ANALYSIS OF THE BENEFITS OF HIGH-SPEED RAIL ON THE NORTHEAST CORRIDOR

Federal Railroad Administration

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Office of Inspector General

Memorandum

Subject: INFORMATION: Analysis of the Benefits of High-Speed Rail on the Northeast Corridor

Date: June 26, 2008

From: David Tornquist
Assistant Inspector General for Rail and Maritime Program Audits and Economic Analysis

Reply to Attn. of: JA-50

To: Federal Railroad Administrator

This report presents the results of our review of the benefits of high-speed rail (HSR) on the Northeast Corridor (NEC). HSR has been proposed as a key option for managing congestion on the NEC, a region that has experienced a significant increase over the past 20 years in the number of vehicles on its congested highways and aircraft in its congested airspace. For example, H.R. 6003, the Passenger Rail Investment and Improvement Act of 2008, which was reported out of the House Committee on Transportation and Infrastructure on May 22, 2008, directs the Secretary of Transportation to solicit proposals for the design, construction, and operation of a HSR system between Washington, DC and New York City. In addition, this bill, and its Senate counterpart S. 294, include other provisions that more broadly promote HSR on the NEC and elsewhere.

The objectives of our review were to: (1) estimate the revenue and congestion relief benefits associated with different levels of HSR on the NEC and (2) determine whether HSR would pay for itself through increased revenues, congestion relief, or a combination of the two. Additionally, we sought to estimate the consumer surplus provided by different levels of HSR on the NEC.[1]

To address our objectives, we worked with Charles River Associates, International (CRA) to model the benefits from two different levels of HSR on the NEC, taking into account the availability of the alternatives of traveling by air and automobile. We compared the results from this analysis to existing estimates of the costs of

[1] Commonly included in transportation cost-benefit analyses, consumer surplus captures the difference between what consumers are willing to pay for a service and what they actually pay for that service.

implementing HSR on the NEC to determine if the benefits from implementing HSR would exceed its costs. Exhibit A provides detailed information on our scope and methodology.

BACKGROUND

HSR has long been discussed as a means to alleviate NEC congestion. In 1976, legislation was passed envisioning 3-hour service between Boston and New York (the north end) and 2 1/2-hour service between New York and Washington (the south end).[2] However, both the condition of the NEC infrastructure and its capacity constraints, in tandem with competing demands from other users such as commuter traffic and freight, have prevented Amtrak's *Acela*, the most rapid rail service on the NEC, from ever meeting the planned travel times. Currently the scheduled trip times of *Acela*, exceed the legislative targets by almost 1/2-hour on both ends.

In this review, we focused our analysis on two scenarios for HSR estimated by CRA. In scenario 1, CRA estimated the benefits associated with achieving the travel times initially envisioned in the 1976 legislation, that is 3-hour service between Boston and New York and 2 1/2-hour service between New York and Washington. In scenario 2, CRA estimated the benefits of achieving travel times that are 1/2-hour shorter on both ends, that is, 2 1/2-hours between Boston and New York, and 2-hours between New York and Washington.

RESULTS IN BRIEF

The benefits from HSR in scenario 1 would exceed the expenditures required to implement it. While the benefits of HSR in scenario 2 would be considerable, the absence of reliable cost estimates for achieving these travel times made it impossible to determine if the benefits in this case would exceed the costs. A sizeable share of air travelers along the NEC would switch to HSR if it were available at scenario 1 speeds, thereby providing some relief to the area's congested airspace.

The benefits from HSR under scenario 1 would exceed the expenditures required to implement it. We found that achieving passenger rail travel times of 3-hours between Boston and New York and 2 1/2-hours between New York and Washington (scenario 1) would produce a net present value benefit of

[2] The Railroad Revitalization and Regulatory Reform Act of 1976.

$16.3 billion in 2006 dollars.[3] This amount exceeds the estimated $14.0 billion in 2006 dollars of infrastructure investments[4] needed to achieve these travel times. These benefits are composed of $11.9 billion in increased rail revenues, $4.1 billion in gains in consumer surplus, and $0.3 billion in congestion relief.

HSR on the NEC would cause a notable share of current air travelers to choose to travel by rail rather than by plane. We found that roughly 11 percent of air travelers would divert to HSR at scenario 1 travel times. This would provide congestion relief at NEC airports and in NEC airspace. However, less than 1 percent of automobile travelers along the NEC would divert to HSR in scenario 1. This result reflects the greater similarities between air and rail travel than rail and automobile travel, particularly with regards to convenience.

Benefits from HSR would grow at an increasing rate with each further reduction in travel time. Scenario 2, with its travel time reduced by an additional 1/2-hour from scenario 1 on both the north and south ends of the NEC, would produce net present value benefits of $36.0 billion. This is more than double those in scenario 1. Our evaluation showed that each further 1/2-hour reduction in travel time would generate benefits at a greater rate as travel time decreased.

Substantial additional benefits beyond those estimated in our evaluation would result from implementing HSR on the NEC. Freight and commuter services also would benefit from the investments needed to enable HSR in scenario 1, producing benefits beyond our estimates. In addition, investments supporting any level of HSR would reduce aircraft and automobile emissions.

OBSERVATIONS AND CONCLUSIONS

Benefits from HSR, under Scenario 1, Exceed the Costs Required to Implement It

The $14.0 billion investment needed to achieve passenger rail travel times of 3-hours between Boston and New York and 2 1/2-hours between New York and Washington would produce a net present value benefit of $16.3 billion in 2006 dollars. Travel times on the NEC have been slowed by the condition of the infrastructure, its capacity constraints, and competing demands for the use of the infrastructure by freight and commuter trains. As a result, *Acela's* scheduled trip

[3] Unless otherwise indicated, all the benefit estimates quoted in this report are calculated for the 33 years following completion of the necessary infrastructure investments and expressed in 2006 net present value terms; that is, they are discounted back to 2006 and expressed in 2006 dollars. We assumed the necessary investments would be completed in 2012 for scenario 1 and in 2017 for scenario 2.

[4] The investment cost estimates quoted in this report effectively assume all investments occurred in a single year, 2006, and are expressed in 2006 dollars. The net present value of the investments would be reduced if they were spread out over time.

time on both the north and south ends exceeds the goals set in 1976 by almost 1/2-hour each. It would require an estimated $14.0 billion in infrastructure investments to achieve these travel times. Three categories of benefits were considered: revenues, consumer surplus, and congestion relief.

Revenues

The majority of the estimated benefits, $11.9 billion, are composed of increased revenues (see figure 1 on the next page), which would grow from a combination of factors, as indicated by our models of HSR demand. First, existing riders would be willing to pay more for the faster service. Second, ridership (and therefore revenues) would increase as travelers from other transportation modes diverted to rail service. Finally, riders who would otherwise not have traveled at all would decide to do so because of the new service. Revenues represent benefits from HSR because they provide an indication of the value of the service to HSR passengers.

Consumer Surplus

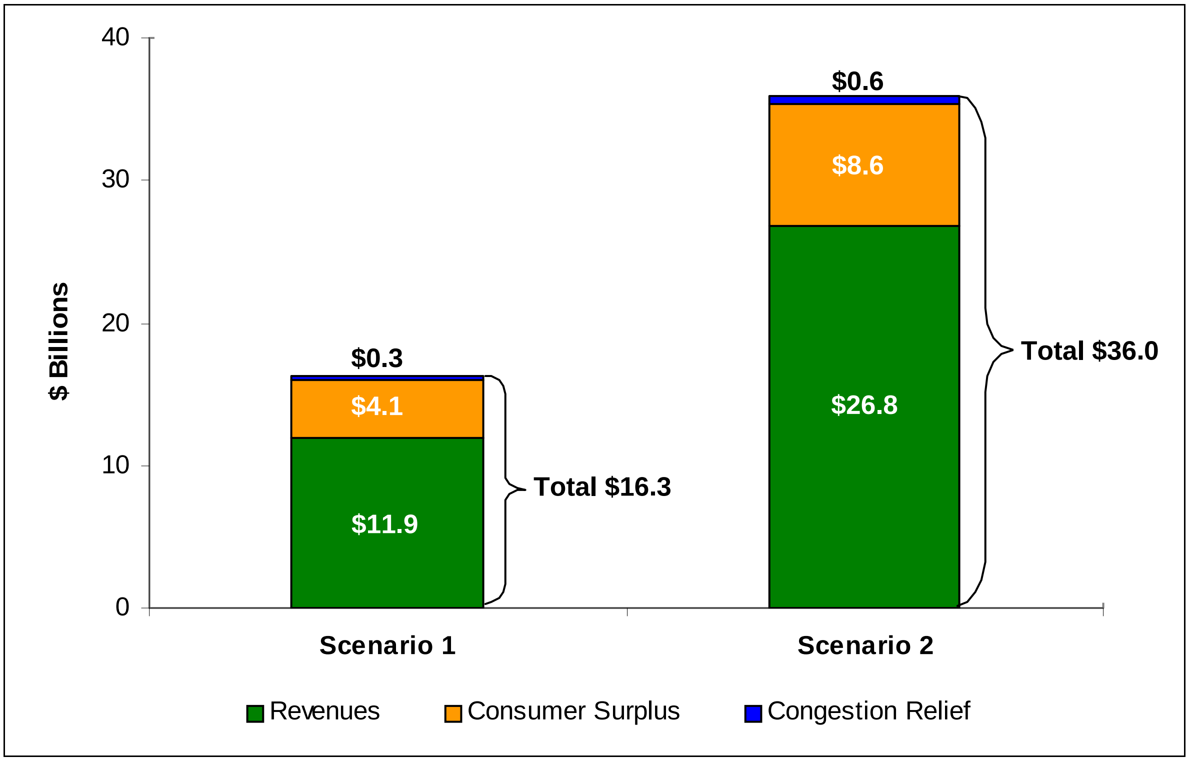
Gains in consumer surplus would total $4.1 billion, which means travelers would be willing to pay $4.1 billion more for HSR than the amount they would actually pay.[5] This difference between the value of the service to consumers and what they would actually pay represents an improvement in consumer welfare or well-being. The calculation of consumer surplus is a commonly used method of determining the improvement in welfare associated with a transportation project. For example, it is used in the evaluation of the Southern HSR project proposed by the North Carolina Department of Transportation.

Congestion Relief

The estimated benefits from congestion relief on the NEC, resulting from reductions in delays on roads and in airports and airways, add another $0.3 billion. Faster rail service diverts travelers from the air and roads to rail. The estimated value of congestion relief is the sum of the value of time saved by NEC air and road travelers and the decrease in operating costs of air carriers along the NEC.

[5] An HSR provider cannot capitalize on this willingness to pay more, in part because it varies from passenger to passenger on the same train. It is not feasible for an HSR provider to identify those passengers who would be willing to pay more, or how much more each would be willing to pay.

Figure 1. Benefits of HSR on the NEC ($ Billions)



Source: OIG analysis.

Required Investment

The estimate of $14.0 billion in needed infrastructure investments is based on the most recent studies available[6]: a 1994 study of the NEC North End (the section between Boston and New York), produced by the Federal Railroad Administration (FRA), and Amtrak's 2000 study of the South End (the section between New York and Washington).[7] The bulk of the costs identified in these studies are required to bring the NEC up to a state of good repair and to expand capacity to accommodate all users, both of which are preconditions for achieving scenario 1 travel times. To the extent that it was possible to identify which investments in these studies have already been made, the costs of completed investments were excluded from the total.

Comparatively minor additional costs beyond those needed to achieve a state of good repair and to expand capacity are required solely for implementing HSR. Only 8 percent or $1.0 billion of the $14.0 billion in investment expenditures are required solely for HSR (see table 1 on the next page). By comparison, the

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[6] These studies do not include the costs of upgrading the 18 mile section of the NEC owned by MetroNorth. We requested this information from MetroNorth representatives, but they did not provide it to us. We do not expect that inclusion of these costs would change our conclusions because the portion of the NEC involved is relatively small.

[7] We also reviewed the 2006 "Engineering State of Good Repair Study". However, that study drew heavily from and provided less detailed information than the 2000 South End Plan.

investments required to achieve a state of good repair total $6.2 billion,[8] and those providing the necessary capacity expansions would cost $6.5 billion. "Life Safety" investments account for the remainder, $0.3 billion, of the $14.0 billion total.

Table 1. Infrastructure Investments Needed for Scenario 1 ($ Millions)

HSR-Specific:	
North End	$182
South End	$867
Subtotal	**$1,049**
State of Good Repair:	
North End	$577
South End	$5,616
Subtotal	**$6,193**
Capacity Improvements:	
North End	$543
South End	$5,955
Subtotal	**$6,498**
Life Safety Investments	**$268**
Grand Total	***$14,008***

Source: OIG analysis of FRA 1994 North End Plan and Amtrak 2000 South End Plan.

A Notable Share of Air Travelers Would Switch to HSR

We estimated that 11 percent of current air travelers along the NEC would choose to travel by HSR instead of by air, if it were available at scenario 1 travel times. Figure 2 on the next page illustrates this for FY 2006.[9] On the other hand, we found that HSR achieving scenario 1 or scenario 2 travel times would have little impact on automobile ridership along the NEC. The difference in the responsiveness of air and automobile travelers is consistent with the findings in other studies, which show that air and rail travel are closer substitutes for each other than they are for automobile travel.[10] Automobile travel differs from air or rail travel in that it generally involves door-to-door service, offers greater flexibility in time of departure, and does not require travelers to share space with

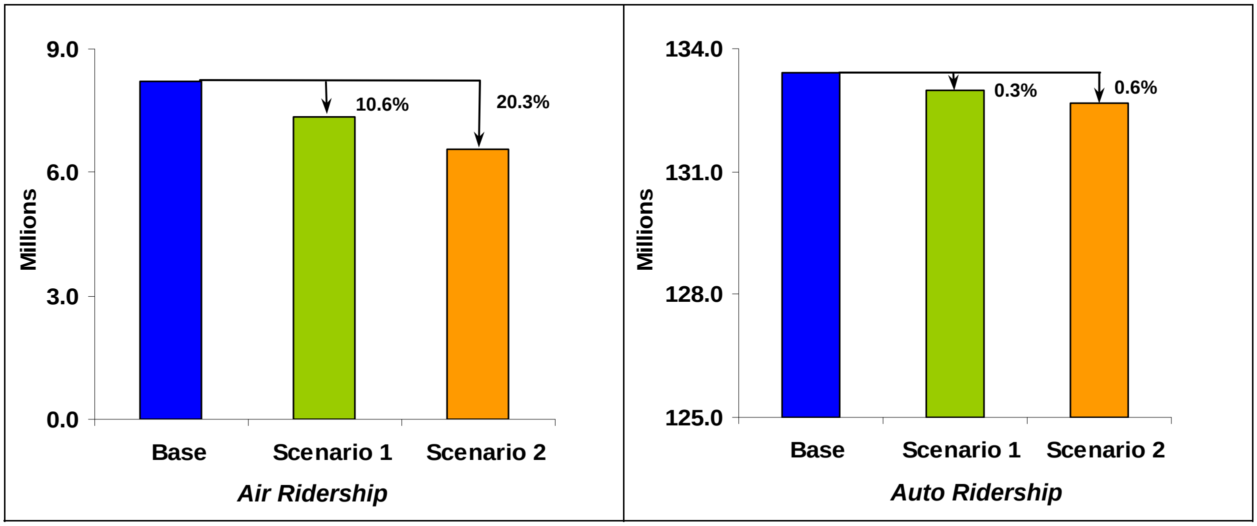
[8] Amtrak recently estimated that it needs $4.8 billion to bring its NEC infrastructure to a state of good repair, with additional funds needed for the portion of the NEC owned by MetroNorth. We could not reconcile that estimate, which was not provided in the context of a study, with our information.

[9] The estimates of the net present value of congestion benefits effectively assumed a constant diversion rate for all the years for which benefits were calculated.

[10] See, for example, "Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study", Cambridge Systematics, Inc., August, 2006 and "A Heteroskedastic Extreme Value Model of Intercity Travel Mode Choice", Chandra Bhat, Transportation Research Part B: Methodological, Volume 29, Issue 6, December 1995, pp 471-483.

strangers. Consequently, rail travel must be extremely competitive in other dimensions, such as speed or cost, to attract automobile travelers.

Figure 2. Effects of HSR on Air and Auto Ridership in FY 2006 [11]



Source: OIG analysis.

Total Benefits from HSR Would Grow at an Increasing Rate with Further Reductions in Travel Time

In scenario 2, we estimated benefits for travel times that were 1/2-hour shorter than in scenario 1 for travel between Boston and New York and between New York and Washington. We found that the net present value of the resulting benefits would be $36.0 billion. This is more than double the benefits that would be realized in scenario 1 (as shown in figure 1 on page 5). Both revenues and consumer surplus would more than double between scenarios 1 and 2. Congestion benefits would just double, as would the percentages of air and auto travelers that would switch to HSR (see figure 2).

In order to see how benefits would vary with travel times, we estimated the ridership and revenues for a wider range of travel times. In this effort, we only estimated results for a single year, 2006, and assumed fares would remain at current levels, because that was sufficient to allow us to see the pattern in the responsiveness of benefits to travel times. We found that the total benefits from

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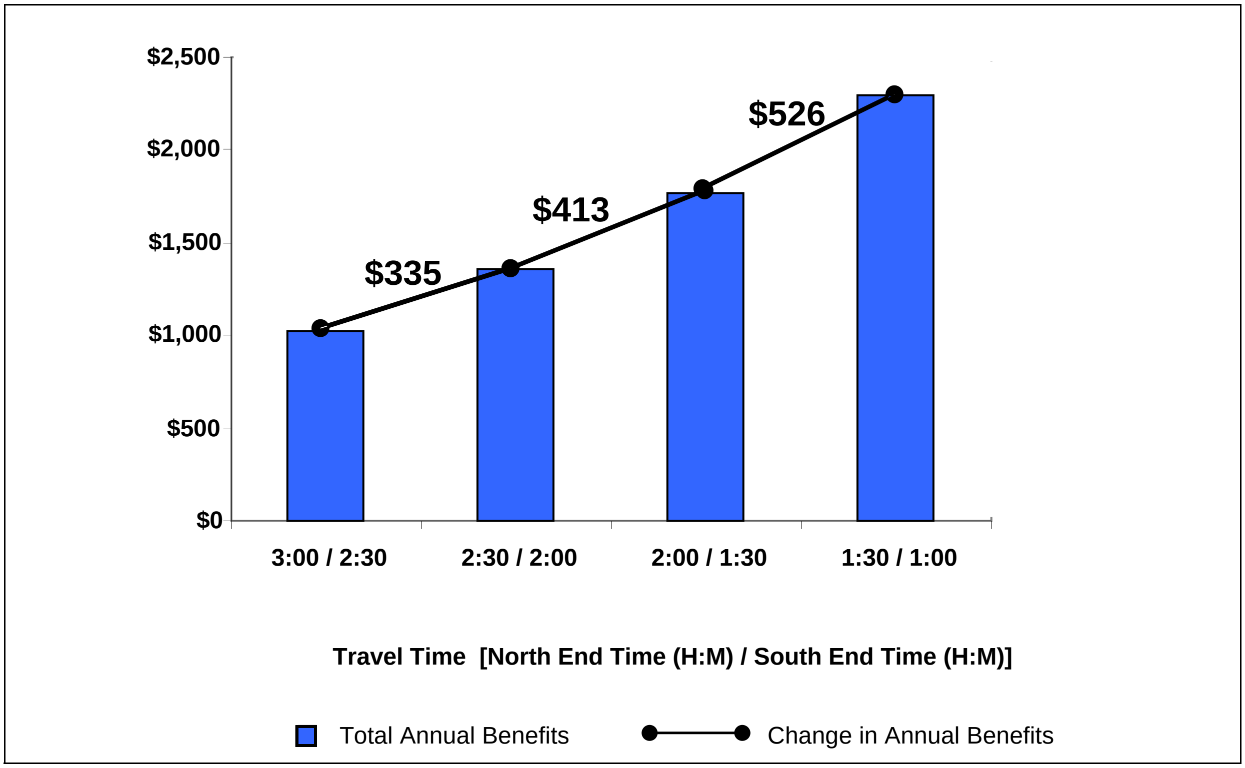
[11] The base ridership numbers depicted in figure 2 differ from actual FY 2006 ridership for two reasons. First, the base figures only track ridership for those counties assumed to receive HSR service (which are the same as those currently receiving *Acela* service). This reasonably approximates the number of actual NEC air travelers, but is significantly less than the actual NEC automobile ridership. Second, the base figures, like the figures for scenario 1 and 2, assume Amtrak is using a revenue maximization process to determine fares that would have diverted more riders from automobiles and airlines to rail than Amtrak's present revenue management process does. Exhibit A provides further discussion of the revenue maximization issue.

HSR would grow at an increasing rate with each successive reduction in travel time, as shown in figure 3. In other words, the benefits from each additional 1/2-hour reduction in time would increase as travel time decreased. This result implies that scenarios 1 and 2 were not unusual in terms of the scale of benefits produced.

Figure 3. Benefits from Various Travel Time Reductions for 2006 ($ Millions)



Source: OIG analysis.

The results from this analysis also imply that investigation of the costs of achieving travel times shorter than those in scenario 1 is warranted to allow for determination of benefits net of costs in those situations. However, at present, there are no comprehensive estimates of the costs of the NEC infrastructure investments necessary to support travel times shorter than those considered in scenario 1. Amtrak and FRA representatives indicated that they anticipate the costs of achieving the second half hour of travel time reduction reflected in scenario 2 would be greater than the costs associated with the first half hour of travel time reduction reflected in scenario 1. The costs of infrastructure investments to further reduce travel times are expected to grow at an increasing rate with each successive decrease in travel time because the most cost-effective options for reducing travel time would be implemented first.

Substantial Additional Benefits Beyond Those Estimated in Our Review Would Flow from the Investments Enabling HSR

Our estimate of the benefits of HSR on the NEC is conservative in that it excludes benefits related to improved nationwide airspace traffic flows and improved commuter and freight services. We did not calculate these effects because each of them would have required extensive additional modeling. For example, producing reliable estimates of the benefits from improved commuter services would require modeling ridership for each of the seven NEC commuter agencies, a task of considerable scope.

Regarding air travel, we only calculated the monetary value of congestion benefits for travel on the NEC. We would expect, for example, that reducing congestion in the New York City area would improve air traffic flows throughout the national airspace system. That is, the delays in other parts of the country caused by delays in flights into or out of New York would be reduced. We did not include the benefits of the broader congestion reduction in our analysis.

Substantial investments in the condition and capacity of the NEC could significantly improve commuter and freight services. Currently, there are many locations at which the condition of the infrastructure or physical constraints limits capacity, speed or both. Even minor delays on one service can quickly cascade into significant delays for all services. With respect to freight, current clearance restrictions on part of the infrastructure mean that essentially only size-restricted local traffic can use the corridor at present.

The benefits to the public of improvements in commuter and freight services could be considerable. By some measures commuter rail services are much larger in scale than Amtrak services. For example, Amtrak accounts for only about 14 percent of weekday NEC train movements and roughly 5 percent of annual NEC riders. Commuter rail traffic comprises virtually all of the rest. Freight operations could change in both scale and nature if clearance constraints were removed.

CONCLUSION

The benefits from HSR, as initially envisioned (scenario 1), exceed the expenditures necessary to implement it. We estimated that HSR at this level of service would produce a net present value benefit of $16.3 billion in 2006 dollars, which exceeds the estimated $14.0 billion in 2006 dollars of infrastructure investments needed to achieve it. While our estimate of the financial impact from congestion relief was small, $0.3 billion, we also estimated that a sizeable share of air travelers along the NEC would divert to HSR, thereby providing some relief to the congested airspace in the area. Our analysis also showed that as travel times decrease further, the resulting benefits from HSR would grow at an increasing rate. The investments initially envisioned for HSR would produce benefits well beyond those quantified here. They would also significantly benefit NEC commuter and freight rail services and provide benefits such as reduced aircraft and automobile emissions.

We have discussed our observations and conclusions with FRA and Amtrak officials. Since we are making no recommendations, no formal response to this product is required. FRA did not offer comments, but Amtrak objected to our characterizing achievement of a state of good repair and capacity improvements as preconditions to realizing scenario 1 travel times. However, we consider these investments essential to the implementation of reliable HSR service and have not changed our report to reflect Amtrak's comment.

We appreciate the courtesies and cooperation of Amtrak and Federal Railroad Administration representatives during this review. If you have any questions concerning this report, please call me at (202) 366-1981 or Mitchell Behm, the Program Director, at (202) 366-1995.

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cc: Audit Liaison, OST, M-1
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EXHIBIT A. SCOPE AND METHODOLOGY

SCOPE

We conducted an analysis of the costs and benefits of HSR along the NEC. Our objectives were to: (1) estimate the revenue and congestion relief benefits associated with different levels of HSR on the NEC and (2) determine whether HSR would pay for itself through increased revenues, congestion relief, or a combination of the two. Additionally, we sought to estimate the consumer surplus provided by different levels of HSR on the NEC.

We worked with CRA to estimate the benefits from reducing the trip times for *Acela* on the NEC. CRA used econometric models to estimate demand for HSR, taking into account the availability of opportunities to travel by air, automobile, and conventional rail. They also estimated revenue maximizing fares and used a model of the NEC highway network to estimate reductions in roadway congestion. We developed estimates of the costs of implementing HSR using available studies.

METHODOLOGY

Revenues

Overview

CRA carried out the estimation of the benefits from HSR for scenarios 1 and 2 in four steps. First, CRA generated demand curves[12] for HSR for every station-pair for each of the two scenarios as well as for travel at the current or base travel times. Second, CRA utilized these demand curves to calculate the HSR fares that would maximize Amtrak's revenues in each of the scenarios and the base case. Third, CRA estimated the change in revenues, consumer surplus, and congestion benefits. Fourth, CRA used forecast values of air and automobile travel demand and socioeconomic variables to project the benefits over the lifespan of the infrastructure investments, and the net present values of the projected benefit streams were calculated. In addition to estimating benefits for scenarios 1 and 2,

[12] In this instance, a demand curve is the relationship between a range of HSR fares and the number of travelers who wish to take HSR at each fare in the range.

CRA conducted analyses of the sensitivity of results to further reductions in travel times. Each of these steps is addressed in greater detail below.

Estimating Demand Curves for HSR

To generate HSR station-pair demand curves for each of the scenarios and the base case, CRA used econometric models (specifically, binary mode choice models) to calculate the HSR ridership corresponding to a wide range of HSR fares for each travel time scenario. The fares for conventional rail were assumed to be held constant at their 2006 levels.

Obtaining Revenue Maximizing Fares

In the second stage of the study, the demand curves generated in the previous stage were used to obtain the HSR fares that maximize Amtrak's revenue for the two scenarios and the base case. This was done by using a method of capacity-unconstrained optimization.[13] This process incorporated certain fare constraints in order to produce more realistic results. For example, fares for a given origin-destination pair were constrained to not exceed the sum of the fares between the origin and an intermediate station and between an intermediate station and the destination. Also, one constraint ensured that there would be a premium on HSR fares as compared with conventional rail fares.

This step was performed because we assumed Amtrak would set fares for the new service using a revenue management process as it does now, rather than simply maintaining current fares. However, we found that the revenue maximization process we modeled would have diverted considerably more revenues and riders from other modes than Amtrak's revenue management process. To isolate the benefits from upgrading travel times alone, we first used our revenue maximization process to estimate the revenues that could have been generated without upgrading travel times. We then also applied it to determine the revenues that could have been generated at the upgraded travel times.

Calculating Benefits for a Single Year

In the third stage of the study, CRA estimated the increase in benefits resulting from shorter HSR trip times for a single year under both scenarios. The increase in benefits was the sum of the increases in Amtrak's revenues, consumer surplus, and congestion relief. The revenue increases were calculated as the difference between the baseline revenue and the revenue in each of the two scenarios, all evaluated at the revenue-maximizing fares.

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13. Optimization is a mathematical tool used to determine the values that maximize (or minimize) an objective. In this case, the objective was revenues from HSR, and the optimal values were the HSR fares that maximized HSR revenues.

The increase in consumer surplus was calculated separately for those who were already riding *Acela*, those who diverted to HSR from air carriers, those who diverted to HSR from automobiles, those who diverted to HSR from conventional rail, and those who had not been traveling previously but were induced to travel by the advent of the new HSR. For the first three groups, the gains in consumer surplus were proportional to the sum of the monetary value of the travel time reduction, net of the fare increase, plus the monetary value of the modal constant change (both of these monetary values were generated by the models). Modal constants in binary choice models measure the preference of travelers for one transportation mode over another. CRA adjusted the modal constants to capture the higher levels of comfort and reliability expected to follow from bringing the NEC infrastructure up to a state of good repair.

For travelers who were expected to divert to HSR from conventional rail, the mode choice models allowed for direct calculation of the gain in consumer surplus as the increase in utility or consumer welfare as measured by a standard economic utility or consumer welfare function. For those travelers who had not been traveling previously, but were induced to travel by the advent of the new HSR, consumer surplus was calculated as a proportion of a function of the change in a generalized measure of costs that included the cost of time.

To calculate congestion benefits, monetary values of time were multiplied by the travel time reductions experienced by those travelers who continued to travel by air carrier or automobile. In addition, the savings in operational costs per unit of time for different categories of aircraft were multiplied by the reductions in airport delays. Delays for each of thirteen airports[14] were derived using a Volpe Transportation Systems Center model of airport congestion, along with data from the Federal Aviation Administration’s Terminal Area Forecasts and information provided by operations personnel from the different airports. Congestion on the NEC highway network was calculated using a highway model constructed in TransCAD from National Highway Planning Network data and traffic count data.

Calculating the Net Present Value of Benefits Occurring Over the Lifetime of the Investments

It was assumed that infrastructure improvements allowing for scenario 1 travel times would be completed by the year 2012, and those supporting scenario 2 travel times would be completed by 2017. In both scenarios, the investments were assumed to last 33 years. Calculating the NPV of the resulting benefits required

[14] The thirteen airports were chosen due to their high air volumes. They were Baltimore-Washington International (BWI), Ronald Reagan Washington National (DCA), Washington Dulles international (IAD), Philadelphia International (PHL), Newark Liberty International (EWR), John F. Kennedy International (JFK), LaGuardia (LGA), Long Island MacArthur (ISP), Westchester County (HPN), Bradley International (BDL), Theodore Francis Green State (PVD), Boston Logan International (BOS), and Manchester Boston Regional (MHT).

determination of the rates at which the benefits would grow during the 33 years following completion of the infrastructure improvements in either 2012 or 2017 and then discounting the benefit streams back to 2006.

Since the diversion rates were assumed to be constant, the benefits associated with each mode would grow at the same rate as demand for travel by that mode. For the most part, the benefits associated with air travel were grown using FAA's Aerospace Forecasts for national air travel reduced by the ratio of anticipated population growth for the NEC relative to the expected national average. Benefits related to travel involving the slot-controlled airports were grown using forecasted enplanements from FAA's Terminal Area Forecasts. Benefits associated with each of the other travel modes were determined using mode-specific econometric models (specifically, direct demand models) in conjunction with socio-economic data forecasts from Woods and Poole.[15] All benefit streams were discounted to the year 2006 using a 3 percent real discount rate.

Conducting Sensitivity Analyses

To assess the sensitivity of the level of benefits to the choice of travel time, CRA estimated the benefits that would have resulted in a single year, 2006, from achieving each of a series of increasingly shorter travel times. Econometric models (specifically, binary mode choice models) were used to estimate the diversions from other transportation modes to HSR that would occur as a consequence of the travel time reductions. To simplify this process it was assumed that fares would remain at existing levels, so these analyses did not involve revenue maximization. The benefits associated with each reduction in travel time were determined as described in the preceding section on calculation of benefits for a single year.

Costs

We interviewed representatives from FRA and Amtrak to ascertain which studies would be relevant to estimating the costs of upgrading the NEC for HSR. Two documents were identified as providing the best available information on the subject: "The Northeast Corridor Transportation Plan: New York City to Boston" by FRA (1994) and "The Northeast Corridor South End Transportation Plan: Washington, DC to New York City" by Amtrak (2000). We also reviewed the report entitled "Engineering State of Good Repair" by Amtrak (2006), which primarily addressed investment needs on the NEC South End and drew heavily from the 2000 South End Transportation Plan.

[15] Woods and Poole Economics, Inc. is an independent firm that specializes in long-term county economic and demographic projections. Woods and Poole's database provides projections of socio-economic variables through 2030 for every county in the United States.

We further consulted with FRA to determine which of the projects listed in the two documents have already been completed. This determination was fairly straightforward with respect to the plan for the North End of the NEC. However, the lack of detail provided in the South End Transportation Plan substantially limited our ability to do this with respect to that portion of the NEC. Consequently, our estimate of the investment needs on the South End may be overstated. Finally, we inflated all costs to 2006 dollars using a gross domestic product deflator.

EXHIBIT B. MAJOR CONTRIBUTORS TO THIS REVIEW

THE FOLLOWING INDIVIDUALS CONTRIBUTED TO THIS REPORT.

Name	Title
Mitchell Behm	Program Director
Betty Krier	Supervisory Economist/Project Manager
Chia-Mei Liu	Economist

508 Compliant Figures for "Analysis of Benefits of High-Speed Rail on the Northeast Corridor"

Figure 1: Net Present Value of Benefits ($ Millions)

Category of Benefits	Scenario 1	Scenario 2
Revenues	11,895	26,749
Consumer Surplus	4,075	8,643
Congestion Relief	322	558
Total	**16,292**	**35,950**

Figure 2: Effects of HSR on Air and Auto Ridership

Type of Ridership	Numbers of Riders in FY 2006	Change from Base	Percent Change from Base
Air: Base Case	8,219,053	na	na
Air: Scenario1	7,346,657	**(872,396)**	**(10.6%)**
Air: Scenario 2	6,552,618	**(1,666,435)**	**(20.3%)**
Auto: Base Case	133,420,489	na	na
Auto: Scenario1	132,964,580	**(455,909)**	**(0.3%)**
Auto: Scenario 2	132,653,645	**(766,844)**	**(0.6%)**

Figure 3. Sensitivity Analysis of Travel Time Reductions

Travel Time North End	Travel Time South End	Total Annual Benefits ($ millions)	Change in Annual Benefits ($ millions)
3:00	2:30	1,022	--
2:30	2:00	1,357	335
2:00	1:30	1,770	413
1:30	1:00	2,296	526