Description of Alternatives

2

2.1 Introduction

This chapter describes the physical and operating features of the project alternatives evaluated in this Major Investment Study/Draft Environmental Impact Report (MIS/DEIR) for the North-South Rail Link (NSRL). Costs for each alternative are described in Chapter 6. In compliance with Federal Transit Administration (FTA) guidelines, the specific alternatives that were evaluated include a No-Build Alternative, Transportation Systems Management (TSM) Alternatives, and a Build Alternative.

Section 2.2 of this chapter describes the screening process that was used to select the Build Alternative alignment corridor; Section 2.3 describes the No-Build Alternative and discusses the assumptions and projects included in this alternative; Section 2.4 describes the TSM alternative, and Section 2.5 describes the Build Alternative and the specific design components.

2.2 Screening and Selection Process

2.2.1 Alternatives Initially Considered

The following three alternatives were initially considered for the NSRL Study:

- No-Build Alternative—assumes the existing conditions at North and South Station, and the continued operation of a separate north side and south side commuter rail system. Transportation improvements planned to be in place by the year 2025 are also included.
- TSM Alternative—assumes the addition of a low-capital cost bus shuttle between North and South Stations on two alternate routes, or increased Orange Line rapid transit service between Back Bay and North Stations. The existing commuter rail operation would remain the same as in the No-Build Alternative.
- Build Alternative—construction of an approximately three mile long rail tunnel within the Central Artery (CA/T) alignment connecting North and South Stations as recommended by the Central Artery Rail Link (CARL) Task Force Study (See Chapter 1 for more detail). The rail

tunnel would connect the separate north and south side Massachusetts Bay Transportation Authority (MBTA) rail systems, and allow for "run-through" train operations. Two- and four-track tunnel options were included.

Three new underground stations were proposed: at South Station under the existing station and tracks, at the intersection of the Surface Artery and State Street under the existing Aquarium Station on the Blue Line, and adjacent to the new MBTA Orange Line/Green Line Superstation at North Station.

2.2.2 Modifications Resulting from Public Scoping

Two additional alignment corridors for the Build Alternative were evaluated based on comments received during public scoping: the Congress Street and Logan Airport corridors. These corridors are described below and are shown along with the CA/T corridor on Figure 2.2-1.

- Congress Street Corridor Alignment. This alignment is similar to the CA/T alignment except that the rail tunnel connecting North and South Stations would be located primarily beneath Congress Street in downtown Boston. Three new underground stations would be provided along the alignment. South Station and North Station would be located in the same area as proposed for the CA/T alignment; however, Central Station would be located at the intersection of Congress Street and State Street.

- Logan Airport Alignment. This alignment would connect portions of the two existing MBTA commuter rail systems via a new tunnel under Boston Harbor providing direct access to Logan Airport. It would connect to the Northeast Corridor east of Back Bay Station on the south side and to the Western Route Main Line (Reading/Haverhill line) near the Wellington Orange Line Station on the north side. Two new stations would be constructed: one at South Station under the existing surface tracks and station and the other at Logan Airport adjacent to the Central Garage.

2.2.3 Screening Process

2.2.3.1 Introduction

Three potential alignment corridors were initially considered for the Build Alternative: the Logan Airport corridor, the Congress Street corridor, and the CA/T corridor. To determine the preferred corridor to carry forward for the Build Alternative, a two-level screening analysis was performed, as fully documented in Technical Appendix B. The first screening level analysis, Level 1, evaluated the ability of the proposed alignments to meet the project goals and objectives listed in Chapter 1. Alignment corridors passing this preliminary test were then carried forward to the Level 2 analysis.

Figure 2.2-1 **Build Alternative Alignment Corridors**

The Level 2 screening analysis provided a relative comparison of the potential Build Alternative alignment corridors passing the Level 1 analysis. A Four Track/Three Station alignment through downtown Boston was assumed. Comparisons were made of train and station operations, pedestrian movements, ridership, project costs, economic benefits/impacts, institutional issues, right-of-way (ROW) issues, engineering design, and construction impacts. Environmental issues relevant to developing a comparison of Build Alternative alignment corridors (e.g., pedestrian access and consistency with land use planning) were also considered during the Level 2 analysis. Environmental impacts common to all Level 2 Build Alternative alignment corridors, such as those associated with portal construction, were not considered in this process.

The screening analysis was primarily based on information obtained from the following studies previously prepared for the Logan Airport, Congress Street, and Central Artery/Tunnel alignment corridors, with some additional engineering analysis to address design and operational issues:

- *Extension of the Northeast Corridor via Logan Airport - An Evaluation*, Central Transportation Planning Staff, July 1994
- *Building for an Intermodal Future, The North-South Rail Link*, Central Artery Rail Link Task Force Final Report, May 1993
- *Implementing Integrated Services*, Central Artery Rail Link Task Force Working Paper, March 1993
- *Feasibility Study of a Proposed Rail Link between North Station and South Station in Boston, Massachusetts*, Final Report, Federal Transit Administration, November 1995
- *Final Supplemental Environmental Impact Report for the Central Artery / Tunnel Project*, Massachusetts Department of Public Works, 1990

2.2.3.2 Level 1 Screening Analysis

The purpose of the Level 1 screening analysis was to determine if the Build Alternative alignment corridors met the NSRL Study goals and objectives. The alignment corridors were evaluated based on their ability to preserve and upgrade the existing rail system and reduce congestion on existing services and facilities; provide increased opportunities for multimodal connections; maximize use of the existing and programmed transportation infrastructure and investments; and maximize environmental and economic benefits.

Table 2.2-1 illustrates the results of the Level 1 screening analysis. A ✓ indicates that the corridor meets the project objective and an **X** indicates that the objective is not met. As shown, the Central Artery/Tunnel corridor meets all of the project objectives, the Congress Street corridor meets most of the project objectives, and the Logan Airport corridor meets only a few of the objectives.

Table 2.2-1 Level 1 Screening Analysis

	Logan Airport Corridor	Congress Street Corridor	Central Artery Corridor
Goal 1: Preserve and Upgrade the Existing Rail System and Reduce Congestion on Existing Services and Facilities			
■ Accommodate anticipated increase in regional rail ridership	X	✓	✓
■ Improve downtown Boston regional rail trip distribution	X	✓	✓
■ Increase downtown Boston transit capacity	X	✓	✓
■ Address future track capacity problems at North and South Stations	X	✓	✓
Goal 2: Provide Increased Opportunities for Multimodal Connections			
■ Provide efficient passenger transfers from the regional rail system to the existing transit system, including transfer to bus and transit connections to Logan Airport	✓	✓	✓
■ Provide opportunities for connections to proposed transit services within downtown Boston	X	✓	✓
■ Improve connectivity of intercity rail service in downtown Boston	X	✓	✓
Goal 3: Maximize Use of the Existing and Programmed Transportation Infrastructure and Investments			
■ Develop cost-efficient transportation facilities that maximize use of existing facilities	X	✓	✓
■ Maximize use of the existing federally designated interstate transportation corridors within the City of Boston	X	X	✓
Goal 4: Maximize Environmental and Economic Benefits			
■ Reduce vehicle miles traveled (VMTs) in Boston metropolitan area by diverting auto trips to transit modes	X	✓	✓
■ Promote attainment of standards of the Clean Air Act Amendments of 1990	X	✓	✓
■ Minimize short- and long-term impacts to the built environment and the downtown business community	✓	X	✓
■ Support economic and environmental sustainability by encouraging development in urban areas	X	✓	✓
■ Preserve and improve economic competition of the region	X	✓	✓

✓ Corridor meets project objective
X Corridor does not meet project objective

Based on this analysis, it was determined that the Logan Airport corridor should not be considered for further analysis for the following reasons:

- The Logan Airport corridor poses many serious operational, environmental, and construction cost issues while offering fewer transportation or environmental benefits than the Congress Street and Central Artery/ Tunnel corridors.
- With the Logan Airport corridor, the extension of the Northeast Corridor to Portland, Maine involves a circuitous path and the use of the Western Route through Reading, Massachusetts, which has ROW and operational constraints.
- With the Logan Airport corridor, only three commuter rail line pairs would be through-routed. Only the northern ends of these line pairs would receive any benefit in terms of downtown distribution.
- The Logan Airport corridor alignment attracts 29 percent fewer commuter rail riders than the Congress Street and Central Artery/ Tunnel corridor alignments (128,500 riders vs. 179,900 riders). Compared to these other alignments, the Logan Airport route attracts approximately 76 percent fewer commuter rail riders who divert from automobile (3,100 riders vs. 23,500 riders).
- The Logan Airport corridor marginally improves ground access to Logan Airport because it provides a high quality trip to Logan on only a few lines (Providence/Newburyport, Stoughton/Rockport, Franklin/Beverly); the majority of the lines have no difference in service when compared to the No-Build Alternative.

Therefore, only the Congress Street and the Central Artery/Tunnel corridors were carried forward to the Level 2 screening analysis. These alignment corridors are similar with respect to meeting the project goals and objectives. As defined by the Level 1 analysis, the primary differences between the corridors lie in the areas of maximizing the use of the existing federally designated interstate transportation corridor within the City of Boston, and minimizing short- and long-term impacts to the built environment and the downtown business community.

2.2.3.3 Level 2 Screening Analysis

The Level 2 screening analysis provided a comparative evaluation of the Congress Street corridor alignment and the Central Artery/Tunnel corridor alignment based on specific criteria in the areas of operations, economic benefits/impacts, institutional issues, engineering, the environment, and urban context. Table 2.2-2 summarizes the analysis for all of the evaluation factors in the Level 2 screening analysis.

Table 2.2-2 **Level 2 Screening Analysis**

	Congress Street Corridor	Central Artery Corridor
Operations		
Train Operations		
■ Pairing capability	✓	✓
■ Operational flexibility	✓	✓
■ Emergency operations	X	✓
Pedestrian Movements		
■ Efficient passenger operations	X	✓
■ Pedestrian access conditions/surface interface	X	✓
■ Safety and accessibility	X	✓
Ridership		
■ Ridership benefits	✓	✓
■ Logan Airport connection	✓	✓
■ Commuter rail ridership	✓	✓
■ Ease of transit transfers	✓	✓
■ Rapid transit system relief	✓	✓
■ Intercity ridership	✓	✓
Economics		
■ Project Costs		
■ Operating costs	✓	✓
■ Construction costs	✓	✓
Economic Benefits/Impacts and Institutional Issues		
■ Construction impacts to businesses	X	✓
■ Degree of predictability	X	✓
■ Governmental support	X	✓
■ Consistency with prior government commitments/investments	X	✓
■ ROW acquisition	X	✓
Engineering		
Design		
■ Accommodate project design criteria	X	✓
■ Use of existing infrastructure	X	✓
■ Physical connections to other transit components	X	✓
Construction		
■ Constructability	X	✓
■ Duration of construction	✓	✓
Environmental Issues and Urban Context		
■ Consistency with land use planning	X	✓
■ Impacts to pedestrian traffic	X	✓
■ Impacts to historical resources	X	✓
■ Permitting	X	✓

✓ Alignment is advantageous
X Alignment is not advantageous

As shown in Table 2.2-2, the alignment corridors are very similar for several of the criteria, particularly in the areas of ridership and project costs. The corridors also have similar operational characteristics. However, they vary in the areas of pedestrian movements, economic benefits/impacts and institutional issues, design and construction, and environmental issues and urban context.

Based on the screening analysis, the Central Artery/Tunnel corridor is recommended as the preferred corridor for further refinement of the Build Alternative for the following reasons:

- Minimal additional ROW acquisition would be required for the Central Artery/Tunnel corridor, because this alignment is located in an already established transportation corridor. In contrast, eminent domain takings and easements would be required for the Congress Street corridor. The associated costs and time to obtain the ROW could have a significant impact on construction of a rail tunnel if the Congress Street corridor was utilized.

- The Central Artery/Tunnel corridor would be able to meet all of the project design criteria developed to date. With the Congress Street corridor, the curvature between South Station and Congress Street would have to be reduced below the preferred minimum as set forth in the project design criteria to avoid conflicts with existing structures and to accommodate the limited availability of access locations from the surface to South Station below grade.[1]

- In addition to requiring the use of a stacked (bi-level) track tunnel arrangement, the narrow and congested ROW along the Congress Street corridor may limit opportunities for locations of vertical access along the alignment and at the Central Station. This may impact construction techniques available along this route and inhibit placement of required egress and ventilation structures. The Central Artery/Tunnel corridor would appear to offer a distinct advantage because of the wide corridor along the CA/T project.

- The Central Artery/Tunnel corridor has the ability to accommodate the high level of pedestrian activity projected from the completion of a rail tunnel and a new Central Station. This alignment, with the Central Station located at the Aquarium Station, would largely benefit from the open spaces of the post CA/T Surface Artery. For the Congress Street corridor, the Central Station would be located near the Congress Street/State Street intersection, which has narrow sidewalks and is already very congested with pedestrian traffic. To alleviate street level impacts with this alignment, consideration would have to be given to extensive underground connectors to other elements of the local

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[1] Subsequent to the screening analysis, a Dorchester Avenue alignment (see Section 2.5.2) was developed to avoid the existing pile foundations under the existing South Station tracks and to minimize impacts to the ancillary ramp structure from the Central Artery/I-90 South Bay Interchange. Continuing the rail link tunnel under Congress Street with this alignment would be unfeasible, due to the horizontal curvature and the fact that the tunnel would be located under the main tower of the Federal Reserve Building.

transportation system, thus adding additional costs to the Central Station.

- The Central Artery/Tunnel corridor has been extensively studied for the CA/T highway project; a rail tunnel alignment within this corridor would make use of much of the existing information that has been developed. The existence of this information and the organizational structure already in place for the project reduces the unknowns and unpredictability of the Central Artery/Tunnel corridor, and would allow environmental studies and engineering design to move along at a quicker pace than the Congress Street corridor. A significant data-gathering effort would be required to bring the Congress Street corridor to the same level of information that is currently available for the Central Artery/Tunnel corridor.

- The use of the Central Artery/Tunnel corridor for both rail and highway travel would help the Commonwealth of Massachusetts to comply with the current federal transportation and environmental policies embodied in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, it's 1998 update, the Transportation Act for the 21st Century (TEA-21), and the Clean Air Act Amendments of 1990, by making the corridor multimodal.

- A Central Station on the Central Artery/Tunnel corridor alignment would provide commuter rail access to the edge of Boston's financial district, and would only be a ten-minute walk to the heart of the financial district at Post Office Square. It would provide better rail access to the Waterfront (including ferry service to the Boston Harbor Islands National Recreation Area) , North End and Quincy Market areas than the Congress Street corridor. It would also be closer to the new federal courthouse on Fan Pier and to the proposed development in the South Boston Waterfront district. A major benefit of the Central Artery/Tunnel corridor is the availability of open space within the CA/T project parcels to accommodate pedestrian traffic. Additionally, construction of Central Station on the Central Artery/ Tunnel corridor would be less disruptive to existing land uses at the surface.

- The Congress Street corridor contains many historic resources while the Central Artery/Tunnel area contains very few. The Central Artery/ Tunnel corridor is partially within the Bulfinch Triangle historic district and passes under one historic structure (the MBTA Blue Line tunnel); there are no other historic structures within the alignment. In comparison, the Congress Street corridor passes through three historic districts, and has the potential to impact three buildings listed on the National Register of Historic Places, including the Old State House.

Based on the evaluation process carried out as part of the multi-level screening analysis, it was recommended that a Build Alternative along the Central Artery/Tunnel corridor be further defined for comparison to the

No-Build and Transportation Systems Management Alternatives in the alternatives analysis. A two-station option (no Central Station) was also added to the Build Alternative for consideration.

2.3 No-Build Alternative

The No-Build Alternative includes the future conditions that would exist if no transportation improvements identified with the North-South Rail Link study effort were implemented. The No-Build Alternative in the analysis provides the basis against which the impacts of the other alternatives are assessed.

To determine the components of the No-Build Alternative, a design year was established consistent with Federal Transit Administration (FTA) planning policy and guidelines. The design year identified is 2025, based on the year that full operation of the TSM and Build Alternatives would be projected to occur.[2] The 2025 No-Build Alternative includes the existing transportation system as described in Chapter 1. It assumes existing conditions at North and South Station, and the continued operation of the MBTA's distinct north side and south side commuter rail systems. In addition, the No-Build Alternative includes all of the projects currently in the region's transportation plan that are expected to be complete and operational by 2025. Table 2.3-1 provides a summary of the transportation improvements included in the 2025 No-Build Alternative, which serves as the base case for the transportation analysis described in Chapter 4. A summary description of the key passenger rail and public transportation improvements included in the 2025 No-Build Alternative is provided in Sections 2.3.1 through 2.3.4.

2.3.1 Intercity Rail Improvements

- Northeast Corridor Electrification. The electrification of the Northeast Corridor between New Haven and Boston was completed in 2000. Travel times between New York and Boston were reduced from over 4 hours to a little over 3 hours as a result of electrification and introduction of high-speed (Acela Express) rail service. The base case considered both the modified 34-train daily schedule as well as the 52-train daily schedule considered in the EIR prepared for the electrification project. [3]

[2] The North South Rail Link study initially considered a 2020 design year. The regional transportation analysis was subsequently updated to 2025 design year to be consistent with the most recent *Boston Region MPO Transportation Plan 2000-2025, Plan Update*, March 14, 2002. See Technical Technical Appendix C for the initial 2020 design year transportation analysis.

[3] Northeast Corridor Improvement Project Electrification *Final Environmental Impact Report/Statement and 4(f) Statement, Volume I,* October 1994.

Table 2.3-1 Transportation Improvements Included in the 2025 No-Build Alternative

HIGHWAY PROJECTS	COMMUTER RAIL PROJECTS
Central Artery	New Bedford/Fall River Commuter Rail
Third Harbor Tunnel/Haul Road	Old Colony Commuter Rail, Phase I
Haul Road/Mass Ave/SE Expressway	Old Colony/Greenbush Commuter Rail
Crosby Dr. (Bedford)	Fairmount Branch Improvements (Boston)
Middlesex Turnpike (Bedford & Burlington)	Newburyport
Rte. 128 Capacity Improvements (Beverly to Peabody)	Worcester, Full Service
Rte. 128 Capacity Improvements (Lynnfield to Reading)	**INTER-CITY RAIL PROJECTS**
Rte. 128 Additional Lanes (Randolph to Wellesley)	AMTRAK Service to Portland, Maine
East Boston Haul Rd. (Boston)	Northeast Corridor Electrification
Rte. 1A/Boardman St. Grade Separation (Boston)	**RAPID TRANSIT PROJECTS**
Rutherford Avenue (Boston)	Arborway Restoration (Boston)
Double Stack Initiative (Boston to Newton)	Red Line/Blue Line Connector (Boston)
Mass. Ave./Lafayette Square (Cambridge)	Medford Hillside Green Line (Boston, Medford, & Somerville)
Cambridgeport Roadways (Cambridge)	Silver Line, Phase 3 (Boston)
I-93/I-95 Interchange (Canton)	Assembly Square Orange Line Station (Somerville)
I-95 (NB)/Dedham St. Ramp (Canton)	Blue Line Platform Lengthening & Modernization
I-95 (SB)/Dedham St. Onramp (Canton)	Mattapan Refurbishment
Concord Rotary (Concord)	South Boston Piers Transitway, Phase I
Rte. 2/Crosby's Corner (Concord)	Washington Street Transitway (Silver Line)
Rte. 1/114 Corridor Improvements (Danvers & Peabody)	Airport Intermodal Transit Connector
Telecom City Roadways (Everett, Malden, & Medford)	**HOV AND BUS PROJECTS**
Revere Beach Parkway (Everett, Medford, & Revere)	Urban Ring Bus Service
Rte. 126/Rte. 135 Grade Separation (Framingham)	Urban Ring, Phase 1 (Inner Core)
Rte. 9/Rte. 126 Interchange (Framingham)	HOV Lanes on the Southeast Expressway
Double Stack Initiative (Framingham to Worcester)	HOV Lanes on I-93 Mystic Avenue
Rte. 140 (Franklin)	**INTERMODAL PROJECTS**
Rte. 53 (Hanover)	10,000 New Park and Ride Spaces since 1991
Rte. 53/Rte. 228 (Hingham & Norwell)	10,000 Additional Park and Ride Spaces
Naval Air Station Access Improvements	Park and Ride (Regionwide) (over the 20,000)
I-495/I-290/Rte. 85 Interchange Hudson & Marlborough)	North Station Improvements
Rte. 1 Improvements (Malden & Revere)	South Station Transportation Center
Rte. 20, Segments 1 & 2 (Marlborough)	Industriplex Intermodal Center
Rte. 20, Segment 3 (Marlborough)	Rte 128 AMTRAK/Commuter Rail Station
Double Stack Initiative (Natick & Wellesley)	Commuter Boat, Inner Harbor - from North Station
Needham St./Highland Ave. (Needham & Newton)	Russia Wharf
Burgin Parkway (Quincy)	
Quincy Center Concourse, Phase 1 (Quincy)	
Quincy Center Concourse, Phase 2 (Quincy)	
I-93/Rte. 129 Interchange (Reading & Wilmington)	
I-93/I-95 Interchange (Reading & Woburn)	
Mahoney Circle Grade Separation (Revere)	
Rte. 1/Rte. 16 Interchange (Revere)	
Rte. 1A/Rte. 16 Connection (Revere)	
Boston St. (Salem)	

HIGHWAY PROJECTS
Bridge St. (Salem)
Bridge St. Bypass (Salem)
Rte. 18 (Weymouth)
Rte. 3 South Additional Lanes (Weymouth to Duxbury)
I-93/Ballardvale St. Interchange (Wilmington)
New Boston Street Bridge (Woburn)
Beverly-Salem Bridge
Route 62, Burlington
Route 38, Wilmington
Route 139 Widening
Blue Hill Avenue Signal Coordination
Brighton Avenue Signal Coordination
Marret Road Signal Coordination
Route 3 North General Purpose Lane
I-495 Interchange between Route 9 and Route 20
I-93 Industriplex Interchange
Route 138 Widening, Canton
Foxborough Route 1 Improvements
Route 9 Improvements, Wellesley

- Portland, Maine Downeaster Service. The restoration of passenger rail service between Boston and Portland became operational in December 2001. The current service provides eight trains per day between the two cities, with run times of approximately 2 hours and 45 minutes. The service includes intermediate stops at Woburn (Anderson Regional Transportation Center) and Haverhill in Massachusetts; Exeter, Durham, and Dover in New Hampshire; and Old Orchard Beach, Wells, and Saco in Maine. An extension of the line from Portland to Brunswick, Maine via Freeport is planned, with service expected to begin by 2005.

2.3.3 MBTA Commuter Rail Improvements

- Commuter Rail Service to Newburyport. The Ipswich Line extension to Newburyport opened for service in 1998. This 9.6-mile extension includes one intermediate stop at Rowley and follows the alignment of the former Boston & Maine Railroad Eastern Main Line.

- Commuter Rail Service for all Old Colony Lines. The restoration of service on the Old Colony Railroad provides new services from South Station to 21 South Shore communities. The Middleborough/Lakeville Line serves Bridgewater, Brockton, Holbrook, Randolph, and Braintree; and the Plymouth/Kingston Line serves communities such as Hanson, Abington, South Weymouth, and Braintree. The Greenbush Line, which is under construction, will serve towns along the coast such as Scituate, Cohasset, Hull, Hingham, and Weymouth. Service on the

Middleborough/Lakeville and Plymouth/Kingston Lines began in the fall of 1997. Service on the Greenbush Line is expected to begin in 2005.

- New Bedford/Fall River Commuter Rail Service. Service restoration to New Bedford and Fall River, with stops provided at East Taunton, Taunton, Mansfield, and Freetown, is currently being planned. The Final Environmental Impact Report for the Stoughton Line extension through Easton, Raynham, and Taunton was completed in 2002.

- Full Commuter Rail Service to Worcester. Full service on the Worcester line includes stops at Grafton, Westborough, Southborough, Ashland, Framingham, and West Natick before traveling express to Back Bay and South Station. This service extension provides five new commuter rail stations for the communities between Worcester and Framingham. Construction of the new stations was completed in 2002.

2.3.4 MBTA Rapid Transit System Improvements

- Blue Line Modernization. The MBTA's Blue Line Modernization Program, currently underway, will improve Blue Line stations and lengthen station platforms to accommodate six-car trains and increase capacity. The project is scheduled to be complete in 2006.

- Green Line Extension. The Green Line extension from its current terminus at Lechmere to Medford Hillside/Tufts University is planned for completion in 2011. Five new stations will be built at major cross streets and the C-Line service will be extended from its terminus at North Station to Lechmere and Medford.

- Red Line-Blue Line Pedestrian Connection. A pedestrian connection between Downtown Crossing and State Street will provide a transfer between the Blue Line and the Red Line that does not currently exist. This connection is assumed to be complete by 2011.

- North Station Superstation. The North Station Superstation project consists of the relocation of the Green Line between Haymarket and Science Park and the construction of a new underground Green Line/ Orange Line station. The project is expected to be complete in 2005.

2.3.5 MBTA Bus/Miscellaneous Service Improvements

- South Boston Piers Transitway (Silver Line Phase II). The Transitway (Silver Line Phase II) is a fixed-guideway, dual-mode bus system that will extend from South Station to areas of new development along the waterfront in South Boston. The Silver Line Phase II segment will be located in a tunnel and will extend from South Station to Fan Pier/Federal Court House and the World Trade Center. This segment is expected to be complete in 2003.

- I-93 Industriplex Interchange and Anderson Regional Transportation Center. The new Anderson Regional Transportation Center near the intersection of Route 128 and I-93 in Woburn provides increased parking capacity for commuter rail and Logan Express services at a new park-and-ride lot. The transportation center was completed in 2001.

- Washington Street Orange Line Replacement Service (Silver Line Phase I). The Silver Line Washington Street Replacement Service provides high capacity bus service to Washington Street between Dudley Square in Roxbury and downtown Boston. The route includes 14 stops. The Silver Line Phase I service began operation in 2002 and is intended to replace that previously provided by the elevated Orange Line, which was relocated to the Southwest Corridor in 1987.

- South Station Transportation Center. The South Station Transportation Center includes the addition of a bus terminal in the air rights over the commuter rail tracks and platforms at South Station. The bus terminal opened in 1995. All private commuter buses from the south and west and intercity buses have been consolidated at South Station and will have direct access to High-Occupancy-Vehicle (HOV) lanes on the Southeast Expressway. Private carriers and/or Massport will also provide improved bus service between South Station and Logan Airport via the Third Harbor Tunnel.

2.4 Transportation Systems Management (TSM) Alternative

2.4.1 Introduction

The Transportation Systems Management (TSM) Alternative is a low-cost option that maximizes the use of the existing transportation infrastructure. Options considered in this category typically include enhancements to the existing transit services that require minimal investment in new or upgraded infrastructure. The two TSM options evaluated for the NSRL include the following:

- A dedicated shuttle bus service between South and North Stations

- Increased Orange Line service between Back Bay Station and North Station

These options were evaluated based on incremental ridership and service, as documented in Technical Appendix C and summarized in Chapter 4, *Transportation Analysis*. Costs for the TSM options are documented in Chapter 6, *Evaluation of Alternatives*.

2.4.2 Dedicated Shuttle Bus between North Station and South Station

2.4.2.1 Introduction

This TSM alternative provides dedicated shuttle bus service that would operate between North Station and South Station using the downtown street network as it evolves during implementation of the Central Artery/Tunnel project. Two alternative routes are proposed for the bus shuttle—a Downtown Route and a Surface Artery Route. The shuttle bus routes are described in more detail below.

2.4.2.2 Downtown Shuttle Bus Route

The proposed Downtown Shuttle Bus route, shown in Figure 2.4-1, would run from North Station via Nashua Street, Lomasney Way, Staniford Street, Cambridge Street, Sudbury Street, Congress Street, Dorchester Avenue, and Summer Street to a South Station stop at the corner of Summer Street and Atlantic Avenue. The return to North Station would be via Summer Street, High Street, Pearl Street, Congress Street, Court Street, Cambridge Street, Staniford Street, Lomasney Way, and Nashua Street.[4] Stops would be provided at North and South Stations and at High Street, Post Office Square, State Street and Government Center.

This service would operate on five-minute headways and provide a trip time between North and South Stations of approximately 10.5 minutes. Six additional buses would need to be acquired to provide the service.

2.4.2.3 Surface Artery Shuttle Bus Route

The proposed Surface Artery Shuttle Bus route, shown in Figure 2.4-2 would run between North and South Stations using the reconstructed surface street network that will be developed when the elevated Central Artery structure is removed. The bus route would leave North Station via Causeway Street, Merrimac Street, New Sudbury Street, and the new Surface Artery, and Essex Street to a South Station stop at the corner of Summer Street and Atlantic Avenue. The return to North Station would be via Atlantic Avenue, the new Surface Artery, North Washington Street and Causeway Street.

Stops would be provided at North and South Stations, with an intermediate stop at the Aquarium Blue Line Station. This service would operate on 5-minute headways and provide a 9.5-minute trip between North and South Stations, and a 9-minute trip in the reverse direction. Six additional buses would need to be acquired to provide this service.

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[4] This route was based on the ìNorth Station/South Station Circulator Busî as documented in the *Central Artery/Tunnel Project Regional Transit Mitigation Program,* January 1994.

Figure 2.4-1 **Downtown Shuttle Bus Route**

Figure 2.4-2 **Surface Artery Shuttle Bus Routes**

2.4.3 Expanded Orange Line Service

The MBTA's Orange Line provides rapid transit service between Oak Grove and Forest Hills. It connects with the south side commuter rail system at Back Bay Station, and with the north side commuter rail system at North Station. Downtown Boston stops between Back Bay and North Stations include New England Medical Center, Chinatown, Downtown Crossing, State Street and Haymarket Stations. Weekday peak period headways are 5 minutes, resulting in 12 to 13 peak hour trips in each direction, utilizing six-car trains. During weekday off-peak periods and on weekends, trains operate on headways of 8 to 14 minutes, resulting in 4 to 8 trips per hour in each direction. The current running time between the Back Bay and North Stations is approximately 6 minutes.

The Orange Line currently serves to distribute commuter rail riders in downtown Boston. Increased service frequency is proposed as a TSM Alternative to improve the connections between the north and south side rail systems. This improved service would increase peak period headways to 2.5 minutes (24 trains per hour in each direction) and would require the addition of 43 cars.

Increasing the service frequency would also require the addition of two pocket tracks to allow the trains to reverse direction after Back Bay and North Station. The closest available location for the pocket track on the north side is between Community College and Wellington Stations, where there is an unused Orange Line track known as the "Test Track". Minimal construction would be required at this location since this track and adjacent platform could be used to accommodate the reverse movement of Orange Line trains. A new track however would need to be constructed on the south side for this TSM Alternative. The closest location to Back Bay for this track would be between Ruggles and Roxbury Crossing Stations. Construction of this additional 1,400 feet of track would require the widening of the Orange Line boat section by approximately thirteen feet.

2.5 Build Alternative

2.5.1 Introduction

The Build Alternative consists of a rail tunnel linking North and South Stations that allows for the combined operation of the separate north side and south side MBTA rail systems. This alternative contains a number of options based on a combination of the number of tracks in the tunnel and the number of stations provided, as follows:

- Two Track/Two Station option
- Two Track/Three Station option
- Four Track/Two Station option
- Four Track/Three Station option

These four options describe the design concept and scope for the Build Alternative as evaluated in the MIS/DEIR. Each option was analyzed in terms of operations, ridership, costs, and impacts.

In addition, several design variables, including the specific tunnel alignment and station location in the area of South Station, the number of tunnel bores, and the number of station platforms, were also considered. They were not considered to be specific Build Alternative options since they represent design details that can be deferred until preliminary engineering; however, any differences in impacts based on the design variables were evaluated, and are discussed in Chapter 5, *Environmental Analysis and Consequences*.

The following sections describe the Build Alternative tunnel alignment, stations, design variables, and construction methodology and operations.

2.5.2 Alignment

The majority of the alignment for the proposed three-mile rail tunnel between South Station and North Station would be within the Central Artery/Tunnel (CA/T) project corridor, as shown in Figure 2.5-1. South of South Station the alignment extends west to Back Bay and south to the South Bay railroad maintenance facility and yard (Southampton Yard). From North Station, the alignment extends northerly to the area of the Boston Engine Terminal (BET). The overall length of the alignment along the main line from Back Bay to the north side is approximately 14,725 feet. Two alignments, differing in the potential general location of the rail link's South Station, were evaluated for the Build Alternative. These alignments, known as the Dorchester Avenue Alignment and the CA/T Alignment are described below.

2.5.2.1 Dorchester Avenue Alignment

The Dorchester Avenue alignment positions the proposed rail link South Station east of the existing South Station, along the western edge of Fort Point Channel at the northern end of the US Postal Service (USPS) facility and extending up to Congress Street. There is some flexibility in the final station location as it can be moved eastward towards the channel or shifted to the south, away from Congress Street. (See Figure 2.5-1). Additional design development would be required to determine the final station location. The Dorchester Avenue alignment was developed during the schematic design phase to provide a station option that avoids the pile foundations under the existing South Station tracks installed to support the South Station Transportation Center (SSTC) Building, as well as future air rights development. This alignment option also minimizes conflicts with ancillary ramp structures from the Central Artery/I-90 South Bay Interchange.

Figure 2.5-1 **Tunnel Alignment**

Four-Track Option. The four-track option would begin at the portals on the southerly end of the project. The first portal begins at Back Bay and follows under the existing rail lines in two 28-foot 6-inch diameter single-track tunnels. These tunnels descend at effective grades approaching 3 percent and pass below the I-90 tunnels with very little clearance to spare. Within the area of the Southampton rail yards twin portals would join into a single two-track 41-foot diameter tunnel and proceed northerly until it joins up with the two single-track tunnels from the Back Bay Portal in the area below the USPS Facility before leading into South Station. From South Station, the alignment would proceed north in twin 41-foot diameter two-track tunnels along Fort Point Channel until it reaches Independence Wharf (the former Harbor Plaza Building on Atlantic Avenue) where the alignment turns west towards Northern Avenue, passing in close proximity to Rowes Wharf before entering into the Central Artery corridor as defined by its exterior soldier pile walls. The two tunnels follow this corridor up to North Station, then cross under the Charles River and emerge on the northerly end in the area of the Boston Engine Terminal in Somerville where the tunnels split to form two portals. One portal would provide access for the Fitchburg Line, the other for the Lowell, Haverhill and Rockport/Ipswich Lines. The maximum horizontal curvature for this alignment would be 8 degrees. The steepest vertical grade would be approximately 3 percent, which would occur in the tunnel section between the Back Bay Portal and South Station as well as between North Station and the North Portal. This grade would become the ruling grade for Northeast Corridor Amtrak operations. Figure 2.5-2 presents a profile of the rail link tunnel.

The portal locations for the proposed tunnel are shown in Figure 2.5-1 and described below:

- Back Bay Portal. This portal would be located to the east of Back Bay Station, approximately 100 feet east of Washington Street. It would provide tunnel access to Amtrak's Northeast Corridor tracks that service Providence and points south, as well as to the MBTA's Attleboro, Framingham, Stoughton, Franklin and Needham lines and the proposed Fall River/New Bedford line.

- South Bay Portals. These two portals would be located in the South Bay service facility in the general vicinity of the Southampton Street overpass and the commuter rail service and inspection (S&I) building. One portal would service the MBTA's Old Colony Lines (Middleborough/Lakeville, Kingston/ Plymouth, and Greenbush), and the other portal would service the Fairmont Line on the Dorchester Branch track.

Figure 2.5-2 **Tunnel Profile (Dorchester Avenue Alignment)**

- North Portals. These two portals would be located to the north of the Gilmore Bridge and west of the I-93 viaduct in Somerville. The eastern portal on the north side would service the majority of the north side MBTA commuter rail lines as well as the extension of Northeast Corridor intercity rail service to Woburn. The western portal would service the MBTA's Fitchburg Line and the MBTA's Commuter Rail Maintenance Facility at the Boston Engine Terminal (BET).

Two-Track Option. The two-track option is similar, but consists of one 41-foot diameter tunnel. One variation of this option consists of the tunnel from Back Bay to the BET. The other tunnel carrying the Old Colony and Fairmont lines from South Bay to the BET would not be constructed.

The other possibility is construction of a single two-track tunnel from South Bay to the BET. Under this option, the tunnel from Back Bay would not be constructed. Both variations of the two-track tunnel operation were analyzed in terms of operations, ridership, constructability and impacts.

2.5.2.2 Central Artery Tunnel Alignment

The CA/T alignment is the alignment specifically proposed by the Central Artery Rail Link (CARL) Task Force in 1993. It differs from the Dorchester Avenue alignment in the area from Back Bay and South Bay leading up to and including South Station. Under the CA/T alignment the new rail link South Station would be located underneath the existing South Station Headhouse and the new South Station Transportation Center bus station on a 1 percent descending grade. All of the portal locations as previously described would remain the same. The geometry from Back Bay to South Station would include tighter curvature in order to avoid the Central Artery/I-90 South Bay Interchange structures.

The CA/T alignment would be close to the I-93 South Bay Interchange viaduct foundations or adjacent viaduct ramp foundations (Frontage Road, Ramp LL, Ramp XX, Ramp KK, Ramp MW), but would not have direct conflict with these structures. Potential areas of conflict in the vicinity of I-90 include the jacking pits for the I-90 eastbound and westbound tunnels as well as the Ramp D tunnels. The walls for the jacking pits are reinforced concrete tee walls or soldier pile-tremie concrete walls. The Ramp D jacking pit is supported by a mat of 3-foot diameter drilled shafts. The CA/T alignment also is in the vicinity of the Ramp C boat section and the Ramp DN boat section, both of which are supported by 3-foot diameter drilled shafts spaced between 10 and 20 feet on center. Any load from the permanent caissons interrupted by the rail link tunnel would need to be picked up and supported by underpinning. The CA/T alignment presented in this report successfully avoids direct conflict with these and the South Bay interchange structures, however, in order to do so, the alignment has conflicts with the SSTC and Federal Reserve Building structures as it continues to the northeast.

In the area of the SSTC, it would be necessary to underpin existing pile clusters that extend the length of the building's footprint. These piles were installed to support the existing SSTC, as well as future air rights development over the tracks between the South Station headhouse and the SSTC. Achieving optimum flexibility between all four rail-link tracks will result in slower train operations due to shorter available turnout lengths. It would also force the northern portion of the station towards the footprint of the Federal Reserve Tower. This would involve close coordination with the Federal Reserve Bank to develop an extensive construction mitigation program to ensure the integrity of the building. The alignment would proceed north past Congress Street and Russia Wharf before entering the Central Artery corridor in the vicinity of Northern Avenue. From this location north, the CA/T alignment and the Dorchester Avenue alignment are the same. The CA/T alignment would be approximately the same length as the Dorchester Branch alignment, but would include tighter horizontal curvature. The vertical curvature would be similar.

2.5.3 Stations

Two-and three-station options are proposed for the Build Alternative. The two-station option includes new underground South and North Stations. The three-station option adds a Central Station in the vicinity of State Street that would connect to the MBTA Blue Line at Aquarium Station. The proposed locations and schematic design for the stations were based on the following design goals:

- Maximize interconnection between the rail link and other mass transportation systems

- Accommodate high passenger volumes

- Provide adequate emergency egress and ventilation

- Present a visual image of the rail link stations as components of an efficient, advanced, safe and clean regional transportation system

Two criteria were used in selecting possible headhouse sites; first, that the multiple locations would form a coherent system of convenient and dispersed points of entry and egress for station patrons; and second, to identify empty or underutilized sites which may accommodate a headhouse with relative ease. These potential headhouse sites have been identified to ensure feasibility; locations may be refined or optimized during preliminary engineering.

The stations are described as follows:

2.5.3.1 South Station

The proposed underground rail link South Station would generally be located in the area of the existing South Station and provide connections to the existing South Station headhouse, the SSTC bus terminal, the Red Line, and the Transitway (Silver Line). Logan Airport connections would be made via bus from the SSTC, and from Massport's proposed Airport Intermodal Transit Connector [5] that would use the Transitway infrastructure. The most significant design issue with South Station is building a large structure underground in an area occupied by large structures on the surface, such as the SSTC, the US Postal Service (USPS) facility, 245 Summer Street (the former Stone and Webster Building), and the Federal Reserve Bank.

Platform length at South Station was assumed to be 1050 feet, which is consistent with maximum Amtrak platform lengths for Northeast Corridor stations.

Several station location options are being considered for the proposed South Station, which would be located approximately 100 feet below the surface. Potential locations include:

- Central Artery Alignment. With this option, the proposed South Station would be located directly below the existing tracks and would extend from the existing South Station headhouse to the rear of the SSTC. This station location is shown in Figure 2.5-3. This location provides the most direct connection to all of the other transportation systems including direct access to the existing South Station concourse. The structural and construction issues with this location are complicated by the need to develop access below two large buildings (SSTC and the existing South Station), thirteen lines of active railroad track and, potentially, the Federal Reserve Building. There would be many difficulties involved with constructing a station at this location due to the piles supporting the South Station Transportation Center (SSTC) and future air right developments, and the need to maintain surface rail operations during construction.

- Dorchester Avenue Alignment. With this option, the proposed South Station would be located along Dorchester Avenue, to the northeast of the existing South Station facility, as shown in Figure 2.5-4. The proposed station would be located adjacent to the Fort Point Channel, and would eliminate several of the construction constraints imposed by the Central Artery Alignment. Access would be provided via the existing South Station headhouse. This location would also provide more convenient pedestrian access to the South Boston Waterfront District on the eastern side of the Fort Point Channel. The new federal courthouse on Fan Pier and the Boston Convention and Exhibition Center are

[5] Boston-Logan International Airport, *Airport Intermodal Transit Connector - Environmental Assessment*, prepared for the Massachusetts Port Authority by Rizzo Associates, January 1998.

located within this district, which has been defined as the next growth frontier for Boston.

These locations present the two extremes for locating the NSRL South Station, where Atlantic Avenue provides the western limit and the Fort Point Channel the eastern limit for potential station sites. More advanced engineering studies would be required to define a specific station site.

For either of the station locations, direct access would be provided from the existing South Station concourse and through the Red Line kiosks at Dewey Square. If the station were to be located directly beneath the existing South Station, additional headhouses would be provided along Atlantic Avenue at the SSTC, and along the Fort Point Channel at the west-end of the Summer Street bridge. For station locations to the east of the existing South Station, headhouses would be provided along the Fort Point Channel at the east-end of the Summer Street Bridge. A headhouse may also be provided near the Federal Reserve Building. These Fort Point Channel headhouse locations would provide better pedestrian access to South Boston. See Figures 2.5-3 and 2.5-4 for headhouse locations.

2.5.3.2 Central Station

Central Station would be located under the CA/T, and extend from Broad Street to State Street. It would be approximately 130 feet below the surface, and would provide access to the adjacent Blue Line Aquarium Station at the northern end of the station. Platform length was assumed to be 800 feet. The location for Central Station is fixed by the confines of the Central Artery slurry walls and the MBTA Blue Line tunnel structure. (See Figure 2.5-5).

For the Central Station alternative, four potential sites have been identified for headhouses (see Figure 2.5-5): on the east side of Franklin Street, just north of Well Street (between India Street and Broad Street); on the north side of Milk Street, east of India Street; on Atlantic Avenue, south of Central Street, in the vacant lot in front of the New England Aquarium between the building at 225 State Street and the Harbor Garage on Milk Street; and on Atlantic Avenue, south of East India Row, in front of the Harbor Towers condominiums.

2.5.3.3 North Station

Two locations are being considered for North Station, which would be approximately 100 feet below the surface and have a platform length of 1050 feet. The first station location would extend under the Central Artery from just north of Causeway Street to the end of Canal Street. In the second location, North Station would begin approximately 160 feet south of Causeway Street and extend under the Central Artery as far as New Sudbury Street. More advanced engineering studies would be required to define a specific station site.

Figure 2.5-3 **South Station Alternative (Central Artery Alignment)**

Figure 2.5-4 **South Station Alternative (Dorchester Avenue Alignment)**

Figure 2.5-5 **Central Station Alternative**

The major headhouse for either North Station location would be an at-grade public urban concourse between the FleetCenter and Causeway Street on the site of the old Boston Garden. This design would maintain a strong relationship between the rail link tunnel, the at-grade tracks, and the new MBTA Orange Line and Green Line Superstation. Two additional headhouse sites would be provided: on the east side of North Washington Street, north of Cooper Street; and on the north side of Merrimac Street, on the corner bordered by Merrimac Street, Portland Street, and Friend Street; with the entrance located on Merrimac Street. (See Figure 2.5-6)

2.5.4 Design Variables

For all of the Build Alternative options, several design variables were considered. These variables included the tunnel alignment in the vicinity of South Station as previously described, the number of tunnel bores utilized, and the number of platforms provided at the stations.

Several combinations of tunnel bores (the number of "tunnel tubes" to be constructed) and station platforms were also investigated. Two large (approximately 41-foot outside diameter) tunnel bores, each housing two-tracks, were investigated, as well as four small (approximately 28-foot 6-inch outside diameter) tunnel bores, each housing one track. Additionally, a three-tunnel bore option (one large bore housing two tracks, and two smaller bores housing one track) was also investigated. Two, three, four, and five platform variations were considered.

For discussion purposes for the NSRL study, the two-tunnel bore, three-platform option was assumed as the base case for the Build Alternative, being utilized for almost the entire length of corridor. This combination resulted in the narrowest tunnel corridor (110 feet) and station (150 feet) and limited excavation requirements. The single tunnel bore is proposed only for that portion of the alignment between the Back Bay Portal and South Station where grade limits and vertical clearance constraints prohibited the larger diameter tunnel bore. Based on the evaluation of design variables, it was determined that the two-tunnel bore, three-platform option and the three-tunnel bore, two-platform option should also be investigated further during the preliminary engineering phase of the project.

2.5.5 Construction Methodology

Several different construction methodologies would be employed for the construction of a rail link tunnel.[6] The portal areas would be constructed with boat sections (a U-shaped cross section consisting of retaining walls and a continuous base slab) and tunnels using open cut and cut-and-cover

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[6] The constructability of the proposed Build Alternative was the subject of a Peer Review conducted in 1997. The Peer Review committee concluded that the proposed Build Alternative as presented in this MIS/DEIS/DEIR was constructible based on the information available at the time of the review.

Figure 2.5-6 **North Station Alternative**

methods of construction. Most of the tunnel would be constructed using a tunnel boring machine (a machine that drills through the earth deep below the surface), thus minimizing the construction impacts on the surface for most of the project area. North and Central Stations and any required transition areas would be constructed with a combination of boring and mining techniques. Depending on the location of South Station, a combination of open cut excavation with mining and/or boring techniques would be utilized in the construction. Figure 2.5-7 presents the tunnel profile and construction methods.

One possible construction scenario involves utilizing the area west of the north portal as a construction staging area, with all excavate being removed via rail from the tunnels to this location. The proposed construction concept initially anticipated using the former Boston & Maine Railroad “piggyback” yard (Yard 15) on the Cambridge/Somerville line as a staging area as shown in Figure 2.5-8. This rail yard has since been incorporated into the proposed North Point mixed-use development site (EOEA #12650). As a result, alternative staging sites would need to be investigated should the Build Alternative be selected to proceed to Preliminary Engineering.

As originally proposed, the tunnel boring machine (TBM) would be launched from the north portal and proceed through the North Station, Central Station, and South Station areas for both tunnel excavations. Tunnel boring would also be possible from the southern portals, but the land area is more constrained in the vicinity of the south portals and it would be more difficult to secure sites for staging in this location.

An alternative approach in which the tunnel bores would start at vertical access shafts located at the sites of North and South Stations was also considered. This approach would allow for multiple tunnel boring machines to operate concurrently, potentially shortening the construction schedule. As much as practical, these access shafts would be located in positions that would eventually become access points for stations and emergency access and egress shafts. The environmental impacts, ROW issues, and construction impacts of both these approaches would be investigated further in preliminary engineering and design if the Build Alternative was selected as the Preferred Alternative.

Construction techniques may vary among the three rail link stations. At South Station, the CA/T alignment location would be extremely difficult to construct due to the existing pile field under the SSTC, the need to maintain all 13 surface tracks at South Station during construction, and the presence of the Federal Reserve tower above the northern portion of the proposed station. The Dorchester Avenue alignment location offers opportunities for cut-and-cover construction, if the USPS site is acquired.

For Central and North Stations, cut-and-cover construction will not be able to be utilized due to the depth of the stations and the presence of the Central Artery and other structures above the stations. In these instances, the

Figure 2.5-7 **Tunnel Construction Methodology**

Figure 2.5-8 **Construction Staging Area**

stations may be bored with the TBM and then mined in between the bores to minimize construction impacts at the surface. This method would require underpinning of the CA/T and/or soil stabilization by grout curtains or other methods in order to prevent soil movement. Concerns with this methodology include excavation support, de-watering, potential impacts on the contracts and construction schedule, and the type (in terms of size) of station that could be constructed with this methodology.

Another possible station construction methodology is the “Mount Baker Ridge Method,” in which many smaller diameter tunnels are bored and filled with concrete to provide a stable shell for excavation without de-watering. This method was used in the Seattle, Washington area with virtually no displacement of the materials above the excavation. Concerns with this methodology include soil stabilization and potential community and environmental impacts due to the required surface access shafts. More advanced engineering and geotechnical studies would be required to define a specific construction methodology.

The construction technologies employed would enable the tunnel to be constructed with only minimal interfacing with the CA/T highway project. Early in the schematic design process, the rail link tunnel was envisioned to be linked to the Central Artery tunnels in the station areas, incorporating the artery base slab as a roof for the rail link and extended artery slurry walls for excavation support. However, as Central Artery construction has progressed and the rail link tunnel’s design concept has moved forward to a deep tunnel bore, the project has evolved into one that can be constructed independently of the Central Artery project. In the station areas, the rail link can take advantage of Central Artery slurry walls to develop access shafts to facilitate station construction.

Other construction impacts include the need to underpin or modify foundation support for several of the buildings or structures that fall within the study corridor. Several buildings fall within the project corridor and the impacts of the rail link construction will need to be evaluated. A list of the potentially impacted structures is presented in Technical Appendix D.

2.5.6 Right-of-Way Requirements

Minimal ROW impacts would be anticipated for a rail link tunnel, because most of the alignment would be located in an already established transportation corridor. Temporary easements, outside of the existing transportation corridor, would be needed along the Dorchester Avenue alignment, and permanent easements may be required at all headhouse and vent shaft locations. These are generally located at or near the North, Central, and South Station locations. Additionally, it would be desirable from a construction perspective to utilize the United States Postal Service (USPS) facility site on Dorchester Avenue to facilitate the construction of a rail link South Station. If this site was acquired, it could potentially be used for joint development. The availability of this site, however, would be subject to a negotiated agreement with the USPS.

2.5.7 Operations and Equipment

2.5.7.1 Introduction

Construction of a rail tunnel connecting North and South Stations would significantly change operations on the MBTA's commuter rail system. Linking the two stations would change rail operations from a stub-end system to a run-through operation. The operational analysis conducted for the Build Alternative has found that a key issue facing the existing commuter rail system in the future is the capacity of South and North Stations. Both facilities handle a large volume of trains and passengers during the peak periods of service each day. In the future, both terminals are projected to be either at or over practical peak period capacity. A run-through operation, which either the four-track or two-track Build Alternative presents, would address this terminal capacity issue by allowing for the efficient movement of trains directly through the downtown area.

This section presents a summary of the proposed equipment and operations for the four- and two-track tunnel options.

2.5.7.2 Equipment

The North-South Rail Link Study evaluated current MBTA commuter rail equipment and assessed how a rail link tunnel could potentially impact future equipment needs. The study evaluated the types of locomotives and coaches presently in use and the changes that would be necessary to operate the system with a rail link tunnel. A summary of the findings is presented in the following sections.

***Motive Power*.** Early investigations into tunnel ventilation systems indicated that it would not be practical to provide sufficient ventilation along the three-mile tunnel route to allow fossil fuel powered locomotives to operate. Therefore, for tunnel operations, trains would have to rely on either electric third rail or overhead catenary power systems.

The existing MBTA fleet of locomotives is all diesel-electric. Given the preliminary tunnel ventilation system findings, the NSRL Study focused on the replacement and/or re-engineering of these units in whole or part to maximize use of the tunnel. In addition to the traction power requirements, locomotives on a commuter rail service must have good acceleration characteristics because of frequent stops and the need to maintain on-time schedule performance. The steep grades (3 percent) in the rail link tunnel immediately after the stations also create a requirement that the locomotive be able to start a nine-car train, or approximately 755 trailing tons, from zero speed on this grade.

The motive power alternatives that were identified as reasonable choices for operation in a rail link tunnel included dual-mode locomotives, electric locomotives, and electric multiple units. Of these alternatives, the dual-mode locomotive, given the ongoing advances in the technology, presents the greatest potential degree of operating flexibility and utilization. This locomotive would be compatible with the Northeast Corridor electrification. It would also allow the MBTA to run trains through the tunnel without having to first electrify the entire commuter rail system to maximize the return on the investment in the tunnel infrastructure. The study concluded that an AC traction, dual-mode locomotive capable of running over electrified and non-electrified lines in either the diesel-electric or high voltage (25KV) overhead electrified mode should be developed for rail link operations.

It should be noted that the high voltage overhead catenary pick-up application for the dual-mode locomotive will be a new development. A full research and development program will need to be undertaken to fully test and develop the proposed unit. While all the proposed technological advances such as lighter carbody materials, AC traction, and radial steering trucks currently exist and have established successful service records, they have not been combined into the dual-mode unit recommended as the future motive power choice. These components have also not been substantially tested under the daily demands of a commuter rail system or the operating conditions that the rail link tunnel will present.

Coaches. The purpose of the passenger/coach interface evaluation was to review the interaction between passengers and train operations, particularly at the proposed rail tunnel stations. The success of a future regional rail system with run-through operations depends on the efficient and timely movement of passengers to their destination. To achieve this success, key characteristics for coaches to be used in a run-through operation include: 1) the ability to discharge large passenger loads with the shortest average dwell time possible for the highest ridership trains at key stations in the rail link portion of the system (Back Bay, South, Central and North Stations); 2) the ability to use automatic door systems on high-level platforms, yet still be operated universally on a system with a mixture of high and low-level platforms; and 3) full Americans with Disabilities (ADA) accessibility and compliance.

A review of the existing operational characteristics of the MBTA commuter rail system was conducted, including an analysis of dwell times, platform configuration, train lengths, and passenger coach attributes. At Back Bay Station, which is the site most comparable to projected operations at rail link stations, it was observed that single-level cars load/unload in 35 to 50 seconds on a consistent basis, and that the bi-level coaches consistently load/unload in 95 to 105 seconds. It was concluded that existing MBTA coaches appear to load/unload with sufficient ease and quickly enough that they would be suitable for use in a run-through rail operation.

2.5.7.3 Fleet Requirements

The No-Build Alternative fleet plan reflects the current MBTA fleet requirements identified in the MBTA's *Capital Investment Program FY2003 – FY 2007* plus those additional coaches that would be needed based on projected demand and accommodated through the State of Good Repair budget. For the Build Alternative options, a new fleet of dual-mode locomotives would be required. The number of additional coaches over and above the No-Build Alternative fleet required for the Build Alternative options was based on the projected 2025 ridership as determined by the regional transportation model. (See Chapter 4 for additional discussion of the transportation model.) For this modeling effort, Build Alternative operations were assumed simply to be a connection of the MBTA's existing south side and north side 2020 commuter rail schedules. A detailed operational analysis of commuter rail operations through the rail link tunnel was not conducted for the 2025 horizon year. This detailed operational analysis would be required to be undertaken should a Build Alternative be selected as the Preferred Alternative.

Table 2.5-1 presents a summary of the fleet assumptions by alternative.

Table 2.5-1 Fleet Assumptions

	Existing Fleet (2002)	2025 No-Build/ TSM[7]	Two Track Build (Back Bay)/ Two Station	Two Track Build (Back Bay)/Three Station	Two Track Build (South Bay)/Two Station	Two Track Build (South Bay)/Three Station	Four Track Build /Two Station	Four Track Build /Three Station
FLEET ASSUMPTIONS								
Total Trainsets								
Locomotives	80	85	85	85	85	85	85	85
Coaches	377	511	596	622	584	584	655	659
DAILY PASSENGERS[8]	132,800[9]	233,200	273,950	282,403	268,200	271,700	300,356	311,540
ANNUAL PASSENGERS (millions)[10]	38.51	67.62	79.45	81.90	77.78	78.79	87.10	90.35

2.5.7.4 Operations

The Build Alternative considers construction of a rail tunnel linking the MBTA's south side and north side commuter rail operations into one unified

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[7] Based on the MBTA Capital Improvement Program (CIP) FY2003-FY2007 and anticipated purchase to meet projected demand.

[8] Projected ridership capped to existing MBTA approved 2020 peak period service frequencies for each commuter rail line. (See Technical Appendix C for additional discussion.)

[9] Ridership for FY 2001 as reported on the MBTA's website, www.mbta.com

[10] Daily ridership multiplied by 290 service days per Central Transportation Planning Staff.

regional rail system. Commuter rail service, which now terminates at South and North stations located on the fringe of the central business district, would be routed through downtown Boston, improving core area trip distribution and connections between the inner suburbs.

Implementation of a rail tunnel linking the two independent commuter rail systems into a unified regional rail system will significantly change operations. Philadelphia, which opened a downtown rail tunnel in 1983 linking two separate systems, is the only US city operating a regional rail service. The three primary attributes of the regional service concept are:

- inbound trains from one side of the city become outbound trains on the opposite side;
- more frequent service could be provided to make it more accessible to off-peak and reverse commuters; and
- the through-service operation combined with more frequent service makes transfers between rail lines easier and more attractive.

Operational Analysis Assumptions. The NSRL Operations Study includes a number of assumptions regarding how the future commuter and intercity rail services may be operated. These assumptions were developed based on the 2020 commuter rail service schedules developed by the MBTA and intercity service options developed by Amtrak. Key assumptions used in the analysis include:

- all tracks within the tunnel would be bi-directional.
- trains would operate on a desired headway of 5 minutes, with a 4-minute minimum headway.
- during peak periods, trains would have a frequency of 30 minutes or less, and a frequency of 60 minutes or less during off-peak periods.
- all terminal tracks at both North Station and South Station would remain in place and operational. These surface-level platform tracks will be necessary to accommodate a portion of existing rail services operated by both Amtrak and the MBTA under each alternative.

For analytical purposes, a safety factor of 0.8 was applied to the desired headway. In addition, the longer station dwell times of intercity trains was factored into the tunnel capacity analysis. As a result, the effective tunnel capacity for the morning peak period (6:30 AM – 9:00 AM) is 37 northbound and 41 southbound trains for the Four Track Alternatives and 17 northbound and 21 southbound trains for the Two Track Alternatives.
The Central Transportation Planning Staff developed an initial set of line pairings for analytical purposes. These line pairings connected southside commuter rail lines with northside commuter rail lines to create a run-

through operation. The pairings vary by alternative and are meant to provide a preliminary analysis of tunnel operations. The initial line pairs for tunnel operations are illustrated in Figure 2.5-9.

Based on the projected 2025 ridership, the existing imbalance in ridership between the south side and north side lines is projected to continue. As a result, the south side service is projected to require the larger volume of trains to meet ridership demands. This imbalance in service requirements presents challenges in operating the rail tunnel during peak periods. Additional operational analysis would be required to determine the optimal track configuration for peak period tunnel operation should the Build Alternative be selected as the Preferred Alternative.

South Station would remain as the base for Northeast Corridor (NEC) inter-city high-speed rail and conventional inter-city passenger rail service operations. Some Northeast Corridor intercity trains would operate through the tunnel during the peak period, stopping only at South Station. For planning purposes, both a 34 train per day (17 in each direction) and a 52 train per day (26 in each direction) schedule was assumed for operations between Boston and New York. The number of Northeast Corridor intercity daily trains that would utilize the tunnel is as follows:

- Four-Track Build Alternative
  - For a 34-train schedule, which represents the current Amtrak business plan, up to 12 Northeast Corridor intercity trains a day (6 in each direction) would use the tunnel and travel north to the Anderson Regional Transportation Center in Woburn. Of these 12 trains, 6 would be Acela Regional trains and 6 would be Acela Express (high speed) trains.
  - For a 52-train schedule, up to 18 Northeast Corridor intercity trains a day (nine in each direction) would use the tunnel and travel north to the Anderson Regional Transportation Center in Woburn. Of these 18 trains, 12 would be Acela Regional trains and 6 would be Acela Express (high speed) trains.
- Two-Track Build Alternative
  - For both the 52- and 34-train schedule, up to 8 Northeast Corridor intercity trains a day (four in each direction) would use the tunnel and travel north to the Anderson Regional Transportation Center in Woburn. Of these 8 trains, 4 will be Acela Regional trains and 4 will be Acela Express (high speed) trains.

Boston/Portland intercity service includes eight trains a day (four in each direction) which were assumed to originate/terminate at the surface tracks at North Station. Portland travelers traveling south of Boston would transfer across the platform at Woburn (Anderson RTC) to another train to continue along the Northeast Corridor. Other options for service between Portland and points south of Boston have not been precluded in this study.

Figure 2.5-9 **Modeled Raillink Line Pairs**

Four-Track Tunnel. The operational analysis of the Four Track Alternatives indicates that all of the scheduled Northside commuter rail service is projected to fit through the tunnel during the morning peak period. This analysis includes three southbound intercity trains originating at the Anderson Regional Transportation Center in Woburn and operating through the tunnel with a single stop at South Station. In total, 41 trains (38 commuter rail and 3 intercity rail) are projected to operate in the southbound direction. The Portland intercity rail service will terminate at North Station on the surface tracks.

For Southside commuter rail service, 34 commuter rail trains and two intercity trains are projected to operate through the tunnel during the morning peak period. Fifteen inbound commuter rail trains are projected to use the surface tracks at South Station along with the balance of the Northeast Corridor intercity service. This operating pattern would provide for express services on the Worcester and Providence lines terminating at South Station and local service from Stoughton and Framingham to make the inner zone stops on these two lines.

Two-Track Tunnel. The operational analysis of the Two Track Alternatives indicates that approximately 45 percent of the scheduled Northside commuter rail service is projected to fit through the tunnel during the morning peak period. This analysis includes two southbound intercity trains originating at the Anderson Regional Transportation Center in Woburn and operating through the tunnel with a single stop at South Station. In total, 19 trains (17 commuter rail and 2 intercity rail) are projected to operate in the southbound direction. The balance of the service (21 commuter rail trains and the Portland intercity service) will terminate at North Station on the existing surface tracks.

With the Back Bay Portal Option, 18 Southside commuter rail trains and one intercity train are projected to operate through the tunnel during the morning peak period. Thirty-one inbound commuter rail trains are projected to use the surface tracks at South Station along with the balance of the Northeast Corridor intercity service. This operating pattern would provide for express services on the Worcester and Providence lines and local service from Stoughton and Framingham to make the inner zone stops on these two lines. All Old Colony Line and Readville Line services would terminate on the surface tracks.

With the South Bay Portal Option, 21 Southside commuter rail trains and one intercity train are projected to operate through the tunnel during the morning peak period. Twenty-eight inbound commuter rail trains are projected to use the surface tracks at South Station along with the balance of the Northeast Corridor intercity service. This operating pattern would provide for express services on the Worcester and Providence lines terminating at South Station and local service from Stoughton and Framingham to make the inner zone stops on these two lines. All Needham

Line, Worcester Line, Franklin Line, and Stoughton Line services would terminate on the surface tracks.

Summary of Build Alternative Operational Considerations . Construction of a rail tunnel could provide a key component of the future commuter rail system in the Boston region. Both downtown terminals are projected to be at or over effective peak period capacity under 2025 No-Build ridership projections. Introduction of the tunnel connection provides a potential solution to terminal capacity issues and provides significant opportunity to both enhance system capacity. The capability to provide run-through service in either a four- or two-track tunnel is expected to:

- Provide a significantly greater level of capacity to accommodate peak period train movements than the existing stub-end terminals at North and South stations.
- Reduce non-revenue (“deadhead”) movement of equipment;
- Reduce the number of equipment turns required under congested terminal conditions;
- Achieve maximum ridership growth through efficient use of equipment; and
- Provide more direct access to equipment maintenance facilities.

In addition, the operation of a four-track tunnel offers the following advantages over the two-track tunnel:

- Four tracks provide a significant increase in overall commuter rail system capability. Combined with continued surface terminal operations, the future commuter rail system with a four track tunnel has greater operational flexibility and the ability to absorb continuing increases in commuter rail ridership;
- Increased equipment utilization adds to the overall operating efficiency and reduces the unit operating cost;
- Operating patterns (such as zone express, skip-stop express, and tandem express) could be maximized to their fullest advantage; and
- Allows for greater operational flexibility particularly in avoiding intercity trains with longer dwell times, thereby increasing operating efficiencies.

A detailed analysis of commuter and intercity rail operations through the rail tunnel would be required to refine the proposed linked north and south side rail operations should one of the Build Alternative options be selected as the Preferred Alternative.