CHOICES FOR MOBILITY ENHANCEMENT
IN THE GREENBUSH CORRIDOR — A REVIEW

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INTRODUCTION

In the fall of 1998, the Town of Hingham approached the Taubman Center for State and Local Government, a research unit within Harvard’s John F. Kennedy School of Government. It asked whether the Center might carry out an independent evaluation of the transportation alternatives analyses that the MBTA and its consultants had carried out in the so-called Greenbush corridor, prior to arriving at its decision to revive commuter rail in this corridor. (The MBTA’s proposed commuter rail project would run from South Station in downtown Boston to Greenbush in the Town of Scituate, passing at-grade through the Town of Hingham on a rail corridor that has been abandoned since 1959.

The Taubman Center had two concerns about this request. First, Hingham was clearly an interested party. Prior to this time, it had already decided to oppose the Greenbush project as designed, and indeed it was the plaintiff in a pending lawsuit against the project. Second, the Taubman Center judged that it had staff capacity to appraise the Greenbush analyses of transportation costs and benefits, but not the analyses of environmental costs and benefits.

The Center agreed, ultimately, to undertake an evaluation, subject to the following provisos: First, it would have complete scholarly independence, and the results, however they might fall out, would be available for public distribution. It bears mention that no one at the Center had any prior acquaintance with the Greenbush studies, nor did anyone have a position on what should be done in the corridor. Second, the evaluation would focus exclusively on the MBTA’s analyses of the transportation costs and benefits of alternative mass transit improvements for the Greenbush corridor. It would not seek to appraise the MBTA’s environmental analyses. It would not seek to generate additional transit options or to carry out new alternatives analyses. And it would not seek to arrive at a determination of which option is best. Rather, its sole concern would be to appraise the adequacy of the transportation analyses on which the MBTA has relied, and to arrive at a judgment as to whether additional analyses of Greenbush corridor alternatives seem advisable.

The Town of Hingham agreed to these conditions. Accordingly, it has not been afforded any opportunity to guide the research or even to comment on drafts of this report. The Town did supply various written materials, and Jonathan Richmond of the Taubman Center, who carried out the research and was the principal author of this report, interviewed several Town officials and filed brief (non-substantive) progress reports from time to time. But the Town has had no other involvement in the work leading up to this report.

Study Process

Initial Work consisted of gathering background information, identifying pertinent documents to be examined, and seeking access to these documents. The most important documents identified, and subsequently examined, were as follows:
The alternatives analysis prepared as part of a Supplemental Draft Environmental Impact Statement/Report and Section 4(f) Evaluation issued jointly by the MBTA and the U.S. Department of Transportation in 1995 (U.S. DOT/MBTA 1995; hereafter referred to as SDEIS/R);

A review of the ridership forecasts in the SDEIS/R alternatives analysis, prepared for the U.S. Army Corps of Engineers in 1998 by the firm of Louis Berger and Associates (acting as a subcontractor to the firm ENSR) (ENSR/Berger 1998); and

A critique of the Berger report prepared for the MBTA by Barry Faulkner of the firm Sverdrup Civil, Inc. (Sverdrup, 1998)

Efforts were subsequently made to interview the authors of these reports and to obtain pertinent data not supplied in the reports themselves. The MBTA expressed reluctance to cooperate, however, except in response to explicit Freedom of Information Act requests, on the ground that it was in litigation with the Town of Hingham. It did, however, permit the author of this report to meet with Barry Faulkner of Sverdrup in the presence of an MBTA legal representative, and Faulkner provided general answers to a number of questions. Moreover, in response to requests made at this meeting, Faulkner subsequently provided several important documents by mail. The Berger firm refused comment on the ground that its involvement had concluded. (More surprisingly, after submitting its report to the U.S. Army Corps of Engineers in 1998, it had also refused to allow the report’s author to discuss his work with the Corps.)

The Massachusetts Highway Department was contacted for information on its high-occupancy vehicle (HOV) lane projects, and promptly supplied all requested information. The state’s Central Transportation Planning Staff (CTPS), which has a study in progress to assess initial results of the reintroduction of commuter rail service in two other corridors proximate to the Greenbush corridor, was also cooperative. Finally, several interviews were conducted (two by phone, one in person) with private bus operators about their experiences competing with new introductions of commuter rail service and their roles, if any, in the MBTA’s deliberations about Greenbush transit improvement alternatives.

Comments on a draft of this report were requested from several individuals, none of whom has had any involvement with the Greenbush controversy. The author wishes to thank those Harvard colleagues who provided in-depth comments, notably: Professor Alan Altshuler, Director of the Taubman Center; Professor Jose Gómez-Ibáñez; David Luberoft, Associate Director of the Taubman Center; and Shelley Metzenbaum, Director of the Kennedy School’s Performance Measurement Program and former Associate Administrator of the U.S. Environmental Protection Agency. Professor Martin Wachs, Director of the Institute of Transportation Studies, University of California, Berkeley, also provided important advice. All opinions expressed in this report are, of course, solely the author’s responsibility.
Background to Greenbush Evaluation

The Greenbush corridor enjoyed (private, unsubsidized) commuter rail service from the mid-19th century until 1959, as one of three branches of the Old Colony line. As of 1936, for example, there were fifteen daily trains from Greenbush, with a journey time ranging from 51 to 74 minutes. Express trains made the trip from Hingham to Boston in just 30 minutes. With commuter rail operations experiencing increased financial distress, service gradually contracted during the 1950s and was discontinued in 1959. In 1984 the Massachusetts Legislature called upon the MBTA to study the possibility of restoring rail passenger service to the South Shore area. The context was a general emphasis on reviving commuter rail service in the Boston region.

The Metropolitan Planning Organization for Greater Boston included the Old Colony Railroad Rehabilitation Project, as it was then labeled, in its Transportation Improvement Program for the years 1987 through 1991, and the federal Urban Mass Transportation Administration (UMTA; since renamed FTA, the Federal Transit Administration) agreed to participate in funding the planning and environmental analyses required to enable this project to qualify for federal capital grant assistance. Among the federal analytic requirements, one of the most important was an analysis of corridor transportation alternatives, considering both their transportation and environmental effects. Sverdrup Civil and Cambridge Systematics conducted most of the work on transportation performance characteristics, ridership, and costs. A variety of other contractors carried out the work on environmental effects. Five commuter rail configurations were considered, along with a “Transportation System Management” (effectively, improved bus service) alternative, two variants of upgraded commuter boat service, and a “no-build” alternative (see below, p. 8-10, for additional detail).

Following a number of preliminary reports, a Draft Environmental Impact Statement/Report was released in March 1990. This report concluded that the best alternative would be restoration of commuter rail service on all three lines. (U.S. DOT/MBTA 1990, Vol. I p. V-6). It did note, however, that “the Greenbush Line…would have the greatest environmental and cultural impacts” (U.S. DOT/MBTA 1990, Vol. I, p. VI-22).

Section 4(f) of the U.S. Department of Transportation Act precludes approval of any federal or federally aided project that requires the use of public land from a park, recreation area, wildlife refuge, or historic site of national, state, or local significance unless (1) there is no prudent and feasible alternative to the use of such land, and (2) such program includes all possible planning to minimize harm” to the protected facilities.” The MBTA determined that in this case Section 4(f) did not apply because of the line’s “longstanding use as a public right-of-way and a commuter rail line” (MBTA 1990, p. 12). The U.S. Department of the Interior disagreed, however, leading UMTA to rule that a Section 4(f) analysis would be required — though only for the Greenbush portion of the Old Colony project. The MBTA Board of Directors then voted, in November 1990, to proceed toward construction of the Middleborough and Plymouth lines, while moving to carry out a 4(f) analysis of the Greenbush Line.
In a related development, on December 19, 1990, the Massachusetts secretary of transportation entered into a Memorandum of Understanding with the Conservation Law Foundation (CLF), an environmental organization that specializes in litigation. CLF had been threatening to sue the state in connection with alleged environmental effects of the Central Artery/Tunnel, a multi-billion dollar expressway project then in advanced engineering. It now agreed to forego litigation, provided that the state carried out a long list of transit and traffic mitigation projects by specified dates. One of the projects listed was the “Old Colony Line Extension,” with a projected completion date of 1995 (EOTC, et. al. 1990, Appendix A). In approving the Final Supplemental Environmental Impact Report on the Central Artery/Tunnel project a few days later, the state Secretary of Environmental Affairs stated that he was requiring compliance with all the provisions of the Memorandum of Understanding (or substitutes that would produce equivalent emissions reductions). The Memorandum itself provided as follows:

The parties recognize that implementation of most or all of the transit improvements addressed in this agreement is subject to public environmental review processes. If any planned improvement is found in the course of such a review process to have environmental impacts which render the project infeasible, EOTC shall develop and implement a substitute transit facility or service that will serve at least the same number of passengers in the same transportation corridor as the transportation improvement contemplated by this agreement [EOTC et. al. 1990, p. 4].

All of the foregoing events occurred in the last year of the gubernatorial administration of Michael Dukakis. Governor William Weld and his administration took office in January 1991. The new Secretary of Transportation, Richard Taylor, was concerned about the uncertainty of funding for many of the transit projects specified in the CLF Memorandum, and he opposed their inclusion in the federal approval documents for the Central Artery/Tunnel project. The Federal Highway Administration (FHWA), anxious to make clear that it had no commitment to fund these projects, concurred. When FHWA’s approval of the Artery/Tunnel environmental impact statement failed to incorporate the Memorandum requirements, CLF initiated litigation to block the project. This action was settled in 1992. The settlement reiterated that the state accepted responsibility for compliance with the Memorandum requirements, and that it could make substitutions where these would provide equivalent air quality benefits.

The FTA approved the Final Old Colony EIS/R — which omitted the Greenbush Line as a “Preferred Alternative” — on March 13, 1992. Subsequently, on June 10, 1992, the FTA issued a Record of Decision, in which it found that the Middleborough and Plymouth Lines of the Old Colony Project satisfied the requirements of the National Environmental Policy Act, and in which it specified that the Greenbush Line “will be the subject of separate environmental documents, including a 4(f) evaluation, should it ever be advanced.” In accord with this determination, a Supplemental Draft Environmental Impact Statement/Report (SDEIS/R) and Section 4(f) Evaluation was prepared for the Greenbush Line, and issued in March 1995 (U.S. DOT/MBTA 1995).
The Massachusetts Secretary of Environmental Affairs appointed a Citizens Advisory Committee (CAC) to provide assistance during the preparation of this report, on the evaluation of environmental impacts. On April 4, 1994, the CAC unanimously recommended “the restoration of passenger rail service on the Greenbush Line as quickly as possible, with a stated preference of Alternative 6a” (which included the provision of a short tunnel through the center of Hingham) (Citizens Advisory Committee 1994, p. 2). On February 16, 1995, a majority of the committee reaffirmed their support for this alternative (Citizens Advisory Committee 1995, p. 1-2, as cited U.S. DOT/MBTA 1995, p. P-21 – P-22). Four of the seventeen members, however, dissented, expressing “our present concerns about the impacts of commuter rail on public safety, noise and vibration, wetlands, the flow of traffic, and historic properties, and the huge financial expense of each commuter rail alternative” (reprinted U.S. DOT/MBTA 1995, p. P-28). The minority maintained, furthermore, that:

…the study format is deficient because each transportation mode is viewed as being mutually exclusive of each other transportation mode. We suspect that a non-rail multi-modal transportation system could provide a level of service approaching, or even exceeding, that predicted for the commuter rail alternatives, but without the harsh environmental impacts and at significantly less cost [U.S. DOT/MBTA 1995, p. P-28].

The minority urged further consideration of “dedicated high-occupancy vehicle lanes on major highways, expanded fare subsidy programs and other improvements to bus service, and water transit.”

Governor William Weld announced on Nov. 30, 1995 that the Greenbush Line, with at-grade passage (rather than a tunnel) through Hingham Square, was the preferred alternative. On January 22, 1996, the MBTA stated that it was no longer seeking federal assistance for the Greenbush Line but would proceed to construction with state funding alone.

On August 13, 1996, the Town of Hingham filed suit, claiming that the project had been “irrevocably federalized” by the earlier study funding, and that the new study failed to meet federal requirements for consideration of all “prudent and feasible” alternatives to minimize harm to Hingham’s historic resources. This litigation is still pending. It will not be discussed further here.

The U.S. Army Corps of Engineers, pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act, has jurisdiction over the MBTA’s application for a wetlands fill permit required for construction of the Greenbush Line. The Corps is required to examine how to minimize impacts to the wetlands and, in doing so, to identify the least environmentally damaging alternative. In arriving at its determination, the Corps is also examining the transportation benefits of the proposed project and impacts on resources protected under Section 106 of the National Historic Preservation Act. The Corps has held a public hearing, examined submissions from a wide variety of interested parties, and commissioned its own evaluation of the alternatives analysis conducted for the Greenbush Line (to be discussed below).
The Corps also requested the New England office of the U.S. Environmental Protection Agency to review the air quality implications of the commencement of service on the Greenbush Line. The EPA responded on February 8, 1999, stating that the proposed rail service would have a mix of positive and negative impacts: “Given the overall increases of smog-forming nitrogen oxide emissions resulting from the diesel-fueled trains, we can no longer view this project as an unqualified air quality improvement project. While the project would also reduce some other types of pollution, the air quality impacts of the project are not significant enough to serve as either an endorsement for, nor argument against, the restoration” (EPA 1999, p. 2).

EPA also urged additional environmental work, as follows:

EPA is well aware that the environmental review process for the Greenbush Line restoration has taken many years. One of the most important objectives we all share is to complete the process not only promptly but in a fashion that does not lead to protracted litigation. We believe it is essential to bring closure to the remaining legitimate, unresolved issues and to do so both thoroughly and expeditiously, with adequate opportunity for public review and comment. In our judgement, the most appropriate way to meet the objective is for the Corps of Engineers, as the lead federal agency, and the [Massachusetts] Executive Office of Environmental Affairs in conjunction with the MBTA, to agree now to collaborate in preparing a joint environmental impact statement/report (EIS/EIR). It should be focused specifically on the legitimate, unresolved issues that in our judgement include the following: 1) impacts to Hingham’s historic district; 2) mitigation for impacts to Hingham, including most especially, the tunnel option; 3) alternatives that have not yet been fully analyzed and made available for formal review and comment, including the ‘super boat’ option as well as the combined intermodal option suggested by Hingham; 4) mitigation for negative air quality impacts from the Greenbush line and other alternatives; and 5) location of the layover facilities [EPA 1999, p. 2-3].

The Conservation Law Foundation has remained active on behalf of the 1990 Memorandum requirements, and it has strongly supported Greenbush Line construction. According to CLF, in its 1997 submission to the U.S. Army Corps of Engineers:

Restoration of the Greenbush branch of the Old Colony Line is clearly in the public interest. It will benefit the regional economy, improve access to and from the South Shore, and encourage sustainable transportation and development in the region. Any localized adverse impacts can be addressed through mitigation. [CLF 1997, p. 2].

Among the other benefits that CLF attributes to the Greenbush choice are greater accessibility to jobs and services for those who cannot drive, slowing the forces of sprawl in the region, and helping to create communities in which people will be less dependent on their cars (CLF 1997, p. 5).

In July, 1999, the U.S. Army Corps of Engineers issued a draft recommendation endorsing the MBTA’s selection of at-grade commuter rail as the preferred alternative (U.S. Army Corps of Engineers, 1999). This was based on the assumption that the results of the MBTA alternatives analysis to be evaluated below were correct.
REVIEW OF THE GREENBUSH ALTERNATIVES ANALYSIS


According to this report: “The Greenbush Line corridor has few transportation options that do not rely heavily on the highway system. Because of chronic and severe traffic congestion and long and variable travel times, especially during the morning and evening peak periods, the Greenbush Line corridor is now considered an underserved corridor” (p. I-10). Evidence of need for the project includes “lack of transportation capacity to serve downtown Boston… severe congestion on highways and transit facilities… [and] legislative support for transportation improvements” (p. I-10, I-11).

Specific objectives of the Greenbush Line Corridor project, according to the report, include the following:

- To increase mobility by increasing transit capacity, ridership, accessibility, reliability, and comfort;
- To reduce transit travel time and traffic congestion;
- To alleviate the burden on existing roadway and transit facilities and services, such as parking facilities, the new Red Line system, Route 3, and the Southeast Expressway;
- To reduce fuel consumption and air pollution;
- To provide transit services that are cost-effective by maximizing the use and capacity of existing facilities and maximizing the natural advantages of each mode of transportation within a multi-modal approach to transportation improvements; and
- To ameliorate inequities in the existing Boston metropolitan area transportation system by increasing services in the now poorly served Greenbush Line corridor and by increasing access for disabled individuals with special needs [U.S. DOT/MBTA 1995, p. I-12].

The report makes clear that its concern is exclusively with radial (Greenbush-Boston) travel demand:

...The basic purpose of the Transportation Improvements in the Greenbush Line corridor project is to meet the work trip needs of Greenbush Line corridor residents working in the Boston regional center. Transportation improvements aimed at other needs, such as better access to suburban work locations, while aided by reducing congestion on Greenbush Line corridor highways, are better addressed in projects developed more specifically for these purposes [U.S. DOT/MBTA 1995, p. I-12].

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The report focuses on four general options, with some variants, as follows (and see maps p. 9):

- **No Build.** This alternative “consists of the existing transportation system and [other] system elements expected to be in operation by 2010 [exclusive of the Greenbush project]” (U.S. DOT/MBTA 1995, p. II-4).

- **Transportation Systems Management (TSM).** This option “builds on existing commuter bus service in the corridor,” adding three new park-and-ride lots and additional service. It also takes into account the negative impact of worsening traffic conditions in the corridor, partially offset by the benefits (for buses) of anticipated HOV lanes on the Southeast Expressway. The current (generally unsubsidized) fares charged by private operators in the corridor were assumed, with annual adjustments for inflation. For those purchasing ten-ride tickets, the average fare (before inflation adjustments) would be $3.30 per trip. When the initial model runs showed very limited patronage gains, the anticipated service frequency was cut back.

  …Evaluation of projected ridership under these circumstances indicated that this route could not support this level of service and still maintain the minimum performance standards operating on the South Shore… subject to a minimum farebox recovery ratio… Consequently, the assumed service levels were adjusted to levels which could be supported within those service standards: 9 round trips per weekday (6 peak, 3 off-peak trips each way); 3 round trips on Saturday, and 2 round trips on Sunday [U.S. DOT/MBTA 1995, p. II-12 – 15].

  These frequencies were similar to those proposed for commuter rail. The estimated capital cost of this option was $7 million.

- **Commuter Boat.** Two variants of this option were considered. Both would expand service at the current Hingham terminal; the second would also inaugurate service from Nantasket. Neither would include feeder bus service, because early model runs indicated that neither “could support even a single [unsubsidized] bus trip, at minimum service standards” (U.S. DOT/MBTA 1995, p. II-19). In other words, the operating loss and related ridership were seen as unacceptable. As in the TSM alternative, current (unsubsidized) fare levels would be held constant, with adjustments for inflation. For those purchasing ten-ride tickets, the fares (before inflation-adjustments) would be $3.40 from Hingham, $3.75 from Nantasket. The estimated capital costs of these options were 22 and 35 million dollars respectively.

- **Commuter Rail.** Five variants were considered, with capital costs ranging from 215 to 430 million dollars (depending, most notably, on whether to proceed at-grade or in tunnel through Hingham), but all had essentially the
Maps, clockwise, show improvements associated with the No Build alternative; the Greenbush commuter rail line as part of the Old Colony System; new bus proposals for the TSM alternative (U.S. DOT/MBTA 1995, p. II-7, P-5, II-10); and the Guided Bus alternative routings (MBTA 1995, p. 13). No map is included in MBTA documentation for the commuter boat or combined bus-boat-rail (“Super Boat”) alternatives.
same operating characteristics. The projected line would run 17.7 miles along the existing (now abandoned) rail right-of-way from its junction with the main Old Colony (Boston-Braintree) line to the Greenbush area of Scituate. There would be seven stations, each with a parking lot and high-level platform for boarding. Trip time would be approximately 58 minutes from Greenbush, 33 and 38 minutes from the two stations in Hingham, and 22 minutes from Weymouth Landing. Every train would stop for about a minute at each station. Twelve trains would be operated each way on a typical weekday, with 20 to 30 minute headways in the peak direction during peak hours and service every 1 ½ to 2 hours at other times, according to the text on p. II-48 (U.S. DOT/MBTA 1995). According to the sample timetable on p. II-50, however, the shortest interval between the five peak-hour trains scheduled in each direction would be 25 minutes.

Fares would reflect current (subsidized) commuter rail fare patterns in the region, with a range from $1.71 to $2.67 per trip, depending on distance, for those with a monthly pass (this assumes 21 round trips per month). A $1 parking fee is assumed. While U.S. DOT/MBTA 1995 does not provide information on parking charges for the other alternatives, a note to Table 9.1 of MBTA 1995, p. 44, suggests that the parking charges, of $1, would be the same for all alternatives.

Travel time was defined in all cases to include access and waiting as well as line-haul time. Access time was

...based on the distance from the origin of the trip to the nearest bus, commuter rail station, or commuter boat terminal using average automobile times of 4 minutes per mile (15 miles per hour) for the short access trips on local streets typical of Greenbush Line corridor communities. [U.S. DOT/MBTA 1995, p. IV-1].

Travel times were taken to be for “representative trips, in particular, those to the South Station area of Boston.” It was assumed that wait time — the period spent after arrival at the station but prior to boarding the line-haul transit vehicle — would average five minutes for the principal transit mode: rail, bus, or boat, regardless of the frequency of service offered [U.S. DOT/MBTA 1995, p. IV-1].

Chapter IV of the SDEIS/R provides an assessment of the transportation impacts of the chosen alternatives along with information on the modeling process used to obtain ridership results. A more detailed presentation of the technical methodology is available in the 1989 Methods and Results Report (MBTA, 1989). The documentation of actual procedures employed is surprisingly vague, given the extensive studies that have been undertaken with it and the magnitude of the decisions that apparently hinge on the results of such studies. One serious problem is clear, nonetheless. The procedures used to estimate commuter rail ridership were different from those used to estimate usage of the other modes, and the difference very much favored commuter rail. This problem is examined in detail below.

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1 All capital cost estimates are rounded herein to the nearest million dollars.
Ridership Estimation for Commuter Rail

The first phase of the methodology used to forecast commuter rail ridership estimates the rate of growth of the market for transportation which the new services might serve. The procedure used reflects 1990 Census work trips, population growth at origins, and employment growth at destinations. Population forecasts were provided by the Metropolitan Area Planning Council and anticipated little change in the population of the Greenbush Corridor. Employment growth projections for 2000 and 2010 were developed by the Central Transportation Planning Staff, and showed modest increases in downtown Boston employment.

The second phase included the development of models for the mode share analysis, and the approach taken here was unusual. Most conventional modeling directly compares the alternatives under consideration, deriving patronage estimates from their specific attributes such as journey time, frequency, and cost. In this instance, however, the modelers chose to assume that regional averages could be used for most purposes, and that only two variables had to be examined directly: (1) distance to a rail station, and (2) distance to an express bus stop (p. IV-10). The main effect of this analytic decision was to preclude any findings that above-average service in a given modal category (e.g., express bus) might lead to increased patronage. As the SDEIS/R explains:

The commuter rail mode choice model developed by the MBTA does not specifically include some variables which are often included in other mode choice models, such as parking costs, auto travel times, bus and rail fares, and the frequency of bus and rail service. The commuter rail ridership data which were used to develop the MBTA model reflect conditions in Boston area communities where such factors (i.e. relative travel times between rail and automobile) do not vary significantly from one community to another, and therefore do not help explain commuter rail ridership levels in Boston area communities. The forecasts for the Greenbush Line corridor alternatives implicitly assume that all of these additional factors will bear the same relationship in the Greenbush Line corridor in 2010 as they currently do in the existing rail corridors of the Boston area.

The MBTA model differs from other mode choice models in use throughout the country in another way as well. The model is mode-specific: that is, the model projections were based upon commuter-rail specific data, and are valid only for projecting commuter rail ridership, and bus ridership from communities served by commuter rail. The model does not provide for analysis of transit services based solely on travel time and cost characteristics (without regard to whether the service is provided by bus or rail), which is the procedure recommended by the Federal Transit Administration (FTA). The results of the MBTA’s ridership forecasting procedures, in terms of total commuter rail boardings, do not appear to be unreasonable. Thus, while the FTA has technical problems with the forecasting methodology, the FTA has consented to the presentation of the results of the MBTA analysis [U.S. DOT/MBTA 1995, p. IV-10 – IV-11].
The MBTA’s 1989 *Methods and Results Report* adds the following explanation:

Because these models include no consideration of the characteristics of other modes (auto, rapid transit and commuter boat), and no consideration of rail or bus service characteristics such as travel speeds, peak period headways, and fares, their predictive ability is limited to situations which can be characterized as essentially like existing commuter rail and commuter bus services in the Boston region. In this context, “essentially like” means services with speeds, headways and fares which are similar to those of existing services. Although this limitation affects the general applicability of the line-haul models which have been developed, it does not affect their usage in forecasting ridership on proposed Old Colony services, because these services are being designed using construction and operating standards which reflect existing conditions on the present commuter rail lines serving Boston [MBTA 1989, p. 4-5].

Despite this explicit statement that the model could not represent boat ridership, Barry Faulkner of Sverdrup explained that commuter boat ridership had been estimated by treating its terminal as “as though it were a competing train station.” Faulkner also said that “there’ll be some people who always take the boat because they like the boat.” If true, such a preference would not be represented in the SDEIS/R methodology.

Ridership on competing bus services (assuming the implementation of Greenbush rail) reflected patterns of attraction to express buses in the metropolitan Boston region as a whole, with the sole direct variable being distance to the closest express bus stop. The 1989 Methods and Results Report lays out the relative effects of access distance on the attractiveness of rail and bus:

- the share for each mode decreases as access distance for the subject mode increases
- the share for each mode increases as access distance for the competing mode increases...
- for a specified set of access distances to rail and bus, rail shares are greater than bus shares
- when the access distance to bus is greater than that to rail, bus shares drop to very low values. Conversely, rail shares do not drop off to insignificant levels until the access distance to rail is five miles greater than the distance to bus [MBTA 1989, p. 16].

The modeling approach is problematic for a number of reasons. Most fundamentally, it assumes that the factors which influence the attraction to commuter rail as measured by the set of existing routes in the Boston metropolitan area is representative of the factors which would be in effect in the Greenbush Corridor. This has not been ascertained. A particular issue is that travelers in the Greenbush Corridor have access to both the Red Line subway and commuter boat services. Commuter boat competition for the proposed commuter rail service is partially addressed by treating its terminals as equivalent to rail stations; however, documentation for the underlying methodology specifically says that this is inappropriate, while proper account is not taken of the impact of the Red Line on commuter rail demand.
The service offered at commuter boat “stations” is assumed to have commuter rail operating characteristics, including trip times and service frequency. In fact, however, commuter boat trip time is less than rail trip time from Nantasket Junction and points on the Greenbush line south and east, and there are twice as many peak hour boat departures from Hingham as would be provided on commuter rail. For many travelers, a 15-minute service interval will offer opportunities for better matching personal scheduling needs — providing reasons why they would drive further to reach a boat departure point than a rail station. By setting the boat terminal as a commuter rail station and assuming that users will drive to the nearest “station,” people who might in fact prefer to drive a bit further to use the boat are assumed to automatically take the rail service and boat ridership may thereby be underestimated, while rail ridership may be overestimated.

No explanation is given for the statement that people will drive far further to gain access to a rail station than they will to reach a bus service. The implication is that rail service is more attractive than bus service in the metropolitan Boston area, but we do not know why. An issue of particular concern is that fares for privately operated buses are set at higher levels than for the competing rail service. It might be argued that, were commuter rail service to be adopted, there would be no change to bus fares, and that it is therefore appropriate to represent the fares which would likely actually prevail. On the other hand, setting fares equal for rail and bus would have provided a better opportunity to gauge the effect of service factors on demand, rather than to sow the idea that people will drive further to get to rail than bus per se.

For certain purposes, rough modeling assumptions are appropriate as a way to arrive quickly at order-of-magnitude estimates. Treating a boat terminal as equivalent to a rail station, for example, makes sense in a low cost/rapid results exercise. Experience has shown, though, that much more refined techniques are essential when the aims are to compare competing services and arrive at fairly precise estimates.

The potential for variability based on specific corridor characteristics is indicated by experience with the two Old Colony lines that have been reconstructed and opened for service in recent years. Ridership on the Plymouth branch of the Old Colony system has been relatively higher than forecast, while ridership on the Middleborough line has been well below forecast. Data obtained from the MBTA for the ENSR/Berger review (to be further discussed below) showed 2,350 average inbound morning peak riders on the Middleborough Line in February 1998, approximately half the 4,696 forecast in the Old Colony DEIS/R for 2000. The Plymouth Line, in contrast, was carrying 2,800 inbound morning am peak riders, essentially the full ridership of 2,780 forecast for the year 2000 (ENSR/Berger 1998, p. 14). The Greenbush SDEIS/R projected 3,184 morning peak inbound riders in 2000 growing to 3,206 riders in 2010 (U.S. DOT/MBTA 1995, p. IV-12 – IV-13).

Ridership Estimation for the TSM Alternative

Having used one set of methods and assumptions to estimate rail patronage, the SDEIS/R employed another set to estimate usage of the non-rail options. As it explains:
The MBTA used a more traditional method to forecast express bus and commuter boat ridership for the TSM and commuter boat alternatives. This procedure, known as a “pivot point” analysis, uses the known relationship among ridership levels and service characteristics, such as travel time and costs, based on previous studies and model development. These relationships are used to forecast an increase in mode share for transit resulting from improvements in travel time, service frequency, or fare levels for the express bus services in the TSM alternative and the commuter boat services in Alternatives 3 and 4 [U.S. DOT/MBTA 1995, p. IV-11].

To put it another way, the analysis takes as a basis the ridership levels found on existing services and adjusts them according to what is seen as the likely impact of changes in travel time and costs, with the scale of those impacts (the “elasticities”) based on a dataset which shows the effects of like improvements that have already taken place. This approach is suitable in circumstances where the model assumptions are applicable to the particular corridor or other corridors which are known to be similar, and where the variables modeled in fact account for nearly all variance in travel mode decisions. The assumed elasticities in the SDEIS/R appear to be generic, however — that is, derived from a number of cities — rather than based on corridor-specific or even Boston-specific data.

Despite the statement on p. IV-11 (U.S. DOT/MBTA 1995) that the relationships between ridership levels and service characteristics “are used to forecast an increase in mode share for transit resulting from improvements in travel time, service frequency, or fare levels,” there is no frequency element indicated in MBTA 1989, Appendix C, which shows that only travel times and fares are explicitly taken into account by the “pivot point” approach used. This means that a new service which offers substantially increased departures will appear to be no more attractive than one which offers only a modest number of trips during the peak, everything else being equal (discussed further, below).

The SDEIS/R estimated that, in the TSM scenario, buses would attract only 840 inbound am peak passengers in 2000, and roughly the same number (857) in 2010. These figures are only about 10 percent higher than the forecasts of bus patronage in the no-build scenario: that is, with no service improvements at all. The most likely reason for this poor showing is that the major improvement contemplated — a dramatic increase in service frequency — failed to register in the model. The initial plan called for a doubling of peak hour service frequency, to eight departures, with an additional eight off-peak trips. The projected increase in service frequency was cut by half when the initial model runs failed to indicate patronage increases. If the main problem was the insensitivity of the model, however, this reduction was merely a symptom of a flaw in the analysis.

The other key variable in the model was fares. Although the projected new TSM bus service would be operated under contract to the MBTA, the analysis assumed much higher bus than rail fares. The reason was simply that current bus fares are higher, reflecting the fact that they are unsubsidized. Where the MBTA itself operates buses in competition with its rail services, however, the bus fares are lower. A monthly rail pass between Salem and Boston, for example, currently costs $82.00, whereas a monthly bus
pass costs $71.10 (assuming 21 work days in the month, since there is a variable component of this fare). To allow a proper comparison of rail vs. bus ridership potential, it would have been appropriate to assume equal fares.

A third issue concerns the design of the TSM bus operations. The bus routes were designed to be slow, with large numbers of stops. An alternative approach would have been to operate a larger number of routes with fewer stops and resultant faster journey times on each one. The reduced travel time would, given the model employed, have generated a higher ridership.

**Ridership Estimation for the Commuter Boat Options**

The analytic problems with the commuter boat projections are similar to those with the TSM projections, but estimated boat ridership is modestly higher, given the improvement in boat journey time (from 35 minutes to 25 minutes for the Hingham route). The SDEIS/R projected 919 inbound boat riders during the am peak in 2000 assuming no improvements (the no-build option), 1192 with improvements in Hingham only, and 1220 with improvements in Nantasket as well. And it projected essentially the same patronage levels in 2010.

There were three main problems with the analysis. First, as with the bus analysis, no credit was given for frequency, so extra boat departures on the Hingham route were shown to attract no new patrons. Second, the boat fares were set at current levels, which are higher than those for commuter rail. Third, although one of the major current deficiencies of boat service is isolation of the downtown terminal (at Rowes Wharf), no effort was made to consider the impact of adding a shuttle-bus from that terminal to the most desired downtown locations.

**Cost Effectiveness Analysis**

Chapter IV of the SDEIS/R presents an “Evaluation of Alternatives,” relating estimated costs and time savings to the forecast ridership. The analysis here is deficient in omitting the proper detailing of fully-allocated costs. Most notably, certain MBTA costs, such as general overhead and the operation of South Station, were omitted on the ground that they were already fully funded (DOT/MBTA 1995, p. VI-16). While such an incremental approach may illustrate short-term impacts, fully-allocated cost data should have also been considered. Costs which are shared are, nonetheless, real. Fixed costs can, furthermore, increase in the long-term should service be expanded beyond the capacity of fixed-cost resources. The approach taken generates a further problem: Commuter bus and boat operations do not require facilities of the costly scale of South Station. They are also run by lean managements, avoiding the high administrative overhead typical of the MBTA. These advantages do not come through, given the analytical technique adopted.

The bus component of the TSM alternative generated positive net incremental operating revenue (meaning that the increase in fares would more than cover the cost of improving services under that alternative). Because some passengers were projected to come from other public transit modes, however, there was nonetheless a net increase in
system operating costs for the alternative as a whole. The commuter boat and commuter rail alternatives generated negative incremental operating revenue (both for those modes taken alone and for the transit system as a whole), although the negative increment was three times as great in the case of commuter rail at-grade as for the commuter boat, Hingham alternative.

In estimating ridership, the SDEIS/R assumed a standard five minute waiting time (p. IV-1). In estimating travel time savings, however, it assumed that wait times would equal half the time between peak hour trips, with a maximum of 30 minutes, subject to the following adjustment: “Wait time for services on an exclusive right of way is reduced by 5 minutes (except where headways are 15 minutes or less) to reflect the improved reliability of departure times on these services” (p. VI-23). This 5-minute reduction appears to apply to the rail mode only, thereby eliminating part of the actual trip time savings of the more-frequent boat.

The total cost per trip of the least expensive rail option (which was the recommended one) was estimated to be $7.91, by comparison with $5.56 - $6.95 for the boat options and $4.22 for the TSM option. Table VI-11 on p. VI-26 also shows total cost per new transit trip — a measure of the cost of attracting someone who previously drove, thereby achieving the environmental objective of removing cars from the road. For this measure, the at-grade rail option, at $15.60, was only slightly higher than the TSM alternative, at $15.09, but lower than the boat options, at $22.61 – $33.69 per new transit trip. These estimates reflect the low ridership forecasts for the TSM and boat alternatives (see Tables 1-3, p. 22-23, which display ridership and cost data for the range of alternatives considered).

EVALUATING A GUIDED BUS ALTERNATIVE

Following public calls for more alternatives to be examined and a request from the Massachusetts Secretary of Environmental Affairs for additional explanation of alternatives not included in the SDEIS/R, the MBTA issued a further report in September 1995, examining the feasibility of a guided busway, with average peak period frequencies of 4 minutes and departures as often as every 2 minutes at times (vs. at least 25 minute headways for rail) in the Greenbush corridor:

MBTA has elected to consider an additional alternative in the Greenbush corridor in order to provide additional information in support of a transportation decision in the Greenbush corridor. Experience in two cities — Essen, in Germany, and Adelaide, in Australia — indicates that guided buses on specially-designed tracks can provide transit service levels comparable to rail systems at lower cost and with reduced noise, vibration and visual impacts than rail systems [MBTA 1995, p. 2].
The new analysis was carried out:

…using analysis methods and assumptions which are comparable to those used for the nine Greenbush alternatives included in the SDEIS/R, and which allow comparison of the guided busway alternative to the SDEIS/R alternative. To make the comparison with competing modes consistent and fair, the busway has been developed in a manner which is as similar as possible to the level of service provided by commuter rail [MBTA 1995, p. 2]

Specially designed dual-mode buses (which can operate on and off a guideway) would complete their journey on a guideway as far as Route 3 and then on regular roads. Five miles of the Southeast Expressway would be driven in an HOV lane. The buses would provide all-station service to the same places as the rail service, and similar parking would be provided (MBTA 1995, p. 5-7).

The maximum speed on the busway would be 62 mph, reduced to 25 mph for passage through grade crossings.

In order to maintain ride characteristics which are comparable to those of commuter rail, the acceleration and deceleration rates of the bus would be limited to the maximum deceleration experienced on the train. This rate (which is experienced when the train slows for a curve or to stop at a station) is .67 meters per second per second (2.2 feet per second per second), or just under 7 percent of the force of gravity. This rate is used for both acceleration and deceleration of the bus. While the bus could accelerate and decelerate somewhat faster than this, this could make it difficult to read or ride on the bus, and would make the ride characteristics worse than the train [MBTA 1995, p. 9].

Dwell times at stations were set at 60 seconds, the same as for commuter rail. Total trip time from Greenbush to South Station came to 61 minutes, three minutes longer than on commuter rail.

Unfortunately, the system design selected for analysis incorporated many of the constraints of rail service while failing to take advantage of characteristics that might give the buses an edge over rail. With a bus system, larger numbers of stops can be provided precisely because of better acceleration/deceleration characteristics. It would have been feasible to have added stops at a number of busway locations, such as Hingham Square, which would have increased the attractiveness to riders. Buses could, furthermore, operate directly to a number of South Shore points off the busway, using the busway for speedy operation and using surface streets for collection/delivery of passengers near their homes. This practice is widely followed where busways are successfully in operation: in Los Angeles, Pittsburgh and Ottawa, for example. Distribution of passengers could also be provided throughout the Boston core, rather than only to South Station, adding further to the attractiveness of the bus option. Finally, bus speeds could be enhanced by skipping stops – as in Pittsburgh, where some buses during peak periods stop at all points, while others run express. Given the high frequencies anticipated in the Greenbush busway scenario, some buses could start at the end of the line, make a couple of stops and then run express to Boston; others could originate at an intermediate station, saving operating costs, compared to having all buses go to the end of the line. Buses originating beyond the
end of the busway might operate non-stop or with only one stop on the busway. All of these measures would significantly reduce journey times while still maintaining service frequencies better than rail from virtually all locations.

Perhaps the most surprising feature of the guided busway analysis was the decision to have buses adopt the constrained operational behavior of diesel trains. Rail patterns of acceleration and deceleration reflect the relationship between the power of the engine, the weight/momentum of the equipment to be accelerated or brought to a halt, and traction with the surface on which equipment runs. Electric trains generally exhibit superior acceleration characteristics to diesels without passengers experiencing less comfort, so why specifically set the bus characteristics to those of diesel?

Buses can accelerate and decelerate much faster than trains, given their power to weight ratios and their traction characteristics (friction between rubber tires and paved roads, vs. that between steel wheels and rails). Successful busway systems around the world take advantage of the operational characteristics of buses, having observed that passengers place a very high value on time savings. No evidence is provided in the Greenbush busway analysis (or anywhere else in the documents reviewed) that passenger comfort would be compromised by adoption of this widespread practice.

Dwell time also appears to have been set higher than necessary. According to the report, a dwell time of 60 seconds is sufficient for boarding passengers, but in the outbound direction passengers could leave the train faster, with two doors open and no fares to collect. “...this would result in lower dwell times” (MBTA, 1995, p. 15). The higher 60 second dwell time was assumed, nonetheless, to prevail at all times.

The cumulative effect of these analytical choices was to make bus journey time slightly greater than for rail; if conventional assumptions of good bus operating practice had instead been adopted, the guided bus journey times would have been less than for rail.

The proposed guided bus service does not, however, meet this criterion, especially because the frequency would be so much greater than for rail. There is no element in the model that reflects the dramatic improvement in service frequency that this option would provide. Even expected waiting time is assumed equal for bus and rail: “Waiting times for the busway buses may be slightly less than for commuter rail; however, the observed average waiting time for commuter rail (because of its schedule reliability) is well under 5 minutes, and this factor plays a minimal role in the prediction of ridership” (MBTA 1995, p. 20).

A. Alfred Taubman Center for State and Local Government
In effect, modeling assumes no difference in attractiveness between a peak bus frequency of 4 minutes, vs. at least 25 minutes for rail. With a bus leaving every few minutes, however, users do not have to time their arrival at the departure point, but can instead arrive when they like and expect a departure shortly thereafter. With a 25 minute or lower frequency, by comparison, arrival must not only be timed to a specific train, but specific departure times are likely to be inconvenient for many potential users (for example, someone who must be at work at 9 am but only has a choice of arriving at, say, 8:45 or 9:10). In addition to the busway alternative’s high peak-hour frequency, its projected 30 minute off-peak headways provided a substantial advantage over the 1½ - 2 hour headways projected for off-peak trains. Daniel Brand and Joy Benham (1982), in a Baltimore analysis, found that a doubling of frequency produced a 26 percent increase in ridership, other things being equal. South Shore elasticities are doubtless different, but it seems highly likely that much greater frequencies (say, 15 per hour vs. 2) would produce very significant ridership increases.

The guided busway study approach outlined above produced estimates that busway patronage would be slightly less than commuter rail: 3,000 vs. 3,200 inbound riders during the am peak period (MBTA 1995, p. 20). Before the report was finalized, however, the busway projection was reduced to 2,500, on the following grounds:

The busway service is not likely to be considered as equivalent to commuter rail service. The use of the Southeast Expressway, with highly variable traffic conditions, will mean that the buses will on occasion be significantly delayed; commuter rail, by comparison, has a 95-percent-plus record of arriving within 5 minutes of schedule. The ride quality, while carefully controlled on the busway, will be subject to bumps and sways and quick stops on the Expressway section and at grade crossings; by comparison, one of the most appreciated attributes of commuter rail is the ability to read and write or do other work on the train [MBTA 1995, p. 21].

Barry Faulkner of Sverdrup, the MBTA’s consultant for this work, described how the decision to reduce the guided bus ridership forecast was made (interview, December 4, 1998). At a meeting of consultant and MBTA personnel, one of the senior MBTA officials asked Faulkner whether a formal process had been undertaken to assess the “qualitative” aspects that might affect ridership. Faulkner replied in the negative. Then, following a general discussion of what might be a “reasonable” number, the bus ridership estimate was reduced. According to Faulkner, this was “chiefly a decision by the Head of Planning at the MBTA at the time.”

Numerous studies, as documented by Wachs (1976, 1991), have shown that ridership levels are mainly determined by variables of trip time, frequency, and cost. While reliability of service has been shown to affect the attractiveness of services, comfort and other “qualitative” variables appear to have little impact upon consumer choice. The reductions in forecast ridership, which reflected a perception of allegedly negative attributes of bus service without taking into account the attractions of the far higher frequency which would be offered compared to rail therefore appear surprising. This is especially so in light of the knowledge reported in the 1995 document that “In Adelaide,
the [guided] busway attracted ridership levels which approached those originally forecast for light rail service, and substantially above the conventional bus service which the guided bus replaced” (MBTA 1995, p. 21).

The estimated capital cost of the busway alternative ($148 million) was 31 percent less than that for the commuter rail at-grade alternative ($215 million) (MBTA 1995, p. 25). Annual operating and maintenance costs for the busway alternative were projected at $4.1 million per annum (1993 dollars), vs. $5.6 million for the at-grade commuter rail alternative. With both capital and operating costs lower, the guided busway option would have been the more attractive option if the report had shown it to have similar travel time and ridership characteristics. Because the report indicated, however, that the guided busway alternative would attract 22 percent fewer riders, rail came out better using the Federal Transit Administration’s overall cost-effectiveness measure. On this basis, at-grade rail’s cost came to $14.76 per new rider, compared with $15.42 for the busway. It was estimated, furthermore, that capital and operating costs combined would be $7.91 per trip for commuter rail and $8.63 for the guided busway.

THE COMBINED BOAT-BUS-RAIL ALTERNATIVE

In 1997 Sverdrup, in its role as contractor to the MBTA, analyzed still another alternative, this one put forward by the U.S. Army Corps of Engineers in order to “address the claims made by several persons, groups, and municipal representatives.” (Sverdrup, 1997, p. 1). Although known as “super-boat alternative,” this alternative in fact combined improvements in three transit modes; so, in order to convey its actual scope, it is labeled here as the “combined boat-bus-rail alternative.” Its main elements were as follows:

- The commuter boat to Hingham, as examined in the SDEIS/R.
- A new commuter boat service from Scituate, with new ferries and a new terminal.
- Park-and-ride lots built at or near each of the stations otherwise proposed for the Greenbush commuter rail alternative.
- Non-stop, “luxury” bus service from each of these station areas to downtown Boston, every fifteen minutes during the peak.
- Extensions of the current HOV lane on the Southeast Expressway — north to provide direct access into South Station, and south to the intersection of Route 3 and Route 228.
- A new commuter rail branch off the Plymouth line, providing access from a new station at Accord.

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2 Estimated guided bus operating costs would need to be increased, relative to those reported, to accommodate the higher forecast ridership of rail. Even if increased proportionately to the higher ridership, they would still be less than for rail. More buses might also be needed, although guided busway capital costs would remain substantially below rail.
This was an unfortunate service design, because it combined a group of expensive options that were also highly competitive with one another. The results were to dilute the ridership potential of each option and to drive up costs per trip served to exceptionally high levels. The estimated capital cost of this set of improvements was almost twice that of the Greenbush commuter rail project, and its estimated operating cost was more than two and one-half times as great. Regardless of the analytic method employed, it seems clear that this alternative would have been found outside the realm of fiscal plausibility. It bears mention, however, that here as elsewhere the analysis was structured with a strong apparent bias toward the favored rail alternative.

For example, Sverdrup charged the entire $204 million cost of the HOV lane extensions to the bus service, though these lanes would be shared with other motor vehicles carrying multiple occupants (except on the immediate approach to South Station). It is highly unusual for the costs of a joint-use highway improvement to be allocated entirely to transit. The full operating costs of the HOV system (policing, placement and removal of the lane barriers each day, barrier moving equipment) were also charged entirely to the bus service.

The extended HOV lane was forecast to reduce the bus trip times by 12.5 minutes in each direction. Absolute journey times are not specified in the Sverdrup memorandum, but this would imply a bus journey time from Greenbush to Boston (via the Rockland park-and-ride specified in the SDEIS/R) five minutes faster than commuter rail — and this with higher service frequencies. Nonetheless, the Sverdrup analysis concluded that the buses would attract only 36 percent as many new transit riders as Greenbush commuter rail service. Although the combined boat-bus-rail alternative as a whole would attract 2 percent more total riders than Greenbush commuter rail service, the analysis found that only 54 percent as many new transit riders would be attracted with the combined alternative as with the Greenbush commuter rail alternative alone.

This was possible because of the inconsistent assumptions that rail ridership would be similar to that on other rail services in the region, adjusted only for the variables of overall corridor demand and distance to the nearest rail station, while bus and boat ridership would relate only to marginal enhancements to ridership on existing services — whose patronage is depressed by such factors as high (unsubsidized) fares, relatively infrequent service, traffic congestion, and the absence of collection/distribution services to and from the commuter boat terminals. Given the extremely low service and ridership on existing bus service, a marginal increment will not amount to much. The method of estimating ridership is inappropriate for forecasting ridership on an entirely different kind of service; once again, moreover, the analysis failed to reflect the attractiveness of increased service frequency: 15 minutes in this case, versus the infrequent bus service currently offered. Even if passengers can arrange to arrive at stations just a few minutes before scheduled train departures, the methodology ignores the benefit that travelers derive from frequencies that enable them to make trips on short notice, and in accord with their own schedules rather than a common carrier timetable. These are often cited as important
### TABLE 1 Forecast Morning Inbound Peak Riders Year 2000

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<tr>
<th></th>
<th>No Build</th>
<th>TSM</th>
<th>Boat 2 terminals</th>
<th>Rail at-grade</th>
<th>Guided Bus</th>
<th>Combined Boat/Bus/ Rail</th>
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<td>Bus</td>
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### TABLE 2 Estimated Costs

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<td>Bus</td>
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TABLE 3 Cost Effectiveness Measures

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<th>FTA Measure</th>
<th>Investment per daily rider</th>
<th>Cost/Trip net of rev.</th>
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<tr>
<td>Guided Busway</td>
<td>$15.42</td>
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<td>2. TSM</td>
<td>$14.81</td>
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<td>3. Commuter Boat</td>
<td>$21.06</td>
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<td>5. Commuter Rail at grade</td>
<td>$14.76</td>
<td>$44,917</td>
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<td>6a. Commuter Rail, short tunnel</td>
<td>$19.45</td>
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<td>$9.83</td>
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</table>

Table 9.1 Comparison of Cost-Effectiveness Measures

- Alternatives 2, 3, 5, 6a from Greenbush SDEIS/R, Table VI-11
- “net” indicates costs net of passenger revenue, which includes fares ($2.36 average for commuter rail and busway, $3.40 average for boat, and $3.30 average for TSM) and parking revenue ($1 per weekday per car).

- FTA measure represents the cost per new transit rider. It includes annualized capital cost, annual operating cost, and dollar value of change in transit time (subtracted from capital/operating costs if a saving). This is divided by the number of new transit riders.

- Investment per new rider consists of total capital investment in 1993 dollars for the principal mode in each alternative divided by number of daily riders on that mode.

- Cost/trip includes annualized capital costs and operating costs for all modes in each alternative divided by total annual ridership for all transit modes.


Table and notes above scanned from MBTA 1995, p. 44. The FTA measure for the combined boat-bus-rail (“super boat”) alternative was $82 (Sverdrup 1997, p. 10). Investment per daily rider and cost/trip data are not provided for this alternative.

The cost/rev. numbers under “net of rev.” provide information on subsidy per trip for each of the alternatives. It should be noted, however, that while the specified fares of $3.40 and $3.30 per trip has been deducted from total cost of commuter boat and TSM (bus improvement) options, $2.63 and not the $2.36 specified has been deducted in the cases of both commuter rail and guided busway. This error appears to have reduced the estimated subsidy costs for the rail and guided busway options by 27 cents per trip.
advantages of the automobile in competition with mass transit, and of airline shuttles in competition with conventionally scheduled airline services.

In contradiction to the approach taken in this alternative, guided bus estimates — before “qualitative” assessment — were based on (high) rail estimates adjusted for trip time differences. Had a method similar to the one used to gauge ridership for the Guided Bus alternative been used here, higher bus ridership would have been shown. Similarly, had commuter rail ridership been estimated on the basis of marginal improvements existing corridor transit services, the analysis would have indicated much lower rail patronage, and much higher costs per trip served.

THE ENSR/BERGER REVIEW AND SVERDRUP’S RESPONSE

To assist in its deliberations, the U.S. Army Corps of Engineers (COE) retained the consulting firm of ENSR to “assess the adequacy and validity of the transportation systems analysis prepared by the MBTA and provide technical comments and guidance to be used by the COE in evaluation of this project.” (U.S. Army Corps of Engineers 1998, p. 1-2) ENSR, in turn, subcontracted with Louis Berger & Associates to carry out this work, and Berger assigned it to Edward Bromage.

Bromage’s report was deeply critical of the ridership estimation component of the Greenbush alternatives analysis. (ENSR/Berger 1998) He has subsequently refused to discuss this report, however, and even stayed out of the discussion at a meeting called at the Corps of Engineers to review it. So the following analysis is based on the report itself and the MBTA’s critique of it.

The Berger (Bromage) report appears to have been completed in May 1998. On July 23 the MBTA’s Andrew Brennan sent a rebuttal to the Army Corps, in the form of a lengthy memorandum by Barry Faulkner of Sverdrup (Brennan 1998, Sverdrup 1998). Faulkner wrote as follows: “The [Berger] report contains numerous errors of fact and interpretation… The conclusions of the report are largely based on these erroneous assumptions, and are therefore unsupported” (Sverdrup 1998, p. 1). He then continued with a point-by-point critique. Having reviewed this interchange, the present author believes that most (but by no means all) of Bromage’s arguments were valid. A full review of the differences between Bromage and Faulkner would require more space than justified in the context of this report, but those that seem especially pertinent are highlighted below.

Bromage begins his review of the travel demand forecasts in the Greenbush analysis by pointing out that the methodology used does not follow the traditional four-step modeling process. Documentation for the approach employed, he writes, is:
…sketchy. The documentation should be of sufficient detail such that other experts could duplicate the methodology and findings. This is not the case. Many assumptions stated in these reports are undocumented and model coefficients and variables are largely undocumented and undefined. However, there is sufficient documentation to determine whether the methodology is sensitive to critical variables; whether the methodology is appropriate for this application; whether the methodology has been adequately calibrated; and whether the methodology produced reliable results [ENSR/Berger 1998, p. 11].

Bromage continues:

It appears, based on our interpretation of the documentation, that mode shares for commuter rail were estimated for the Greenbush corridor based on commuter rail shares from other communities which currently have commuter rail service. This basically assumes that commuter rail ridership is a binary decision. If commuter rail access exists the ridership will be a certain percentage even if transportation or socio-economic conditions are different. This is inconsistent with current modeling practice. At a minimum, commuter rail ridership should consider the highway and transit network characteristics, travel patterns, and household characteristics.

The documentation provided does not present any statistical analysis to suggest that commuter rail mode share is transferable. It may be invalid to assume that it is. Certainly, some statistical analysis would be needed to investigate community level mode share characteristics in comparison to other community characteristics [ENSR/Berger 1998, p. 13].

Faulkner replies that the model used to estimate commuter rail ridership was developed by Cambridge Systematics, and was:

…based on an analysis of actual transit usage in the MBTA commuter rail service area. A wide range of variables was considered, including frequency of service, fares, and travel times. Except for access distance to commuter rail and competing modes, none of these service factors was found, through the mathematical process used to develop such models, to have a significant explanatory effect on commuter rail demand. There is very little variation in commuter rail travel times, frequency of service, fares, or other passenger amenities on the existing system. There is also very little difference from one part of the region to the other in the relative costs or travel times by automobile or in congestion conditions on the way to the commuter rail station. What little difference there is has no measurable impact on the commuter rail mode share.

Travel times, frequency of service, fares, and other passenger amenities on the Old Colony lines were and are being designed to be the same as what is provided on the existing commuter rail lines. [Sverdrup 1998, p. 2-3].

In short, Faulkner maintained that the issues of “highway and transit network characteristics, travel patterns, and household characteristics” had been taken into account, though implicitly rather than explicitly. He did not provide any documentation, however, for his claim that differences from one part of the region to another have “no measurable impact on the commuter rail mode share.”
Bromage writes that:

The Commuter Rail Access Mode Model was based solely on observations at other stations. This implies that mode of access has no bearing on rail ridership. Therefore the availability of a feeder bus system would not impact ridership. In a more traditional model structure, access mode and travel time would be an integral part of the ridership projection. [ENSR/Berger 1998, p. 19]

Faulkner responds, correctly, that “Access time at both ends of the trip (represented by distance from the residential zone to the rail station and from the terminal station to the final destination zone) is the dominant determinant of base case commuter rail share in the Old Colony model” (Sverdrup 1998, p. 4). Bromage is correct, however, that mode of access does not influence rail ridership in the model. Only distance from the rail station does so. This is to assume a generic network of access systems with negligible variation from one part of the Boston region to another. Thus, for example, the presence or absence of a feeder bus system in the design of a specific alternative would have no effect on forecast ridership.

Bromage analyzes ridership statistics for the Middleborough and Plymouth Old Colony Lines (which commenced service in September 1997), using February 1998 MBTA data:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Middleborough</td>
<td>4696</td>
<td>2350</td>
</tr>
<tr>
<td>Plymouth</td>
<td>2780</td>
<td>2800</td>
</tr>
</tbody>
</table>

He writes, “The Plymouth count already exceeds the 2000 forecasts and the Middleborough count is 50% of what it is forecast to be two years from now. The methodology used in the Old Colony DEIS appears inadequate to the task of predicting which line (Middleborough or Plymouth) will have the greater ridership” (ENSR/Berger 1998, p. 14).

Faulkner acknowledges that Middleborough line ridership:

...is just about 50 percent of the year 2000 projection. We would expect to be at approximately 70 percent, given the 3-to-5-year ramp-up period. The shortfall is almost entirely in the city of Brockton, where the three stations are expected to draw a large number of walk-in passengers, as well as drop-offs, bus [passengers], and parkers. The walk and bus patronage... is highly sensitive to the residential location of the traveler. If a passenger doesn’t live within a mile of the train station, or within a quarter-mile of a bus route, he or she is not as likely to walk or take the bus to the train. This is particularly true at Brockton, where extensive bus services to the Red Line at Ashmont provide a reasonable travel choice [Sverdrup 1998, p. 12].

There are, Faulkner continues, five departures on the Plymouth Line each morning, compared to four on the Middleborough. “These scheduling details, by necessity, were not completed until well after the ridership forecasting was completed.” In addition,
“Passengers may not feel as comfortable parking at stations in urban neighborhoods of Brockton as they do in more suburban towns. Under state and federal civil rights law, the MBTA cannot use such highly race-and nationality-based factors as a criteria [sic] for capital investment or service decisions (this restriction applies to the Corps as well).” Over time, Faulkner adds, people change their place of residence to be near rail stations and thus “it may take up to five years to see the full ridership from these sources. To reach the projected ridership by the end of the year 2002 (five years after opening), Middleborough Line ridership would have to grow at an annual rate of 15 percent, which is not out of the question.” Faulkner comments, finally, that: “Overall, the combined ridership on the two lines is at 63 percent of that projected for year 2000, compared to the 70 percent mark that would be expected based on the three-year ramp-up… By all standards, these forecasts are reasonably close to actual ridership” (Sverdrup 1998, p. 12).

Faulkner’s argument appears, however, in fact to corroborate Bromage’s criticisms. As Bromage points out, the model has not discriminated accurately between the two lines. While Faulkner has previously maintained that the practice of basing ridership estimates on Boston regional averages is reasonable, on the ground that there is “very little” variation in factors that affect demand, he now argues that such variations explain the discrepancies between model predictions and actual results in the Middleborough corridor. The fact that ridership for the lines taken together may be seen as reasonable is not relevant when the object of the exercise, as in the case of Greenbush, is to estimate ridership for a particular line. Whatever the future may bring, as of 1998 one line is at 50 percent of the level forecast for 2000 while the other is at 100 percent, and these are the two lines most obviously comparable to the projected Greenbush line.

Other valid points made by Bromage include:

- The model is not proved applicable in a corridor with commuter boat service. This is a valid criticism because the boat offers faster service from certain points than the train, but is assumed by the analysis to have similar speeds to the train; and because the greater frequency of boat departures is not accounted for by the analysis.

- It was inappropriate to impose the constraints of commuter rail operation on the guided bus proposal and calls for improved service design.

- The forecasting methodology is not sensitive to important variables and therefore cannot predict a reliable bus patronage number. Faulkner replies that the pivot point model used for the analysis is sensitive to all the “key decision variables” (travel time and cost) (Sverdrup 1998, p. 14). As noted above, however, the model is not sensitive to the key decision variable of frequency.

- Bromage says that the commuter boat options could have been enhanced by the provision of distribution facilities at the Boston end.

Bromage also did not believe it “reasonable to use a 3 minute time difference on a 58 minute trip as the sole variable for predicting a 20% reduction in ridership [for the guided
bus alternative, compared to rail]" (ENSR/Berger 1998, p. 21). He apparently did not realize that most of the difference in ridership was due to a “qualitative” adjustment of the quantitative model forecasts.

THE ROLE OF PRIVATE BUS OPERATORS

The Greenbush analysis paid little attention to the potential contribution of private bus operators, and this appears to reflect a general pattern. Three bus operators were interviewed for this study — Plymouth and Brockton, Peter Pan, and C & J Trailways. Their statements have not been documented, and are at most suggestive. They raise issues, however, that may be worthy of more careful analysis. Despite repeated requests, it should be noted, the MBTA refused to comment on any of the issues raised in this section.

The most intense grievance of the private operators is that the MBTA, which can ignore costs in setting fares, invariably sets commuter rail fares below those that they can afford to charge. Jim Jalbert of C & J Trailways comments: “My full fare [from Newburyport] to Boston is $9… Their one-way fare is $4, their senior fare is $2. Their operating deficit would pay for more than two years of operating buses at no charge to the public (phone interview, February 1, 1999). Bob Schwartz of Peter Pan added: “They put us out of service on Boston – Worcester… The trip time is the same. Peter Pan can compete with rail service any day of the week except when the farebox is subsidized” (phone call, January 22, 1999).

A second major complaint is that the MBTA has treated the bus companies as competitors rather than potential resources. John Green of Plymouth & Brockton noted that, while commuter rail monthly pass riders get free use of connecting MBTA subway services, there is no similar provision for those arriving by bus. He has for years, he claimed, been suggesting a comparable arrangement for those who arrive by (unsubsidized) private bus, but the MBTA has never responded. John Green of Plymouth and Brockton claims to have raised the idea of a universal fare with the MBTA, and also the idea of providing off-peak bus service from rail stations during the off-peak hours, when scheduled rail departures are now far apart and very poorly patronized. The latter suggestion, according to Green, has been pending for ten years without a response from the MBTA (interview, December 2, 1998).

Green also claims to have proposed the option of private bus service on the Greenbush right-of-way if the MBTA would simply pave it over. According to Green, Plymouth and Brockton offered to serve every station, to run express buses from multiple locations, to offer expanded midday services, and to utilize buses with reclining upholstered seats. Again, he claimed, the MBTA has never expressed interest.

Insofar as these charges are valid, it appears that the MBTA does not regard private bus operators as a resource for potential integration into a unified system. What is clear in any event is that the opportunity for a Greenbush alternative using the right-of-way, paved over, as a conventional busway with privately-operated service has not been formally analyzed.
CONCLUSIONS AND RECOMMENDATIONS

The Greenbush alternatives analysis is deficient in several important respects, and further work should be carried out before any final choice is made among transit investment alternatives for the Greenbush corridor. The major problems are as follows:

- The model used to estimate rail ridership assumes that all corridors in the Boston region are essentially alike. Yet the ratios of actual to forecast ridership for the two Old Colony lines recently brought back into service differ substantially, with one performing far below and the other above forecast expectations. This suggests that the model’s ability to accurately project ridership on a particular line is poor.

- Special factors not adequately accounted for in the Greenbush corridor include proximity to Red Line service (which provides excellent in-town distribution) and competition from commuter boat service (which runs non-stop to downtown at a higher peak frequency than proposed for rail).

- The alternatives to rail service suffer in the current official comparison from the following analytic decisions:
  - Use of existing (mainly unsubsidized) modal demand in the corridor as the base (pivot) point from which to project growth for the non-rail alternatives (except guided bus) rather than the far more optimistic (regionwide, heavily subsidized) base used in projecting rail demand;
  - A failure to reflect the effects of dramatic increases in frequency of service on the non-rail modes. A guided bus departure every 4 minutes is said to be no more attractive than train service every 25 minutes, everything else being equal. National studies show this is incorrect. The MBTA’s own documentation states that the pivot-point method is inappropriate when new service is to be substantially different from existing service;
  - The guided busway alternative apart, a decision to assume higher fares for non-rail services even though their costs would in most cases be lower;
  - a consistent failure to design the non-rail services imaginatively;
  - a decision in one case (guided busway) to constrain service potential artificially by assuming rail operating characteristics; and
  - a decision to reduce the guided bus ridership forecast for “qualitative” reasons which national studies have shown to generally have little role in affecting ridership.
It would, in short, seem prudent to carry out further analytic work before determining the best transportation option for the Greenbush corridor. Such studies should incorporate the following elements:

- A consistent approach should be taken for the evaluation of all alternatives. The impacts of cost, travel time, and frequency on ridership should be explicitly identified and discussed for each alternative to ensure that they are consistent with the research literature.

- Comparable fares should be assumed for all modes, except where it can be shown that lower fares are suitable for intrinsically lower-cost modes, so as to maximize their patronage potential (without driving their total subsidy costs above those estimated for the high cost alternatives). Higher fares should not be assumed for any mode simply because it is currently unsubsidized, and thus charges relatively high fares. If a mode is selected, the level of subsidy to be provided will, after all, be a policy decision.

- Alternatives should be designed for realistic levels of performance that take advantage of their specific modal advantages. The knowledge and creativity used in designing existing bus, boat, and rail services should be employed so as to ensure both that the service designs tested are as attractive as possible and that the analyses produced are as credible as possible.

- A logical theoretical basis should be supplied for the use of all procedures, and complete documentation should be provided.

- The following options appear to merit fresh analysis:
  - High-frequency express bus service using the Greenbush right-of-way (paved over), and an extended HOV lane on Routes 3 and 93 (including the approach to South Station), with some collection and distribution on local streets at both the suburban and in-town ends. The potential for private provision of such service, with subsidy requirements determined on the basis of competitive bids, should be directly compared with the option of conventional MBTA operation.
  - A variant of the express bus option might include guided busway technology, but without the constraints on performance characteristics that were assumed in the MBTA’s 1995 analysis.
  - High frequency bus service using the extended HOV lanes specified above, but without use of the Greenbush right-of-way.
  - High frequency, fare-subsidized commuter boat service, including feeder/distributor buses at both the in-town and suburban ends.
REFERENCES


U.S. Army Corps of Engineers (1999), *Alternatives — Section 404 Mitigation MOA requirements MBTA Greenbush Commuter Rail Project*. Draft, July.


