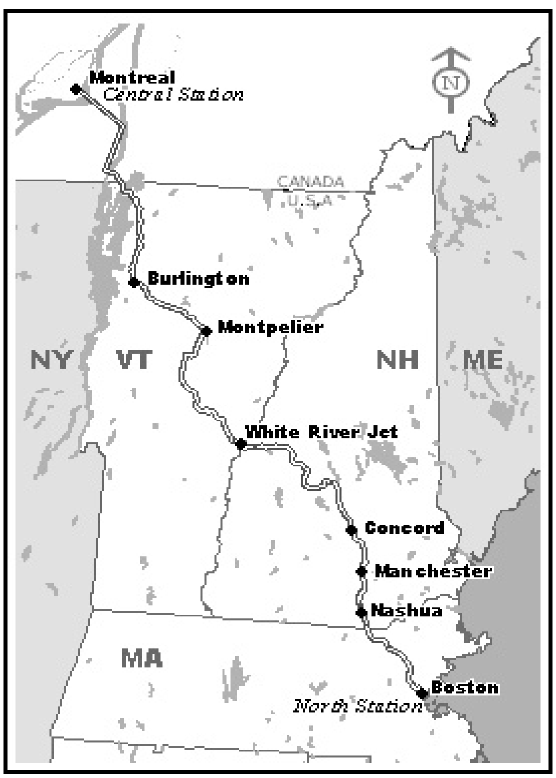
Boston to Montreal High-Speed Rail Planning and Feasibility Study Phase I

Final Report



prepared for

Vermont Agency of Transportation
New Hampshire Department of Transportation
Massachusetts Executive Office of Transportation and Construction

prepared by

Parsons Brinckerhoff Quade & Douglas

with

Cambridge Systematics
Fitzgerald and Halliday
HNTB, Inc.
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Table of Contents

Table of Contents
(continued)

List of Tables

List of Tables
(continued)

List of Tables
(continued)

List of Tables
(continued)

List of Tables
(continued)

List of Figures

List of Figures
(continued)

Executive Summary

E.1 Background and Purpose of the Study

In late 2000, the Federal Railroad Administration (FRA) designated the Boston to Montreal rail route as one of the nation's two new High-Speed Rail Corridors. The designation was in response to a joint application by the states of Vermont, New Hampshire, and Massachusetts that identified the desire to study the feasibility of development of a rail transportation alternative for service between the major metropolitan cities of Boston, Massachusetts and Montreal, Quebec, Canada and intermediate points.

Designation of High-Speed Rail (HSR) corridors has been established by the U.S. Federal Railroad Administration to facilitate planning for alternative travel modes in specific regions. In the application letter to FRA, the potential for use of HSR to reduce congestion on major highway and air corridors within the Boston to Montreal High-Speed Corridor route was cited as a principal reason to evaluate the feasibility of HSR service. As with any long term transportation project, planning and implementation requires a comprehensive series of steps to first determine the feasibility of a proposed transportation alternative and then, if appropriate, progress to implementation of a project. The feasibility analysis used for this study generally follows the methodology utilized in the 1997 FRA Report *High-Speed Ground Transportation for America*[1] and in the 2002 FRA publication *Railroad Corridor Transportation Plans, A Guidance Manual*.

The purpose of the Boston to Montreal High-Speed Rail (BMHSR) Corridor Feasibility and Planning Study is to employ appropriate methodologies to determine if a HSR service is feasible within the BMHSR Corridor. To address all the criteria needed to fully evaluate the feasibility of the BMHSR, the Study has been divided into two phases. This report documents the findings of Phase I of the Study.

E.2 Study Overview

The Boston to Montreal High-Speed Rail Feasibility and Planning Study (Study) is managed by the Vermont Agency of Transportation (VTrans) through a cooperative agreement with the FRA, and directed in partnership with the New Hampshire Department of Transportation (NHDOT), and the Massachusetts Executive Office of Transportation and Construction (EOTC). A steering committee, comprised of representatives of the three

[1] U.S. Department of Transportation, September 1997.

partner States, the Quebec Ministry of Transportation, the Metropolitan Community of Montreal, and the FRA has provided oversight, direction and primary product review for the Study.

The scope of Phase I is to provide information on three primary tasks:

- Identification of institutional and policy issues,
- Development of preliminary service ridership projections, and
- Inventory of basic corridor infrastructure elements.

The scope of Phase II will include study of the remaining elements of High-Speed Rail evaluation criteria. The major items to be studied in Phase II include:

- Detailed operational analysis and planning,
- Assessment of alignment, infrastructure, and environmental requirements,
- Determination of projected capital and operating costs and revenue, and
- Comparison of benefits and costs.

The objective of dividing the Study in two Phases was to assess if sufficient ridership potential exists to warrant additional study of train operations, revenue, and costs required for a HSR service. Also, the investigation of institutional and policy issues during Phase I was intended to document potential "fatal flaws" that could prevent implementing a BMHSR service. The findings of Phase I were, therefore, expected to be either that the BMHSR service was not feasible in the foreseeable future; or that sufficient evidence was developed to support progression to Phase II of the Study.

Included in Phase I Study efforts was the development and implementation of a significant public awareness program. The purpose of this program was to make individuals and public and private organizations aware of the objectives of the Study and the potential issues associated with the BMHSR service; and to seek input that would aid in identifying benefits and impacts for the potential BMHSR service. Activities included establishing a Study website (www.bostonmontrealhsr.org), holding public meetings at the beginning and end of the Phase I Study, and holding two focus group meetings with representation from specific public and private interests.

Description & Definition of High-Speed Rail

High-Speed Rail is often described as a subset of the more general term, High-Speed Ground Transportation (HSGT). HSGT has been documented most thoroughly in the FRA report, *High-Speed Ground Transportation for America*.[2] According to the report, HSGT can be defined in terms of travel market and performance characteristics as:

[2] Ibid.

> "…a self-guided intercity passenger ground transportation – by steel-wheel railroad or magnetic levitation (Maglev) – that is time-competitive with air and/or auto for travel markets in the approximate range of 100 to 500 miles."[3]

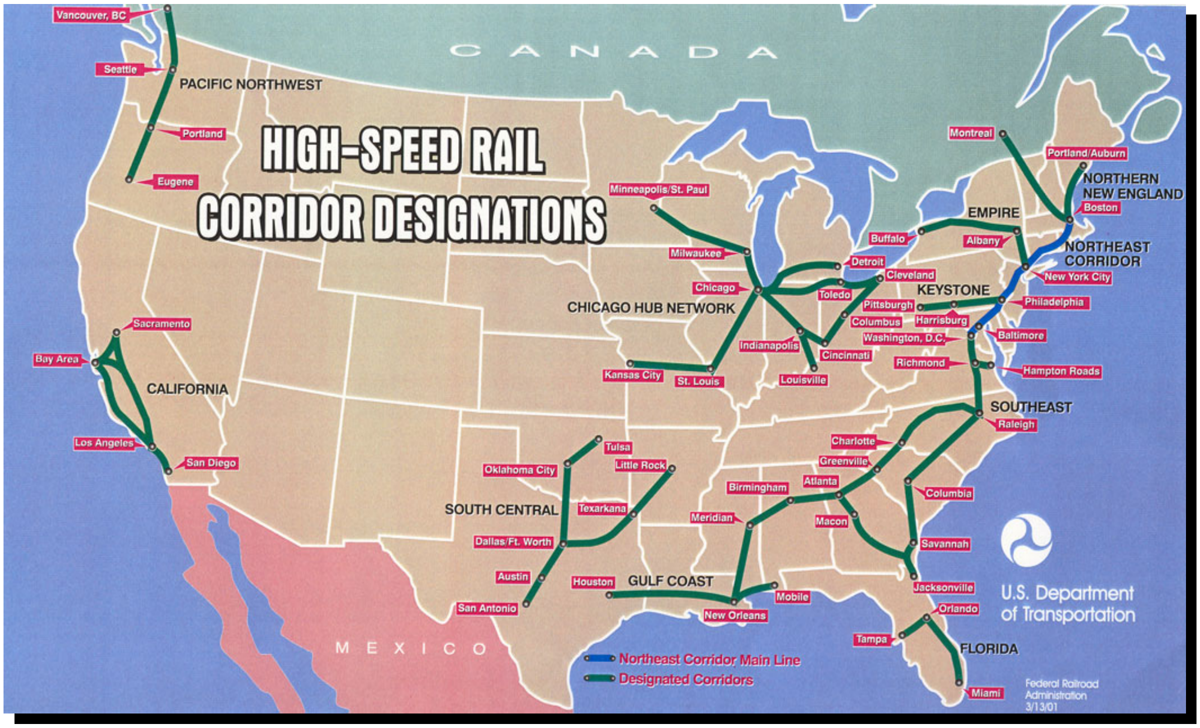
This is a market-based, not a speed based definition. However, to provide time-competitive travel times, high-speed trains must operate at maximum speeds that result in an average speed that corresponds to competitive travel times. When considering if a rail route could qualify for designation as a high-speed corridor, the Secretary of Transportation is required to consider whether railroad speeds of 90 miles per hour or more are occurring or can reasonably be expected to occur in the future. For the BMHSR Corridor it is anticipated that speeds within segments of the route in excess of 90 mph would be possible. This assumption was utilized in developing estimated trip times used to support development of the ridership forecasts projected in Chapter 3. The detailed analysis of operations, including development of specific operating speed limits, will be included in Phase II of the Study.

Designated High-Speed Rail Corridors

The FRA has designated high-speed corridors under section 1010 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and Section 1103(c) of the Transportation Equity Act for the 21st Century of 1998 (TEA-21). The designation allows states through which the corridor passes to receive earmark funding for study, design, and construction as well as receive specially targeted funding for highway-rail grade crossing safety improvements, and recognizes that the corridor has a potential for HSR activity. The BMHSR Corridor was designated by U.S. Transportation Secretary Rodney E. Slater on October 11, 2000 as a high-speed rail corridor as part of the "Northern New England Corridor," with a hub at Boston and two spokes: one to Montreal, Quebec, Canada, via Concord, New Hampshire, and Montpelier, Vermont; and the other to Portland/Lewiston-Auburn, Maine. The BMHSR Corridor is shown with other corridors in Figure E.1.

[3] Ibid.

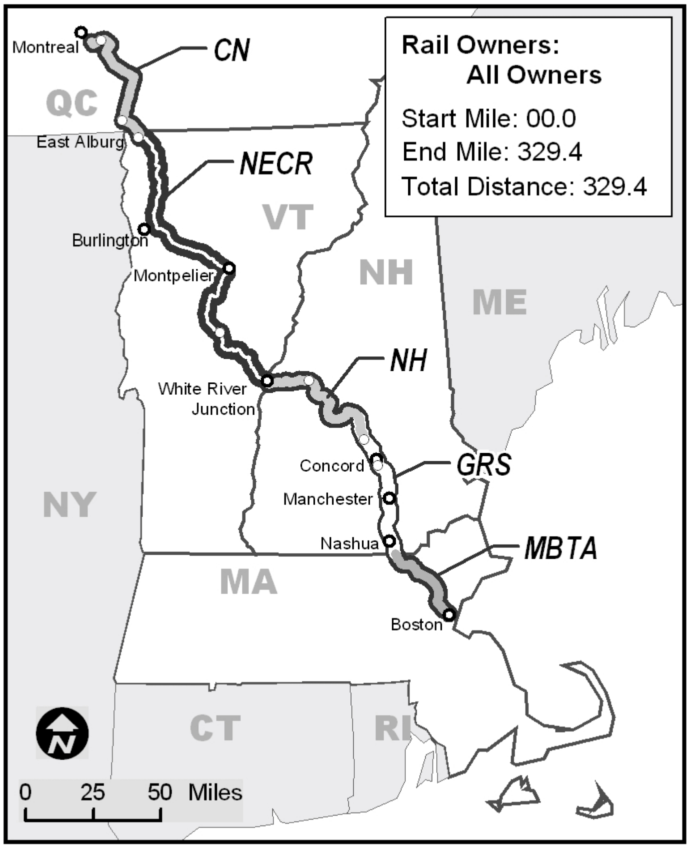
Figure E.1 - FRA High-Speed Rail Corridor Designations



Current Rail Services

The BMHSR Corridor is owned by the Canadian National Railroad (CN), New England Central Railroad (NECR), State of New Hampshire, Guilford Rail System (GRS), and the Massachusetts Bay Transportation Authority (MBTA) as shown in Figure E.2. Six railroads operate on right of way in the BMHSR Corridor: the Canadian National, New England Central Railroad, Claremont Concord Railroad (CCRR), New England Southern (NEGS), Guilford Rail System, and the Massachusetts Bay Transportation Authority. The majority of the segment owned by the State of New Hampshire is not operated. There are freight operations on all active corridor segments. Also, passenger services on the BMHSR Corridor include commuter rail operations serving Boston and Montreal, and intercity Amtrak service in Vermont from White River Junction to St. Albans and VIA Rail in the area of Montreal. The study team met with representatives from railway owners and operators of the proposed high-speed route to develop information concerning existing rail services on the proposed BMHSR Corridor. A detailed description of the current services provided by each operator is included in Chapter 2 of this report. As noted in the report, operators of the service in some segments of the BMHSR Corridor are not the owners of the railroad.

Figure E.2 – BMHSR Corridor Owners

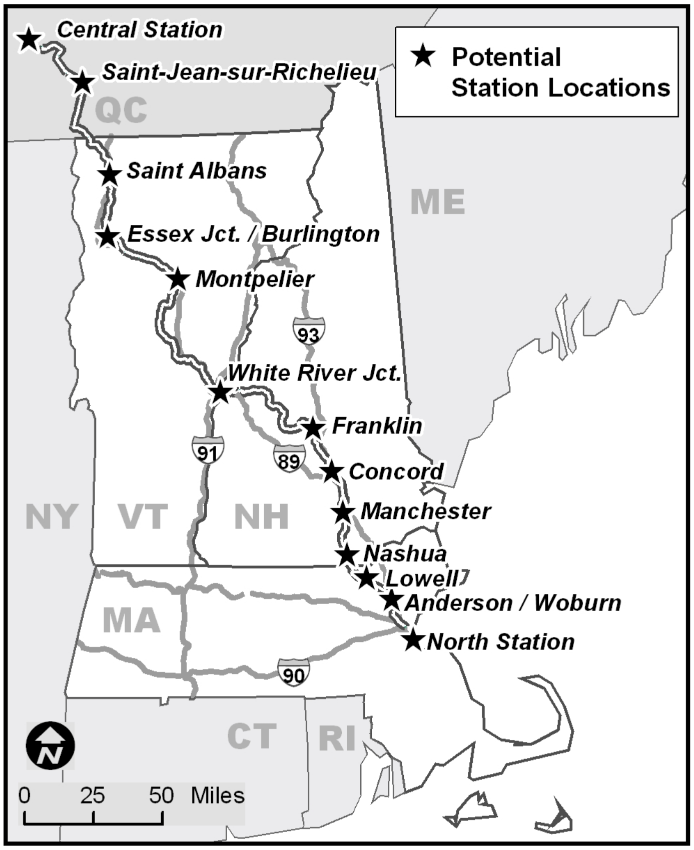


Stations

A passenger train station comprises a number of elements that support the arrival and departure of passengers utilizing a specific rail service. Principal elements include station platforms, station buildings, parking areas, pickup and drop off areas, and intermodal connections. How each of these elements are designed and implemented has a substantial impact on the experience of passengers.

Thirteen potential station service areas have been identified for conceptual service design. Spacing between station sites varies between seven and sixty miles. Primary stations are spaced on average 15 to 18 miles apart on the south end of the BMHSR Corridor and generally further apart on the north end. The criteria used to identify station service areas includes proximity to key population and employment centers, proximity to high growth areas and/or major tourism and recreational areas, potential to serve key travel markets or city pairs, accessibility by auto, connectivity to other modes (transit, air) and station spacing. Figure E.3 illustrates potential station locations.

Figure E.3 – Potential Station Locations



Terminal Stations

The two endpoint terminal stations of the BMHSR route are large multi-tracked stations in the Montreal and Boston downtown areas.

Central Station - Montreal

CN's Central Station in Montreal is a substantial subterranean rail passenger terminal with 19 tracks and 8 passenger platforms serving 16 tracks. The passenger concourse at street level is above the passenger platforms. A service concourse below the track level is used for automobile parking, baggage handling and logistics. No freight trains use this station.

North Station – Boston

Serving communities north of Boston, the MBTA-owned North Station provides rail service with ten tracks and five platforms. The MBTA uses the station to serve four different commuter rail lines. Amtrak uses the station for the southern terminus of its Downeaster service to Maine. On a normal weekday, 188 passenger trains serve North Station. No freight trains use this station. Currently North Station provides service for diesel locomotives only.

Track Configuration

Physical Characteristics

The 329-mile long corridor that connects Boston and Montreal is a composite of five different railroad properties. As part of Phase I of the Study, an initial inventory of the physical characteristics of the BMHSR Corridor was conducted. This effort was made to support development of travel time estimates. Detailed evaluation of the physical characteristics of the line will be made during Phase II of the study. Current right-of-way conditions that have impact on the potential feasibility of high-speed train operations include curvature, grade crossings, right-of-way width, and grades. Current track conditions are indicative of the opportunities and challenges associated with upgrading the track.

Track conditions vary from the MBTA's New Hampshire Main Line (Boston to Lowell), currently maintained at FRA Classes 3 and 4 (maximum passenger operating speed 60 mph and 80 mph, respectively), and a section of CN's St. Hyacinthe Sub maintained at the equivalent of FRA Class 6 (maximum passenger speed 110 mph), to sections of track operated at a maximum speed of 10 mph, or indeed, no track at all. It should be noted that since much of the line would require track and signal improvements, current track conditions are less important to the development of a high-speed rail operation than are other right-of-way characteristics such as curvature, grade crossings, right-of-way width, and grades.

Railroad-Highway Grade Crossings

Rail/highway crossings at-grade are a safety issue, especially at high train speeds. Conditions at each crossing must to be addressed individually. Options to provide adequate safety at the grade crossings include crossing elimination, grade separation, active warning systems and limiting speed.

Three hundred sixty (360) grade crossings have been identified on the BMHSR Corridor. The grade crossings are classified as public, private, and farm. The warning systems for the public crossings from Boscawen, New Hampshire to Lebanon, New Hampshire, where the tracks have been removed, have been either deactivated or removed. Virtually all the private and farm crossings have no active warning systems. Some are equipped with passive sign-type warning devices, but most have no warning devices. Many of the public crossings over active tracks have active warning systems, but are not equipped with gates.

■ E.3 Ridership Analysis

Overview

A train simulation model was developed to determine train travel times. A travel demand model was developed that utilized the train travel times and included mode choice analysis based on traveler preference surveys. These efforts enabled the development of ridership estimations for various scenarios. Each of these steps is outlined below.

Train Operations Planning and Modeling

A computer rail network simulation model of the study area for the BMHSR Corridor was developed to simulate anticipated train operations. The model was utilized to establish potential BMHSR trip times required to support the ridership forecasting.

The network simulation model for the study area between North Station in Boston and Central Station in Montreal was constructed using available track charts and timetable special instructions to replicate the physical characteristics of the infrastructure, including track distances, speeds, geometry, grades and curvature.

Three different infrastructure "case" characteristics were defined to test in the simulation model, as summarized below:

- Low Speed: Present alignment was utilized including existing track conditions, existing track geometry and existing timetable running speeds for passenger service on time respective lines. For the abandoned BMHSR Corridor segment between Concord, New Hampshire and White River Junction, Vermont, the last available published timetable was utilized. Maximum train speed is 60 mph. This would be similar to the existing Amtrak intercity service on the BMHSR Corridor.
- Mid Speed: FRA Class 6 with improved curve speeds: Present alignment was utilized with a 110 mph maximum speed with curve speeds restricted by track geometry. Non-geometric timetable speed restrictions were maintained. Existing grades were maintained
- High Speed: FRA Class 6 with no speed restrictions: A 110 mph maximum speed was utilized with no speed restrictions through curves. Existing grades were maintained.

An upper limit of 110 mph was identified to correlate with the likely maximum operating speed over the majority of the BMHSR Corridor. One reason for this is that for train speeds from 111 mph to 125 mph highway grade crossings must be either grade separated or have a sophisticated FRA-approved warning/barrier; and for speeds above 125 mph, no at-grade highway crossings, public or private, are permitted. Furthermore, the High Speed case requires that all restrictions for curves be eliminated. This approximates construction within a new and dedicated right of way such as was done for the French TGV train. As the BMHSR Corridor will utilize the existing right of way, it is deemed unlikely that all curve restrictions could be removed. Therefore, it is assumed that the Mid Speed case represents the maximum practical operating condition that could be obtained for the BMHSR Corridor.

Market Analysis

BMHSR Corridor Overview

The BMHSR Corridor is roughly equal in length to the Northeast Corridor between Boston and Philadelphia. The project's study area links key population centers of northern New England and connects the major economic centers of Boston and Montreal.

The BMHSR Corridor traverses three states: Massachusetts, New Hampshire and Vermont, and the southern part of Quebec. Combined, these states and the Montreal metropolitan area have a population of approximately 11.6 million people. In the U.S. portion of the BMHSR Corridor, the population is concentrated in the southern end of the corridor, close to the Boston area, declining in density as the distance from Boston increases, until Chittenden County (Burlington), another population center. Similarly, population in the Quebec province is concentrated in Montreal and its density decreases as the distance from the city increases.

BMHSR Corridor Travel Options

The travel options within the BMHSR Corridor can be broken down into essentially three modes: private automobiles, motor coach (bus), and airplane. Each of these modes offers trade-offs in the level of convenience, flexibility, or price.

Three U.S. border gates exist in the vicinity of the BMHSR Corridor: Champlain-Rouses Pt., New York, Highgate Springs, Vermont and Richford, Vermont. Over 2 million vehicle crossings occur annually at these three border crossings. Additional information regarding travel demand in the BMHSR Corridor is provided in Chapter 3 of this Study.

In the U.S., personal vehicles are used as the primary mode of transportation for eight out of 10 trips greater than 100 miles in length. In the U.S. BMHSR Corridor, however, this number increases to nearly 97 percent. Massachusetts had the highest use of modes other than automobile, with about 5 percent of long-distance trips being made by airplane, bus or train.

As a component of the travel demand model, four individual surveys were conducted within the BMHSR Corridor. Two surveys, one at the Hooksett tolls and the other at the Highgate Welcome Center near the Canadian border, targeted interstate automobile traffic. One survey focused on intercity bus passengers as they traveled in the BMHSR Corridor and a final survey was conducted at Logan Airport in Boston with airline passengers traveling to Montreal. The combined results of the surveys provided an overview of both typical traveler characteristics and stated preference with regard to service characteristics of current and potential travel modes in the BMHSR Corridor.

A key component in determining the feasibility of high-speed rail service from Boston to Montreal is the development of reliable forecasts for intercity rail travel in the BMHSR Corridor. For this Study, an integrated discrete choice model was developed to reliably predict ridership for a series of intercity rail alternatives. The projected ridership consists of both diverted trips (trips currently being made on other modes that would be made by rail if it were available) and induced trips (trips that will be made only if the proposed rail service is available).

Model Assumptions and Travel Times

The project steering committee reviewed seven alternative service scenarios to determine the potential ridership range of the BMHSR service. The scenarios utilized the three operating cases developed for the network simulation model for low speed, mid speed, and high-speed. The ridership model utilized information on the comparable costs and travel time for auto, air, and bus operations. The cost for auto was established at $0.12/mile. This cost has been used in similar studies and reflects the perceived cost for a motorist deciding to make a trip. The costs for air and bus, based on the current fares for travel between Boston and Montreal, were established at $0.31/mile and $0.14/mile, respectively. Round trips available per day for the air and bus service were assumed to be eight and six, respectively. The test fares for rail were selected based on the range of fares between existing regional lower speed intercity trains and new and existing high-speed trains. The actual rates would be set to optimize ridership and revenue that maximizes the benefits of the BMHSR Corridor. The detail fare analysis will be included in Phase II of the Study.

Currently, trains traveling between U.S. and Canada are required to stop at the border for customs and immigration inspections and clearance. Discussions with customs and immigration staff indicate that efforts are underway to improve and expedite the inspection and clearance procedures to enable trains to be operated without stopping at the border. Thus, the ridership modeling assumed that the trains would not be required to stop at the border.

Diverted and Induced Trips

Most of the projected trips within the BMHSR Corridor are diverted from other modes. That is, the trips would have occurred without the construction of the BMHSR but would have used another mode, in this case mainly automobile. Furthermore, each alternative also produces some additional induced trips that would be taken only with the availability of HSR. Forecasts of ridership for combined induced and diverted trips and revenues for each scenario were developed as shown in the Table E.1.

Table E.1 – 2025 Summary Table of BMHSR Ridership

	Low Speed	Mid Speed	Mid Speed High Fare	Mid Speed Low Frequency	Mid Speed All Stations	Mid Speed Low Fare	High Speed
Annual Ridership							
Total Corridor	213,276	446,710	330,097	86,962	588,630	683,667	644,232
Boston-Montreal	13,469	129,508	84,428	27,143	129,508	221,227	200,564
Annual Passenger Revenue							
Total Corridor	$4,784,504	27,893,059	22,559,907	5,724,020	32,291,348	34,614,601	59,062,561
Boston-Montreal	$744,341	11,619,093	8,739,297	2,434,820	11,619,093	15,271,257	24,917,799
Cost per Passenger-Mile (fare)							
HSR (Varies by scenario)	$0.16	$0.26	**$0.30**	$0.26	$0.26	**$0.20**	$0.36
Round trips per day							
HSR (Varies by scenario)	4	6	6	**2**	6	6	8
Number of Stations	12	8	8	8	**12**	8	6
Boston to Montreal Total Trip Time – Vehicle and Terminal (hours: mins)							
HSR (Varies by scenario)	8:55	5:48	5:48	5:48	5:48*	5:48	4:31
Air (Same all scenarios)	3:20	3:20	3:20	3:20	3:20	3:20	3:20
Bus (Same all scenarios)	6:20	6:20	6:20	6:20	6:20	6:20	6:20
Auto (Same all scenarios)	5:52	5:52	5:52	5:52	5:52	5:52	5:52

* Travel trip time was not increased to test only the sensitivity of number of stations stops at this level of the analysis

Summary of Results

The ridership forecasts predict that a significant number of riders would use the service. As noted above, the Mid Speed scenario represents the maximum practical operating condition that could be obtained for the BMHSR Corridor. Therefore, the results of the Mid Speed scenarios are of principal interest. The maximum ridership forecast of 683,667 was derived from the Mid Speed scenario with the lowest fare rate. In addition, the Mid Speed scenario with the lowest fare rate also realized the maximum revenue from fares of $34,614,601. Therefore, the results indicate that a competitively priced HSR service would have both the greatest ridership and the highest operating revenue.

E.4 Government and Policy Issues

The U. S. Secretary of Transportation has recently outlined the Administration's goals with respect to national intercity passenger rail services. Essentially, the emerging policy suggests that a national system should be regionally based, be shaped by market forces, and receive support of state government to meet operating costs that exceed revenue.

Thus, the multi-state and international structure of the BMHSR Corridor is reflective of this emerging policy as it is a state-led initiative, focused on regional connectivity. The response of the Quebec government that indicates support for the continuation of the Study to determine if the BMHSR service is feasible underscores the appropriateness of evaluating the BMHSR Corridor. Chapter 4 of this study identifies the federal and state laws that are applicable to the proposed BMHSR service. Environmental considerations, followed by more specific regulatory and permit issues, and U.S. and Canada customs and immigration regulations for border crossings, are assessed. Both U.S. and Canadian Customs and Immigration officials expressed optimism that new technology and new agreements would help to provide for safe, effective and efficient border crossing for train passengers. Therefore, the Study assumes that methods will be developed that will eliminate the need for stopping the BMHSR train at the border.

In future Study phases, site-specific issues related to environmental permitting, historic and archeological resources, will need to be addressed. International issues must also be considered in terms of both opportunity and challenge. However, the BMHSR Corridor has long served as a transportation corridor, and this current level of analysis indicates that all legal and regulatory requirements can be met.

E.5 Conclusion

Based on this initial assessment of existing operations, infrastructure, and institutional issues, and consideration of alternative service scenarios, it is concluded that, given the potential ridership of the BMHSR service, the further study of associated operational, engineering and cost/revenue factors is warranted.

The BMHSR Corridor would require substantial rail infrastructure improvements to support high-speed rail service. However, the service is expected to be compatible with existing and future passenger and freight rail operations. Further, an initial assessment of environmental and institutional issues indicates that with appropriate planning and design, environmental and institutional requirements can be satisfied.

Sufficient potential ridership and fare revenue exists to warrant the implementation of Phase II of the Study for evaluation of the operating and capital costs, and associated benefits, of implementing a high-speed rail service between Boston and Montreal.

1.0 Introduction and Background

1.1 Purpose of the Study

In late 2000 the Boston to Montreal rail route was designated as one of the nation's three new High Speed Rail Corridors by the Federal Railroad Administration (FRA). The designation was in response to a joint application by the states of Vermont, New Hampshire, and Massachusetts.

Designation of High Speed Rail (HSR) corridors has been established by the U.S. Federal Railroad Administration to facilitate planning for alternative travel modes in specific corridors. In the application letter to FRA, the potential for use of HSR to reduce congestion on major highway and air corridors within the Boston to Montreal High Speed Route (BMHSR) was cited as a principal reason to evaluate the feasibility of HSR service. As with any long term transportation project, planning and implementation requires a comprehensive series of steps to first determine the feasibility of a proposed transportation alternative and then, if appropriate, progress to implementation of a project. The feasibility analysis used for this study generally follows the methodology utilized in the *FRA Report High Speed Ground Transportation for America*, 1997 and in the publication *Railroad Corridor Transportation Plans, A Guidance Manual*, 2002.

The purpose of the Boston to Montreal High Speed Rail (BMHSR) Corridor Feasibility and Planning Study is to evaluate the Boston to Montreal High Speed Rail using appropriate methodologies to determine if a HSR service is feasible within the Boston to Montreal corridor.

1.2 Study Overview

The Boston to Montreal High Speed Rail Feasibility and Planning Study (Study) is managed by the Vermont Agency of Transportation (VTrans) through a cooperative agreement with the FRA and directed in partnership with the New Hampshire Department of Transportation (NHDOT), and the Massachusetts Executive Office of Transportation and Construction (EOTC). A steering committee comprised of representatives of the three partner States, the Quebec Ministry of Transportation and the City of Montreal, has provided oversight, direction and primary product review for the Study.

To address all the criteria needed to fully evaluate the feasibility of the BMHSR, the Study has been divided into two phases. This report documents the findings of Phase I of the Study. The scope of Phase I is to provide information on three primary tasks:

- Identification of institutional and policy issues,
- Development of primary preliminary service ridership projections, and
- Inventory of basic corridor infrastructure elements.

Phase II will study the remaining elements of High Speed Rail evaluation criteria. The remaining major items to be studied in Phase II include:

- Detailed operational analysis and planning,
- Assessment of alignment, infrastructure, and environmental requirements,
- Determination of projected capital and operation costs and revenue, and
- Comparison of benefits and costs.

The BMHSR Study was divided into two phases to allow initial consideration of institutional and policy issues, potential ridership forecasts, and the identification of basic corridor infrastructure elements. The objective of this approach was to assess if sufficient ridership potential exists to warrant additional study of train operations, revenue, and costs required for a HSR service. In addition, the investigation of institutional and policy issues during Phase I was intended to document potential fatal flaws to implementing a BMHSR service. The findings of Phase I were, therefore, intended to be that either the BMHSR service was not feasible in the foreseeable future, or sufficient evidence was developed to support progression to Phase II of the Study.

Included in Phase I Study efforts was the development and implementation of a significant public awareness program. The purpose of this program was to make individuals and public and private organizations aware of the objectives of the Study and the potential issues associated with the HSR service, and to seek input that would aid in identifying benefits and impacts for the potential HSR service. Activities included establishing a Study website, holding public meetings at the beginning and end of the Phase I Study, and holding two focus group meetings with representation from specific public and private interests.

In addition, key stakeholders associated with the BMHSR corridor and the Study were encouraged to provide input and direction. Key stakeholders included railroad owners and operators, current bus operators within the corridor, local and regional planning organizations, environmental contacts, and representatives of US state, and federal agencies, as well as appropriate Quebec agencies. To facilitate the involvement of key stakeholders, a day-long partnering session was held at the beginning of the Study that promoted candid discussion of project goals, objectives, and issues. This early contact with groups directly involved with or potentially affected by the BMHSR service enabled the Study team to clearly focus on the key issues of the Study. Prior to completion of

Phase I, a second partnering session with the key stakeholders was held to inform them of the study findings, and to receive their input and comments.

1.3 Description & Definition of High Speed Rail

High Speed Rail is often described as a subset of the more general term, High Speed Ground Transportation (HSGT). HSGT has been documented most thoroughly in a Federal Railroad Administration (FRA) report, "High Speed Ground Transportation for America."[1] According to the report, HSGT can be defined in terms of travel market and performance characteristics as:

> "…a self-guided intercity passenger ground transportation – by steel-wheel railroad or magnetic levitation (Maglev) – that is time-competitive with air and/or auto for travel markets in the approximate range of 100 to 500 miles."[2]

This is a market-based, not a speed based definition. However, to provide competitive travel times, high-speed trains must operate at maximum speeds that provide an average speed that corresponds to competitive travel times. When considering if a rail route could qualify for designation as a high-speed corridor, the Secretary of Transportation is required to consider whether railroad speeds of 90 miles per hour or more are occurring or can reasonably be expected to occur in the future. For the BMHSR it is anticipated that speeds within segments of the corridor in excess of 90 mph would be possible. This assumption was utilized in developing estimated trip times used to support development of the ridership forecasts projected in Chapter 3. The specific analysis of operations, including development of operating speed limits, will be included in Phase II of the Study.

Types of High Speed Rail Corridors

Most individuals, when asked how they would define HSR, would typically include the maximum speed of the train in the definition. Many people would respond that HSR means speeds in excess of 90, 150 or over 200 mph. Interestingly, each answer could be considered correct using the HSGT definition. For HSR to be competitive with air and auto travel in a specific transportation corridor, however, the maximum train speed can be significantly lower than the higher speeds normally associated with HSR corridors. To illustrate this point it is helpful to understand the types of systems in use or being considered for use today.

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[1] U.S. Department of Transportation, September 1997.

[2] Ibid.

- **Accelerail** is the term coined by the U.S. Department of Transportation in its 1997 study of high-speed ground transportation, referenced above for the lower-speed end of the technology spectrum. Recently, **Incremental High-Speed Rail** has been utilized to describe this type of HSR service. Within the Incremental High-Speed Rail category is a range of both non-electrified and electrified systems capable of between 90 to 150 mph top speeds.

Typical Incremental High-Speed Rail type systems include tilt trains such as the X-2000 in Sweden, Talgo in Spain, Pendolino in Italy and Acela in the U.S. Northeast Corridor. Examples of non-tilt trains in this category are the Amtrak Turboliners, in service between New York City and Albany and the British InterCity 125 in the U.K.

- **New HSR** represents advanced steel-wheel-on-rail passenger systems generally on new, dedicated rights-of-way. Through a combination of electrification and other advanced components, expeditious alignments, and state-of-the-art rolling stock, New HSR can attain maximum practical operating speeds on the order of 200 mph. Prominent examples of New HSR include the French TGV, the Japanese Shinkansen, and the German Intercity Express.

- **Maglev** is an advanced transport technology in which magnetic forces lift, propel, and guide a vehicle over a specially designed guideway. Utilizing state-of-the-art electric power and control systems, this configuration eliminates the need for wheels and many other mechanical parts, thereby minimizing resistance and permitting excellent acceleration, with cruising speeds on the order of 300 mph or more. This high performance would enable Maglev to provide air-competitive trip times at longer trip distances than other HSR options. The first commercial application between of Maglev between Pudong Airport and Shanghai, China is scheduled to begin operations in 2003. Germany has a Maglev technology ready for commercial introduction (Transrapid) and Japan has a competing and technologically different system under test.

As the BMHSR corridor would require accommodation of both freight and passenger train operation, the service in the corridor would likely be an Incremental High-Speed Rail type of service.

1.4 History of High Speed Ground Transportation in the U.S.

In the United States, interest in High Speed Ground Transportation has resulted in various federal and state government programs and policies since the 1960s. Federal support for High Speed Ground Transportation began with the passage in 1965 of the High Speed Ground Transportation Act. Originally authorized for $90 million in federal funding, the act resulted in the development and demonstration of various HSGT technologies, most notably the 1969 introduction of self-propelled Metroliner cars and the Turbotrain in service along the Northeast Corridor between Washington, D.C. and New York City. Passage of the Rail Passenger Service Act in 1970 created Amtrak which thus became the operator of Metroliner service between Washington and New York City.

Beginning in the 1970's, federal efforts in support of HSGT also resulted in improved rail infrastructure between Washington and New York. Improvements included track reconstruction, new signal and control systems, elimination of many highway/railroad grade crossings and maintenance-of-equipment facilities, improvements to stations, and bridge replacement and repair.[3]

Government interest in the 1980's resulted in both federal studies of potential HSGT corridors, as well as the formation of several high speed rail entities in individual states. At the federal level, the Passenger Railroad Rebuilding Act of 1980 included funding authority for engineering and design studies, which resulted in Seven HSGT analyses in various corridors. Several states such as California, Florida, Texas, and Ohio formed authorities or agencies to investigate the feasibility of developing High Speed Rail networks between their major cities.

In the 1990's, interest in HSGT included continued efforts by states such as California and New York to improve HSGT planning and implementation. By the end of the decade, 15 states had passed enabling legislation facilitating HSGT activities. Additionally, federal interest has included further investigation of Maglev technology and demonstration projects.

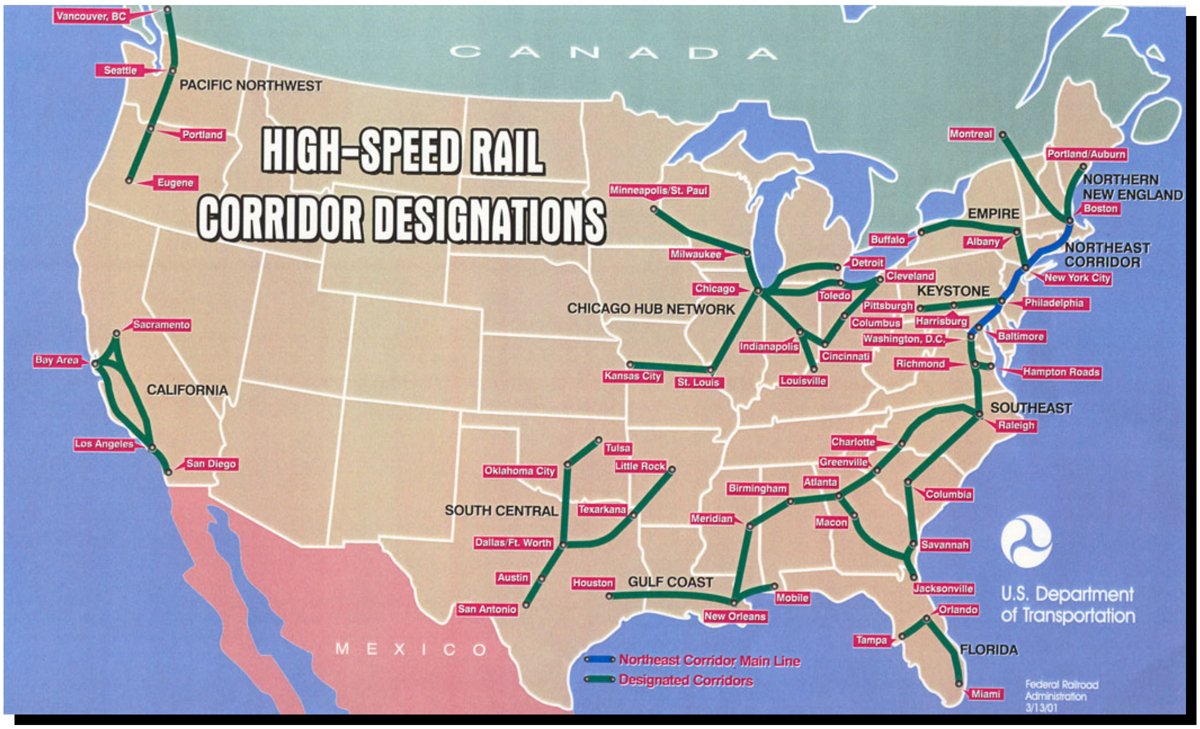
1.5 Designated High Speed Rail Corridors

The FRA has designated high-speed corridors under section 1010 of the Intermodal Surface Transportation Act of 1991 (ISTEA) and Section 1103(c) of the Transportation Efficiency Act for the 21st Century of 1998 (TEA-21). The designation allows owners and operators of the corridors to receive specially targeted funding for highway-rail grade

[3] U.S. Department of Transportation, September 1997. Reference Publication.

crossing safety improvements, and recognizes the corridor as a potential focus of HSR activity. The Boston to Montreal High Speed Rail (BMHSR) Corridor was designated by U.S. Transportation Secretary Rodney E. Slater on October 11, 2000 as a high speed rail corridor as part of the "Northern New England Corridor," with a hub at Boston and two spokes: one to Montreal P.Q. Canada, via Concord, New Hampshire, and Montpelier, Vermont; and the other to Portland/Lewiston-Auburn, Maine. The BMHSR corridor is shown with other corridors in Figure 1.1.

Figure 1.1 – FRA High Speed Rail Corridor Designations

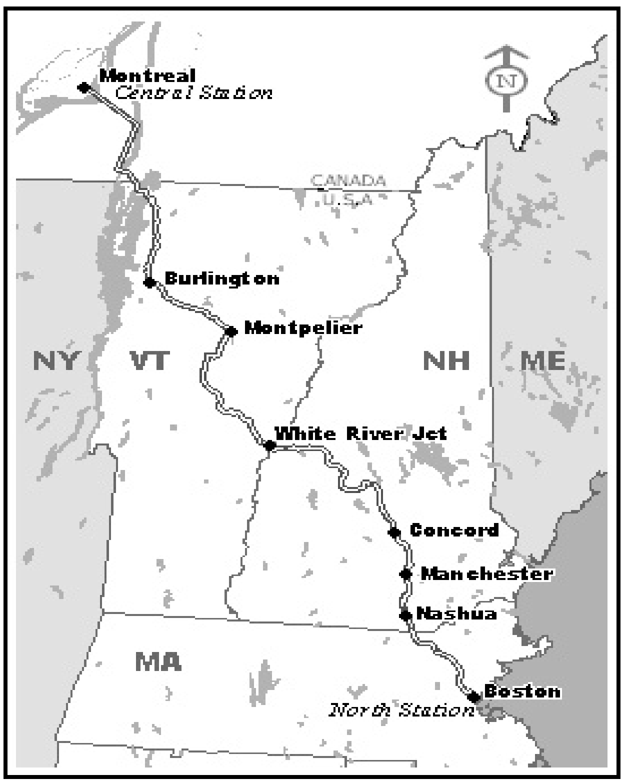


1.6 History of the Boston to Montreal Corridor

The Boston to Montreal railroad corridor dates back to the mid-nineteenth century. The combined facilities of the Canadian National, Central Vermont, and Boston & Maine systems were utilized to provide "through" passenger services between Boston and Montreal, whereby passengers could travel without having to change trains at connecting points. As early as 1852, Boston-Montreal passenger services were advertised using the combined systems. Two daily trains, named the "Ambassador" and the "New Englander," continued to operate over this route until the early 1960's. Comparable Boston-Montreal service was also provided by a Boston & Maine – Canadian Pacific joint operation via Wells River, Vermont.

The connection from Montreal to the US border at East Alburg, VT was provided via Canadian National railroad subsidiary, the Canada Atlantic Railroad. Beginning in the 1840s, the Central Vermont Railway developed an extensive network of rail lines, notably throughout Vermont and southeastern Canada. In 1899, as a consequence of bankruptcy, the Central Vermont railway became a subsidiary of the Canadian National Railroad. In Vermont, the BMHSR route utilizes the tracks of the New England Central Railroad from East Alburg to St. Albans through Essex Junction and Montpelier Junction and to White River Junction. The New England Central is the recent successor to the Central Vermont Railway. In 1994 the Canadian National placed the Central Vermont railway up for sale. A short-line railroad holding company, RailTex, purchased the Central Vermont Railway and continued operations as the New England Central Railroad. RailTex was, in turn, purchased by a holding company named Rail America. The New England Central Railroad continues to operate as a key freight route, with traffic composed primarily of paper, lumber, grain, cement, and LP gas, much of which crosses the international border.

Figure 1.2 – BMHSR Corridor Map



From White River Junction into New Hampshire and Massachusetts, BMHSR follows the former Boston & Maine's New Hampshire Main Line. The portion of the route between Boston's North Station and Lowell has its origins in the Boston & Lowell Railroad founded in 1835. From Lowell, through Nashua and Concord to White River Junction, the route traces its origins to the predecessors of the Boston & Maine Railroad's New Hampshire Main Line. Railroad operations on the rail line between Lowell and Nashua began in 1838, and by 1848 a second main-line track was added along its entire length to Manchester. Operations were extended to the Vermont/New Hampshire border at White River Junction in 1847.

Passenger service on the 70-mile segment between White River Junction and Concord was discontinued in 1965. Freight service continued to be operated over this segment until 1982. Guilford Rail System (GRS) obtained permission to abandon approximately 60 miles of this segment between West Lebanon and Boscawen in 1992. When it sold the line to the state of New Hampshire in 1995, GRS retained ownership of the track and began removing it in 1996. In 1999, GRS sold the remaining 2.5-mile section between White River Junction and West Lebanon to the state of New Hampshire. In May of 2000 the Claremont Concord Railroad (CCRR) entered into an agreement to operate this section for a period of ten years. The CCRR has begun using the Westboro Yard and anticipates shipping aggregate materials on the line.

From Concord, south to the Massachusetts-New Hampshire border the rail line remains in ownership by GRS. The railroad line has served both passenger and freight services throughout its history. Passenger service north of Lowell to Concord was discontinued in 1967; and by then one of the two main-line railroad tracks had already been removed between Concord and North Chelmsford. In Massachusetts, the Massachusetts Bay Transportation Authority (MBTA) owns the railroad right-of-way from the New Hampshire state line to North Station. The MBTA operates commuter rail service along the corridor from the Gallagher Transportation Terminal in Lowell to North Station in Boston. This service includes stops at eight stations: Lowell, North Billerica, Wilmington, Anderson Regional Transportation Center, Mishawum, Winchester Center, Wedgemere, and West Medford. The NHDOT is planning a Nashua to Lowell Commuter Rail Extension project which includes the replacement of the removed second track, and a rail bed and signal system upgrade to both tracks to provide commuter rail service with a maximum operating speed of 59 mph. The distance between the proposed station location near the Everett Turnpike Exit 1 in Nashua and the Lowell station is 10.5 miles. Service is proposed to begin in 2005.

On September 29, 1972, Amtrak inaugurated operation of a New York – Montreal passenger train named "The Montrealer" over the tracks of the then Central Vermont Railway. The service was suspended during 1987-1989 to permit repairs to deteriorated sections of track. Service resumed in 1989 until Amtrak budget cuts forced its suspension on April 1, 1995. The next day, the currently operated and state of Vermont-subsidized "Vermonter" commenced operations from New York through Springfield and Palmer, MA, then traveling up the eastern side of Vermont to White River Junction. The "Vermonter" then continues on the BMHSR route to a terminus at St. Albans. Passengers traveling further north into Quebec, Canada continue to be provided with bus connections.

1.7 Public Involvement and Outreach

The project team sought to inform and involve the public in the BMHSR Study on several levels. News of the Study was broadcast on television and radio, an interactive website was established and many stories ran in newspapers in Massachusetts, New Hampshire, Vermont, and Canada. The public had an opportunity to learn more about the Study and share their views through a series of public meetings. More intensive dialogue and discussion were possible through focus groups and a partnering workshop with key stakeholders.

This approach disseminated information to a wide audience in the three participating states, while targeting groups and individuals with an interest in rail for more focused discussion. This resulted in a high level of awareness of the project among stakeholders and the media. Many people followed the progress of the Study by checking the BMHSR Corridor website. As a result, as Phase I drew to a close, the Study team fielded many inquiries from the press and public anxious to know what was learned in the Study.

Public Informational Meetings

At the outset of the project, a series of public meetings was held to both announce the beginning of the Study and to give the public an opportunity to share their views and ask questions about what the Study would entail. Meetings were held during February 2002 in Lowell, Massachusetts, Concord, New Hampshire, and Montpelier, Vermont. Attendance ranged from 30-60 participants per meeting. People who attended the public forums were largely interested in rail as an alternative mode of transportation or as a stimulus to tourism and economic development.

Discussion at the public meetings was lively and people were encouraged to ask questions and make comments during the meetings. Some common themes emerged:

- There was general overall support for the development of the BMHSR corridor.
- Feasibility should be defined to consider economic and social impacts to the region from high speed rail, not just the number of tickets that can be sold.
- Connectivity to other transportation services is important, including regional airports, bus and other rail services.
- Minimizing delays at customs on the US/Canadian border should be a priority.
- Flexibility was desired to serve many needs. Ideas to meet potential needs included equipping trains to store bicycles and skis, providing rail service between intermediate cities without making the complete Boston to Montreal run.
- Understanding the positive and negative impacts on freight service in the corridor.

A second round of public meetings was held at the conclusion of Phase I in November 2002 in Lowell, Concord, Montpelier, and Montreal. Attendance at these meetings ranged from 30 to 70 people. Each meeting began with a formal presentation, followed by a question and answer session. People attending the public meetings had similar questions and comments including:

- Can a high speed rail service be implemented in a phased approach, installing one segment at a time?
- How many station stops will there be?
- Who would operate the service?
- Will the service share the line with freight?
- How many trains a day will there be?
- Will it help tourism, the major industry of New England? Will enhanced freight infrastructure attract businesses?
- When looking at subsidies for high speed rail, the government should apply the same subsidy for all modes of transportation – airline, automobile, etc.
- High speed rail ridership should not be viewed as the only benefit of this system, additional system benefits should be considered.

Partnering Workshops

To build good communication and understanding of the HSR Study, two partnering meetings were held. Key stakeholders such as railroad and bus company operators, regional planning agencies, transit agencies, representative of rails to trails programs, the Federal Railroad Administration and state Department of Transportation officials from the partnering states were invited.

The initial meeting was held in January 2002, with 30 participants. The group identified objectives, agency/stakeholder responsibilities, issues and impacts of a high speed rail corridor. Through a brainstorming process, three topics were selected for further discussion in break out groups. They were:

- What are the impacts?
- What are the critical success factors for BMHSR?
- What are the issues for protecting/enhancing existing investment in transportation infrastructure?

Partnering workshop stakeholders, realizing the potential importance of the project to regional mobility committed to working together to study the corridor by signing an agreement. It said that the partners agree "to the principles of honesty, trust, professionalism and open communication." In addition, the partners committed themselves to the following principles:

- Full cooperation and communication with key stakeholders and local communities,
- A proactive approach,
- Thorough identification of potential positive and negative project impacts.

A second partnering workshop was held in November 2002 in Concord, New Hampshire near the conclusion of Phase I to share the findings of the Study. Discussion centered on the details of the report, especially the ridership model. The group recommended the Study more thoroughly examine economic and environmental benefits of a high speed rail service and develop more information on who might use segments of the service rather than looking solely at the feasibility of the whole route.

Focus Groups

In May 2002, focus groups were held in Nashua, New Hampshire and South Burlington, Vermont. While each meeting provided an opportunity to inform participants about the BMHSR Study, the primary purpose was to listen to the views of participants. Unlike the partnering workshop, whose participants were heavily involved in the transportation business within the BMHSR corridor, many of the people who attended the focus groups were involved in the tourism industry or interested in economic development issues and opportunities. Discussion in these groups centered on consumer amenities, such as good food, comfortable seating and bathrooms, storage capacity for bicycles, skis and travel gear, as well as the need for convenient stops, schedules and connectivity to other transportation facilities. Concerns were also raised about whether adequate funding would be provided for BMHSR.

Project Website

To reach a wide audience and provide a vehicle for the public to keep abreast of the Study's activities, a website, www.bostonmontrealhsr.org, was developed at the beginning of the Study in January 2002. The website communicated the vision of the project and provided an effective means of communicating with and soliciting feedback from the public. The site provided a source of study documents, information on high speed rail systems developed internationally, as well as news on other HSR corridors in the United States. Minutes of the focus groups and public meetings, accompanied by photos, were also posted on the website.

The website was designed for two-way communication. The public could write messages, register for e-mail updates on project status, or receive notification of upcoming meetings, as well as ask questions about the project. All questions were responded to by the project team.

The first month the website was available it received approximately 2,000 visits. This level of website activity has been consistently maintained throughout the course of the Study. People who attended the public informational meetings praised the website for both its graphic presentation of information and its content.

Media Interest in Study

The BMHSR Study generated significant media attention. It has been reported on in the *Boston Globe, Boston Herald, Lowell Sun (*Lowell, Massachusetts*), Manchester Union Leader* (Manchester, New Hampshire) *The Telegraph* (Nashua, New Hampshire), *Foster's Daily Democrat* (Dover, New Hampshire), *Times Argus* (Rutland, Vermont), the *Andover Beacon* (Andover, New Hampshire) *and La Presse and Le Devoir* (Montreal, Quebec). Some of the stories were featured in prime locations, including popular transportation columns or the newspaper's front page. The New Hampshire public meeting in Concord was telecast on the evening news and was recorded by New Hampshire Public Radio. The Vermont public meeting received news coverage by two television stations, including one based in Plattsburg, New York. Interviews with Vermont Public Radio and distribution of stories by the Associated Press to local newspapers spread news of the BMHSR Study throughout northern New England.

Future Public Involvement

Subsequent study of the BMHSR corridor can build on a solid base of public awareness and involvement established in Phase I. An extensive database of transportation organizations and officials, regional planners, rail advocates, economic development and tourism agencies as well as interested members of the public has been developed. Additionally, media resources and contact people in Massachusetts, New Hampshire, Vermont, and Quebec have been identified, which will enable efficient and extensive distribution of information on high speed rail in the future.

2.0 BMHSR Corridor Overview

This chapter provides an overview of the BMHSR Corridor, and documentation on the existing BMHSR Corridor as shown on the system map in Figure 2.1. The length of the BMHSR Corridor is approximately 329.4 miles, roughly equal to the Northeast high rail corridor between Boston, MA and Philadelphia, PA. The proposed BMHSR Corridor travels along existing rail rights-of-way from Boston, north to Nashua, NH and up through Manchester to Concord, then turns northwesterly following the former Boston & Maine, Northern Line from Concord to West Lebanon, NH. It crosses the Connecticut River into VT at White River Junction and travels northwesterly to Montpelier, Burlington and St. Albans, Vermont, linking with the Canadian National railroad at Alburg, VT. From Alburg, the line travels the final 65 miles to Central Station in Montreal, Quebec. The existing owners of the rail corridor are:

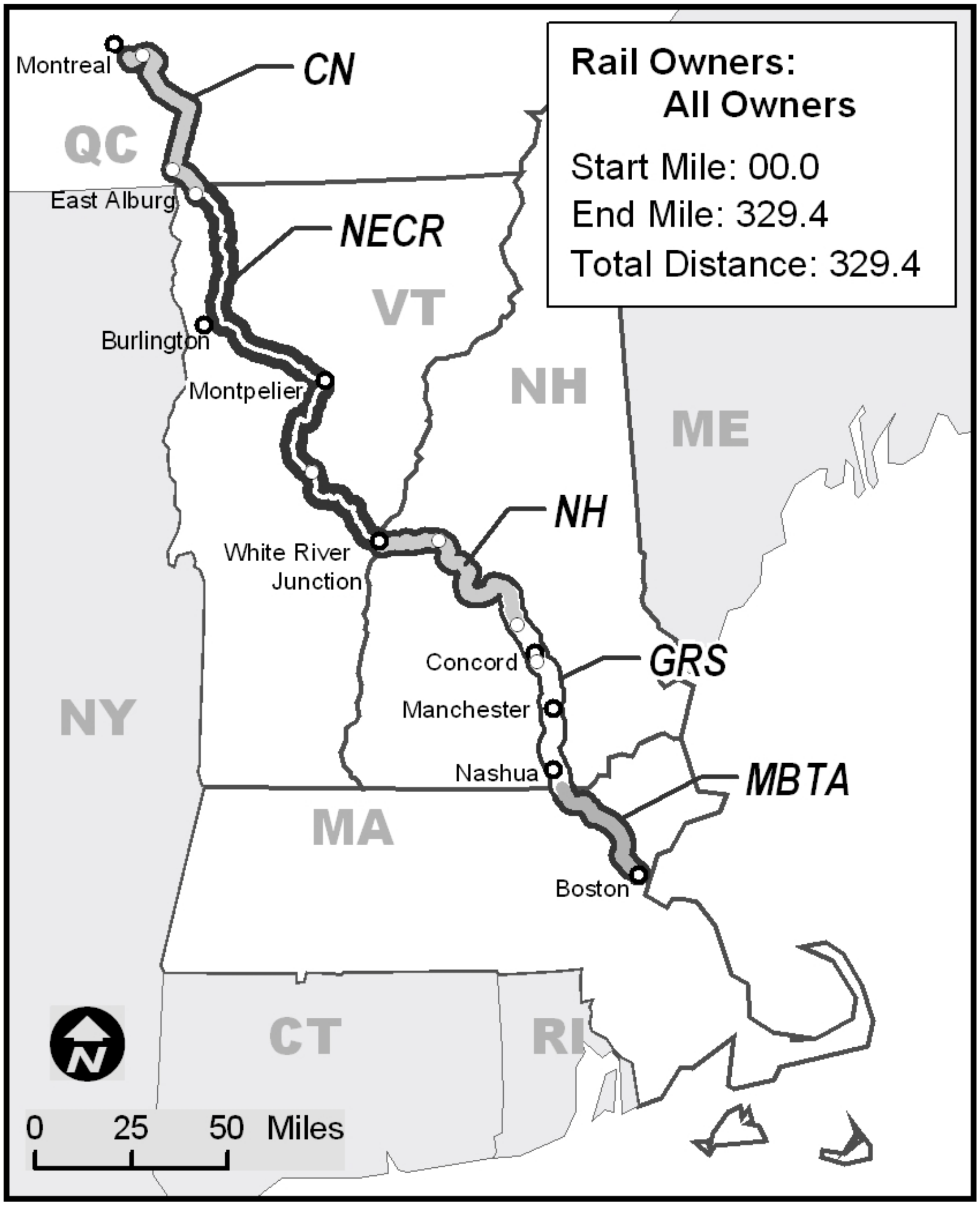
- Canadian National Railroad (CN),
- New England Central Railroad (NECR),
- State of New Hampshire (NH),
- Guilford Rail System (GRS), and
- Massachusetts Bay Transportation Authority (MBTA).

Additional railroad operators on the BMHSR Corridor include:

- Claremont Concord Railroad (CCRR)
- New England Southern (NEGS).

Specific discussion of the additional railroad operators is included in following sections of this chapter.

Figure 2.1 – BMHSR Corridor



2.1 Historic and Current Use of the Right of Way

Historic Passenger Service Overview

To provide an overview of the history of passenger rail service between Boston and Montreal, information on service levels was obtained for the years 1910, 1926, and 1961. Boston and Maine Railroad (B&M) and CN rail service between Montreal and Boston using the old Central Vermont (CV) line[1] offered three trains in each direction in 1910 and 1926. By 1961 service was reduced to one roundtrip a day. In 1910 and 1926 the 329 mile trip was scheduled to take 10:39 to 11:55 hours depending upon time of day. In 1961 the number of stops and connections on the route was reduced, cutting the overall travel time to approximately 8:30. In 1961 the train averaged 39 miles per hour from Boston to Montreal. Tables 2.1 through 2.3 illustrate the Montreal and Boston train services provided on the BMHSR Corridor in 1910, 1926, and 1961.

Table 2.1 – Boston-Montreal 1910 Service Schedule

Northbound	**5**	**3**	**1**	**Southbound**	**2**	**8**	**6**
Service	m-sa	daily	daily	Service	daily	m-sa	Daily
Boston	9:00	11:30	19:30	Montreal	8:31		20:10
Lowell	9:41	12:09	20:10	St. Jean	9:17		21:05
Nashua	10:05	12:33	20:37	lve. St. Albans	10:39	7:00	22:42
Manchester	10:31	13:00	21:05	arr. White River Jct.	14:20	11:35	3:10
Concord	11:08	13:35	21:50	lve. White River Jct.	14:40		3:35
arr. White River Jct.	13:30	16:10	0:20	Concord	17:08	14:30	6:00
lve. White River Jct.	13:45	16:30	0:40	Manchester	17:36	15:02	6:27
lve. St. Albans	18:35	20:10	5:20	Nashua	18:01	15:33	6:55
St. Jean	19:50	21:20	6:35	Lowell	18:27	15:57	7:19
Montreal	20:40	22:10	7:25	Boston	19:10	16:40	8:05
Travel Time (HH:MM)	11:40	11:35	11:55	Travel Time (HH:MM)	10:39	9:40	11:55
Service Velocity (mph)	28	28	27	Service Velocity (mph)	31	34	27

Source: The Official Guide of the Railways and Steam Navigation Lines of the United States. Allen, W.F. The National Railway Publication Company, Publishers and Proprietors. New York. January 1910.

[1] An alternate route between Boston and Montreal was also once operated via a Canadian Pacific Railroad connection to the Boston and Maine at Wells River Vermont. Information on that route is not reported in this document.

Table 2.2 – Boston to Montreal 1926 Service Schedule

Northbound	307	325	3003	Southbound	302	320	332
Service	m-sa	daily	su	Service	daily	m-sa	Daily
Boston	9:00	20:00	10:30	Montreal	20:25		8:35
Lowell	9:41	20:43	11:10	St. Jean	21:18		9:25
Nashua	10:06	21:11	11:35	St. Albans	22:40	7:00	10:50
Manchester	10:35	21:40	12:02	Arr. White River Jct.	2:23	11:28	14:22
Concord	11:15	22:20	12:37	Lve. White River Jct.	2:40	11:45	14:45
arr. White River Jct.	13:55	1:00	14:50	Concord	4:43	14:20	17:22
lve. White River Jct.	14:40	1:24	15:10	Manchester	5:15	14:58	17:56
St. Albans	18:30	5:13	19:08	Nashua	5:43	15:33	18:25
St. Jean	20:02	6:40	20:42	Lowell	6:10	16:00	18:51
Montreal	20:55	7:35	21:40	Boston	7:03	16:45	19:37
Travel Time (HH:MM)	11:55	11:35	11:10	Travel Time (HH:MM)	10:38	9:45	11:02
Service Velocity (mph)	27	28	29	Service Velocity (mph)	31	33	29

Source: The Official Guide of the Railways and Steam Navigation Lines of the United States. Allen, E.S. The National Railway Publication Company, Publishers and Proprietors. New York. February 1926.

Table 2.3 – Boston to Montreal 1961 Service Schedule

Northbound	75	Southbound	76
Service	daily	Service	daily
Boston	12:45	Montreal	10:50
White River Jct.	16:15	St. Albans	12:48
Montpelier Jct.	17:43	Essex Jct.	13:24
Essex Jct.	18:31	Montpelier Jct.	14:14
St. Albans	19:07	White River Jct.	15:45
Montreal	21:05	Boston	19:30
Travel Time (HH:MM)	8:20	Travel Time (HH:MM)	8:40
Service Velocity (mph)	39	Service Velocity (mph)	38

Source: B&M Passenger Train Schedules Gallagher, G.F. Boston & Maine. Boston. July 1961.

Through passenger service was discontinued by 1967. With the exception of a one-year demonstration service operated by the Boston and Maine between Concord and Boston in 1980, no passenger service on the route in New Hampshire has run in more than 30 years.

Current Rail Services on ROW

There are several existing rail services that operate along the BMHSR Corridor. The Study team met with representatives from railway owners/users of the proposed high-speed service to develop information concerning existing rail services on the proposed BMHSR Corridor. A description of the current services is provided below for each operating segment. As noted in the descriptions, operators of the service in some segments of the

BMHSR Corridor are not the owners of the railroad. A summary of miles operated and owned is provided in Table 2.4 and Table 2.5 respectively.

Table 2.4 – BMHSR Corridor Mileage by Operator

Railroad Operator	From Station	Corridor Mile	To Station	Corridor Mile	Mileage Operated
CN	Montreal	329.4	East Alburg	275.9	53.5
NECR	East Alburg	275.9	White River Junction	142.9	133.0
CCRR	White River Junction	142.9	Westboro	139.9	3.0
N/A	Westboro	139.9	Boscawen	82.7	0.0
NEGS	Boscawen	82.7	Bow	71.3	11.4
GRS	Bow	71.3	Lowell	25.5	45.8
MBTA	Lowell	25.5	Boston	0.0	25.5
TOTAL					272.2

Table 2.5 – BMHSR Corridor Mileage by Owner

Railroad Owned	From Station	Corridor Mile	To Station	Corridor Mile	Mileage Owned
CN	Montreal	329.4	East Alburg	275.9	53.5
NECR	East Alburg	275.9	White River Junction	142.9	133.0
NH	White River Junction	142.9	Boscawen	82.7	60.2
GRS	Boscawen	82.7	MA/NH Border	34.5	48.2
MBTA	MA/NH Border	34.5	Boston	0.0	34.5
TOTAL					329.4

Canadian National (CN)

The BMHSR Corridor segment within Canada and in the U.S. to East Alburg is owned and operated by Canadian National Railroad (CN), as shown in Figure 2.2 and Table 2.6. The 50.5 miles of track of the BMHSR Corridor operated by CN serves both passenger and freight service. Because the operating conditions vary along the CN portion of the BMHSR Corridor, it is useful to consider the CN segment of the BMHSR Corridor in four sub-segments: Central Station (or Gare Centrale) to Cape, Cape to Cannon, Cannon to Cantic, and Cantic to the East Alburg, VT.

Figure 2.2 – Canadian National Railroad

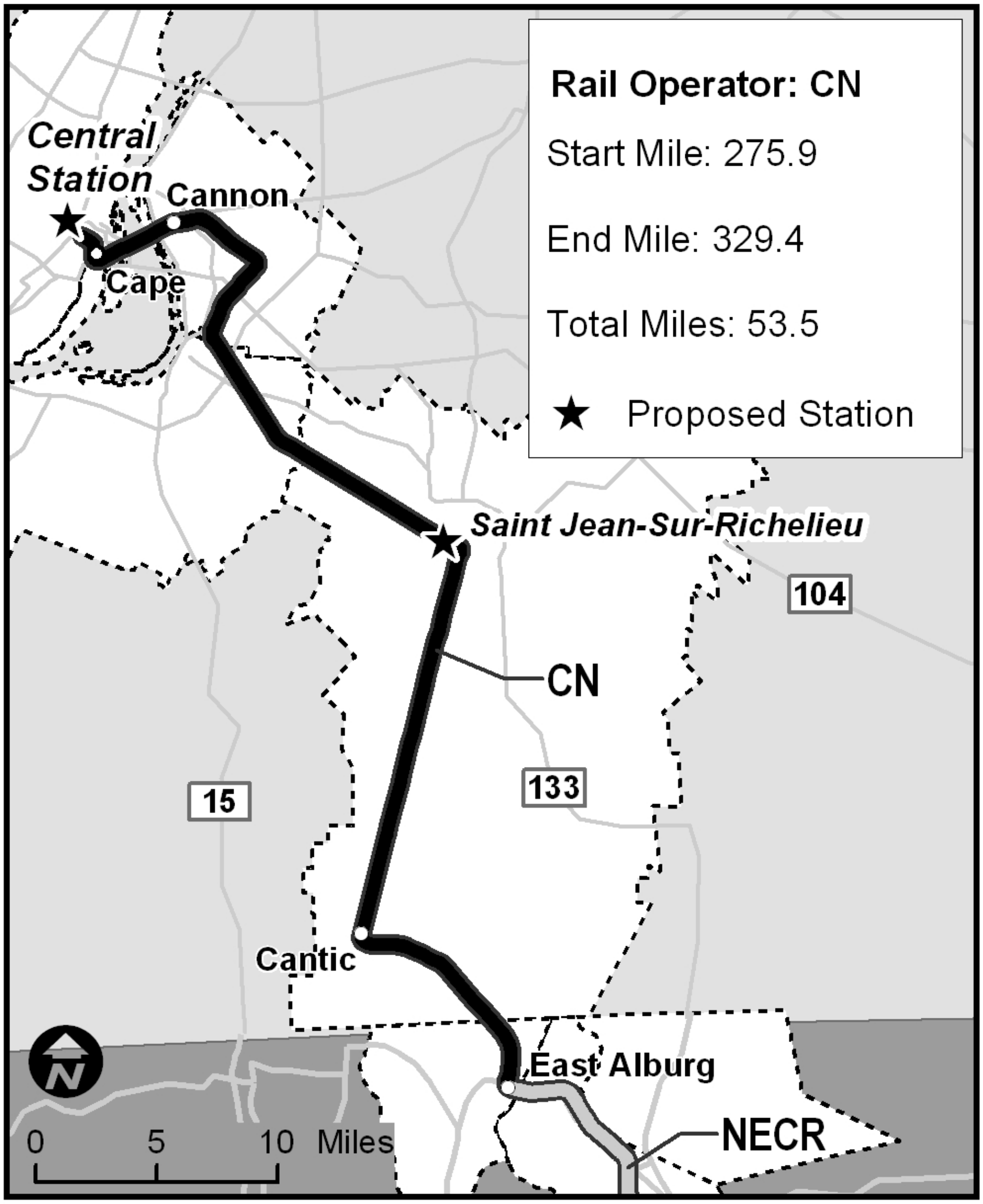


Table 2.6 – Locations Operated by CN

Railroad	Subdivision	Location	Distance to Boston	Distance to Montreal	Current Passenger Speed Limit (mph)
CN	Montreal	Central	329.4	0.0	10
CN	Montreal	Wellington	328.5	0.9	20
CN	Montreal	Cape	328.4	1.0	30
CN	Saint Hyacinthe	Rue Bridge	327.7	1.7	30
CN	Saint Hyacinthe	Pont Victoria	326.8	2.6	20
CN	Saint Hyacinthe	Saint-Lambert	325.4	4.0	30
CN	Saint Hyacinthe	Cannon	323.2	6.2	60-90
CN	Rouses Point	Castle	320.4	9.0	50
CN	Rouses Point	Brossard	316.8	12.6	50
CN	Rouses Point	Lacadie	309.3	20.1	50
CN	Rouses Point	Saint-Jean	302.7	26.7	50
CN	Rouses Point	Cantic (U.S. Border)	278.9	50.5	50
CN	Rouses Point	East Alburg, VT	275.9	53.5	25

Note: Some speed restrictions exist on the right of way. For example, at Cannon speeds are reduced to 60 mph.

The 5.2 mile segment between Cape and Cannon is a segment of CN's mainline to Eastern Quebec and the Maritimes. The segment between Cape and Cannon typically handles 20 passenger trains and 25 to 30 freight trains per day.

Between Central Station and Cape the subdivision handles Amtrak and VIA Rail (VIA) intercity passenger trains serving Montreal. Within Canada, intercity trains are operated by VIA. The subdivision also handles commuter service to Mont-Saint-Hilaire and numerous passenger-switching movements. No freight movements are typically operated over this short one-mile segment of the BMHSR Corridor.

The passenger traffic also includes VIA intercity service to Toronto, Ottawa, Quebec City, New York City, Halifax, and Gaspe. The Toronto service operates seven round trips on a typical weekday. The Ottawa service operates ten round trips per weekday. The New York, Quebec and Maritime services are described below. The passenger service also includes the weekday Mont-Saint-Hilaire commuter service operated by CN for the Agence Métropolitaine de Transport (AMT).

The passenger traffic includes intercity service to Quebec City, Halifax and Gaspe, Canada, and New York City. There are generally four daily round trips to Quebec City. The Halifax service operates one round trip six days per week. The Gaspe service operates only three days per week. The Amtrak Adirondack service operates one round trip per day to and from New York City.

The VIA maintenance and storage yard is located west of Central Station on the Montreal Subdivision so non-revenue VIA equipment moving between the passenger terminal and the maintenance depot moves regularly over the BMHSR Corridor. AMT trains are serviced and stored on tracks at the station. Non-revenue AMT equipment moves use the subdivision to shuttle between various station tracks.

The passenger service from Montreal Central Station also includes weekday Mont-Saint-Hilaire commuter service to McMasterville, operated by CN for AMT. The service, at this time, is limited to two revenue trips each morning and three revenue trips each evening. There is a planned expansion to six daily revenue trips with possible future increases in service levels. All AMT equipment is stored at Central Station at this time so each revenue trip has an associated non-revenue deadhead trip.

The freight service on the Cannon to Cape segment includes main line traffic to and from Eastern Quebec and the Maritimes, limited local service and traffic to/from the Rouses Point Subdivision. It reportedly averages 25 to 30 train movements daily.

At Cannon, the proposed BMHSR Corridor diverges from the CN mainline to the more lightly used Rouses Point Subdivision. The Rouses Point subdivision is used by the daily Amtrak Adirondack round trip train (one train in each direction) to New York City and a variety of through and local freight trains between Cantic and Cannon. The Amtrak trains consist of a southbound train each morning after 10 am and a northbound train each evening after 6 pm. Most freight traffic on the Rouses Point segment is based at Triage Taschereau, a yard 8.9 miles east of Cape on the Montreal Subdivision. The normal weekday schedule of freight trains includes a total of five or six train starts.

- 324 Southward daily from Taschereau to Cantic with traffic for the New England Central Railroad (NECR) originating at 4 am each morning
- 325 Northward daily from Cantic to Taschereau with NECR traffic originating at 11 pm each evening
- 528 Road Switcher serving Saint Jean-sur-Richelieu weekdays from Taschereau originating at 9:30 am and terminating back at Taschereau at 4 pm
- 525 Road Switcher serving Brossard and the Massena Spur weekdays leaving Taschereau at 4:30 pm
- 527 Local switcher serving Brossard and the Massena Spur weekdays from Saint-Lambert leaving at 6:30 each evening
- 512 Local switcher from Saint-Lambert serving Castle Garden Tuesdays starting at 11:30 pm
- 512 Local switcher from Saint-Lambert serving Cantic on Thursdays starting at 11:30 pm

New England Central Railway (NECR)

The NECR operates 133.0 miles of the BMHSR Corridor from East Alburg to White River Junction, Vermont as shown in Figure 2.3 and detailed in Table 2.7. This rail segment is used primarily by the NECR, but also carries some traffic by other railroads including CN in the north and the Claremont Concord in the south connecting at White River Junction.

Figure 2.3 – New England Central Railroad

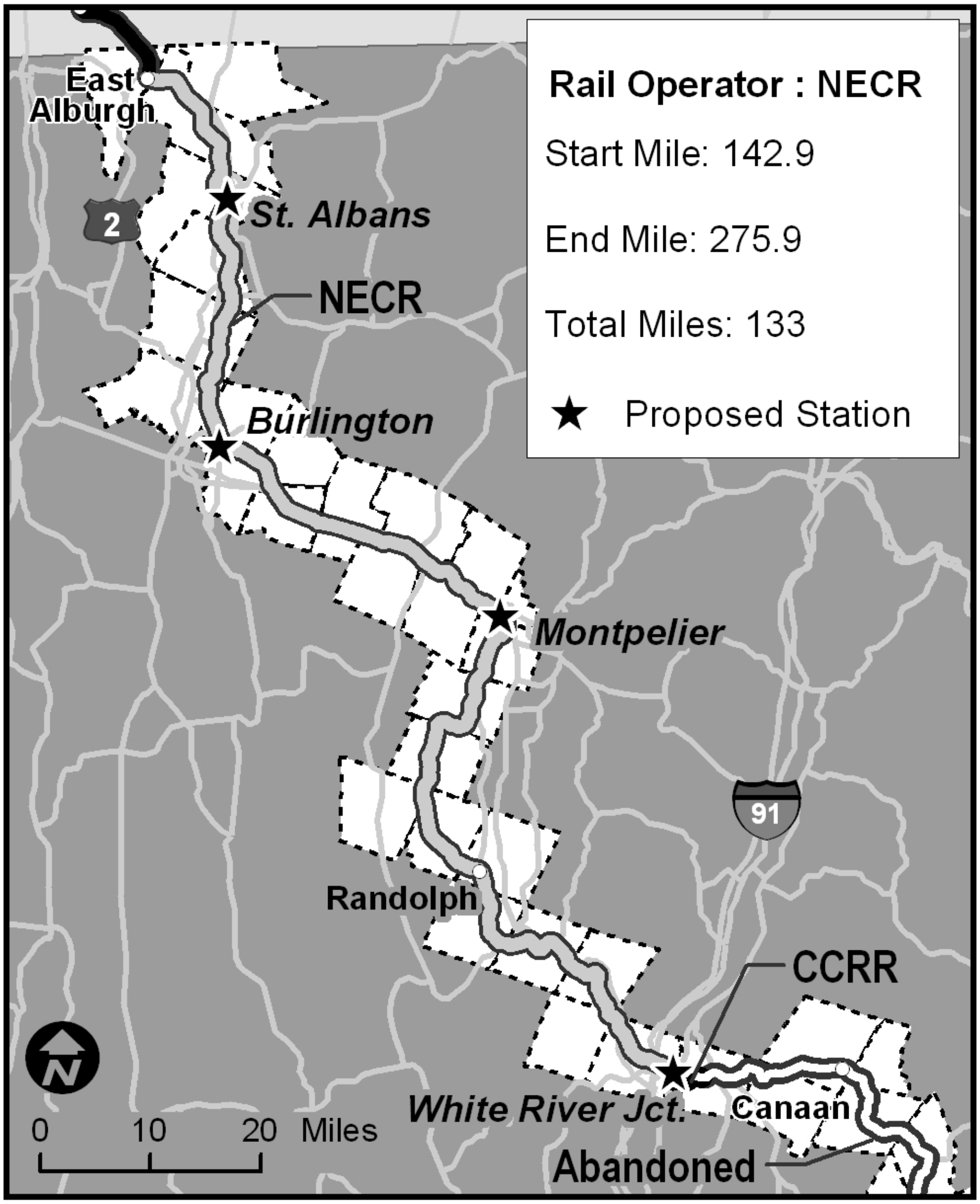


Table 2.7 – Locations Operated by NECR

Railroad	Subdivision	Locations	Distance to Boston	Distance to Montreal	Passenger Speed Limit (mph)
NECR	Swanton	East Alburg	275.9	53.5	25
NECR	Swanton	Swanton	269.7	59.7	25
NECR	Swanton	Fonda	265.7	63.7	25
NECR	Swanton	Newton	262.8	66.6	25
NECR	Swanton	North Junction	261.7	67.6	25
NECR	Swanton	Saint Albans	260.2	69.2	25
NECR	Roxbury	Oakland	255.1	74.3	60
NECR	Roxbury	Milton	247.1	82.3	60
NECR	Roxbury	Burlington Sub Jct.	236.2	93.3	60
NECR	Roxbury	Essex Junction	236.1	93.3	60
NECR	Roxbury	Richmond	227.1	102.3	60
NECR	Roxbury	Bolton	221.5	107.9	60
NECR	Roxbury	Waterbury	213.1	116.3	60
NECR	Roxbury	Montpelier Junction	204.5	124.9	60
NECR	Roxbury	Roxbury	189.1	140.3	60
NECR	Roxbury	Randolph	174.1	155.3	60
NECR	Roxbury	Bethel	167.1	162.3	60
NECR	Roxbury	South Royalton	160.1	169.3	60
NECR	Roxbury	White River Junction	142.9	186.5	60

The BMHSR Corridor segment between Cantic and Saint Albans is used to move cars between CN and the NECR. This interchange constitutes approximately two-thirds of NECR total traffic. The flow of traffic is primarily southbound loaded cars and northbound empty cars. Most of the southbound traffic terminates on the NECR.

The current interchange point between the CN and NECR occurs at Saint Albans. CN trains 324 (Southbound) and 323 (Northbound) carry the flow of cars along the segment between the CN and NECR. Typically CN324 arrives in Saint Albans at 7:00 am with predominantly loaded cars. The train crew and locomotive from the CN324 train turn in Saint Albans to make the return trip to Montreal later in the day. At Saint Albans, the local AM switcher sorts cars and then assembles the southbound NECR train number 324. The local PM switcher serves local customers along the BMHSR Corridor between Saint Albans and East Alburg.

South of Saint Albans the NECR operates completely independent of CN. Over the 56 miles between Saint Albans and Montpelier Junction the NECR operates two daily through-trains and one local train based in Saint Albans.

Every day except Sunday, the NECR operates a northward (323) and southward (324) road train between Saint Albans and Brattleboro (south of Bellows Falls). It also operates a five-day per week daylight local train (500) based in Saint Albans that serves local customers between Saint Albans and Montpelier including the branch at Essex Junction to

Burlington and interchange with the Vermont Railway. The volume of traffic at this interchange is minimal.

For the 61 miles between Montpelier Junction and White River Junction local freight operations are based in White River Junction.

Through operations include the same through freight and passenger trains that operate between Saint Albans and Montpelier. Local service is based out of White River Junction using the weekday daylight train 600. Train 600 handles interchange traffic at White River Junction with Springfield Terminal Railway (operated by GRS), Claremont Concord Railroad, and the Northern Vermont Railroad. It also handles interchanges with the Washington County Railway at Montpelier and with the Green Mountain Railway (GMRC) at Bellows Falls, south of the proposed BMHSR Corridor.

Most of these interchanges are understood to be relatively low volumes except for the Green Mountain connection. The GMRC connection constitutes the NECR's second largest and fastest growing source of traffic – predominately inbound loads from the Norfolk Southern and Canadian Pacific networks "bridged" by the Green Mountain from Whitehall, New York via Rutland.

Amtrak operates a daily round trip between Saint Albans and Washington, DC. The southbound "Vermonter" leaves Saint Albans at 8:05 am and arrives in Washington, DC 13 hours and 31 minutes later. The northbound "Vermonter" arrives in Saint Albans at 9:05 pm. Relevant schedule times for the "Vermonter" are found in Table 2.8. The Vermonter requires approximately 2.5 hours to cover the 118 miles of railway between Saint Albans and White River Junction while making four intermediate station stops, for an average service velocity of 45 mph.[2]

Table 2.8 – Spring 2002 Vermonter Timetable

Train 55/57	Miles	Station	Train 56/54
8:05	0	Saint Albans	21:05
8:35	24	Essex Junction	20:25
9:03	47	Waterbury	19:56
9:17	56	Montpelier	19:42
9:52	86	Randolph	19:07
10:35	118	White River Junction	18:20
17:50	380	New York Penn Station	11:30
21:36	606	Washington Union Station	7:30

[2] The end to end service velocity of the Vermonter from Washington DC to Saint Albans is also 45 miles per hour despite much higher maximum allowable speeds between New Haven and Washington.

Claremont Concord Railroad (CCRR)

On the right of way owned by the State of New Hampshire from White River Junction, Vermont to Boscawen, New Hampshire[3], the Claremont Concord Railroad provides freight service on three miles of the BMHSR Corridor between White River Junction, Vermont and Westboro, New Hampshire (Refer to Table 2.9 and Figure 2.4).

Table 2.9 – Locations Operated by CCRR

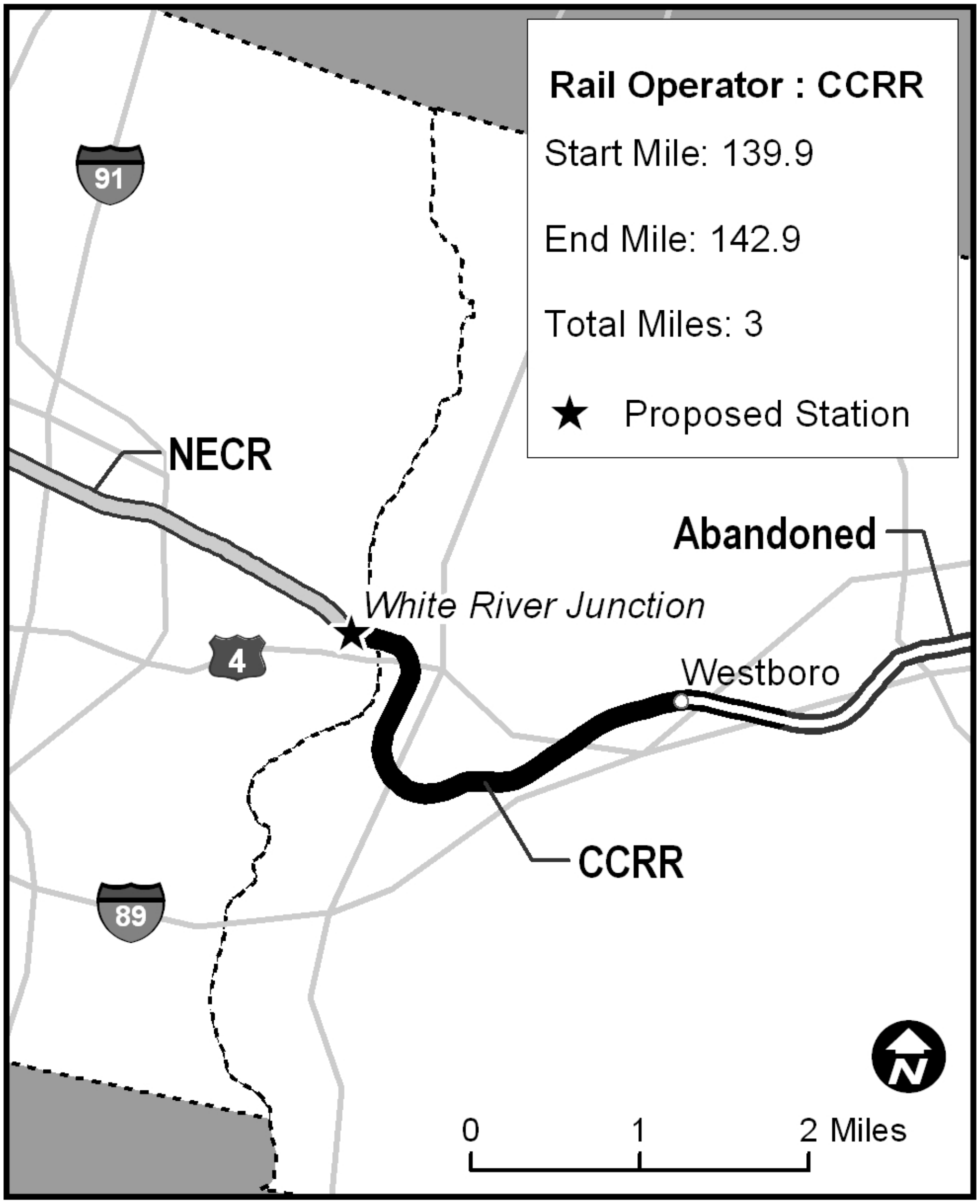
Railroad	Locations	Distance to Boston	Distance to Montreal	Passenger Speed Limit (mph)
CCRR	White River Junction	142.9	186.5	10
CCRR	Westboro	139.9	189.5	10

Under agreement with the State of New Hampshire, the CCRR is granted permission to use the railway from White River Junction to Lebanon and to use Westboro yard. The CCRR plans to operate two services on the BMHSR Corridor. First, it has recently opened a cement transload operation in Westboro yard immediately east of the Connecticut River crossing. Covered hopper cars of cement are hauled from NECR's White River Junction Yard to Westboro Yard. At Westboro, a CCRR subsidiary transfers the dry cement from railcars to tracks for delivery to concrete plants in New Hampshire and Vermont. Second, CCRR is planning to haul sand and gravel from a nearby quarry site on the New England Central Railway to a plant in Lebanon. The gravel operation is not yet underway. When operational, the gravel rail service will haul as much as twenty cars of gravel per day, replacing truck service that currently links the quarry and the plant. The cement service generates much less daily traffic than the gravel service will.

In the absence of the proposed high-speed railway, the CCRR anticipates that most of its traffic growth over the foreseeable future will occur in Westboro yard and elsewhere in Lebanon. However, the prospect of developing freight business east of Lebanon should the high-speed operation restore the rail line between Lebanon and Concord would be considered. Some limited opportunities to serve freight customers could be explored, such as the provision of direct service to a structural steel fabrication plant in Canaan.

[3] CCRR owns two miles of railway in Claremont, New Hampshire, approximately 20 miles south of the proposed high-speed corridor.

Figure 2.4 – Claremont Concord Railroad



Abandoned Right of Way- New Hampshire Owned (NH)

The State of New Hampshire owns 60.2 miles of right of way in the BMHSR Corridor between White River Junction, Vermont and Boscawen, New Hampshire as shown in Table 2.10 and Figure 2.5. As noted above, CCRR operates on 3.0 miles of this right-of-way. The remaining 57.2 miles of right of way between Westboro, New Hampshire and Boscawen (once a part of the Boston & Maine's White Mountain Division) is abandoned. While both the CCRR and the New England Southern Railroad believe that they would have some potential business along the BMHSR Corridor, neither company is able to expand without government investment in the right of way. Currently the abandoned right-of-way is used as a snowmobile and recreation trail.

Figure 2.5 – New Hampshire Owned BMHSR Corridor Locations

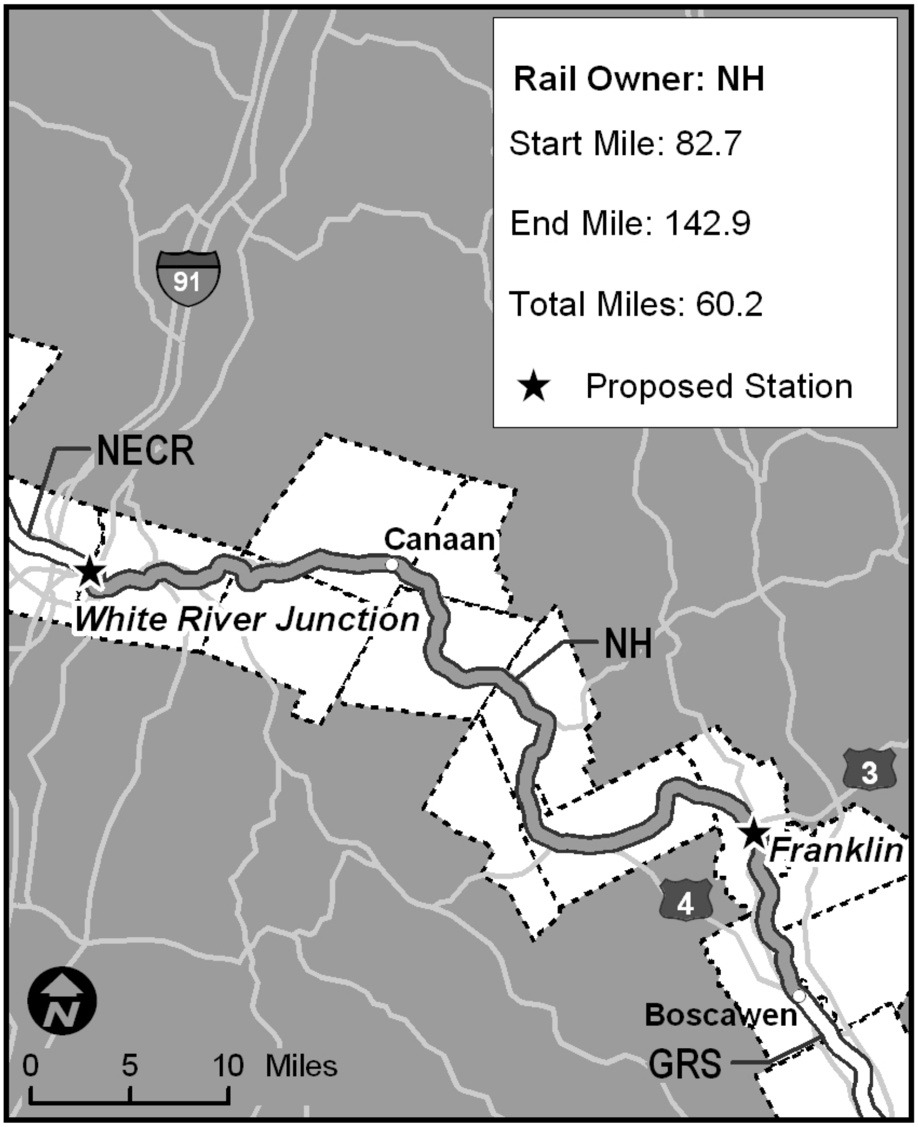


Table 2.10 – BMHSR Corridor Mileage in the Abandoned Segment

Railroad	Location	Distance to Boston	Distance to Montreal	Passenger Speed Limit (mph)
NH	Westboro	139.9	189.5	N/A
NH	Mascoma	134.2	195.2	N/A
NH	Canaan	124.9	204.5	N/A
NH	Potter Place	104.3	225.1	N/A
NH	Halcyon	98.2	231.2	N/A
NH	Franklin	92.0	237.4	N/A
NH	Boscawen	82.7	246.7	N/A

New England Southern (NEGS)

The New England Southern operates freight service on a 27-mile track segment along the proposed BMHSR Corridor between Boscawen and Manchester, New Hampshire (Refer to Table 2.11 and Figure 2.6). This segment of the BMHSR Corridor is owned by Guilford Rail System (GRS). The 11.4 miles between Boscawen and Bow is leased to NEGS by GRS, which services approximately 12 customers in the Hooksett, Bow, and Concord area. The 16 miles south of Bow is maintained by GRS. NEGS has rights to operate on this segment to interchange with GRS for NEGS customers north of Manchester (except for the Bow power plant).

Table 2.11 – Locations Operated by NEGS

Railroad Subdivision	Location	Distance to Boston	Distance to Montreal	Passenger Speed Limit (mph)
NEGS	Boscawen	82.7	246.7	10
NEGS	Penacook	79.9	249.5	10
Northern	Bow	71.3	258.1	40

The NEGS has twelve customers on the proposed BMHSR Corridor. Two of these customers do not have a siding and receive their loads at the team track in Concord. NEGS operations provide for train service three days per week with trains operated from 10 to 12 hours per day. When traffic is stronger, operations are provided five days per week with trains operated 8-10 hours per day. Operations are performed by a single two-person crew.

The NEGS segment of the line is single track with no traffic control signals. The segment between Bow and Boscawen is considered the yard limits. GRS dispatchers control the segment south of Bow.

Current NEGS traffic is approximately 3,000 carloads per year. Absent restoration of rail service between Boston and Montreal, NEGS hopes to grow rail traffic by assisting customers expand their businesses and by capturing some new business on the line. With potential restoration of rail service between Concord and White River Junction, NEGS envisions new connections to the NECR and growth of interchange traffic from the north. NEGS projects that on the currently abandoned section of railway between Boscawen and Lebanon, Franklin would be the strongest freight market. NEGS considers that Franklin could potentially be developed as a transload center.

Guilford Rail System (GRS)

The BMHSR Corridor uses 48.2 miles of railway belonging to GRS[4] between Boscawen, New Hampshire and the NH/MA State Line as shown in Table 2.5 and Figure 2.6. As noted in the section above, between Boscawen and Bow, the 11.4 miles of rail line is owned by GRS and leased to NEGS. The remaining 36.8 miles between Bow and the NH/MA State Line is operated by GRS, as shown in Table 2.12. The 9.0 miles between the NH/MA State Line and Lowell on the BMHSR Corridor is owned by the MBTA, but currently only operated by GRS for its freight operations. The State of New Hampshire is currently working with the MBTA on a plan to extend commuter passenger service from Lowell to Nashua. In the initial phase it is expected that 16 passenger trains will operate daily between Lowell and Nashua. In the longer term, New Hampshire envisions extending passenger service to Manchester.

[4] Guilford owns the right of way north of the New Hampshire border and the MBTA owns the track between the New Hampshire/Massachusetts border and North Station.

Figure 2.6 – Locations Operated by Guilford Rail System

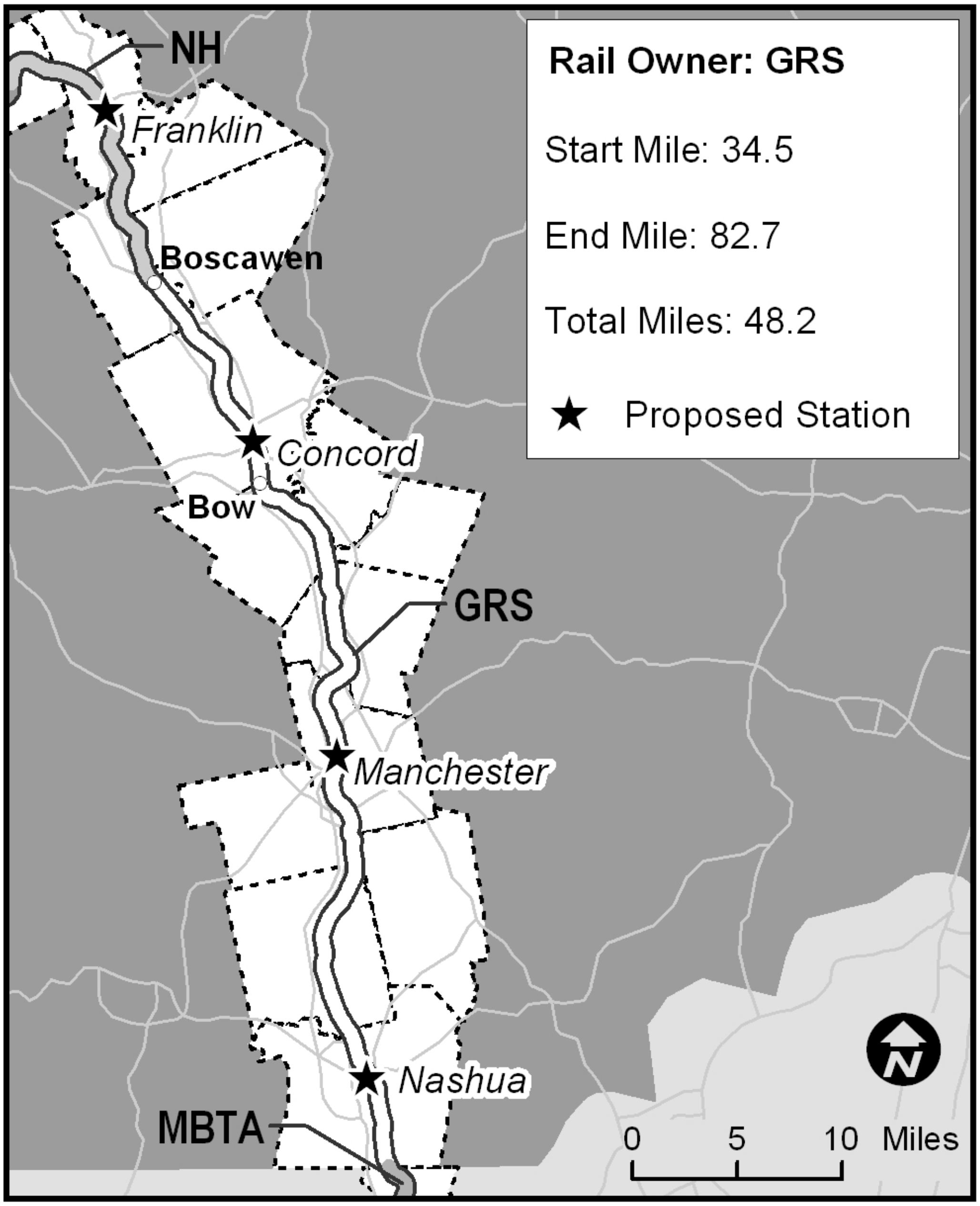


Table 2.12 – GRS Operated Route Mileage

Owner	Subdivision	Locations	Distance to Boston	Distance to Montreal	Current Passenger Speed Limit (mph)
GRS	Northern	Bow	71.3	258.1	40
GRS	Northern	Hooksett	63.6	265.8	40
GRS	Northern	Martins	61.4	268.0	40
GRS	Northern	Amoskeag North	58.6	270.8	40
GRS	Northern	Amoskeag South	56.6	272.8	40
GRS	Northern	Manchester	55.7	273.7	40
GRS	Northern	South Manchester	53.9	275.5	40
GRS	Northern	Goffs Falls	52.0	277.4	40
GRS	Northern	Reeds Ferry	47.8	281.6	40
GRS	Northern	Merrimack	46.2	283.2	40
GRS	Northern	Merrimack South	45.7	283.7	40
GRS	Northern	Thornton's Ferry	44.7	284.7	40
GRS	Northern	Tie Plant	40.8	288.6	40
MBTA	Northern	Nashua	39.0	290.4	40
MBTA	Northern	Tyngsboro	32.1	297.3	40
MBTA	Northern	North Chelmsford	28.3	301.1	10
MBTA	Lowell	Lowell	25.5	303.9	40

At North Chelmsford the BMHSR Corridor joins the GRS mainline between Maine and Western Massachusetts. The GRS mainline between Maine and Western Massachusetts follows the BMHSR Corridor approximately three miles to Lowell. A wye track at North Chelmsford provides track legs to transit to either direction on the GRS mainline.

On the BMHSR Corridor northerly of North Chelmsford, GRS operates several different services on the line with varying frequencies. A coal train averaging 90 cars serves a power plant in Bow with one or two round trips each week. In addition, there is a daily roundtrip from East Deerfield, Massachusetts, which is a major yard for GRS, to Nashua, New Hampshire. A weekday local freight train operates to some local customers north to Manchester including customers on the Hillsboro branch that joins the mainline at Nashua. NEGS operates between Concord and Manchester to interchange traffic with GRS three to five days each week.

From North Chelmsford to Boston the BMHSR Corridor is double track. Between North Chelmsford and the Gallagher Intermodal Transportation Center in Lowell, GRS generally operates four long-haul freight trains each day in each direction and the local train to Nashua.

Massachusetts Bay Transportation Authority (MBTA)

The MBTA owns the southernmost segment of the BMHSR Corridor between the New Hampshire State Line and Boston. Passenger service from Boston to Lowell is operated by the MBTA as shown in Table 2.13 and Figure 2.7. On a typical weekday, the MBTA operates 42 trains between Lowell and Boston. It also operates five daily trains in its Haverhill service over the portion of the BMHSR Corridor between Boston and Wilmington[5]. Amtrak's Downeaster service and a few MBTA trains in Haverhill service use a portion of the line between Wilmington and Boston. In addition, Amtrak operates eight daily trains in its Downeaster service from Boston to Portland, Maine over the segment between Boston and Wilmington. Guilford is the freight service provider between Lowell and Boston. One local train operates daily serving the freight customers on the line with trains based in Lawrence.

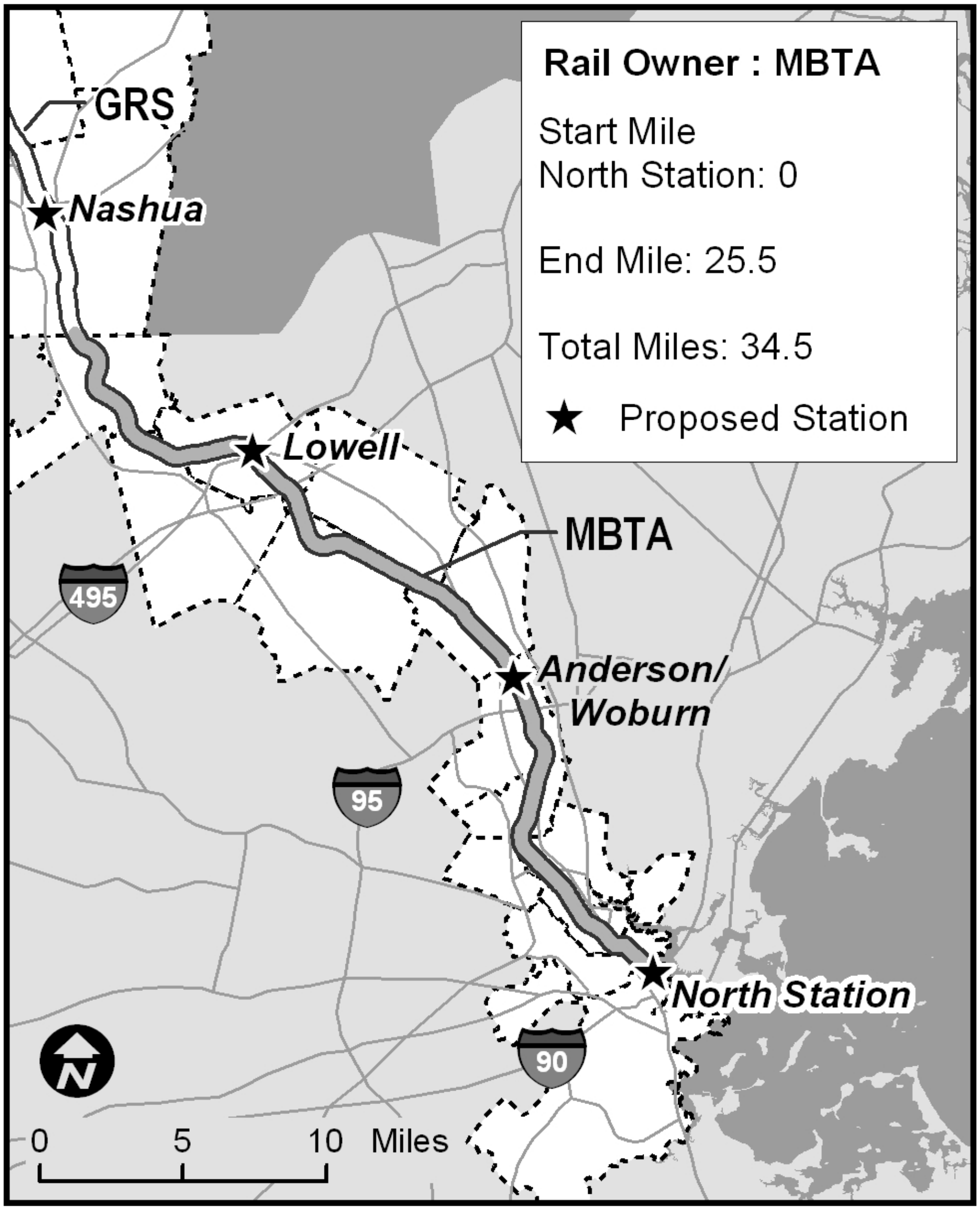
Table 2.13 – Locations Operated by MBTA

Railroad	Subdivision	Locations	Route Mileage	Distance from Prev Station	Distance to Montreal	Passenger Speed Limit (mph)
MBTA	Lowell	Lowell	25.5	3.7	303.9	40
MBTA	Lowell	North Billerica	21.8	6.6	307.6	60
MBTA	Lowell	Wilmington	15.2	2.5	314.2	60
MBTA	Lowell	Anderson	12.7	1.1	316.7	60, 70*
MBTA	Lowell	Mishawam	11.6	3.8	317.8	60, 70*
MBTA	Lowell	Winchester	7.8	0.5	321.6	60, 70*
MBTA	Lowell	Wedgemere	7.3	1.8	322.1	60, 70*
MBTA	Lowell	West Medford	5.5	5.5	323.9	60, 70*
MBTA	Lowell	Boston - North	0.0	0.0	329.4	60, 70*

***Note**: When two speed limits are shown, the right of way is double tracked and the tracks have different speed restrictions.

5 Most MBTA trains serving Haverhill do not use this route.

Figure 2.7 – MBTA Rail System



2.2 Description of the Proposed BMHSR Corridor

With many different users, owners and operators along the proposed BMHSR Corridor, each segment is in varying condition, from well maintained to abandoned. This section discusses the end terminals on the right-of-way, the configuration of the track, the geometry of the right of way, the signal systems in operation throughout the BMHSR Corridor and the speed restrictions that are in place along the BMHSR Corridor.[6]

Terminals

The two endpoint terminals for the proposed high-speed rail service are large multi-tracked stations in metropolitan areas. This section discusses the setup of these major stations of the BMHSR Corridor.

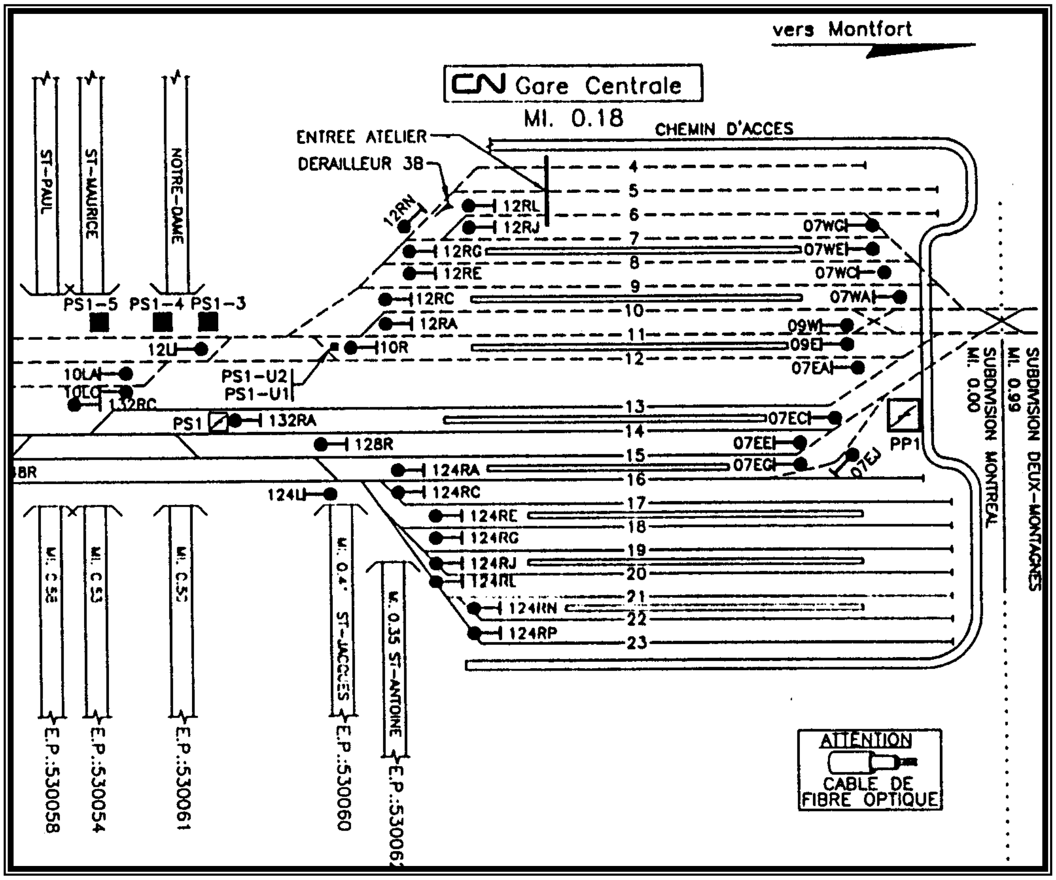
Central Station - Montreal

CN's Central Station in Montreal (Refer to Figure 2.8) is a substantial subterranean rail passenger terminal with 19 tracks and 8 passenger platforms (serving 16 tracks). The passenger concourse at street level is above the passenger platforms. A service concourse below the track level is used for automobile parking, baggage handling and logistics.

The station is the Montreal terminal for VIA and AMT services described above, in addition to the AMT Deux-Montagnes line that enters the station on Tracks 10 and 11 through a tunnel from the north. The Deux-Montagnes service is operated by CN for AMT using fleet of electric multiple unit cars owned by AMT. The Deux-Montagnes line is equipped with 25kV electric catenary for operation through Mont-Royal tunnel to Deux-Montagnes and Montfort. The service includes 42 daily revenue trains to/from Gare Centrale.

[6] Mileposts noted throughout this section are taken from the track charts of the different railroads in the proposed high-speed corridor. They do not represent the actual route mileage of proposed service.

Figure 2.8 – Central Station Montreal

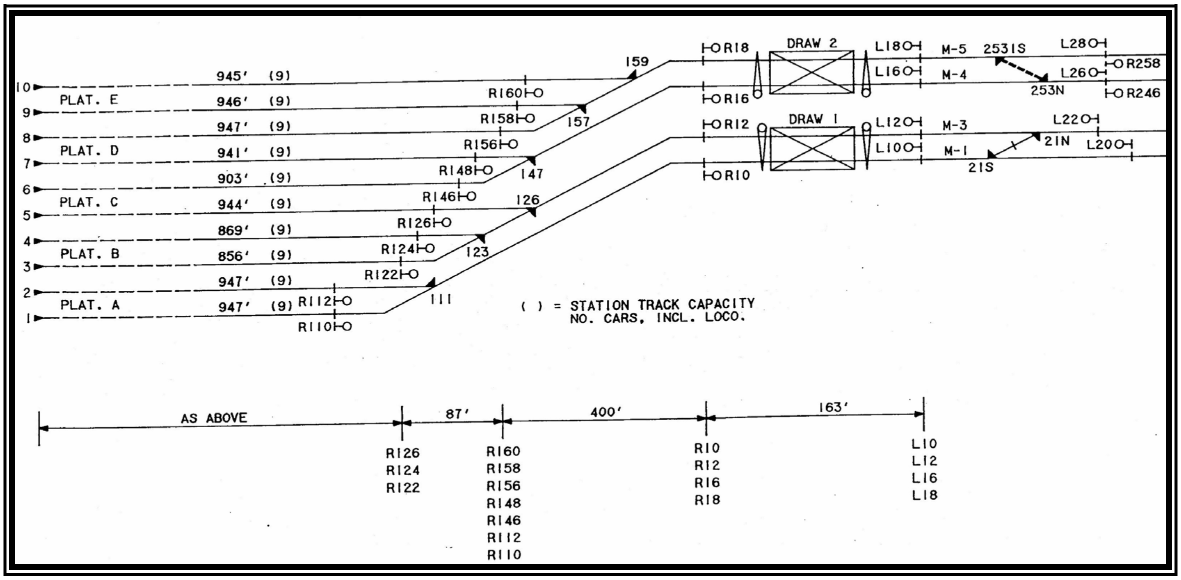


North Station – Boston

North Station serves communities north of Boston with ten tracks and five platforms (Refer to Figure 2.9). Amtrak uses the station exclusively for their Downeaster service, and the MBTA uses the station to serve four different lines. On a normal weekday, 188 passenger trains serve North Station. No freight trains use this station. Currently North Station provides service for diesel locomotives only.

Current peak commuter operations combined with the Amtrak Downeaster service require use of a minimum of nine station tracks in the ten-track terminal. With growth in MBTA commuter rail service over the next several decades, it is expected that the tenth track will be required to operate the normal schedule of daily peak service. Consequently, there is no long run peak platform capacity in the North Station terminal available to receive, hold, and service BMHSR trains. Operation of a 16-train per day high-speed rail service at the station would almost certainly require an expansion. An 11th and 12th track were partially constructed during the 1990's, but not completed because MBTA did not own the necessary right-of-way. Full build-out of the tracks would require the demolition of a large building. Plans to acquire the necessary right-of-way and building have been abandoned.

Figure 2.9 – North Station Boston



In contrast to Central Station, the passenger waiting and service areas in North Station are spartan with few benches for waiting passengers, limited passenger amenities on the concourse and very limited passenger waiting space. An upgrade to this commuter station would probably be required to make it an appropriate terminal for effective high-speed intercity rail service.

Track Configuration

Physical Characteristics

The 329-mile long BMHSR Corridor that connects Boston and Montreal is a composite of five different railroad properties, as previously described. As part of Phase I of the Study, an initial inventory of the physical characteristics of the BMHSR Corridor was made. This effort was done to support development of travel time estimates. Detailed evaluation of the physical characteristics of the line will be made during Phase II of the study. Current ROW conditions that have impact on the potential feasibility of high-speed train operations include curvature, grade crossings, width, and grades. Current track conditions also indicate the opportunities and challenges associated with upgrading the track.

Track conditions vary from the MBTA's New Hampshire Main Line (Boston to Lowell), currently maintained at FRA Classes 3 and 4, and a section of CN's St. Hyacinthe Sub maintained at the equivalent of FRA Class 6, to sections of excepted track, or indeed, no track at all. It should be noted that current track conditions are less important to the development of a high-speed rail operation than are other ROW characteristics such as curvature, grade crossings, width, and grades.

Curvature

Operating speed is directly related to the curvature of the track structure, as determined by the alignment of the right-of-way. New England's railroads were constructed following lowlands and rivers, and therefore curvature has long been the major speed-limiting factor. In the rounding of curves, a train and its passengers are subject to an outbound acting centrifugal force. For a given speed of a train, the outward force becomes higher as the "sharpness" of the curve increases. The sharpness of a curve is expressed in terms of degrees of curvature. The sharpness of a curve increases with the increase of the degree of curvature. The BMHSR Corridor has numerous curves, with a maximum degree of curvature identified at 8°-30′.

To counteract the centrifugal force, the outer rail of the track within the curve is typically elevated. The degree to which the outer rail is elevated over the inner rail is termed super elevation, and is generally expressed in inches. For a given degree of curvature and speed of train, equilibrium is reached when the centrifugal force is exactly counteracted by the superelevation of the track. If train speed is increased above the speed where equilibrium is reached, the superelevation becomes "unbalanced" and passengers would begin to feel the push to the outside of the curve. Unbalanced superelevation is the amount of superelevation that would need to be added to restore equilibrium through the curve for the specific train speed. Generally the maximum unbalanced superelevation for a comfortable riding experience is three inches unbalanced for non-tilting train equipment.

The maximum amount of actual superelevation (EA) allowed with combined freight and passenger operations is six inches. Therefore, for a given speed, the maximum degree of curvature that can be operated with an actual superelevation of six inches, and three inches of unbalanced elevation can be calculated. Table 2.14 presents the maximum speeds that can be operated at the indicated speeds and the number of curves on the BMHSR Corridor that exceed the respective maximum degree of curvature.

In the development of high-speed rail service, however, a range of options exists to address this matter. Tilting equipment that maintains passenger comfort at high-speeds has been used successfully both in the US and abroad to help overcome restrictions due to curvature. Tilting equipment currently can operate at up to nine inches of unbalanced superelevation. Future engineering analysis in Phase II of the Study will identify possible means to provide for reducing curvature in the BMHSR Corridor. Included in the Phase II effort will be evaluation of spirals need to higher operating speeds. Spirals or easement curves are used at the beginning and end of simple curves to provide a gradual increase in the degree of curvature from tangent (straight) track to the full degree of curvature and from the curve back to tangent track. Many curves within the BMHSR Corridor were not constructed with spirals. The evaluation of curvature modifications will include consideration of spirals.

Table 2.14 – Maximum Speed and Curvature for Non-tilting Train Equipment

V (maximum speed)	Ea (actual elevation)	Eu (unbalanced elevation)	Dm (maximum curvature)	Number of Curves over Dm
70 mph	6 inches	3 inches	2°-37′	143
80 mph	6 inches	3 inches	2°-00′	196
90 mph	6 inches	3 inches	1°-35′	286
100 mph	6 inches	3 inches	1°-17′	312
110 mph	6 inches	3 inches	1°-03′	327
120 mph	6 inches	3 inches	0°-53′	375

Railroad-Highway Grade Crossings

Safety of railroad-highway at-grade crossings is an issue with operation of any rail line. The increased operating speed of high-speed trains requires that safety at railroad-highway grade crossings be a principal consideration during evaluation and design of any high-speed rail corridor.

During Phase I of the Study, three-hundred-sixty (360) railroad-highway at-grade crossings (grade crossing) were identified on the BMHSR Corridor. Existing information on each grade crossing was obtained that included: rail line and owner, U.S. DOT inventory number, milepost, state and municipality location, street name, crossing type, and existing warning devices.

The grade crossings are classified as closed, farm, private or public. Grade crossings designated as closed signify that the right to have an at-grade crossing at a particular location has been eliminated. Grade crossings designated as "farm" are associated with crossings established to allow a property owner access to land parcels that were bisected, or for which access routes to land were allocated during the construction of the rail line. Farm grade crossings were established as a condition of the railroad right-of-way acquisitions. As the majority of the farm grade crossings were established to permit access for agricultural purposes, the general term farm crossing is used by the rail industry for these crossings.

Private grade crossings are typically established by agreement between the railroad and the user(s) of the grade crossing. The private grade crossing access is for specific purposes.

Public crossings have been established to provide continuation of a public road or right-of-way over a rail line. The public grade crossings are established in accordance with state and federal government regulations. Public crossings can be used by the general population without restriction. Public crossing can be used for pedestrian and/or vehicle access.

Warning devices are used on many grade crossings to identify to vehicle operators or pedestrians that the roadway crosses a rail line. The installation of warning devices is dependent on the type and volume of train and vehicle and/or pedestrian use, and on the classification type of a grade crossing. The type of warning device is further designated as passive or activated. Passive type warning devices include railroad cross-buck signs, stop signs and other signs, and locked gates. Active warning devices indicate the approach of a train. They include flashing red lights, flashing red lights with gates, and train whistles.

The application of warning devices varies from no passive or active warning devices at a grade crossing such as most farm grade crossings, to the installation of flashing lights with gates activated by the approaching train. The sounding of the locomotive horn or bell is required at most public grade crossings and some private grade crossings. The locomotive whistle is generally not sounded at a farm or private grade crossing.

A summary of the grade crossings is given in Table 2.15. Virtually all the farm and private crossings have no active warning systems. Some are equipped with passive warning devices. Some of the private and most of the public crossings over active tracks have active warning systems, but relatively few are equipped with gates. The warning systems for the public grade crossings from Boscawen, NH to Lebanon, NH, where the tracks have been removed, have been either deactivated or removed.

Table 2.15 – Grade Crossing Types and Warning Devices

Crossing Type	Number	Warning Device	Number
Closed	2	Gates & Flashing Lights	35
Farm	127	Flashing Lights	84
Private	47	Cross bucks and/or Stop Signs	35
Public	184	NONE	155
		Track Removed	51
Total	360		360

Because of the higher speeds of HSR trains, improvements to warning devices for a significant number of grade crossings would be required. While a more in depth evaluation of improvements needed for the grade crossing on the BMHSR Corridor will be included in Phase II of the Study, the general approach to grade crossings improvements is expected to follow the general guidelines of similar HSR corridors. The improvements to specific grade crossings will be designed based on the proposed operating speed over the individual crossing rather than the top speed of the BMHSR Corridor. The changes to railroad-highway grade crossings are anticipated to follow the grade crossing treatment profile outlined in the U.S. Department of Transportation’s Action Plan for Highway-Rail Crossing Safety. The distribution of crossings by treatment at each operating speed level appears in Table 2.16.

Table 2.16 – Assumed Treatment of Grade Crossings

Operating speed over crossing (mph)		% Crossings retaining existing warning levels	% Crossings at each speed level improved by-			
From	**To**		**Installing or upgrading flasher gate systems**	**Providing positive barriers against intrusions**	**Separating**	**Closing**
PUBLIC CROSSINGS						
0	79	65%	10%			25%
80	110		65%		10%	25%
111	125			50%	25%	25%
126	and up				75%	25%
PRIVATE CROSSINGS						
0	79	75%				25%
80	110		60%			40%
111	125			30%	30%	40%
126	and up				60%	40%

Farm grade crossings, while not included in Table 2.16, will need to be evaluated to determine the most effective means to control access over the grade crossings. It is anticipated that locked gates will need to be installed on most crossings and some inactive crossings would be closed or combined with adjacent grade crossings.

The issues associated with grade crossing treatments will have substantive impacts on environmental issues and project cost. This includes the upgrading of sign and warning systems, separation of grade crossings, and closing of grade crossings. The magnitude of these impacts will increase with the speed of the HSR train. This will be particularly evident for train speeds above 79 mph. As noted in Table 2.16, each grade crossing is assumed to be equipped with gates with flashing light or the at-grade crossing is discontinued. At-grade crossings can be discontinued by either grade separating the grade crossing, closing the grade crossing by combining it with another grade crossing or eliminating it if the grade crossing is inactive.

The specific treatment of individual grade crossings will be evaluated in subsequent phases of the Study. This will require discussions with local and regional interests as specific plans for grade crossing improvements are developed. Included in this effort will be the consideration of the use of locomotive whistles at grade crossings.

Currently FRA is considering regulations that would allow for designation of "quiet zones" in which a locomotive whistle is not sounded at specific grade crossings. Currently, locomotive whistles must be sounded at a public grade crossing unless state regulatory agencies have individually designated grade crossings at which locomotive whistles shall not be sounded. As the regulations for restricting the sounding of horns at grade crossings has varied between states, the FRA has proposed a rule to establish consistent requirements for "quiet zones."

The proposed FRA rule stipulates that to eliminate sounding of the locomotive whistle, the grade crossing must be equipped with active warning devices and traffic control devices that reduce the possibility of vehicles entering the crossing as a train passes. Each crossing must have automatic flashing lights and gates. In addition, specific control of vehicles must be provided to prevent motorists from driving around gates in the down position. This can be accomplished by installation of median barriers or the addition of gates on the exit side quadrants at the grade crossings. Such grade crossings are described having a four-quadrant gate system. As the proposed rule for quiet zones is expected to be an issued in the near future, the specific application of quiet zones on the BMHSR Corridor will need to be evaluated. This may be a particular issue in the area of the abandoned segment of the BMHSR Corridor, as restoration of service will require the sounding of the locomotive whistle at grade crossings.

The other significant grade crossing issue will involve grade crossings located in areas of train speed above 110 mph. The FRA requires that for train speeds from 111 mph to 125 mph highway grade crossings must be either grade separated or have a sophisticated FRA approved warning/barrier system that protect against intrusion of vehicles into the track area. For speeds above 125 mph, FRA requires that all grade crossings must be grade separated.

The treatment of grade crossings will be considered during the evaluation of speed limits for individual segments of track in Phase II of the Study. In certain locations the type and density of grade crossing may be the controlling factor in establishing maximum train speeds.

Right-of-Way Width

Typical right-of-way width in New England is 66 feet (four rods). However, over time, some rail corridors right-of-way widths have been narrowed through land sales to as little as 15 feet, just enough to maintain a single track and allow for passage of the train. In evaluating the BMHSR Corridor, the Project Team reviewed valuation plans and identified right-of-way widths less than 64 feet. This is a reasonable standard to provide for double track construction, maintenance and operation. Table 2.17 illustrates locations where the right-of-way is less than 64 feet wide. These exceptions are approximately 2 percent of the total right of way.

The reason that consideration of double track is important is the need to have opportunities for the BMHSR trains pass each other as well as other passenger and freight operations. Typically in most train operations passing requirements are for trains operating in opposing directions. As most current trains on the BMHSR Corridor operate at similar speeds there is minimal needs to provide passing opportunities for trains overtaking other trains traveling in the same direction. As the BMHSR train will operate at much higher speeds than existing freight and most passenger trains, there will be an increased need to provide passing siding to accommodate overtaking situations.

Table 2.17 – Locations of Right of Way Width Less than 64 Feet

Location City/Town	Route MP	Min Width	Length	Property Owner
Somerville	2.5	55′	300′	MBTA
Medford	5.8	55′	1200′	MBTA
Woburn	10.5	55′	1300′	MBTA
Lowell	25.7	32′	300′	MBTA
Lowell	26.2	50′	500′	MBTA
Lowell	26.4	50′	500′	MBTA
Chelmsford	30.0	50′	2000′	MBTA
Tyngsboro	30.2	55′	200′	MBTA
Tyngsboro	32.2	28′	2300′	MBTA
Manchester	51.1	38′	5100′	GRS
Manchester	59.0	55′	600′	GRS
Hooksett	64.8	50′	600′	GRS
Bow	70.1	48′	1000′	GRS
Bow	70.6	42′	1100′	GRS
Concord	72.2	50′	3400′	GRS
Concord	73.3	20′	600′	GRS
Andover	96.0	55′	500′	NH
Wilmot	106.6	50′	200′	NH
Grafton	116.8	58′	200′	NH
Canaan	126.2	50′	2000′	NH
Lebanon	136.7	50′	300′	NH
Lebanon	138.5	15′	2200′	NH
Lebanon	141.0	30′	500′	NH
Royalton	161.4	50′	200′	NECR
Royalton	162.5	50′	400′	NECR
Middlesex	209.2	35′	200′	NECR
Waterbury	214.4	48′	200′	NECR
Bolton	220.4	48′	3800′	NECR
Bolton	223.2	55′	300′	NECR
Richmond	227.3	48′	400′	NECR
Williston	231.4	58′	1100′	NECR
St. Albans	260.2	50′	300′	NECR

Therefore, with minimal need for land takings, the BMHSR Corridor should have adequate width to provide for double track, where required. Specific analysis of the BMHSR Corridor in future phases of the study will identify features external to the ROW that may have impacts such as adjacent historic structures, environmental resources, and other land use issues.

Track Grade Profiles

The grade of the track structure is another key component influencing the operation of railroad equipment. The maximum grade under ideal conditions would not exceed one percent. Grades that exceed one percent decrease the ability of trains to maintain the maximum speed limits. This is particularly applicable to freight trains. The inability of trains to maintain maximum speed limits results in increased passing situations. The specific impacts of grades on the BMHSR operation will be evaluated in Phase II of the Study. Table 2.18 identifies locations with grades that exceed one percent.

Table 2.18 – Locations with Grades Greater than One Percent

Location City/Town	Location State	Route MP	% Grade	Length (feet)
Orange	NH	122.3	1.01	2,000
Canaan	NH	126.0	1.15	1,500
Enfield	NH	132.0	1.12	2,000
Lebanon	NH	136.0	1.10	10,500
Lebanon	NH	141.0	1.07	8,500
Northfield	VT	193.7	1.18	800
Waterbury	VT	217.9	1.11	1,000
Colchester	VT	240.6	1.01	800
Georgia	VT	254.7	1.10	400

Track Configuration

Track Configuration of each segment is described separately in Table 2.19. The segments are developed based on major changes in the route or operations on the route. The information includes discussion of the route miles of the segment, number of mainline tracks, general description of the service on the segment, and the number of grade crossings.

Table 2.19 – BMHSR Corridor Segment Summary

BMHSR Corridor Existing Conditions: Track Configuration Summary	
CN Central Station-Cape Route Miles 1.0	The line between the Central Station and Cape narrows from 19-tracks in the station to a two-track line at Cape via a series of crossovers and ladder tracks. Grade Crossings: None
CN: Cape-Cannon Route Miles 5.2	The line between Cape and Cannon is entirely double tracked. Between Saint-Lambert and Cannon the route passes through Southwark yard. Saint-Lambert (MP 70.3) passenger station is used by VIA and AMT services. Between MP 70.4 and MP 71.4 the route includes a double track “diversion” track circumnavigating a lock on the Saint Lawrence Seaway. The mainline and the diversion both include lift bridges that allow maritime vessels to navigate into and out of a lock on the Seaway. When the eastern lift bridge is raised, rail traffic is diverted to the diversion track the passes west of the lock. The Victoria Bridge crossing the Saint-Lawrence River is a combination railway/roadway bridge slightly more than a mile in length. Grade Crossings: 1
CN: Cannon-Cantic Route Miles 37.4	The line between Cannon and Cantic is single tracked with three passing sidings Brossard MP 35.3; 5,940 feet Lacadie, MP 27.9; 5,780 feet Saint- Jean, MP 22.2; 6,110 feet Grade Crossings: 42

BMHSR Corridor Existing Conditions: Track Configuration Summary	
CN/NECR: Cantic-Saint Albans Route Miles 25.6	The line between Cantic and Saint Albans is single tracked with a single passing siding (Rodgers) between MP 17.6 and MP 18.4 immediately south of the international border at MP 18.7. Grade Crossings: Cantic to US Border 5 Grade Crossings: US Border to St. Albans 21
NECR: Saint Albans-Montpelier Junction Route Miles 55.7	The line segment is single tracked with eight sidings. Two of the six sidings appear to be primarily for use by track equipment and very short trains. Grade Crossings: 83
NECR: Montpelier Junction–White River Junction Route Miles 61.6	The 61-mile segment is single tracked with six passing sidings including the sidings at Montpelier Junction and White River Junction. Grade Crossings: 101
CCRR: White River Junction-Lebanon Route Miles 3.0	The entire segment is single tracked. Grade Crossings: 4
Abandoned Right of Way: Lebanon-Boscawen Route Miles 57.2	The abandoned segment right of way was single tracked when it was operating freight. Grade Crossings: 51
NEGS: Boscawen-Concord Route Miles 9.3	The NEGS segment of right of way is single tracked. Grade Crossings: 6
GRS: Concord– North Chelmsford Route Miles 45.1	The line is single track between Bow and North Chelmsford. The yards at Manchester and Nashua are the principal locations where more than one track is present, but some additional sidings exist for freight delivery. Between MP 38 and 40, the line has a second track called the Perini siding used to store cars, especially coal trains. At Nashua the line connects with the GRS Hillsboro branch. Grade Crossings: 37
GRS: North Chelmsford–Lowell Route Miles 2.8	The freight line is double tracked between North Chelmsford and Lowell. At North Chelmsford, there is a short single-track section at the wye where the GRS Main Line intersects its route to Bow, New Hampshire. At North Chelmsford, westbound freight traffic diverts from the proposed BMHSR Corridor. In Lowell, GRS has a four-track yard called Bleachery. Grade Crossings: None
MBTA: Lowell – Boston Route Miles 25.5	The track is double tracked for the entire BMHSR Corridor. Grade Crossings: 4

Geometry

This section of the report discusses the track geometry of the line. Summary information on geometry for each segment is described separately in Table 2.20.

Table 2.20 – BMHSR Existing Conditions – Geometry Summary

CN Central Station-Cape Route Miles 1.0	This segment of the right-of-way is tangent (straight track).
CN: Cape-Cannon Route Miles 5.2	West of Central Station and Cape interlocking the line curves toward Rue Bridge. Between the Rue Bridge and Cannon the line is primarily tangent with two curves greater than two degrees.
CN: Cannon-Cantic Route Miles 37.4	From Cannon to Brossard the line is principally tangent but there are three curves of three degrees and two curves of five degrees. From Brossard to the urbanized area of Saint-Jean-sur-Richelieu the line is nearly tangent a distance of more than ten miles with only one curve of two degrees. At the former station location in Saint Jean-sur-Richelieu there is 6°-40′ curve. The line is tangent for approximately 15 miles between Saint-Jean-sur-Richelieu and Cantic.
CN/NECR: Cantic-Saint Albans Route Miles 25.6	Information concerning curvature and grade is incomplete between Cantic and the international border. In the United States there are eight curves in excess of two degrees. North of Swanton grades tend to be less than 0.5%. There is a long but relatively gentle grade upgrade between Swanton and Saint Albans.
NECR: Saint Albans-Montpelier Junction Route Miles 55.7	The railway includes 40 curves of at least two degrees over the 56 miles between Saint Albans and Montpelier.
NECR: Montpelier Junction–White River Junction Route Miles 61.6	Over the 61 miles of railway there are 75 curves of two degrees or greater in curvature. In the vertical dimension, the line crests at Roxbury with virtually continuous grades descending toward both Montpelier and White River. With adjustments for curvature, it appears that the ruling grade on the Roxbury Subdivision is 1.36% at Roxbury.
CCRR: White River Junction-Lebanon Route Miles 3.0	The 3-mile segment has 27 curves greater than two degrees.
Abandoned Right of Way: Lebanon-Boscawen Route Miles 57.2	The abandoned right of way has several severe curves that could cause speed restrictions for any high-speed passenger operation. There are 83 curves over two degrees, including six that are at least four degrees.
NEGS: Boscawen-Concord Route Miles 9.3	This segment of the proposed route has seven curves of at least two degrees. At Concord Yard, there is a five-degree curve.
GRS: Concord– North Chelmsford Route Miles 45.1	The track is mostly tangent, but there are sharp curves. At MP 11 in Nashua, there are two sharp curves of greater than six degrees.

GRS: North Chelmsford–Lowell Route Miles 2.8	The line is mostly tangent, however there are some major curves that reduce speed. Exiting Bleachery Yard, there are two severe curves, 6°-17′ and 5°-32′, that limit speeds to 30 mph between MP 25.5 and 25.7. There are two additional curves greater than 1.5 degrees. At MP 26.6 there is a 4°-12′ curve at a bridge. North Chelmsford is on a 2°-45′ curve.
MBTA: Lowell – Boston Route Miles 25.5	The ROW on this segment has 13 curves greater than two degrees.

Signals and Controls

This section of the report discusses the signal and control systems employed along the BMHSR Corridor. Summary information on signals and control for each segment is described separately in Table 2.21.

- Centralized traffic control (CTC) signals provide for safe bi-directional train operations at track speed on all tracks without the use of special written train orders from train dispatchers. CTC signals provide the highest density of operations and flexibility of use for a railway track segment.

- Automatic block signal system (ABS) signals provide for the regulation of trains to automatically provide for safe headways between trains operating in the same direction on the same track. Trains operating against the normal flow of traffic for the track cannot operate without written permission from the train dispatcher. All reverse flow train movements on any track are made at restricted speeds.

- Track warrant control (TWC), Occupancy control system (OCS), and Form D control system (DCS) are "manual block" traffic control signal systems where written permission from the train dispatcher is required for a train to operate on any track segment. Manual block methods are only suitable for low density of train operations such as those that characterize most of the proposed BMHSR Corridor between Cannon in Quebec and Nashua in New Hampshire. Tracks controlled with manual block signal systems are commonly referred to as "dark territory" because no signal lamps are provided to assist with traffic control of train movements.

- Yard operations are for areas with slow speed operation. They generally apply to areas with substantial back and forth activity to sort rail cars. Movements within yard limits can be made without permission from the dispatcher. Speeds are limited to allow stopping in one half the seeing distance.

Table 2.21 – BMHSR Corridor Existing Conditions – Signals and Controls Summary

CN Central Station-Cape Route Miles 1.0	Between Central Station and Cape the entire segment is within the confines of Wellington Interlocking under CTC control from CN's operations control center.
CN: Cape-Cannon Route Miles 5.2	Between Cape and Cannon the line is under CTC signal controls.
CN: Cannon-Cantic Route Miles 37.4	The line is operated OCS control methods.
CN/NECR: Cantic- White River Junction Route Miles 142.9	The line is operated using TWC.
CCRR: White River Junction-Lebanon Route Miles 3.0	Operations on this segment are classified as operations within yard limits.
Abandoned Right of Way: Lebanon-Boscawen Route Miles 57.2	There is no signal system on this abandoned segment of ROW.
NEGS: Boscawen-Concord Route Miles 9.3	Operations on this segment are classified as operations within yard limits.
GRS: Concord– North Chelmsford Route Miles 45.1	For the 15.6 mile segment between Bow and CPN28 the line is DCS (manual block) operated. From CPN28 (Manchester, New Hampshire) to CPF-NC (North Chelmsford) the single track line is CTC controlled.
GRS: North Chelmsford–Lowell Route Miles 2.8	Between CPF-NC Lowell and the tracks are equipped with CTC signal control
MBTA: Lowell – Boston Route Miles 25.5	CTC signals are installed along the majority of the line. ABS signals prevail between MP 20.3 and 15.2 and MP 7.8 and 3.2 between.

Speeds

This section of the report discusses the current maximum allowable speeds along the line. The Federal Railroad Administration (FRA) has established minimum track safety standards for railroad tracks. The FRA regulations have established classes of track based on maximum operating speed as shown in Table 2.22. The FRA track safety standards are primarily related to track geometry conditions but do contain specific requirements for higher speed operation. For operation at Class 5 or higher speeds (above 80 mph) trains must be equipped with positive train stop and or cab signal systems. For operations at Class 7 (111 mph to 125 mph) the FRA requires that highway grade crossings must be either grade separated or have a sophisticated FRA approved warning/barrier system that protect against intrusion of vehicles into the track area. For speeds above 125 mph, FRA requires that all grade crossings must be grade separated.

Table 2.22 – FRA Track Classifications

Over track that meets all of the requirements prescribed for -	The maximum allowable speed for Freight trains is	The maximum allowable speed for Passenger trains is
Class 1	10 mph	15 mph
Class 2	25 mph	30 mph
Class 3	40 mph	60 mph
Class 4	60 mph	80 mph
Class 5	80 mph	90 mph
Class 6	110 mph	110 mph
Class 7	125 mph	125 mph

Summary information on maximum allowable speeds for each segment is described separately in Table 2.23.

Discussions of train speed assumptions for the train performance simulation are presented in Chapter 3.

Table 2.23 – BMHSR Existing Conditions – Speed Summary

CN Central Station-Cape Route Miles 1.0	Trains speeds at Central Station are 10 mph then increase to 20 mph and increase to a maximum allowable passenger train speed on the line segment of 30 mph at Cape.
CN: Cape-Cannon Route Miles 5.2	Speeds for all trains are restricted. From Cape (30 mph passenger) speeds are reduced across the Saint Lawrence Seaway to 20 mph for all trains then increasing through Saint-Lambert to 30 mph. The maximum allowable speed on the line at Cannon is 95 mph for passenger trains equipped with LRC technology[7] (90 to 60 without LRC). Freight trains operate through Cannon at 45 mph.
CN: Cannon-Cantic Route Miles 37.4	The maximum allowable speed on the line is 50 mph passenger trains (and 40 mph freight) with substantial stretches of reduced speeds for urban operations and tight curves in the vicinity of Castle Gardens, Brossard, and Saint-Jean-sur-Richelieu. Speeds are reduced at Cantic where trains enter and exit the line segment.

[7] LRC trains are a special class of diesel powered intercity rail trains that once operated on CN's Montreal Subdivision. It is understood that the last of these trains however has recently been retired by VIA and that rules pertaining to the LRC technology, while still in existence, are now obsolete.

CN/NECR: Cantic-Saint Albans Route Miles 25.6	The maximum allowable speed on the line is 25 miles per hour with permanent speed restrictions at two drawbridges where the railway crosses the Richelieu River near Cantic and Missisquoi Bay in East Alburg.
NECR: Saint Albans-Montpelier Junction Route Miles 55.7	This line segment is maintained to FRA Class III standards. Passenger trains are allowed to operate at maximum speed of 59 mph where not otherwise specifically restricted. The maximum allowable speed for freight trains is 40 mph. There are eight permanent speed restrictions for passenger trains along this 56 mile segment. The total length of the restrictions is approximately 8.6 miles.
NECR: Montpelier Junction–White River Junction Route Miles 61.6	This line segment is maintained to FRA Class III standards. Passenger trains are allowed to operate at maximum speeds of 59 mph where not otherwise specifically restricted. The maximum allowable speed for freight trains is 40 mph. There are 15 permanent speed restrictions for passenger trains along this 61 mile segment. The total length of the restrictions is approximately one quarter of the total segment (15.5 miles).
CCRR: White River Junction-Lebanon Route Miles 3.0	The maximum allowable speed between White River Junction and Lebanon is 10 mph for freight on this Class I track.
Abandoned Right of Way: Lebanon-Boscawen Route Miles 57.2	No service is currently provided on the right of way segment.
NEGS: Boscawen-Concord Route Miles 9.3	The maximum allowable speed between Concord and Boscawen is 10 mph for freight on this Class I track.
GRS: Concord– North Chelmsford Route Miles 45.1	From Concord to Bow, the maximum allowable speed is 10 mph yard speeds. From Bow to Manchester the train runs at 30 mph, and then through Manchester, trains operate at between 20 and 30 mph. Freight train speeds are 40 mph between MP 26 and MP 1 at North Chelmsford with a few exceptions. Speed restrictions of 10 mph between MP 10 and 11 at the Nashua Yard and 30 mph occur between MP 7 and 8 by the Hampshire Chem siding.
GRS: North Chelmsford–Lowell Route Miles 2.8	The maximum allowable speed for freight trains is generally 40 mph. CPF-NC (North Chelmsford) has a speed restriction of 10 mph.
MBTA: Lowell – Boston Route Miles 25.5	North of Wilmington the maximum allowable speed for both tracks is 60 mph. At Wilmington (MP 15.1), the passenger train speeds are limited to 40 mph. South of Wilmington, the two tracks do not always have the same maximum allowable speed. The northbound track allows speeds as high as 70 mph between Boston and Wilmington, while the southbound track only allows speeds up to 60. Speed restrictions at North Station limit trains to 10 mph travel in the first mile and to 35 mph for the second mile. A 40 mph restriction along the line comes between MP 5 and 6 in West Medford for a grade crossing.

Railroad Stations

Overview

A passenger train station includes a number of elements that support the arrival and departure of passengers, such as station platforms, station buildings, parking areas, pickup and drop off areas, and intermodal connections. How each of these elements is designed and implemented has a substantial impact on the experience of passengers.

A positive experience will encourage future use and can be conductive for growth. Station designs and operations that give a negative impression to passengers will become a significant obstacle to growth of the service and could decrease ridership. This will be particularly important for those that are using a system for the first time. Many of these individuals will be comparing the rail service to other modes of transportation including automobile, air, or bus. Therefore, it is important to set standards for stations so that they provide a positive experience for passengers and are compatible with the type of service being offered.

The following sections provide information on the station design criteria that were developed to support subsequent station design and evaluation for the BMHSR service. As with any study, initial evaluation and design criteria were established to provide the basis for continued review and development associated with subsequent planning and design phases. The categories of station criteria are divided into the following sections:

- Demographics of Station Locations,
- Preliminary Station Locations, and
- Station Design Criteria.

For Phase I of the Study the criteria were utilized to support initial station planning assumptions as discussed in greater detail below.

Demographics of Station Locations

The location and number of stations along the BMHSR Corridor will impact the system's ridership and revenue, as well as local land uses. The location of the stations with respect to travel markets and transportation infrastructure, the relative ease of intermodal access to stations, and travel time to and from stations will be critical in determining ridership, system performance, and system costs. There is an important tradeoff between system accessibility and line-haul travel time.

The BMHSR Corridor traverses both urban and rural areas. For each of these areas the function of individual stations will vary substantially. Therefore, the design considerations for each of the type of stations will vary significantly. To categorize the range of station types, the following definitions of station types have been adopted.

These five station service types describe the roles and/or types of services afforded by the various station service areas and station site options.

- **Urban Hub Station** – Urban Hub Stations are typically located at major city centers to address the significant demand for downtown service as well as to take advantage of intermodal access and businesses located in or around Central Business Districts. The Urban Hub Stations in the BMHSR Corridor are Boston North Station and Montreal Central Station, which will serve as the system's terminals. The terminals are near service and maintenance facilities, connect with regional transit systems, and offer attractive opportunities for urban development. Specific requirements for the BMHSR will be evaluated in future phases of the study to define any required service plan modifications at the terminals to support the Boston service.

- **Urban Intermediate Station** – Urban Intermediate Stations are located to serve smaller population centers. Such stations are intended to be located at existing or past station locations along the BMHSR Corridor. Manchester, Concord, Montpelier and Essex Jct./Burlington are potential locations for stations of this type. At Manchester, NH, the station could either be located downtown or near the airport. The Essex Junction station is located approximately 11 miles from Burlington. Access to Burlington could be by highway-based modes or train via the proposed commuter rail extension from Burlington to Essex Junction. This type of station should be designed to allow through running at maximum speed, in order to accommodate possible skip-stop and express service.

- **Suburban Hub Station** – Suburban Hub Stations are sited at suburban locations with the potential to evolve into intermodal hubs and gateways to entire metropolitan areas. These stations are typically located 10-20 miles from downtowns and are usually close to major activity centers. In most cases, such stations are integrated or closely linked with an existing urban transit system and/or an urban highway. Target locations will be in areas near existing or planned major highways. The Woburn/Anderson station located adjacent to Route 128 (inner beltway roadway) is an example of this type of station.

- **Suburban or Rural Intermediate Station** – These locations are on the urban fringe (20-50 miles from the city center) or in rural areas. They are considered because of the potential for developing the surrounding land or serving a tourist or recreational area. This station type is an alternative to a suburban hub station, and would generally be served by local or skip-stop rail service. These stations could be seasonal to support a specific recreational or tourist demand. Annual ridership at these stations would be expected to be low compared to urban stations. Stations in this category include Lowell, Nashua, Franklin, White River Junction, St. Albans, and Saint-Jean-sur-Richelieu, and should be designed to allow through running at maximum speed, in order to accommodate possible skip-stop and express service.

- **Airport Connection Station** – High-speed rail stations should be located at or close to major airports wherever possible to take advantage of the intermodal connectivity offered at these sites. When located close to the airport, the sites should be linked with a "peoplemover" of some type to facilitate transfers between air and rail. Manchester, NH is a possible candidate to be an airport connection station in the BMHSR Corridor.

The first activity in establishment of conceptual station locations was to define the following general station criteria.

A – **Presence of existing stations.** It is assumed that existing passenger stations will not be eliminated with implementation of the BMHSR service. Therefore, use of existing stations would give opportunities to realize cost savings associated with joint use with other passenger rail services.

B - **Potential locations for intermodal connections**. The proximity of a potential station to major roadways or the location of major airport or bus terminal near a station would improve intermodal connection between travel modes.

C - **Distance between stations**. Adequate distance between stations should be provided to maximize average operating speed. Location of stations in close proximity to each other would be unreasonable for train operations except in instances where stations provide essential distribution for passengers in large urban areas. Placement of stations must be supported by specific benefits each station brings to the overall system operations.

D - **Provides access to a major economic center.** This criterion provides consideration of a station in a regional area that has potential to generate specific ridership opportunities. This would apply to areas of high tourism activity.

In the development of the model simulation utilized, a wide range of operating assumptions was used to predict the maximum and minimum run times that could be anticipated for rail operation within the BMHSR Corridor. The travel time predictions were made using a computer based Train Performance Calculator (TPC) (see Chapter 3). To support ridership forecasting, predictions of maximum and minimum travel times were developed. To determine the minimum run time, train operations where predicated on maintaining maximum distance between station stops. This represents an express type of service that potentially will bypass some passenger stations. Train operations for determination of maximum run times were therefore based on servicing a greater number of stations. This type of service could be described as providing local service.

To identify stations that should be included in the TPC operating plans, stations were divided into primary locations and secondary locations. Stations identified as primary locations were considered to be locations that would most likely be utilized in any operating plan scenario. Secondary stations were also likely locations for stations, but it is assumed that express trains would not serve these locations. Primary and secondary stations are identified in Table 2.24.

Table 2.24 – Primary and Secondary Conceptual Station Locations

Primary Station Locations	Secondary Station Locations	Miles from Boston	Miles Between Primary Stations	Miles Between Adjacent Stations
Boston North Station		0		-
Woburn Anderson Station, MA		7	7	7
	Lowell, MA	25		18
	Nashua, NH	39		14
Manchester, NH		55	48	16
	Concord, NH	73		18
	Franklin, NH	90		17
White River Jct., VT		141	86	51
	Montpelier, VT	201		60
Essex Jct./Burlington, VT		232	91	31
	St. Albans, VT	257		25
	Saint-Jean-sur-Richelieu, QC	299		42
Montreal Central Station		329	88	30

Thirteen potential station service areas have been identified. Spacing between station sites varies between seven and sixty miles. Primary stations are spaced on average 15 to 18 miles apart on the south end of the BMHSR Corridor and generally further apart on the north end. The criteria used to identify station service areas include proximity to key population and employment centers, proximity to high growth areas and/or major tourism and recreational areas, potential to serve key travel markets or city pairs, accessibility by auto, connectivity to other modes (transit, air) and station spacing. Table 2.25 summarizes the station type and selection criteria for each station.

Table 2.25 – Conceptual Station Type and Criteria

Key

Station Type	Station Criteria
1. Urban Hub Station	A. Existing Passenger Station
2. Urban Intermediate	B. Potential Location for Intermodal Connections
3. Suburban Hub Station	C. Adequate Distance Between Stations
4. Suburban/Rural Intermediate Station	D. Access to Major Economic or Tourism Center
5. Airport Connection Station	

Primary Station Locations	Secondary Station Locations	Station Type	Station Criteria
Boston North Station		1	A,B,D
Woburn Anderson Station, MA		3	A,B
	Lowell, MA	4	A,D
	Nashua, NH	4	D
Manchester, NH		2 & 5	B,C,D
	Concord, NH	2	D
	Franklin, NH	4	D
White River Jct., VT		4	A,C
	Montpelier, VT	2	A
Essex Jct./Burlington, VT		2	A,B,C
	St. Albans, VT	4	A
	Saint-Jean-sur-Richelieu QC	4	C,D
Montreal Central Station		1	A,B,D

Station Design Criteria

The quality of a passenger's experience at a station will greatly impact the perception of the overall trip. The passenger's "first" and "last" impressions of a trip are associated with passing through a station. It is therefore important to consider development of stations that provide positive passenger reactions, in addition to meeting the needs of railroad operations.

The rail station is generally considered a point of access and departure to the rail service, but particular stations can also be considered a destination. This is especially true for urban stations located in a downtown area. The Montreal Central Station is a significant example of this concept. The associated underground shopping and business centers, located in the station or accessed from the station, illustrate the relationship between travel by train and station design.

As identified in Chapter 3, many types of passengers would utilize the BMHSR. The criterion outlined below identifies the major station design elements that should be used for design of the types of stations presented above. As the BMHSR service will utilize an existing corridor, all design criteria must support continuous operation of both the HSR service and additional passenger and freight operations. This gives consideration to utilizing station criteria developed by the current rail operations on the rail line. As the MBTA currently has the largest passenger rail operation on the BMHSR Corridor, the station design criteria for commuter rail was considered a benchmark for the HSR station criteria. However, consideration must be given to specific design requirements for intercity passengers. A principal difference between the commuter and intercity passenger is that the latter will more likely be a traveler carrying luggage. This requires inclusion of baggage holding facilities, which are not common in most commuter rail stations. The differences between high-speed rail and commuter rail stations are considered in the sections below.

The American Railway Engineering and Maintenance-of-Way Association (AREMA) section *Design Criteria for Railway Passenger Stations* provides specific recommendations on space requirements for interior station design and parking and curb requirements that have been adopted as the basis for future station evaluation. The design of stations for the BMHSR service will require that specific stations be evaluated individually. This is necessary because of the varying nature of each station. However, each HSR station should strive to meet criteria of the four main station functions:

- Station Location,
- Station Area and Access,
- Building Appearance and Function, and
- Train Platform.

The following sections provide discussion on principal elements that are included in each of the four major station functions. The information is intended to provide guidance for station evaluation in subsequent phases of the BMHSR study and should be considered a general assessment of station design criteria.

Station Location Criteria

Adjacent to mainline - The most important consideration in siting a station is finding a location that is adjacent to the mainline of the rail BMHSR Corridor. While this may seem like an obvious conclusion, individuals unfamiliar with railroad operation may suggest locations that are located "close" to tracks or on a connecting spur or branchline. A HSR train station must be located on mainline tracks to provide run-through operation.

Roadway access - For every HSR station roadway access must be provided. Station placement will preferably be made to enable the use of existing roadway systems with little or no modification. This will have both economic and environmental benefits. Specific consideration must be given to the capacity of adjacent roadway network. Stations with projected high volumes of traffic should be located adjacent to roadways with sufficient capacity to accommodate the additional traffic generated by passengers accessing the station.

A basic premise of HSR rail design is that grade rail crossings shall be reduced or eliminated. Therefore, all roadway and pedestrian access across the tracks to the station site shall be grade separated.

Accommodations in roadway design must consider the following travel modes of arrivals/departures.

- Pedestrian walk-in and bicycles,
- Public transportation, including taxis,
- Automobile or van pick-up and drop-off, and
- Park and Ride including long term and short term.

Station sites must be selected to maximize opportunities for the types of travel modes predicted to access the station. As an example, for a station located adjacent to an interstate highway exit in a rural setting, the principal access mode at the rural site would likely be by automobile and/or bus with minimal pedestrian or bicycle access. The configuration for this station would be focused on movement of vehicles. This would contrast with a station located in a downtown center, which would be focused more on access for pedestrian and public transportation.

For stations that are anticipated to experience substantial growth in ridership, the station site must include provision for future expansion. For the BMHSR service it is anticipated that this would apply to primary stations. Consideration should be given to expansion opportunities on a specific site that would include above and/or below ground parking garages. The economics of potential on site versus off site expansion should be considered for each station. The purchase of necessary areas for present and future needs should be considered as part of the first phase of project implementation.

Station Area and Access Criteria

The parking and access roadways within the station facility must provide convenient and efficient access to station facilities. Specific consideration must be given to pick-up and drop off areas that allow unimpeded access to the station building from private and public transportation. AREMA has included recommended parking and curb requirements for Intercity and Commuter operations. As the HSR service will approximate the intercity operation, the AREMA Intercity criteria are deemed appropriate for the BMHSR project.

Utilizing the above criteria, station areas can be established for specific locations. For stations located in areas with commuter rail service, consideration must be given to the different requirements of commuter and intercity passengers. Stations may need to be constructed to segregate services for the two types of passengers. This would require duplication of certain facilities or providing bypass routes of ticket and baggage areas not needed for commuter passengers. For station access areas, separation of intercity and commuter passengers could include providing individual pick-up and drop-off areas for each type of passenger. Routes from the respective curbside areas will direct passengers to the specific areas within the station building.

The roadway network within each station access area will need to be configured to allow the free flow of vehicles and passengers in an efficient manner. Roadway lanes for through movement of vehicles will be required to facilitate vehicle access and egress. The through lanes will enable vehicles to bypass standing vehicles and will minimize the queuing of the vehicles within the station access area.

Stations should be designed to accommodate pick-up and drop-off areas for private cars, taxis, limousines, hotel and rental car shuttle buses, and public buses. Specific curbside areas will be required for the staging of such vehicles. Staging areas should be located in close proximity of the intercity passenger service entrance.

Passenger walkways will be required to provide access to curbside and parking areas. Access to parking areas may require crossing of station access roadways. These crossings can be at-grade, or if warranted by design of the station facilities or because of high passenger and vehicle volumes, the crossings can be integrated with internal roadways. If walkways are at-grade, adequate sight distances must be maintained for pedestrian and vehicle drivers. Curbside stopping areas must be designed to maintain adequate sight distances.

Adequate signage for traffic and passengers must be provided. Traffic signage should comply with the Manual of Uniform Traffic Control Devices (MUTCD). Signage that identifies the BMHSR service should be developed and utilized for all stations. Signage within the station area and building should be uniform throughout the system. This will be an issue for MBTA stations, as they are designed to have coordinated signage.

Building Appearance and Function

The BMHSR Corridor will follow an existing rail right-of-way and will most likely utilize existing stations where possible. In some locations, new stations will also be required. Their design will provide the greatest opportunity to match desired passenger amenities to the type and volume of projected intercity and commuter passengers. The use of existing buildings for passenger stations will require evaluation of many factors, including station access to pedestrian flow, compliance with current design standards, including ADA regulations, and historical and environmental regulations. The specific design of each station will be developed in subsequent phases of the work. The designs should follow the general criteria noted below.

The station building design will be a function of projected passenger volume and relative volume of intercity and commuter passengers. As discussed in the previous section on Station Area and Access, the needs of intercity and commuter travels are different. AREMA has developed recommendations for building interior space requirements, and these recommendations will be utilized to develop conceptual building space requirements to support station design.

The BMHSR service will attract a wide range of users. Travelers using the service will include intercity business, non-business and commuter passengers. The BMHSR passenger make-up differs from higher-density HSR passenger corridors, which tend to have a higher percentage of business passengers. The higher percentage of tourist passengers (as described in Chapter 3) will require station design to accommodate greater amounts of baggage and friends or family accompanying passengers into the station. Intercity travel will include passenger trips not only between the major terminals of Boston and Montreal, but also between locations within the BMHSR Corridor. The standards for building space requirements given in Table 2.26 for Intercity, Suburban/Rural and Commuter Downtown needs, will facilitate station design.

Waiting areas within the station building are necessary for passengers to assemble prior to arrival and boarding of trains, and those awaiting the arrival of passengers. Placement of waiting areas should be made to minimize direct travel of passengers moving between the train platforms and building entrances. This will facilitate movement of passengers through the station that do not need to access functions such as ticketing or baggage handling areas.

The volume of ticket sales will determine the number of windows required. The relative volume of intercity and commuter rail sales will need to be evaluated to determine if separate areas for sale of intercity and commuter passenger tickets is warranted. The ticket counter areas will need to allow for the handling of money and processing of credit card transactions. Secure areas within the ticket area must be provided for handling and storage of money and related material. A station with a large number of ticket agents will likely require provisions for a separate locker room, lunchroom, and toilet facilities for station personnel.

Passenger station building should be provided with public restrooms. Provision for security within the restrooms will be required. This can include placement of the restroom entrances within sight of station employees' work areas including ticket windows. For times of limited use, restroom entrances can be locked, requiring users to obtain a key from a station employee.

Stations with low volumes may require special evaluation of ticketing and station building operation. Stations may not be open at all times of train operations. This may require advance on-board ticketing. Station design should seek to include retail space. The inclusion of retail services encourages the use of the station. Additional staff located within the building during hours or operation will increase security for passengers and station personnel. Significant retail activity can also become a source of revenue to offset operating costs. Station planning shall also consider development of other commercial space integrated to the station building but independent of station functions. Such space could include office and general retail space. Design of such a station building could support a private/public partnership to provide additional financial benefits for the operation of station facilities.

Train Platforms

The train platform serves to provide transfer of passengers between the train and station. For HSR service, station dwell times must be minimized. This requires the platform design to accommodate efficiency of movement of passengers and baggage on and off the train. The platform and canopy must be designed to provide protection from inclement weather.

The design of individual platform layouts will vary substantially as a function of passenger volume. As the station passenger volumes of the BMHSR service are predicted to vary substantially, the station platform design will be significantly different from station to station. As such, the station platform and track configuration will need to be developed for each station location.

The frequency of trains within the BMHSR Corridor will also affect the configuration of train platforms. Within areas of high commuter rail train frequency it should be assumed that double track mainlines will be provided. This condition should be assumed for all stations from Boston North Station to Manchester, New Hampshire. For the remainder of the BMHSR Corridor, single-track layouts are currently assumed to be sufficient for operation of the combined BMHSR service and freight and passenger services from Manchester to Cannon. Therefore, some stations could be located on a single track mainline.

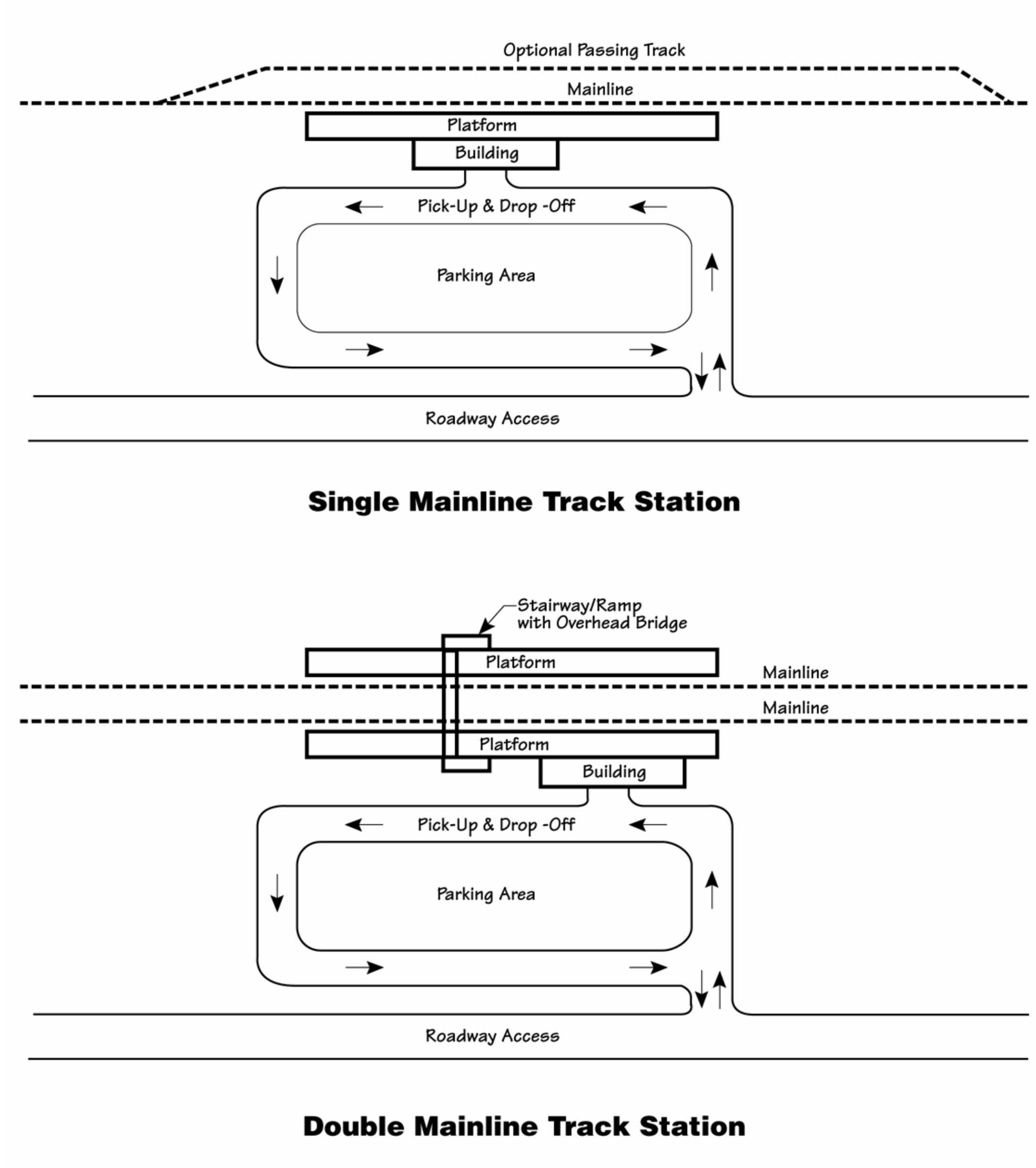
Double track station platform configurations could be designed for either separate platforms located on either side of the double main tracks, or a single center-island platform located between two main tracks or between a main track and a passing siding. Single main track platform configurations could be a single platform located adjacent to the mainline track.

Typical track configurations for double and single-track stations are illustrated in Figure 2.10.

For purposes of concept planning, platform widths should be assumed to be 20 feet. Train platform lengths shall be designed to accommodate the longest potential trainset. The TPC runs assumed a train set of six passenger cars. However, the train platforms at North Station in Boston have been designed to accommodate train lengths of nine, 85-foot commuter passenger cars and a single locomotive. For maximum flexibility, new station platforms should be designed to conform to MBTA design criteria for platform length. This assumed platform length is 800 feet (85 feet x 9 cars + 35 feet for train stop variation).

The design height of station platforms will be dictated by whether the rail line will be used exclusively for passenger service or a combination of passenger and freight operation. The two modes of train operation have varying requirements for horizontal side clearance. The horizontal clearance becomes the principal criterion to determine station platform design. In particular, passenger cars are designed to have a specific side clearance that remains constant for all train sets. This allows for construction of train platforms that are set at a uniform height and distance from the centerline of track. Freight car clearances are not uniform, and maximum freight car clearances exceed the side clearance for passenger equipment. In addition, freight rail lines will often handle special high or wide loads. These unique rail car movements must receive special clearance by respective railroads prior to transit via a specific route. The high-wide loads move under special orders to train and dispatch personnel. As the value of operating fees generated by these specialized movements is very high compared to normal freight movements, owners of the freight lines will typically seek to maintain the maximum clearances on a particular rail line.

Figure 2.10 – Typical Station Configuration



These differences in passenger and freight equipment clearances are an issue for existing, as well as future passenger and freight operations on the BMHSR Corridor. Practical examples of this are the designs of several of the stations on the BMHSR Corridor segment between Boston and Lowell that are owned and operated by MBTA. This segment has some locations where passenger service only is operated, and others where the service is combined passenger and freight. Design of stations is different for each of these conditions. The reasons for the variation in design are explained below.

The desired HSR (and commuter) passenger car platform design is for the platform height to be elevated to match the floor level of the rail cars. Typical height of passenger rail car doorways above the top-of-rail is 48 inches. The typical horizontal spacing of the platform edge is set to provide no more than three inches between the floor of the entryway to the rail car and the edge of the platform. This facilitates the movement of passengers from the platform to the rail car without the need to step up into the rail car. It also allows passengers to step across the platform directly into the car. This eliminates the use of any temporary bridge to span the gap between the rail car and the platform. This configuration provides movement for the general public and passengers with disabilities in accordance with Department of Transportation Regulations 49 CFR Appendix A to Part 37 – Standards for Accessible Transportation Facilities.

In areas where freight car movements are required on tracks that pass by the station platform, the platform edge must be located with sufficient distance from the centerline of track to provide movement of the maximum width freight cars without striking the platform edge. To address this side clearance issue on most combined passenger and freight rail lines, the platforms are constructed at a low height. Typical platform heights are eight inches above the top of rail. For this situation, the general public boards the train by use of steps up into the rail car. As many individuals with disabilities cannot utilize the stairs to access the rail car, an alternative means of entering and exiting the rail car must be provided.

On the many combined passenger and freight lines, the means to meet ADA requirements is to utilize a mini-high platform. This feature consists of a short segment of elevated platform placed at the height of the rail car floor. The horizontal edge clearance is set to provide required maximum freight clearance. Access from the low level platform to the mini-high platform is provided by a ramp from the low level platform. Access from the mini-high platform to the rail car is provided by placement of a bridge plate to span the horizontal gap. The bridge plate is placed and removed by the train crews. The bridge plate can be stored at the individual platform or carried on the train. On some lines with mini-high platforms, a hinged platform extension is used to extend the width of the mini-high platform edge. The extension can be retracted to provide freight clearance when required. However, freight railroads may not approve this feature, as the extension can be inadvertently left in the external position.

An alternative to the mini-high platform is the use of a portable lift that can be used to elevate individuals from the low level platform to the height of the rail car floor. The placement of this lift is made to provide minimum clearance between the elevated deck of the lift rail and the rail car floor. The lift is moved into place after the train has stopped at the station. The train crew or other railroad staff (such as a station attendant) can operate the portable lift. The lift is currently used for Amtrak service on the New England Central Railroad operated segment of the BMHSR Corridor.

During the subsequent planning for specific station stops, the configuration of station platforms will need to be assessed. This will include consideration of existing design standards for the individual rail line owners and current regulations including requirements for ADA. For the Phase I analysis, the station stop times were assumed to be based on stations with full high level platforms. During subsequent study, the specific stations will need to be evaluated to determine if full height platforms can be accommodated.

3.0 Ridership Analysis

Overview

The most important element in any transportation plan is to understand who will potentially use the transportation service being considered. The objective of the passenger ridership analysis is to develop reliable forecasts of the market for intercity HSR travel in the BMHSR Corridor.

The ridership market will consist of both trips diverted from a different mode to the BMHSR service, and induced trips that would be made only if the proposed BMHSR rail service is available. The total trips for both diverted and induced riders will be a major indicator of the overall demand for the potential BMHSR service. The development of the ridership forecasts requires three major steps:

- Train Operation Planning and Modeling for development of conceptual HSR travel times
- Market Analysis of the BMHSR Corridor
- Model Analysis and Ridership Estimates

As detailed in the following sections, each one of these steps has been completed for the BMHSR Corridor. The specific ridership forecasts are identified in this chapter and details of the respective operating scenarios analyzed are given in Appendix A.

■ 3.1 Train Operations Planning and Modeling

Train Operation Model

To define specific travel times required to support the ridership forecasts, a rail network computer model of the study area for the BMHSR Corridor between North Station in Boston and Central Station in Montreal was developed to simulate anticipated train operations. The train performance calculator (TPC) simulation system is the Berkeley Simulation Software (BSS) Rail Traffic Controller (RTC) model. This modeling instrument accurately represents the characteristics of the rail infrastructure and realistically simulated train movements. The TPC simulates train operating characteristics, including movements through curves, up and down grades, and braking/acceleration. It will be utilized to identify dispatching conflicts in any subsequent study phases. The simulation presents accurate comparisons of rail network performance associated with trip time analysis, capacity, and train delays at specified levels of service for proposed improvements to the infrastructure and train operations. The working model of the BMHSR Corridor was designed as a flexible tool that is easily modified and upgraded. It provides significant utility in evaluating the operational and infrastructure improvements needed to achieve the operational and service objectives as defined by the stakeholders and the states of Massachusetts, New Hampshire and Vermont and Quebec Province.

Modeling Criteria

Trainset Technology Assumptions

For model simulation, F-59 PH locomotives and Bombardier Bi-Level coaches were selected for the analysis because they are widely used in passenger corridors throughout United States. For example, this trainset is used in the state of California on the Capitol Corridor, which is the fastest growing passenger corridor in the country, and on the Pacific Surfliner Corridor, which has the highest level of service and ridership outside of the Northeast Corridor.

The F-59 PH locomotive and Bombardier Bi-Level coaches were used to build two train consists for the simulation model. The first consist type was composed of one F-59 PH locomotive and six bi-level coaches. The second consist type was composed of two F-59 PH locomotives and six bi-level coaches. In both cases, a passenger load factor of .70 was assumed to account for the additional weight, equating to seventy percent of a seated load (ninety-eight passengers at one hundred fifty pounds each).

A third consist type representing the performance characteristics of the Talgo train was applied to the simulation model to examine the potential impact of passive tilt technology on speed and trip time over the BMHSR Corridor.

Infrastructure Assumptions

The network simulation model for the BMHSR Corridor was constructed using available track charts and timetable special instructions to replicate the physical characteristics of the infrastructure, including track distances, speeds, geometry, grades and curvature.

Three different infrastructure "case" characteristics were defined to test in the simulation model, as summarized below:

- Low Speed Case: Present alignment was utilized including existing track conditions, existing track geometry and existing timetable running speeds for passenger service on time respective lines. For the abandoned BMHSR Corridor segment between Concord, New Hampshire and White River Junction, Vermont, the last available published timetable was utilized. Maximum train speed is 60 mph. This would be similar to the existing Amtrak intercity service on the Vermont segment of the BMHSR Corridor.

- Mid Speed Case: FRA Class 6 was utilized with improved curve speeds. Present alignment was utilized with a 110 mph maximum speed with curve speeds restricted by track geometry. Non-geometric timetable speed restrictions were maintained. Existing grades were maintained

- High Speed Case: FRA Class 6 was utilized with no speed restrictions. A 110 mph maximum speed was utilized with no speed restrictions through curves. Existing grades were maintained.

The FRA regulations have established classes of track based on maximum operating speed as shown in Table 3.1 (reproduces Table 2.22). The FRA track safety standards are primarily related to track geometry and infrastructure conditions, but these standards do contain specific requirements for higher speed operation. For operation at Class 5 or higher speeds (above 80 mph), trains must be equipped with positive train stop and/or cab signal systems. A positive train stop system will automatically slow or stop a train if an engineer fails to respond to a signal indication. A cab signal system duplicates signal indications on a display within the locomotive cab.

Table 3.1 – FRA Track Classifications Maximum Operating Speeds

Class	Freight	Passenger
1	10 mph	15 mph
2	25 mph	30 mph
3	40 mph	60 mph
4	60 mph	80 mph
5	80 mph	90 mph
6	110 mph	110 mph
7	125 mph	125 mph

These three cases were developed in order to examine a range of trip times in the simulation model and provide a comparison of running times, depending on the specific track configuration assumptions.

The "Low Speed Case" model assumed a service similar to that of a typical Amtrak intercity train operating over existing railroad (i.e. freight) infrastructure. Running speeds were limited to those presented in the current timetables and track charts for the respective subdivisions. This scenario includes a maximum speed of 60 mph (for passenger trains) over the majority of the BMHSR corridor, with limited areas of 70 mph on the MBTA segment between Lowell and Boston, and 80 mph on a two mile segment of CN track in the area of Montreal. It is important to note that the current timetable track speeds include a multitude of restrictions. These slower speed limits are associated with specific track geometry or curve alignment, or a "local" condition such as a grade crossing speed restriction. The TPC model was constructed with the existing published speed restrictions for each segment of track. As noted below, the results of the "Case 1- Base Case" model yields the "low range" and longest trip time estimates for both express and local service between Boston and Montreal.

The “Mid Speed Case “ model assumptions were developed to examine the effects of significant speed increases on trip time. The maximum running speed for this case was 110 mph, based upon applying an FRA Class 6 standard for track. Speed restrictions for reasons other than track geometry were not applied to this case. Existing horizontal alignment characteristics (degree of curvature) were retained, although speed increases through curves were achieved with increases in unbalance. An unbalance of three inches was applied to the simulation with the two conventional trainsets. The first consist was one F59-PH locomotive and six Bombardier bi-level coaches and the second consist was two F59PH locomotives and six Bombardier bi-level coaches. An unbalance of five inches and six inches, respectively, were applied to the two simulations with the Talgo train.

A specification of a maximum of six inches unbalance is currently in effect where the Talgo train is operated in revenue service for Amtrak in the Pacific Northwest. In addition, six inches of unbalance is also in effect for the operation of the Amtrak Acela train on the Northeast Corridor. The FRA has approved use of higher unbalanced conditions. Detailed operational analysis planned for subsequent Study phases will evaluate use of higher unbalanced limits.

An upper limit of 110 mph was identified to correlate with the likely maximum operating speed over the majority of the BMHSR Corridor. It is important to note that for train speeds from 111 mph to 125 mph highway grade crossings must be either grade separated or have a sophisticated FRA-approved warning/barrier; and for speeds above 125 mph, no at-grade highway crossings, public or private are permitted. Given the large quantity and locations of the grade crossings along the BMHSR Corridor, grade crossing eliminations would be challenging to implement. However, during future operational analysis, locations will be identified and analyzed to determine where segments of track could be operated at 125 mph, even though it is assumed that the overall distance subject to a potential speed of 125 mph is relatively small. Furthermore, any trip time reductions associated with 125 mph operation would likely be offset by retention of some geometry based speed restrictions in place today. Therefore, the upper limit of 110 mph for F-59 PH locomotive trainsets represents a reasonable approximation of the most favorable travel times that could be obtained on the BMHSR Corridor.

The “High Speed Case” model assumptions were developed to examine trip times associated with a train operation at a maximum speed of 110 mph but unimpeded by any horizontal geometric (curve) or other speed restrictions. The only impacts on running speed in this case are associated with station stops and vertical grades. The vertical profile specified in “Low Speed Case” and “Mid Speed Case” was maintained. “Case 3” represents the minimum optimal run time that could be achieved if all constraints associated with horizontal geometric and local speed restrictions were eliminated, approximating conditions similar to those that would be realized with the construction of a new, dedicated HSR rail alignment designed for the operation of passenger trains only. This approach would require significant capital investment and would likely have substantial environmental impacts. It is likely that the assumptions applied to this case would be extremely challenging to realize.

Service Plan Assumptions

The TPC was configured with certain operating assumptions. The assumptions included consideration of train operating parameters and other conditions noted below.

It is anticipated that by the time a BMHSR service is implemented, US/Canadian border regulations will be developed to allow operation with no stops for Customs or Immigration inspections. Chapter 4 of this report discusses the border security issues.

The TPC simulation assumes that sufficient passing tracks will be constructed to allow trains to pass in areas of single track. Since the TPC simulation did not include evaluation of HSR trains with freight and other passenger trains, the TPC simulation for each case alternative yields a "pure", unimpeded running time and establishes optimal trip times for the operation of a single train.

Initially, a conceptual service plan was defined specifying two stopping pattern configurations to test in the simulation; one for "express" service and one for "local" service. North Station in Boston and Central Station in Montreal were the end terminals in both service configurations. As shown Table 3.2, the station stops for the "express" configuration include three intermediate stations: Woburn Anderson, Massachusetts; Manchester, New Hampshire; White River Junction, Vermont; and Essex Junction/Burlington, Vermont. The station stops for the "local" configuration included all of the aforementioned "express" station stops plus seven additional intermediate stations: Lowell, Massachusetts; Nashua, New Hampshire; Concord, New Hampshire; Franklin, New Hampshire; Montpelier, Vermont; St. Albans, Vermont; and Saint-Jean-sur-Richelieu, Quebec. A schedule dwell time of two minutes was applied to each intermediate station stop in the simulation model.

Table 3.2 – Potential Station Stops

Local Station Stops	Express Station Stops
Boston – North Station, MA	Boston – North Station, MA
Woburn – Anderson, MA	
Lowell, MA	
Nashua, NH	
Concord, NH	
Franklin, NH	
White River Junction, VT	White River Junction, VT
Montpelier, VT	
Essex Junction/Burlington, VT	Essex Junction/Burlington, VT
Saint Albans, VT	
Saint-Jean-sur-Richelieu, QC	
Montreal – Central Station, QC	Montreal – Central Station, QC

Train simulations were performed using the RTC model developed for the BMHSR study area, applying the conceptual service plans, trainset characteristics and infrastructure assumptions. Table 3.3 shows the TPC simulated terminal-to-terminal run times.

Table 3.3 – Initial Conceptual Service Plan

	Express Run Times	Local Run Times
Low Speed Case		
1-F59PH	7 hrs 42 min	7 hrs 59 min
2-F59PH	7 hrs 40 min	7 hrs 56 min
Mid Speed Case		
1-F59PH	5 hrs 28 min	5 hrs 46 min
2-F59PH	5 hrs 13 min	5 hrs 29 min
Talgo (5 “ unbalance)	4 hrs 37 min	4 hrs 55 min
Talgo (6” unbalance)	4 hrs 24 min	4 hrs 43 min
High Speed Case		
1-F59PH	4 hrs 07 min	4 hrs 42 min
2-F59PH	3 hrs 36 min	4 hrs 06 min

Operations Plans for Ridership Forecasts

To define specific travel times needed to support ridership forecasts, three specific service scenarios were identified. These scenarios were used in the TPC to determine the trip times associated with each scenario. As noted above, the Conceptual Service Plan simulation trip times are unimpeded by restrictions imposed by operations with existing passenger and freight service. The model was run using the single F-59 PH locomotive trainset, the slowest trainset that was studied. This was done because this resulted in run times that more closely approximate service that could reasonably be expected using faster tilting trains operated with existing freight and passenger service and with speed restrictions that are anticipated to remain within the BMHSR Corridor. As with the Conceptual Service Plan, the operations plans used for the ridership forecasts assume no stops required at the U.S./Canada border for customs or immigration inspections.

Low Speed Scenario

This Low Speed Scenario was defined as a basic local-type service operating on existing track conditions. The scenario utilized the “Low Speed Case” modeling criteria for infrastructure and speeds. The scenario represented the slowest speed and included all the cities defined as potential station locations. The results of this TPC simulation are displayed in Table 3.4.

Table 3.4 – TPC Simulation – Low Speed Scenario

Station	Arr/Dep	Schedule	Running Time
Boston – North Station, MA	Dep	0:00	
Anderson-Woburn, MA	Arr	0:19	0:19
	Dep	0:21	
Lowell, MA	Arr	0:35	0:14
	Dep	0:37	
Nashua, NH	Arr	0:52	0:15
	Dep	0:54	
Manchester, NH	Arr	1:11	0:17
	Dep	1:13	
Concord, NH	Arr	1:33	0:20
	Dep	1:35	
Franklin, NH	Arr	1:53	0:18
	Dep	1:55	
White River Junction, VT	Arr	2:51	0:56
	Dep	2:53	
Montpelier, VT	Arr	4:04	1:11
	Dep	4:06	
Essex Junction/Burlington, VT	Arr	4:41	0:35
	Dep	4:43	
Saint-Jean-sur-Richelieu, QC	Arr	7:03	2:20
	Dep	7:05	
Montreal – Central Station, QC	Arr	7:55	0:50

Mid Speed Scenario

The mid speed scenario was defined to represent a reasonable approximation of likely BMHSR Corridor travel times. This scenario utilized the “Mid Speed Case” modeling criteria for infrastructure and speeds. Specific station stops were identified based upon a limited stopping pattern service. The results of this TPC simulation are displayed in the following Table 3.5.

Table 3.5 – TPC Simulation – Middle Speed Scenario

Station	Arr/Dep	Schedule	Running Time
Boston – North Station, MA	Dep	0:00	
Lowell, MA	Arr	0:26	0:26
	Dep	0:28	
Manchester, NH	Arr	0:53	0:25
	Dep	0:55	
Concord, NH	Arr	1:10	0:15
	Dep	1:12	
White River Junction, VT	Arr	2:07	0:55
	Dep	2:09	
Montpelier, VT	Arr	3:05	0:56
	Dep	3:07	
Essex Junction/Burlington, VT	Arr	3:33	0:26
	Dep	3:35	
Montreal – Central Station, QC	Arr	4:48	1:13*

High Speed Scenario

The high speed scenario was defined to determine the minimum trip time for express-type service levels with stops to stations in the largest cities. This scenario utilized the "High Speed Case" modeling criteria. The high speed scenario is not expected to be realistically obtainable due to restrictions associated with utilizing an existing rail corridor. The results of this TPC simulation are displayed in Table 3.6.

Table 3.6 – TPC Simulation – High Speed Scenario

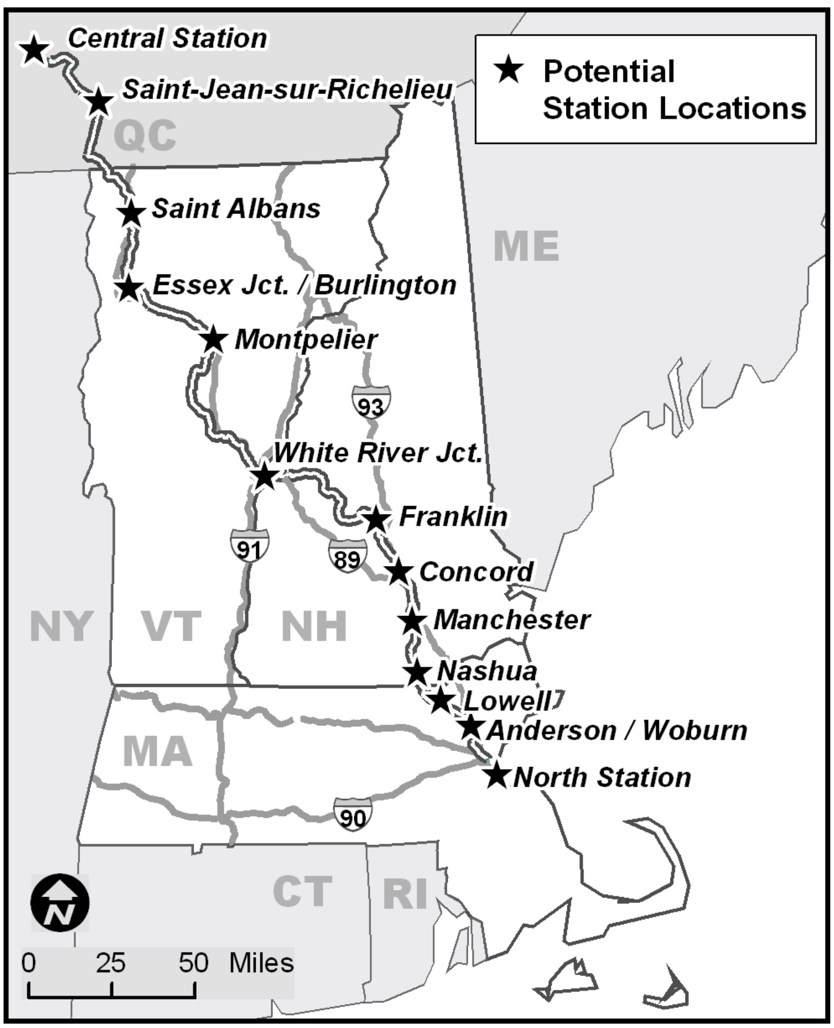
Station	Arr/Dep	Schedule	Running Time
Boston – North Station, MA	Dep	0:00	
Lowell, MA	Arr	0:21	0:21
	Dep	0:23	
Manchester, NH	Arr	0:42	0:19
	Dep	0:44	
Concord, NH	Arr	0:56	0:12
	Dep	0:58	
Essex Junction/Burlington, VT	Arr	2:32	1:34
	Dep	2:34	
Montreal – Central Station, QC	Arr	3:31	0:57

3.2 Market Analysis

BMHSR Corridor Overview

The BMHSR Corridor is 329 miles in length, roughly equal to the Northeast Corridor between Boston and Philadelphia. The study area links key population centers of northern New England and connects the major economic centers of Boston and Montreal. Figure 3.1 provides a summary of the alignment and details potential station locations.

Figure 3.1 – Potential Station Locations



The affected study area includes counties in eastern Massachusetts, southern New Hampshire, northern Vermont, as well as Administrative Regions in Southern Quebec. Specifically, the study area includes the following counties and administrative regions.

- Massachusetts Counties
  - Suffolk, MA
  - Plymouth, MA
  - Bristol, MA
  - Essex, MA
  - Norfolk, MA
  - Middlesex, MA

- New Hampshire Counties
  - Hillsborough, NH
  - Rockingham, NH
  - Strafford, NH
  - Belknap, NH
  - Merrimack, NH
  - Cheshire, NH
  - Sullivan, NH
  - Grafton, NH

- Vermont Counties
  - Grand Isle, VT
  - Franklin, VT
  - Chittenden, VT
  - Addison, VT
  - Orleans, VT
  - Lamoille, VT
  - Essex, VT
  - Caledonia, VT
  - Washington, VT
  - Orange, VT,
  - Windsor, VT

- Quebec Administrative Regions
  - Laval, QC
  - Laurentides, QC
  - Lanaudiere, QC
  - Monteregie, QC
  - Montreal, QC

BMHSR Corridor Demographics

Population and Employment

The BMHSR Corridor traverses Massachusetts, New Hampshire, Vermont, and the southern part of Quebec. Combined, these states and the Montreal metropolitan area have a population of approximately 11.6 million people. In the U.S. portion of the BMHSR Corridor, the population is concentrated in the southern end of the BMHSR Corridor, close to the Boston area, declining in density as the distance from Boston increases until the Chittenden County (Burlington) population center. Similarly, population in the Quebec province is concentrated in Montreal and decreases in density as the distance from the city increases. Table 3.7 provides a listing of population and employment figures based on recent U.S. Census and Statistics Canada data.

Table 3.7 – Population and Employment

	Population	Employment
United States	275,206,000	166,657,000
Canada	30,007,094	14,909,700
Massachusetts	6,349,097	4,099,000
New Hampshire	1,235,786	774,000
Vermont	608,827	405,000
Province of Quebec	7,237,479	3,474,500
Boston Metropolitan area (PMSA)	3,297,201	1,481,839
Montreal Metropolitan Area	3,426,350	1,609,820
Rockingham County, NH	282,041	173,744
Hillsborough County, NH	385,368	244,646
Strafford/Belknap County, NH	170,592	94,762
Merrimack/Grafton County, NH	220,925	157,011
Sullivan/Cheshire County, NH	114,915	64,352
Windsor County, VT	57,910	34,176
Orange/Washington County, VT	86,837	57,025
Chittenden County, VT	148,574	118,936
Franklin/Grand Isle County, VT	52,958	23,507
Addison County, VT	36,387	20,968
Caledonia/Essex County, VT	36,336	19,681
Orleans/Lamoille County, VT	50,119	30,360

Source: U.S. data sources: 2000 U.S. Census population data, 1997 Economic Census. Canadian data sources: 2001 Canadian Census population data, 1996 Economic Census.

Over the past decade, the population of U.S. states within the BMHSR Corridor has grown by 5.5 percent. While this is below the U.S. national growth of 13.1 percent for the decade, specific communities along the BMHSR Corridor are growing at a much faster rate. In particular, communities in southern New Hampshire are experiencing high growth rates, in part due to increasing housing costs in the Boston Metropolitan area.

While Boston shows a declining population of between 0.0 percent and -3.0 percent, counties north of Boston in New Hampshire and Vermont show significant growth rates.

Of the eight counties in New Hampshire and Vermont that are traversed by the rail line, all but one are expected to grow in population by more than 12 percent for the period of 2000 to 2025.

Employment is another key demographic factor that is necessary to analyze as part of the market assessment for the BMHSR Corridor. As the number of jobs in the BMHSR Corridor increases, so does the need for transportation services. Employment in the U.S. portion of the BMHSR Corridor is currently highest in the Boston area, decreasing as it moves farther outside the metropolitan area. A secondary 'hub,' albeit at a substantially reduced level exists in Burlington, Vermont providing another important node in the U.S. portion of the BMHSR Corridor.

Employment in the U.S. portion of the BMHSR Corridor is concentrated in metropolitan areas. Dominant of these cities is Boston, which accounts for an estimated 565,000 jobs in the BMHSR Corridor, based on Massachusetts Division of Employment and Training estimates. The Boston area is expected to add about 75,000 new jobs by 2008. Employment in the Canadian portion of the BMHSR Corridor is concentrated in the Montreal area, with dramatically lower employment totals in the outlying areas. Employment in Montreal has been projected to expand between 1996 and 2021 by 26 percent, resulting in approximately 400,000 new jobs.[1]

BMHSR Corridor Travel Options

Travel options within the BMHSR Corridor consist of three modes: private automobiles, motor coach (bus), and airplane. Each of these modes offers trade-offs in the level of convenience, flexibility, or price. The following section provides an overview of existing service characteristics of each mode.

Automobile Travel

The driving distance between Boston and Montreal is approximately 308 miles, 21 miles less than the 329 BMHSR route miles. The portion of the route between Boston and the Canadian border, about 250 miles, is all on interstate highways with speed limits of between 55 and 65 mph. The Quebec portion of the BMHSR Corridor has slightly lower speed limits of between 80 km/h (50 mph) and 90 km/h (55 mph) until reaching Highway 35 near Saint-Jean-sur-Richelieu, where the speed limit increases to 100 km/h (62.5 mph).[2] With an average travel speed of 60 mph, the trip from Boston to Montreal would take about five hours, however, there will necessarily be stops for people driving the length of the BMHSR Corridor, most notably at the U.S./Canadian border where delays,

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[1] Martin Fernand (May 2002), *Crossing Scenario for the South River*. Report summarizing the Reduction of mobility between Montreal and Rive-Sud.

[2] Note: Highway 35 is anticipated to be upgraded to a four-lane divided highway from the U.S. border to St. Jean-sur-Richelieu by 2007.

particularly post-9/11, can significantly increase overall travel times. In addition, traffic congestion on either end of the BMHSR Corridor can also contribute to overall delays in the BMHSR Corridor. One portion of I-93 in New Hampshire has a nominal toll.

Daily traffic volumes on the segments of the roadways in the BMHSR Corridor that comprise the most direct route between Boston and Montreal are provided in Table 3.8. The traffic volumes in the southern half of the BMHSR Corridor are the highest, decreasing as the checkpoints move farther away from Boston. Volumes then increase or decrease relative to the population of surrounding towns. Traffic volumes increase significantly as one approaches Montreal. The significance of this table is that it provides an estimate of the existing travel pool from which the BMHSR service will draw its passengers.

Table 3.8 – Daily Traffic Volumes at Locations between Boston and Montreal

Roadway Segment	**Year 2000 Daily Volume[1]**
I-93 Boston to Concord (approx. 70 miles)	
Medford/Stoneham town line	185,000
Andover, north of Route 125	135,000
Massachusetts/New Hampshire line	112,000
Manchester at Merrimack River	49,000
Concord (North of NH 132)	36,000
I-89 Concord to Canadian border (approx. 200 miles)	
New Hampshire/Vermont line	38,000
Montpelier (between Exit 8 and Exit 9)	25,000
South Burlington (between Exit 13 and Exit 14)	38,000
South Burlington (between Exit 14 and Exit 15)	50,000
St. Albans (between Exit 20 and Exit 21)	10,000
Highgate Border Crossing	4,000
Canadian Border to Montreal (approx. 50 miles)	
Route 133	
North of Highgate border	5,000
At Sabrevois	9,000
Highway 35	
At Saint-Jean-sur-Richelieu	31,000
35/10 at Chambly	28,000
Highway 10/30	
At Longueuil	60,000
Champlain Bridge	115,000

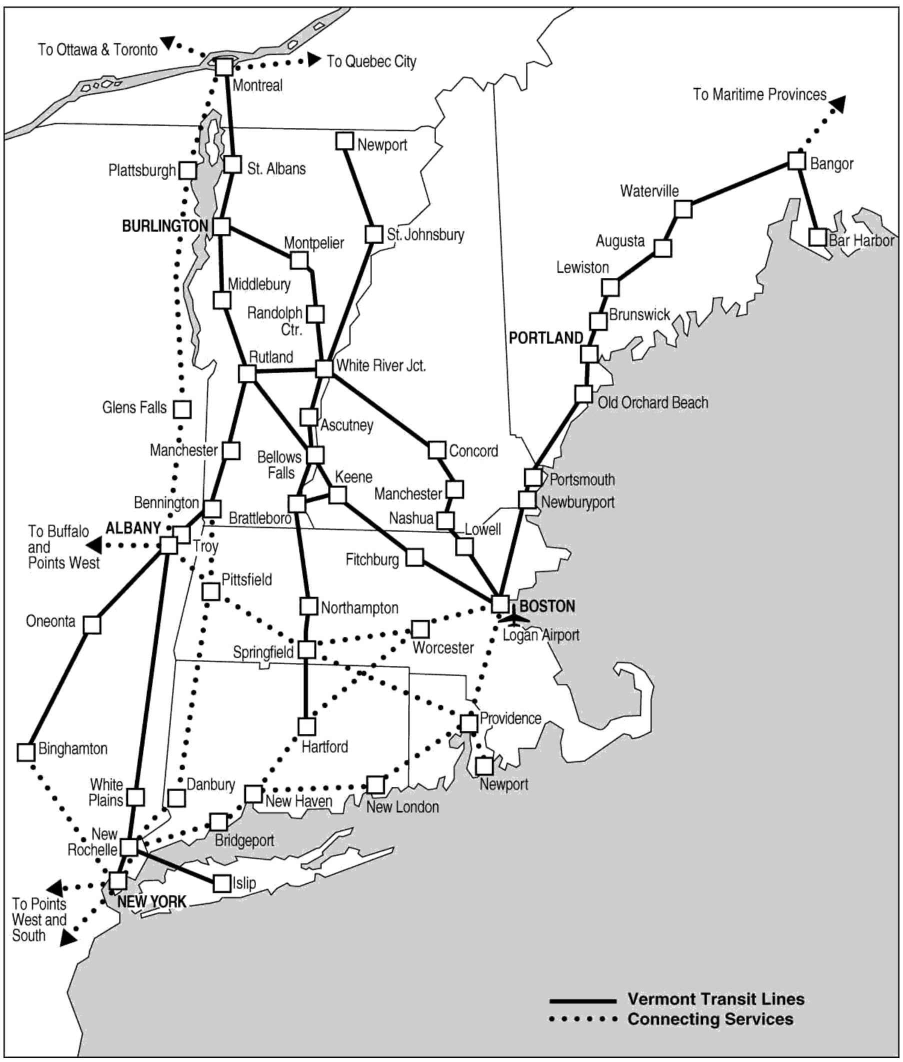
[1] Sources: www.nhdot.com, www.state.ma.us/mhd, www.aot.state.vt.us, MTQ.

Intercity Bus Services

Two intercity carriers, Greyhound/Vermont Transit and Concord Trailways, provide intercity bus service along the BMHSR Corridor.

Greyhound/Vermont Transit. Greyhound/Vermont Transit provides bus service in Vermont, New Hampshire, Maine, Massachusetts, and New York (Figure 3.2). Within the BMHSR Corridor, intercity routes operate between Boston and Montreal, with major stops in many of the cities proposed for stops on the BMHSR Corridor including: Concord, White River Junction, Montpelier, and Burlington (Essex Junction).

Figure 3.2 – Vermont Transit Intercity Bus Services



Vermont Transit currently runs four daily trips between Boston and Montreal, including one express trip in each direction that takes about six hours. The non-express buses stop in New Hampshire at Manchester, Manchester Airport, and Hanover and in Vermont at

White River Junction, Montpelier, and Burlington. With these stops, a typical one-way trip between Boston and Montreal takes between seven and eight hours. A few of these trips also serve Nashua, New Hampshire and Lowell, Massachusetts.

White River Junction is the primary transfer station where connections to Vermont Transit services south to Springfield, Hartford, and New York City are made. The travel time from White River Junction to New York City is about six hours. Table 3.9 shows current service levels for selected Vermont Transit services in the BMHSR Corridor.

Table 3.9 – Vermont Transit Intercity Bus Service in the BMHSR Corridor

Origin	Destination	Frequency (Daily Trips)	One-Way Travel Time	One-Way Fare (US$)
Boston	Montreal	4	6-8 hours	$58
Montreal	Boston	4	6-8 hours	$58
Boston	White River Junction	8	2.5-3.5 hours	$25
White River Junction	Boston	8	2.5-3.5 hours	$25
Burlington	White River Junction	3	2 hours	$16
White River Junction	Burlington	3	1.5-2 hours	$16
Burlington	Montreal	4	2.5 hours	$20
Montreal	Burlington	3	2.5 hours	$20
Boston	Nashua	6	1.0 hour	$9
Nashua	Boston	3	1.0 hour	$9
Boston	Lowell	4	45 minutes	$6
Lowell	Boston	3	45 minutes	$6

Source: Vermont Transit web site (www.vermonttransit.com), and Greyhound web site (www.greyhound.com), February 2002.

Concord Trailways. Another carrier is Concord Trailways, providing service in New Hampshire, Maine, and Massachusetts, primarily with routes for Boston-bound commuters from the southern New Hampshire cities of Concord, Manchester, and Londonderry. Concord Trailways also operates routes that serve Laconia, Berlin, and Littleton.

Concord Trailways operates frequent peak-period service from Concord and Manchester to downtown Boston and Logan Airport. The travel time between Concord and Boston South Station is about 90 minutes. Throughout the day, Concord Trailways operates about 20 inbound trips to Boston and 20 outbound trips to Concord/Manchester. Most of the inbound trips start in Concord and stop in Manchester before continuing into Boston. A few runs, however, start in Manchester, serving Boston directly.

Concord Trailways provides commuter bus service between Londonderry and downtown Boston with eight inbound morning trips to Boston and 10 outbound afternoon and evening trips to Londonderry. Table 3.10 summarizes the levels-of-service for selected Concord Trailways service in the BMHSR Corridor.

Table 3.10 – Concord Trailways Intercity Bus Service in the BMHSR Corridor

Origin	Destination	Frequency (Daily Trips)	One-Way Travel Time	One-Way Fare (US$)
Concord, NH	Boston	17	1.5 hours	$12.50
Boston	Concord, NH	19	1.5 hours	$12.50
Concord, NH	Manchester, NH	14	0.5 hour	$4.50
Manchester, NH	Concord, NH	17	0.5 hour	$4.50
Londonderry, NH	Boston	8	1.0 hour	$8.50
Boston	Londonderry	10	1.0 hour	$8.50

Source: Concord Trailways web site (www.concordtrailways.com), February 2002.

Airline Services

Airline travel within the BMHSR Corridor originates either at Boston's Logan International Airport, Burlington International Airport in Burlington, Vermont or Dorval International Airport in Montreal, Quebec. While Manchester Airport in New Hampshire is located within the BMHSR Corridor, there are no commercial flights to Montreal, Boston or Burlington from this location. This section summarizes airline travel activity between Boston and Montreal, Montreal and Boston, Boston and Burlington, and Burlington and Boston. No commercial airline service is available between Burlington and Montreal.

Several sources of data were used to evaluate existing airline services and their operating characteristics, including the Official Airline Guide web site, and quarterly aviation reports obtained from Back Aviation Solutions for the period of the first quarter of 1996 through the second quarter of 2001. Because some of the data were not accurately reported, this study focused on a 12-month period from July 1, 2000 through June 30, 2001 for which most data is reliable. This period also predates September 11, 2001, which had a devastating influence on airline travel including the discontinuation of American Airlines service between Boston and Montreal in September 2001.

The quarterly data includes seating capacity of all flights by airline and the estimated number of passengers by airline. Based on this information the load factor (percent of seats occupied) was calculated for each market. Missing data is indicated by “na.”

Boston to Montreal Three carriers currently serve the passenger airline market between Boston and Montreal: Air Canada, Delta Airlines and United Airlines. United Airlines flights, however, are operated by Air Canada. As shown in Table 3.11, these carriers provide nine direct flight options on weekdays and seven or eight options on the weekend. Scheduled flight time is between 70 and 95 minutes, depending on the time of day.

Table 3.11 – Current Non-stop Direct Flights between Boston and Montreal

Carrier	Weekday		Saturday		Sunday	
	Boston to Montreal	Montreal to Boston	Boston to Montreal	Montreal to Boston	Boston to Montreal	Montreal to Boston
Air Canada/ United Airlines	4	4	2	2	3	3
Delta Airlines	5	5	5	5	5	4
Total	9	9	7	7	8	7

Source: Official Airline Guide Web site (www.oag.com) February 2002.

The cost of airline tickets varies widely depending upon travel options and ticket restrictions. A sample of ticket prices during February 2002 show that the lowest round-trip cost for coach class is about US$204, and for business class about US$550. Connecting flights are available through New York, Pittsburgh or Philadelphia, and can reduce the fare slightly, although travel time is increased to four to six hours.

Table 3.12 shows the seating capacity, estimated passengers, and the load factor, for flights from Boston to Montreal. The data for this period includes information on American Airlines, which at the time was operating service between Boston and Montreal.

The results indicate that both American Airlines and Delta Airlines maintain an average load factor of 17 percent to 24 percent on all flights. Air Canada load factors could not be calculated due to missing data in the OAG database. Similar results can be seen for the service from Montreal to Boston. Overall, utilization is light with only 14 percent to 28 percent of available seats occupied.

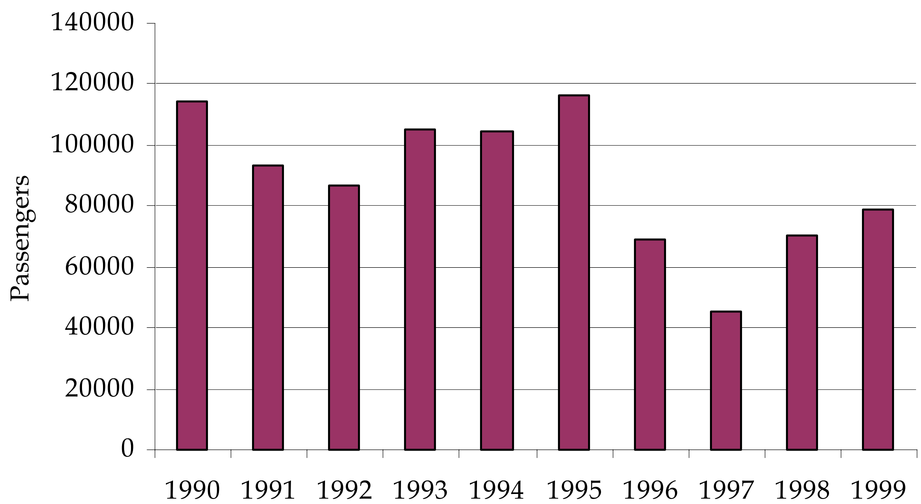
Table 3.12 – Airline Service Characteristics

		Year 2000 3rd quarter	Year 2000 4th quarter	Year 2001 1st quarter	Year 2001 2nd quarter
Boston to Montreal					
Air Canada	Seats	20,900	19,500	20,000	20,350
	Passengers	na	na	na	na
	Load Factor	na	na	na	na
American Airlines	Seats	2,618	10,846	8,738	11,662
	Passengers	630	2,200	1,600	2,650
	Load Factor	24%	20%	18%	23%
Delta Airlines	Seats	16,999	16,350	14,660	14,432
	Passengers	3,750	3,060	2,540	3,070
	Load Factor	22%	19%	17%	21%
Total	**Seats**	**40,517**	**46,696**	**43,398**	**46,444**
	Passengers	**na**	**na**	**na**	**na**
	Load Factor	**na**	**na**	**na**	**na**
Montreal to Boston					
Air Canada	Seats	20,900	19,500	20,000	20,350
	Passengers	na	na	na	na
	Load Factor	na	na	na	na
American Airlines	Seats	2,564	10,846	8,738	11,662
	Passengers	730	1,980	1,240	2,650
	Load Factor	28%	18%	14%	20%
Delta Airlines	Seats	16,999	16,350	14,660	14,432
	Passengers	3,690	3,000	2,540	3,070
	Load Factor	22%	19%	17%	21%
Total	**Seats**	**40,334**	**46,696**	**43,448**	**46,444**
	Passengers	**na**	**na**	**na**	**na**
	Load Factor	**na**	**na**	**na**	**na**

Source: Back Aviation Solutions, Official Airline Guide Database, January 2002.

Airline travel between Boston and Montreal has declined significantly between 1990 and 1999 (Figure 3.3). From 1990 through 1995, annual ridership remained in the 90,000 to 120,000 range. Airline travel between the cities dropped precipitously to a low of less than 50,000 passengers in 1997, due to a reduction in flights serving the Boston to Montreal market. Since that time, ridership has been picking up with annual passengers nearing 80,000 in 1999. Due to the volatility of annual airline ridership between Boston and Montreal in the period of 1990 through 1999, it is difficult to determine future trends in airline ridership. Given the events of 9/11 and the airport security aftermath, it is even more difficult to predict future ridership trends.

Figure 3.3 – Airline Passengers between Boston and Montreal



Boston to Burlington, Vermont Delta Airlines and U.S. Airways currently provide airline service between Boston and Burlington, Vermont. As shown in Table 3.13, these carriers provide eight direct flight options on weekdays and six or seven options on the weekend. Scheduled flight time is between 60 and 75 minutes, depending on the time of day.

Table 3.13 – Current Non-stop Direct Flights between Boston and Burlington

	Monday - Friday		Saturday		Sunday	
	Boston to Burlington	**Burlington to Boston**	**Boston to Burlington**	**Burlington to Boston**	**Boston to Burlington**	**Burlington to Boston**
Delta Airlines	4	4	4	4	4	4
U.S. Airways	4	4	3	3	2	2
Total	8	8	7	7	6	6

Source: Official Airline Guide Web site (www.oag.com) February 2002.

A sample of ticket prices during February 2002 show that the lowest roundtrip coach class ticket is about US$200. No business class travel is available on these non-stop flights. Connecting flights are available through Albany, White Plains, Newark, New York, or Washington D.C., increasing travel time to three to six hours. No fare savings are associated with the connecting flight options and the price can be substantially more. Business class tickets can be purchased for connecting flights for about US$1,000.

Table 3.14 shows the seating capacity, estimated passengers, and the load factor, for flights from Boston to Burlington. As with the Boston to Montreal data presented in the previous section, some of the data was not usable for this summary and is indicated by a "na." The valid results indicate that Delta Airlines and U.S. Airways exhibited load factors between 4.0 percent and 9.0 percent during the first six months of 2001.

Similar results can be seen in Table 3.14 for the service from Burlington to Boston, with 6.0 percent to 9.0 percent of available seats occupied.

Table 3.14 – Airline Service Characteristics

		Year 2000 3rd quarter	Year 2000 4th quarter	Year 2001 1st quarter	Year 2001 2nd quarter
Boston to Burlington					
Air Canada	Seats	29,138	21,318	17,986	21,828
	Passengers	na	na	1,550	1,770
	Load Factor	na	na	9%	8%
Continental	Seats	0	3,914	13,908	12,293
	Passengers	0	na	na	na
	Load Factor	-	-	na	na
Delta	Seats	0	0	9,440	14,368
	Passengers	0	0	530	880
	Load Factor	-	-	6%	6%
U.S. Airways	Seats	11,514	13,434	15,688	15,836
	Passengers	na	na	920	1,210
	Load Factor	na	na	6%	8%
Total	**Seats**	**40,652**	**38,666**	**57,022**	**15,836**
	Passengers	**na**	**na**	**na**	**na**
	Load Factor	**na**	**na**	**na**	**na**

Source: Compiled from data obtained from Back Aviation Solutions, Official Airline Guide Database, January 2002.

Airline Travel Summary

Table 3.15 summarizes the airline characteristics for service within the BMHSR Corridor, including number of flights, average load factor, travel times and cost. On average, the non-stop flights in the BMHSR Corridor operate at about 20 percent of capacity, and offer a maximum flight time of 90 minutes between Boston and Montreal. For travel between Boston and Burlington, the percent of seats occupied is very low at 7 percent, with a travel time of 75 minutes between Boston and Burlington, Vermont.

Coach seats can be purchased for about $200 or less for all connections. For travel between Boston and Montreal, a connecting flight can reduce the round-trip cost, but adds two to four hours to the travel time. For travel between Boston and Burlington, Vermont, a connecting flight will not save any money, but can add up to five hours to the travel time.

Table 3.15 – Airline Travel Characteristics Summary

	Type of Flight	Number of Weekday Flights Each Direction (2002 Data)	Load Factor (2001 Data)	Travel Time (2002 Data)	Round-trip Cost (2002 Data)
Boston to Montreal/ Montreal to Boston	Non-stop	13	20%	70-90 minutes	$250 coach $550 business
Boston to Montreal/ Montreal to Boston	Connection in New York, Pittsburgh, or Philadelphia.	About 5	NA	4-6 hours	$170 coach $800 business
Boston to Burlington/ Burlington to Boston	Non-stop	8	7%	60-75 minutes	$ 225 coach No first class or business class service is offered
Boston to Burlington/ Burlington to Boston	Connection in Albany, White Plains, Newark, New York, or Washington DC	About 20	NA	3-6 hours	$250-800 coach $1,000 business

Current Rail Services

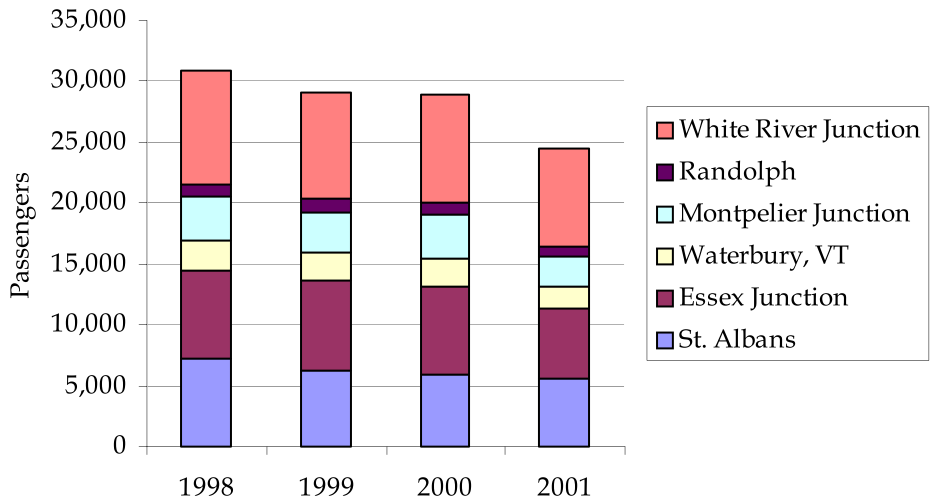
Amtrak Vermonter Service The Amtrak Vermonter train operates one daily trip in each direction between Washington, DC and St. Albans, Vermont, with major stops at New York City, Springfield, White River Junction, Montpelier, and Burlington. In both directions, the Vermonter schedule at St. Albans coordinates with the Vermont Transit bus service to and from Montreal, allowing a relatively easy transfer between train and bus. Table 3.16 shows travel time and fare for selected segments of the Vermonter service.

Table 3.16 – Amtrak Vermonter Service – Selected Connections

Origin	Destination	Frequency (Daily Trips)	One-Way Travel Time	One-Way Fare (US$)
New York City	St. Albans, VT	1	9 hours	$61
St. Albans, VT	New York City	1	14 hours	$61
White River Junction	St. Albans, VT	1	2.5 hours	$18
St. Albans, VT	White River Junction	1	2.5 hours	$18
White River Junction	Essex Junction, VT	1	2 hours	$18
Essex Junction, VT	White River Junction	1	2 hours	$18

Although passenger boardings at each of the Vermont stations between 1998 and 2001 have declined only slightly each year, the culmination of these declines has caused the overall ridership to drop from about 31,000 in 1998 to under 25,000 in 2001; a decline of 19 percent. Figure 3.4 shows boardings at each of the Vermont stations, and the cumulative on-counts for Vermont in total.

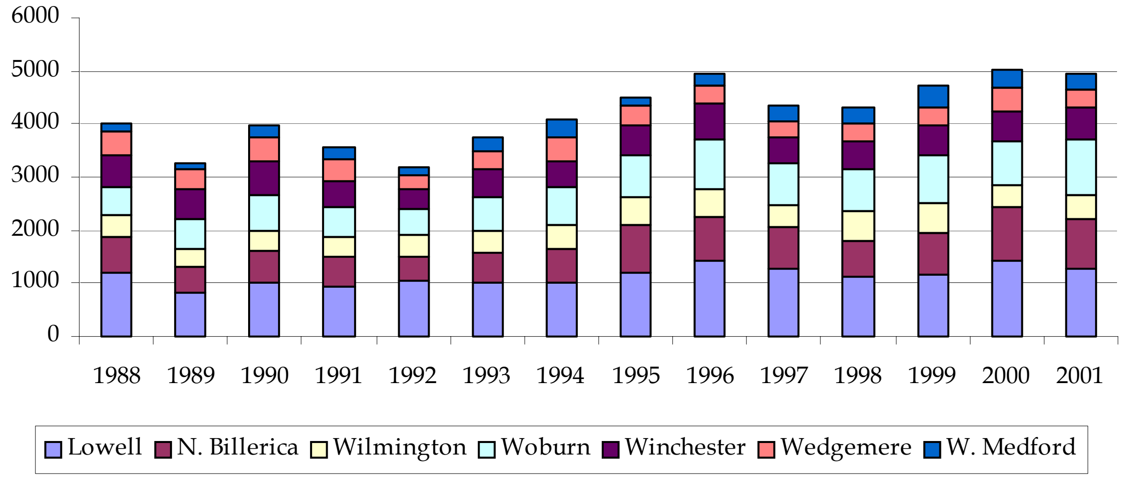
Figure 3.4 – Passenger Boardings on Vermonter Stops between St. Albans and White River Junction 1990-2001



Boston Area Commuter Rail Another rail service in the BMHSR Corridor is provided by the Massachusetts Bay Transportation Authority's Lowell line. The Lowell line operates between Lowell and North Station in Boston, with six intermediate stops in the communities of Medford, Winchester, Woburn, Wilmington and North Billerica. One-way travel time is about 45 minutes in either direction. On weekdays, 21 round trip trains operate between Lowell and North Station with a one-way fare of $4.50.

Ridership on the Lowell line has been increasing since the early 1990s, and as of February 2001, was nearly 11,000 daily (Figure 3.5). The station providing the highest number of boardings is the terminal station at Lowell. Recognizing the needs of commuters north of Lowell, the MBTA in partnership with the New Hampshire Department of Transportation, the Nashua Regional Planning Commission and the city of Nashua, is working to extend MBTA service on the Lowell line to Nashua. This extension is being provided to help meet the needs of residents of southern New Hampshire who commute to Boston. Upon completion of the extension, it is envisioned that ridership on the Lowell line will increase by approximately 1,000 riders per day.

Figure 3.5 – Daily Passenger Boardings on the Lowell Commuter Line



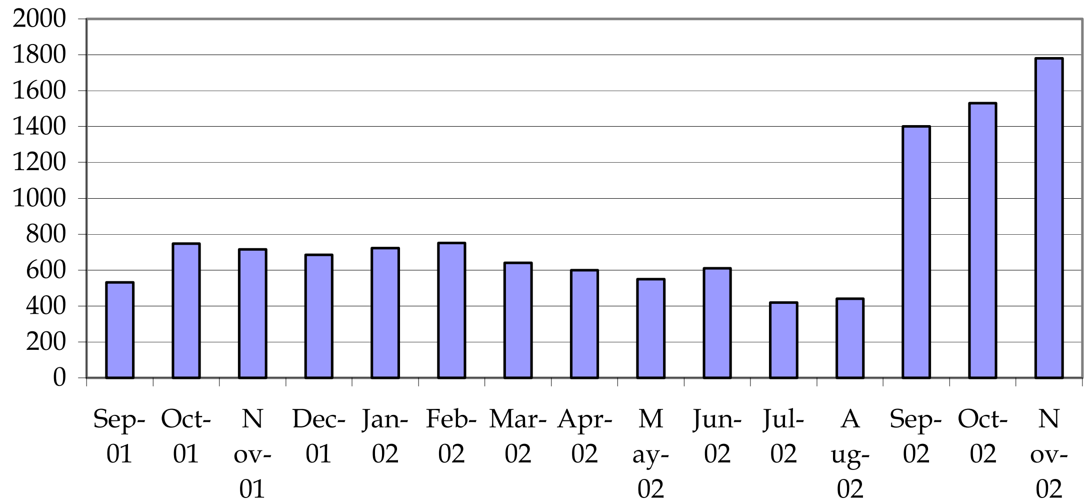
Source: MBTA, 2002.

Montreal Area Commuter Rail Similar to the MBTA, the Agence-Metropolitaine de-Transport (AMT) provides commuter rail service operating between Montreal Lucien-L'Allier Station and Delson, eight kilometers from Saint-Jean-sur-Richelieu with five intermediate stops in Vendome, Montreal-Ouest, LaSalle, Sainte-Catherine and Saint-Constant. This line was opened in September 2001 with a one-way trip time of 30 minutes. The service was instituted on a trial basis, and will be evaluated to determine if it should be continued. On weekdays, 4 inbound trains operate between 6:05 a.m. and 9:05 a.m. and 4 outbound trains operate between 3:40 p.m. and 6:10 p.m. There is no train service on weekends and holidays. One-way travel is CA$5.75 (about US$3.75). Current ridership levels on the service are relatively low, with approximately 650 total daily riders, however, ridership is expected to increase in time as commuters become more aware of this new option. Figure 3.6 provides monthly ridership compiled by Agence-Metropolitaine de-Transport from September 2001 to November 2002.

In addition to commuter rail services, a number of long distance, intercity services are provided by VIA Rail. These services include:

- Toronto-Montreal Overnight (the Enterprise)
- Oakville-Toronto-Montreal
- Ottawa-Alexandria-Montreal
- Quebec-Charny-Montreal
- Jonquiere-Montreal (the Saguenay)
- Senneterre-Montreal (the Abitibi)
- Gaspe-Perce-Montreal (the Chaleur)
- Halifax-Montreal (the Ocean)

Figure 3.6 – Daily Ridership on the Montreal/Delson Commuter Rail Line



Source: Agence-Metropolitaine de-Transport (AMT), 2002.

Burlington-Essex Junction. The Chittenden County Metropolitan Planning Organization (CCMPO) recently completed a study with the Vermont Agency of Transportation to examine the feasibility of passenger rail service in the Burlington-Essex corridor, as an extension of the Charlotte-Burlington passenger rail project. Two scenarios were estimated: an "All Day Scenario" that would provide service every 30 minutes, from 6:00 a.m. to 9:00 p.m., seven days a week (with a reduced level of service on weekends and holidays) and a "Moderate Scenario" that would provide hourly service only during the morning and evening peak traffic periods (three trains would depart Charlotte and Essex in the morning hours and three trains would repeat that service in the afternoon peak traffic period), weekdays only. A one dollar per trip (one way) fare is assumed in all scenarios.

CCMPO and VTrans are continuing to study this project to determine how this link might affect rail transportation in Vermont. While not a part of the Boston to Montreal alignment, this service, if constructed, could act as a direct feeder between the high-speed rail station and the cities of Burlington and Charlotte.

BMHSR Corridor Travel Demand

Border Crossing

Three U.S. border gates exist in the vicinity of the BMHSR Corridor: Champlain-Rouses Pt., New York, Highgate Springs, Vermont and Richford, Vermont. Over 2 million vehicle crossings occur annually between the three crossings.

Table 3.17 – Vehicles Crossing the U.S. Border from Canada in the BMHSR Corridor, 2000

	Cars		Trains		Buses		Trucks		Total
Champlain-Rouses Pt.	980,130	70.8%	1,386	0.1%	11,728	0.8%	390,836	28.2%	1,384,080
Highgate Springs	446,046	76.4%	353	0.1%	4,446	0.8%	132,709	22.7%	583,554
Richford	143,638	92.2%	242	0.2%	86	0.1%	11,758	7.6%	155,724
Total BMHSR Corridor	**1,569,814**	**73.9%**	**1,981**	**0.1%**	**16,260**	**0.8%**	**535,303**	**25.2%**	**2,123,358**

Source: U.S. Customs, 2002.

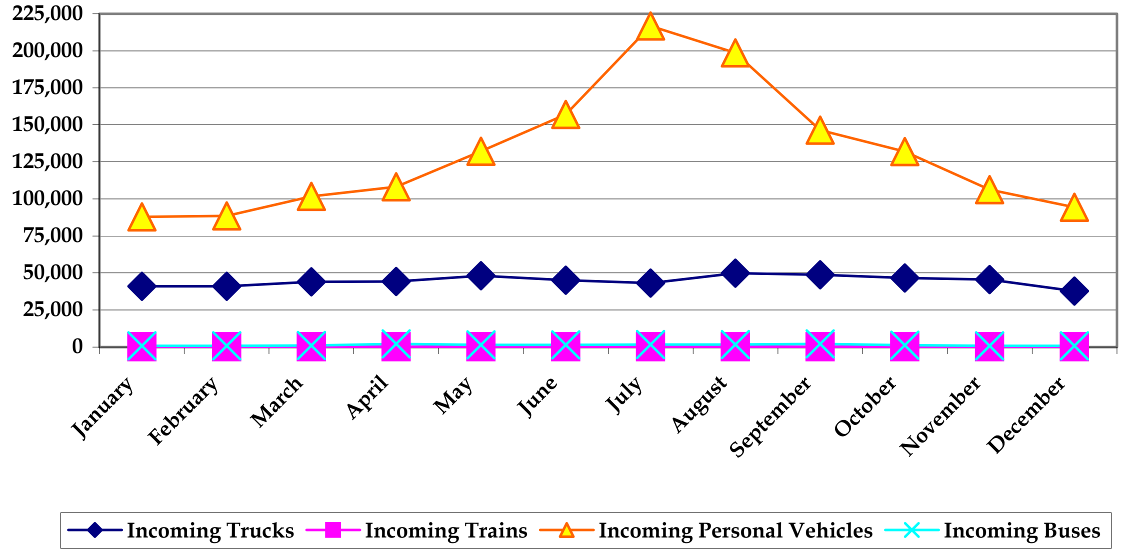
Table 3.18 – People Crossing the U.S. Border from Canada by Mode in the BMHSR Corridor, 2000

	Cars		Train		Bus		Pedestrians		Total
Champlain-Rouses Pt.	2,747,141	88.4%	38,459	1.2%	317,205	10.2%	3,281	0.1%	3,106,086
Highgate Springs	957,869	89.2%	706	0.1%	115,341	10.7%	314	0.0%	1,074,230
Richford	271,861	97.3%	784	0.3%	2,355	0.8%	4,348	1.6%	279,348
Total BMHSR Corridor	**3,976,871**	**89.2%**	**39,949**	**0.9%**	**434,901**	**9.8%**	**7,943**	**0.2%**	**4,459,664**

Source: U.S. Customs, 2002.

The total number of incoming vehicles at border crossings in the BMHSR Corridor is seasonal, with the highest volume of traffic occurring during summer months. Virtually all of the seasonal variation is attributable to personal vehicles that make up about 80 percent of traffic during the peak month of July. Figure 3.7 portrays the total number of vehicles by month for 2000.

Figure 3.7 – Vehicular Traffic from Canada to the U.S. at Border Crossings in the Vicinity of the BMHSR Corridor

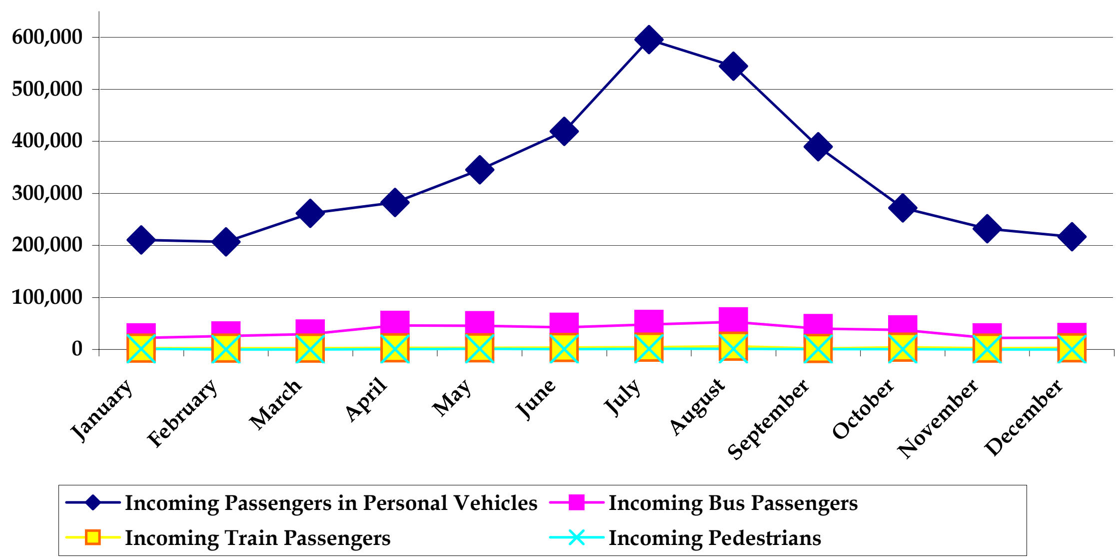


Note: Border Crossings included are Champlain/Highgate Springs, Vermont, Champlain-Rouses Point, New York and Richford, Vermont.

Source: U.S. Customs, 2002.

Similar to the seasonality of vehicular traffic in the BMHSR Corridor, the number of people entering the United States from Canada is also highest during summer months (Figure 3.8). During this time period, the average number of people per vehicle increases from about 1.1 passenger per personal vehicle to nearly 3 people per vehicle. While the number of vehicle border crossings increases during summer months, the number of people increases at an even faster rate.

Figure 3.8 – Incoming People from Canada to the U.S. at Border Crossings in the Vicinity of the BMHSR Corridor



Note: Border Crossings included are Champlain/Highgate Springs, Vermont, Champlain-Rouses Point, New York and Richford, Vermont.

Source: U.S. Customs, 2002.

Tourism Demand

The BMHSR Corridor provides access to the Quebec/New England tourism region by linking two major metropolitan areas in the Northeast and passing through key cities in Vermont, New Hampshire, and Massachusetts.

Quebec Travel to U.S. Corridor In 2001, 2.7 million Quebecois traveled within the three-state corridor of Massachusetts, New Hampshire and Vermont. Seventy-seven percent of these trips were to Vermont, 14 percent to New Hampshire, and 9.0 percent to Massachusetts. Twenty-six percent of those tourists stayed overnight: 56 percent in Vermont, 26 percent in Massachusetts and 18 percent in New Hampshire (Table 3.19).

Table 3.19 – Quebec Visitors and Tourists to the U.S. Portion of the BMHSR Corridor in 2001

Destination	Overnight Person-Visits		Total Person-Visits	
Massachusetts	189,000	26%	245,000	9%
New Hampshire	131,000	18%	385,000	14%
Vermont	404,000	56%	2,117,000	77%
BMHSR Corridor	725,000	100%	2,747,000	100%

Source: 2001 International Travel Survey (Statistics Canada, 66-201-XIE).

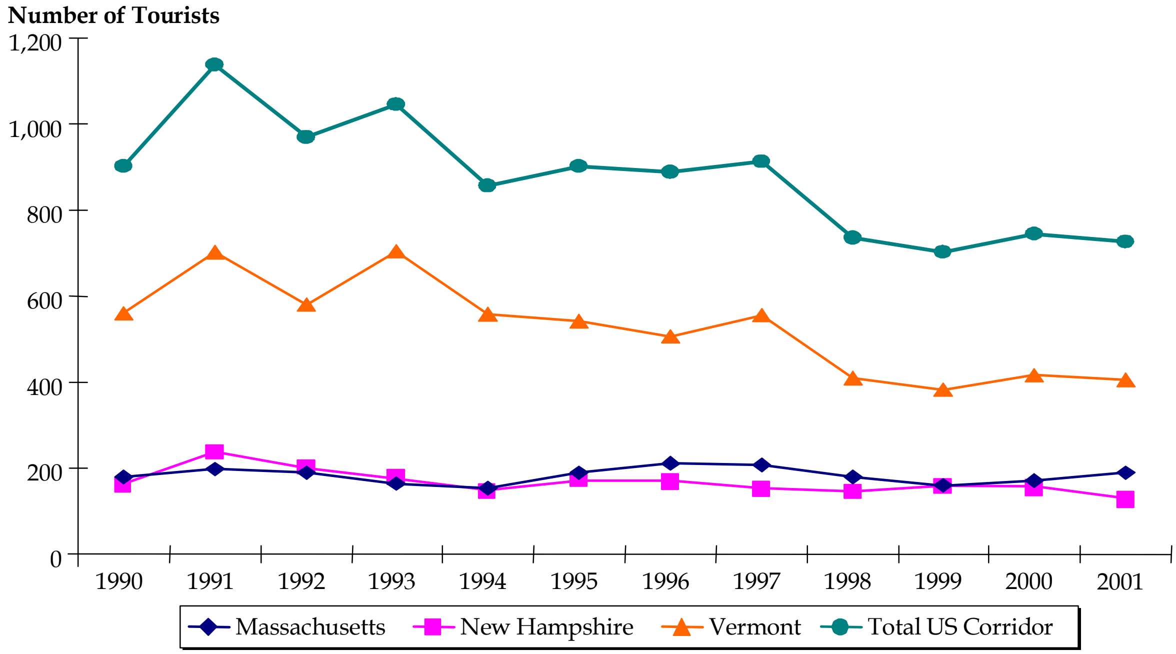
Travelers from Quebec represented 54 percent of Canadian overnight visits to the three states in 2001. This proportion was 70 percent in Vermont, and 40 percent and 45 percent in New Hampshire and Massachusetts, respectively. Quebec tourism to states in the BMHSR corridor declined from 1990 to 2001 largely due to a decline in visits to Vermont (Figure 3.9). This is due in part to a shift in the U.S./Canadian currency exchange rate, favoring the U.S. For example, a Canadian dollar that was worth 83 American cents in 1990 was worth about 60 American cents in 2001 – a decline of 28 percent.

Business trips represented on average 5 percent of all Quebec overnight visits to the three states. This proportion was highest in Massachusetts at 12 percent. The proportion was 5 percent in New Hampshire, and 3 percent in Vermont. More than 70 percent of Quebec tourists went to New Hampshire and Vermont for pleasure. Half of those pleasure trips to Vermont were to visit a second home, cottage or condominium. Pleasure trips represented 49 percent of trips to Massachusetts, whereas one third of Quebec tourist's trips were made to visit friends or relatives. Visit to friends and relatives represented 18 percent to 20 percent of Quebecois trips to Vermont and New Hampshire.

Seventy-five percent of Quebec parties are composed of adults without children. This proportion is highest in Vermont (80 percent) and lower in Massachusetts and New Hampshire where parties composed of adults and children represented one third of all parties in 2001.

Distance appeared to play a role in the length of the trip. Quebec tourists stayed on average 4.5 nights in Massachusetts, whereas they stayed 2.8 and 3.0 nights in Vermont and New Hampshire, respectively.

Figure 3.9 – Overnight Quebec Tourists to States within the BMHSR Corridor (1990-2001)



Source: 2001 International Travel Survey (Statistics Canada, 66-201-XIE).

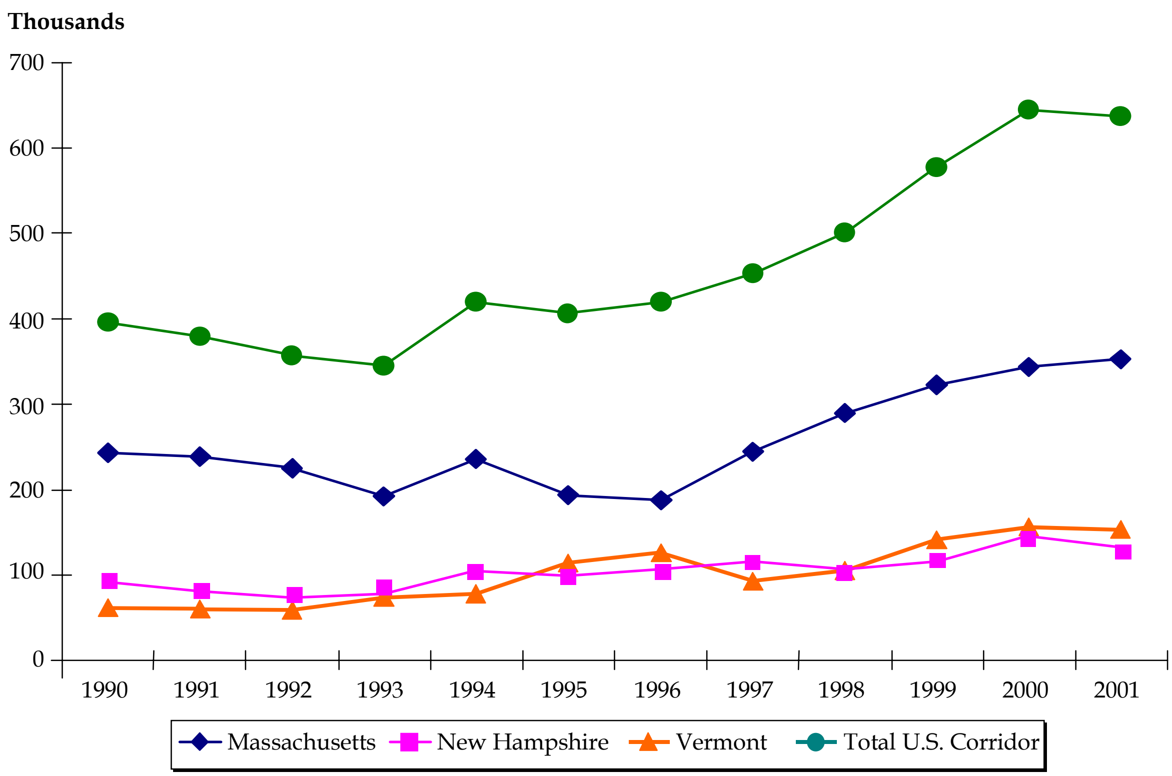
U.S. Tourism to Quebec Tourism is also important to the Quebec economy. More than 36 million people visited Quebec overnight in 1999. Fifty-three percent of those visitors spent more than one day in the province: 74 percent were from Quebec, 12 percent from other Canadian provinces, 11 percent from United States and 4.0 percent from other countries. Of those 36 million visitors to the province, about 10.1 million traveled to Montreal. About 5.8 million visitors spent at least one night in the Province. The visitors come from varied destinations: 32.4 percent come from within the province of Quebec, 29.7 percent from the rest of Canada, 23.7 percent from the United States and 14.2 percent from overseas.

Tourists who stayed overnight in Quebec spent $4.6 billion Canadian dollars (about $3.0 billion in U.S. dollars) in 1999 of which Americans contributed 24 percent. American visitors to Montreal spend about CA$2.0 billion dollars each year, of which CA$1.8 billion comes from tourists who stay overnight. Americans visitors to Quebec stayed on average 3.4 nights in 1999. The majority of these trips were for pleasure, as only 26.3 percent of visitors cite business as the purpose of their trip.

In 2001, 637,000 overnight tourists from Massachusetts, Vermont and New Hampshire visited Quebec. Fifty-five percent were from Massachusetts, 24 percent from Vermont and 21 percent from New Hampshire (Figure 3.10). Overall there are about 100,000 more Quebecois that spend the night in the three-state region than persons from the three-state region that spend the night in Quebec. This is primarily due to the fact that more than twice as many Quebecois have overnight trips in Vermont than the reverse. Tourists from Vermont and New Hampshire to Quebec increased slightly from 1990 to 1997, whereas tourists from Massachusetts fluctuated during that period. The number of tourists from the U.S. portion of the BMHSR corridor to Quebec increased 50 percent from 1996 to 2001, due to an increase in the number of tourists from Massachusetts during this period (Figure 3.11).

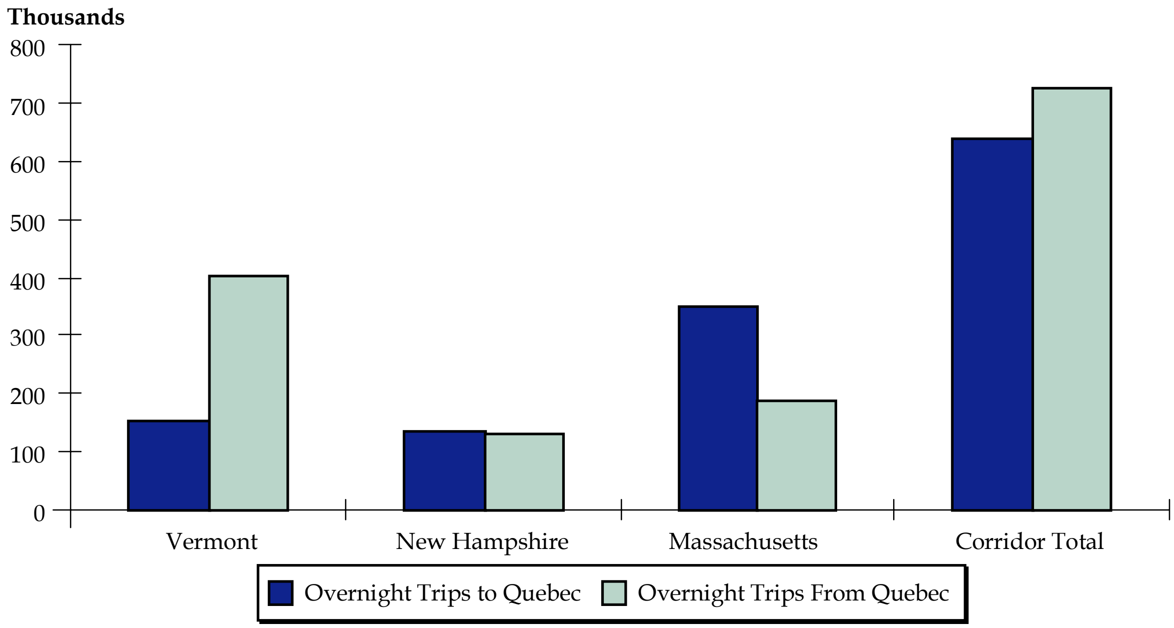
Tourist trips within the BMHSR Corridor are short in duration: visitors from Vermont, Massachusetts and New Hampshire stay on average 2.5, 2.9 and 3.0 nights, respectively. Tourists were predominantly comprised of adult parties with parties with children encompassing only between 12 and 23 percent of all trips depending on the state of trip origin. Most parties were comprised of two or more adults who traveled for pleasure (69 percent, 67 percent and 43 percent for Massachusetts, New Hampshire and Vermont) or to visit friends and relatives (18 percent, 25 percent and 44 percent, respectively). Business trips represent only 4.0 percent to 6.0 percent of all visits.

Figure 3.10 – Overnight Visitors to Quebec by State of Origin within BMHSR Corridor (1990-2001)



Source: 2001 International Travel Survey (Statistics Canada, 66-201-XIE).

Figure 3.11 – Overnight Visits Between Quebec and the BMHSR Corridor States



Source: 2001 International Travel Survey (Statistics Canada, 66-201-XIE).

Overall, there are more overnight visits from Quebecois to the U.S. than U.S. overnight visits to the Quebec province. This of course varies by state, with more Quebecois traveling to Vermont than Vermonters traveling to Quebec, but more Massachusetts residents traveling to Quebec than Quebec residents traveling to Massachusetts. The number of visitors between New Hampshire and Quebec is roughly equal.

Profiles of Domestic Tourism in Massachusetts, Vermont and New Hampshire

The American Travel Survey (ATS) is a national survey conducted by the U.S. Census Bureau. In 1995, the ATS collected information from approximately 80,000 households about their long-distance travel in 1995. Information from this survey provides a basis for origin/destination information within the BMHSR Corridor. Because the survey only looks at trips that are greater than 100 miles in length, short trips such as errands and most commuter trips are excluded from the study results.

Americans from Massachusetts, New Hampshire and Vermont made 17.9 million domestic trips of more than 100 miles in 1995. Thirty-four percent of all those trips were destined to locations within those three states, as shown in Table 3.20. Massachusetts, the most populated state, generates the most trips. Sixty-six percent of trips originated in Massachusetts, 21 percent in New Hampshire and 13 percent in Vermont. Of all trips within the U.S. corridor, 42 percent were destined to Massachusetts, 40 percent to New Hampshire, and 18 percent to Vermont.

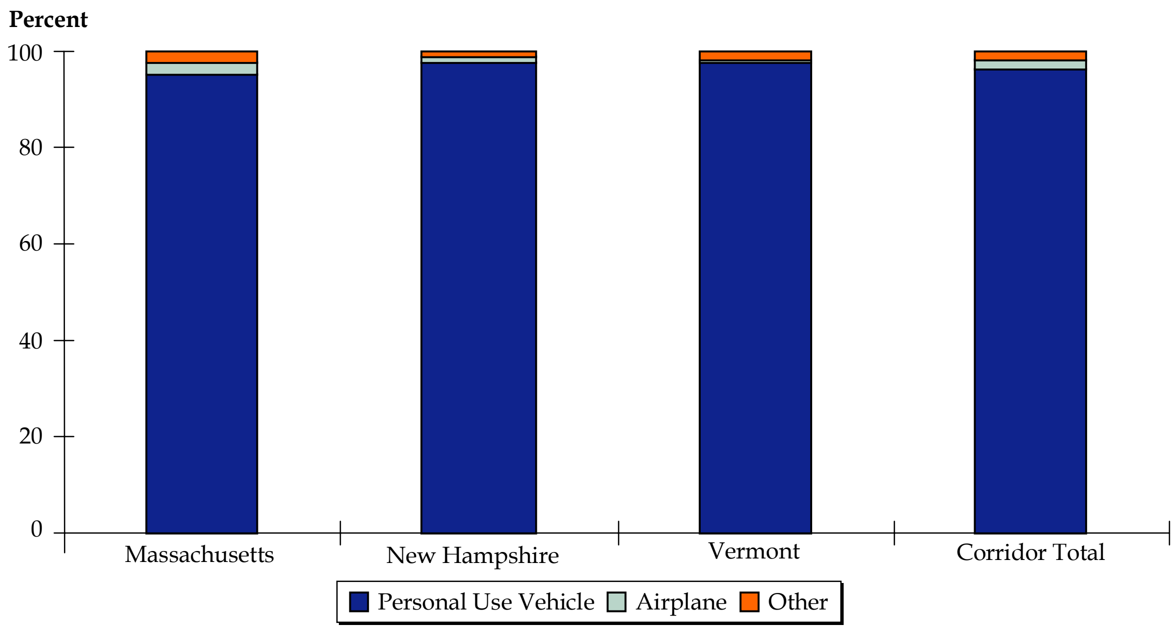
Table 3.20 – Trips Greater Than 100 Miles Inside the U.S. Corridor, 1995

From/To	Massachusetts	New Hampshire	Vermont	Total U.S. Corridor
Massachusetts	1,685,000	1,656,000	696,000	4,037,000
New Hampshire	516,000	566,000	189,000	1,271,000
Vermont	341,000	210,000	220,000	771,000
Total U.S. Corridor	2,542,000	2,432,000	1,105,000	6,079,000

Source: American Travel Survey (1995, No. BTS/ATS95-ESTC/1120).

Nationally, eight out of 10 trips greater than 100 miles in length use personal vehicles as their primary mode of transportation. In the U.S. BMHSR Corridor, however, this proportion increases to nearly 97 percent. Massachusetts had the highest use of modes other than automobile with about five percent of long-distance trips being made by airplane, bus or train. Figure 3.12 shows the mode of transportation for travelers within the U.S. portion of the BMHSR Corridor.

Figure 3.12 – Mode of Transportation for Trips Greater than 100 Miles in Length in the U.S. Portion of the BMHSR



Source: American Travel Survey (1995, No. BTS/ATS95-ESTC/1120).

Adults are the primary travelers in the U.S. portion of the BMHSR Corridor. According to the 1995 American Travel Survey, only about 11 percent of traveling parties include children as their members.

Profile of Travelers Based on BMHSR Corridor Surveys

As a component of the travel demand model, four individual survey efforts were conducted within the BMHSR corridor, as follows:

- Automobile users at the Hooksett tolls
- Automobile users at the Highgate Welcome Center near the Canadian border
- Bus passengers at locations along the corridor
- Airplane travelers at Logan Airport

The travel surveys were performed in order to obtain information for the development of mode choice, destination, and trip frequency models. The data elements obtained in these surveys included detailed trip information about relevant intercity trips within the corridor. This information also included trips between Montreal and Boston, and also other corridor trips to locations greater than 100 miles in length. Among the trip data items that were collected are:

- Details on the chosen mode
- Location of the trip origin
- Location of the trip destination
- Trip purpose
- Number of nights away from home on this trip
- Access and egress modes for each mode except auto
- Travel group size
- Type of non-home end location (hotel, rental home, etc.)

In addition to the trip information, demographic information for surveyed households was collected including:

- Age,
- Gender
- Auto ownership
- Educational characteristics
- Monthly household income
- Total number of long-distance trips by mode in past year

The surveys were not designed to provide detailed origin-destination trip pattern information. A much larger survey effort would be required to do so. Preferred origin and destination information was obtained from statewide and provincial travel demand models, as well as the Stats Canada international travel survey and American Travel Survey.

This enabled the Study team to focus the traveler surveys on obtaining information that would provide traveler profile and mode choice data.

As part of the surveys, respondents were asked to complete stated preference exercises. First, respondents were asked to make tradeoffs between their current travel mode with its current travel times, costs, and travel attributes and a hypothetical service consisting of the same mode with different travel times, costs, and travel attributes. Respondents were then asked to choose between their current mode and hypothetical intercity rail services with different times and costs.

Several versions of the tradeoff exercises were developed and respondents were randomly assigned a set of relevant exercises. The specific tradeoff levels were developed using a design which ensures that the choice experiment is relevant to the particular respondent, through the using where appropriate short, medium and long trip lengths, that there are no dominant choices, and that individual variables are not overly correlated with each other.

In order to develop a reliable mode choice model, the survey data collection effort intercepted travelers in the corridor using a variety of modes including: airplanes, buses and automobile.

To collect stated preference data from air travelers, survey crews were stationed at departure gates at Logan airport in Boston to meet statistically selected travel trips over a two week period which included early mornings, nights, and weekends. Passengers traveling to Montreal or Burlington were asked to complete a survey, which was then either collected in the passenger waiting area or else mailed back to the consultant team's offices for processing. All survey forms were available in both French and English.

Bus travelers were also surveyed to determine their preferences with regard to travel within the BMHSR Corridor. To conduct this survey, surveyors rode selected buses in the corridor and requested passengers complete a survey. As with the airplane surveys, both French and English versions were available and the passengers were able to fill them out en-route or mail them back at the leisure.

The vast majority of travelers in the BMHSR Corridor travel by private automobile. For this reason, a large number of surveys were distributed at the Hooksett toll in New Hampshire. Subsequent to this survey, additional surveys were distributed at the Highgate Welcome Center to provide greater geographic distribution and to gauge the effects that a border crossing would have on travelers' choices.

The combined results of the surveys provided an overview of both typical traveler characteristics and stated preference with regard to service characteristics of current and potential travel modes in the corridor. The results of each of the responses have been presented as percentages of responses to allow for easy comparisons between modes where the absolute number of surveys may have been different.

State of Origin

In composite, the stated preference surveys provided a good representation of the views of residents of each of the three states in the study, as well as residents of Quebec and most specifically Montreal. Table 3.21 provides an overview of the distribution of the surveys by place of residence for each of the surveys included in this analysis.

Table 3.21 – State of Origin by Survey

	Massachusetts	New Hampshire	Vermont	Quebec
Hooksett Tolls	26%	60%	13%	1%
Highgate Visitor Center	23%	10%	34%	33%
Bus	45%	6%	22%	27%
Logan Airport (Boston)	72%	6%	7%	15%

Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Gender of Survey Respondents

The gender of people who submitted surveys varied by mode (Table 3.22). Most striking is the air travel market, which reflects a 70 percent male response to the survey whereas females completed 62 percent of the bus surveys. Men, at 57 percent of the surveys, also predominantly submitted responses to the automobile surveys.

Table 3.22 – Gender of Survey Respondents by Mode

	Car	Bus	Air
Male	57%	38%	70%
Female	43%	62%	30%

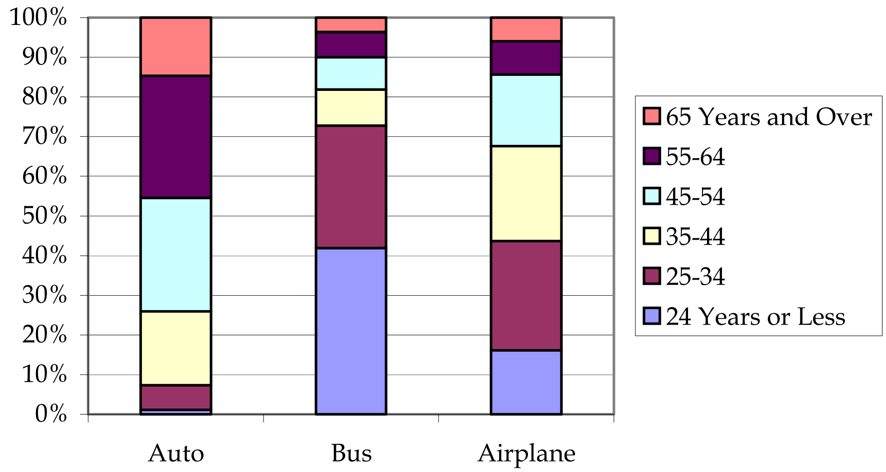
Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Age of Respondents

There was also a distinct variation in the age of survey respondents by mode (Figure 3.13). Older automobile respondents (55 years in age or older) filled out proportionally four times as many surveys as either the bus or airline passengers. Conversely, 72 percent of the bus respondents were 34 years of age or less, a proportion greater than either of the other modes.

Based on the survey responses, older travelers are more likely to drive, younger travelers are more likely to take the bus and airplane travelers have fairly even distribution in the age groups below 55 years in age, with a lower proportion of respondents older than 55 years old.

Figure 3.13 – Age of Survey Respondents by Mode

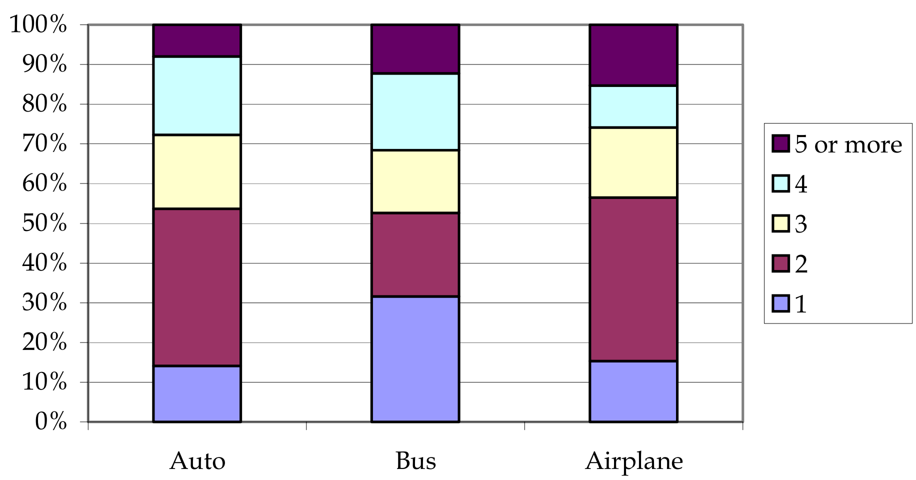


Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Household Size

Survey respondents also were asked to report the size of their household (Figure 3.14). This figure varied by mode. Interestingly, more than 30 percent of all bus riders reported that they lived alone. This figure is almost twice as high as either of the other modes.

Figure 3.14 – Size of Household by Mode



Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Vehicles per Household

The number of vehicles per household also varied by mode. Not surprisingly, persons surveyed in their automobiles possessed significantly more cars per household than the other modes. Eighty-five percent of the auto surveys indicated they had two or more vehicles in their household, whereas only 30 percent of the bus riders and 60 percent of the airplane respondents had the same level of car ownership. Bus riders had the lowest car ownership of any of the modes, with 65 percent reporting that they had one or no vehicle in their households. This figure was more than four times greater than the number reported by airplane passengers. Table 3.23 reflects the number of vehicles per household as reported by the survey results.

Table 3.23 – Number of Vehicles per Household by Mode

Vehicles per Household	Automobile	Bus	Airplane
0	0%	36%	8%
1	15%	29%	32%
2	52%	19%	42%
3	22%	13%	13%
4 or More	11%	3%	5%
TOTAL	**100%**	**100%**	**100%**

Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Education Level

Based on the survey results, level of educational attainment did not vary with mode choice. Table 3.24 provides a breakdown of the level of education attainment by mode. The greatest difference between modes was that persons with some college experience (between 1 and 3 years) were 5-6 percent more likely to be traveling by bus than the other modes, reflecting the popularity of the bus among college students.

The greatest percentage of automobile and bus survey respondents came from college graduates, with the proportion of airplane survey respondents being highest for those with graduate or professional degrees. Persons without a high school education were the least likely respondent for the automobile and airplane surveys.

Table 3.24 – Level of Educational Attainment by Mode

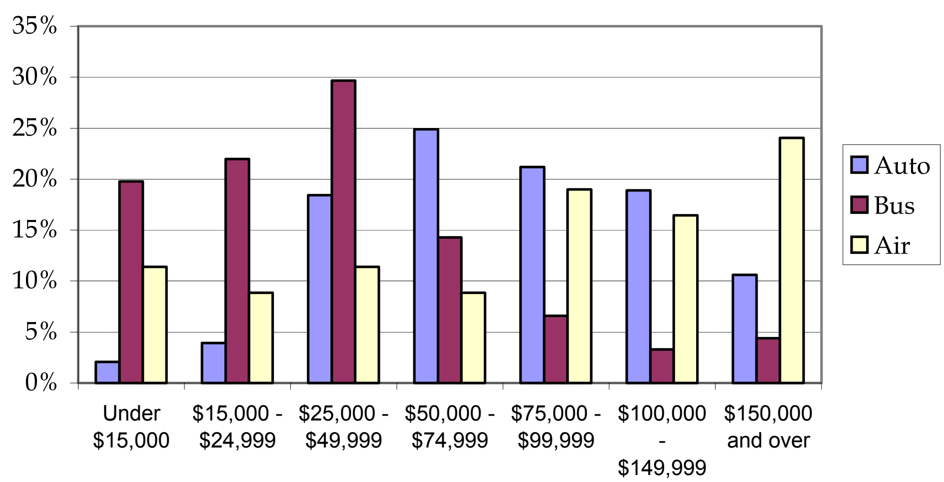
	Automobile	Bus	Airplane
Some High School	1%	4%	2%
High School Graduate or Equivalent	8%	3%	4%
Technical or Vocational School	5%	1%	4%
Some College (1-3 Years)	16%	22%	17%
College Graduate	36%	40%	36%
Graduate or Professional Degree	34%	30%	37%

Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Household Income

Household income had a strong correlation with mode choice. Based on the survey results, bus riders had the lowest income levels, people who drove had moderate incomes and airline travelers had the highest incomes. Figure 3.15 provides a summary of household income by mode.

Figure 3.15 – Household Income by Mode

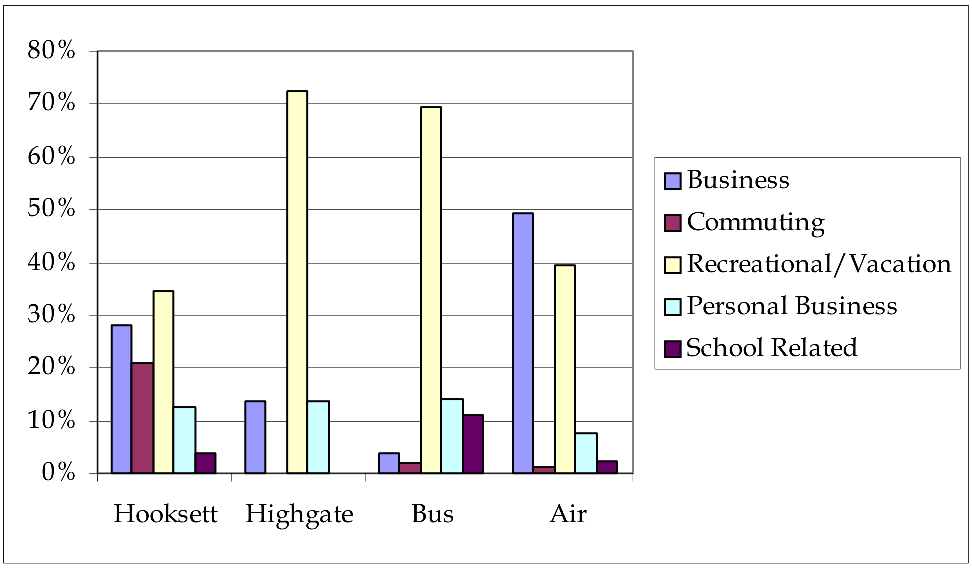


Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Trip Purpose

Trip purpose also varied by mode (Figure 3.16). For the purpose of this discussion, auto trips were broken out by both those from the Hooksett tolls and those from the border survey at the Highgate Welcome Center. This was done primarily to accentuate the variation in trip purpose between the two auto surveys. In this instance, about 72 percent of the Highgate border surveys indicated that they were traveling for recreational purposes. The Hooksett surveys, however, had a lower proportion with this response – only 35 percent. Overall, recreation was the dominant trip purpose in the BMHSR Corridor.

Figure 3.16 – Trip Purpose by Mode



Origins and Destinations

Two important pieces of information that were collected through the traveler surveying process were trip origin and destination. This information is similar to trip purpose, but provides additional information on the combining of multiple trip purposes. Each of the surveys requested the traveler state his or her trip origin and destination. The most common origin and destination was to a private home, accounting for more than half of all trips regardless of travel mode. The Highgate Springs welcome center and the airplane survey also expressed a high level of travel to and from hotel rooms, reflecting the importance of tourism as indicated by the trip purpose figure. The origin and destination information for the traveler surveys was utilized to supplement principal origin and destination information obtained from statewide and provincial travel demand models, as well as the Stats Canada international travel survey and the American Travel Survey. A summary of trip origins and destinations for the traveler surveys is provided in Table 3.25.

Table 3.25 – Trip Origins and Destinations

	Hooksett		Highgate		Bus		Airplane	
	O	D	O	D	O	D	O	D
Private home	56%	56%	59%	52%	71%	68%	59%	58%
Place of work or business	26%	32%	0%	0%	4%	10%	14%	10%
Hotel or motel	7%	3%	34%	34%	17%	14%	20%	26%
Tourist attraction	9%	5%	3%	7%	3%	7%	1%	5%
School	2%	1%	0%	0%	1%	2%	6%	0%
Airport	0%	3%	3%	7%	3%	0%	NA	NA

Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Access and Egress

A unique component of modal choice is how travelers access that mode. For automobile travel it was assumed that the car was readily available and did not require another mode to access it. For bus and airline travel, however, people had to determine how to reach that mode. These choices affect many aspects of the job including total overall travel time. Table 3.26 provides an overview of intermodal connections for bus and airplane travel in the BMHSR Corridor. Getting dropped off by a privately owned vehicle or using public transit were the key methods of access for those passengers surveyed on the bus. For airplane travelers, the connections were more evenly split across several modes including driving a privately owned vehicle, being dropped off, rental cars and taxis.

Table 3.26 – Airplane and Bus Access and Egress Methods

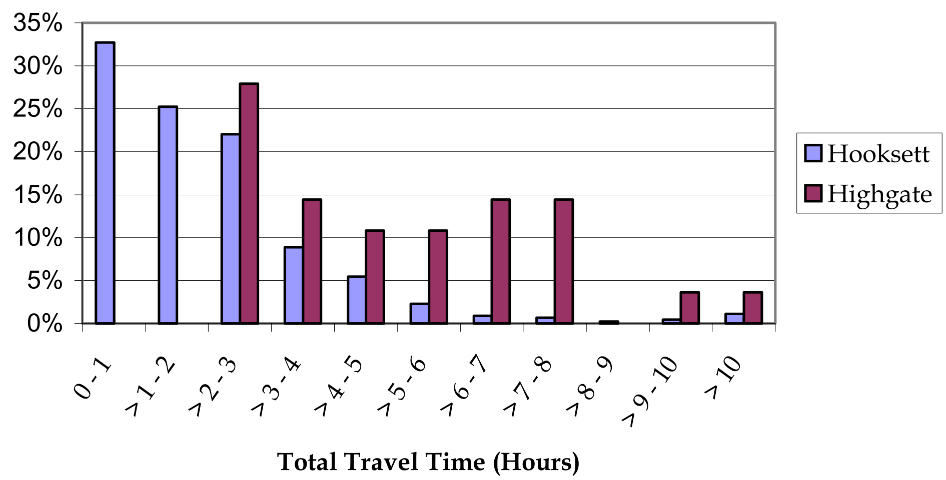
	Bus		Airplane	
	Access	Egress	Access	Egress
Drove Privately Owned Vehicle	3%	14%	19%	18%
Drop off/Pick up by Privately owned Vehicle	37%	28%	11%	19%
Rental Car	0%	1%	13%	19%
Taxi	16%	17%	23%	31%
Limo or Van	2%	0%	9%	3%
Public Transit	36%	40%	18%	7%
By Foot or Bike	6%	1%	7%	2%

Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Auto Trip Times

Automobile survey respondents were asked to estimate their trip travel times. The reported average trip times varied significantly, with the median trip time being about one hour and forty-five minutes. Average trip times at the Highgate welcome center were significantly longer with a median trip time of 5 hours, although it was not specified what proportion of this time was attributable to border delays. Figure 3.17 provides an overview of the average trip times for each of the survey locations.

Figure 3.17 – Automobile Travel Times



Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

Mode Choice

Automobile travel is the most common mode of travel in the BMHSR Corridor. The most common reason that people cited for using automobiles was that they were the only practical alternative to make the trip. The top three reasons cited for auto use are as follows:

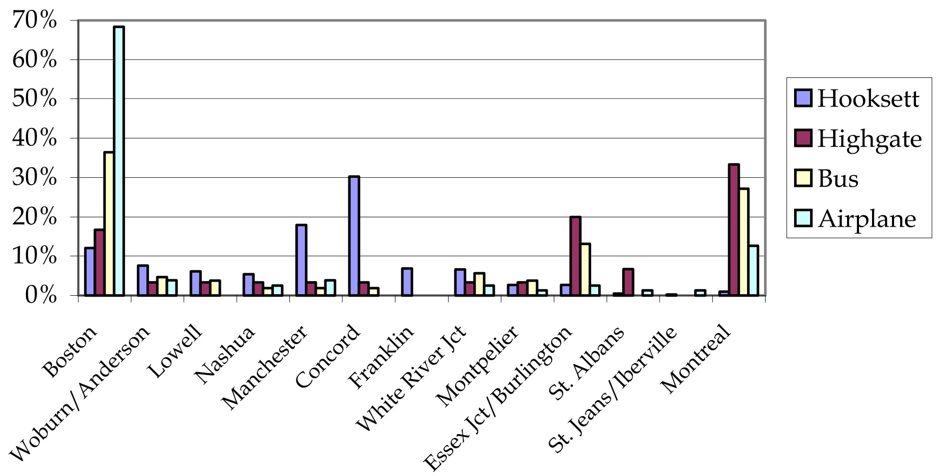
- Auto only practical alternative,
- Auto is needed at destination, and
- Auto is needed along the way.

Preferred Station Locations

An interesting finding from the stated preference surveys was preferred station of origin. Figure 3.18 provides a composite view of the preferences for station of origin across each of the four surveys. The most convenient station of origin for the travelers varied, of course, by where the surveys were distributed. For airplane travel, for example, the preferred station of origin for that trip was Boston, with 67.5 percent of the respondents choosing it. Preferred destination stations were Montreal, Boston and Burlington with a small number of respondents indicating other destinations along the BMHSR Corridor. This information is skewed, however, due to the fact that the surveys were distributed in Boston on flights traveling to Montreal and Burlington – the only cities with intercorridor airplane service in the BMHSR Corridor.

The border survey also indicated station origin preferences in Montreal, Burlington and Boston, in that order. Responses for station destination preferences produced a similar distribution.

Figure 3.18 – Stated Preference of Origin Station by Mode



Source: Cambridge Systematics, Inc. Corridor Travel Surveys, 2002.

The bus surveys, which occurred on both northbound and southbound trips, revealed a preference for trip origination on both the Boston and Montreal ends of the trip with smaller, but significant demand in Burlington and White River Junction. The destination preferences mirrored these findings, with additional demand for service to Montpelier and Anderson Station in Woburn.

■ 3.3 Model Analysis and Ridership Estimates

The Ridership Modeling Process

A key component in determining the feasibility of HSR service from Boston to Montreal is the development of reliable forecasts for intercity rail travel in the BMHSR Corridor. To forecast the ridership, the Study team assembled data on how travelers in the BMHSR Corridor currently make their choices. Mathematical relationships between the measures of transportation supply and demand in the BMHSR Corridor were developed. And, then these mathematical relationships were applied to different future year scenarios to predict how people will travel in the BMHSR Corridor in the future.

For this Study, an integrated discrete choice model was developed to predict ridership for a series of intercity rail alternatives. The projected ridership consists of both diverted trips (trips that would be made by a different travel mode if the proposed rail service was not available) and generated trips (trips that will be made only if the proposed rail service is available).

To predict the demand for high-speed intercity rail, service characteristics such as travel times and station locations were simulated and integrated with information regarding the set of choices that individuals make with regard to intercity travel in the BMHSR Corridor. Overall demand was predicted for each high-speed rail alternative by aggregating the individual choices to the relevant population. The first basic choice an individual makes is whether and how often to travel for a specific purpose. This choice is a function of the traveler's individual and household characteristics and the overall accessibility of the traveler's home to potential intercity destinations.

At the same time that an individual chooses whether and how much to travel, he or she makes a decision as to the location of the trip destination. The choice of destination may be modeled with information on the trip being made, information on the characteristics of the traveler's household, measures of the relative size or attractiveness of the different potential destinations, and the cost (both in time and money) of traveling between the traveler's home location and each specific potential destination. Finally, the individual chooses the means by which to travel and by which routes. Mode choice is a function of trip characteristics, the traveler's household characteristics, and the relative levels of service of the different modes and routes for the origin-destination pair in question.

Most transportation demand models treat these choices sequentially through a set of separate model elements. Trip frequency choice is modeled with trip generation equations. Destination choice is modeled with trip distribution relationships (such as gravity models), and mode/route choice is modeled with mode split and assignment algorithms. These model components generally stand alone, and usually do not reference the other components.

The model developed for this Study, however, connects the different model components by passing information from one choice component to the others during model development. Therefore, the model components are fully consistent with each other and are sensitive to each other's changes. In this model system, changes to the transportation infrastructure, such as the introduction of new intercity rail service, affect each component of the model system. The discrete choice model outputs are forecasts of travel by each available mode between specific origins and destinations.

The objective of the passenger demand forecasting effort was to develop reliable forecasts of intercity rail travel in the BMHSR Corridor through the development and application of an integrated discrete choice model system that predicts both diverted and generated traffic.

The following general steps were performed:

1. Intercity travel patterns within the BMHSR Corridor were defined;
2. Mode choice (diverted demand) models based on newly-collected BMHSR Corridor travel surveys were developed;
3. Induced demand models were constructed; and
4. Diverted and induced demand models were applied to the BMHSR Corridor travel patterns to obtain forecasts.

The first step of the forecasting effort was to define the trip patterns within the BMHSR Corridor. This was accomplished by synthesizing market segment specific trip tables based on available information, including statewide and provincial travel demand model outputs and available travel survey data that have been compiled by tourism agencies in the BMHSR Corridor and by national statistical agencies. Using these data sources, base year and forecast year estimates of the number of trips between each of the communities in the study area were defined.

The next step was to develop mode choice models that were used to forecast rail demand. The key methodological issue for the mode choice models relates to the use of the available travel data. For this modeling effort, the revealed-preference survey data was used to estimate models of mode choice behavior for the base year. In addition, the data collected through the stated-preference surveys were used to assess the attractiveness of the rail mode. Revealed preference data shows what people do. Stated preference data is what people say they would do. From the combined revealed preference and stated preference analyses, models of intercity travel choice were developed.

The mode choice models were used to predict the number of travelers that would choose high-speed rail over other competing travel modes. The logit models also provide a measure of the relative impedance (across all travel modes) between different towns in the study area. Using multinomial regression techniques, this measure of interzonal impedance was related to the number of trips between zones. Then, the number of trips that would be generated for each zone pair as a result of the improved intercity travel options was derived.

The passenger demand forecasting process estimated future year inputs to forecast the key model inputs for the future year inputs. A simplified forecast-year intercity highway network and alternative air, bus, and rail transportation scenarios were developed and utilized to define the future transportation network. In addition, zone-level forecasts of population, households and characteristics of households were assembled. The diversion models and induced travel model were applied in a spreadsheet-based forecasting tool to develop demand forecasts.

Advantages of the Model System

The model system selected for use in this study offered several advantages over other demand models:

- It maximizes the use of revealed-preference data, rather than stated-preference data;
- It provides an integrated approach to analyzing diverted trips and generated trips, both in terms of new trips and trips to new destinations;
- It results in fairly sophisticated statistical models that can produce reliable forecasts, but which are straightforward in application; and
- It provides a validated model system with which to perform a wide range of future intercity travel demand analyses.

The biggest advantage of the model approach is that it relies, to the extent possible, on models developed from travelers' actual behavior. This technique is highly desirable because stated-preference data often are prone to a number of biases that are difficult to detect or correct. Careful survey design and experimental analysis minimize these biases, but the possibility of reduced reliability of these forecasts persists.

A second advantage of the model system is that it integrates the forecasts of diverted trips and generated trips by using models that are linked to each other. Information from the mode/route choice models is used in the destination model, and information from the destination model is used in the trip frequency model. Therefore, projections of the different components of travel are consistent with each other. Often in intercity forecasting efforts, forecasts of generated and diverted trips are developed independently for individual market segments, leading to inconsistencies.

Another advantage of the approach is that it relies on fairly sophisticated statistical estimation procedures that are rooted in microeconomic consumer theory, but that can be applied effectively without a detailed knowledge of the estimation procedures. To accomplish this, the model system has been converted to a spreadsheet application for ease of use.

The final advantage of the modeling approach is that the resulting forecasting tool is flexible, which allowed a range of high-speed rail operating scenarios to be tested.

Detailed Market Definition and Identification

At the beginning of the passenger demand forecasting effort, a segmentation scheme was developed for the BMHSR Corridor. Segmentation defines the pieces of the BMHSR Corridor and allows them to be assigned values, such as travel times, that affect the potential ridership in the BMHSR Corridor. While the ultimate market segmentation was developed through testing a variety of service scenarios, the results from each iteration of the model provided valuable information regarding the influence of each variable and its effects on BMHSR Corridor ridership including sub-market travel patterns.

Initial travel markets were defined based on trip purpose, directionality, traveler characteristics, and characteristics of the journey (number of days away from home, need for an auto at the destination, etc.). To ensure that all relevant market data was obtained during the data collection process, a complete list of potential travel markets was developed prior to the design of the travel surveys.

In addition to defining travel markets, the project's study area was established. For the purpose of this model, the study area included all cities that were served by rail service between Boston and Montreal. Within the study area, analysis zones were defined.

In total, the travel demand model developed for the BMHSR Study accounted for several key inputs:

- Zone-Based demographic and development data and forecasts;
- Level of service data by mode;
- Travel volume statistics;
- Available intercity travel patterns data; and
- Travel survey data (stated preference).

Zone-Based Demographic and Development Data and Forecasts. Zone-based data and forecasts provide measures of the overall attractiveness of individual zones as long-distance trip destinations, and are used to determine the overall growth in BMHSR Corridor intercity trips. Relevant base year and forecast year data include:

- Population by zone;
- Households by income category;
- Employed labor force;
- Total employment;
- Employment by sector;
- Land area and;
- Population and employment densities.

These data were assembled from the U.S. Census Bureau, Statistics Canada, state and provincial demographers' offices, state and provincial agencies such as the offices of labor and tourism, and metropolitan planning organizations (MPOs). In addition, county level forecasts were obtained from commercial data sources.

Level of Service Data by Mode The model system relies on a database of level-of-service data for each travel mode which provides current information on and forecasts of the various components of travel time, travel cost, and service frequency by each intercity mode in the study area.

The primary source of highway-related time and operating cost data is existing highway planning networks, combined and modified to incorporate the larger intercity zone system. Statewide models were also used to obtain intercity highway times and costs, and metropolitan models were used to obtain access and egress costs and times for public transportation modes. Travel times, costs, and frequencies for airlines, intercity buses, and Amtrak services were obtained from timetables and fare schedules.

The components of the travel levels-of-service include:

- In-vehicle travel time: Terminal-to-terminal (airport-to-airport, bus station-to-bus station, and rail-station-to-rail station) times for public modes; Door-to-door times for auto trips. These times were developed from Statewide and Provincial travel demand model travel times.

- Access/egress time: Time to travel between trip origins and origin terminals (airports, bus and rail stations), plus time from the destination terminals to trip destinations; Access/egress times are not relevant for auto trips. These times were developed from Statewide and Provincial travel demand model travel times.

- Terminal time: Time needed at origin and destination terminals to check-in, deal with baggage, and maneuver through customs/immigration; for auto trips, terminal processing time is the customs/immigration time at the border crossing, plus (for longer trips only) time for one twenty minute break in driving.

- Frequency: Number of services per day offered by public modes; not relevant for auto trips;

- Fares: Cost per person to use the public modes; not relevant for auto trips;

- Auto operating cost: Per-mile cost per vehicle; not relevant for public mode trips. The cost of $0.12 per mile was used based on operating cost estimates developed by the American Automobile Association (AAA). These costs include the average per mile cost of gas, oil, and tires. They do not include ownership related costs of the vehicles. The average auto occupancy for relevant trips was set to 1.8 persons per vehicle based on the travel survey results.

- Access/egress cost: Per-mile cost per person to go between trip origins and origin stations and to go between destination stations and trip destinations. This is not applied to auto trips.

Travel Volume Statistics To calibrate and fine-tune the estimated model system to more accurately reflect actual base-year travel patterns, travel data collected by local agencies and transportation providers were used. Aggregate statistics assembled through this process reflect summary counts of passengers using each of the modes under study. Traffic counts from the states and Quebec transportation agencies were also incorporated. Aviation data was obtained via origin-destination aviation data from Back Aviation Solutions, a commercial vendor of airline industry data, and the U.S. Department of Transportation and Statistics Canada databases. In addition, travel volumes for both intercity bus and rail service providers were obtained from public and private sources.

Intercity Travel Patterns Data Prior to the start of this study, limited data sources existed to estimate travel behavior and preferences data needed for developing high-speed rail ridership forecasts in the corridor. Nevertheless, data from several surveys and travel demand models were used to validate the intercity model. Among these data were the outputs of statewide and provincial travel demand models, the American Travel Survey dataset, the Nationwide Personal Transportation Survey dataset, and household travel surveys and vehicle intercept surveys recently performed in the corridor, including information from recent Canadian studies. In addition, available tourism data was assembled from the various tourism agencies in the corridor.

Based on the statewide and provincial models, there are a substantial number of annual trips within the corridor. However, the BMHSR system will serve only a segment of these trips: the longer distance intercity trips. Table 3.27 shows the forecast number of interstate trips of more than 50 miles in the corridor. It is important to note that the figures shown in this table under represent the number of corridor trips that the BMHSR service will affect. Longer distance intrastate trips will also be served by the BMHSR, as will shorter distance trips where HSR station-to-station travel is a reasonable alternative. The number of trips in the corridor that fit these descriptions and that are eligible for the BMHSR to serve depends on the location and number of stations.

Table 3.27 – Forecast of Year 2025 Annual Interstate Trips of More than 50 Miles

From:			**To:**		
	Massachusetts	**New Hampshire**	**Vermont**	**Quebec**	**Total**
Massachusetts	---	7,096,831	1,277,795	722,130	**9,096,756**
New Hampshire	7,096,831	---	1,231,344	439,190	**8,767,365**
Vermont	1,277,795	1,231,344	---	705,637	**3,214,775**
Quebec	722,130	439,190	705,637	---	**1,866,957**
Total	**9,096,756**	**8,767,365**	**3,214,775**	**1,866,957**	**22,945,853**

Source: Cambridge Systematics, Inc. based on Statewide and Provincial Models, American Travel Survey, and Stats Canada International Travel Surveys, 2002.

As discussed, the year 2025 trip forecasts are based on the projected growth in corridor trips that have been forecast by the Statewide and Provincial travel demand models. The number of corridor trips forecast for 2025 is about 22 percent higher than that of the year 2000. This represents about a 0.8 percent annual increase in long-distance corridor travel.

Development of the Modeling System

The development of the ridership model required the estimation and linkage of three separate categories of models. The three categories of models can be summarized as follows:

1. The **Mode Choice Models** relate travelers' choice of a mode to the level of service and price attributes of the competing options;

2. The **Destination Choice Models** relate travelers' choice of a destination to attributes of the destination and the level of service provided to each destination; and

3. The **Trip Frequency Models** relate the number of trips taken by different travelers to their socioeconomic characteristics and the overall accessibility offered by the multi-modal transportation system.

These three main modeling components are discussed below.

Mode Choice Models The mode choice model development includes the estimation and validation of a group of market specific models. The key methodological issue for the mode choice models relates to the use of the available travel data. This modeling effort relied to the greatest extent possible on the revealed-preference data to estimate models of mode choice behavior for the base year. In addition, the data collected through the stated-preference surveys was used to guide the assessment of the attractiveness of intercity rail services that might be available in the future-year horizon. The mode choice models relate the choice of travel mode to specific characteristics of the traveler, the trip being made, and attributes of each mode.

The modal estimation effort was an iterative process. Many different modal specifications with various combinations of explanatory variables and model structures of different complexity were tested until a set of final models was developed. The estimation process began by testing simple model specifications and as information about particular variables was included, more complex model specifications and model structures were created and evaluated.

The basic decisions in developing the mode choice models were:

- The selection of the variables to be included in the utility function for each mode along with the mathematical forms of each variable; and

- The selection of the appropriate model structure (multinomial logit or nested logit) as allowed by the data and the nature of the choice behavior under study.

The estimated mode choice model was validated to ensure that the model outputs were reasonable and accurate when evaluated in comparison to observed and known travel conditions and behavior. The model validation steps consisted of the following:

- Reasonableness checks;
- Disaggregate validation; and
- Aggregate validation.

Reasonableness checks consist of comparisons of model parameters and results to known or expected values. This form of model validation was conducted throughout the model estimation process on each interim model result. The **d*isaggregate validation*** consisted of tests where the model was applied to see whether the results match observed or expected values. The best way to do this is to apply each model to a disaggregate data set other than the one from which the model was estimated. For the purpose of this study, information from the *American Travel Survey* and other data sources were used. Finally, the model used an **a*ggregate validation*** process to compare the model results to known aggregate data that was not used in model estimation.

Destination Choice Models Destination choice models were used to describe the probability that individuals will decide to travel for a specific purpose to a particular destination rather than other destinations that are available in the study area based on:

- The relative ease or difficulty of travel to the destination in question compared to the other destinations;
- The relative size or attractiveness of the zone under study compared to the other zones;
- Unobserved characteristics of the destination zone; and
- Characteristics of the household or the individual decision maker.

The destination model used a set of traditional gravity models complemented by a multinomial logit model with the model zones as potential choices to determine the effect on intercity travel levels that would occur if one or more of these destinations became more accessible to other BMHSR Corridor locations through the introduction of high-speed rail service.

Trip Frequency Models The objective of the trip frequency model estimation was to examine the number of trips made by each purpose to all of the available destinations, and to quantify the determinants of a traveler's trip making. The model structure uses trip frequency categories to differentiate among travelers with different travel patterns. The utility of each trip frequency category is that it accounts for a traveler's socioeconomic characteristics associated with his/her propensity to travel and the composite utility of traveling to all the destinations that are included as part of the study area. Existing data sources and the recently completed surveys provided the necessary travel data, including retrospective descriptions of all household intercity trips made over an extended period within the study area. The surveys completed through the course of this study also provided household characteristic data that provides explanatory variables in the trip frequency models.

The accessibility measures used in the modeling process were developed from the mode and destination choice models. These measures capture the differences in the ability of residents of different study area zones to travel to all the other study area zones. The hypothesis underlying the trip frequency models is that residents of zones from which it is easier to travel will on average have higher trip rates than residents of zones from which it is more difficult to travel. The implication of this hypothesis in forecasting is that major improvements in transportation infrastructure which improve the accessibility of potential travel destinations, such as the addition of a high-speed rail line, will increase trip rates.

The destination choice and trip frequency phases of model development provide future-year origin-destination trip tables for the study area that are sensitive to changes in transportation infrastructure, such as the proposed intercity rail service. These future-year trip tables reflect changes in both the total amount of travel between the base and future years and the distribution of travel among the various origin-destination zone pairs.

Model Alternatives

The project steering committee reviewed seven alternative service scenarios to determine the potential ridership range of the BMHSR service. Initially three base alternatives were defined: low speed, mid speed and high speed. Operating speeds were developed based on existing conditions for the low speed scenario, 110 mph with FRA regulation restrictions for curves and travel through towns for the mid-speed scenario, and unrestricted 110 mph for the high-speed alternative.

To test sensitivity of the ridership to variations in the services, five scenarios were developed for the mid speed alternative. These variations include:

- **Mid Speed Base Case**: In this alternative, the mid speed scenario was tested with an assumed cost of $0.26 cents per mile. The fare rate was selected based on a fare of approximately 80 percent of the cost of an airline ticket. This costing assumption was utilized in the FRA Report *High-Speed Ground Transportation for America*.[3]

- **Mid Speed High Fare**: In this alternative, the mid speed scenario was tested with an increase in the cost per mile. The mid speed high fare scenario raised this fare to $0.30 cents per mile. This reflects the upper range of HSR corridor costs per mile.

- **Mid Speed Low Frequency**: In this alternative, the mid speed scenario was tested with a decrease in the frequency of service. In the original mid speed alternative, trains were tested with an operational frequency of six trains per day, the mid speed low frequency scenario decreased the number of trains from six to two.

[3] U.S. Department of Transportation, September 1997.

- **Mid Speed All Stations**: In this alternative, the mid speed scenario was tested with additional station stops. In the original mid speed alternative, trains served eight station locations, the mid speed all stations scenario increased the number of stations from eight to twelve. It is important to note however, that for the purpose of this test travel time was held constant to test the sensitivity of the number of station stops at this level of analysis.

- **Mid Speed Low Fare**: In this alternative, the mid speed scenario was tested with a decrease in the cost per mile. The mid speed low fare scenario decreased fares to $0.20 cents per mile. The fares of the Amtrak Vermonter and Downeaster trains range between $0.16 and $0.26 per mile for relevant station pairs. Thus, the fare rate of $0.20 per mile was selected to test the average fare rate of these two existing New England intercity trains.

Model Results

Table 3.28 provides definitions of the operational scenarios used to estimate ridership for the BMHSR service. This table outlines the service parameters including cost, frequency and speed of service for each of seven scenarios: low speed, mid speed, mid speed high fare, mid speed low fare, mid speed low frequency of service, mid speed all station stops and high speed.

By applying the parameters shown in Table 3.28 to the model, ridership numbers have been generated for each of the seven alternative scenarios. Table 3.29 provides a summary of each scenario's projected ridership along with other pertinent service information such as trip time from Boston to Montreal.

Total trip time for each alternative can be calculated by adding the in vehicle trip time and terminal time. Terminal time for BMHSR service includes time required to be at the station in advance of the train as well as customs/immigration processing time. Terminal time for air travel was estimated based on arriving at the airport one hour in advance of the flight and one hour to complete customs/immigration processing. Terminal time for bus includes time to arrive before the bus gets to the station and processing time at the border. Auto terminal time includes 20 minutes for customs and immigration processing and a 20-minute gasoline/services break. It is anticipated that by the time a BMHSR service is implanted, US/Canadian border regulations would be developed to allow operation with no stops at the border for customs or immigration services. For further discussion, see section 4.4.

Table 3.28 – Scenario Definitions for BMHSR Ridership Forecasts*

Parameters	**Scenario Name**						
	Low Speed	**Mid Speed**	**Mid Speed High Fare**	**Mid Speed Low Freq**	**Mid Speed All Stations**	**Mid Speed Low Fare**	**High Speed**
Trip Table	Year 2025 trip tables synthesized from statewide and MTQ demand models for all alternatives.						
High Speed Rail Characteristics							
Stations:	Boston	Boston	Boston	Boston	Boston	Boston	Boston
	Woburn	Lowell	Lowell	Lowell	Woburn	Lowell	Lowell
	Lowell	Manchester	Manchester	Manchester	Lowell	Manchester	Manchester
	Nashua	Concord	Concord	Concord	Nashua	Concord	Concord
	Manchester	White River Junction	White River Junction	White River Junction	Manchester	White River Junction	Burlington/ Essex Junction
	Concord	Montpelier	Montpelier	Montpelier	Concord	Montpelier	Montreal
	Franklin	Burlington/ Essex Junction	Burlington/ Essex Junction	Burlington/ Essex Junction	Franklin	Burlington/ Essex Junction	
	White River Junction	Montreal	Montreal	Montreal	White River Junction	Montreal	
	Montpelier				Montpelier		
	Burlington/ Essex Junction				Burlington/ Essex Junction		
	St. Jean				St. Jean		
	Montreal				Montreal		
Travel Times	475	288	288	288	288	288	211
Fares	$0.16	$0.26	$0.30	$0.26	$0.26	$0.20	$0.36
Train Frequency	4 trains per day in each direction	6 trains per day in each direction	6 trains per day in each direction	2 trains per day in each direction	6 trains per day in each direction	6 trains per day in each direction	8 trains per day in each direction
Access and Egress Times and Costs Based on future year highway origin/destination tables from available demand models for all alternatives. Additional terminal processing times were added to each mode to account for ticketing/check-in, security procedures, and baggage processing.							
Competitive Mode Characteristics							
Auto times	Based on future year highway origin/destination tables from available demand models.						
Auto Operating Cost	$0.12 per mile	$0.12 per mile	$0.12 per mile	$0.12 per mile	$0.12 per mile	$0.12 per mile	$0.12 per mile
Intercity bus times, fares and frequencies	Current year operating levels as reported on Vermont Transit, Concord Trailways and Dartmouth Coach websites						
Airline times, fares and frequencies	Current year operating levels as reported in the OAG with representative fares of US$102 for Boston-Montreal and US$96 for Boston-Burlington						
Competing Rail Services	Montrealer, Downeaster, and commuter rail lines:						
	- Haverhill Line as currently configured						
	- Lowell Line extended to Nashua						
	- Montreal Delson Line extended to St. Jean						
	Fare per mile, speeds, and frequencies assumed to be the same as current						

*All figures in 2001 U.S. dollars.
Source: Cambridge Systematics, Inc. Model Input Assumptions, 2002.

Table 3.29 – 2025 Summary Table of BMHSR System Ridership

	Low Speed	Mid Speed	Mid Speed High Fare	Mid Speed Low Frequency	Mid Speed All Stations	Mid Speed Low Fare	High Speed
Annual Ridership							
Total Corridor	213,276	446,710	330,097	86,962	588,630	683,667	644,232
Boston-Montreal	13,469	129,508	84,428	27,143	129,508	221,227	200,564
Annual Passenger Revenue							
Total Corridor	$4,784,504	27,893,059	22,559,907	5,724,020	32,291,348	34,614,601	59,062,561
Boston-Montreal	$744,341	11,619,093	8,739,297	2,434,820	11,619,093	15,271,257	24,917,799
Annual Passenger-Miles							
Total Corridor	29,903,149	107,267,243	75,189,849	22,013,126	124,183,740	173,050,633	164,062,668
Boston-Montreal	4,652,131	44,688,819	29,130,991	9,364,691	44,688,819	76,356,287	69,216,109
Cost per Passenger Mile							
HSR	$0.16	$0.26	**$0.30**	$0.26	$0.26	**$0.20**	$0.36
Auto	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12
Air	$0.31	$0.31	$0.31	$0.31	$0.31	$0.31	$0.31
Bus	$0.14	$0.14	$0.14	$0.14	$0.14	$0.14	$0.14
Frequency							
HSR	4	6	6	**2**	6	6	8
Air	8	8	8	8	8	8	8
Bus	6	6	6	6	6	6	6
Auto	NA	NA	NA	NA	NA	NA	NA
Number of Stations	12	8	8	8	**12**	8	6
HSR Speed	60 mph	110 mph restricted	110 mph restricted	110 mph restricted	110 mph restricted	110 mph restricted	110 mph no restrictions
Average Miles per Hour	41 mph	68 mph	68 mph	68 mph	68 mph	68 mph	92 mph
In Vehicle Trip Time (mins)							
HSR**	475	288	288	288	288*	288	211
Air	80	80	80	80	80	80	80
Bus	320	320	320	320	320	320	320
Auto	312	312	312	312	312	312	312
Terminal Time (mins)							
HSR	60	60	60	60	60	60	60
Air	120	120	120	120	120	120	120
Bus	60	60	60	60	60	60	60
Auto	40	40	40	40	40	40	40
Total Trip Time (hours)							
HSR	8h 55m	5h 48m	5h 48m	5h 48m	5h 48m	5h 48m	4h 31m
Air	3h 20m	3h 20m	3h 20m	3h 20m	3h 20m	3h 20m	3h 20m
Bus	6h 20m	6h 20m	6h 20m	6h 20m	6h 20m	6h 20m	6h 20m
Auto	5h 52m	5h 52m	5h 52m	5h 52m	5h 52m	5h 52m	5h 52m

Notes: *Travel trip time was not increased to test only the sensitivity of number of stations stops at this level of the analysis.

** Travel time for HSR service can vary depending on equipment choice. For this analysis, F-59 PH locomotive and Bombardier Bi-Level coach technologies were selected because they are widely used for the delivery of rail service in a multitude of passenger corridors throughout United States. See Chapter 2 for details. All dollar figures are shown in year 2001 U.S. dollars.

Source: Cambridge Systematics, Inc. Model Input Assumptions, 2002.

Ridership for each of the BMHSR alternative varies significantly depending on the service attributes. For example, the reduction of service levels on the mid speed scenario from six trains per day to two trains per day resulted in a drop in ridership levels to less than 20% of the ridership for the six trains a day scenario. Furthermore, reduction in the fares from $0.26 per mile to $0.20 per mile resulted in an increase of ridership from 446,710 to 683,667. Interestingly, the increase in ridership at the lower fare actually resulted in a 24% increase in total passenger revenue. The following provides a summary of each scenario:

- **Low Speed Scenario**: The low speed scenario provided the second lowest ridership of any of the alternatives. With a travel time between Boston and Montreal of nearly nine hours, projected ridership levels within the BMHSR Corridor on this alternative only reached 213,276, with only 13,469 riders traveling the full distance between Montreal and Boston.

- **Mid Speed Scenario**: The mid speed scenario projected ridership of more than double that of the low speed scenario. Aside from increased operating speed, this alternative also ran an increased number of trains from the low speed alternative, six versus four, however, the mid speed only stopped at eight stations as compared with the low speed alternative which stopped at twelve station locations.

- **Mid Speed High Fare**: In this alternative, the mid speed scenario was tested with an increase in the cost per mile. In the original mid speed alternative, fares were listed at $0.26 cents per mile, the mid speed high fare scenario raised this fare to $0.30 cents per mile. This increase resulted in a decrease of ridership of 26 percent, highlighting the fare sensitivity of ridership in the BMHSR Corridor.

- **Mid Speed Low Frequency**: In this alternative, the mid speed scenario was tested with a decrease in the frequency of service. In the original mid speed alternative, trains were tested with an operational frequency of six trains per day, the mid speed low frequency scenario decreased the number of trains from six to two. Results of this service reduction caused ridership to plummet, resulting in the lowest ridership of any of the alternatives (86,962 annual riders). This indicates the importance of frequent service to attract riders.

- **Mid Speed All Stations**: In this alternative, the mid speed scenario was tested with additional station stops. In the original mid speed alternative, trains served eight station locations, the mid speed all stations scenario increased the number of stations from eight to twelve. It is important to note however, that for the purpose of this test the travel time for this alternative was not increased. Results of this alternative showed particularly heavy ridership gains in the vicinity of Concord and Saint-Jean-sur-Richelieu.

- **Mid Speed Low Fare**: In this alternative, the mid speed scenario was tested with a decreased cost per mile. In the original mid speed alternative, fares were listed at $0.26 cents per mile, the mid speed low fare scenario used a fare of $0.20 cents per mile to estimate ridership. In this scenario, the ridership increased by more than 50 percent, resulting in the highest projected ridership of any of the alternatives.

- **High Speed Scenario**: The High Speed Scenario for the BMHSR service projected the second highest ridership and the highest passenger revenue of any of the alternatives. Under the high-speed rail alternative, fares were increased to $0.36 per mile and the number of stations was reduced to 6 key locations. In addition, the frequency of the service was increased to 8 round trips per day.

Diverted and Induced Trips

Most of the trips projected to be taken by the BMHSR Service users are diverted from other modes. That is, the trips would have occurred without the construction of the BMHSR but would have used another mode, in this case mainly automobile, to make the trip. In addition, each alternative also produces additional trips that would not have been taken without the availability of the BMHSR. These trips are called "induced" trips. Table 3.30 provides a breakdown of each of the alternatives by diverted and induced trips.

Table 3.30 – Annual Diverted and Induced Trips by Service Alternative

	Diverted	Induced	Total
Low Speed	205,230	8,046	213,276
Mid Speed	435,152	11,558	446,710
Mid Speed High Fare	320,826	9,271	330,097
Mid Speed Low Frequency	86,651	311	86,962
Mid Speed All Stations	570,291	18,338	588,630
Mid Speed Low Fare	666,983	16,685	683,667
High Speed	627,785	16,447	644,232

Source: Cambridge Systematics, Inc. Travel Demand Model Output, 2002.

Appendix A provides a series of station by station matrices for diverted and induced ridership based on the service parameters presented in Table 3.27 and 3.28. Overall, the proportion of induced trips for the BMHSR service is relatively small, ranging from 0.4% to 3.8% depending on the alternative.

Additional Ridership

The ridership analysis conducted for this feasibility study focused on long distance travel within the corridor study area. However, high-speed rail investment will support a number of additional rail traveler benefits to the corridor, and could attract additional rail passengers.

BMHSR passengers will find improved connections with other intercity rail services. In Montreal, VIA Rail provides service to most other major Canadian cities. From Boston North Station, Amtrak provides the Downeaster service to Portland, ME, and from Boston South Station, Amtrak serves the Northeast Corridor and the rest of the U.S. national rail network. The BMHSR service can therefore allow rail to be used for a wider range of origins and destinations for trips that have one end in the corridor and for through trips.

In addition to connecting rail service opportunities, BMHSR service could become an option for corridor residents seeking to make long distance air trips. BMHSR Corridor residents frequently travel long distances by auto and bus to reach Boston Logan Airport to complete travel throughout the world. BMHSR trains could provide this service, as well (albeit with the need for a short shuttle trip between the rail station and the airport). Similar service could be provided in Montreal where airport-rail station access service already exists.

Since the construction of BMHSR will result in improvements to the existing track and structure over which the MBTA, Amtrak, VIA Rail and Montreal commuter rail systems are operated, improvements in travel times and reliability for passengers of all these services could be realized. Because extensions of existing MBTA commuter rail operations into southern New Hampshire is actively being studied, this study did not focus on the large potential of attracting shorter distance commuter trips. Depending on the conclusions of the commuter rail analysis, significant additional ridership could be realized for the BMHSR service.

4.0 Government and Policy Issues

4.1 Introduction and Background

Transportation policy in the United States has been dominated by the highway mode for much of the last century. The development of aviation services since the 1950's has also been a major focus for U.S. policy makers. The passenger rail mode had been relegated to an historical anachronism by many in both government and industry.

As noted in Chapter 1, public demand has refocused attention on the potential of rail passenger services to not only augment other modes, but to function as an integral element of a multi-modal transportation system to serve metropolitan areas, multi-state regions, and a national network serving to stitch together the fabric of the nation.

The U.S. Secretary of Transportation has recently outlined the Administration's goals with respect to national passenger rail services. Essentially, the emerging policy suggests that a national system should be regionally based, shaped by market forces, and receive support of state government to meet operating costs that exceed revenue income. Planning for passenger rail must be integrated into the state transportation planning process, and not be done in isolation. The federal role may provide for capital and overall structure of the services, but the expectation is that states will take a pro-active role in service planning, delivery and performance. The Administration expects that good investment decisions will be made when costs are shared among the several stakeholders.

Thus, the multi-state and international structure of the BMHSR Corridor is reflective of the emerging policy as it is a multi-state initiative focused on regional connectivity.

Implementation of high-speed rail service in the BMHSR Corridor will require compliance with a multitude of laws, regulations and other institutional procedures. The following sections identify the federal and state laws that are applicable to the proposed BMHSR service. Local regulatory issues should be addressed in future phases of the BMHSR Corridor Study. Environmental considerations, followed by more specific regulatory and permit issues, and U.S. and Canada customs and immigration regulations for border crossings are assessed.

■ 4.2 National Environmental Laws and Regulations

National Environmental Policy Act (NEPA)-United States

The National Environmental Policy Act (NEPA) establishes a process whereby federal agencies, as well as those individuals or agencies undertaking projects with federal funding or occurring on federal lands, are required to evaluate and avoid, to the extent practicable, environmental impacts. The NEPA process is intended to assist public officials in decision-making that is based on an understanding of environmental consequences, and to guide them to take actions that protect, restore and enhance the environment.

Projects which have been authorized to proceed to the design and permitting level, which have an identifiable "purpose and need," are reviewed to determine if potential environmental consequences rise to the level of a formal NEPA filing. If this is not the case, the project is classified as a Categorical Exclusion (CE), and no further NEPA review is required. In the event those potential environmental consequences meet or exceed certain thresholds, or their significance is uncertain, an Environmental Assessment or more detailed Environmental Impact Statement is prepared and made available for public comment.

Clean Water Act

The Clean Water Act (CWA) of 1972 was designed to assist in restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. The CWA covers discharge of pollutants into navigable waters, wastewater treatment management, and protection of relevant fish, shellfish, and wildlife. Section 404 of the CWA requires a permit from the U.S. Army Corps of Engineers (Corps) for the discharge of dredged or fill material into wetlands or other waters of the United States. Section 401 of the CWA requires states to issue water quality certificates before the Corps can issue a Section 404 permit. Any future impacts from the construction of a rail structure into the nation's waters or any fill material placed into wetlands would require adherence to the Sections 401 and 404 of the CWA.

Rivers and Harbors Act of 1899

Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the Corps for the construction of any structure in or over any navigable water of the United States, the excavation from or disposition of material in such waters, or any obstruction or alteration in a "navigable water of the United States." This Act applies to all structures including piers, as well as dredging and disposal activities. Any future construction of a rail structure in or over a navigable water of the United States would require a Department of the Army permit pursuant to Section 10.

The portion of the Merrimack River located between the Massachusetts–New Hampshire State line and Concord, NH falls under the Federal Rivers and Harbors Act. In addition, within the State of Vermont, Lake Champlain falls under the protection of the Rivers and Harbors Act of 1899.

National Historic Preservation Act

The National Historic Preservation Act (NHPA), 16 USC Part 470a, was passed in 1966 to provide for the protection, enhancement, and preservation of any property that possesses significant architectural, archeological, historical, or cultural characteristics. Executive Order 11593 of 1974 further defined the obligations of federal agencies concerning the NHPA. Under Section 106 of the NHPA, if it is determined that the undertaking will potentially affect historic properties, the federal agency undertaking the study must coordinate with the State Historic Preservation Office to preserve and protect the resource. If the federal agency determines that it has no undertaking, or that its undertaking has no potential to affect historic properties, the federal agency has no further Section 106 obligations.

The NHPA requires site-specific information in order to prepare the documents and obtain approvals. A clear and complete understanding of all project elements, obtained through railroad engineering and planning, is needed to complete these documents.

For example, the BMHSR Corridor passes through the Lowell National Historic Park. However, in the current effort to extend commuter rail service to Nashua, NHDOT has examined the implications related to the BMHSR Corridor and the historic resources. Working with the state historic preservation officer the determination has been made that the commuter rail service extension will not impact the historic (cultural) resources.

In addition to the U.S. Federal environmental laws and regulations, there are a number of Canadian environmental laws and regulations that need to be adhered to. The following is a brief summary of the applicable regulations for this type of project.

Canadian Environmental Assessment Act

The Canadian Environmental Assessment Act was established to provide an effective means of integrating environmental factors into planning and decision-making processes. Projects that would require a Canadian Environmental Assessment include those where a federal authority is the proponent of the project, and projects that commit the federal authority to fully or partially carrying out the project. Future planning and implementation for the BMHSR Corridor would include an assessment of land ownership. Any part of the BMHSR Corridor on federal lands would trigger the need for a federal environmental assessment.

Canadian Environmental Protection Act

The Canadian Environmental Protection Act (CEPA) was established to preserve the quality of the environment in Canada. The CEPA contains environmental quality guidelines aimed at pollution prevention, waste control, conservation of natural resources, and maintaining sustainable development. The primary purpose of the CEPA is to contribute to sustainable development through pollution prevention. Any action undertaken to establish a high-speed passenger rail line within Canada would have to abide by the rules and regulations established within the CEPA.

Canada Water Act

The Canada Water Act (CWA) was established to provide management of water resources of Canada, including the administration of present and future demands of the water resources, and to manage provisions for water pollution prevention. Water resources that pass through the international boundary between the United States and Canada would have to be addressed under the CWA. Any action that discharges, degrades or alters the quality of waters within Canada or those waters that flow through the international boundary would be regulated by the CWA.

Canadian Federal Policy on Wetland Conservation

Wetland conservation is a shared federal, provincial, and territorial responsibility. The Canadian federal government is responsible for managing the impacts of over 900 of its policies and programs in Canada. The federal government views its role in wetland conservation as a partner with other governments and the private sector, reflecting the national interest. By virtue of their ownership of natural resources that lie within their boundaries, provinces retain authority over their wetlands. Any impact to wetlands within Canada would have to abide by the Federal Wetlands Policy. A key commitment of the policy is that no net loss of wetland functions on federal lands and waters occur, through mitigation of all impacts of development related to these wetlands. Another commitment focuses on continued enhancement and rehabilitation of wetlands in areas where the continuing loss or degradation of wetlands has reached critical levels.

All of these acts and policies require site-specific information in order to prepare the documents and obtain approvals. A clear and complete understanding of all project elements, obtained by thorough railroad engineering and planning, is needed to complete these documents, and meet federal regulations and approvals.

4.3 State and Quebec Laws and Regulations

The BMHSR Corridor passes through Vermont, New Hampshire, Massachusetts and the Province of Quebec. Each jurisdiction has its own set of established laws and regulations governing how proposed projects would impact the environment and the transportation system. Below are the laws and regulations that would have to be adhered to within each state or province to design, construct and operate BMHSR service.

Vermont Laws/Regulations

Vermont Wetland Rules

It is the policy of the State of Vermont to identify and protect significant wetlands and the values and functions that they serve in such a manner that the goal of no net loss of such wetlands and their functions is achieved. These rules are pursuant to Title 10 V.S.A. Chapter 37, Section 905 (7-9). This statute limits the applicability of these rules to those wetlands that are so significant that they merit protection in this program. Wetlands not designated as significant under these rules should be assumed to have public value, and therefore may merit protection under other statutory or regulatory authority. Any wetlands that are found within the high-speed rail study area that are considered significant under these rules would be protected under this statute. For example, any significant wetlands identified within the right-of-way of the railroad track in Saint Albans would be protected under these rules.

Vermont Water Quality Certification

Under Section 401(a)(1) of the Clean Water Act, states have the authority to review and approve, condition, waive, or deny water quality certification for any activity that is subject to a Federal permit or license and may might result in a discharge to waters of the United States. In Vermont, Section 401 Water Quality Certification applications are reviewed to determine if the activity will comply with the Vermont Water Quality Standards adopted by the Vermont Water Resources Board and any other requirements of state law. If the Vermont Water Resources Board denies the 401 Water Quality certification, the federal license or permit may not be granted.

Vermont Historic Preservation Act

The Vermont Historic Preservation Act (22 VSA 14) gives the state the authority to protect historic resources. The Vermont Division for Historic Preservation coordinates preservation activities on behalf of the state. The Division reviews any projects that may impact historic buildings, structures, historic districts, historic landscapes and settings, and known or potential archeological resources. Compliance with the statutes of the Vermont Historic Preservation Act together with Section 106 of the National Historic Preservation

Act would need to be adhered to when the high-speed rail study enters into an engineering and design phase.

Title 5 Aeronautics and Surface Transportation

Title 5, Aeronautics and Surface Transportation of the Vermont Statutes, details the rules and regulations pertaining to the railroad operations within the state. The following chapters from this statute pertain to the Study.

Chapter 56, Intercity Rail Passenger Service, outlines Agency of Transportation responsibilities, including operating, using, and managing land and buildings and charging fees to use the land and buildings and other facilities acquired for the intercity rail line. Chapter 58, State Acquisition of Railroads, outlines a policy aimed at preserving and modernizing railroad service, or in some cases, preserving established railroad rights-of–way for future reactivation. Chapter 60, General Provisions, details the general contracts, rights and liabilities for railways operating within Vermont. Chapter 62 details the powers and duties of the Board relating to Railroads within the State of Vermont. Chapter 70 details grade crossing regulations for any alteration, repair or taking of land for a grade crossing.

New Hampshire Laws/Regulations

New Hampshire Wetland Program Rule

New Hampshire protects its tidal and non-tidal wetlands and surface waters from "unregulated despoliation" under state law RSA 482-A. RSA 482-A authorizes the Department of Environmental Services (DES) to protect the state's wetlands and surface waters by requiring a permit for dredge and fill or construction of structures in wetlands or other waters of the state. Permitting and enforcement is centralized at the state level. Municipal Conservation Commissions have a statutory intervention status and can place a hold on any permit application they wish to investigate. Almost all federal permitting is conducted through the New Hampshire State Programmatic Permit process. The purpose of the New Hampshire State Programmatic Permit process is to minimize duplication between New Hampshire's Regulatory Program governing work within coastal and inland waters and wetlands and U.S. Corps of Engineers regulatory program under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act, while maintaining the environmental protections guaranteed by those Acts.

Any potential impacts to wetlands or water bodies within New Hampshire would have to be analyzed through the New Hampshire State Permitting process. Any wetlands that occur within the right-of-way of the railroad would require adherence to this rule.

Surface Water Quality Regulations

The New Hampshire surface water regulations are intended to protect public health and welfare, enhance the quality of water and serve the purposes of the federal Clean Water Act. These standards provide for the protection and propagation of fish, shellfish, and wildlife, and provide for such uses as recreational activities in and on the surface waters, public water supplies, agricultural and industrial uses, and navigation. Any potential impacts to surface waters within New Hampshire must comply with the New Hampshire surface water quality regulations.

The Merrimack and Connecticut Rivers are protected under the New Hampshire Rivers Management and Protection Program (NHRMPP), which was established in 1988 to recognize and designate rivers to be protected for their outstanding natural and cultural resources. After a river has been designated for protection, a management plan is developed. In the area of the BMHSR Corridor, the segment of the Merrimack River that is protected under this program begins at the Merrimack-Bedford town line and flows approximately 15 miles through the communities of Merrimack, Litchfield, Hudson, and Nashua before entering Massachusetts. In addition, the upper Merrimack River is protected under this program, which includes the confluence of the Winnipesaukee and Pemigewasset Rivers to Franklin and Garvins Falls in Bow. The segment of the Connecticut River that is protected under the NHRMPP begins at the outlet of the Fourth Connecticut Lake to the New Hampshire/Massachusetts State Line.

New Hampshire Passenger Rail Operations

New Hampshire revised Statute Title XXXIV Public Utilities, Chapter 377 outlines the general operating procedures for passenger rail carriers operating within the State of New Hampshire. In addition, Chapter 367 outlines railroad safety and inspection program. These statutes would have to be adhered to when the high-speed rail is operational.

This passenger rail statute may be pre-empted by Federal Railway statutes, however, this will be determined at the final design and permitting phase.

Massachusetts Laws/Regulations

Massachusetts Wetlands Protection Act

The Massachusetts Wetlands Protection Act (MWPA), Massachusetts General Laws Chapter 131, Section 40, protects wetlands and the public interests they serve. Any activity that will fill, dredge, or alter a wetland would have to comply with the MWPA. The Conservation Commissions of each town/city have a vested interest in preserving wetlands within their borders, and are actively involved in their management and preservation. Any wetlands impacted by the high-speed rail would subject to provisions outlined in the MWPA, including those located along the Merrimack River in Lowell.

Massachusetts Surface Water Quality Standards

The Surface Water Quality Standards were established to protect the public health and enhance the quality and value of water resources within Massachusetts. The Surface Water Quality Standards designate the most sensitive uses for which the various waters in Massachusetts shall be enhanced, maintained and protected. Any future construction or alteration to the surface waters as a result of the implementation of the high-speed rail line within Massachusetts would have to abide by these standards.

Massachusetts Environmental Policy Act

The Massachusetts Environmental Policy Act (MEPA) requires that Commonwealth agencies or project proponents study the environmental consequences of their actions, including permitting and financial assistance. A requirement of MEPA is to study all alternatives to the proposed project, and to develop enforceable mitigation commitments, which would become permit conditions for the project if and when it is permitted. The MEPA also requires evaluation all feasible measures to avoid, minimize, and mitigate damage to the environment.

MEPA applies to projects above a certain size that involve some Commonwealth action. That is, they are either proposed by a state agency or are proposed by a municipal, non-profit, or private party and require a permit, financial assistance, or land transfer from Commonwealth agencies. If it is determined that any one of these three conditions are met by the HSR study, a MEPA document would have to be prepared.

Quebec Provincial Laws/Regulations

Environmental Quality Act, 2000 (RSQ c.Q-2) -Environmental Impact Assessment and Review

Division II, Section 2 (h) requires that projects that propose the establishment of a marshalling yard, railway station, or the construction of more than 2 kilometers of railway conduct an Environmental Impact Assessment. If it is determined that this project will require any of these facilities, then an Environmental Impact Assessment and Review will be required.

Act Respecting the Conservation and Development of Wildlife—Regulation Respecting Wildlife Habitats

Wetlands are protected in the province of Quebec through habitat protection legislation. The central statute for wetland protection is the Act Respecting the Conservation and Development of Wildlife-Regulation Respecting Wildlife Habitats. Under this regulation wetland habitat for specific wildlife species on public lands is protected. The focus of the legislation is on the wetlands along the St. Lawrence River where the greatest wetland loss has occurred. The legislation does not include wetlands on private lands. There is currently an initiative to work with municipalities to protect wetlands under their jurisdiction. This regulation would apply to all public wetlands impacted by the BMSHR service.

The manner in which these acts and regulations would be followed would be determined primarily in the preliminary engineering phase of the study. With the support of federal and local agencies, the federal and provincial environmental assessment documentation would commence. Once the project has successfully completed the environmental assessment phase, and if no significant impacts are recorded, the project would have to meet the requirements of the various permits outlined above. The BMHSR project would be required meet the all the regulations to proceed to the construction phase.

Ecological Reserves Act

Lands within the Province of Quebec may be established as an ecological reserve by the Government of Quebec where the government considers it appropriate for any of the following purposes: to conserve the lands in their natural state; to reserve the lands for scientific research, and where applicable, for education; and to protect threatened or vulnerable plant and animal species.

The following activities are prohibited in ecological reserves: hunting, trapping, fishing, any activity relating to mining, gas or petroleum exploration and development, any underground reservoir exploration activity, prospecting, digging and boring, forest management activities, earthwork and construction activities, agricultural, industrial or commercial activities, and, generally, any activity likely to alter the state or nature of ecosystems.

The BMHSR Corridor would be located along already established rail routes in Quebec. Therefore, it is unlikely that any part of the existing BMHSR Corridor is located within an already established ecological reserve. Earthwork and construction activities are prohibited in ecological reserves, therefore any future construction plans for the BMHSR route would not be allowed within the ecological reserve. Therefore, any BMHSR alignment modifications would need to be evaluated to determine any impacts on the ecological reserve lands.

An Act Respecting the Conservation and Development of Wildlife

The Act Respecting the Conservation and Development of Wildlife outlines the responsibilities of the wildlife protection officers in ensuring that wildlife conservation measures are carried out by ensuring that the hunting, fishing or trapping of wildlife is carried out in a responsible manner.

Tree Protection Act

The Tree Protection Act was established to ensure that any person within Quebec does not destroy or damage, wholly or partially, a tree, sapling or shrub, or any underwood, anywhere other than in a forest under the management of the Minister of Natural Resources, without having obtained the authorization of the Minister of the Environment. A tree may be removed if consent has been previously given by the owner of such tree, sapling or shrub. This regulation does not apply in cases of such trees or shrubs accidentally come in contact with wires or apparatus of a public utility in a manner to endanger life or property or to interrupt service.

Any trees that may be in the BMHSR Corridor within the Province of Quebec would fall under this regulation and permission for removal would require approval of the Minister of the Environment.

An Act Respecting Threatened or Vulnerable Species

The Act Respecting Threatened or Vulnerable Species applies to threatened and vulnerable species that are found in Quebec or are imported into Quebec. The act states that no person in the habitat of a threatened or vulnerable plant species, carry on an activity that may alter the existing ecosystem, the biological diversity, or the physical or chemical components peculiar to that habitat. During the permitting and design phase of the BMHSR Corridor, the locations of any threatened or vulnerable plant species would be researched and provisions would be put in place to avoid or minimize potential impacts to them.

Cultural Property Act

The Cultural Property Act (CPA) was established to regulate, protect, and conserve cultural resources found within the Province of Quebec. Under the CPA, no person may alter, restore, repair, change in any manner or demolish in all or part any recognized cultural property, and in the case of immovable objects, move it or use it as a backing for construction without notifying the Minister of Culture and Communications. The Government of Quebec may also declare a territory to be a historic district because of its concentration of monuments or historic sites found there. An area may also be declared a territory because of its aesthetic qualities or because of its scenic interest of its natural setting. Permission to construct, alter or change the arrangement of a territory must be given by the Minister of Culture and Communications. If it is found that any part of the BMHSR Corridor that passes through Quebec runs through a property that has been identified as a cultural resource, permission to alter it would have to be granted from the Minister of Culture and Communications.

An Act Respecting Municipal Contribution to Railway Crossing Protection

The council of any local municipality may pass a by-law providing for the contribution of the expense of safeguarding, whether by the erection and maintenance of gates or the construction of tunnels, overhead bridges or other like devices, the approaches to a railway which crosses on the level any public road which the municipality is interested in protecting within its territory or within a distance of 8 km (5 mi). The municipality may borrow money and issue bonds for such construction. Any municipality located along the high speed rail route within Quebec may elect to construct some type of safety device in the interest of protecting its citizens.

4.4 U.S./Canadian Customs and Immigration Issues

Customs and Immigration (U.S. and Canadian)

The U.S./Canadian border is the longest non-militarized border in the world. Trade between these two neighbors approaches $500 billion each year. A 30 point plan is being developed and implemented to create a "smart border" that will eliminate delays for both trade and travelers thereby enabling the continued growth of this unique situation . The following discussion places in context the issues related to border crossing for future high-speed rail passengers. U.S. and Canadian Customs and Immigration officials expressed optimism that new technology and new agreements would help to provide for safe and effective border crossing for train passengers.

Contained within this section are discussions of typical procedures for handling of customs and immigration issue for travel by train. The following section provides an more detailed description of recent and current procedures utilized for specific trains that transit over the U.S./Canadian border.

U.S. Customs

The role of U.S. Customs is to act as guardians of the nation's borders, to enforce the laws of the United States, and to foster lawful international trade and travel. The goals of U.S. Customs are to stop the flow of illegal drugs and other contraband that enter into the country, verify that import duty have been paid, and to ensure that only those individuals that are lawfully eligible to enter into the United States are permitted to do so.

Whether visitors are traveling by car, plane, or train, U.S. Customs officials are the first officers to greet them in the United States. As a standard procedure for travel by train , a U.S. Customs declaration form is distributed to each passenger on board the train prior to reaching the U.S./Canadian border. The purpose of the form is to assist the traveler in declaring any and all goods purchased outside of the United States that may be subject to duties. Once the train crosses into the United States from Canada, the train will stop shortly after the border. U.S. Customs officers will board the train once it is in the United States to conduct a preliminary inspection to determine each passenger's eligibility to enter into the United States.

U.S. Customs officials greet passengers with a series of questions, first of which would be to determine their citizenship. The passenger then produces a passport, birth certificate, or other photo identification for inspection. In addition, the U.S. Customs officer will ask if the purpose of the trip is business or personal, the final destination of the trip, the length of stay.

The U.S. Customs officer will ask what items are being brought into the country other than personal items, including gifts and souvenirs and if there are any items that the passenger wishes to declare. Passengers are to have filled out the U.S. Customs forms on route to the U.S., and the passenger would have documented any and all items to declare on the U.S. Customs declaration form. To declare an item is to inform the U.S. Customs officer about the value of item(s) purchased outside of the United States that were not with the passenger when they originally left the United States. Duty limitations depend upon the length of the visit and the types of items purchased. The U.S. Customs official may also request that the passenger produce their baggage for inspection. The length of time it takes to complete this preliminary inspection depends upon the number of passengers on board the train. On average, an inspection takes twenty minutes to one hour.

Once the preliminary inspection is completed, passengers with improper identification or illegal items are removed from the train by the U.S. Immigration and Naturalization Service. The U.S. Customs officers then disembark the train and allow it to proceed onto its next scheduled station stop.

U.S. Immigration and Naturalization Service

The U.S. Immigration and Naturalization Service (INS) is responsible for admitting individuals into the United States for various purposes, including permanent settlement, study, temporary work, and short-term visits. The documentation needed to enter the United States from other countries will depend upon the traveler's country of origin. Travelers who are either Canadian or U.S. citizens must have an valid passport, or a birth certificate, citizenship certificate or naturalization certificate as proof of citizenship. Non-U.S. citizens permanently or temporarily residing in the U.S. must have an Alien Registration Card. Citizens of other countries must have a passport, or in some cases they may also be required to have a visa, or a U.S. Employment Authorization Card.

U.S. Customs and INS officials cooperate in admitting lawfully eligible people into the United States. The U.S. Customs officer conducts the preliminary inspection of train passengers to determine which passengers do not have the proper identification to lawfully enter the United States. The U.S. Customs officer removes the passenger from the train and transfers him or her over to an INS official.

Future Policies and Regulations (U.S.)

Future travel between the United States and Canada would involve a greater role in the use of technology for both U.S. Customs and INS officials. Discussions with U.S. Customs officials revealed that future high-speed rail service between Boston and Montreal would involve three possible alternatives to adhere to the rules and regulations of U.S. Customs, as follows:

1. Stop a southbound train at the closest stop near the U.S./Canadian border (St. Albans, VT) and allow the U.S. Customs officers to board the train to conduct inspections; once the inspections are complete and all passengers are cleared, the train would proceed to its next designated stop.

2. Place U.S. Customs officers on the train in Montreal to ride the train from Montreal to the U.S./Canadian border. The U.S. Customs officers would conduct their inspection while riding the train and then they would disembark the train once it crossed the border. The U.S. Customs officers would then get a ride back (through the use of a passenger van or other means) to Montreal after they crossed the border.

3. Create a U.S. Customs inspection station in Montreal at the Central Station, where passengers would be pre-screened. Once the passengers have cleared U.S. Customs, they would be allowed to board the train. The train would leave Montreal and proceed directly to its first stop within the United States, in St. Albans, VT. The train would not pick up any passengers until its first stop in the United States.

Future policies and procedures that U.S. Immigration and Naturalization officials would adhere to could include the following scenarios:

1. Place a camera at the boarding area of the train, and monitor boarding passengers remotely.

2. Have U.S. Immigration officers board the train in Montreal and ride the train from Montreal to St. Albans, VT, where they would then conduct their inspection.

3. Have a pre-screening system similar to Dorval and Toronto airports; U.S. Immigration would screen people within a designated area; and then clear them for admission into the United States. Once all the passengers are cleared the train is considered "sealed"; there would not be any passengers allowed between Montreal and the first stop after crossing the U.S./Canadian border.

As noted above, the joint U.S./Canadian "Smart Border" plan seeks to reduce delays at border crossings. A demonstration photo-identification card system is underway between Washington and British Columbia. The Amtrak Cascades service also provides a potential model for efficient border crossing in the future, and its operating procedures are described in the section below.

Canada Customs and Revenue Service

The role of the Canada Customs and Revenue Service (CCRS) is similar to that of the U.S. Customs, which is to act as guardians of the nation's borders, to enforce the laws of Canada, and to foster lawful international trade and travel. The goals of the CCRS are to stop the flow of illegal drugs and other contraband that enter into the country, verify that import duty have been paid, and to ensure that only those individuals that are lawfully eligible to enter into Canada are permitted to do so.

Current policy for passenger train service from the United States into Canada is to stop the train once it has crossed the border onto Canadian soil. CCRS officials will then board the train and conduct interviews on behalf of Citizenship and Immigration Canada (CIC). As required by law, each passenger would be required to complete a CIC Declaration Card. The card must be filled out to declare every item that the passenger is bringing into

Canada, and it serves to answer questions about the passenger's stay in Canada. The CCRS officer will ask passengers for their proof of citizenship, the nature of their trip, how long they plan to stay in Canada, and what items they wish to declare. In addition, the passengers' baggage would be subject to inspection. All luggage has to have a tag with the passenger's name. Luggage that is not tagged will be removed if it is not matched with an on-board passenger.

Once the CCRS officer completes the preliminary inspection, he or she will disembark the train and allow it to proceed. Those passengers who are refused entry into Canada are removed from the train and are then dealt with by CIC officials for processing or, in some cases, detainment. In some cases, the passenger would be required to leave Canada and return to either the United States, or, in some extreme cases, the country of their origin (if other than the United States).

Although it is not a standard policy of CCRS or CIC, Amtrak may forward a list of all confirmed passengers in advance of the train arriving there. The passenger listing would then be pre-screened before the train arrives at the border, which helps facilitate which passengers would be subject to further security screening.

Citizen and Immigration Canada

Existing Conditions (Canada)

Citizen and Immigration Canada (CIC) is responsible for admitting individuals into the country for various purposes, including to permanently settle, study, temporarily work, and to visit. When traveling by train into Canada, visitors must meet certain criteria established by CIC in order to gain lawful entry into Canada. Conditions for entry into Canada differ depending upon the visitor's country of origin. The majority of Canadian and U.S. citizens may cross the U.S./Canadian border provided that they are carrying proof of citizenship with them. Proof of citizenship consists of a birth certificate or certificate of naturalization. In addition, a passport is also an acknowledged form of citizenship. Persons under 18 years old who are not accompanied by an adult must bring a letter from a parent or guardian giving them permission to enter Canada. Evidence of the reason for travel into Canada may also be required. For those traveling as tourists, an explanation of where they will travel, and the length of travel will be required. A business visitor would need to state the nature of his/her business, where he/she will go, what companies will be visited, and in some cases, produce letters from prior contacts with those companies for inspection.

Future Policies and Regulations (Canada)

Future policies and regulations established for CIC include a five-part security strategy in response to the events of September 11, 2001. Included in the security strategy is to hire additional staff to enforce upgraded security at all Ports of Entry. Additional staffing and resources were committed to key enforcement activities, including examination and security screening at ports of entry. CIC also plans to continue to work closely on security and intelligence issues with CCRS, as well as with the U.S. and international counterparts in order to fight terrorism.

Discussions with CCRS officials indicated that the potential future rail facilities in Montreal would need to adhere to Section 6 of the Canada Customs Act, which states that the operator of the rail service would be responsible for constructing an examination facility within the train station. This examination facility could be designed to accommodate both U.S. and Canada Customs and Immigration operations, as does the Cascades High Speed Rail Line in Vancouver, BC. Another option would be to construct a facility at Lacolle, Quebec, which would provide Canada Customs and Immigration with an area in which to conduct their screening. The train would stop at this facility, and CCRS and CIC officers would process the passengers immediately after crossing the border into Canada. In order to ensure that this facility is properly staffed, the established ratio of inspectors to rail passengers is one CCRS inspector for every 50 passengers, and one CIC inspector for every 50 passengers.

At present, CCRS and CIC do not have pre-clearance facilities within any airport or railroad station within the United States. To help expedite the clearance process, the train operator provides CCRS and CIC with a listing of passenger names prior to the trains departure. Once at the border, the train stops to allow CCRS and CIC officials to board the train and conduct their preliminary inspection.

CCRS and CIC currently use a program called CANPASS-Dedicated Commuter Lanes program, designed for frequent travelers to Canada from the U.S. The CANPASS program is one of the results of the United States of America Accord on Our Shared Border. This is a program designed to simplify border crossings for low-risk travelers. Citizens or permanent residents of Canada, citizens or resident aliens of the U.S. that meet visitor requirements, or citizens or resident aliens of the U.S. entering Canada to work or study who meet all immigration requirements are eligible for this program. This program involves a dedicated lane for frequent travelers between Canada and the U.S., and a photo permit that identifies travelers each time they cross the border.

A similar system has been implemented in the United States for air travel. The INS Passenger Accelerated Service System (INSPASS) is an automated system currently implemented in airports that can significantly reduce immigration inspection processing time for authorized travelers. At the port-of-entry, the traveler proceeds to an INSPASS inspection queue. There, the traveler inserts an INS issued card to an INSPASS kiosk. The automated inspection kiosks are not staffed, and INSPASS is only available at airports. Citizens of the United States, Canada and Bermuda are eligible to enroll in this program. There are currently no plans to implement the INSPASS for rail travel, but this may be an option once an increase in rail travel between Canada and the U.S. occurs.

4.5 Existing Amtrak Services

Amtrak Cascades Train

Formerly known as Amtrak's Mt. Baker International Service, the Amtrak Cascades Train runs between Portland, Oregon, and Vancouver, British Columbia, Canada. The procedures implemented by both the U.S. and Canadian customs and immigration departments have set the precedent for high-speed train travel between the United States and Canada. Currently, the train route offers one scheduled daily service from Portland, Oregon to Vancouver, British Columbia.

Currently, U.S. Customs agents are not allowed to conduct inspections within train stations. Prior to September 11, 2001, U.S. Customs officials would perform a "rolling inspection" whereby they would board the train and the train would proceed on its route. The train would be considered "sealed", and no passengers would be allowed to board or exit the train after it left the station in Vancouver, BC and it entered U.S. territory. The agents would collect information and search luggage once they were on the train. On board inspections resulted in no additional trip time for this train route.

However, since September 11, 2001, U.S. Customs inspections have been conducted differently. After departing Pacific Central Station, the first train stop within the U.S. is in Blaine, Washington. This is a dedicated train stop for U.S. Customs officers only, and not a regular train stop for ticketed passengers. No passengers are allowed either on or off the train at this stop. The train remains parked at the Blaine stop until the U.S. Customs inspections are completed. Once the U.S. Customs officers have completed their inspection, they disembark the train. The train then proceeds to its first scheduled passenger stop, in Bellingham, Washington, located south of Blaine. As a result of this change in inspection procedure, the inspection time for southbound trains to the U.S. requires approximately one hour.

For northbound trains to Canada, CIC cards are handed out to every passenger by the train crew at the last stop in the United States. The train then proceeds, crosses the border, and continues directly to the Pacific Central Station in Vancouver.

Upon arriving at the Pacific Central Station in Vancouver, the train enters a segregated area of the train station. Passengers are required to take their luggage and proceed to the CIC inspection area located within the station. CIC staff will then screen all arriving passengers within the train station. The train will remain parked within the secure area until its next daily scheduled departure to Portland.

For trains returning to the United States, INS staff performs pre-clearance on all ticketed passengers at Pacific Central Station. The INS staff is located within the facility occupied by CIC. Passengers that have met the U.S. immigration requirements then board the train.

Amtrak Adirondack Train

Amtrak's Adirondack train route operates between New York City and Montreal. Currently, the Adirondack offers one scheduled daily service from New York City to Montreal. CIC cards are handed out to every passenger at Rouses Point, New York, the last stop in the United States. The train then proceeds across the U.S./Canadian border, and stops at Cantic, Quebec. CIC officials board the train at this stop, and conduct their inspections of each passenger. The train remains parked until the inspection is complete. The average length of time for inspections is 45 minutes to 2 hours. In light of heightened security procedures since September 11, 2001, the delays at the border for passenger rail service along this line have been unpredictable, partly due to staffing limitations, resulting in fluctuation in lengths of delay at the border. Reportedly, Canadian officials plan to alter this procedure in the near future, conducting inspections at the border (Rouses Point) instead of Cantic. Recent issues related to refugees have created concern, and this change may result in further delays for this service.

Passengers heading southbound from Montreal into New York State are given a U.S. Customs Declaration Card to fill out. Once at the U.S./Canadian border, the train proceeds to Rouses Point, New York, the U.S. Customs and INS stop for southbound trains. This stop operates mostly as a rail maintenance facility; however, there are plans to upgrade this stop to improve administration and security facilities.

Amtrak Maple Leaf Train

Amtrak's Maple Leaf route runs from New York City to Toronto. This route operates mainly in New York State, and crosses the U.S./Canadian border at Niagara Falls. The train offers one scheduled daily service from New York to Toronto. Upon purchasing tickets on this train route, passengers are required to provide their date-of-birth and country of origin information. The U.S. Customs and INS officials are provided this information in advance of the train arriving at the border. Upon its approach to the U.S./Canadian border, the train stops at Niagara Falls, New York, where U.S. Customs and INS officials board the train and conduct an exit inspection. This inspection is conducted to confirm the names and citizenship of all ticketed passengers with those physically on the train. The exit inspection takes between 20 minutes to 30 minutes.

Upon crossing the border into Canada, the train stops in Niagara Falls, Ontario, where CIC officials conduct their inspection. The CIC officials board the train and conduct their inspection. The average length of time of the inspection is from 45 minutes to one hour.

Passengers heading southbound from Toronto are given a U.S. Customs declaration card to complete upon crossing the border into the United States. The train stops at Niagara Falls, New York, and the U.S. Customs and Immigration officials board the train to conduct their inspection. Customers purchasing tickets on the Canadian side of the border are not required to provide evidence of their country of citizenship, due to Canadian privacy laws. The average length of time of the inspection is from 45 minutes to one hour.

■ 4.6 Railroad Laws and Regulations

The United States and Canada both have developed their own unique railroad laws and regulations, aimed at improving rail facilities and operations to the greatest extent possible. A summary is provided below.

U.S. Railroad Regulations

Federal Railroad Administration

The Federal Railroad Administration (FRA) of the U.S. Department of Transportation was created in 1966 to ensure, promote and enforce safety throughout America's railroad system. The FRA implements railroad safety laws by developing regulations and applying them to the railroads. The FRA regulates a number of operations, including track safety operations, signal and train control operations, motive power and equipment, operating practices, hazardous materials, and highway-rail grade crossing safety. By law, the FRA is responsible for promoting railroad safety nationwide and enforcing safety standards through these operations.

The FRA also develops and implements legislation pertaining to railroad operations. Under the United States Code, Chapter 49, passenger transportation laws pertaining to Amtrak, the Amtrak Route System, and the Northeast Corridor Improvement Program have been established to develop the potential of modern rail transportation to meet intercity and commuter rail passenger transportation needs. The establishment of a high speed rail system would have to adhere to the rules and regulations outlined within Title 49 of the United States Code, and the legislation established by the Federal Railroad Administration.

United States Code, Title 49-Rail Transportation

Several chapters found within the United States Code, Title 49, Rail Transportation, pertain to passenger rail operations. In particular, Chapter 241 outlines several passenger rail goals, including providing passenger convenience, providing modern and efficient commuter rail transportation, providing cooperation between intercity and commuter rail passenger transportation, developing rail corridors, and marketing rail transit. Chapter 243 deals exclusively with the operation of Amtrak. Chapter 249 deals with the Northeast Corridor Improvement Program, which is aimed at improving high-speed rail transportation between Boston and Washington. This statute states that the rail operator is authorized to acquire, build, improve, and install passenger stations, communications, electric power facilities and equipment, public and private highway and pedestrian crossings, and other facilities to provide high-speed rail passenger transportation over the corridor.

In addition, Chapter 261 provides guidelines pertaining to HSR corridor planning, including technology and safety regulations. All of these regulations would need to be followed to develop plans for the high-speed rail line. Operational rules and regulations would apply following construction.

Canadian Railroad Regulations

Canadian Federal Laws

Railway Safety Act, R.S. 2001

The objectives of the Railway Safety Act are to:

- Promote and provide for the safety of the public and personnel and the protection of property and the environment, in the operation of railways,
- To encourage the collaboration and participation of interested parties in improving railway safety,
- Recognize the responsibility of railway companies in ensuring the safety of their operations, and;
- Facilitate a modern, flexible and efficient regulatory scheme that will ensure the continuing enhancement of railway safety.

Any construction or alteration of railways within Canada would need to adhere to Part I of the Railway Safety Act. Part I gives a general overview of the standards that need to be adhered to and the types of ministerial approval that must be gained to construct or alter any segment of railway in Canada. In addition, Part II outlines regulations that pertain to the operation and maintenance of rail lines.

Canada Transportation Act

The Canada Transportation Act provides rules and regulations that pertain to developing a safe, efficient, and adequate network of viable and effective transportation services accessible to all. The Canada Transportation Act provides regulatory powers over economic matters and issues of public convenience and necessity. Part III of the act deals with railway transportation, which outline the rules and regulations pertaining to the construction and operation of railways and rail lines. This act must be followed in conjunction with the Railway Safety Act.

Under the Canada Transportation Act, the Canadian Transportation Agency, a quasi-judicial body, is responsible for certain provisions of the Railway Safety Act. When deciding whether the location of the proposed railway line is reasonable, the Agency will consider the requirements for railway operations and services, the interests of any localities that the line will affect and the impact on the environment.

Railway Relocation and Crossing Act

This act was established to facilitate the relocation of railway lines or the rerouting of railway traffic in urban areas, and to provide financial assistance for work done for the protection, safety and convenience of the public at railway crossings. This act states that any changes made to a railway line must be submitted to the Canadian Transportation Agency. In addition, a financial plan outlining how the costs are to be shared by the province, the municipalities concerned, the railways, and any other interests that may be affected must also be submitted to the Canadian Transportation Agency when any work is done to a railway line.

■ 4.7 Security Considerations

Since the events of September 11, 2001, various branches of the U.S. federal government have developed reports and analysis focused on security and travel. The following is a brief summary.

Report to Congress on Enhanced Security Measures by the Transportation Security Administration (TSA)

The Report to Congress on Enhanced Security Measures by the Transportation Security Administration (TSA) advocates requirements to implement passenger programs and use available technologies to expedite the security screening of passengers. The implementation of these programs is intended to expedite the screening process and allow security screening personnel to focus on those passengers who would be subject to more extensive screening.

The Transportation Security Administration is pursuing multiple actions to minimize the “hassle factor” for the traveling public. Evaluation of a traveler or a pre-screened and registered passenger program is among the priorities.

To implement a passenger screening program, TSA would need a simple, fast, affordable and nationally distributed technology to provide effective background clearances for a very large number of individuals. TSA is working with the Office of Personnel Management and private vendors to put in place a process that would be based on an efficient method of validation at a terminal of a pre-screened and registered passenger.

Enhanced Border Security and Visa Entry Reform Act

The Enhanced Border Security and Visa Entry Reform Act strengthens the requirement that all commercial passenger ships and airplanes entering the United States provide a list of passengers and crew before arrival. This allows border authorities to research the passenger names in advance to aid with preventing someone from entering the country if he or she poses a threat to U.S. citizens. The submittal of passenger lists for train travel could also be used to research the names of train passengers in advance.

Secure and Smart Border Action Plan

The Secure and Smart Border Action Plan recommends that clearance of visitors and tourists be made away from the border, prior to any individual crossing the border. Its approach is to develop an integrated method to improve security and facilitate trade through away-from-the-border processing for rail, including inland pre-clearance/post-clearance, international zones, and pre-processing centers at the border.

Common Borders, Shared Destinies: Canada, the United States and Deepening Integration Report

The Common Borders, Shared Destinies: Canada, the United States and Deepening Integration Report states that virtually all travel across the border involves properly documented and eligible individuals pursuing legitimate objectives, from business to tourism. Much of the activity of immigration officers, therefore, is routine and makes a marginal contribution to safety and security. This initiative is aimed at identifying how these routine requirements can either be eliminated, be performed away from the border, or be satisfied by relying on more modern technologies. In the future, the U.S. and Canadian governments are expected to have resources targeted toward pre-clearance programs for people and goods.

4.8 Funding Issues for U.S./Canadian Joint Projects

The international nature of the BMHSR Corridor presents both challenges and opportunities. Participant stakeholders in Phase I of the Study have included: Transport Canada; City of Montreal; Province of Quebec, and the Communaute Metropolitaine de Montreal (regional planning agency for greater Montreal). Response and interest in the project has been positive, and both staff and officials have provided data input, analysis and commentary throughout the process.

Future study phases will require considerably more effort, and the U.S. participants will investigate the idea of cost sharing with the Canadian stakeholders. However, there are existing restrictions on the acceptance and use of "foreign" funds for projects receiving US federal funding. FRA has advised the Study Team that funds expended for in-kind services provided by Canadian agencies will be considered as eligible matching for future BMHSR Study phase grants. However, this funding restriction may have an impact on the available means to fund construction and operation of any HSR service. Therefore, the specific funding mechanisms and costs sharing plans for implementation of any BMHSR service will need to evaluated in greater detail in subsequent phases of the Study.

■ 4.9 Summary of Government and Policy Issues

As with any major transportation infrastructure development project, the implementation of high-speed passenger rail service in the BMHSR Corridor will require compliance with a myriad of laws, regulations and permitting requirements. It should not be inferred that such rules are hurdles to be crossed, or objections to be overcome, but rather are safeguards to protect the public interest in safety, health and environmental quality. It is well recognized that passenger rail service provides a safe, environmentally positive means of moving people. These laws and regulations will assure that the construction and development of the project does nothing to detract from the objective of protecting the public interest in safety, health and environmental quality.

The U.S. Secretary of Transportation has recently outlined the Administration's goals with respect to national intercity passenger rail services. Essentially, the emerging policy suggests that a national system should be regionally based, be shaped by market forces, and receive support of state government to meet operating costs that exceed revenue.

Thus, the multi-state and international structure of the BMHSR Corridor is reflective of this emerging policy as it is a state-led initiative, focused on regional connectivity. The response of the Quebec government that indicates support for the continuation of the Study to determine if the BMHSR service is feasible underscores the appropriateness of evaluating the BMHSR Corridor. Chapter 4 of this study identifies the federal and state laws that are applicable to the proposed BMHSR service. Environmental considerations, followed by more specific regulatory and permit issues, and U.S. and Canadian customs and immigration regulations for border crossings, are assessed. Both U.S. and Canadian Customs and Immigration officials expressed optimism that new technology and new agreements would help to provide for safe, effective and efficient border crossing for train passengers. Therefore, the Study assumes that methods will be developed that will eliminate the need for stopping the BMHSR train at the border.

In future Study phases, site-specific issues related to environmental permitting, historic and archeological resources, will need to be addressed. International issues must also be considered in terms of both opportunity and challenge. However, the BMHSR Corridor has long served as a transportation corridor, and this current level of analysis indicates that all legal and regulatory requirements can be met.

5.0 Findings

The purpose of Phase I of the BMHSR Study is to perform an initial assessment of existing operations, infrastructure, and institutional issues to confirm that no fatal flaws exist for implementation of a high speed rail service and to develop ridership forecasts and evaluate if sufficient demand exists to warrant study of associated operational, engineering, and cost/revenue factors.

The following provides a summary of the findings associated with Phase I of the Study.

■ 5.1 Current and Potential BMHSR Corridor Operations

Historic Services – Direct rail services between Boston and Montreal using the proposed route operated for approximately 110 years until the early 1960's. In the first half of the 20th Century, the Boston-Montreal services along this route ran using steam locomotives with two or three round trips per day, with one way trip times in the range of 10 to 12 hours. By 1961, a diesel propulsion service along this route was offered with one round trip per day making fewer stops, with a one-way trip time of 8 hours and 30 minutes.

Existing railway users and capacity for high speed services – The distance of the BMHSR Corridor is 329.4 miles. The density of current rail operations is greatest in locations approaching and including Boston and Montreal. Operations along the BMHSR Corridor are summarized below:

- In the Montreal area, it appears that Central Station (with 19 tracks) has sufficient platform capacity to host a high speed rail passenger service. Between Central Station and Cannon (6.2 miles) existing rail traffic along the route is fairly dense, presenting the potential for conflicts with the proposed high-speed service. Potential for conflicts would likely be greatest for northbound trains that may not always arrive on time for their scheduled slot on CN's Saint-Hyacinthe subdivision. However, since the total length of potentially congested track is relatively short (only 6 miles) and because it is in an area where curvature and switching moves will undoubtedly restrict speeds, the impacts on overall velocity for the high speed service could be manageable.

- South of Cannon, the density of railway activity on the proposed BMHSR Corridor to the U.S./Canadian border (44 miles) is more modest. With track and signal improvements to this currently unsignaled single track line, it would seem that capacity could be increased for high speed passenger trains to pass freight activity on this line segment.

- At the U.S./Canadian border, an institutional barrier might exist to hold all trains. Presently, all passenger trains are held standing at the U.S./Canadian border for Customs and Immigration inspection. Unless the mode of this inspection is shifted to provide for "inspection-in-motion", a severe time penalty for the high-speed service would be expected. The assumption for the study is that procedures will be established in the future that would eliminate the need for a BMHSR train to stop at the border.

- Between the U.S./Canadian border and White River Junction, (136 miles), the railway remains single track with no automatic block signals. It is maintained for 60 mph maximum speeds by passenger trains. With track and signal improvements, it would seem that capacity could be constructed for high speed passenger trains to pass freight activity on this line segment.

- Between Concord and Nashua (34 miles), the density of traffic along the route seldom exceeds four freight trains per day. The 50.9 mile segment of track from White River Junction to Boscawen is owned by the State of New Hampshire. The Claremont Concord Railroad operates three miles of the segment between White River Junction and West Lebanon. The remainder of the segment is unused. Track structures have been removed.

- In the 40 miles between Nashua and Boston's North Station, the density of rail traffic increases dramatically with more than 50 daily trains for some segments of the route. It has not been determined if this 40-mile segment has the capacity to handle eight to sixteen high speed trains per day in addition to its current traffic base, without additional trackage. Potential for conflicts between existing scheduled trains and the high speed service would probably be greatest for southbound trains that would not always arrive in their assigned schedule slots. Boston's North Station, with only ten tracks, does not appear to have sufficient platform capacity at this time to host a high speed rail service to Montreal without adding station trackage.

Required Infrastructure – None of the proposed route has track or signal infrastructure necessary for 110 mph operations. For speeds above 80 mph, substantial improvements to both the track and signal systems would be required for all trackage along the route. The specific analysis of operational and infrastructure improvements will be completed in subsequent phases of the study.

■ 5.2 Potential Ridership

Potential Running Times for High Speed Rail Service – The project team used a Train Performance Calculator program to estimate the running times that could be achieved for the Boston-Montreal route using a range of modern rolling stock, fixed plant investment levels, and station stopping patterns. Three sets of service scenarios were used for the ridership forecasting analysis as shown in the Table 5.1 below.

Table 5.1 – Potential Service Scenarios

Service Scenario	Case 1. Lower Speed Local Service	Case 2. Mid Speed Limited Service	Case 3. Highest Speed Express Service
Maximum Allowable Speeds	Generally 60 mph with speeds up to 80 mph where currently allowed	110 mph with restrictions for existing horizontal curves	110 mph with no restrictions for existing horizontal curves
Intermediate Stops	12	8	6
Running Time	7:55	4:48	3:31
Service Velocity (Commercial Speed)	42 mph	68 mph	94 mph
Rolling Stock	One F59PH Locomotive and Six Coaches	One F59PH Locomotive and Six Coaches	One F59PH Locomotive and Six Coaches

Utilizing the three operating cases, ridership numbers have been generated for seven alternative scenarios. For each scenario, associated costs and travel time for comparative auto, air and bus service remained constant. Table 5.2 provides a summary of each scenario's projected ridership along with other pertinent service information such as trip time from Boston to Montreal. Details of each scenario are provided in Chapter 3.

Benefits

Ridership for each of the BMHSR alternative varies significantly depending on the service attributes. For example, the reduction of service levels on the mid speed scenario from six trains per day to two trains per day resulted in ridership levels dropping to less than 20% of the ridership for the six trains a day scenario. Furthermore, reduction in the fares from $0.26 per mile to $0.20 per mile resulted in an increase of ridership from 446,710 to 683,667. Interestingly, the increase in ridership at the lower fare actually resulted in a 24% increase in total passenger revenue. This provides the potential benefit of maximizing usage of a BMHSR at the lowest cost to the user and simultaneously maximizing revenues for operational support.

High speed rail supports a number of additional benefits to the BMSHR Corridor, particularly for existing rail services. The construction of HSR will result in improvements to the existing track and structure of the MBTA, Amtrak, VIA and Montreal passenger rail systems.

Provision of HSR will also enhance the need for and use of alternative transportation services. For example, the HSR in Boston would connect at North Station, a major hub for the MBTA. Passengers could use the MBTA's other transit modes to access or egress the HSR service. Similarly, HSR passengers will find improved connections with VIA and Montreal Commuter Rail services at the Lucien-L'Allier Station.

Table 5.2 – 2025 Summary Table of BMHSR Ridership

	Low Speed	Mid Speed	Mid Speed High Fare	Mid Speed Low Frequency	Mid Speed All Stations	Mid Speed Low Fare	High Speed
Annual Ridership							
Total Corridor	213,276	446,710	330,097	86,962	588,630	683,667	644,232
Boston-Montreal	13,469	129,508	84,428	27,143	129,508	221,227	200,564
Annual Passenger Revenue							
Total Corridor	$4,784,504	27,893,059	22,559,907	5,724,020	32,291,348	34,614,601	59,062,561
Boston-Montreal	$744,341	11,619,093	8,739,297	2,434,820	11,619,093	15,271,257	24,917,799
Cost per Passenger-Mile (fare)							
HSR (Varies by scenario)	$0.16	$0.26	**$0.30**	$0.26	$0.26	**$0.20**	$0.36
Round trips per day							
HSR (Varies by scenario)	4	6	6	**2**	6	6	8
Number of Stations	12	8	8	8	**12**	8	6
Boston to Montreal Total Trip Time – Vehicle and Terminal (hours: mins)							
HSR (Varies by scenario)	8:55	5:48	5:48	5:48	5:48*	5:48	4:31
Air (Same all scenarios)	3:20	3:20	3:20	3:20	3:20	3:20	3:20
Bus (Same all scenarios)	6:20	6:20	6:20	6:20	6:20	6:20	6:20
Auto (Same all scenarios)	5:52	5:52	5:52	5:52	5:52	5:52	5:52

* Travel trip time was not increased to test only the sensitivity of number of stations stops at this level of the analysis.

** Travel time for HSR service can vary depending on equipment choice. For this analysis, F-59 PH locomotive and Bombardier Bi-Level coach technologies were selected because they are widely used for the delivery of rail service in a multitude of passenger corridors throughout United States.

In addition to improved alternative transportation services, the completion of a high speed rail line between Boston and Montreal would result in a reduction in automobile traffic within the BMSHR Corridor. The number of vehicles and associated VMT would depend specifically on the service parameter associated with the service.

5.3 Government and Policy Issues

Planning, designing and constructing a high-speed passenger rail service in the BMHSR Corridor will require compliance with federal, state and local laws and regulations. Furthermore, the successful development of the service will also require development of consensus among a wide range of stakeholders.

This Study phase has identified the major statutory and regulatory environmental, safety and security requirements to be met. The preliminary assessment of the BMHSR Corridor suggests that implementation of a HSR service could meet these major requirements.

The BMHSR Corridor does contain natural and cultural resources that will need to be protected, both during construction and operations. However, by judicious use of the existing rail line, and with careful planning in coordination with local, state and federal agencies, the BMHSR Corridor offers viable potential for provision of passenger rail service without significant negative impacts to such resources.

5.4 National Trends in Passenger Rail

Currently there are indicators that suggest that passenger rail, and especially high-speed (and high quality) passenger rail service, will play an increasingly important role in the nation's transportation system.

Demand for transportation in North America continues to grow at exponential rates. Freight traffic demands are predicted to double by 2020; vehicle miles traveled ("VMT") will also increase significantly, thereby increasing demand for roadway capacity and maintenance. Business travel trends show no decline, and 60% of this travel involves air trips of less than 400 miles.

USDOT Secretary Norman Mineta is advocating for a strong role for states in the revitalization of passenger rail services. Members of Congress have filed a variety of proposals to provide funding for enhanced passenger rail. Regarding Amtrak, it is currently seeking U.S. government support for FY 2003 funding in the amount of $1.2B. Amtrak has identified this amount as the current level of funding. The Senate has concurred with that amount, but the House is supporting the Administration's recommendation of $900M.

As was described in Chapter 1, states throughout the United States and Canada are collaborating in regional approaches to passenger rail development. The twenty-two member "States for Passenger Rail Coalition" has organized to provide a forum to develop a unified approach to state and federal funding of passenger rail programs. Canada is seriously considering HSR service in the Windsor to Quebec corridor. This suggests that it is appropriate to continue planning and implementing rail projects that have sufficient public support.

5.5 Conclusion

Based on this initial assessment of existing operations, infrastructure, and institutional issues, and consideration of plausible alternative service scenarios, it is concluded that no fatal flaws exist for implementation of a high speed rail service in the BMHSR Corridor, Additionally, given the potential ridership of the BMHSR service, the further study of associated operational, engineering and cost/revenue factors is warranted.

The BMHSR Corridor would require substantial rail infrastructure improvements to support high speed rail service. However, the service is expected to be compatible with existing and future passenger and freight rail operations. Further, an initial assessment of environmental and institutional issues indicates that with appropriate planning and design, environmental and institutional considerations can be satisfied.

Sufficient potential ridership and fare revenue exists to warrant the implementation of Phase II of the Study for evaluation of the operating and capital costs, and associated benefits, of implementing a high speed rail service between Boston and Montreal.

Appendix A

Trip Tables for Service Scenarios

Trip Tables for Service Scenarios

Attached is a summary of assumptions used in the development of each alternative scenario. Following these assumptions are a series of tables which provide station by station ridership predictions. For each alternative, three ridership tables are provided:

- **Diverted Trips –** Trips which would be made on existing modes if BMHSR service is not available.
- **Induced Trips –** Trips that would not be made without the existence of the BMHSR service; and
- **Total Trips –** A summary of both diverted and induced trips.

Terminal time for high-speed rail, air and bus includes time required to be at station prior to departure and processing time to get through customs and immigration. Terminal time for automobiles includes time for processing through customs and immigration at the border and a 20-minute break for all trips over 150 miles in length.

Table A.1 – 2025 Summary Table of BMHSR Ridership

	Low Speed	Mid Speed	Mid Speed High Fare	Mid Speed Low Frequency	Mid Speed All Stations	Mid Speed Low Fare	High Speed
Annual Ridership							
Total Corridor	213,276	446,710	330,097	86,962	588,630	683,667	644,232
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Total Corridor	$4,784,504	27,893,059	22,559,907	5,724,020	32,291,348	34,614,601	59,062,561
Boston-Montreal	$744,341	11,619,093	8,739,297	2,434,820	11,619,093	15,271,257	24,917,799
Cost per Passenger-Mile (fare)							
HSR (Varies by scenario)	$0.16	$0.26	**$0.30**	$0.26	$0.26	**$0.20**	$0.36
Round trips per day							
HSR (Varies by scenario)	4	6	6	**2**	6	6	8
Number of Stations	12	8	8	8	**12**	8	6
Boston to Montreal Total Trip Time – Vehicle and Terminal (hours: mins)							
HSR (Varies by scenario)	8:55	5:48	5:48	5:48	5:48*	5:48	4:31
Air (Same all scenarios)	3:20	3:20	3:20	3:20	3:20	3:20	3:20
Bus (Same all scenarios)	6:20	6:20	6:20	6:20	6:20	6:20	6:20
Auto (Same all scenarios)	5:52	5:52	5:52	5:52	5:52	5:52	5:52

* Travel trip time was not increased to test only the sensitivity of number of stations stops at this level of the analysis.

Table A.2 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"Low-Speed Scenario"
Diverted Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston		0	0	11,417	1,307	2,161	170	49	2,205	14,818		116	6,727	38,969
Woburn	0		0	1,727	1,592	1,099	53	15	576	1,438		10	459	6,968
Lowell	0	0		3,291	3,097	4,008	211	58	1,006	3,088		57	1,371	16,186
Nashua	11,417	1,727	3,291		0	0	0	1	32	341		0	33	16,842
Manchester	1,307	1,592	3,097	0		0	614	33	395	4,251		2	1,104	12,395
Concord	2,161	1,099	4,008	0	0		0	47	809	3,136		11	701	11,972
Franklin	170	53	211	0	614	0		12	446	4,278		2	319	6,105
White River Jct.	49	15	58	1	33	47	12		982	4,698		153	554	6,603
Montpelier	2,205	576	1,006	32	395	809	446	982		4,339		23	228	11,039
Burlington/Essex Jct.	14,818	1,438	3,088	341	4,251	3,136	4,278	4,698	4,339			15	9,112	49,515
St. Albans														0
St. Jean	116	10	57	0	2	11	2	153	23	15			3,820	4,210
Montreal	6,727	459	1,371	33	1,104	701	319	554	228	9,112		3,820		24,427
TOTAL	**38,969**	**6,968**	**16,186**	**16,842**	**12,395**	**11,972**	**6,105**	**6,603**	**11,039**	**49,515**	**0**	**4,210**	**24,427**	**205,230**

Table A.3 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"Low-Speed Scenario"
Induced Trips – 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston		0	0	147	115	87	8	0	3	28		0	15	403
Woburn	0		0	1	19	87	1	0	0	0		0	0	108
Lowell	0	0		4	19	758	9	0	1	1		0	0	794
Nashua	147	1	4		0	0	0	0	0	0		0	0	151
Manchester	115	19	19	0		0	149	1	3	44		0	0	349
Concord	87	87	758	0	0		0	3	15	17		0	0	966
Franklin	8	1	9	0	149	0		0	14	45		0	0	228
White River Jct.	0	0	0	0	1	3	0		16	99		0	0	120
Montpelier	3	0	1	0	3	15	14	16		494		0	0	547
Burlington/Essex Jct.	28	0	1	0	44	17	45	99	494			0	1,502	2,232
St. Albans														0
St. Jean	0	0	0	0	0	0	0	0	0	0			315	315
Montreal	15	0	0	0	0	0	0	0	0	1,502		315		1,833
TOTAL	**403**	**108**	**794**	**151**	**349**	**966**	**228**	**120**	**547**	**2,232**	**0**	**315**	**1,833**	**8,046**

Table A.4 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"Low-Speed Scenario"
Total Annual Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston		0	0	11,563	1,422	2,248	178	49	2,208	14,846		116	6,742	39,371
Woburn	0		0	1,728	1,611	1,186	54	15	576	1,438		10	459	7,076
Lowell	0	0		3,295	3,116	4,766	221	59	1,007	3,089		57	1,371	16,980
Nashua	11,563	1,728	3,295		0	0	0	1	32	341		0	33	16,994
Manchester	1,422	1,611	3,116	0		0	764	34	398	4,295		2	1,104	12,745
Concord	2,248	1,186	4,766	0	0		0	50	823	3,153		11	701	12,938
Franklin	178	54	221	0	764	0		13	460	4,324		2	319	6,333
White River Jct	49	15	59	1	34	50	13		998	4,797		153	554	6,723
Montpelier	2,208	576	1,007	32	398	823	460	998		4,834		23	228	11,586
Burlington/Essex Jct	14,846	1,438	3,089	341	4,295	3,153	4,324	4,797	4,834			15	10,614	51,747
St. Albans														0
St. Jean	116	10	57	0	2	11	2	153	23	15			4,135	4,525
Montreal	6,742	459	1,371	33	1,104	701	319	554	228	10,614		4,135		26,260
TOTAL	**39,371**	**7,076**	**16,980**	**16,994**	**12,745**	**12,938**	**6,333**	**6,723**	**11,586**	**51,747**	**0**	**4,525**	**26,260**	**213,276**

Table A.5 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"Mid-Speed Scenario"
Diverted Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		2,338	4,010		108	5,133	33,021			64,742	109,352
Woburn														0
Lowell	0				5,167	5,536		120	2,221	7,144			23,060	43,248
Nashua														0
Manchester	2,338		5,167			0		58	749	7,650			12,669	28,630
Concord	4,010		5,536		0			82	1,528	6,308			10,079	27,544
Franklin														0
White River Jct	108		120		58	82			1,690	2,617			2,876	7,552
Montpelier	5,133		2,221		749	1,528		1,690		7,673			2,273	21,267
Burlington/Essex Jct	33,021		7,144		7,650	6,308		2,617	7,673				8,724	73,136
St. Albans														0
St. Jean														0
Montreal	64,742		23,060		12,669	10,079		2,876	2,273	8,724				124,424
TOTAL	**109,352**	**0**	**43,248**	**0**	**28,630**	**27,544**	**0**	**7,552**	**21,267**	**73,136**	**0**	**0**	**124,424**	**435,152**

Table A.6 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"Mid-Speed Scenario"
Induced Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		369	303		1	17	164			25	879
Woburn														0
Lowell	0				54	1,459		1	6	7			1	1,528
Nashua														0
Manchester	369		54			0		2	10	163			13	611
Concord	303		1,459		0			9	53	70			8	1,902
Franklin														0
White River Jct	1		1		2	9			48	31			2	94
Montpelier	17		6		10	53		48		1,557			36	1,728
Burlington/Essex Jct	164		7		163	70		31	1,557				1,370	3,362
St. Albans														0
St. Jean														0
Montreal	25		1		13	8		2	36	1,370				1,454
TOTAL	**879**	**0**	**1,528**	**0**	**611**	**1,902**	**0**	**94**	**1,728**	**3,362**	**0**	**0**	**1,454**	**11,558**

Table A.7 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario"
Total Annual Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		2,707	4,313		109	5,150	33,186			64,766	110,231
Woburn														0
Lowell	0				5,220	6,995		121	2,227	7,151			23,062	44,776
Nashua														0
Manchester	2,707		5,220			0		60	759	7,812			12,682	29,241
Concord	4,313		6,995		0			91	1,581	6,379			10,087	29,445
Franklin														0
White River Jct	109		121		60	91			1,738	2,648			2,879	7,646
Montpelier	5,150		2,227		759	1,581		1,738		9,230			2,309	22,994
Burlington/Essex Jct	33,186		7,151		7,812	6,379		2,648	9,230				10,093	76,498
St. Albans														0
St. Jean														0
Montreal	64,766		23,062		12,682	10,087		2,879	2,309	10,093				125,878
TOTAL	**110,231**	**0**	**44,776**	**0**	**29,241**	**29,445**	**0**	**7,646**	**22,994**	**76,498**	**0**	**0**	**125,878**	**446,710**

Table A.8 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Rail Fare at 30 Cents per Mile
Diverted Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		2,100	3,511		84	3,694	23,927			42,210	75,526
Woburn														0
Lowell	0				4,868	5,089		99	1,659	5,113			15,551	32,379
Nashua														0
Manchester	2,100		4,868			0		50	590	6,077			9,452	23,138
Concord	3,511		5,089		0			73	1,239	4,927			7,334	22,173
Franklin														0
White River Jct	84		99		50	73			1,531	2,252			2,164	6,253
Montpelier	3,694		1,659		590	1,239		1,531		7,294			1,898	17,906
Burlington/Essex Jct	23,927		5,113		6,077	4,927		2,252	7,294				7,627	57,216
St. Albans														0
St. Jean														0
Montreal	42,210		15,551		9,452	7,334		2,164	1,898	7,627				86,235
TOTAL	**75,526**	**0**	**32,379**	**0**	**23,138**	**22,173**	**0**	**6,253**	**17,906**	**57,216**	**0**	**0**	**86,235**	**320,826**

Table A.9 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Rail Fare at 30 Cents per Mile
Induced Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		297	231		1	9	80			9	627
Woburn														0
Lowell	0				48	1,230		1	3	4			1	1,286
Nashua														0
Manchester	297		48			0		1	6	96			6	455
Concord	231		1,230		0			7	35	42			4	1,548
Franklin														0
White River Jct	1		1		1	7			39	23			1	73
Montpelier	9		3		6	35		39		1,406			25	1,523
Burlington/Essex Jct	80		4		96	42		23	1,406				1,031	2,682
St. Albans														0
St. Jean														0
Montreal	9		1		6	4		1	25	1,031				1,077
TOTAL	**627**	**0**	**1,286**	**0**	**455**	**1,548**	**0**	**73**	**1,523**	**2,682**	**0**	**0**	**1,077**	**9,271**

Table A.10 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Rail Fare at 30 Cents per Mile
Total Annual Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		2,397	3,743		85	3,703	24,007			42,219	76,153
Woburn														0
Lowell	0				4,916	6,318		99	1,663	5,117			15,552	33,665
Nashua														0
Manchester	2,397		4,916			0		52	597	6,173			9,458	23,593
Concord	3,743		6,318		0			80	1,274	4,969			7,338	23,722
Franklin														0
White River Jct	85		99		52	80			1,570	2,275			2,165	6,326
Montpelier	3,703		1,663		597	1,274		1,570		8,700			1,922	19,429
Burlington/Essex Jct	24,007		5,117		6,173	4,969		2,275	8,700				8,658	59,898
St. Albans														0
St. Jean														0
Montreal	42,219		15,552		9,458	7,338		2,165	1,922	8,658				87,312
TOTAL	**76,153**	**0**	**33,665**	**0**	**23,593**	**23,722**	**0**	**6,326**	**19,429**	**59,898**	**0**	**0**	**87,312**	**330,097**

Table A.11 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Rail Fare at 20 Cents per Mile
Diverted Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		2,747	4,889		156	8,268	51,432			110,566	178,057
Woburn														0
Lowell	0				5,648	6,280		162	3,411	11,613			39,541	66,655
Nashua														0
Manchester	2,747		5,648			0		72	1,067	10,526			18,716	38,776
Concord	4,889		6,280		0			97	2,084	9,042			15,684	38,076
Franklin														0
White River Jct	156		162		72	97			1,961	3,278			4,371	10,098
Montpelier	8,268		3,411		1,067	2,084		1,961		8,278			2,965	28,034
Burlington/Essex Jct	51,432		11,613		10,526	9,042		3,278	8,278				10,638	104,806
St. Albans														0
St. Jean														0
Montreal	110,566		39,541		18,716	15,684		4,371	2,965	10,638				202,482
TOTAL	**178,057**	**0**	**66,655**	**0**	**38,776**	**38,076**	**0**	**10,098**	**28,034**	**104,806**	**0**	**0**	**202,482**	**666,983**

Table A.12 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Rail Fare at 20 Cents per Mile
Induced Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		511	453		2	47	463			95	1,571
Woburn														0
Lowell	0				64	1,884		2	15	20			5	1,991
Nashua														0
Manchester	511		64			0		3	21	349			38	986
Concord	453		1,884		0			12	101	150			21	2,622
Franklin														0
White River Jct	2		2		3	12			65	48			5	137
Montpelier	47		15		21	101		65		1,814			63	2,125
Burlington/Essex Jct	463		20		349	150		48	1,814				2,090	4,935
St. Albans														0
St. Jean														0
Montreal	95		5		38	21		5	63	2,090				2,317
TOTAL	**1,571**	**0**	**1,991**	**0**	**986**	**2,622**	**0**	**137**	**2,125**	**4,935**	**0**	**0**	**2,317**	**16,685**

Table A.13 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"Mid-Speed Scenario" With Rail Fare at 20 Cents per Mile
Total Annual Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		3,258	5,342		158	8,315	51,895			110,661	179,628
Woburn														0
Lowell	0				5,713	8,164		164	3,426	11,633			39,546	68,646
Nashua														0
Manchester	3,258		5,713			0		75	1,087	10,875			18,754	39,762
Concord	5,342		8,164		0			110	2,185	9,192			15,705	40,698
Franklin														0
White River Jct	158		164		75	110			2,026	3,326			4,376	10,235
Montpelier	8,315		3,426		1,087	2,185		2,026		10,092			3,028	30,159
Burlington/Essex Jct	51,895		11,633		10,875	9,192		3,326	10,092				12,728	109,740
St. Albans														0
St. Jean														0
Montreal	110,661		39,546		18,754	15,705		4,376	3,028	12,728				204,799
TOTAL	**179,628**	**0**	**68,646**	**0**	**39,762**	**40,698**	**0**	**10,235**	**30,159**	**109,740**	**0**	**0**	**204,799**	**683,667**

Table A.14 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"Mid-Speed Scenario" With Two Trains per Day
Diverted Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		378	656		18	880	6,709			13,571	22,211
Woburn														0
Lowell	0				823	905		19	368	1,214			4,914	8,244
Nashua														0
Manchester	378		823			0		9	122	1,555			3,265	6,153
Concord	656		905		0			13	252	1,088			2,210	5,123
Franklin														0
White River Jct	18		19		9	13			270	419			484	1,233
Montpelier	880		368		122	252		270		1,238			404	3,535
Burlington/Essex Jct	6,709		1,214		1,555	1,088		419	1,238				1,541	13,764
St. Albans														0
St. Jean														0
Montreal	13,571		4,914		3,265	2,210		484	404	1,541				26,388
TOTAL	**22,211**	**0**	**8,244**	**0**	**6,153**	**5,123**	**0**	**1,233**	**3,535**	**13,764**	**0**	**0**	**26,388**	**86,651**

Table A.15 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Two Trains per Day
Induced Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		10	8		0	0	5			1	24
Woburn														0
Lowell	0				1	38		0	0	0			0	40
Nashua														0
Manchester	10		1			0		0	0	5			1	17
Concord	8		38		0			0	1	2			0	50
Franklin														0
White River Jct	0		0		0	0			1	1			0	2
Montpelier	0		0		0	1		1		40			1	45
Burlington/Essex Jct	5		0		5	2		1	40				39	92
St. Albans														0
St. Jean														0
Montreal	1		0		1	0		0	1	39				41
TOTAL	**24**	**0**	**40**	**0**	**17**	**50**	**0**	**2**	**45**	**92**	**0**	**0**	**41**	**311**

Table A.16 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Two Trains per Day
Total Annual Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		387	663		18	881	6,714			13,572	22,235
Woburn														0
Lowell	0				825	943		20	369	1,214			4,914	8,284
Nashua														0
Manchester	387		825			0		9	123	1,561			3,266	6,170
Concord	663		943		0			14	253	1,090			2,210	5,173
Franklin														0
White River Jct	18		20		9	14			272	420			484	1,236
Montpelier	881		369		123	253		272		1,278			405	3,580
Burlington/Essex Jct	6,714		1,214		1,561	1,090		420	1,278				1,579	13,856
St. Albans														0
St. Jean														0
Montreal	13,572		4,914		3,266	2,210		484	405	1,579				26,430
TOTAL	**22,235**	**0**	**8,284**	**0**	**6,170**	**5,173**	**0**	**1,236**	**3,580**	**13,856**	**0**	**0**	**26,430**	**86,962**

Table A.17 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Additional Stations
Diverted Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston		0	0	19,572	2,338	4,010	327	108	5,133	33,021		1,551	64,742	130,802
Woburn	0		0	2,794	2,679	1,913	98	31	1,292	3,426		151	9,440	21,824
Lowell	0	0		5,276	5,167	6,873	382	120	2,221	7,144		810	23,060	51,052
Nashua	19,572	2,794	5,276		0	0	0	3	67	778		4	705	29,200
Manchester	2,338	2,679	5,167	0		0	948	58	749	7,650		29	12,316	31,933
Concord	4,010	1,913	6,873	0	0		0	82	1,528	6,197		144	9,750	30,497
Franklin	327	98	382	0	948	0		22	354	3,685		11	2,069	7,895
White River Jct	108	31	120	3	58	82	22		1,690	2,503		558	2,758	7,933
Montpelier	5,133	1,292	2,221	67	749	1,528	354	1,690		7,342		165	2,184	22,725
Burlington/Essex Jct	33,021	3,426	7,144	778	7,650	6,197	3,685	2,503	7,342			165	8,724	80,634
St. Albans														0
St. Jean	1,551	151	810	4	29	144	11	558	165	165			8,231	11,819
Montreal	64,742	9,440	23,060	705	12,316	9,750	2,069	2,758	2,184	8,724		8,231		143,978
TOTAL	**130,802**	**21,824**	**51,052**	**29,200**	**31,933**	**30,497**	**7,895**	**7,933**	**22,725**	**80,634**	**0**	**11,819**	**143,978**	**570,291**

Table A.18 - Forecasts of Boston-Montreal High-Speed Rail System Ridership

"Mid-Speed Scenario" With Additional Stations
Induced Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston		0	0	434	369	303	30	1	17	164		0	25	1,343
Woburn	0		0	2	53	265	3	0	2	1		0	0	327
Lowell	0	0		10	54	2,265	31	1	6	7		0	1	2,375
Nashua	434	2	10		0	0	0	0	0	0		0	0	446
Manchester	369	53	54	0		0	358	2	10	163		0	12	1,022
Concord	303	265	2,265	0	0		0	9	53	68		0	7	2,970
Franklin	30	3	31	0	358	0		1	9	33		0	1	468
White River Jct	1	0	1	0	2	9	1		48	28		1	2	94
Montpelier	17	2	6	0	10	53	9	48		1,425		7	33	1,610
Burlington/Essex Jct	164	1	7	0	163	68	33	28	1,425			17	1,370	3,277
St. Albans														0
St. Jean	0	0	0	0	0	0	0	1	7	17			1,465	1,491
Montreal	25	0	1	0	12	7	1	2	33	1,370		1,465		2,916
TOTAL	**1,343**	**327**	**2,375**	**446**	**1,022**	**2,970**	**468**	**94**	**1,610**	**3,277**	**0**	**1,491**	**2,916**	**18,338**

Table A.19 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"Mid-Speed Scenario" With Additional Stations
Total Annual Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston		0	0	20,006	2,707	4,313	358	109	5,150	33,186		1,551	64,766	132,146
Woburn	0		0	2,796	2,732	2,179	101	31	1,294	3,427		151	9,440	22,151
Lowell	0	0		5,286	5,220	9,137	413	121	2,227	7,151		810	23,062	53,428
Nashua	20,006	2,796	5,286		0	0	0	3	67	778		4	705	29,646
Manchester	2,707	2,732	5,220	0		0	1,306	60	759	7,812		29	12,328	32,954
Concord	4,313	2,179	9,137	0	0		0	91	1,581	6,265		144	9,757	33,467
Franklin	358	101	413	0	1,306	0		23	363	3,718		11	2,070	8,363
White River Jct	109	31	121	3	60	91	23		1,738	2,531		560	2,760	8,027
Montpelier	5,150	1,294	2,227	67	759	1,581	363	1,738		8,767		172	2,217	24,335
Burlington/Essex Jct	33,186	3,427	7,151	778	7,812	6,265	3,718	2,531	8,767			182	10,093	83,910
St. Albans														0
St. Jean	1,551	151	810	4	29	144	11	560	172	182			9,696	13,309
Montreal	64,766	9,440	23,062	705	12,328	9,757	2,070	2,760	2,217	10,093		9,696		146,894
TOTAL	**132,146**	**22,151**	**53,428**	**29,646**	**32,954**	**33,467**	**8,363**	**8,027**	**24,335**	**83,910**	**0**	**13,309**	**146,894**	**588,630**

Table A.20 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"High-Speed Scenario"
Diverted Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		8,431	6,372				54,327			100,250	169,381
Woburn														0
Lowell	0				6,407	9,806				14,344			41,134	71,690
Nashua														0
Manchester	8,431		6,407			0				12,631			18,102	45,571
Concord	6,372		9,806		0					14,059			16,383	46,620
Franklin														0
White River Jct														0
Montpelier														0
Burlington/Essex Jct	54,327		14,344		12,631	14,059							11,646	107,007
St. Albans														0
St. Jean														0
Montreal	100,250		41,134		18,102	16,383				11,646				187,516
TOTAL	**169,381**	**0**	**71,690**	**0**	**45,571**	**46,620**	**0**	**0**	**0**	**107,007**	**0**	**0**	**187,516**	**627,785**

Table A.21 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"High-Speed Scenario"
Induced Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		594	586				446			63	1,689
Woburn														0
Lowell	0				83	3,624				24			4	3,734
Nashua														0
Manchester	594		83			0				460			31	1,169
Concord	586		3,624		0					233			19	4,462
Franklin														0
White River Jct														0
Montpelier														0
Burlington/Essex Jct	446		24		460	233							2,057	3,219
St. Albans														0
St. Jean														0
Montreal	63		4		31	19				2,057				2,174
TOTAL	**1,689**	**0**	**3,734**	**0**	**1,169**	**4,462**	**0**	**0**	**0**	**3,219**	**0**	**0**	**2,174**	**16,447**

Table A.22 - Forecasts of Boston-Montreal High-Speed Rail System Ridership
"High-Speed Scenario"
Total Annual Trips - 2025

	Boston	Woburn	Lowell	Nashua	Manchester	Concord	Franklin	White River Jct	Montpelier	Burlington/ Essex Jct	St. Albans	St. Jean	Montreal	TOTAL
Boston			0		9,026	6,958				54,773			100,313	171,070
Woburn														0
Lowell	0				6,489	13,429				14,368			41,138	75,424
Nashua														0
Manchester	9,026		6,489			0				13,091			18,133	46,739
Concord	6,958		13,429		0					14,292			16,403	51,082
Franklin														0
White River Jct														0
Montpelier														0
Burlington/Essex Jct	54,773		14,368		13,091	14,292							13,703	110,226
St. Albans														0
St. Jean														0
Montreal	100,313		41,138		18,133	16,403				13,703				189,690
TOTAL	**171,070**	**0**	**75,424**	**0**	**46,739**	**51,082**	**0**	**0**	**0**	**110,226**	**0**	**0**	**189,690**	**644,232**