent to $2.6 million per unit [2]. By way of contrast, Bechtel-18 estimates the cost of such a 120-mph vehicle at $1.19 million and reports the costs of Swedish and British 100-mph electrics at $940,000 and $1.118 million, respectively [3]. Although the contrast between an estimate reported by an independent engineering consultant in 1976 and the allowance by Amtrak for similar units in FY 1978 is stark, the $2.6-million Amtrak figure has been accepted as normative for the purpose of this report.

The phasing for this locomotive order would be 8 units in FY 1978, 22 units in FY 1979, and 23 units in FY 1980 [2]. For purposes of analysis, any additional units of the initial NEC fleet would be phased in during FY 1981.

Metroliners. Amtrak envisions an upgrading program for 57 Metroliners at a total cost of $60.461 million, for an average upgrading expense of $1.06 million per Metroliner [2]. Nineteen Metroliners would undergo upgrading in FY 1978 and 38 in FY 1979. In addition, the Federal Railroad Administration (FRA) NEC Project office (NECP) estimates that the 4 Metroliners presently upgraded would be retrofitted at a cost of $200,000 each to accommodate the new NEC electrification and signaling system [4]. This analysis assumes that such upgrading would take place in FY 1980, should such vehicles be needed.

Coaches. Since 317 Amfleet cars, dating from FY 1976 and FY 1977, already traverse the NEC [2], no capital cost ensues from retaining them for the purpose to which they were originally dedicated. Any required cars over and above the 317 now in the NEC would be bought at $600,000 each, in equal numbers during 1979, 1980, and 1981. In reality, such additional cars would be existing Amfleet cars replaced by the low-level car program on national routes [2]. A corollary to these assumptions is that the 175 cars now on national routes are fully utilized—and their replacement by low-level cars would be necessitated by NEC requirements, rather than the requirements of the national routes that the Amfleet now serves.

SERVICE LIFE/SCRAP VALUE

Assumptions regarding service life and scrap value of vehicles have varied widely in previous NEC studies. For example, the 1973 Report [5] assumed a 14-year service life for all vehicles; Bechtel-9 [6] allocates a service life of 25 years, with a 5-percent scrap value across the board to Metroliners, locomotives, and coaches. Sensitivity tests for this report have addressed both the 1973 Report and the Bechtel-9 assumptions. (In this context, scrapping implies removal from the Amtrak NEC high-performance main line fleet and not necessarily metal recycling.)

Nevertheless, the question of service life/scrap value goes far beyond the 1973 Report and Bechtel-9 assumptions because it involves such complex issues as the following.

- Intensity of equipment utilization per year
- Inherent durability of each equipment type
- Marketing image: a need, totally apart from technical considerations, to replace equipment with ever more modern-looking stock for competitive reasons.
- Ability to cascade equipment to other uses; profitability of those other uses
- Historical experience with similar equipment types

These complex, interrelated factors yield the following observations and assumptions by equipment type.

Locomotives

The experience of the GG-1, which has had a service life (but not an economic life) of 40 years, indicates that electric locomotives can be extremely durable. Since the precise design of the new lightweight locomotive is not yet established, since no such locomotive has ever run in sustained service in this country, and since analogous European equipment is relatively new, no historical data base guarantees the longevity of the new lightweight units. However, some British lightweight electric locomotives are now approaching 15 years and are expected to continue in 100-mph service for at least 5 years.

A reasonable assumption, however, would be as follows. The locomotive would serve for 15 years, at which time a major cleaning, inspection, and overhaul would take place with no rewinding of transformers. The 15-year overhaul would cost 35 percent of the purchase price of a new locomotive.

Since these locomotives could be cascaded to other electrified intercity, commuter, or freight services, these vehicles are assumed to be scrapped after 15 years but retain 65 percent of their original value.

Metroliners

Although, in theory, a Metroliner should have a longevity equal to that of a locomotive, the Metroliners, in fact, need at least a $947,000 overhaul after less than 9 years in service. It is true that these cars will not be merely overhauled, but they will also be upgraded and the resulting equipment could have greater reliability and a lower maintenance burden, which may translate into a longer service life. At this point, no one can tell. What is clear, however, is that the Metroliners in their present configuration cannot be readily cascaded; they are too complex and expensive to operate in commuter service and therefore, might not merit a second overhaul at the end of what will be their "second life." For these reasons, two Metroliner assumptions were made.

Metroliner—Positive. Metroliners will have a 15-year service life after upgrading, with a 5-percent scrap value (per Bechtel-9).
Metroliner—Negative. Metroliners will have a 10-year service life after upgrading, with a 5-percent scrap value.

The above assumptions do not take into account the full range of possible future dispositions of Metroliner cars, including their conversion into nonpowered trailer equipment. Such opportunities, over and above the sample assumptions developed here, might present the Metroliners in a better light and would require careful scrutiny prior to ultimate decisions regarding this multiple-unit equipment.

Coaches

Stainless steel, Amfleet-type coaches have a virtually unlimited life with proper cyclic maintenance and can be cascaded anywhere; indeed, 175 of these cars are now in service outside the NEC. From a marketing point of view, it may be undesirable for the same equipment to be used on premium NEC services indefinitely. This analysis assumes a 10-year life on the NEC; $100,000 per car would meet any interior rehabilitation needs at the end of that period for cascading or reuse; and the Amfleet would, therefore, have an 83-percent scrap value after 10 years.

In summary then, this analysis uses several sets of assumptions for vehicle life and salvage value, as shown in table F-2. Sensitivity runs have been performed on the basis of these assumptions, with the results shown in table F-3. Metroliners evidence a superiority only under the indiscriminate vehicle-life assumptions.

TABLE F-3. RESULTS OF VEHICLE LIFE AND SALVAGE VALUE SENSITIVITY RUNS

Assumptions	Type of dual service: With Metroliners	Type of dual service: Without Metroliners
	(NPV=FY 1978 million $)	
1973 Report	-479.7	-485.2
Bechtel-9	-392.6	-403.3
Metroliner, positive	-475.2	-467.3

OPERATING COSTS

The following is a detailed discussion of the cost-estimating relationships used in this report and listed in table F-4.

TRAIN COSTS

Train costs include movement expense (crew and energy), on-board services, and maintenance of equipment (MOE).

Train Operations—Crew Costs

High. Crews are divided into two distinct parts: engine crew and train crew. For a Metroliner, the engine crew consists of one person, the engineer. The train crew consists of a minimum of two persons, a conductor and a trainman. Thus, the minimum Metroliner crew is three, according to union rules. (In practice, specific local agreements have raised the minimum Metroliner crew to four.) For a locomotive-hauled train, the engine crew must include an engineer and a fireman; the train crew must have a minimum of two persons, for a total minimum crew of four. Additional crew requirements over and above these minimums reflect company policy, which considers the number of cars on the train, how quickly tickets can be collected, how many doors are to be opened and attended at station stops, and the like. As a rule, a four-car train takes the minimum allowable crew; for every pair of cars over four, the company generally provides an additional trainman. Variations in this policy could result from experience with the high-speed system; for example, a hypothetical nonstop train between New York and Washington, D.C., might be able to dispense with some of the extra trainmen since ample time would

TABLE F-2. ASSUMPTIONS FOR VEHICLE LIFE AND SALVAGE VALUE

Assumptions	Locomotives	Metroliners	Coaches
Indiscriminate:			
1973 Report:			
Life (years)	14	14	14
Scrap value (%)	0	0	0
Bechtel 9:			
Life (years)	25	25	25
Scrap value (%)	5	5	5
Vehicle specific:			
Metroliner, positive:			
Life (years)	15	15	10
Scrap value (%)	65	5	83
Metroliner, negative:			
Life (years)	15	10	10
Scrap value (%)	65	5	83

TABLE F-4. SUMMARY OF COST-ESTIMATING RELATIONSHIPS (FY 1978 $)

Item	Cost per unit ($)
	High-cost assumptions
Train costs:	
Operations:	
Crew	3.97/loco-hauled train-mile
	2.51/Metroliner train-mile
Energy	2.50/loco-mile
	.43/Metroliner-mile
Fixed transportation	16.49 million/yr
On-board services	.32/car-mile
Maintenance-of -equipment	
Variable	.69/loco-mile
	1.01/Metroliner-mile
	.32/Amfleet car-mile
Fixed	32.72 million/yr
Station costs:	
Marketing and reservations	19.78 million/yr
Station services	22.41 million/yr
Fixed plant maintenance	46.50 million/yr.
Other costs:	
Operating support	22.20 million/yr.
Taxes and insurance	3.01 million/yr.
	Low-cost assumptions
Train costs:	
Operations	
Crew	3.42/loco-hauled train-mile
	2.72/Metroliner train-mile
Energy	1.71/loco-mile
	.35/Metroliner-mile
Fixed transportation	4.56 million/yr.
On-board services	.30/car-mile
Maintenance-of-equipment	.26/loco-mile
	.58/Metroliner-mile
	.32/Amfleet car-mile
Station costs:	
Station personnel	.60/passenger
Baggage carts	.03/passenger
Reservations	.27/passenger
Commissions	.02/dollar of revenue
Promotion	.05/dollar of revenue
Utilities, cleaning, stationmasters	10.05 million/yr.
Fixed plant maintenance:	
Maintenance-of-way and structures	36.79 million/yr.
Catenary	11.88 million/yr.
Signals and communications	9.07 million/yr.
Stations and service facilities	6.82 million/yr.

be available for ticket collection. Such economies must, however, await the inauguration of, and experimentation with, service after NECIP completion. This analysis adopts the crew costs in the Bertrand letter [7] and adds to them a 3-percent railway transportation department burden rate, a 10-percent transportation department liability [8], and an inflation factor of 8.5 percent to FY 1978. The resulting costs are $3.97 per locomotive-hauled train-mile. For a Metroliner train-mile, a $2.51 crew charge is assumed.

Low. Adjusted Bechtel-9 [6] costs include a 13-percent transportation department overhead and liability and an escalation factor from 1976 to FY 1978. On this basis, crew costs are $3.42 per locomotive-hauled train-mile and $2.72 per Metroliner train-mile.

Train Operations—Energy Costs

High. The Bertrand Letter estimates power costs at $2.50 per locomotive-mile and $0.43 per Metroliner-mile (escalated by 8.5 percent to FY 1978 dollars).

Low. Bechtel-9 reports energy requirements at $1.71 per locomotive-mile and $0.35 per Metroliner-mile. Rather than reflecting actual costs over the existing electric traction system, this estimate is an idealized reflection of train performance calculations, under the assumption of an efficient, modern power supply.

Discussion. Many factors, internal and external to NEC operation, could exert dramatic effects on per-mile power charges. At present, the electric traction system relies upon self-generated and utility-generated power at 25 cycles, plus rotary conversion from utility-supplied 60 cycle (commercial frequency) to the railway standard of 25 cycles. The distribution system is essentially railway-owned and maintained. Once the proposed NECIP construction is complete, power would be at 60 cycles, with a completely new approach to distribution. On top of this major system change, the railway operating pattern and performance requirements would alter; higher speeds, better train acceleration, and more trains would affect power needs and costs. The current uncertainties with regard to post-1982 equipment mix and schedules further complicate the issue.

External to NEC itself is the question of electric power pricing policy. Under current regulations, larger users pay less per kilowatt-hour than smaller users; energy conservation measures could put a stop to this approach, with considerable penalties against railway traction. Also under discussion are time-of-day disincentives, under which major contributors to daily peak demand would pay dearly for their ill-timed electrical needs. Unfortunately, the NEC demand peak occurs at the daily power peak, so that such a disincentive could harm the railway economy. For all these reasons, although actual costs are the best available predictor of high costs, major fluctuations loom.

In all calculations involving trains with more than one locomotive, the second locomotive is assumed (on the basis of train performance calculations) to consume 30 percent of the energy used by the first.

Train Operations—Fixed Transportation Cost

High. When energy and crew costs from the Bertrand Letter are multiplied by Amtrak operating statistics for FY 1977 (see table 2–3) and when the result is subtracted from the total train operations costs for the same period in the Statement [9], a residual expense remains. This residual, annualized and escalated to FY 1978, is the basis for the fixed transportation cost (high); it amounts to $16,490,704 and reflects the following cost elements: train control (dispatching, interlocking towers); transportation supervision; yard operations; joint terminal expenses, including all charges by the Washington Terminal Co. except its equipment maintenance functions. This is an essentially optimistic estimate of fixed transportation costs. PMM-2 projected, under a fair cost allocation scenario, Amtrak costs of $24,558,430 for the very same items and, under a worst-case-for-Amtrak scenario, $31,346,781 [10]. Furthermore, optimism forms the basis for the very assumption that these costs are fixed at all; while the rearrangement of shop facilities may eliminate certain yard moves and the installation of partial centralized traffic control will eliminate many tower expenses, the numerical increase in train movements may cause many of the other fixed costs to rise. The Washington Terminal Co., half-owned by the Baltimore and Ohio Railroad, will not be under the total control of NEC management; thus, even if the high-speed system brings about technical efficiencies, their translation into operating economies may not be feasible from an institutional standpoint. At the Washington Terminal Co., alone, transportation accounts amount to approximately $8 million [10].

Low. If the fixed transportation estimate under high costs is optimistic, then the same estimate under low costs is positively exuberant. PMM-1 estimated switching and dispatching to total $4,559,604 (including 3-percent transportation burden and escalation to FY 1978) for NEC intercity operations. Nowhere in that projection do joint terminal expenses appear; the assumption is that elimination of all inefficiencies will take place once the NECIP is completed. Also, PPM-1 assumes these costs to be truly fixed and allows for no long-term variability. With due regard to all these serious qualifications, this analysis adopts the PMM-1 switching/dispatching estimate as the low boundary for fixed transportation costs.

ON-BOARD SERVICES

This category includes train supplies and expenses as well as labor costs over and above the train and engine crews. Snackbar attendants are the principal component of labor in this category.

High. High costs for on-board services result from a simple division of the totals reported in the Statement by the car-miles for the Statement period. The result equals $0.32 per car-mile.

Low. PMM-1 projects train supplies and expenses at $0.21 per car-mile, and snackbar attendants (assumption: one attendant per three cars) at $0.09 per car-mile, for a total of $0.30 per car-mile. These figures include a 3-percent passenger service burden rate.

Maintenance-of-Equipment (MOE)

High. The Bertrand Letter provides estimates of per-mile maintenance costs for locomotives and Metroliners. Escalated to FY 1978 and increased by 10 percent for shop burden per PMM-1, these costs are $0.69 per locomotive-mile and $1.01 per Metroliner-mile. Bertrand provides no figures for coaches; under the assumption that a Metroliner unites the maintenance requirements of a coach with those of a locomotive [3], $1.01 minus $0.69 yields a coach-mile maintenance cost of $0.32. By no means do these per-mile costs account for the total MOE expense as shown in the Statement. In fact, if the Amtrak operating statistics for FY 1977 are multiplied by the above per-mile figures, and if the result is subtracted from the Statement MOE total, an annual residual of $35.717 million remains. In view of the already wide divergence between the Bertrand (high) and the Bechtel-18 (low) numbers (for locomotives the ratio is 2.7 to 1; for Metroliners, 1.7 to 1) the predictive value of the high-unit costs would hardly benefit from an arbitrary increase resulting from an apportionment of the residual on a per vehicle-mile basis. Therefore, the residual remains intact as a fixed MOE expense in the high costs. Further research is clearly indicated to determine the components of this fixed MOE.

Low. On the basis of an idealized vehicle, rigorous preventive maintenance cycles, and efficient shops, Bechtel-18 provides the following cost estimates, which now include a 10-percent shop burden and an escalation to FY 1978 dollars: $0.26 per locomotive-mile; $0.58 per Metroliner-mile; $0.32 per Amfleet car-mile. This formulation has no fixed component.

Discussion. As the most prominent component of existing Amtrak costs in NEC, MOE expenses will exert a strong influence on future system profitability and on train service decisions. The high and low costs included here provide a wide range for analysis but leave many unanswered questions, of which the $35,717,464 fixed MOE under the high estimate is the most important. Even if the high-cost solution adopted herein is fully accurate for 1977 conditions and even if the low-cost estimate fully reflects the best present prediction for the improved system, the NECIP will bring two major changes, the effects of which cannot be predicted in the absence of a detailed, time-consuming, highly technical study. A discussion of the two major changes follows.

- New vehicles. While the Amfleet will not be changed, the motive power will; a new fleet of lightweight, high-speed electric locomotives, totally different from anything operated in this country in revenue service, will be in place. Even though these vehicles will effect certain economies simply by replacing the old GG-1 locomotives, which are now prone to high-maintenance costs, the exact design, performance, and maintenance characteristics of the new units are not yet fixed.

- Maintenance facilities. The NECIP will be making revisions to the vehicle-servicing facilities on the NEC; although these revisions will be designed for efficiency and high-quality work, their precise cost implications are not yet known.

Over and above these two major areas of uncertainty, other complications exist. For example, the MOE work at Washington Terminal — a charge of $9,334,920 in 1975 [10] — is not under the direct control of Amtrak. Until such direct control can be imposed, it will be impossible to assess the amount and type of cost reductions to flow from the new shop facilities and equipment at that location.

STATION COSTS

This discussion involves a breakdown of high and low costs for specific station functions.

High Breakdown

The high costs for station expenses reflect the breakdown in the Statement and consist of the following.

Station Services. The Statement provides a $22,412,009 annual estimate for station services. This is assumed to be fixed during the study period — an optimistic assumption indeed, since PMM-1 has developed per passenger unit costs for station personnel, and since logic suggests that significant patronage increases at peak hours may mandate additional terminal staff.

Marketing and Reservations. The Statement indicates an annual expense of $19,778,465 for marketing and reservations. This equates to approximately 20 percent of revenues. Since the Five-Year Corporate Plan [2] calls only for spending 12 to 13 cents per constant revenue-dollar for the functions of marketing and reservations, the existing figure should suffice for many years and, as an optimistic assumption, is assumed fixed throughout the study period.

Low Breakdown

PMM-1 has constructed station costs on a far more detailed basis than appears in the Statement.

Station Personnel. PMM-1 provides an estimate of $0.60 (including a 3-percent passenger service burden) per passenger for this category and bases it on a multiple regression analysis of personnel costs for all stations in the months January — November 1974.

Baggage Carts. PMM-1 estimates the cost of providing self-help baggage carts at stations at $0.030 per passenger; no checked baggage service is addressed, nor are the Redcap baggage attendants. Since the elimination of Redcaps has recently surfaced as a potentially significant economy move by Amtrak, the failure to include such costs is an optimistic element of PMM-1. The exact nature and financing (free or self-financed) of future checked baggage service at NEC stations is currently under consideration.

Reservations. PMM-1 assumes that all seats will be reserved and adds an expenditure of $1.37 per passenger for this purpose. Nevertheless, current practice, as reflected in the Five-Year Plan, projects a reservation rate of approximately 20 percent. This analysis assumes that the 20-percent rate will persist after 1982, so that the reservation cost per passenger becomes 20 percent of $1.37 or $0.27. (Note: In developing service options for the future, Amtrak will have a wide range of reservation policies from which to choose, ranging from no reservations to reservations at the discretion of the passenger to full reservations for any market or for any combination of markets. Financing can vary from the current "free" practice, where reservation expenses become a system cost, to a "pay-as-you-go" plan, where a specific charge might be assessed from the reserved-seat passenger.)

Commissions Promotion. PMM-1 projects that 2 percent of revenues will go toward travel agency commissions, and 5 percent of revenues will support promotion.

Fixed Station Expenses. PMM-1 allocates a $2,000,027 fixed yearly charge for station cleaning and utilities (not included in fixed plant maintenance, discussed below) and $7,143,379 per year to station masters. Both these figures include a 3-percent passenger service burden rate.

FIXED PLANT MAINTENANCE

This section includes a discussion of high and low costs.

High Costs

The Statement shows an annual maintenance-of-way (MOW) expense of $30,043,621, which includes all fixed-facility maintenance, but makes an allowance for the Consolidated Rail Corporation (Conrail) trackage-rights payments as an offset against costs. (This is true in all operating-cost categories upon which the Conrail payment is based.) Amtrak projects a 59-percent constant-dollar increase in NEC MOW costs; this has been applied to the Statement figure to arrive at a total MOW cost of $46.5 million, assumed to be fixed.

Low Costs

PMM-1 estimated the following yearly maintenance costs.

- MOW and structures: $36,786,708 (includes a $4.85 million burden)
- Maintenance of catenary: $11,881,531 (adds a 10-percent burden rate)
- Maintenance of signals and communications: $9,073,464 (adds a 10-percent burden rate)
- Maintenance of stations, shops, yards: $6,817,272 (adds a 10-percent burden rate)

The total for these items is $64,558,975; this is a conservative estimate of future costs to Amtrak, because it appears to include, by comparison with PMM-2, all fixed plant costs, rather than just the portion attributable to Amtrak operations.

OTHER COSTS

High. Amtrak has a cost category—Operations Support—that includes the following items.

- Police and security
- Operations control center
- Procurement (not materials themselves)
- Personnel and labor relations
- Administration
- Information systems (computer services)
- Revenue accounting
- Mechanical engineering staff

This category amounts to $22,199,900 per year. Taxes and insurance account for another $3,007,612 per year, for a total of $25,207,602 other costs [9]. Excluded from this analysis are depreciation accounts and corporate expenses (general and administrative and interest).

Low. There are no other costs included here from PMM-1. Corporate overhead (at 8.5 percent) is specifically excluded from this analysis.

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[1] Association of American Railroads, *Yearbook of Railroad Facts*, Combined Index of Charge-out Prices and Wage Rates, 1977.

[2] *Amtrak, Five-Year Corporate Plan*. Fiscal Years 1978–1982, Washington, D.C., Oct. 1977.

[3] Bechtel, Inc., *Task 18-Support Services: Engineering, Economics, and Cost Estimating*, Final Report to FRA-Northeast Corridor Project, July 1976.

[4] Internal FRA memo, Aug. 26, 1977.

[5] Department of Transportation, *Improved High Speed Rail in the Northeast Corridor*, Jan. 1973.

[6] Bechtel, Inc., *Task 9-Technical and Economic Analysis of Vehicle/Right-of-Way Systems*, Final Report to FRA-Office of Northeast Corridor Development, Aug. 1975.

[7] Letter from Charles E. Bertrand, Vice President and General Manager, Northeast Corridor Amtrak, to Thomas F. Ferrara, Chief, Planning and Analysis Division, Northeast Corridor Project, FRA, Oct. 28, 1977.

[8] Peat, Marwick, Mitchell & Co., *Financial Analysis of the Northeast Corridor Project (PMM-1)* Feb. 1976.

[9] Amtrak Financial Planning Department, "Statement of Northeast Corridor Financial Operations for the Nine Months Ending June 30, 1977," Aug. 1977.

[10] Peat, Marwick, Mitchell & Co., *Development of Pro-Forma Costs for Entities in the NEC Assuming Alternative Operating Patterns, (PMM-2)* Mar. 1976, for FRA-Office of Federal Assistance.

APPENDIX G. TABULATIONS OF NEC SERVICE OPTIONS AFTER NECIP COMPLETION

This appendix provides operating statistics, financial results, and performance measures upon which the financial analysis of the Northeast Corridor (NEC) after Northeast Corridor Improvement Project (NECIP) completion depends.

Figures G-1 through G-3 are samples of the output of a computer model (especially developed for this report) that translates demand, operating statistics, capital requirements, and operating cost-estimating relationships into financial projections for a given rail passenger service option. The output consists of a vehicle plan, whose summary page appears here as figure G-1. Figure G-2 shows high and low costs, yearly operating statistics and financial results. A summary of performance measurements appears in figure G-3.

As summarized in table G-1, tables G-2 through G-9 extract from the computer printouts the most pertinent projections for the years 1982, 1986, 1990, and 2000 for the options discussed in chapter 5 and summarized in table 5–4.

TABLE G-1. SUMMARY OF TABLES G-2–G-9

Category	Table Nos.
Service option:	
Dual	G-2,G-3,G-6,G-7,G-8,G-9
Single	G-4,G-5
Equipment turnaround:	
Standard	G-2,G-3,G-4,G-6,G-7,G-8,G-9
Reduced	G-5
No. of Metroliners:	
61	G-2
0	G-3,G-4,G-5,G-6,G-7,G-8,G-9
Fare levels:	
High	G-7
Normative	G-2,G-3,G-4,G-5,G-8,G-9
Low	G-6
Demand increase, 1980-82:	
100% high	G-8
Normative	G-2,G-3,G-4,G-5,G-6,G-7
50% low	G-9

VEHICLE PLAN SUMMARY

		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
LOCOS	REQUIRED	0	0	0	0	0	0	32	32	32	32
MU-S	REQUIRED	0	0	0	0	0	0	61	61	61	61
COACHES	REQUIRED	0	0	0	0	0	0	304	312	319	327
LOCOS	IN STOCK THIS YEAR	0	0	8	30	32	32	32	32	32	32
MU-S	IN STOCK THIS YEAR	0	0	19	57	61	61	61	51	51	61
COACHES	IN STOCK THIS YEAR	159	317	317	317	317	317	317	317	319	327
LOCOS	PURCHASED	0	0	8	22	2	0	0	0	0	0
MU-S	PURCHASED	0	0	19	38	4	0	0	0	0	0
COACHES	PURCHASED	159	158	0	0	0	0	0	0	2	8
LOCOS	SCRAPPED	0	0	0	0	0	0	0	0	0	0
MU-S	SCRAPPED	0	0	0	0	0	0	0	0	0	0
COACHES	SCRAPPED	0	0	0	0	0	0	0	0	0	0

		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
LOCOS	REQUIRED	32	32	32	32	32	32	32	32	32	32
MU-S	REQUIRED	61	61	61	61	61	61	61	61	61	61
COACHES	REQUIRED	335	342	351	359	367	376	385	394	404	413
LOCOS	IN STOCK THIS YEAR	32	32	32	32	32	32	32	32	32	32
MU-S	IN STOCK THIS YEAR	61	61	61	61	61	61	61	61	51	61
COACHES	IN STOCK THIS YEAR	335	342	351	359	367	376	385	394	404	413
LOCOS	PURCHASED	0	0	0	0	0	0	0	0	0	0
MU-S	PURCHASED	0	0	0	0	0	0	0	0	0	0
COACHES	PURCHASED	8	7	9	8	8	9	9	9	10	9
LOCOS	SCRAPPED	0	0	0	0	0	0	0	0	0	0
MU-S	SCRAPPED	0	0	0	0	0	0	0	0	0	0
COACHES	SCRAPPED	0	0	0	0	0	0	0	0	0	0

		1996	1997	1998	1999	2000	2001
LOCOS	REQUIRED	32	32	32	32	32	0
MU-S	REQUIRED	61	61	61	61	61	0
COACHES	REQUIRED	423	433	444	454	465	0
LOCOS	IN STOCK THIS YEAR	32	32	32	32	32	0
MU-S	IN STOCK THIS YEAR	61	61	61	61	61	0
COACHES	IN STOCK THIS YEAR	423	433	444	454	465	0
LOCOS	PURCHASED	0	0	0	0	0	0
MU-S	PURCHASED	0	0	0	0	0	0
COACHES	PURCHASED	10	10	11	10	11	0
LOCOS	SCRAPPED	0	0	0	0	0	32
MU-S	SCRAPPED	0	0	0	0	0	61
COACHES	SCRAPPED	0	0	0	0	0	465

FIGURE G-1. FACSIMILE OF FINANCIAL ANALYSIS PROGRAM PRINTOUT (VEHICLE PLAN SUMMARY).

REVENUE AND COST ANALYSIS - HIGH COSTS

NET PRESENT VALUE OF PROJECT IS -392.6 MILLION IN 1978 DOLLARS

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
PASSENGERS (NP) (MILLIONS)	17.66	18.11	18.55	19.02	19.50	19.99	20.49	21.00	21.53	22.07
PASSENGER MILES (PM) MILLIONS	2020.10	2067.36	2115.74	2165.24	2215.90	2267.75	2320.81	2375.11	2430.68	2487.55
CAR MILES (CM) (MILLIONS)	48.93	50.07	51.24	52.44	53.67	54.92	56.21	57.52	58.87	60.25
TRAIN MILES (TM) (MILLIONS)	8.14	8.14	8.14	8.14	8.14	8.14	8.14	8.14	8.14	8.14
REVENUE (R) $ MILLIONS	207.0	211.9	216.9	222.0	227.3	232.7	238.2	243.8	249.6	255.5
CM TRAIN COSTS	15.4	15.8	16.1	16.5	16.9	17.3	17.7	18.1	18.5	19.0
LOCO-MILE TRAIN COSTS	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
MU-MILE TRAIN COSTS	12.7	13.0	13.3	13.6	13.8	14.1	14.5	14.8	15.1	15.4
COACH-MILE TRAIN COSTS	12.9	13.2	13.5	13.9	14.2	14.5	14.9	15.2	15.6	16.0
LOCO-HAULED TM TRAIN COSTS	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
MU TM TRAIN COSTS	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
FIXED TRAIN COSTS	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2
TOTAL TRAIN COSTS	140.8	141.8	142.8	143.7	144.8	145.8	146.8	147.9	149.0	150.2
REVENUE LESS TRAIN COSTS	66.1	70.1	74.2	78.3	82.5	86.9	91.3	95.9	100.6	105.3
NP TERMINAL COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R TERMINAL COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIXED TERMINAL COSTS	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2
TOTAL TERMINAL COSTS	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2
TRAIN + TERMINAL COSTS	183.0	184.0	184.9	185.9	186.9	188.0	189.0	190.1	191.2	192.4
REVENUE LESS T + T COSTS	24.0	27.9	32.0	36.1	40.4	44.7	49.2	53.7	58.4	63.2
FIXED PLANT MAINTENANCE	46.5	46.5	46.5	46.5	46.5	46.5	46.5	46.5	46.5	46.5
REVENUE LESS T + T + MAINT	-22.5	-18.6	-14.5	-10.4	-6.1	-1.8	2.7	7.2	11.9	16.7
OTHER COSTS	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
TOTAL OPERATING COSTS	254.7	255.7	256.7	257.6	258.6	259.7	260.7	261.8	262.9	264.1
SURPLUS OVER OP COSTS	-47.7	-43.8	-39.7	-35.6	-31.3	-27.0	-22.6	-18.0	-13.3	-8.6
CAPITAL - FIXED PLANT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL - INITIAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL - VEHICLE EXPANSION	4.8	4.2	5.4	4.8	4.8	5.4	5.4	5.4	6.0	5.4
CAPITAL - VEHICLE REPLACEMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL - VEHICLE NEW EXCESS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL - TOTAL	4.8	4.2	5.4	4.8	4.8	5.4	5.4	5.4	6.0	5.4
SALVAGE VALUE - VEHICLE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SALVAGE VALUE - OTHER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SALVAGE VALUE - TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NET GAIN	-52.5	-48.0	-45.1	-40.4	-36.1	-32.4	-28.0	-23.4	-19.3	-14.0
DISCOUNTED GAIN	-24.5	-20.4	-17.4	-14.2	-11.5	-9.4	-7.4	-5.6	-4.2	-2.8
CUMULATIVE DISCOUNTED GAIN	-299.4	-319.8	-337.2	-351.3	-362.8	-372.2	-379.6	-385.2	-389.4	-392.2

FIGURE G-2. FACSIMILE OF FINANCIAL ANALYSIS PROGRAM PRINTOUT (REVENUE AND COST ANALYSIS).

PERFORMANCE MEASUREMENTS - HIGH COSTS

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
LOCOS IN STOCK THIS YEAR	32	32	32	32	32	32	32	32	32	32
LOCO MILES	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84
LOCO-HAULED TRAIN MILES	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84
MU-S IN STOCK THIS YEAR	61	61	61	61	61	61	61	61	61	61
MU MILES	8.80	8.99	9.18	9.38	9.59	9.80	10.01	10.23	10.45	10.68
MU TRAIN MILES	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
COACHES IN STOCK THIS YEAR	335	342	351	359	367	376	385	394	404	413
COACH MILES	40.13	41.08	42.06	43.06	44.08	45.13	46.20	47.30	48.42	49.57
MU-S PLUS COACHES IN STOCK	396	403	412	420	428	437	446	455	465	474
SEAT MILES	3372.06	3451.03	3531.85	3614.57	3699.23	3785.88	3874.55	3965.31	4058.19	4153.25

DERIVATIVE PERFORMANCE MEASURES

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
LOAD FACTOR	.599	.599	.599	.599	.599	.599	.599	.599	.599	.599
MILES PER LOCO	182500.	182500.	182500.	182500.	182500.	182500.	182500.	182500.	182500.	182500.
LOCOS PER LOCO-HAULED TRAIN	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MILES PER MU	144229.	147363.	150565.	153837.	157180.	160596.	164086.	167652.	171295.	175017.
AVG MU-S PER MU TRAIN	3.83	3.91	3.99	4.08	4.17	4.26	4.35	4.45	4.54	4.64
MILES PER COACH	119786.	120122.	119823.	119936.	120109.	120019.	119999.	120043.	119953.	120027.
COACHES PER LOCO-HAULED TRAIN	6.87	7.03	7.20	7.37	7.55	7.73	7.91	8.10	8.29	8.49
AVG. CARS PER TRAIN	6.01	6.15	6.30	6.44	6.59	6.75	6.91	7.07	7.23	7.40
REVENUE PER PM	.102	.102	.103	.103	.103	.103	.103	.103	.103	.103
REVENUE PER CM	4.23	4.23	4.23	4.23	4.24	4.24	4.24	4.24	4.24	4.24
REVENUE PER TM	25.43	26.03	26.65	27.28	27.92	28.58	29.26	29.95	30.66	31.39
T + T COSTS PER PM	.091	.089	.087	.086	.084	.083	.081	.080	.079	.077
T + T COSTS PER CM	3.74	3.67	3.61	3.55	3.48	3.42	3.36	3.31	3.25	3.19
T + T COSTS PER TM	22.49	22.60	22.72	22.84	22.97	23.09	23.22	23.36	23.49	23.63
OPERATING SURPLUS PER PSGR	-2.70	-2.42	-2.14	-1.87	-1.61	-1.35	-1.10	-.86	-.62	-.39
OPERATING SURPLUS PER PM	-.024	-.021	-.019	-.016	-.014	-.012	-.010	-.008	-.005	-.003
OPERATING RATIO	1.23	1.21	1.18	1.16	1.14	1.12	1.09	1.07	1.05	1.03

FIGURE G-3. FACSIMILE OF FINANCIAL ANALYSIS PROGRAM PRINTOUT (PERFORMANCE MEASUREMENTS).

TABLE G-2. DUAL SERVICE, STANDARD TURNAROUND, 61 METROLINERS, NORMATIVE FARES, NORMATIVE DEMAND INCREASE (Constant FY 1978 $)

Category	1982		1986		1990		2000	
Statistics:								
Passengers (millions)	16.00		17.66		19.50		24.97	
Passenger-miles (millions)	1,841.60		2,020.10		2,215.90		2,792.50	
Locomotives in fleet	32		32		32		55	
Locomotive-miles (millions)	5.84		5.84		5.84		10.44	
Metroliners in fleet	61		61		61		0.	
Metroliner-miles (millions)	8.07		8.80		9.59		0.	
Amfleet cars in fleet	317		335		367		521	
Amfleet car-miles (millions)	36.53		40.13		44.08		66.62	
Train-miles (millions)	8.14		8.14		8.14		8.14	
Seat-miles (millions)	3,073.84		3,372.06		3,699.23		4,663.05	
Revenue (million $)	188.5		207.0		227.3		287.2	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	179.5	112.6	183.0	118.5	186.9	125.0	198.8	144.5
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	251.2	177.1	254.7	183.0	258.6	189.5	270.5	209.0
Surplus/deficit (million $):								
Train plus station costs	9.0	75.9	24.0	88.5	40.4	102.3	88.4	142.7
Total operating costs	-62.7	11.4	-47.7	24.0	-31.3	37.8	16.7	78.2
Derivatives:								
Operating ratio	133	94	123	88	114	83	94	73
Load factor (%)	60	60	60	60	60	60	60	60
Annual miles (million):								
Locomotive	.18	.18	.18	.18	.18	.18	.19	.19
Metroliner	.13	.13	.14	.14	.16	.16	0	0
Amfleet car	.12	.12	.12	.12	.12	.12	.13	.13
Cars per train:								
Locomotive-hauled	6.26	6.26	6.87	6.87	7.55	7.55	8.18	8.18
Metroliner	3.51	3.51	3.83	3.83	4.17	4.17	7.00	7.00
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.23	4.23	4.23	4.23	4.24	4.24	4.25	4.25
Train-mile	23.16	23.16	25.43	25.43	27.92	27.92	35.28	35.28
Train-plus-stations costs ($):								
Passenger-mile	.10	.06	.09	.06	.08	.06	.07	.05
Car-mile	4.02	2.52	3.74	2.42	3.48	2.33	2.94	2.14
Train-mile	22.05	13.83	22.49	14.55	22.67	15.35	24.42	17.75
Total operating costs ($) per passenger-mile	.14	.10	.13	.09	.12	.09	.10	.07
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	.0	.04	.01	.04	.02	.05	.03	.05
Total operating costs	-.03	.01	-.02	.01	-.01	.02	.01	.03

NOTE: Net present value under high costs = $ -475.2 million; under low costs = $ -35.9 million.

TABLE G-3. DUAL SERVICE, STANDARD TURNAROUND, NO METROLINERS, NORMATIVE FARES, NORMATIVE DEMAND INCREASE
(Constant FY 1978 $)

Category	1982		1986		1990		2000	
Statistics:								
Passengers (millions)	16.00		17.66		19.50		24.97	
Passenger-miles (millions)	1,841.60		2,020.10		2,215.90		2,792.50	
Locomotives in fleet	50		50		50		50	
Locomotive-miles (millions)	8.14		8.14		8.14		8.14	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	360		396		434		549	
Amfleet car-miles (millions)	43.91		48.17		52.85		66.62	
Train-miles (millions)	8.14		8.14		8.14		8.14	
Seat-miles (millions)	3,073.84		3,372.13		3,699.36		4,663.19	
Revenue (million $)	188.5		207.0		227.3		287.2	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	180.7	113.3	183.4	118.7	186.4	124.7	195.1	142.4
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	252.4	177.9	255.1	183.3	258.1	189.3	266.8	207
Surplus/deficit (million $):								
Train plus station costs	7.8	75.2	23.6	88.2	40.9	102.6	92.1	144.8
Total operating costs	-63.9	10.6	-48.1	23.7	-30.8	38.0	20.4	80.3
Derivatives:								
Operating ratio	134	94	123	89	114	83	93	72
Load factor (%)	60	60	60	60	60	60	60	60
Annual miles (million):								
Locomotive	.16	.16	.16	.16	.16	.16	.16	.16
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.12	.12	.12	.12	.12	.12	.12	.12
Cars per train:								
Locomotive-hauled	5.39	5.39	5.92	5.92	6.49	6.49	8.18	8.18
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.29	4.29	4.30	4.30	4.30	4.30	4.31	4.31
Train-mile	23.16	23.16	25.43	25.43	27.92	27.92	35.28	35.28
Train-plus-stations costs ($):								
Passenger-mile	.10	.06	.09	.06	.08	.06	.07	.05
Car-mile	4.11	2.58	3.81	2.47	3.53	2.36	2.93	2.14
Train-mile	22.20	13.92	22.53	14.59	22.89	15.32	23.97	17.49
Total operating costs ($)/ passenger-mile	.14	.10	.13	.09	.12	.09	.10	.07
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	.0	.04	.01	.04	.02	.05	.03	.05
Total operating costs	-.04	.01	-.02	.01	-.01	.02	.07	.03

NOTES: NA = not applicable.
Net present value under high costs = $ -467.3 million; under low costs = $ -28.2 million.

TABLE G-4. SINGLE SERVICE, STANDARD TURNAROUND, NO METROLINERS, NORMATIVE FARES, NORMATIVE DEMAND INCREASE (Constant FY 1978 $)

Category	1982		1986		1990		2000	
Statistics:								
Passengers (millions)	17.92		19.78		21.84		27.97	
Passenger-miles (millions)	2,062.60		2,262.51		2 481.80		3,127.57	
Locomotives in fleet	91		91		91		91	
Locomotive-miles (millions)	16.70		16.70		16.70		16.70	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	317		321		351		442	
Amfleet car-miles (millions)	53.57		58.77		64.46		81.23	
Train-miles (millions)	8.35		8.35		8.35		8.35	
Seat-miles (millions)	3,750.18		4,113.65		4,512.34		5,686.42	
Revenue (million $)	211.11		231.8		254.6		321.7	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	200.4	130.2	203.7	136.5	207.3	143.5	218.0	164.1
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	272.1	194.7	275.4	201.1	279.0	208.1	289.7	228.7
Surplus/deficit (million $):								
Train plus station costs	10.8	80.9	28.2	95.3	47.3	11.1	103.7	157.6
Total operating costs	-60.9	16.4	-43.5	30.7	-24.4	46.5	32.0	93.0
Derivatives:								
Operating ratio	129	92	119	87	110	82	90	71
Load factor (%)	55	55	55	55	55	55	55	55
Annual miles (million):								
Locomotive	.18	.18	.18	.18	.18	.18	.18	.18
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.17	.17	.18	.18	.18	.18	.18	.18
Cars per train:								
Locomotive-hauled	6.42	6.42	7.0	7.0	7.7	7.7	9.73	9.73
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	3.94	3.94	3.95	3.95	3.95	3.95	3.96	3.96
Train-mile	25.29	25.29	27.77	27.77	30.49	30.49	38.53	38.53
Train-plus-stations costs ($):								
Passenger-mile	.10	.05	.09	.06	.08	.06	.07	.05
Car-mile	3.74	2.43	3.47	2.32	3.22	2.23	2.68	2.02
Train-mile	24.00	15.59	24.39	16.35	24.83	17.19	26.11	19.96
Total operating costs ($)/ passenger-mile	.13	.09	.12	.09	.11	.08	.09	.07
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	.01	.04	.01	.04	.02	.04	.03	.05
Total operating costs	-.03	.01	-.02	.01	-.01	.02	.01	.03

NOTES: NA = not applicable.
Net present value under high costs = $ -474.5 million; under low costs = $ -21.1 million.

TABLE G-5. SINGLE SERVICE, REDUCED TURNAROUND, NO METROLINERS, NORMATIVE FARES, NORMATIVE DEMAND INCREASE
(Constant FY 1978 $)

Category	1982		1986		1990		2000	
Statistics:								
Passengers (millions)	17.92		19.78		21.84		27.97	
Passenger-miles (millions)	2,062.20		2,262.29		2,481.80		3,128.32	
Locomotives in fleet	78		78		78		78	
Locomotive-miles (millions)	16.70		16.70		16.70		16.70	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	317		263		277		317	
Amfleet car-miles (millions)	53.56		56.31		59.19		67.04	
Train-miles (millions)	8.35		8.35		8.35		8.35	
Seat-miles (millions)	3,750.18		3,942.81		4,143.23		4,692.97	
Revenue (million $):	211.1		231.8		254.6		321.7	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	200.4	130.2	202.1	135.0	203.9	140.2	208.9	155.4
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	272.1	194.7	273.8	199.6	275.6	204.8	280.6	219.9
Surplus/deficit (million $):								
Train plus station costs	10.8	80.9	29.7	96.9	50.6	114.3	112.8	166.3
Total operating costs	-60.9	16.4	-42.0	32.3	-21.1	49.8	41.0	101.8
Derivatives:								
Operating ratio	129	92	118	86	108	80	87	68
Load factor (%)	55	55	57	57	60	60	67	67
Annual miles (million):								
Locomotive	.21	.21	.21	.21	.21	.21	.21	.21
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.17	.17	.21	.21	.21	.21	.21	.21
Cars per train:								
Locomotive-hauled	6.42	6.42	6.74	6.74	7.09	7.09	8.03	8.03
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	3.74	3.74	4.12	4.12	4.30	4.30	4.80	4.80
Train-mile	25.29	25.29	27.77	27.77	30.49	30.49	38.53	38.53
Train-plus-stations costs ($):								
Passenger-mile	.10	.06	.09	.06	.08	.06	.07	.05
Car-mile	3.74	2.43	3.59	2.40	3.45	2.37	3.12	2.32
Train-mile	24.00	15.59	24.21	16.17	24.43	16.80	25.03	18.61
Total operating costs ($)/ passenger-mile	.13	.04	.12	.09	.11	.08	.09	.07
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	.01	.04	.01	.04	.02	.05	.04	.05
Total operating costs	-.03	.01	-.02	.01	-.01	.02	.01	.03

NOTES: NA = not applicable.
Net present value under high costs = $ -410.6; under low costs = $42.3 million.

TABLE G-6. DUAL SERVICE, STANDARD TURNAROUND, NO METROLINERS, LOW-FARE LEVELS, NORMATIVE DEMAND INCREASE
(Constant FY 1978 $)

Category	1982		1986		1990		2000	
Statistics:								
Passengers (millions)	18.10		19.86		21.80		27.51	
Passenger-miles (millions)	2,133.00		2,326.43		2,537.40		3,152.37	
Locomotives in fleet	49		49		49		49	
Locomotive-miles (millions)	8.14		8.14		8.14		8.14	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	390		412		434		497	
Amfleet car-miles (millions)	50.87		55.48		60.52		75.18	
Train-miles (millions)	8.14		8.14		8.14		8.14	
Seat-miles (millions)	3,560.90		3,883.83		4,236.05		5,262.75	
Revenue (million $):	182.0		199.0		217.6		272.0	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	184.1	118.1	187.5	124.2	191.2	130.9	202.6	150.8
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	255.8	182.7	259.2	188.7	263.0	195.4	274.3	215.4
Surplus/deficit (million $):								
Train plus station costs	-2.1	63.9	11.5	74.8	26.4	86.7	69.5	121.2
Total operating costs	-73.8	-0.7	-60.2	10.3	-45.4	22.2	-2.3	56.7
Derivatives:								
Operating ratio	14	100	130	95	121	90	101	79
Load factor (%)	60	60	60	60	60	60	60	60
Annual miles (million):								
Locomotive	.17	.17	.17	.17	.17	.17	.17	.17
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.13	.13	.13	.13	.14	.14	.15	.15
Cars per train:								
Locomotive-hauled	6.25	6.25	6.82	6.82	7.43	7.43	9.24	9.24
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.09	.09	.09	.09	.09	.09	.09	.09
Car-mile	3.82	3.82	3.71	3.71	3.60	3.60	3.34	3.34
Train-mile	22.36	22.36	24.45	24.45	26.73	26.73	33.42	33.42
Train-plus-stations costs ($):								
Passenger-mile	.09	.06	.08	.05	.08	.05	.06	.05
Car-mile	3.86	2.48	3.49	2.31	3.16	2.16	2.48	1.85
Train-mile	22.62	14.51	23.03	15.26	23.49	16.08	24.89	18.53
Total operating costs ($)/ passenger-mile	.12	.09	.11	.08	.10	.08	.09	.07
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	-.00	.03	.00	.03	.01	.03	.02	.04
Total operating costs	-.03	.00	-.03	.00	-.02	.01	-.00	.02

NOTES: NA = not applicable.
Net present value under high costs = $ -533.3 million; under low costs = $ -122.3 million.

TABLE G-7. DUAL SERVICE, STANDARD TURNAROUND, NO METROLINERS, HIGH FARES, NORMATIVE DEMAND INCREASE (Constant FY 1978 $)

Category	1982		1986		1990		2000	
Statistics:								
Passengers (millions)	13.8		14.86		16		19.25	
Passenger-miles (millions)	1,548.30		1,649.12		1,756.50		2,056.55	
Locomotives in fleet	49		49		49		49	
Locomotive-miles (millions)	8.14		8.14		8.14		8.14	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	320		330		340		367	
Amfleet car-miles (millions)	39.52		40.69		41.89		45.05	
Train-miles (millions)	8.14		8.14		8.14		8.14	
Seat-miles (millions)	2,766.68		2,848.32		2,932.37		3,153.51	
Revenue (million $):	190.9		211.9		235.2		305.3	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	177.9	108.8	178.6	111.9	179.4	115.3	181.4	125.1
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	249.6	173.3	250.3	176.5	251.1	179.9	253.1	189.7
Surplus/deficit (million $):								
Train plus station costs	13.0	82.1	33.3	100.0	55.8	119.9	123.9	180.2
Total operating costs	-58.7	17.6	-38.4	35.4	-15.9	55.3	52.2	115.6
Derivatives:								
Operating ratio	131	91	118	83	107	76	83	62
Load factor (%)	56	56	58	58	60	60	65	65
Annual miles (million):								
Locomotive	.17	.17	.17	.17	.17	.17	.17	.17
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.12	.12	.12	.12	.12	.12	.12	.12
Cars per train:								
Locomotive-hauled	4.86	4.86	5.00	5.00	5.15	5.15	5.53	5.53
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.12	.12	.13	.13	.13	.13	.15	.15
Car-mile	4.83	4.83	5.21	5.21	5.61	5.61	6.78	6.78
Train-mile	23.45	23.45	26.03	26.03	28.89	28.89	37.51	37.51
Train-plus-stations costs ($):								
Passenger-mile	.12	.07	.11	.07	.10	.07	.09	.06
Car-mile	4.50	2.75	4.39	2.75	4.28	2.75	4.03	2.78
Train-mile	21.85	13.36	21.94	13.75	22.04	14.17	22.28	15.37
Total operating costs ($)/ passenger-mile	.16	.11	.15	.11	.14	.10	.12	.09
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	.01	.05	.02	.06	.03	.07	.06	.09
Total operating costs	-.04	.01	-.02	.02	-.01	.03	.03	.06

NOTES: NA = not applicable.
Net present value under high costs = $ -340.9 million; under low costs = $112.6 million.

TABLE G-8. DUAL SERVICE, STANDARD TURNAROUND, NO METROLINERS, NORMATIVE FARE LEVELS, 100% HIGHER DEMAND INCREASE
(Constant FY 1978 $)

Category	1982		1986		1990		2000	
Statistics:								
Passengers (millions)	21		23.19		25.60		32.79	
Passenger-miles (millions)	2,417.10		2,668.39		2,945.80		3,772.15	
Locomotives in fleet	50		50		50		50	
Locomotive-miles (millions)	8.14		8.14		8.14		8.14	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	474		485		495		523	
Amfleet car-miles (millions)	57.65		63.64		70.26		89.96	
Train-miles (millions)	8.1		8.1		8.1		8.1	
Seat-miles (millions	4,035.22		4,454.73		4,917.85		6,297.39	
Revenue (million $):	246.7		272.2		300.5		384.8	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	189.4	130.4	193.2	137.9	197.4	146.2	210.0	170.8
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	261.1	195.0	264.9	202.4	269.2	210.7	281.7	235.3
Surplus/deficit (million $):								
Train plus station costs	57.1	116.1	79.0	134.3	103.1	154.3	174.8	214.1
Total operating costs	-14.6	51.6	7.2	69.7	31.3	89.8	103.1	149.5
Derivatives:								
Operating ratio	106	79	97	74	90	70	73	61
Load factor (%)	60	60	60	60	60	60	60	60
Annual miles (million):								
Locomotive	.16	.16	.16	.16	.16	.16	.16	.16
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	12	12	13	13	14	14	17	17
Cars per train:								
Locomotive-hauled	7.08	7.08	7.82	7.82	8.63	8.63	11.05	11.05
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Train-mile	30.29	30.29	33.44	33.44	36.92	36.92	47.28	47.28
Train-plus-stations costs ($) per:								
Passenger-mile	.08	.05	.07	.05	.07	.05	.06	.05
Train-mile	3.29	2.26	3.04	2.17	2.81	2.08	2.33	1.90
Train-mile	23.27	16.02	23.74	16.94	24.26	17.96	25.80	20.98
Total operating costs ($)/ passenger-mile	.11	.08	.10	.08	.09	.07	.07	.06
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	.02	.05	.03	.05	.03	.05	.05	.06
Total operating costs	-.01	.02	.00	.03	.01	.03	.03	.04

NOTES: NA = not applicable.
Net present value under high costs = $ -113.2 million; under low costs = $263.2 million.

TABLE G-9. DUAL SERVICE, STANDARD TURNAROUND, NO METROLINERS, NORMATIVE FARE LEVELS, 50% LOWER DEMAND INCREASE
(Constant FY 1978 $)

Category	1982		1986		1990		2000	
Statistics:								
Passengers (millions)	13.50		14.92		16.50		21.20	
Passenger-miles (millions)	1,553.85		1,715.20		1,893.30		2,423.72	
Locomotives in fleet	50		50		50		50	
Locomotive-miles (millions)	8.14		8.14		8.14		8.14	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	317		337		372		477	
Amfleet car-miles (millions)	37.06		40.91		45.17		57.84	
Train-miles (millions)	8.14		8.14		8.14		8.14	
Seat-miles (millions)	2,594.06		2,863.81		3,161.62		4,048.76	
Revenue (million $):	158.5		175.0		193.2		247.4	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	176.3	104.7	178.8	109.5	181.5	114.9	189.5	130.8
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	248.0	169.3	250.5	174.1	253.2	179.4	261.2	195.3
Surplus/deficit (million $):								
Train plus station costs	-18	53.8	-4	65.5	12	78.3	58	116.7
Total operating costs	-89.5	-10.8	-75.5	.9	-60.0	13.8	-13.8	52.1
Derivatives:								
Operating ratio	156	107	143	99	131	93	106	79
Load factor (%)	60	60	60	60	60	60	60	60
Annual miles (million):								
Locomotive	.16	.16	.16	.16	.16	.16	.16	.16
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.12	.12	.12	.12	.12	.12	.12	.12
Cars per train:								
Locomotive-hauled	4.55	4.55	5.03	5.03	5.55	5.55	7.11	7.11
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Train-mile	19.47	19.47	21.50	21.50	23.73	23.72	30.40	30.40
Train-plus-stations costs ($):								
Passenger-mile	.11	.07	.10	.06	.10	.06	.08	.05
Car-mile	4.76	2.83	4.37	2.68	4.02	2.54	3.38	2.26
Train-mile	21.66	12.86	21.96	13.46	22.29	14.11	23.29	16.07
Total operating costs ($)/ passenger-mile	.16	.11	.15	.10	.13	.09	.11	.08
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	-.01	.03	-.00	.04	.01	.04	.02	.05
Total operating costs	-.06	-.01	-.04	.00	-.03	.01	-.01	.02

NOTES: NA = not applicable.
Net present value under high costs = $ -619 million; under low costs = $ -149.7 million.

APPENDIX H. POST-NECIP IMPROVEMENTS

What follows is a detailed discussion of some conceivable additions to the Northeast Corridor (NEC). These examples were introduced in chapter 7.

BALTIMORE TUNNEL

Interference between passenger and freight traffic in the vicinity of the Baltimore and Potomac (B&P) tunnel in Baltimore, Md., is worse than at any other location along the NEC. While correcting much deferred maintenance and providing a stable track structure in the tunnel, the Northeast Corridor Improvement Project (NECIP) alone will not relieve the inherent congestion problems. Some combination of operational revisions and capacity additions would be necessary to relieve the bottleneck on a permanent basis.

Over the past few years, the Department of Transportation (DOT), the State of Maryland, and the city of Baltimore have been conducting feasibility studies for congestion relief of Baltimore. The Study of the Rail System in the Baltimore Region prepared for the Maryland Department of Transportation in September 1976 by Peat, Marwick, Mitchell, and Co., provides an excellent summary of "improvement alternatives for through traffic." Since then, further alternatives have been explored by DeLeuw, Cather/Parsons in a June 1977 interim report, "Tunnels Study—B&P Segment." The following is a brief summary of the major schemes developed thus far; the interested reader is referred to the above cited reports for more details [1] [2].

Regardless of the routing policies for freight throughout the rest of the NEC, there are basically two alternatives for handling Consolidated Rail Corporation (Conrail) trains through Baltimore: either via the B&P Tunnel and the existing route (on-Corridor), or via the Chessie System trackage (off-Corridor). The physical plant alternatives discussed below are generally geared to one or the other routing.

Parallel B&P Tunnel. The Pennsylvania Railroad in the early 20th century developed a plan and acquired an easement for a parallel tunnel under Presstman Street, north of the existing B&P tunnel. Such a parallel tunnel, having many alternative configurations, could handle either passenger trains (leaving the old B&P for freight and expediting passenger service) or freight trains. It could be compatible with the on-Corridor, off-Corridor, or hybrid handling of freight service through Baltimore.

Improvements to Chessie System. This approach would comprise the following: construction of appropriate connections between Conrail and Chessie; assumption of an off-Corridor freight routing; and the upgrading of Chessie facilities including the Howard Street Tunnel.

Improvements to Chessie Plus Harbor Freight Tunnel. This approach, studied by Baltimore City, would involve the construction of a rail freight tunnel from Locust Point to Canton and would imply an off-Corridor freight routing.

Operation of Chessie and Conrail As A One-Way Pair. This would, of course, involve a series of connections between the two lines.

Operation of Amtrak on the Chessie, All Freight On The NEC. This would be a virtually complete reversal of roles.

Rebuild Existing B&P Tunnel. In the absence of an effective Baltimore detour route, this approach would entail major dislocations to Amtrak and Conrail traffic.

No Action. This alternative would allow congestion to grow as traffic increases.

Imposition of Schedule Changes. This alternative would minimize congestion in the B&P tunnel through adroit manipulation of passenger schedules and the imposition of rigid schedules on NEC freight.

Major Diversions of Freight Traffic. Should the penalties for freight operation through Baltimore become too severe, Conrail may elect to divert traffic through other gateways—for example, the Delmarva car ferry or Hagerstown. The physical, financial, and institutional feasibility of such diversions would require intensive research, since it may be assumed that Conrail's existing routings tend to maximize the company's revenues and that diversions would result in a loss of revenues.

All existing (and many new) alternatives would require further analysis before a solution can be selected.

FLYOVERS

The following grade-separated junctions (flyovers) have been suggested as useful capacity enhancements.

LANE GRADE SEPARATION

Freight trains entering and leaving Waverly Yard, Conrail's principal freight facility adjacent to the NEC in northern New Jersey, utilize No.2 and No.3 tracks between Elmora and Lane interlockings. Track No.1 avoids conflicts with freight traffic by use of an existing flyover. Both NEC and New Jersey Department of Transportation commuter trains eastbound use track No. 1. Track No. 2, however, is shared by freight and passenger trains, and delays frequently occur when freight trains occupy the track. All solutions to this problem have been aimed at minimizing the amount of time that freight must be stored on main tracks awaiting access to Waverly and the amount of time it takes the freight cars to cross over Nos. 2 and 3 tracks leaving Waverly.

Previous simulations (Task 4 and 4B) had recommended the construction of a six-track railroad in place of the existing four-track system, with the east- and westbound freight and eastbound commuter tracks located to the east (Waverly side) of the NEC and thus completely separated from NEC trains. Recent simulations have not reached the same conclusion. Rather, a detailed analysis of the problem, performed for the Federal Railroad Administration in early 1977, suggested the construction of the additional grade separation of No.2 track to avoid interface with westbound freights leaving Waverly and the construction of an additional track entering the yard from track No.1. This will have a significant positive impact on eastbound NEC trains but may impact negatively on some commuter service.

Harold Flyover

Long Island Railroad (LIRR) commuter trains use the Harold interlocking on Amtrak's Hell Gate line when entering or leaving Penn Station in New York City. A conflict between 3,400 weekly high-speed intercity passenger trains and commuter trains, both vying for passage through the interlocking, occurs regularly and at substantial penalty. Both types of traffic are expected to increase. Systems simulations indicate that significant reductions in delays to NEC trains are achieved by the construction of a grade separation at Harold interlocking. The NECIP calls for the construction of an additional track that will eliminate the westbound NEC/LIRR conflict; the grade separation would eliminate the eastbound delays. These latter delays, currently and in the simulation, result from holding NEC trains at Harold while LIRR east- and westbound trains are given priority by tower operators controlled by the LIRR. Once released, each NEC train must then cross every track in the interlocking to reach the Hell Gate line; a grade separation at Harold would eliminate all interface between LIRR and NEC trains and produce an estimated savings of 1.755 minutes per train. Additionally, 1.5 minutes more would be saved if present crossover moves now made by NEC trains were eliminated. The total time saved per train by this improvement would thus be an estimated 3.255 minutes, to which must be added time waiting for access.

Shell Flyover

This would be a grade separation at Shell interlocking to eliminate the interface between NEC trains connecting to and from the Hell Gate line and Metropolitan Transportation Authority (MTA)/Connecticut Department of Transportation trains and would thus eliminate congestion delays.

The results of previous systems simulations indicated that a reduction in the number and magnitude of delays to NEC trains (not nearly so significant as at Harold) would be achieved by the construction of a grade separation at Shell interlocking in New Rochelle, N.Y.

The delays are the result of the interface with commuter trains at Shell, which is controlled by the MTA, and therefore, priority is given to commuter trains. The main line of the former New Haven was the route to Grand Central Terminal, and access to Penn Station was a diverging move from the main to the Hell Gate line or from the Hell Gate line to the main line. Since the two inside tracks between Shell and New Haven are the NEC-dedicated tracks, NEC trains must cross at least the track on which New Haven-bound commuter trains are operated. This results in NEC trains being held while commuter trains run. The delays are further complicated by the geometry of the interlocking which restricts NEC moves to a maximum speed of 20 mph.

The geometry and signaling improvements funded in the NECIP would increase the crossover speed to 60 mph and thus minimize the amount of time NEC trains spend in the interlocking. This should minimize delays to both NEC and commuter trains. If further simulations and operating experience do not indicate that these NECIP alterations are effective, then the complete grade separation could be constructed.

REFERENCES

[1] Maryland Department of Transportation, *The Study of the Rail System in the Baltimore Region*, prepared by Peat, Marwick, Mitchell, and Co., Sept. 1976.

[2] Department of Transportation, Federal Railroad Administration, Northeast Corridor Project, "Tunnels Study—B&P Segment," an interim report prepared by DeLeuw, Cather/Parsons, June 1977.

APPENDIX J.
FIXED-PLANT IMPROVEMENTS FOR POST-NECIP REDUCED TRIP TIMES

To achieve the 2-hour, 30-minute, timings from New York—Washington, D.C., and the 3-hour timings from New York—Boston, the following improvements beyond the Northeast Corridor Improvement Project (NECIP) have been studied under a fixed-plant-intensive solution. These improvements are, of course, subject to further research and investigation. The total cost of these fixed-plant improvements for post-NECIP reduced trip times is estimated, on a preliminary basis, at $890 million (FY 1978 dollars).

IDENTIFICATION OF 150-MPH STRETCHES

Preliminary engineering analyses, including train performance calculations, have identified the following route sections for upgrading to speeds over 120 mph, presumptively to 150 mph.

- Milepost 27.79 (Kilmer) N.J. to 56.15 (Trenton) N.J.
- Milepost 75.18 (Torresdale) to 80.81 (Frankford Junction) Pa.
- Milepost 30.50 (Newport) Del. to 59.40 (Perryville) Md.
- Milepost 104.25 (Winans) Md. to 125.14 (Seabrook) Md.

TOTAL south of New York: 94.38 miles

- Milepost 209.57 (Boston South) to 190.55 (Sharon Heights) Mass.
- Milepost 180.40 (Cranston) to 174.6 (Appenaug) R.I.
- Milepost 170.41 (E. Greenwich) to 154.5 (Kenyons) R.I.

TOTAL north of New York: 40.73 miles

These higher speed areas would require appropriate curve realignments, track centers, and signaling revisions, the estimates for which are presented here. Additional requirements would be complete fencing, as well as electrical catenary modifications south of New York, for which the estimates have not yet been prepared.

CURVE REALIGNMENTS

To negotiate curves at 150 mph with nontilt suspension equipment requires track realignment to a 34-minute maximum degree of curvature and the provision of 6-inch superelevation. Within the stretches of the 150-mph track, noted above, as well as in other areas of major speed restrictions, potential curve realignments have been identified at an estimated cost of $502 million north of New York and $161 million south of New York. These curves would require a maximum of $54 million per minute saved north, and $97 million per minute saved south of New York.

WIDER TRACK SPACING

Operation at speeds in excess of 120 mph may require 14-foot track centers between the easterly dedicated passenger track and the freight tracks below New York. Implementation of such a standard would require shifting either track No.1 or track No.2, depending upon the location, between 6 and 18 inches from tracks Nos.2 or 3. The amount of shift would depend upon existing track centers and would require reconstruction of bridges, catenary structures and, at times, passenger stations. The costs have been estimated, by location, to be $42 million.

INCREMENTAL IMPROVEMENTS IN THE NEW ROCHELLE—NEW HAVEN SEGMENT

The NECIP will be improving a few selected components between New Haven (Conn.) and New Rochelle (N.Y.), a 56.6-mile stretch owned by the Metropolitan Transportation Authority (MTA) and the Penn Central Trustees. In this segment, however, most facilities — notably the track — are the responsibility of the current owners, lessees, and/or maintainers. Irrespective of legal responsibilities, if the tracks currently dedicated to intercity service were incrementally upgraded, the 3-hour trip time between Boston and New York would be more readily attainable. Therefore, this report identifies as a possible incremental improvement in the New Rochelle—New Haven segment, the installation of wooden or concrete ties and rail, the upgrading of interlockings, and other related track enhancements at an estimated total cost of $89 million.

In addition, the conversion of MTA/Connecticut Department of Transportation commuter equipment to allow for the switch from 12.5 kV to 25 kV would cost an estimated $32 million. Such a switch, provided for but not executed under the NECIP, would permit high-speed trains to approach their full performance potential over this segment, thereby contributing to the attainment of the 3-hour timing.

SIGNALING AND TRAFFIC CONTROL

Additional changes would be required to properly manage and control train movements at the higher speed. The following would be required.

- An additional signal aspect to authorize speeds above 120 mph and to provide safe braking distances for 150-mph speeds.

- An overlay speed control system to insure that high-speed trains comply with civil speed restrictions placed on curves and bridges.

The total additional cost of these improvements is estimated to be $64 million.

APPENDIX K. TABULATION OF OPTIONS UNDER POST-NECIP TRIP-TIME REDUCTIONS

As summarized in table K-1 below, tables K-2 through K-6 extract from the computer printouts the most pertinent projections for the years 1985, 1986, 1990 and 2000 for the reduced trip-time operations discussed in the body of the report.

TABLE K-1. SUMMARY OF TABLES K-2–K-6

Post-NECIP reduced trip-time option	Table Nos.
Fixed plant intensive:	
Dual service	K-2
Single service	K-3
Vehicle intensive:	
Dual service	K-4
Single service	K-5
Fixed plant plus tilt vehicle, single service	K-6

TABLE K-2. FIXED PLANT INTENSIVE OPTION, DUAL SERVICE
(Constant FY 1978 $)

Category	1985		1986		1990		2000	
Statistics:								
Passengers (millions)	17.23		19.75		21.80		27.92	
Passenger-miles (millions)	1,974.91		2,354.03		2,582.20		3,254.12	
Locomotives in fleet	75		75		75		50	
Locomotive-miles (millions)	8.14		8.14		8.14		8.14	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	567		408		434		549	
Amfleet car-miles (millions)	47.17		56.15		61.60		77.65	
Train-miles (millions)	8.14		8.14		8.14		8.14	
Seat-miles (millions)	3,294.95		3,930.57		4,312.00		5,435.45	
Revenue (million $):	202.2		239.0		262.5		331.7	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	182.7	117.3	188.5	127.8	191.5	134.7	202.2	155.0
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	254.4	181.9	260.2	192.4	263.6	199.3	273.9	219.6
Surplus/deficit (million $):								
Train plus station costs	19.5	84.9	50.6	111.2	70.6	127.8	129.5	176.7
Total operating costs	-52.2	20.3	-21.1	46.7	-1.1	63.2	57.8	112.1
Derivatives:								
Operating ratio	126	90	109	80	100	76	83	66
Load factor (%)	60	60	60	60	60	60	60	60
Annual miles (million):								
Locomotive	.11	.11	.11	.11	.11	.11	.16	.16
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.08	.08	.14	.14	.14	.14	.14	.14
Cars per train:								
Locomotive-hauled	5.78	5.78	6.90	6.90	7.57	7.51	9.54	9.54
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.30	4.30	4.26	4.26	4.26	4.26	4.27	4.27
Train-mile	24.84	24.84	29.37	29.37	32.25	32.25	40.75	40.75
Train-plus-stations costs ($):								
Passenger-mile	.09	.06	.08	.05	.07	.05	.06	.05
Car-mile	3.88	2.49	3.36	2.28	3.12	2.19	2.60	2.00
Train-mile	22.44	14.42	23.15	15.70	23.58	16.55	24.84	19.04
Total operating costs ($)/ passenger-mile	.13	.09	.11	.08	.10	.08	.08	.07
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	.01	.04	.02	.05	.03	.05	.04	.05
Total operating costs	-.03	.01	-.01	.02	0	.02	.02	.03

NOTES: NA = not applicable.
Net present value under high costs = $ -973.7 million; under low costs = $ -552.4 million.

TABLE K-3. FIXED PLANT INTENSIVE OPTION, SINGLE SERVICE (Constant FY 1978 $)

Category	1985		1986		1990		2000	
Statistics:								
Passengers (millions)	19.30		22.12		24.42		31.27	
Passenger-miles (millions)	2,210.79		2,637.20		2,892.80		3,645.51	
Locomotives in fleet	117		117		117		78	
Locomotive-miles (millions)	16.70		16.70		16.70		16.70	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	449		305		321		367	
Amfleet car-miles (millions)	55.61		64.64		68.99		78.14	
Train-miles (millions)	8.35		8.35		8.35		8.35	
Seat-miles (millions)	3,893		4,594.59		4,829.37		5,470.15	
Revenue (million $):	226.5		267.7		294		371.5	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	201.7	133.8	208	145.4	210.2	133.8	216.0	168.7
All other operating costs	71.7	64.6	71.7	64.6	71.7	64.6	71.7	64.6
Total operating costs	273.4	198.3	279.8	210.0	281.9	198.3	287.7	233.3
Surplus/deficit (million $):								
Train plus station costs	24.8	92.7	59.7	122.3	83.8	92.7	155.5	202.8
Total operating costs	-46.9	28.1	-12	57.8	12.1	28.1	83.8	138.2
Derivatives:								
Operating ratio	121	88	104	78	96	73	77	63
Load factor (%)	57	57	57	57	60	60	67	67
Annual miles (million):								
Locomotive	.14	.14	.14	.14	.14	.14	.21	.21
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.12	.12	.21	.21	.21	.21	.21	.21
Cars per train:								
Locomotive-hauled	6.66	6.66	7.86	7.86	8.26	8.26	9.36	9.36
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.07	4.07	4.08	4.08	4.26	4.26	4.75	4.75
Train-mile	27.13	27.13	32.07	32.07	35.21	35.21	44.50	44.50
Train-plus-stations costs ($):								
Passenger-mile	.09	.06	.08	.06	.07	.05	.06	.05
Car-mile	3.63	2.41	3.17	2.22	3.05	2.19	2.76	2.16
Train-mile	24.15	16.02	24.92	17.42	25.17	18.14	25.87	20.21
Total operating costs ($)/ passenger-mile	.12	.09	.11	.08	.10	.07	.08	.06
Surplus/deficit ($)/ passenger-mile:								
Train-plus-station costs	.01	.04	.02	.05	.03	.03	.04	.06
Total operating costs	-.02	.01	-.01	.02	.0	.01	.02	.04

NOTES: NA = not applicable.
Net present value under high costs = $ -917.9 million; under low costs = $ -484.9 million.

TABLE K-4. VEHICLE INTENSIVE OPTION, DUAL SERVICE
(Constant FY 1978 $)

Category	1985		1986		1990		2000	
Statistics:								
Passengers (millions)	17.23		19.75		21.80		27.92	
Passenger-miles (millions)	1,974.91		2,354.03		2,582.20		3,254.12	
Locomotives in fleet	75		75		75		50	
Locomotive-miles (millions)	8.14		8.14		8.14		8.14	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	567		408		434		549	
Amfleet car-miles (millions)	47.07		56.15		61.60		77.65	
Train-miles (millions)	8.14		8.14		8.14		8.14	
Seat-miles (millions)	3,295.95		3,931.57		4,312.00		5,435.45	
Revenue (million $):	202.2		239		262.5		331.7	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	183.7	117.3	188.5	127.8	191.9	134.7	202.2	155
All other operating costs	71.7	64.9	71.7	64.9	71.7	64.9	71.7	64.9
Total operating costs	254.4	181.9	260.2	192.4	263.6	199.3	273.9	219.6
Surplus/deficit (million $):								
Train plus station costs	19.5	84.9	50.6	111.2	70.6	127.8	129.5	176.7
Total operating costs	-52.2	20.3	-21.1	46.7	-1.1	63.2	57.8	112.1
Derivatives:								
Operating ratio	126	90	109	80	100	76	83	66
Load factor (%)	60	60	60	60	60	60	60	60
Annual miles (million):								
Locomotive	.11	.11	.11	.11	.11	.11	.16	.16
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.08	.08	.14	.14	.14	.14	.14	.14
Cars per train:								
Locomotive-hauled	5.8	5.8	6.9	6.9	7.6	7.6	9.5	9.5
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.30	4.30	4.26	4.26	4.26	4.26	4.27	4.27
Train-mile	24.84	24.84	29.37	29.37	32.25	32.25	40.75	40.75
Train-plus-stations costs ($):								
Passenger-mile	.09	.06	.08	.05	.07	.05	.06	.05
Car-mile	3.88	2.49	3.36	2.28	3.12	2.19	2.60	2
Train-mile	22.44	14.42	23.15	15.70	23.58	16.55	24.84	19.04
Total operating costs ($)/ passenger-mile	.13	.09	.11	.08	.10	.08	.08	.07
Surplus/deficit ($)/ passenger-mile on:								
Train-plus-station costs	.01	.04	.02	.05	.03	.05	.04	.05
Total operating costs	-.03	.01	-.01	.02	0	.02	.02	.02

NOTES: NA = not applicable.
Net present value under high costs = $ -477.8 million; under low costs = $ -56.5 million.

TABLE K-5. VEHICLE INTENSIVE OPTION, SINGLE SERVICE
(Constant FY 1978 $)

Category	1985		1986		1990		2000	
Statistics:								
Passengers (millions)	19.30		22.12		24.42		31.27	
Passenger-miles (millions)	2,210.79		2,637.20		2,892.80		3,645.51	
Locomotives in fleet	117		117		117		78	
Locomotive-miles (millions)	16.70		16.70		16.70		16.70	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	449		305		321		367	
Amfleet car-miles (millions)	55.61		65.64		68.99		78.14	
Train-miles (millions)	8.35		8.35		8.35		8.35	
Seat-miles (millions)	3,893		4,594.59		4,829.37		5,470.15	
Revenue (million $):	226.5		267.7		294.0		371.5	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	201.7	133.8	208	145.4	210.2	151.4	216	168.7
All other operating costs	71.7	64.9	71.7	64.9	71.7	64.9	71.7	64.9
Total operating costs	273.4	198.3	279.8	210.0	281.9	216	287.7	233.3
Surplus/deficit (million $):								
Train plus station costs	24.8	92.7	59.7	122.3	83.8	142.6	155.5	202.8
Total operating costs	-46.9	28.1	-12	57.8	12.1	78	83.8	138.2
Derivatives:								
Operating ratio	121	88	104	78	96	73	77	63
Load factor (%)	57	57	57	57	60	60	67	67
Annual miles (million):								
Locomotive	.14	.14	.14	.14	.14	.14	.21	.21
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.12	.12	.22	.22	.21	.21	.21	.21
Cars per train:								
Locomotive-hauled	6.66	6.66	7.86	7.86	8.26	8.26	9.36	9.36
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.07	4.07	4.08	4.08	4.26	4.26	4.75	4.75
Train-mile	27.13	27.13	32.07	32.07	35.21	35.21	44.50	44.50
Train-plus-stations costs ($):								
Passenger-mile	.09	.06	.08	.06	.07	.05	.06	.05
Car-mile	3.63	2.41	3.17	2.22	3.05	2.19	2.76	2.16
Train-mile	24.15	16.02	24.92	17.42	25.17	18.14	25.87	20.21
Total operating costs ($)/ passenger-mile	.12	.09	.11	.08	.10	.07	.08	.06
Surplus/deficit ($)/ passenger-mile on:								
Train-plus-station costs	.01	.04	.02	.05	.03	.05	.04	.06
Total operating costs	-.02	.01	-.01	.02	0	.03	.02	.04

NOTES: NA = not applicable.
Net present value under high costs = $ -422.1 million; under low costs = $10.9 million.

TABLE K-6. FIXED PLANT PLUS TILT VEHICLE, SINGLE SERVICE
(Constant FY 1978 $)

Category	1985		1986		1990		2000	
Statistics:								
Passengers (millions)	19.30		23.55		26.00		33.29	
Passenger-miles (millions)	2,210.79		2,971.35		3,259.36		4,107.45	
Locomotives in fleet	117		117		117		85	
Locomotive-miles (millions)	16.70		18.05		18.05		18.05	
Metroliners in fleet	0		0		0		0	
Metroliner-miles (millions)	NA		NA		NA		NA	
Amfleet cars in fleet	449		344		362		414	
Amfleet car-miles (millions)	55.61		73.95		77.73		88.05	
Train-miles (millions)	8.35		9.03		9.03		9.03	
Seat-miles (millions)	3,893		5,176.78		5,441.31		6,163.28	
Revenue (million $):	226.5		302.7		332.5		420.1	
	High cost	Low cost	High cost	Low cost	High cost	Low cost	High cost	Low cost
Operating costs (million $):								
Train plus station costs	201.7	133.8	219.2	158.5	221.6	165.1	228.1	184.2
All other operating costs	71.7	64.9	71.7	64.9	71.7	64.9	71.7	64.9
Total operating costs	273.4	198.3	290.9	223.0	293.3	229.7	299.9	248.8
Surplus/deficit (million $):								
Train plus station costs	24.8	92.7	83.6	144.3	110.9	167.3	191.9	235.9
Total operating costs	-46.9	28.1	11.9	79.7	39.2	102.8	120.2	171.3
Derivatives:								
Operating ratio	121	88	96	74	88	69	71	59
Load factor (%)	57	57	57	57	60	60	67	67
Annual miles (million):								
Locomotive	.14	.14	.15	.15	.15	.15	.21	.21
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Amfleet car	.12	.12	.21	.21	.21	.21	.21	.21
Cars per train:								
Locomotive-hauled	6.7	6.7	8.2	8.2	8.6	8.6	9.8	9.8
Metroliner	NA	NA	NA	NA	NA	NA	NA	NA
Revenue ($):								
Passenger-mile	.10	.10	.10	.10	.10	.10	.10	.10
Car-mile	4.07	4.07	4.09	4.09	4.28	4.28	4.77	4.77
Train-mile	27.13	27.13	33.54	33.54	36.83	36.83	46.54	46.54
Train-plus-stations costs ($):								
Passenger-mile	.09	.06	.07	.05	.07	.05	.06	.05
Car-mile	3.63	2.41	2.96	2.14	2.85	2.12	2.59	2.09
Train-mile	24.15	16.02	24.28	17.56	24.55	18.29	25.28	20.41
Total operating costs ($)/ passenger-mile	.12	.09	.10	.08	.09	.07	.07	.06
Surplus/deficit ($)/ passenger-mile on:								
Train-plus-station costs	.01	.04	.03	.05	.03	.05	.05	.06
Total operating costs	-.02	.01	0	.03	.01	.03	.03	.04

NOTES: NA = not applicable.
Net present value under high costs = $ -882.6 million; under low costs = $ -399.2 million.

GLOSSARY

Catenary—Overhead wires transmitting electric power to trains on an electrified railway.

Centralized Traffic Control—A system to control, from one location, a section of railway many miles long.

Coaxial Cables—High-capacity cables used for train signaling and communications.

Consist—Number, type, and placement of cars and locomotives in a train.

Dedicated Service—Direct, exclusive limousine, bus, or van service between railway stations and particular hotels and airports.

Dedicated Track—A segment of track intended to be used exclusively for one type of rail service.

Equivalent Noise Impact—A noise measurement of intensity and extensity that includes both the number of people affected and the sound level to which they are exposed.

FAR 36—Federal Aviation Regulation Part 36 prescribes noise standards that must be economically reasonable, technologically practicable, and appropriate to the type of aircraft to which they apply.

Fixed Consist—A train in which the number and placement of cars and locomotives does not vary.

Flyover—A grade-separated junction between rail lines It is similar to a cloverleaf interchange on a highway where conflicts between opposing streams of traffic are eliminated.

Hot Boxes—Train-car axle boxes that overheat when a train is moving.

Interlocking—A group of track junctions controlled from a central point. It is a fail-safe set of crossovers permitting trains to move from one track to another at a specific location.

Maintenance-of-Way—Upkeep of railway track.

Net Present Value—A method of making financial comparisons. All expenditures and receipts are discounted at an agreed interest rate and figured, normally, from the starting date of the project.

Noise Exposure Forecast(NEF)—A measurement of all aircraft noise at a location near an airport, with an added penalty for nighttime noise.

Signal Block—A section of track between signals that safely spaces consecutive trains.

Spiral—A transition curve between straight level track and the curve itself. The outer rail is gradually raised above the level of the inner rail to achieve the required superelevation.

Superelevation—Banking of railway track on a curve.

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