City of

Woonsocket Rhode Island

Commuter Rail Feasibility Study

RHODE ISLAND STATEWIDE PLANNING PROGRAM

TRANSPORTATION
LAND USE * CENSUS
ECONOMIC DEVELOPMENT
COMPREHENSIVE PLANNING
GEOGRAPHIC INFORMATION SYSTEMS

U.S. Department of Transportation Federal Highway Administration

JACOBS Edwards and Kelcey

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I. Executive Summary

Woonsocket was once served by passenger rail services to Boston, Providence and Worcester. However, these services have been inactive for several decades. The principal question posed by the Woonsocket Commuter Rail Feasibility Study was whether the geography and transportation economics of the region had changed sufficiently in the last forty to fifty years to warrant the restoration and rejuvenation of passenger rail services. To answer this question, the City of Woonsocket assisted by Jacobs Edwards and Kelcey with input from a variety of interested stakeholders prepared a historical analysis, projected potential ridership, evaluated the opportunities and constraints associated with alternative service restoration regimes, prepared an economic impact analysis, and developed recommendations for further study. This summary report reviews the planning team's most salient findings regarding restoration of passenger rail services to Boston, Providence and Worcester and offers recommended next steps towards passenger rail restoration.

HISTORICAL ANALYSIS

A historical overview of Woonsocket area passenger rail services was assembled using reference materials including vintage timetables and maps of active and abandoned rail lines. The overview focused on the rail segments that comprise the potential routes for restored passenger service to Woonsocket:

1. Boston & Willimantic: The Boston and Willimantic (B&W) began in 1849 as a railroad between Dedham and Blackstone, passing through Franklin and Woonsocket Junction. In 1855 new owners reorganized the route to provide better access to Boston and through service from Boston to New York. By 1909 service to the Woonsocket Junction station had been discontinued with trains stopping in Blackstone, 1.7 miles west of Woonsocket Junction. In 1926, 22 trains on this line were traveling between Boston and Franklin, each weekday. Every weekday, about half of these trains would make the longer trip between Boston and New York, stopping in Blackstone along the way. The line was eventually shortened to Hartford, Connecticut but continued to service Blackstone. In 1955, the route was shortened again to Blackstone after a hurricane damaged track in Connecticut. Passenger service between Boston and Blackstone continued until the late 1960s when the route was cut-back to Franklin after a flood destroyed the bridge crossing the Blackstone River near the Massachusetts Rhode Island border. The track west of Franklin was abandoned three years later.

2. Boston and Pascoag: In 1863, a railroad originating in Boston and serving Brookline, Needham, and Medway was extended to reach Woonsocket. In 1889, the line was extended again to Pascoag, Rhode Island where it connected to the

Providence & Springfield RR. By 1909, 16 trains ran between Boston and the Woonsocket River Street Station[1] on the Boston and Pascoag (B&P) line, each weekday. All 16 trains also stopped in Bellingham Junction, and 2 stopped in Woonsocket Junction. Service on this line declined in the 1920's and passenger service to Woonsocket ended in 1926. When service to Woonsocket ended approximately 12 trains were running to the city each weekday, stopping also in Bellingham Junction and East Blackstone. The tracks between Bellingham Junction and Woonsocket were removed in 1935 and by 1967 all tracks on the Boston and Pascoag line West of Millis had been removed. The B&P line in Woonsocket is currently owned by the Providence & Worcester Railroad for freight operations and is known as the Slatersville Secondary.

3. Providence & Worcester: Operation of the Providence and Worcester (P&W) Railroad began in 1847 mostly within the right-of-way of the Blackstone Canal which connected the cities of Providence and Worcester. By 1909, 18 weekday passenger trains stopped at Woonsocket's Main Street station and 11 other stations between the two cities. By 1926, seven stations had been added on the line between Providence and Woonsocket. Service began to decline in the 1930s until the last passenger train was operated in 1960. The P&W railroad continues to provide freight service on the line between Worcester and Central Falls. The five miles of track between Central Falls and Providence station are now part of Amtrak's Northeast Corridor (NEC). The P&W provides freight service on Amtrak's NEC south to Kingston under a trackage rights agreement.

4. Amtrak Northeast Corridor: The P&W Mainline terminates at the Boston Switch in Central Falls, however, the freight route continues south into Providence using Amtrak's mainline particularly the unelectrified Track 7 that runs the Boston switch for the five miles to Amtrak's Providence Station. Track 7 is one of three tracks on Amtrak's Mainline in this area. Track 7 is not presently used by passenger trains.

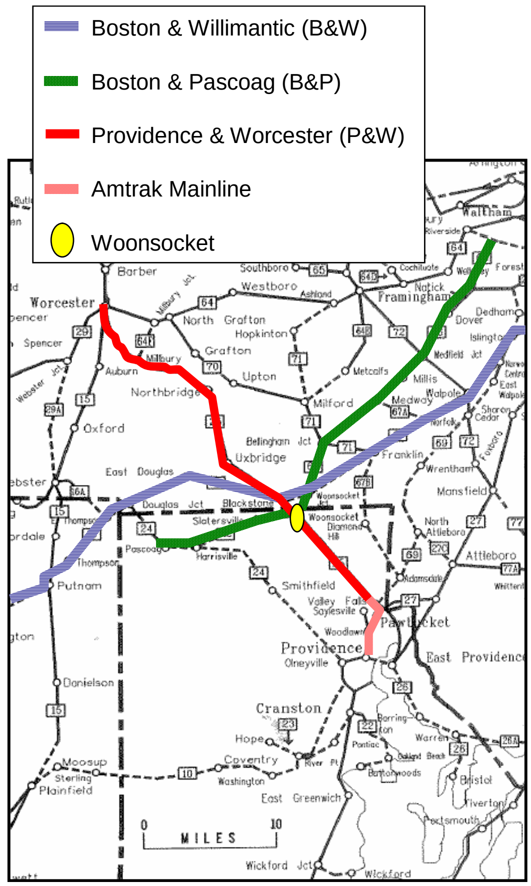


Figure I.1: Rail Lines included in Proposed Routes to/from Woonsocket

An inventory of historic stations revealed that two stations served Woonsocket, Main

[1] As opposed to the extant Woonsocket Main Street station. The River Street Station on what is now P&W's Slatersville Secondary Line has been demolished.

Street (B&W) and River Street (B&P), and that few other train stations existed in the immediate Woonsocket vicinity with the three nearest stations being Woonsocket Junction, Blackstone, and East Blackstone, all in Massachusetts.

STUDY AREA DEMOGRAPHICS

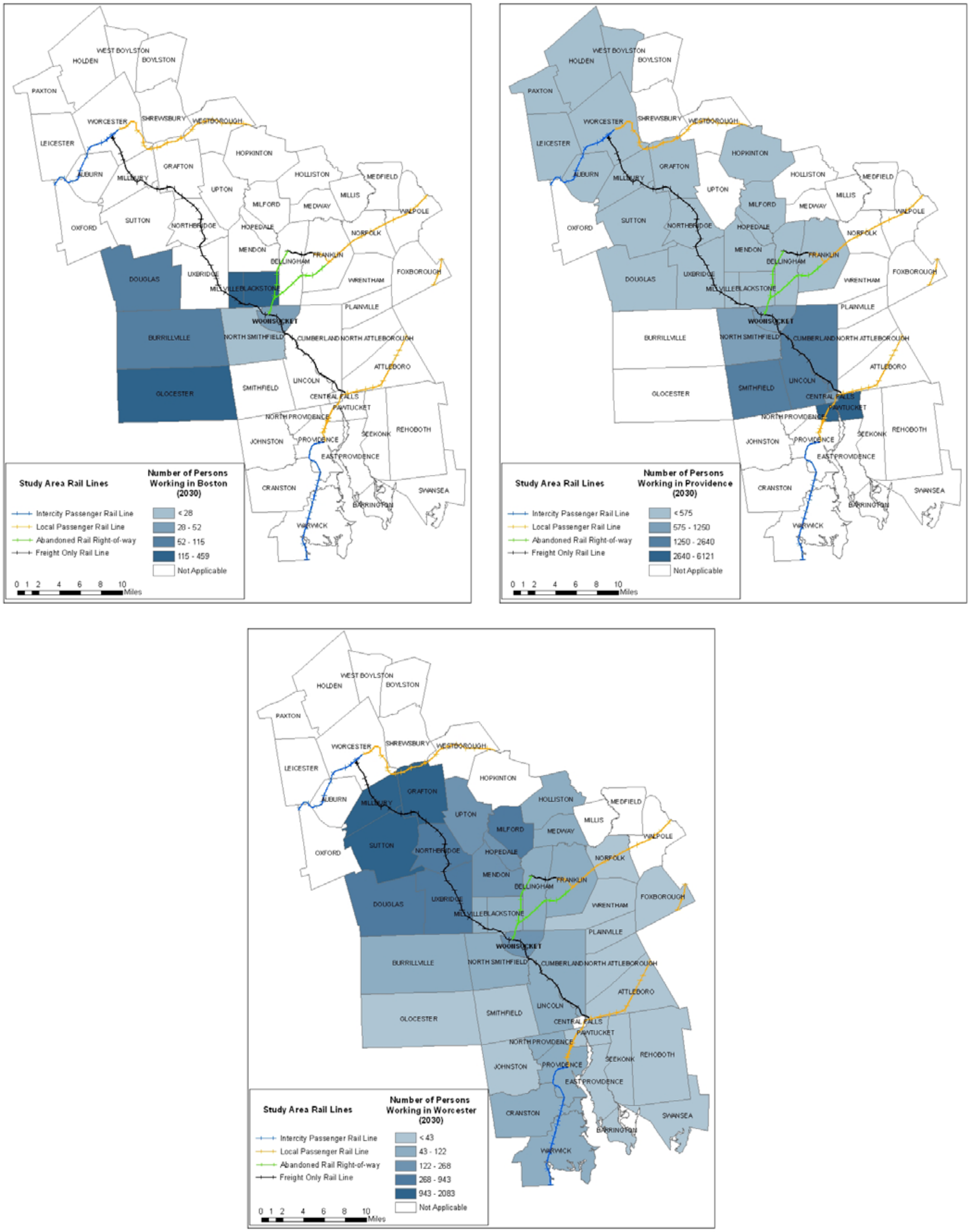
Three study areas were defined, one for each potential commuter rail destination. The study team used 2000 census data and 2030 population and employment projections to evaluate each potential market.

Table I.1: Existing and Forecast Study Area Commuters to Boston, Worcester and Providence

Destination	2000: Study Area Commuters to Destination	2030: Study Area Commuters to Destination	Percent Increase
Boston	943	1,101	17%
Worcester	8,321	10,330	24%
Providence	15,462	16,818	9%

Figure I.2 displays the distribution of forecast study area commuters to respective employment destinations in 2030.

Figure I.2: Forecast Numbers of Study Area persons working in Boston, Providence, and Worcester in 2030



RIDERSHIP PROJECTIONS

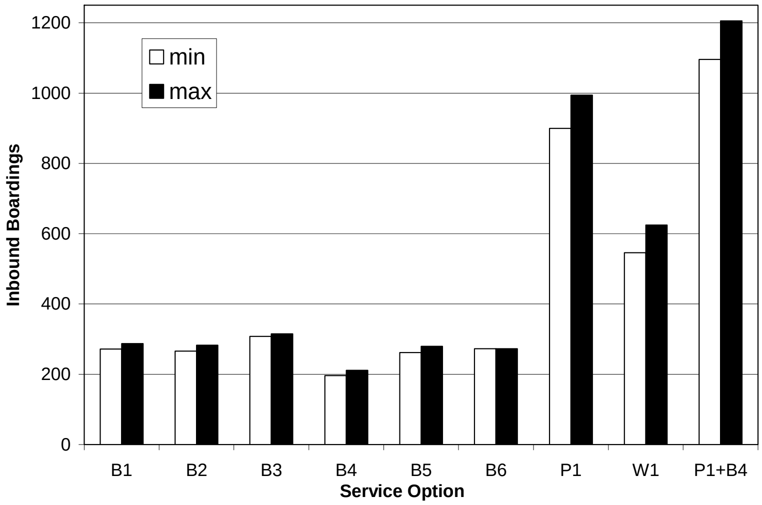
Eight service options, six to Boston and one each to Providence and Worcester, were defined. A commonly used forecasting tool developed by the National Cooperative Highway Research Program was applied to regional journey-to-work forecasts to derive ridership estimates for alternative rail service options listed in Table I.2. Two levels of service were considered for each option:

- Fast, frequent service: 42 trains per day averaging 35 mph from origin to destination
- More typical service: 24 trains per day averaging 25 mph from origin to destination

Table I.2: Summary of Service Options Evaluated and Ridership Forecasts

Service Regime	Description	Travel Time from Woonsocket Station to Destination Station (minutes)		Forecast Total Weekday Inbound Boardings	
		Min	Max	Max	Min
B1: Forge Park Extension	Extends existing Boston bound MBTA Forge Park service to Woonsocket via the B&P.	72	76	287	272
B2: Franklin Transfer	Woonsocket passengers would transfer to existing MBTA trains at Franklin for service to Boston. Trains would travel via the B&P and B&W to Franklin.	71	77	283	266
B3: Franklin Direct	New semi-express service from Woonsocket to Boston via Franklin. Trains would travel via the B&P and B&W to Franklin.	62	68	315	308
B4: Pawtucket Transfer	Woonsocket passengers would transfer to existing MBTA Boston trains at Pawtucket (offered in conjunction with service to Providence). Trains would travel via the P&W to Pawtucket.	99	109	212	196
B5: Feeder Bus	Service from Woonsocket to Boston via a rubber wheeled connection to Franklin, on local arterials, where passengers would transfer to existing MBTA trains.	81		273	
B6: Via Blackstone	Service from Woonsocket to Boston via the P&W to Blackstone and the former Boston B&W line to Franklin; passengers would transfer to existing MBTA trains at Franklin.	73	81	280	262
P1: Providence Service	Service from Worcester to Providence via the existing P&W route.	27	38	994	899
W1: Worcester Service	Service to Worcester from the Providence via existing P&W route.	47	66	624	546

Figure I.3: Total Forecast Weekday Boardings



The range of total forecast weekday inbound boardings is illustrated in Figure I.3. The Providence market is forecast to achieve the highest overall ridership with at least 900 daily inbound boardings. Service to Worcester would attract approximately 550 inbound passengers. None of the Boston services would attract more than 315 daily riders overall. The Pawtucket transfer service (B4) could be offered in conjunction with the Providence service (P1). Together the two services would attract as many as 1,200 weekday inbound boardings.

Figure I.4: Forecast Weekday Boardings at Woonsocket

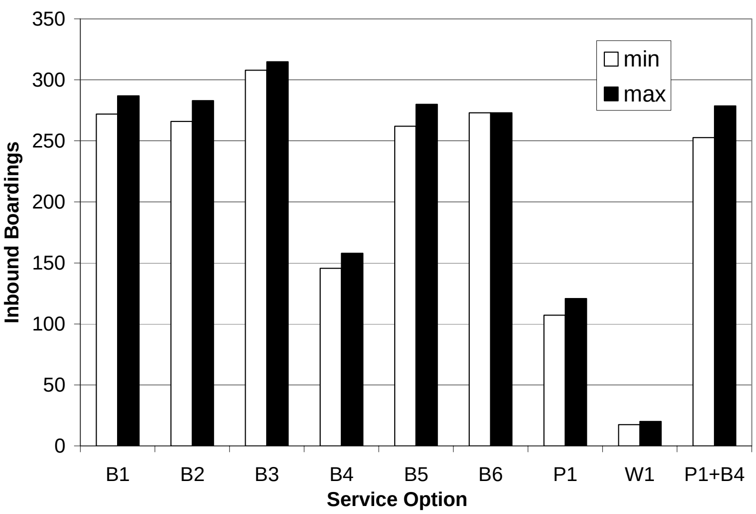


Figure I.4 depicts weekday boardings, by travelers using Woonsocket station. At Woonsocket station, the Boston services are forecast to attract the greatest ridership with as many as 300 boardings at Woonsocket. Travel to Providence via Woonsocket station would be more modest with approximately 100 weekday boardings. Fewer than 25 persons would board weekday trains at Woonsocket bound for Worcester. The combination of the Pawtucket transfer service to Boston and direct service to Providence would attract as many as 280 weekday boardings to Woonsocket station.

Caveat: It is JEK's opinion that the forecasting model over predicts ridership response to the feeder bus service option. Actual performance of bus to commuter rail feeder service is generally less attractive than direct services or rail to rail transfers. Actual ridership of the feeder bus would be unlikely to be as high as predicted by this forecasting tool. In the event that Woonsocket is interested in developing a feeder bus service, JEK recommends that it be implemented on a trial basis to evaluate actual ridership potential.

OPPORTUNITIES AND CONSTRAINTS

The study team assessed the opportunities and constraints associated with each potential service option in an iterative screening process allowing subsequent evaluation efforts to focus on the options that were expected to provide the greatest benefit to Woonsocket and Rhode Island. After evaluation of each service option's implementation challenges, the planning team narrowed the initial eight options to the four most viable alternatives. Evaluation of the estimated capital infrastructure costs relative to the expected benefits for each of the four alternatives guided the planning team to the most attractive alternative.

Implementation Challenges

Restoration of direct rail service between Woonsocket and Boston under any service regime that would operate on the B&P and B&W would entail a surmounting of opposition from the Massachusetts Department of Conservation and Recreation (Mass DCR) (B2, B3, B6), a Harris Pond water crossing (B1, B2, B3), private ownership of right-of-way parcels in Woonsocket (B1, B2, B3) and Bellingham (B1, B2, B3, B6) and the proposed abandonment of right-of-way in Woonsocket (B1, B2, B3).

Figure I.5: ROW embankment across Harris Pond

The majority of the B&W line between Blackstone and Franklin is owned by the Mass DCR for use as a trail. A representative of the Mass DCR has established that the agency would not support restoration of the right-of-way for active rail use.

Portions of the B&P right-of-way linking Woonsocket to Franklin through Harris Pond in Blackstone, Massachusetts no longer exist. The pond is a tertiary water supply for the City of Woonsocket. The B&P originally ran on an embankment across Harris Pond; however, large sections of the embankment have eroded away so that restoration of this route would require construction of at least 250 feet of embankment through the pond (see Figure I.5). The environmental concerns associated with restoring and operating a railroad across a public water supply would be manifold.

Various portions of abandoned railway that would be critical for multiple Boston service options are privately owned and have either been adapted for other purposes or are in the process of being sold for development. A one-mile portion of the B&W in South Bellingham, within the Mass DCR's trail, is privately owned. In Blackstone, another mile of right-of-way is actively used as an access road for residential development. In Woonsocket, a short section of the B&P is used as a driveway in between two homes.

Further north on the B&P, the long abandoned right-of-way is unidentifiable and has been incorporated into residential development so that a restored railroad would run across backyards, driveways and houses in Bellingham. The P&W railroad is currently pursuing a petition to formally abandon a portion of the B&P alignment in Woonsocket with the intention of selling the parcel for private development.

Development of passenger rail service would require the State and the City to surmount a number of critical challenges, as summarized below.

- B1: Forge Park extension
    - Unavailable right-of way and encroachment in Woonsocket and Bellingham
    - Harris Pond crossing
    - Proposed abandonment and sale of critical portions of the abandoned B&P in Woonsocket.
    - Development of a new passenger station in Woonsocket.
    - Seating capacity on existing MBTA trains.

- B2: Franklin Transfer
    - Massachusetts Department of Conservation and Recreation opposition
    - Harris Pond crossing
    - Privately owned right-of-way parcels in Woonsocket and South Bellingham
    - Proposed abandonment and sale of critical portions of the abandoned B&P in Woonsocket
    - Significant structural challenges required by B&P to B&W connection
    - Development of a new passenger station in Woonsocket
    - Seating capacity on existing MBTA trains

- B3: Franklin Direct
    - Same as above, except for seating capacity on existing MBTA trains, plus
    - MBTA capacity on Franklin Branch
    - MBTA capacity at South Station

- B5: Feeder Bus
    - Expected low ridership due to unattractive travel times and service characteristics

- B6: Via Blackstone
    - Massachusetts Department of Conservation and Recreation opposition
    - Privately owned right-of-way parcel in South Bellingham
    - Reclamation or redevelopment of one mile of right-of-way that has been developed as a roadway in Blackstone
    - Significant structural and land taking challenges of building a P&W to B&W connection in North Smithfield

  - Construction of 350 foot bridge spanning the Blackstone River
  - Seating capacity on Existing MBTA trains

- W1: Worcester Service
  - Low projected ridership
  - Low projected benefits to Rhode Island and City of Woonsocket

- P1+B4: Service to Providence and Boston via Pawtucket Transfer[2]
  - Coordination with P&W, Amtrak and MBTA

Based on this preliminary route analysis and the ridership forecasts, the planning team concurred that limited evaluation resources should focus on alternatives B2, B3, B6, and P1+B4.

Estimated Capital Costs

The cost of infrastructure construction and land acquisition required for passenger rail restoration was estimated for each alternative routing. Costs estimated include those related to acquisition of privately owned right-of-way parcels, track and signals, stations, other facilities, and contingency and construction support.

Table I.3: Estimated Capital Costs by Alternative

	B2: Franklin Transfer	B3:Franklin Direct	B6: Via Blackstone	P1+B4: Woonsocket to Providence
Estimated Capital Cost (millions)	$55.8	$55.8	$60.8	$60.0
Capital Cost per Route Mile (millions)	$7.0	$7.0	$6.8	$3.7
Capital Cost Per Forecast Weekday Passenger	$210,000	$181,000	$232,000	$58,000

The estimated infrastructure costs for Boston service (B2, B3, and B6) range between $56 million and $61 million while the estimated infrastructure cost for Providence service (P1+B4) is $59 million.

Since the Providence route is approximately double the length of proposed Boston route extensions, the estimates translate to infrastructure costs per route mile of $3.7 million for service to Providence, as compared to approximately $7 million per route mile for service to Boston (see Table I.3). The Boston schemes are associated with higher route mile costs of infrastructure restoration because they would require complete replacement of the majority of track, as opposed to an upgrade of existing track to Providence. Each Boston route would also require extraordinary infrastructure projects that would not be required for Providence passenger service.

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[2] Evaluation of option P1 (Providence service) that followed ridership projections focused solely on the Woonsocket to Providence segment due to low projected demand for this service between Worcester and Woonsocket. Options P1 and B4 were subsequently consolidated as the service to Boston via a transfer at Pawtucket would be offered in conjunction with service to Providence.

Because service between Woonsocket and Providence, offering a connection to Boston at Pawtucket, would provide the greatest benefit at the lowest cost per passenger and route mile, the study team recognized this route as the most viable. Routes to Boston appear to be impractical due to the substantial obstacles facing rail service restoration on long abandoned routes and the high cost of implementation per forecast passenger. Further evaluation of passenger rail service including estimation of operating cost and fare revenue focused solely on the route between Woonsocket and Providence.

Operating Costs & Revenue

The primary objective of the planned service to Providence was to provide a convenient alternative for travel between Woonsocket and downtown Providence and Boston. Trains were scheduled with a focus on serving commuters to downtown locations during the morning peak period and to residential areas during the afternoon peak period. Trains from Woonsocket were scheduled to provide timed transfers to MBTA trains at Pawtucket.

Figure I.6: Preliminary Schedule – Woonsocket/Providence Service

Inbound Service

STATION	MP	2	4	6	8	10	12	14	16	18	20	22	24	26	28
Cycle	MP	y	x	y	x	y	x	x	x	x	x	x	y	x	x
Woonsocket	16.2	5:06	5:48	6:52	7:18	8:09	9:25	10:44	13:12	14:56	16:17	17:39	18:25	19:17	21:24
Manville	14.2	5:09	5:51	6:55	7:21	8:13	9:29	10:48	13:16	15:00	16:21	17:43	18:29	19:21	21:28
Berkeley	8.8	5:18	6:00	7:04	7:30	8:21	9:37	10:56	13:24	15:08	16:29	17:53	18:37	19:29	21:36
Pawtucket	4.5	5:26	6:08	7:12	7:38	8:28	9:44	11:03	13:31	15:15	16:36	18:01	18:46	19:36	21:43
Providence	0.0	5:34	6:16	7:20	7:46	8:35	9:51	11:10	13:38	15:22	16:43	18:08	18:53	19:43	21:50
South Station (Boston)	43.5	6:40	7:19	8:16	8:49		10:55		14:38		17:40	19:03			10:55

Outbound Service

STATION	MP	1	3	5	7	9	11	13	15	17	19	21	23	25	27
Cycle	MP	y	x	y	x	x	x	x	x	x	y	x	y	x	x
South Station (Boston)	43.5						10:25	13:25	14:37		16:35	17:40	18:10	19:10	21:05
Providence	0.0	5:58	6:38	7:30	8:20	10:01	11:20	14:20	15:32	17:00	17:37	18:34	19:03	20:10	22:02
Pawtucket	4.5	6:04	6:44	7:36	8:26	10:07	11:26	14:26	15:39	17:07	17:44	18:41	19:10	20:16	22:08
Berkeley	8.8	6:13	6:51	7:45	8:33	10:14	11:33	14:33	15:46	17:15	17:52	18:49	19:18	20:23	22:15
Manville	14.2	6:22	7:02	7:54	8:42	10:23	11:42	14:42	15:54	17:23	18:00	18:57	19:26	20:32	22:24
Woonsocket	16.2	6:26	7:06	7:58	8:46	10:27	11:46	14:46	15:59	17:28	18:05	19:02	19:31	20:36	22:28

YD = To/From Yard

Four different service plans were evaluated for the service between Woonsocket and Providence. These service plans differed in the type of vehicle operated, DMU versus Push-pull, and the train crew size, one person train operation (OPTO) versus two person train operation (TPTO). Operating costs include estimates relating to rail transportation, mechanical, maintenance of way, trackage fees, and administration expense.

Table I.4: Performance Statistics for Woonsocket to Providence Service Regimes

	DMU Service		Push-Pull Service	
	TPTO	**OPTO**	**TPTO**	**OPTO**
Operating Cost (millions)	$4.0	$3.6	$4.8	$4.3
Capital cost per weekday inbound passenger	$70,881	$70,881	$71,739	$71,739
Operating cost per annual passenger trip	$7.15	$6.45	$8.52	$7.73
Forecast passenger revenue per annual passenger trip (millions)	$3.36	$3.36	$3.36	$3.36
Fare recovery ratio	47%	52%	39%	44%
Required annual operating support (millions)	$2.1	$1.7	$2.9	$2.4

RECOMMENDED NEXT STEPS

Given the relatively high range of recovery ratios estimated and the substantial forecast demand for service, the study team believes a service between Woonsocket and Providence offering a transfer to Boston service to be economically feasible and worthy of further consideration.

Recommended next steps are listed below.

1. Finalized feasibility report should be shared with Rhode Island Statewide Planning the Rhode Island Department of Transportation and the Providence and Worcester Railroad for their edification and consequent formal feedback.

2. Support for this project from the community and/or city officials should be communicated to elected state leadership to facilitate future evaluation, planning or implementation efforts.

3. Further study, focusing on an extension of the Woonsocket-Providence service to TF Green Airport, should be considered. The planning team believes an intrastate service linking Woonsocket, Cumberland, Lincoln, Central Falls, Pawtucket, Providence, Cranston and Warwick with fast, frequent service would engender statewide benefits, including increased mobility for people traveling among the most densely populated communities in Rhode Island.

II. Ridership Report

INTRODUCTION

For the Woonsocket Commuter Rail Feasibility Study, the Jacobs, Edwards and Kelcey (JEK) study team identified potential challenges and opportunities to restoring passenger rail service. Three routes were under evaluation (1) connecting Woonsocket with Boston (2) connecting Woonsocket with Providence and (3) connecting Woonsocket with Worcester. The study team prepared estimates of expected future ridership for each of the three service options to better understand the feasibility of passenger rail service.

STUDY AREAS

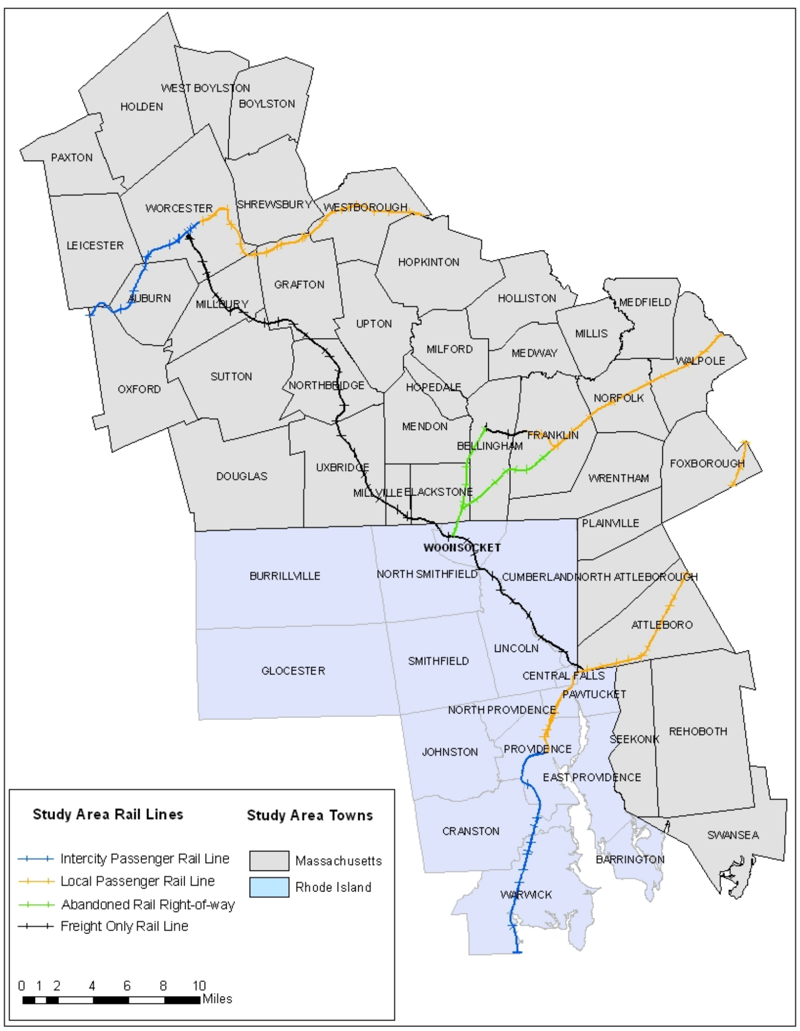


Figure II.1

The project study area was defined to include all communities within a rough ten mile radius of the proposed rail routes, as shown in Figure II.1. 2000 U.S. Census data was compiled to gain a better understanding of the study area communities in terms of population and employment.

Figure II.2 illustrates the population density of the study area as documented by the 2000 Census. From this map, it is evident that the highest concentrations of population are found within the vicinities of Providence and Worcester. The city of Woonsocket also exhibits significant population densities, but at a smaller scale than Providence or Worcester.

Figure II.3 depicts the density of employment opportunities within each community. Employment density follows a pattern similar to population, with the highest concentrations in Providence and Worcester, and a smaller scale concentration in Woonsocket.

Figure II.2

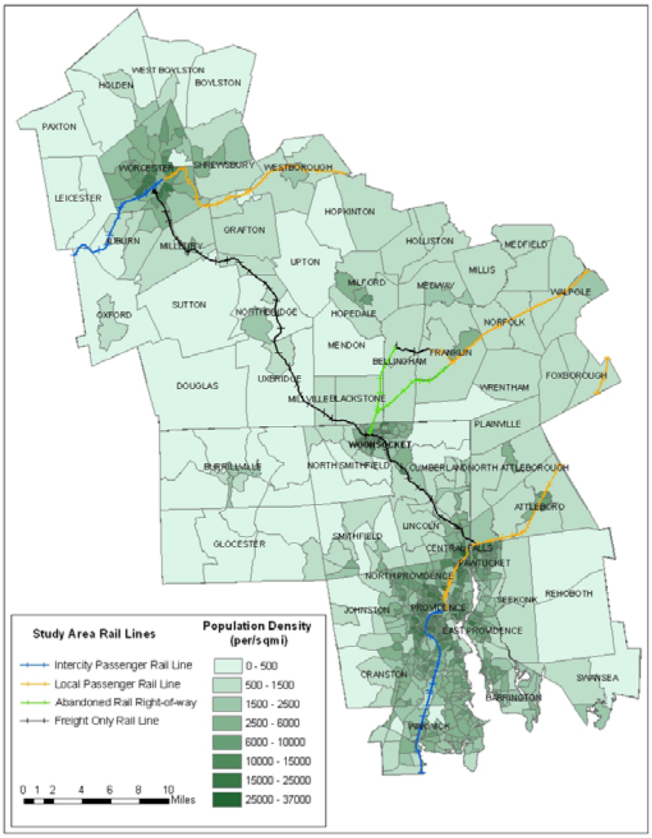
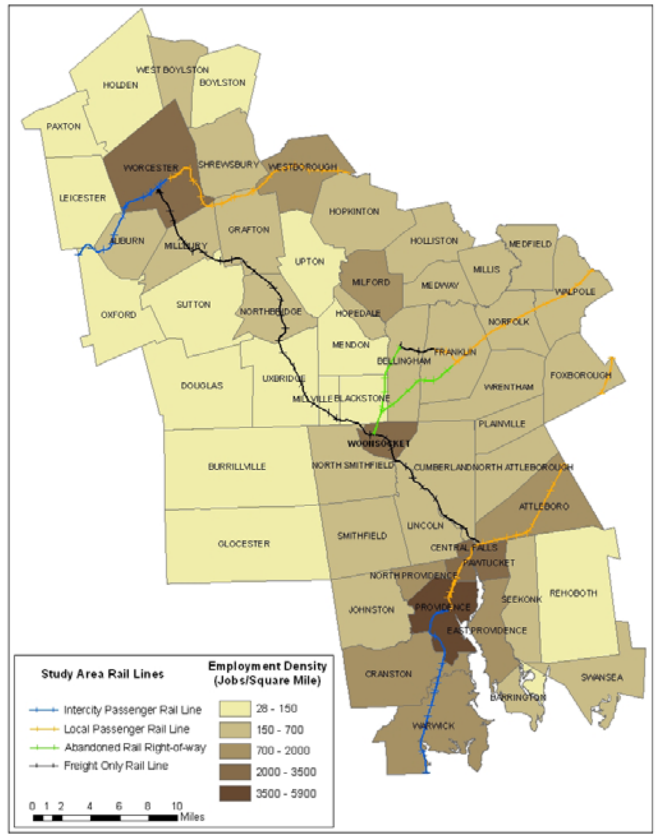


Figure II.3



<u>Market Determination</u>

To prepare forecasts of ridership, market study areas for each of the three routes were defined. Through evaluation of existing transit services and road networks, JEK developed a list of communities that would be well served by and a reasonable source of ridership for each of the proposed passenger rail services to Boston, Providence and Worcester. Communities were included in the market for a specific major city destination if:

1. That community was not already served by passenger rail service to the specified destination city, and
2. The proposed passenger rail service could compete with the automobile mode for travel from that community to the destination city.

This market determination resulted in three different study areas each associated with commuters interested in passenger rail service to one of the three destinations. Communities included in the study rail travel markets for Boston, Providence, and Worcester are listed below.

Boston – Blackstone and Millville in Massachusetts; and Woonsocket, North Smithfield, Douglas, Burrillville, and Glocester in Rhode Island.

Providence – Paxton, Holden, West Boylston, Boylston, Leicester, Worcester, Shrewsbury, Auburn, Millbury, Grafton, Oxford, Sutton, Northbridge, Upton, Hopkinton, Milford, Hopedale, Mendon, Douglas, Uxbridge, Millville, Blackstone, Bellingham, and Franklin in Massachusetts; and North Smithfield, Woonsocket, Cumberland, Smithfield, Lincoln, Central Falls, and Pawtucket in Rhode Island.

Worcester – Millbury, Grafton, Upton, Milford, Holliston, Medway, Sutton, Northbridge, Hopedale, Douglas, Mendon, Bellingham, Franklin, Norfolk, Uxbridge, Wrentham, Foxborough, Millville, Blackstone, Plainville, North Attleboro, Attleboro, Seekonk, Rehoboth, and Swansea in Massachusetts; and Burrillville, North Smithfield, Woonsocket, Cumberland, Lincoln, Smithfield, Glocester, Central Falls, Pawtucket, North Providence, Providence, Johnston, East Providence, Cranston, Warwick, and Barrington in Rhode Island

COMMUTER FLOWS

Forecasts of future travel between communities within the defined study area are a critical input for ridership forecasting. The study team requested projections of future travel from the regional planning offices that maintain regional travel demand models. The communities in the study area are covered by three planning agencies: Rhode Island Statewide Planning, the Central Massachusetts Regional Planning Commision (CMRPC), and the Central Transportation Planning Staff (CTPS) of the Metropolitan Area Planning Commision (MAPC). Model outputs from all three planning agencies were received. The model outputs differ for each planning agency:

- **Rhode Island Statewide Planning:** Conveyed full trip table to study team including daily home based work, home based non-work, and non home based trips for 2000 and 2030 from each Rhode Island major census division (MCD) and one external to each Rhode Island MCD and the one external. Demographic projections for the year 2000 through 2030 for all Rhode Island MCDs were also acquired.[3]

- **CMRPC:** Conveyed trip table for total daily vehicle trips between Blackstone, Millville, Uxbridge, Northbridge, Grafton, Sutton, Millbury, and Worcester for the years 2005 and 2030. Demographic projections for the years 2000, 2005, 2010, 2015, 2020, 2025 and 2030 for all CMRPC communities were also acquired.[4]

[3] Travel demand model outputs sent by Vinny Flood (401.222.1243), Rhode Island Statewide Planning. Demographic projections also sent by Rhode Island Statewide Planning.
[4] Travel demand model outputs and demographic projections sent by Mary Ellen-Blunt (508.459.3337), CMRPC.

- **MAPC:** For each municipality listed below, delivered the daily volume of total trips, trips within each municipality, trips to other communities in the study area[5], trips to the Boston metropolitan area, external trips to CMRPC, external trips to RI, external trips to SRPEDD, and all other trips for years 2000 and 2030. Population and employment projections for the year 2000 and 2030 for each of the 23 study area communities and Greater Boston were also acquired.[6] The 23 study area municipalities covered in the MAPC model are: Bellingham, Foxborough, Franklin, Holliston, Hopkinton, Medfield, Medway, Milford, Millis, Norfolk, Walpole, Wrentham, Blackstone, Hopedale, Mendon, Millville, Northbridge, Upton, Uxbridge, Westborough, Attleboro, North Attleboro, and Plainville.

Tables II.1a and II.1b presents demographic statistics for each study area community. An increase in population is forecast for almost all study area communities with the exception of East Providence and Warwick, both expected to decrease in population. Most saliently, Rhode Island Statewide Planning forecasts that Woonsocket, will decrease in population by 6% by 2030.

Table II.1a: Demographics of Rhode Island Study Area Communities

RI Study Area Community	2000 Population	2030 Population	Change in Population	2000 Total Employed Residents
Barrington	16,819	17,407	3%	7,805
Burrillville	15,796	18,195	15%	8,288
Central Falls	18,928	20,690	9%	7,000
Cranston	79,269	85,903	8%	35,991
Cumberland	31,840	36,189	14%	16,221
East Providence	48,688	46,599	**-4%**	22,434
Glocester	9,948	12,134	22%	5,454
Johnston	28,195	31,192	11%	13,352
Lincoln	20,898	24,498	17%	10,434
North Providence	32,411	35,349	9%	15,984
North Smithfield	10,618	11,207	6%	5,345
Pawtucket	72,958	74,557	2%	32,241
Providence	173,648	188,947	9%	67,169
Smithfield	20,613	24,011	16%	10,038
Warwick	85,808	84,764	**-1%**	43,088
Woonsocket	43,224	40,772	**-6%**	18,729
Totals	**709,661**	**752,414**	**6%**	**319,573**

[5] Study area defined here as the 23 towns included in the CTPS model.
[6] Travel demand model outputs and demographic projections sent by William Kutner (617.973.7132), CTPS.

Table II.1b: Demographics of Massachusetts Study Area Communities

MA Study Area Community	2000 Population	2030 Population	Change in Population	2000 Total Employed Residents
Attleboro	42,067	46,750	11%	21,540
Auburn	15,901	17,800	12%	8,067
Bellingham	15,314	16,641	9%	8,462
Blackstone	8,804	10,000	14%	4,658
Boylston	4,008	5,000	25%	2,058
Douglas	7,045	11,400	62%	3,822
Foxborough	16,246	18,880	16%	8,525
Franklin	29,797	35,867	20%	14,807
Grafton	14,894	22,500	51%	7,838
Holden	15,621	19,500	25%	7,856
Holliston	13,801	16,079	17%	6,942
Hopedale	5,907	6,700	13%	2,993
Hopkinton	13,347	15,602	17%	6,549
Leicester	10,471	12,000	15%	5,510
Medfield	12,273	13,530	10%	5,694
Medway	12,448	14,121	13%	6,567
Mendon	5,286	9,300	76%	2,818
Milford	26,799	32,713	22%	13,724
Millbury	12,784	15,000	17%	6,696
Millis	7,902	8,952	13%	4,204
Millville	2,724	4,000	47%	1,391
Norfolk	10,461	12,439	19%	4,348
North Attleborough	26,702	30,813	15%	14,668
Northbridge	13,182	16,000	21%	6,389
Oxford	13,352	15,200	14%	7,035
Paxton	4,386	5,500	25%	2,193
Plainville	7,684	8,397	9%	4,159
Rehoboth	10,172	12,217	20%	5,575
Seekonk	13,425	16,124	20%	6,814
Shrewsbury	31,640	41,300	31%	15,791
Sutton	8,250	12,000	45%	4,291
Swansea	15,901	19,098	20%	8,213
Upton	5,642	9,800	74%	2,725
Uxbridge	11,156	15,300	37%	5,839
Walpole	22,826	25,244	11%	11,406
West Boylston	7,481	9,000	20%	3,071
Westborough	17,997	23,200	29%	8,553
Worcester	172,648	187,200	8%	75,537
Wrentham	10,554	15,885	51%	5,219
Totals	**696,898**	**827,052**	**19%**	**342,547**

Methodology

Because the proposed passenger rail routes would provide service between the three MPO's, it was important that data provided by each MPO could be consolidated for use in a single mode split model. This consideration was complicated by the following issues.

- Each MPO provided travel projections in different formats: (1) home-based-work trips, (2) total vehicle trips, (3) total trips.
- Travel outside the boundaries of each MPO was not classified by destination. For example, a trip from Woonsocket to Boston or from Woonsocket to Worcester would be labeled as Woonsocket to external in both cases.

The study team found certain results of the MPOs' travel models to be impractical, in terms of the purposes of this study. For instance, Woonsocket area work trips to Boston were forecast to decrease by 2030, probably as a result of considerable increases in forecast employment within the study area. Additionally, 2000 trip flow estimates generated by MPO models differed significantly from 2000 census journey-to-work data that would be employed to estimate travel across MPO borders.

In order to attain a consistent, useable data set the study team expanded journey-to-work data (taken from the most recent census in 2000), using 2030 population and employment projections provided by MPOs, to synthesize forecasts of travel among the study-area communities in the year 2030. Because census journey-to-work data is collected at a nationwide level, there were no issues with travel across MPO boundaries. The methodology employed to expand 2000 data to 2030 forecasts of travel consisted of the following steps.

1. Compile 2000 journey-to-work data into a trip table indicating the number of people commuting from each study area community to each study area community.
2. Calculate the percent of population growth between 2000 and 2030, for each community, using MPO projections.[7]
3. Estimate a 2030 journey-to-work trip table by increasing the amount of people commuting *from* each community by the percentage of population growth at the *origin*.
4. Calculate the percent of employment growth between 2000 and 2030, for each community, using MPO projections.
5. Estimate a 2030 journey-to-work trip table by increasing the amount of people commuting *to* each community by the percentage of employment growth at the *destination*.
6. Estimate a final 2030 journey-to-work trip table by taking the average of the trip tables calculated in steps 3 and 5.

Two 2030 journey-to-work tables were compiled, one for travel to Boston from the Boston Market and one for travel between all study area communities including

[7] No MPO projections were collected for Seekonk, Rehoboth, and Swansea, Massachusetts. 2000 census data was utilized, and grown by the average population and employment factors to achieve 2030 projections of employment and population.

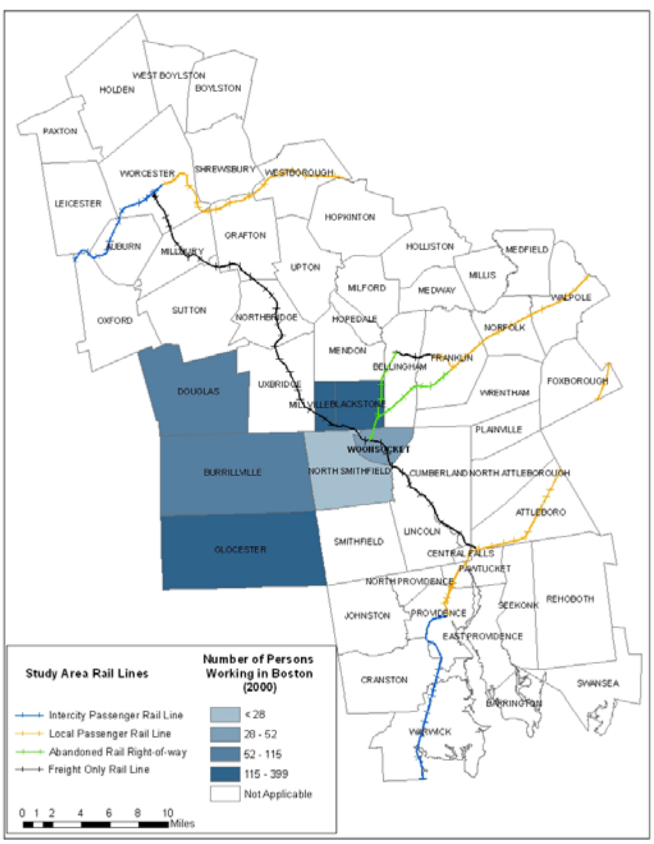
Providence and Worcester. Summary travel statistics for each major city destination are presented in Tables II.2a, II.2b, and II.2c.

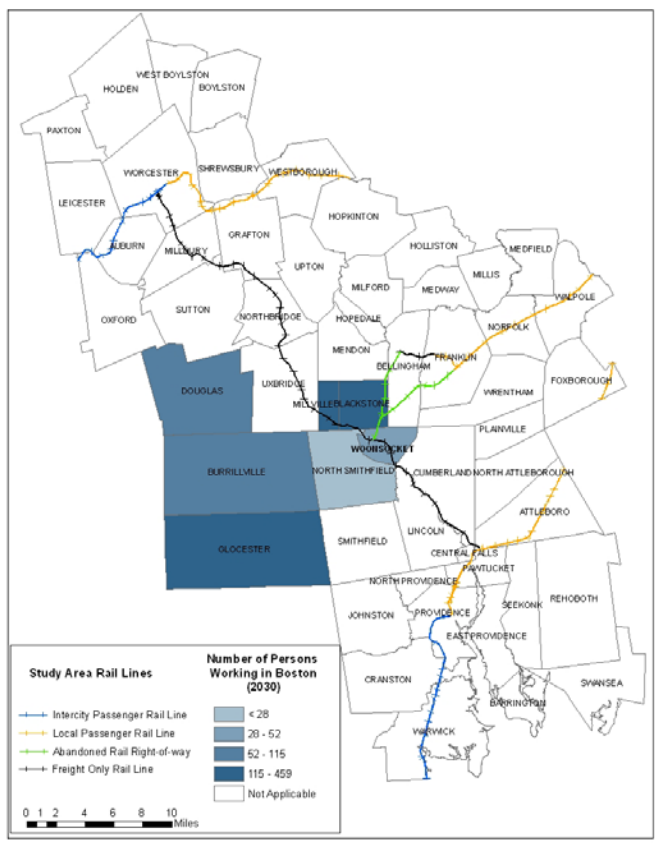
<u>Findings</u>

Boston – For the study area communities used to evaluate service to Boston, a 17 percent increase in total work travel to Greater Boston was forecast accumulating to 1,101 commuters.

Table II.2a: Study Area Commuters to Boston

Origin Community	2000 Workers to Boston	2030 Workers to Boston	Percent Change
Blackstone	137	152	11%
Woonsocket	51	52	2%
Millville	157	200	27%
North Smithfield	26	28	8%
Douglas	70	95	36%
Burrillville	103	115	12%
Glocester	399	459	15%
Total	**943**	**1,101**	**17%**

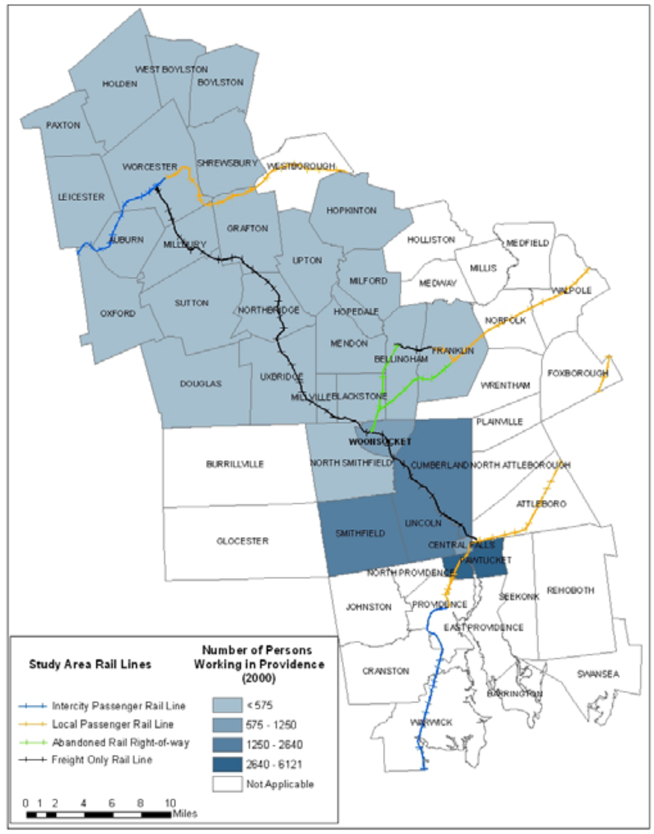


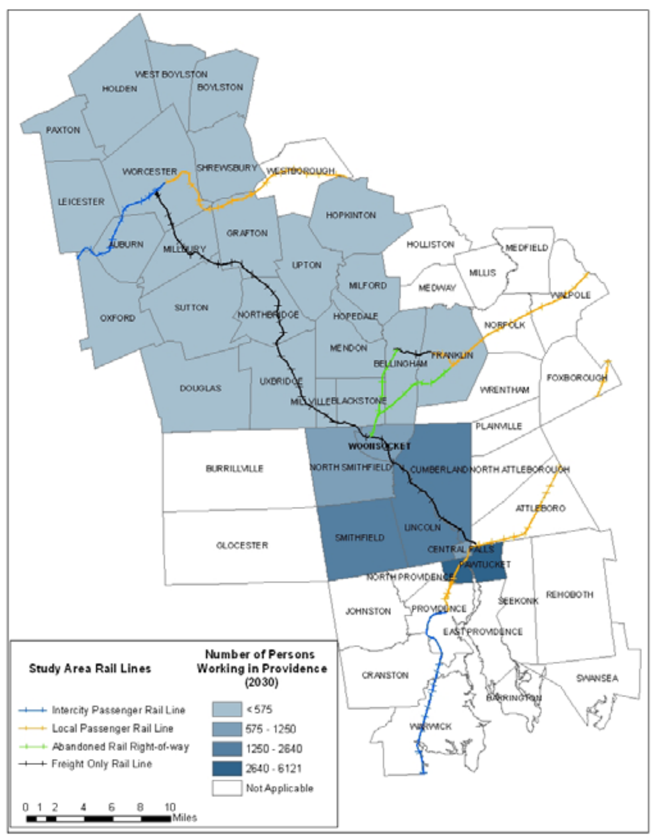


Providence – For the study area communities used to evaluate service to Providence, a nine percent increase in total work travel to Providence was forecast growing to 16,818 daily commuters by 2030.

Table II.2b: Study Area Commuters to Providence

Origin Community	2000 Workers to Providence	2030 Workers to Providence	Percent Change
Paxton	13	15	15%
Holden	23	27	17%
West Boylston	5	6	20%
Boylston	0	0	0%
Leicester	5	6	20%
Worcester	58	63	9%
Shrewsbury	0	0	0%
Auburn	7	8	14%
Millbury	15	17	13%
Grafton	24	31	29%
Oxford	0	0	0%
Sutton	17	22	29%
Northbridge	19	22	16%
Upton	0	0	0%
Hopkinton	7	8	14%
Milford	43	50	16%
Hopedale	21	23	10%
Mendon	31	44	42%
Douglas	28	38	36%
Uxbridge	94	116	23%
Millville	16	20	25%
Blackstone	94	105	12%
Bellingham	53	58	9%
Franklin	112	128	14%
North Smithfield	539	578	7%
Woonsocket	1,229	1,248	2%
Cumberland	2,039	2,268	11%
Smithfield	2,342	2,639	13%
Lincoln	1,864	2,107	13%
Central Falls	963	1,050	9%
Pawtucket	5,801	6,121	6%
Total	**15,462**	**16,818**	**9%**

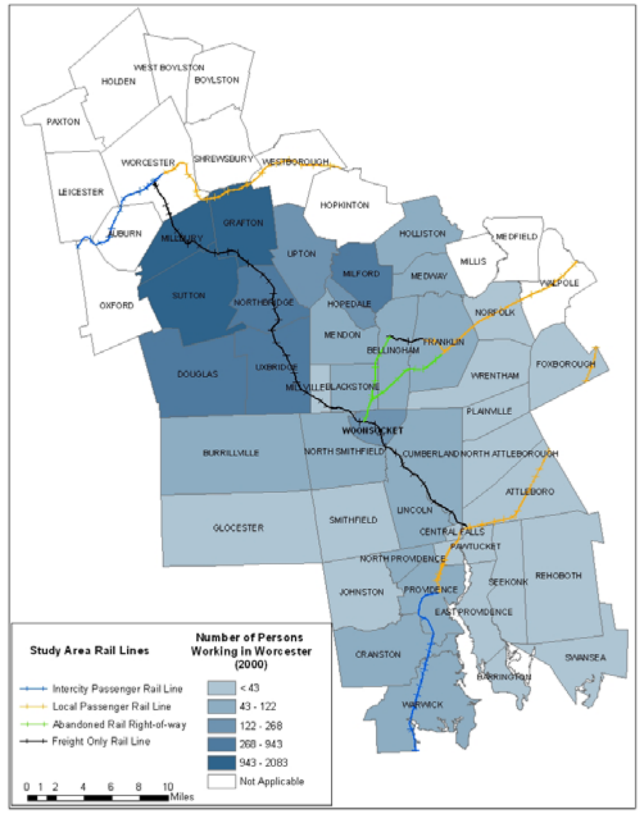


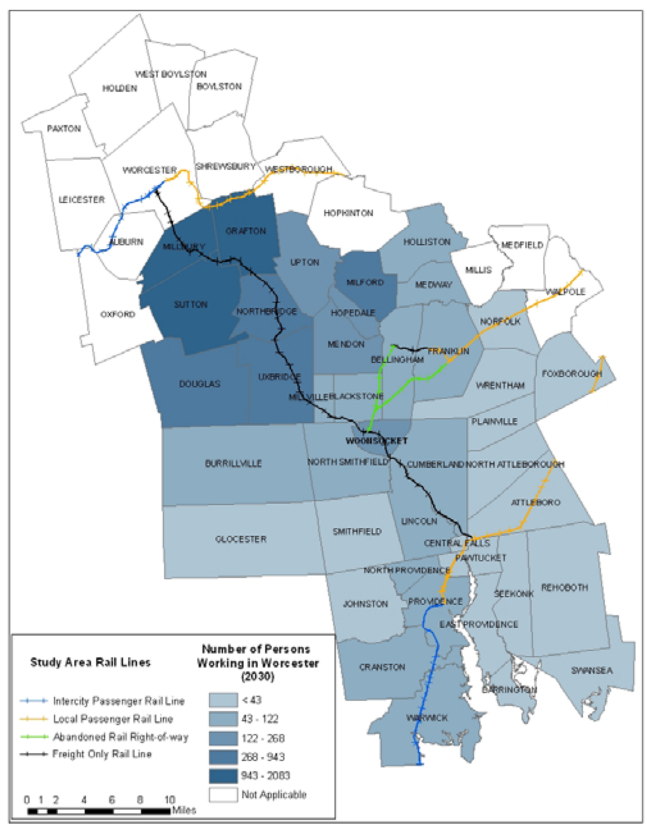


Worcester - For the study area communities used to evaluate service to Worcester, a 24 percent increase in total work travel to Providence was forecast growing to 10,330 by 2030.

Table II.2c: Study Area Commuters to Worcester

Origin Community	2000 Workers to Worcester	2030 Workers to Worcester	Percent Change
Millbury	1,785	2,083	17%
Grafton	1,493	1,994	34%
Upton	185	268	45%
Milford	434	517	19%
Holliston	72	84	17%
Medway	98	112	14%
Sutton	1,165	1,523	31%
Northbridge	794	943	19%
Hopedale	134	154	15%
Douglas	440	611	39%
Mendon	109	159	46%
Bellingham	73	82	12%
Franklin	84	99	18%
Norfolk	19	22	16%
Uxbridge	387	490	27%
Wrentham	26	35	35%
Foxborough	7	8	14%
Millville	42	55	31%
Blackstone	106	122	15%
Burrillville	70	81	16%
North Smithfield	79	88	11%
Woonsocket	163	171	5%
Plainville	27	30	11%
Cumberland	64	74	16%
Lincoln	44	51	16%
Smithfield	9	10	11%
Glocester	32	38	19%
North Attleboro	25	29	16%
Attleboro	38	43	13%
Central Falls	0	0	0%
Pawtucket	23	25	9%
North Providence	22	25	14%
Providence	74	83	12%
Johnston	19	22	16%
East Providence	16	17	6%
Seekonk	36	43	19%
Rehoboth	11	13	18%
Cranston	45	50	11%
Warwick	60	64	7%
Barrington	3	3	0%
Swansea	8	9	13%
Total	**8,321**	**10,330**	**24%**





FORECAST PASSENGER RAIL SERVICES

Two levels of rail service were evaluated for each travel market:

1. **Fast, Frequent Service –** represents the approximate upper bound of service speed and frequency that could be expected for Woonsocket service. Entails 42 weekday trains with an end-to-end service velocity of approximately 35 mph.
2. **More Typical Service –** reflects more modest service speeds and frequencies. Entails 24 weekday trains with a service velocity of approximately 25 mph.

In preparing forecasts for service to Boston, two alternative routings and three alternative operating plans were considered. The first Boston service alternative would route trains through Bellingham Junction en route to Forge Park, the current Park-n-Ride terminus for MBTA commuter service on the Franklin Branch. Under this alternative, it is assumed that MBTA service would be extended to serve Woonsocket. The other alternatives involve a more direct route to the Franklin Branch, however, this shorter route would miss Forge Park Station and could not be seamlessly merged with current MBTA services. The second alternative would make use of this more direct routing requiring travelers to transfer at Franklin for service to Boston. The third, and likely most costly, alternative for service to Boston would utilize the more direct routing and provide for a one-seat ride between Woonsocket and Boston. New trains from Woonsocket to Boston via Franklin would operate via semi-express mode North of Franklin.

The forecast rail travel time from Woonsocket to Boston would fall within the range of 86 to 102 minutes (door to door) depending on speed and routing. This compares favorably with the forecast peak highway travel time of 92 minutes.

In preparing forecasts for service to Providence, the team considered a single routing via the P&W to Pawtucket and via the “FRIP” track to Providence. The service to Providence also provides an opportunity for a “two-seat” rail service to Boston via a transfer at Pawtucket. For service to Providence from Woonsocket, rail travel times would range between 51 and 62 minutes depending on speed, compared with 39 minutes for travel by private auto. For service to Boston via Pawtucket, rail travel times from Woonsocket would be between 124 and 134 minutes, compared with 92 minutes for peak period auto travel.

For passenger rail service to Worcester, the team considered a single routing via the P&W. The forecast rail travel time between Woonsocket and Worcester is between 71 and 90 minutes. The peak period travel time between Woonsocket and Worcester by automobile is forecast be 42 minutes.

MODE CHOICE MODEL: NCHRP REPORT 187

A widely used ridership-forecasting tool was employed to forecast potential ridership on the three sub corridors. The National Cooperative Highway Research Program (NCHRP) formulated a modeling process, presented in NCHRP Report 187: Quick-Response Urban

Travel Estimation Techniques and Transferable Parameters[8], which forecasts ridership by determining the travel market share of a transit service through analysis of key parameters in automobile and transit travel.

The NCHRP model provides a concise process to generate useful output statistics with limited data input requirements. While Report 187 documents techniques for calculating auto occupancy, trip distribution and trip generation, the technique for mode-choice analysis was of most interest for calculating potential ridership. Mode-choice analysis generates market share estimations that can be used with journey to work data to forecast potential ridership.[9]

The mode-choice analysis technique employed is mathematically based on a logistic distribution (logit) formulation[10]. Specifically, this technique estimates transit percent use from the ratio of transit impedance to a gravity exponential, B, and automobile impedance to a gravity exponential:

$$\text{\% Commuters using rail} = 1/\left(1+\left(\text{Transit Impedance}^{B}/\text{Automobile Impedance}^{B}\right)\right)$$

Impedance values, which represent the traveler's perception of a mode's utility for a specific trip, are calculated using simple travel characteristics. The model estimates the impedance for automobile and transit use based on the following parameters:

- Automobile
    - Travel time
    - Travel cost
    - Parking fee
- Transit
    - Travel time to transit station
    - Travel cost to transit station
    - Parking fee
    - Transit wait time
    - Transit travel time
    - Transit fare
    - Travel time from alighting transit to destination

Table II.3: Model Bs by Destination

Destination	B
Worcester	1.99
Providence	1.99
Boston	2.00

The gravity exponential, B, was determined empirically by the NCRHP and takes into account the population of the attraction area and the trip purpose. The travel characteristics may then be

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[8] Sosslau, A. B., Hassam, A. B., Carter, M. M., & Wickstrom, G. V. (1978). *National Cooperative Highway Research Program Report 187: Quick Response Urban Travel Estimation Techniques and Transferable Parameters, User's Guide*. Transportation Research Board, National Research Council: Washington DC.

[9] See, for details, Edwards and Kelcey (Jan 2007) "Woonsocket Commuter Rail Feasibility Study: 2030 Journey to Work Forecasts". Prepared for the City of Woonsocket: Woonsocket, RI.

[10] See, for example, Ben Akiva, M. E. & Lerman, S. R. (1985). *Discrete Choice Analysis: Theory and Application to Travel Demand*. MIT Press: Cambridge, MA.

adjusted to produce different impedances to generate alternative scenarios.[11]

IMPEDANCE INPUT DATA & ASSUMPTIONS

A key element of ridership analysis was developing the data required for calculation of impedances.

Travel Time

Origin Community Centroids - For the purposes of evaluating automobile trip times from study area communities to rail stations and to downtown destinations, the starting point for all trips within a community was assumed to be one central location. Maps depicting residential density were reviewed to establish each community's centroid. Centroid locations were used as the starting point for all trips from that community, except in the case where a proposed rail station and a community's centroid were in close proximity. For instance, in Woonsocket, although the geographical centroid of all residences is in downtown, it would be unreasonable to expect the average access times from all household to the rail station to be very short based on the fact that the rail station is also located downtown. In these cases, a location that was of "average distance" from residences to the proposed rail station was used as the starting point for transit access trips.

Table II.4: Rail Stations Accessed by Origin Community

Origin Community	Nearest Rail Station for Travel to		
	Worcester	Providence	Boston
Attleboro	Albion	Millbury	
Auburn			
Barrington	Providence		
Bellingham	Uxbridge	Woonsocket	
Blackstone	Blackstone	Blackstone	Woonsocket
Boylston		Worcester	
Burrillville	Millville		Manville
Central Falls	Pawtucket	Pawtucket	
Cranston	Providence		
Cumberland	Manville	Berkeley	
Douglas	Whitinsville	Uxbridge	Woonsocket
East Providence	Providence		
Foxborough	Northbridge		
Franklin	Whitinsville	Woonsocket	
Glocester	Millville	Saundersville	Berkeley
Grafton	Saundersville		
Holden		Worcester	
Holliston	Whitinsville		
Hopedale	Whitinsville	Uxbridge	
Hopkinton		Northbridge	
Johnston	Providence		
Table II.4 cont'd: Rail Stations Accessed by Origin Community			

[11] This model is not constrained by the number of parking spaces available for transit park and ride services.

Origin Community	Nearest Rail Station for Travel to		
	Worcester	Providence	Boston
Leicester		Worcester	
Lincoln	Albion	Berkeley	
Medfield			
Medway	Northbridge		
Mendon	Whitinsville	Uxbridge	
Milford	Whitinsville	Whitinsville	
Millbury	Millbury	Millbury	
Millis			
Millville	Millville	Millville	Woonsocket
Norfolk	Whitinsville		
North Attleboro	Albion		
North Providence	Pawtucket		
North Smithfield	Millville	Manville	Manville
Northbridge	Northbridge	Northbridge	
Oxford		Northbridge	
Pawtucket	Pawtucket	Pawtucket	
Paxton		Worcester	
Plainville	Woonsocket		
Providence	Providence		
Rehoboth	Providence		
Seekonk	Pawtucket		
Shrewsbury		Saundersville	
Smithfield	Albion	Berkeley	
Sutton	Millbury	Saundersville	
Swansea	Providence		
Upton	Northbridge	Northbridge	
Uxbridge	Uxbridge	Uxbridge	
Walpole			
Warwick	Providence		
West Boylston		Worcester	
Westborough			
Woonsocket	Woonsocket	Woonsocket	Woonsocket
Worcester		Worcester	
Wrentham	Uxbridge		

Automobile Travel to Employment Destinations – Once the origin locations had been established, automobile travel times were determined, using a traffic routing tool[12] to find the shortest path from study area communities to the three downtown destinations (Boston, Providence, and Worcester). For Boston and Providence, estimates of free-flow travel time were inflated to reflect minutes of delay experienced by commuters traveling during peak periods. For travel to Boston, 25 delay minutes were added to free-flow travel times, for travel to Providence 10 minutes were added. No congestion delay was added for travel to Worcester.

[12] 2007 Google – map data 2007 NAVTEQ, Maplink/Teleatlas

Automobile Travel to Rail Stations – Using approximate locations of proposed rail stations (see Table II.5)[13], rail access times from each origin community were determined based on a manual assignment process. Selection of the rail station accessed by a given community depended on two factors (1) the access movement was in the same general direction as the commute, and (2) the rail station was reasonably close to the originating community. A traffic routing tool[14] was employed to determine the travel time between the centroid of the origin community and the rail station accessed.

Transit Transferring and Waiting Time – In order to avoid the penalty of missing a train, commuters must arrive at the train station before their train departs. For this study, the estimated rail wait time was 20% of the forecast automobile travel time to the origin station plus a constant of five minutes. Additionally, five minutes of transfer time was included in the travel time for journeys that entailed a transfer between transit routes. In impedance calculations, waiting and transfer times were weighted by a factor of two to account for the inconvenience perceived by commuters.

Rail Travel to Downtown Terminal – Assumed commercial velocities and rail mileage between stations were used to estimate the duration of line haul travel between origin stations and the downtown terminals in Boston, Providence or Worcester. Commercial velocities of 25 and 35 mph represent a range of potential services, with the 35 mph velocity associated with a higher quality service. For Boston routings, current MBTA schedules were utilized to estimate travel times on existing services. The Woonsocket services to Boston were assumed to be an extension of MBTA services currently terminating in Forge Park.

Travel to Employment Destinations from Downtown Terminals – Destination access time from the downtown stations in Boston, Providence, and Worcester was included in travel time estimates for rail trips. Table II.5 lists the destination access travel times input into the model for each downtown destination. Walking access time is weighted by a factor of three to account for the inconvenience perceived by commuters.

Table II.5: Average Destination Access Times

Destination City	Average Destination Access Time
Boston	16 minutes
Providence	15 minutes
Worcester	15 minutes

Costs

Driving Costs – In order to estimate the cost of driving to rail stations or downtown destinations, a cost per mile driven was selected. The 2007 average cost for driving, according to the U.S. General Service Administration is $0.485/mile[15]. This cost was

[13] Rail station locations within Rhode Island derived from: Rhode Island Department of Transportation (1994). *Rail Corridor Feasibility Study*. Prepared for the State of Rhode Island.
[14] 2007 Google – map data 2007 NAVTEQ, Maplink/Teleatlas
[15] US General Services Administration (2007). *Privately Owned Vehicle (POV) Mileage Reimbursement Rates*. Retrieved January 24, 2007 from http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentId=9646&contentType=GSA_BASIC

applied to both the transit access leg for the rail mode, and the entire trip for the private auto mode.

Parking Costs – Daily parking costs for a regular commuter were estimated for both the automobile and rail modes.

A survey of parking garages in each of the three downtown destinations revealed average daily parking rates as shown in Table II.6. However, previous work has shown that commuters working in cities comparable to Worcester and Providence enjoy free or company-subsidized employee parking with only 27% of automobile commuters paying out-of-pocket for parking. This finding was taken into account when determining the average cost of parking for commuters driving to Providence and Worcester.

Table II.6: Average Parking Rates by Destination

Destination City	Average Parking Rate
Boston	$10.00
Providence	$7.14
Worcester	$4.37

Consistent with policy elsewhere in the MBTA network, it was assumed that the daily parking rate at commuter rail stations would be $2.00. For both Park-and-Ride and Downtown parking rates, half of the average daily costs of parking was attributed to each direction of a commute.

Rail Fares – Using the MBTA's zonal fare structure, fare zones were estimated for each origin station and destination pair as shown in Table II.7. Current fares for the associated zones were used to represent the cost of rail trips.

Table II.7: Station Locations and Fare Zones

Station Name	Station Address	Fare Zone to Providence	Fare Zone to Worcester	Fare Zone to Boston
Providence	100 Gaspee St, Providence, RI 02903	NA	8	NA
Pawtucket	Broad St & Clay St, Central Falls, RI	1A	8	NA
Berkeley	Martin St & Mendon Rd, Cumberland, RI	1	7	NA
Albion	School St & Main St, Lincoln, RI	1	7	NA
Manville	Main St Manville & Railroad St, Manville, RI	2	6	NA
Woonsocket	Main St & Railroad St, Woonsocket, RI	3	6	7
Blackstone	Main St & Church St, Blackstone, MA	3	5	NA
Millville	Main St & Central St, Millville, MA	4	5	NA
Uxbridge	S Main St & Mendon St, Uxbridge, MA	5	4	NA
Whitinsville	N Main St & E Hartford Ave, Uxbridge, MA	6	3	NA
Northbridge	Sutton St & Railroad St, Northbridge, MA	6	3	NA
Saundersville	Elmwood St & Pleasant St, Grafton, MA	7	1	NA
Millbury	Elm St & Worcester Providence Tpk, Millbury MA	8	1A	NA
Worcester	75 Madison St, Worcester, MA	8	NA	NA

Determining Employee Value-of-Time – For the NCHRP model, each parameter included in a mode's impedance must be expressed in terms of minutes of travel. All costs were converted to travel minutes using a value-of-time conversion factor. The value of an individual's "nonworking" time assumed in the model is equal to one-third of the value associated with an equivalent amount of working time. According to Report 187, the value of working time is estimated based on the median household income and a 2,000 hour work year, so that:

Cost in minutes = Cost ($) / (1/3 * (Median Household Income ($) / 120,000))

Median household incomes for each community in the study area were obtained from 2000 Census data

Once all of the impedance data was compiled, automobile and transit impedances were input into the mode-choice model. For each market, the model predicted the portion of all commuters that would utilize the proposed rail service. These market shares were then applied to forecasts of total work travel from study area communities to either Boston, Providence, or Worcester, to generate base forecasts of ridership.

ADJUSTMENTS

Once the base forecasts were prepared, adjustments were required to develop accurate estimates of travel.

Long Rail Access Journeys

Experience in the Northeast United States shows that only a very small fraction of commuter rail riders are willing to make a long drive of 20+ minutes to start their rail journey in the morning. For these remote commuters, the introduction of commuter rail is generally irrelevant but the NCHRP model tends to predict healthy mode shares for the rail services from these outer communities. To adjust for this tendency to over predict, the study team adjusted the forecasts from the NCHRP logit model to reflect empirical access-time versus ridership distribution findings.[16] Ridership projections were adjusted using a set of factors shown in Table II.8.

Table II8: Access Time Adjustment Factors

Rail Access Time from Origin	Ridership Distribution Adjustment Factor
0-2 minutes	100%
3-7 minutes	59%
8-12 minutes	59%
13-17 minutes	59%
18-22 minutes	37%

[16] KKO and Associates L.L.C. (2005). *KKO Lowell Passenger Survey*. Prepared for the Nashua Regional Planning Commision.

23-27 minutes	32%
28-32 minutes	19%
33-37 minutes	12%
38-42 minutes	10%
42 minutes or more	2%

Accessible Employment in Destination City

Because the forecast transit market share was applied to the total amount of work trips, an adjustment to account for the portion of employment in Providence and Worcester not accessible from the downtown rail stations was necessary. Through communication with Rhode Island Statewide Planning and the Worcester Regional Research Bureau, the study team identified 30% as the portion of all employment in both Worcester and Providence that could be easily accessed from the proposed rail service.

Expanding Work Trips to All Travel

The base forecasting methodology focuses on predicting typical weekday commuter travel. Work trip projections were then expanded to include non-work travel by using data from the most recent systemwide MBTA commuter rail survey[17] which contained a distribution of ridership by trip purpose. The systemwide ratio of total travel to work trips acquired from the MBTA survey was 1.19, meaning work trips make up 83.7% of typical weekday commuter rail travel.

The MBTA Systemwide Passenger Survey also contained statistics on average weekend ridership, as shown in Table II.9. The ratio of weekend to weekday ridership was used to estimate Saturday and Sunday ridership based on the forecast of weekday travel.

Table II.9: MBTA Systemwide Ratio of Weekday to Weekend Commuter Rail Riders

	Systemwide Count	Ratio to Weekday
Weekday	67,663	100%
Saturday	13,222	20%
Sunday	10,095	15%
Total	90,980	

Service Frequency

In addition to faster travel times (35 vs 25 mph), the higher quality service alternative for each route is associated with double the off-peak frequency compared to the medium quality service. More specifically, 24 trains per day would be operated on the medium quality service, while the higher quality alternatives are associated with 42 trains per day.

[17] Central Transportation Planning Staff (1993). *MBTA Systemwide Passenger Survey: Commuter Rail 1993*. Prepared for the Massachusetts Bay Transportation Authority: Boston, MA.

Based on a series of published demand elasticities[18], the ridership forecasts for higher quality alternatives were adjusted upwards. The adjustment is based on the empirical observation that a 50% reduction in the interval between trains generally results in a 20.5% increase in ridership. In this case, only the off-peak ridership was adjusted since only the off-peak frequency is affected.

FORECAST RESULTS

Boston

The forecast ridership figures for the Boston market are presented in Table II.10. Based on the analysis, between 272 and 315 inbound boardings to Boston can be expected on a typical weekday via the proposed routings. The direct routing through Franklin would be expected to attract slightly greater ridership than the routing through Forge Park, whereas the service requiring a transfer at Franklin would attract slightly fewer travelers than the Forge Park routing.

Table II.10: Forecast Daily Inbound Ridership to Boston (2030)

Route	Service Type	Total Weekday	Total Saturday	Total Sunday
via Forge Park	Typical	272	54	41
	Faster	287	57	43
via Transfer at Franklin	Typical	266	53	40
	Faster	283	57	40
via Franklin Direct	Typical	308	62	46
	Faster	315	63	47

Tables II.10a and II.10b display trip characteristics and forecast inbound boardings to Boston by origin community and origin station, respectively. In both Table II.10a, and II.10b, the high quality alternative is represented by the faster, more frequent and direct service via Franklin while the medium alternative is represented by the slower, less frequent service via Forge Park.

Table II.10a: Forecast Weekday Ridership to Boston by Origin Community (2030)

Origin Community	Total Rail Travel Time (minutes)[19]		Total Automobile Travel Time (minutes)	2030 Forecast Weekday Inbound Boardings		2030 Forecast Work Trips
	Min	Max		Max	Min	
Woonsocket	86	102	92	24	20	52
Blackstone	88	103	91	70	60	152
Millville	96	111	92	97	83	200
North Smithfield	97	112	88	12	10	28
Burrillville	113	128	101	29	24	115

[18] Richard H Pratt et al. TDRP Web Document 12 (Project B-12): Traveler Response to Transportation System Changes, Interim Handbook. Chapter 9, page 12, "Individual Commuter Rail Elasticities from the Boston Area Demonstration". Quoted from Lago, Mayworm, and McEnroe (1981).
[19] Rail travel times from Franklin and Forge Park derived from current MBTA schedules.

Douglas	116	132	97	15	13	95
Glocester	120	135	105	68	55	459
Totals				**315**	**266**	**1,101**

Table II.10b: Forecast Weekday Ridership to Boston by Station

Station	Rail Miles		Rail Travel Time (minutes)		2030 Forecast Inbound Boardings	
	Min	Max	Min	Max	Max	Min
Woonsocket	36.7	39.3	62	77	315	266

<u>Providence</u>

Forecast ridership for the Providence market is presented in Table II.11. A range of 899 to 994 inbound boardings to Providence can be expected on a typical weekday. However, a planned expansion of the MBTA's commuter rail network, connecting Boston with Warwick, Rhode Island via Pawtucket/Central Falls and Providence, would provide new indirect service to Boston from some of the communities along the route via a transfer at Pawtucket, potentially increasing the overall forecast ridership.

Table II.11: Forecast Daily Inbound Ridership to Providence (2030)

Service Type	Total Weekday	Total Saturday	Total Sunday
Typical	899	180	135
Faster	994	199	149

Table II.11a: Forecast Weekday Ridership to Providence by Origin Community (2030)

Origin Community	Total Rail Travel Time (minutes)		Total Automobile Travel Time (minutes)	2030 Forecast Weekday Inbound Boardings		2030 Forecast Work Trips
	Min	Max		Max	Min	
Central Falls	33	36	25	80	74	1,050
Pawtucket	35	38	22	366	337	6,121
Lincoln	43	49	22	83	74	2,107
Cumberland	44	50	35	163	147	2,268
Woonsocket	51	62	39	109	97	1,248
Blackstone	51	63	39	15	13	105
Smithfield	52	57	29	77	70	2,639
Millville	55	68	38	3	2	20
North Smithfield	58	66	34	32	29	578
Uxbridge	63	80	44	18	15	116
Bellingham	65	76	46	5	5	58
Mendon	72	88	52	4	3	44
Franklin	73	84	47	6	5	128
Hopedale	75	91	55	2	2	23
Northbridge	77	98	49	2	2	22
Douglas	79	95	49	3	3	38
Milford	83	101	53	5	4	50
Grafton	85	109	59	3	3	31
Upton	85	106	61	0	0	0
Millbury	86	112	52	3	2	17
Sutton	90	114	49	2	1	22
Hopkinton	95	116	55	0	0	8
Auburn	97	123	59	1	1	8
Shrewsbury	97	121	66	0	0	0
Oxford	97	118	59	0	0	0
Worcester	104	134	63	8	6	63
Leicester	111	141	68	1	1	6
Paxton	116	146	80	1	1	15
West Boylston	116	146	75	0	0	6
Holden	118	148	77	2	1	27
Boylston	120	150	75	0	0	0
Totals				**994**	**899**	**16,818**

Table II.11b: Forecast Weekday Ridership to Providence by Station

Station	Rail Miles	Rail Travel Time (minutes)		2030 Forecast Inbound Boardings	
		Min	Max	Max	Min
Pawtucket	4.5	8	11	445	411
Berkeley	8.6	15	21	323	291
Manville	12.2	21	29	32	29
Woonsocket	15.8	27	38	121	107
Blackstone	17.5	30	42	15	13
Millville	19.7	34	47	3	2
Uxbridge	24.3	42	58	27	23
Whitinsville	26.3	45	63	5	4
Northbridge	30.6	52	73	3	2
Saundersville	34.0	58	82	5	4
Millbury	37.3	64	90	4	3
Worcester	43.3	74	104	11	10
Totals				**994**	**899**

Because of the planned service expansion that would connect the Pawtucket/Central Falls station with Boston, additional analysis was completed to estimate the volume of traffic that would travel east on commuter rail to the Pawtucket/Central Falls station where it would transfer to MBTA service to Boston (Tables II.12, II.12a, II.12b). The analysis suggests that approximately 200 travelers would make this journey on each weekday increasing the range of potential weekday riders on the Providence service to between 1095 and 1206. While the number of people willing to make this journey is less than those who would utilize the direct service, the cost of implementation could be much lower.

Table II.12: Forecast Daily Inbound Ridership to Boston via Pawtucket (2030)

Service Type	Total Weekday	Total Saturday	Total Sunday
Typical	196	39	29
Faster	212	42	32

Table II.12a: Forecast Weekday Ridership to Boston (via Pawtucket) by Origin Community (2030)

Origin Community	Total Rail Travel Time (minutes)		Total Automobile Travel Time (minutes)	2030 Weekday Inbound Rail Passenger Trips		2030 Forecast Work Trips
	Min	Max		Max	Min	
Woonsocket	124	134	92	19	17	52
North Smithfield	124	129	88	9	8	28
Blackstone	125	135	91	56	51	152
Millville	133	144	92	74	68	200

Burrillville	138	144	101	20	18	115

Table II.12a cont'd: Forecast Weekday Ridership to Boston (via Pawtucket) by Origin Community (2030)

Origin Community	Total Rail Travel Time (minutes)		Total Automobile Travel Time (minutes)	2030 Weekday Inbound Rail Passenger Trips		2030 Forecast Work Trips
	Min	Max		Max	Min	
Glocester	141	143	105	25	24	459
Douglas	154	164	97	10	9	95
Totals				**212**	**196**	**1,101**

Table II.12b: Forecast Weekday Ridership to Boston (via Pawtucket) by Station

Station	Rail Miles	Rail Travel Time (minutes)		2030 Forecast Inbound Boardings	
		Min	Max	Max	Min
Berkeley	43.2	80	83	25	24
Manville	46.8	86	91	28	27
Woonsocket	50.4	99	109	158	145
Totals				**212**	**196**

<u>Worcester</u>

The forecast ridership figures for the Worcester market are presented in Table II.13. Based on the analysis, between 546 and 624 inbound boardings to Worcester can be expected on a typical weekday.

Table II.13: Forecast Daily Inbound Ridership to Worcester (2030)

Service Type	Total Weekday	Total Saturday	Total Sunday
Typical	546	109	82
Faster	624	125	94

Table II.13a: Forecast Weekday Ridership to Worcester by Origin Community (2030)

Origin Community	Total Rail Travel Time (minutes)		Total Automobile Travel Time (minutes)	2030 Weekday Inbound Boardings		2030 Forecast Work Trips
	Min	Max		Max	Min	
Millbury	33	37	16	134	119	2,083
Sutton	37	42	22	70	63	1,523
Grafton	43	50	24	73	64	1,994
Northbridge	47	55	27	52	45	943
Uxbridge	54	67	31	57	48	490
Upton	55	64	34	13	11	268

Millville	62	78	35	7	6	55
Table II.13a cont'd: Forecast Weekday Ridership to Worcester by Origin Community (2030)						
	Total Rail Travel Time (minutes)		Total Automobile Travel Time (minutes)	2030 Weekday Inbound Boardings		2030 Forecast Work Trips
Origin Community	Min	Max		Max	Min	
Mendon	62	74	39	11	10	159
Douglas	64	75	32	39	34	611
Blackstone	65	83	38	18	15	122
Hopedale	66	78	43	10	8	154
Milford	70	81	40	41	36	517
Woonsocket	71	90	42	19	16	171
North Smithfield	71	87	36	7	6	88
Bellingham	75	88	41	4	3	82
Burrillville	80	96	44	6	5	81
Cumberland	82	103	48	7	6	74
Lincoln	84	107	37	5	4	51
Medway	85	94	46	1	1	112
Holliston	86	98	47	2	1	84
Central Falls	88	114	56	0	0	0
Glocester	88	104	44	2	1	38
Pawtucket	88	115	58	6	5	25
Franklin	89	100	44	1	1	99
Wrentham	90	103	49	1	1	35
North Attleboro	93	115	53	3	2	29
Foxborough	96	104	55	0	0	8
Smithfield	96	119	45	1	1	10
Attleboro	96	119	57	4	4	43
Norfolk	97	109	51	0	0	22
Plainville	99	118	50	1	1	30
Providence	100	130	54	11	10	83
Johnston	106	136	55	2	2	22
East Providence	107	137	59	2	2	17
North Providence	108	135	58	2	1	25
Seekonk	108	135	61	3	2	43
Cranston	109	138	59	6	5	50
Rehoboth	118	148	69	1	1	13
Swansea	119	149	70	1	0	9
Barrington	122	152	71	0	0	3
Warwick	123	153	76	4	4	64
Totals				**624**	**546**	**10,330**

Table II.13b: Forecast Weekday Ridership to Worcester by Station

Station	Rail Miles	Rail Travel Time (minutes)		2030 Weekday Inbound Rail Passenger Trips	
		Min	Max	Max	Min
Millbury	6.0	10	14	204	182
Saundersville	9.3	16	22	73	64
Northbridge	12.7	22	30	66	57
Whitinsville	17.0	29	41	104	91
Uxbridge	19.0	33	46	61	51
Millville	23.6	40	57	22	18
Blackstone	25.8	44	62	18	15
Woonsocket	27.5	47	66	20	17
Manville	31.1	53	75	7	6
Albion	32.6	56	78	12	11
Pawtucket	38.8	67	93	10	9
Providence	43.3	74	104	26	23
Totals				**624**	**546**

ADDITIONAL FORECASTS

After review of the original forecasts with the Project Advisory Committee, the study team evaluated two additional service options to Boston: (1) feeder bus service between Woonsocket station and the Franklin MBTA station (2) rail shuttle service between Woonsocket station and the Franklin MBTA station via the P&W mainline to Blackstone. Using the same forecasting methodology[20], ridership forecasts were prepared for the two additional commuter service options.

Table II.14: Summary of Additional Service Options Evaluated

Service Regime	Description	Transit Travel Time from Woonsocket Station (min)		Forecast Total Weekday Inbound Boardings	
		Min	Max	Max	Min
B5: Feeder Bus	Service from Woonsocket to Boston via a rubber wheeled connection to Franklin where passengers would transfer to existing MBTA trains	81		273[21]	
B6: Via Blackstone	Service from Woonsocket to Boston via the P&W mainline to Blackstone and the Boston & Willimantic (B&W) line to Franklin, passengers would transfer to existing MBTA trains at Franklin	73	81	280	262

For comparative purposes, summaries of the service options previously evaluated are presented in Table II.15.

[20] For detailed information refer to Edwards & Kelcey (January 2007) "Woonsocket Commuter Rail Feasibility Study Task 2: Ridership Forecasts" prepared for the City of Woonsocket

[21] EK believes this modelled forecast is high and that actual service will not perform as well as forecast by the NCHRP tool. For more information see caveat on Page 5.

Table II.15: Summary of Service Options Previously Evaluated

Service Regime	Description	Rail Travel Time from Woonsocket Station (minutes)		Forecast Total Weekday Inbound Boardings	
		Min	Max	Max	Min
B1: Forge Park Extension	Extends existing MBTA Forge Park service to Woonsocket	72	76	287	272
B2: Franklin Transfer	Woonsocket passengers would transfer to existing MBTA trains at Franklin	71	77	283	266
B3: Franklin Direct	New semi-express service from Woonsocket to Boston via Franklin	62	68	315	308
B4: Pawtucket Transfer	Woonsocket passengers would transfer to existing MBTA Boston Trains at Pawtucket (offered in conjunction with service to Providence)	99	109	212	196
B5: Feeder Bus	Service from Woonsocket to Boston via a rubber wheeled connection to Franklin where passengers would transfer to existing MBTA trains	81		273	
B6: Via Blackstone	Service from Woonsocket to Boston via the P&W mainline to Blackstone and the former Boston & Willimantic (B&W) line to Franklin, passengers would transfer to existing MBTA trains at Franklin	73	81	280	262
P1: Providence Service	Service from Worcester to Providence via existing PWRR route	27	38	994	899
W1: Worcester Service	Service to Worcester from Providence via existing PWRR route	47	66	624	546

The range of total forecast weekday inbound boardings, for all service options evaluated, is illustrated in Figure II.4a. The results of the additional forecasting work, for options B5 and B6, are outlined in red. With forecast ridership ranging from 262 to 280, options B5 and B6 are expected to attract volumes of commuters within the range of the potential ridership forecast for the initial service options to Boston (B1 through B4).

Figure II.4b depicts forecast weekday boardings by travelers using Woonsocket station. The initial forecasts revealed that the Boston services are expected to attract the greatest ridership to Woonsocket Station with as many as 300 boardings there. The additional service options to Boston, outlined in red in Figure A2, also follow this pattern with between 262 and 280 commuters expected to board at Woonsocket station.

Figure II.4a: Total Forecast Weekday Boardings

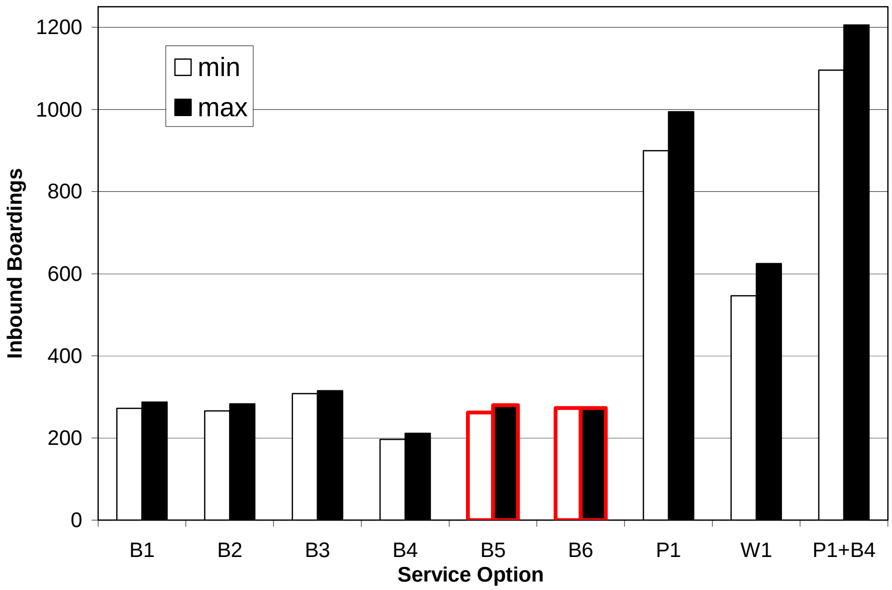
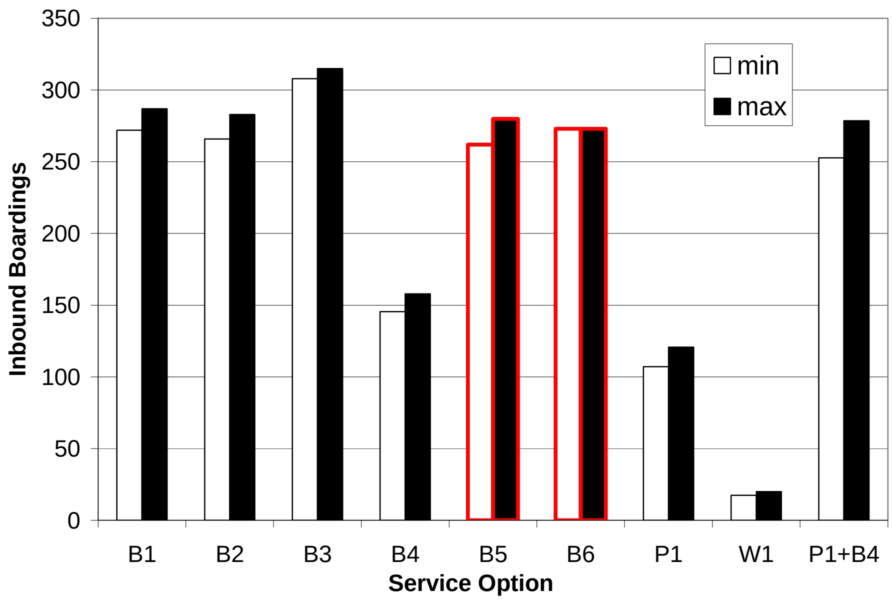


Figure II.4b: Forecast Weekday Boardings at Woonsocket



<u>Boston via Feeder Bus</u>

In order to estimate the potential ridership for service options involving lower capital cost, feeder bus service between Woonsocket and Franklin was evaluated. The feeder bus alternative was assumed to operate closed door service between Woonsocket and Franklin providing timed transfers and express service to MBTA commuter trains to Boston. Traffic routing tools were utilized to find the shortest path between Woonsocket and Franklin stations, the selected route is illustrated in Figure II.5.

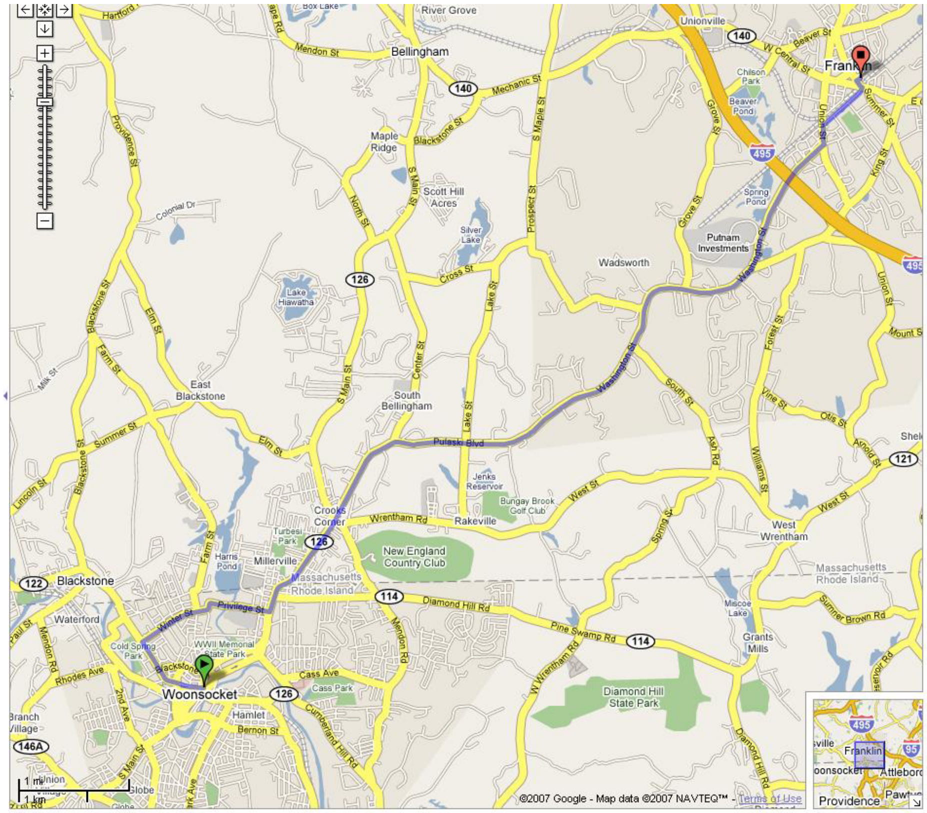


Figure II.5: Feeder Bus Route

The forecast ridership figures are presented in Table II.1. Based on the analysis, 273 inbound boardings to Boston can be expected on a typical weekday on the “rubber tired” connection to Franklin. Because the feeder bus service was assumed to meet all Franklin MBTA trains currently operated, the frequency of bus service was tied to the frequency of Franklin service. Therefore, only one level of service was considered in forecasts of feeder bus ridership.

Table II.16: Forecast Daily Inbound Ridership to Boston via Feeder Bus (2030)

Total Weekday	Total Saturday	Total Sunday
273	55	41

Table II.1a displays trip characteristics and forecast inbound boardings by origin community; all passengers were assumed to board in Woonsocket. Travel time between an origin community’s centroid and destinations in Boston, via feeder bus service to MBTA commuter trains at Franklin, were estimated to range from 106 to 139 minutes.

The forecast ridership figures are presented in Table II.2. Based on the analysis, 273 inbound boardings to Boston can be expected on a typical weekday on the rubber wheeled connection to Franklin.

Table II.16a: Forecast Weekday Ridership to Boston by Origin Community (2030)

Origin Community	Total Transit Travel Time (minutes)[22]	Total Automobile Travel Time (minutes)	2030 Forecast Weekday Inbound Boardings	2030 Forecast Work Trips
Woonsocket	106	92	21	52
Blackstone	107	91	61	152
Millville	107	92	87	200
North Smithfield	116	88	10	28
Burrillville	132	101	25	115
Douglas	136	97	14	95
Glocester	139	105	53	459
Totals			**273**	**1,101**

Caveat: It is JEK's opinion that the forecasting model over predicts ridership response to this feeder bus service option. Actual performance of bus to commuter rail feeder service is generally less attractive than direct services or rail to rail transfers. Actual ridership of the feeder bus would be unlikely to be as high as predicted by this forecasting tool. In the event that Woonsocket is interested in developing a feeder bus service, JEK recommends that it be implemented on a trial basis to evaluate actual ridership potential.

<u>Boston via P&W North</u>

Due to the number of challenges associated with rail service to Boston via the routes originally studied, a new rail route was evaluated. Trains on this rail service would travel the P&W mainline north to Blackstone and turn east onto the historic B&W alignment which becomes the Franklin Branch. At Franklin passengers would transfer to existing MBTA service for travel to Boston. Two levels of service were considered:

- -Fast, frequent service: 42 trains per day averaging 35 mph from Woonsocket to Boston
- -More typical service: 24 trains per day averaging 25 mph from Woonsocket to Boston

Figure II.6: Boston via P&W North Route

[22] Total travel times include automobile access to station, transfer/wait times, and egress time; rail travel times from Franklin derived from current MBTA schedules.

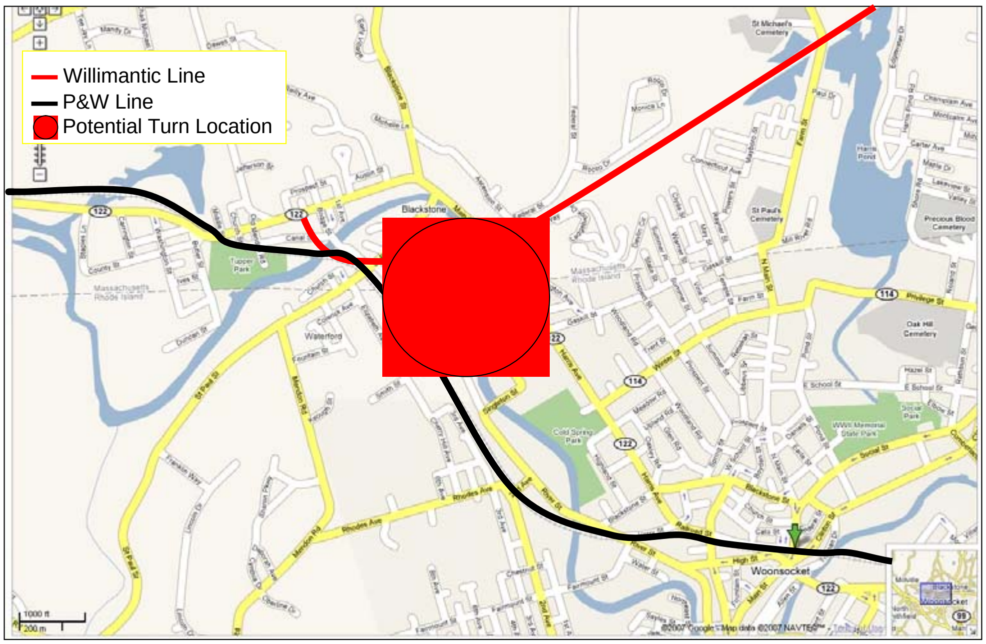


Table II.17: Forecast Daily Inbound Ridership to Boston via P&W North (2030)

Service Type	Total Weekday	Total Saturday	Total Sunday
Typical	262	52	39
Faster	280	56	42

Table II.2a displays trip characteristics and forecast inbound boardings by origin community, where all passengers were assumed to board in Woonsocket. Travel times between an origin community's centroid and destinations in Boston, via passenger rail service to MBTA commuter trains at Franklin, were estimated to range from 105 to 139 minutes.

The potential to reduce transit access time, and in turn increase ridership, exists under this option's alignment. If a convenient station location is established in Blackstone, commuters from Blackstone, Millville and Douglas may find the service more attractive. Additional station stops, however, would increase travel times for passengers boarding at Woonsocket. Further analysis would be necessary to evaluate the benefits and challenges associated with a Blackstone station.

Table II.17a: Forecast Weekday Ridership to Providence by Origin Community (2030)

Origin Community	Total Rail Travel Time (minutes)		Total Automobile Travel Time (minutes)	2030 Forecast Weekday Inbound Boardings		2030 Forecast Work Trips
	Min	Max		Max	Min	
Woonsocket	105	98	92	21	20	52
Blackstone	99	106	91	64	59	152
Millville	108	115	92	87	82	200
North Smithfield	109	116	88	11	10	28
Burrillville	124	132	101	25	24	115
Douglas	128	135	97	14	13	95
Glocester	132	139	105	58	54	459
Totals				**280**	**262**	**1,101**

INDUCED DEMAND

The methodology for estimating future travel patterns included expanding journey-to-work data (taken from the most recent census in 2000), using 2030 population and employment projections provided by MPOs, to synthesize forecasts of travel among the study area communities in the year 2030[23]. Because the methodology employed did not take into account the range of potential travel demand induced through the introduction of new passenger rail service, the study team evaluated the effects of new commuter rail service on commuter flows in the region.

Methodology

In order to estimate the range of potential induced demand, commuter travel into Boston was analyzed. Using journey-to-work data from 1980 and 2000, the study team compared the growth in total employed residents and in work travel to Boston for two groups:

(1) Communities within Eastern Massachusetts that did not have rail service into Boston in 1980 or 2000, and
(2) Communities within Eastern Massachusetts that did not have rail service into Boston in 1980 but did in 2000.

Findings

With available US Census data for the Greater Boston Area the team was unable to demonstrate any significant relationship between the introduction of commuter rail and the overall growth in the number of employed residents in the typical community.

However, the team did find a statistically significant relationship that indicates the introduction of commuter rail into a community shifts the fraction of overall employed residents working in Boston upwards by an average of 1.4 percentage points.

[23] For detailed information refer to Edwards & Kelcey (January 2007) "Woonsocket Commuter Rail Feasibility Study Task 2: Ridership Forecasts" prepared for the City of Woonsocket

The statistical equation predicting the change in Boston oriented employment due to the introduction of commuter rail service is shown below. All model coefficients are statistically significant at the 95% confidence level.

$$BOS\%_{00} = 1.9 + (0.8*BOS\%_{80}) + (1.4*CR)$$

Where:
$BOS\%_{00}$ = Percent of total employed residents working in Boston in 2000
$BOS\%_{80}$ = Percent of total employed residents working in Boston in 1980
CR = 1, if commuter rail was introduced into the community between 1980 and 2000
0, if no commuter rail service was offered in either year.

BUILD OUT POTENTIAL

Because Woonsocket was forecast to decrease in population by the year 2030, the study team evaluated the potential demand for service given a more optimistic forecast of the future population. This alternative forecast assumed that market conditions would be such that all likely and potential housing development projects identified by the Woonsocket City Planning Office would be built and inhabited within the next 22 years.

Table II.18: Woonsocket Build Out Potential[24]

Project	No. of units	Status
Mill Conversions		
Riverfront Lofts	140	Likely
Bernon Mills	48	Likely
Hamlet Avenue	250	Potential
Singleton Street	200	Potential
Alice Mill	140	Potential
Middle School	50	Potential
River View furniture	50	Potential
Bonin Mill	48	Potential
Island Place	40	Potential
Mason Street Warehouse	30	Potential
Railroad Street	18	Potential
Privilege Street	12	Potential
Longley Building	12	Potential
Notheast Street	10	Potential
Mill Conversion Subtotal	**1,048**	
Subdivisions		
Oak Grove	80	Master plan and Phase I approvals
Broadway	24	Pending
Hamlet Heights	15	Master plan approval
Holley Springs	90	Potential
Cottage and Merrill	11	Master plan approval
Subdvisions Subtotal	**220**	
Total	**1,268**	

[24] Build out numbers received from Catherine Ady, Woonsocket City Planner on April 12, 2007.

To calculate an upper bound on any increase in ridership (for Boston services) that would result from increased Woonsocket development, it was assumed that one Boston commuter would reside in half of the new households and that 25% of these Boston commuters would utilize transit for their journey to work.[25]

Table II.19: Maximum Possible Increase in Ridership to Boston from a Full Build Out of Potential Housing Sites

No. of New Units	Max Increase in Boston Commuters	Max Increase in Boston Transit Commuters
1268	634	159

Under these very optimistic assumptions, the increase in Boston transit commuters due to increases in Woonsocket housing would be no more than 160 people. This would constitute a 50% to 75% increase in forecast potential ridership above the base Boston ridership forecasts presented for packages B1, B2, B3, B4, B5 and B6. This upper bound should not be interpreted as the result of a formal projection. The study team believes that a more formal projection would forecast a much smaller increase in ridership to Boston than the upper bound presented here.

Table II.20: Estimated Maximum Upperbound Potential Growth in 2030 Boston Ridership due to Housing Build Out

Package	Max Base Forecast	Estimated Maximum Potential Growth	% Increase Above Max Base Forecast
B1	287	159	55%
B2	283	159	56%
B3	315	159	50%
B4	212	159	75%
B5	273	159	59%
B6	280	159	57%

[25] The study team does not believe these assumptions to be reasonable forecasts of future conditions, but a representation of the best possible outcome in terms of transit ridership.

III. Opportunities & Constraints

Jacobs, Edwards and Kelcey (JEK) and the City of Woonsocket have been studying the feasibility of restoring passenger rail service from Woonsocket to Boston, Providence, and Worcester. Because the implementation of new regional passenger rail service to Boston, Providence, or Worcester would face challenges and opportunities specific to the selected route and destination, JEK has identified and evaluated the constraints and opportunities associated with each potential route. This section describes the various routes, and presents an evaluation of the feasible routes in terms of expected development and operating costs and forecast benefits.

PART I: IDENTIFICATION

Although six rail alignment and service combinations were identified as possible routes for passenger rail service to and from Woonsocket, only four are considered in detail. The examined routes include three between Woonsocket and Boston and one to Providence with intermediate station stops along the rail corridor in Rhode Island.

1. <u>Woonsocket to Boston (direct service)</u> via the abandoned Boston & Willimantic and the Boston & Pascoag lines to Franklin station on the MBTA's Franklin branch.
2. <u>Woonsocket to Boston (connecting service)</u> via the abandoned Boston & Willimantic and Boston & Pascoag lines to Franklin station on the MBTA's Franklin branch.
3. <u>Woonsocket to Boston (connecting service)</u> via the Providence and Worcester freight line and the abandoned Boston & Willimantic line to Franklin station on the MBTA's Franklin branch.
4. <u>Woonsocket to Providence</u> via the Providence and Worcester freight route to Providence using its Mainline to Pawtucket and Track 7 of Amtrak's Northeast Corridor from Pawtucket to Providence.

Alternatives screening based on ridership forecasts and preliminary route analysis led the study team to categorize two alignments as infeasible. The two eliminated routes connected:

5. <u>Woonsocket to Worcester</u> via the Providence & Worcester freight line[26], and
6. <u>Woonsocket to Boston</u> via the abandoned Boston & Pascoag line to the Forge Park terminus of the MBTA's Franklin Branch[27].

[26] Due to low projected benefits to Rhode Island and City of Woonsocket
[27] Due to right-of-way availability and encroachment.

Each of the four passenger rail routes is made up of sections of at least two rail lines. Across all proposed routes, sections considered for restoration or upgrade involved segments of four railroad lines (see Figure III.1).

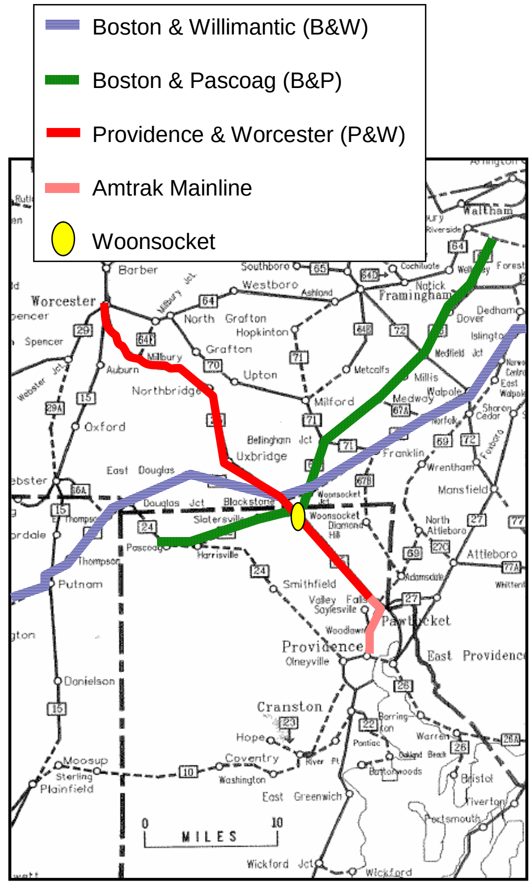


Figure III.1: Rail Lines included in Proposed Routes to/from Woonsocket

1. Boston & Willimantic: The Boston and Willimantic (B&W) began in 1849 as a railroad between Dedham and Blackstone, passing through Franklin and Woonsocket Junction. In 1855 new owners reorganized the route to provide better access to Boston and through service from Boston to New York. By 1909 service to the Woonsocket Junction station had been discontinued with trains stopping in Blackstone, 1.7 miles west of Woonsocket Junction. In 1926, 22 trains on this line were traveling between Boston and Franklin, each weekday. Every weekday, about half of these trains would make the longer trip between Boston and New York, stopping in Blackstone along the way. The line was eventually shortened to Hartford, Connecticut but continued to service Blackstone. In 1955, the route was shortened again to Blackstone after a hurricane damaged track in Connecticut. Passenger service between Boston and Blackstone continued until the late 1960s when the route was cut-back to Franklin after a flood destroyed the bridge crossing the Blackstone River near the Massachusetts Rhode Island border. The track West of Franklin was abandoned three years later.

2. Boston and Pascoag: In 1863, a railroad originating in Boston and serving Brookline, Needham, and Medway was extended to reach Woonsocket. In 1889, the line was extended again to Pascoag, Rhode Island where it connected to the Providence & Springfield RR. By 1909, 16 trains ran between Boston and the Woonsocket River Street station[28] on the Boston and Pascoag (B&P) line, each weekday. All 16 trains also stopped in Bellingham Junction, and 2 stopped in Woonsocket Junction. Service on this line declined in the 1920's and passenger service to Woonsocket ended in 1926. When service to Woonsocket ended approximately 12 trains were running to the city each weekday, stopping also in Bellingham Junction and East Blackstone. The tracks between Bellingham Junction and Woonsocket were removed in 1935 and by 1967 all tracks on the Boston and Pascoag line West of Millis had been removed. The B&P line in

[28] As opposed to Woonsocket Main Street station.

Woonsocket is currently owned by the Providence & Worcester Railroad for freight operations and is known as the Slatersville Secondary.

3. Providence & Worcester: Construction of the Providence and Worcester (P&W) Railroad began in 1846 mostly within the right-of-way of the Blackstone Canal which connected the cities of Providence and Worcester. When the rail line opened in 1847, the railroad also obtained rights to the five miles of track between downtown Providence and Boston Switch in Valley Falls, Rhode Island. In 1848, a train station was built in downtown Providence allowing for passenger service between Worcester and Providence. By 1909, 18 trains stopped at Woonsocket Main Street as well as 11 other stations between the two cities, each weekday. By 1926, seven stations had been added on the line between Providence and Woonsocket, however service began to decline by the 1930s until the last passenger train was operated in 1960. The P&W railroad continues to provide freight service on their Mainline between Worcester and Boston Switch in Valley Falls. The five miles of track between Boston Switch and Providence station are now part of Amtrak's Northeast Corridor (NEC). The P&W provides freight service on Amtrak's NEC south to Kingston under a trackage rights agreement between Amtrak and the P&W.

4. Amtrak Freight Track: The P&W Mainline terminates at the Boston Switch in Valley Falls, however, the freight route continues south into Providence on Amtrak's Track 7 (also known as the Freight Railroad Improvement Project, or FRIP, south of Providence). Track 7 is one of three tracks on Amtrak's Mainline in this area. Track 7 is not presently used by passenger trains.

Routes to Boston

The physical, operating, institutional and service design issues related to restoration of service on the three potential routes to Boston are presented in this section.

According to historical records, two stations were used to provide passenger rail service to Woonsocket. The existing historic P&W station building is located at Main Street and Railroad Street in downtown Woonsocket along the P&W Mainline. The second site, the B&P's River Street Station, which served trains on the B&P line is no longer extant.

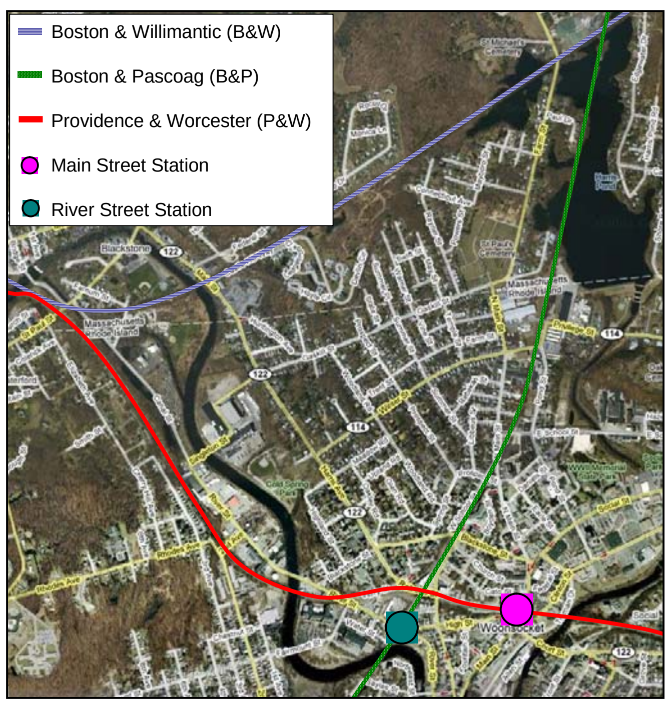


Figure III.2: Historic Woonsocket Stations

<u>Alternative 1: B&P to B&W to Franklin – Direct Service</u>

The most direct (8-mile) route between Woonsocket and Boston would restore the former B&W line, between Franklin Junction and Woonsocket Junction, a distance of approximately 6 miles. Additionally, a portion of the former B& P line would be restored from Woonsocket Junction to downtown Woonsocket, a distance of 1.8 miles.

Right-Of-Way Availability

Although the alignment between Woonsocket and Boston as it exists today is mostly free of encroachment, the right-of way has fallen into an obvious state of disrepair after decades on disuse.

The majority of the B&W Line, between Woonsocket and Franklin, is owned by the Massachusetts Department of Conservation and Recreation and is used as a trail. A representative of the Massachusetts DCR has established that the agency would not support restoration of the right-of-way for active rail service. Within the DCR's rail trail, a section of the alignment (on the B&W Line in South Bellingham), is under private ownership. This section is over one mile long. Furthermore, the P&W railroad is currently pursuing a petition to abandon a section of the alignment, on the B&P Line in Woonsocket, with the intention of selling the parcel for private development.

Figure III.3: ROW embankment across Harris Pond

Perhaps the largest deterrent to restoration of this alignment is that portions of the right-of-way through Harris Pond in Blackstone, Massachusetts no longer exist. The pond is owned by the City of Woonsocket and is a tertiary water supply for the city. The B& P originally ran on an embankment across Harris Pond; however, large sections of the embankment have been eroded away so that restoration of this route would require construction of at least 250 feet of embankment through the pond (see Figure III.3). A connection between the B&P and the B&W that meet at an obtuse angle would also be necessary. The B&P is approximately 25 feet below the B&W. The two rail lines were historically grade separated, meaning no connection between the B&P and B&W existed previously.

Figure III.4: B&P R/W adjacent to Woonsocket homes

The environmental concerns associated with restoring and operating a railway across a public water supply would be manifold. Review and approval from the Massachusetts Environmental Protection Agency (MEPA), the local Conservation Commission and possibly the Massachusetts

Department of Environmental Protection (DEP) would be required.[29]

The study team also noted a potential impact of restoring the B&P line across Prospect Street in Woonsocket. Two homes stand immediately adjacent to the right-of-way. The right-of-way between the two private homes is used as a driveway (Figure III.4). These houses might be affected if rail service was restored on this line south of Prospect Street.

At Franklin, trains would continue north on to the MBTA Franklin Branch for access to Boston. This rail line is currently maintained for passenger rail service with 31 passenger trains each weekday between Franklin and Boston.

Infrastructure

Track & Signals – Eight miles of new single track with passing sidings and signal systems would be installed on this alignment between Woonsocket and Franklin. Class 3 track and a centralized train control (CTC) signal system would support passenger operations.

Stations – There remains no visual evidence of the River Street Station in Woonsocket which historically served the B&P Line. A new station along the B&P line would be required to allow Woonsocket commuters access to this route to Boston. It has been suggested that a new station in Woonsocket would be located along Winter Street, on an underutilized industrial parcel, immediately south of Harris Pond. As the alignment between Franklin and Boston is already served by commuter service, there are 14 active stations on this portion of the alignment. It is assumed, however, that direct commuter service from Woonsocket would not serve every station between Franklin and Boston.

Parking - Based on forecast daily boardings at Woonsocket of 308 passengers and allowing one parking space for every two forecast passengers, a total of 154 parking spaces would be necessary in Woonsocket to accommodate passengers.

Other Facilities - A new commuter rail layover yard and maintenance facility for MBTA trains would be required in or near Woonsocket.

Institutional Issues

Because the Boston terminal, South Station, is currently operating near capacity, Woonsocket services would be competing with future MBTA service expansions for an allowance of sparsely available platform time. Furthermore, operation of additional trains on the Franklin Branch would increase the complexity of MBTA operations on that line. For these reasons, the MBTA may associate additional trains into South Station via the Franklin Branch with an increase in administrative effort and a decrease in available network capacity.

Challenges

[29] Although Harris Pond is owned by the city of Woonsocket, environmental permitting would be conducted by the state of Massachusetts since the majority of Harris Pond is located in Blackstone, Massachusetts.

Development of a passenger rail service to Boston via this route would require the State of Rhode Island and the City of Woonsocket to surmount the following challenges:

- Massachusetts Department of Conservation and Recreation opposition
- Harris Pond crossing
- Privately owned right-of-way parcels in Woonsocket and South Bellingham
- Proposed abandonment and sale of critical portions of the abandoned B&P in Woonsocket
- Significant structural challenges required by B&P to B&W connection
- Development of a new passenger station in Woonsocket
- MBTA capacity on Franklin Branch
- MBTA capacity at South Station

<u>Alternative 2: B&P to B&W to Franklin – Connecting Service</u>
The second alternative for service to Boston would utilize the same alignment as the first to Franklin station; that being the B&P from Woonsocket to Woonsocket Junction and the B&W to Franklin. Under the second alternative, trains would turn at Franklin where Boston bound commuters would be provided with a convenient transfer to existing MBTA service to South Station.

As the alignment is unchanged from the first alternative most of the right-of-way and infrastructure challenges are also unchanged, including the Harris Pond crossing and the DCR opposition to rail restoration. However, Woonsocket trains terminating in Franklin would not present the same institutional challenges to the MBTA as the direct service since it is assumed that no additional trains would operate on the Franklin Branch or platform in South Station.

Parking – Because this alternative provides a less direct service than Alternative 1, only 266 weekday inbound boardings were forecast, as compared to 308 for Alternative 1. Under Alternative 2, 133 parking spaces would be required in Woonsocket.

Other Facilities - A layover yard and maintenance facility for the rolling stock used to provide the connecting service would be required.

Challenges
Development of a passenger rail service to Boston via this route would require the State of Rhode Island and the City of Woonsocket to surmount the following challenges:

- Massachusetts Department of Conservation and Recreation opposition
- Harris Pond crossing
- Privately owned right-of-way parcels in Woonsocket and South Bellingham
- Proposed abandonment and sale of critical portions of the abandoned B&P in Woonsocket
- Significant structural challenges required by B&P to B&W connection
- Development of a new passenger station in Woonsocket
- Seating capacity on Existing MBTA trains

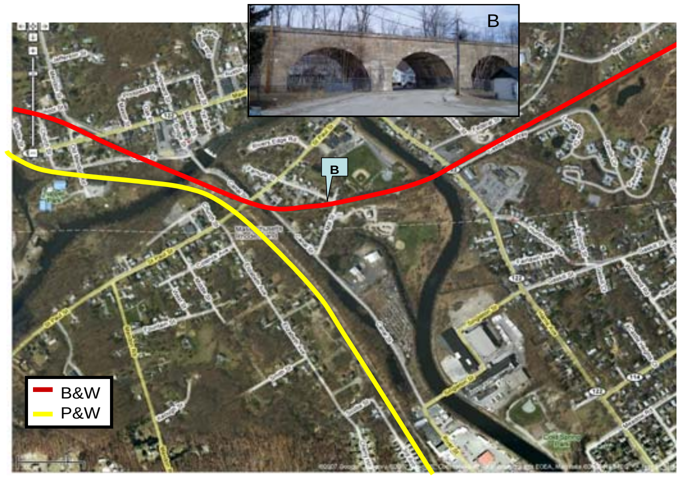


Figure III.5: B&W and P&W in Blackstone, MA

<u>Alternative 3: P&W to B&W to Franklin – Connecting Service</u>
An option for service between Woonsocket and Boston which avoids replacement of the embankment through Harris Pond could operate on the P&W North to Blackstone a distance of 1.7 miles and on the B&W from Blackstone to Franklin, a distance of 7.2 miles for a total distance of approximately 9 miles. At Franklin, travelers destined for Boston would transfer to existing MBTA commuter rail trains.

Right-Of-Way Availability
Because the P&W is a "going concern" railroad, its right-of-way is completely intact and currently used for rail operations. The B&W right of way between Blackstone and Franklin, however, has been adapted for other purposes over the 40 years since it was last operated as a railroad. As described previously, the Massachusetts DCR owns and maintains the majority of this rail line as a rail trail, except for a section in South Bellingham which is privately owned. Additionally, an approximately one mile stretch of the B&W in Blackstone is privately owned and actively used as an access road for a residential development.

In order to provide service to Boston along this route, a connection would need to be constructed between the elevated P&W and B&W lines. Construction of this elevated connection would require right-of-way acquisition in a neighborhood of North Smithfield occupied mainly by industrial land uses including a trash processing facility and junkyard. This route would also require reconstruction of the flood destroyed bridge across the Blackstone River.

Infrastructure
Track & Signals – The P&W main line between Providence and Worcester is currently single track for most of its length and primarily maintained for 40 mph freight operations. This standard of maintenance allows maximum allowable passenger train speeds of 60mph, adequate for most regional and commuter passenger rail operations. Therefore, restoration of this alignment for passenger service would require only minor upgrades on the 1.7 miles of P&W track. An elevated connection would be required between the P&W and the B&W. The entire B&W track to Franklin would need to be replaced. A CTC signal system would be installed on the entire alignment between Woonsocket and Franklin.

A new bridge crossing the Blackstone River on the B&W line, to replace the one destroyed by flood waters in 1968, would also have to be constructed. This bridge would be approximately 350 feet long and 50 feet above the water's surface.

Figure III.6: Remnants of B&W Bridge over Blackstone River

Stations – Woonsocket Main Street and Franklin MBTA stations exist for passenger rail service. Upgrades would be necessary at Woonsocket Main Street station which has not been used for rail operations in over 40 years.

Parking – Based on forecast daily boardings at Woonsocket of 262 passengers and allowing one parking space for every two forecast passengers, a total of 131 parking spaces would be necessary in downtown Woonsocket convenient to the historic depot.

Other Facilities - A new yard and maintenance facility for rolling stock used to provide connecting service would be required in or near Woonsocket.

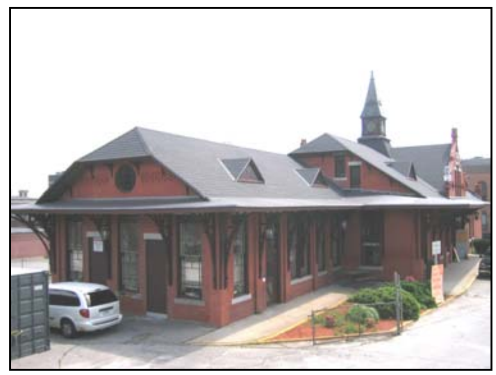


Figure III.7: Woonsocket Main Street Station

Institutional
Cooperation of the Providence and Worcester Railroad, owner of the line, would be required. The P&W serves freight customers on the sections of track that would be necessary for restoration of passenger service.

P&W Freight Traffic - Most freight cars traveling on the P&W connect with the national freight network in Worcester where the P&W interchanges with CSXT, a national rail carrier operating throughout the Eastern United States and with the Pan Am Railways, a regional freight railroad operating in New York and Northern New England. Each evening the P&W operates a train (WOPR) from Worcester to Providence hauling cars inbound to its customers along the Blackstone Valley and in Rhode Island. WOPR typically arrives at P&W's Valley Falls Yard in Cumberland between midnight and 5:30 am. Cars arriving at Valley Falls are distributed to shippers along the proposed Woonsocket to Providence Route by two local trains.

- PR-3 starts each weekday at approximately 7:00 am at Valley Falls, working in the yard before departing to serve customers (– delivering and picking up cars –) to the south along Amtrak's Northeast Corridor as far south as Kingston. Where available (between Boston Switch to Wickford Junction) the local switcher uses the non-electrified Track 7 (FRIP track) as much as possible. PR-3 also serves the P&W's coal dock and Port of Providence along the city waterfront before returning to the Valley Falls Yard at approximately 3 pm.

- PR-2 starts each weekday in Valley Falls at approximately 9:30 am. PR-2 typically works in the yard until 10:30 am when it heads out to serve customers along the proposed passenger route north to Woonsocket before it returns to the yard then heads out to serve other local lines served by the P&W. PR-2 is typically done each day at 5:30 pm.

Cars retrieved from local customers by PR-2 and PR-3 are assembled into a westbound train for departure at approximately 9:00 pm on train PRWO from Valley Falls to P&W's yard in Worcester.

Challenges
Development of a passenger rail service to Boston via this route would require the State of Rhode Island and the City of Woonsocket to surmount many of the same challenges facing the B&P routes to Boston while avoiding the cost and potential environmental impacts of restoring the railway across Harris Pond, the remaining challenges include:

- Massachusetts Department of Conservation and Recreation opposition
- Privately owned right-of-way parcel in South Bellingham
- Reclamation or redevelopment of one mile of right-of-way that has been developed as a roadway in Blackstone
- Significant structural and land taking challenges of building a P&W to B&W connection in North Smithfield
- Construction of 350 foot bridge spanning the Blackstone River
- Seating capacity on Existing MBTA trains

Route to Providence

The physical, operating, institutional and service design issues related to restoration of service on the potential alignment to Providence are less challenging than the direct routes to Boston described above.

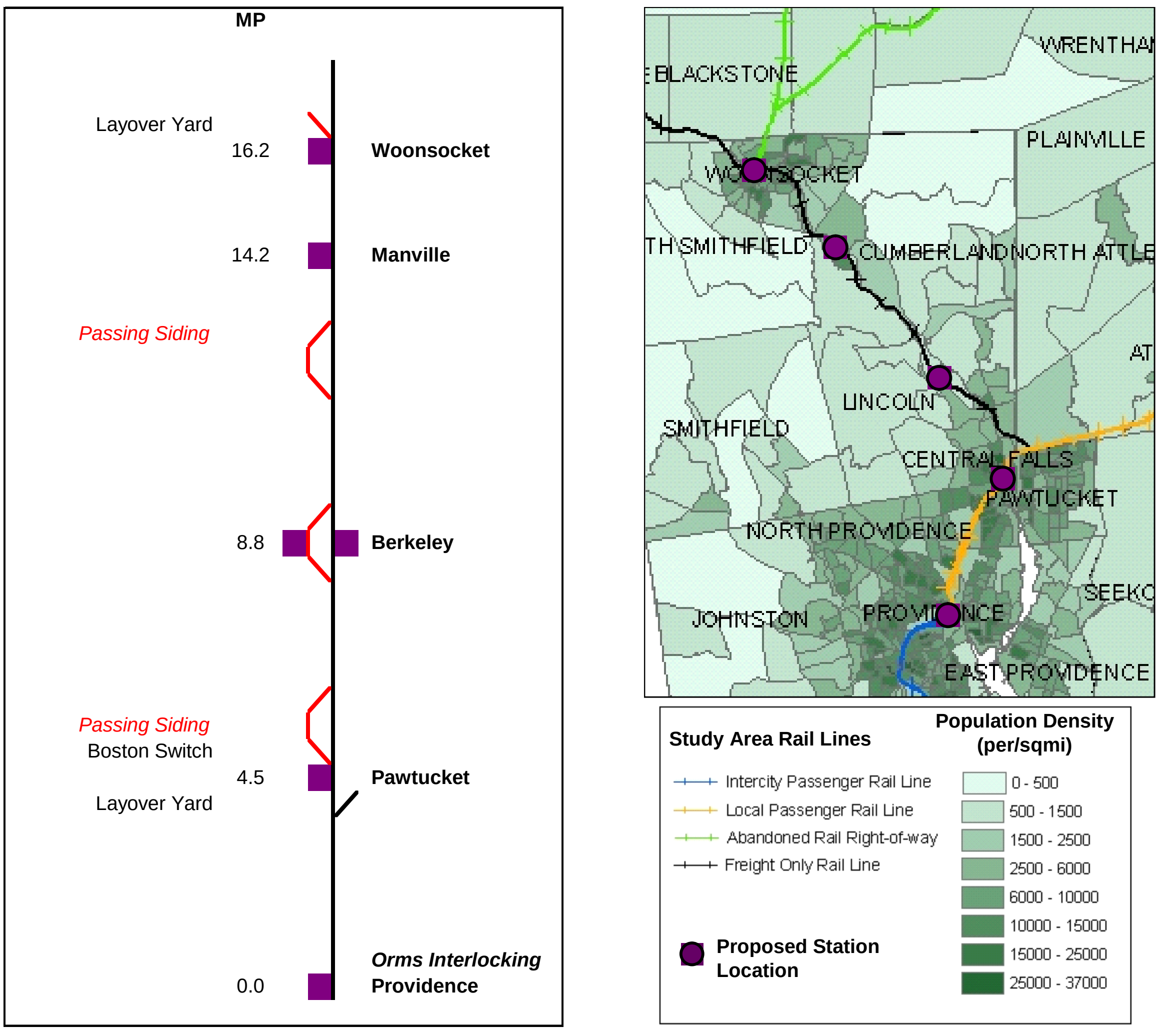
<u>Alternative 4: P&W to Providence</u>
Service to Providence would entail a cooperative arrangement with the P&W railroad allowing the passenger service to share track and facilities with the private owner over the 11.2 miles between Woonsocket and Boston Switch. At Boston Switch passenger trains would continue for five miles on Amtrak's Track 7 to access downtown Providence. The proposed service would stop at three stations between Woonsocket and Providence: Manville, Berkeley and Pawtucket.

Right-Of-Way Availability
Because the P&W and Amtrak are both going concern railroads, the right-of-way is completely intact and currently employed for rail operations.

Infrastructure

Track & Signals - With only a single track available, the options for developing frequent bi-directional passenger service are limited by the inability for opposing trains to meet and pass. A program of track and signal upgrades would be necessary to offer an attractive passenger service in conjunction with the P&W's current and future freight operations. These upgrades would include track upgrades, CTC signaling of the entire 16.2 mile alignment and construction of three passing sidings totaling up to 3 miles in length (shown in Figure III.8 in red).

Figure III.8: Proposed Track and Station Layout



In order to allow passengers to board or alight at Providence station, passenger trains departing Woonsocket must either crossover to Amtrak's Mainline or else a platform must be constructed to serve the Amtrak's Track 7 (see Figure III.9). Because of the challenges anticipated in constructing a Track 7 platform, the following infrastructure upgrade is proposed:

At Orm's Interlocking, a crossover could be added just north of Providence Station. The interlocking would connect Track 7 to Amtrak's Northeast Corridor Track 1 allowing Woonsocket trains to access either of the platforms serving Tracks 3 and 5 at Providence station. Of all potential crossovers evaluated, this option would have the least impact on Amtrak and MBTA services on the Northeast Corridor.

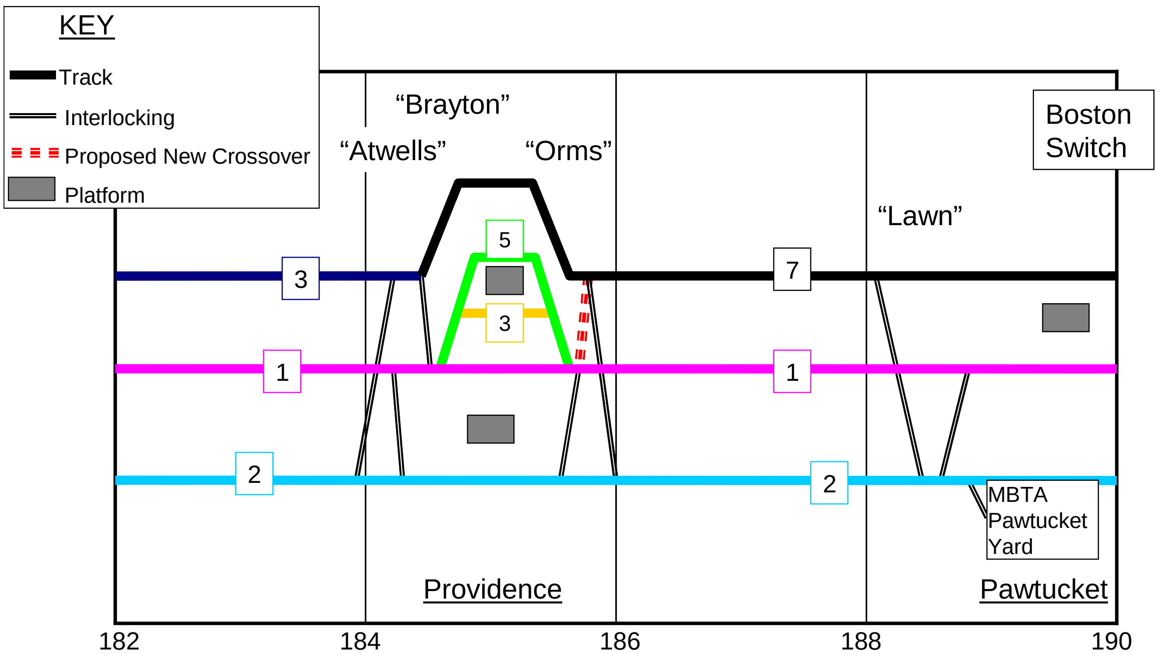


Figure III.9: Schematic of Existing Conditions and Proposed Crossover at Providence Station

Stations - Three of the five proposed passenger stations, Woonsocket, Pawtucket and Providence, are extant, with Providence being the only station currently in use. Two stations, Berkeley and Manville, would be constructed to provide the proposed service (see Figures III.10 and III.11). Woonsocket station platforms would be upgraded for the passenger service. It is assumed that Pawtucket/Central Falls station is restored to service under the aegis of its own passenger rail project and is therefore not discussed here.

Table III.1: Proposed Station Locations

Station	MP	Proposed Station Address
Woonsocket	16.2	Main Street & Railroad Street, Woonsocket, RI
Manville	14.2	Main Street Manville & Railroad Street, Manville, RI
Berkeley	8.8	Martin Street & Mendon Road, Cumberland, RI
Pawtucket	4.5	Broad Street & Clay Street, Central Falls, RI
Providence	0.0	100 Gaspee Street, Providence, RI

Parking – In order to accommodate the 252 passengers traveling from Woonsocket each weekday, 126 parking spaces would need to be provided at a location convenient to the historic depot in downtown Woonsocket. Similarly, 28 parking spaces would be required near the Manville station and 158 near the Berkeley Station. It was assumed that the restored Pawtucket/Central Falls station would provide sufficient parking capacity for forecast passengers.

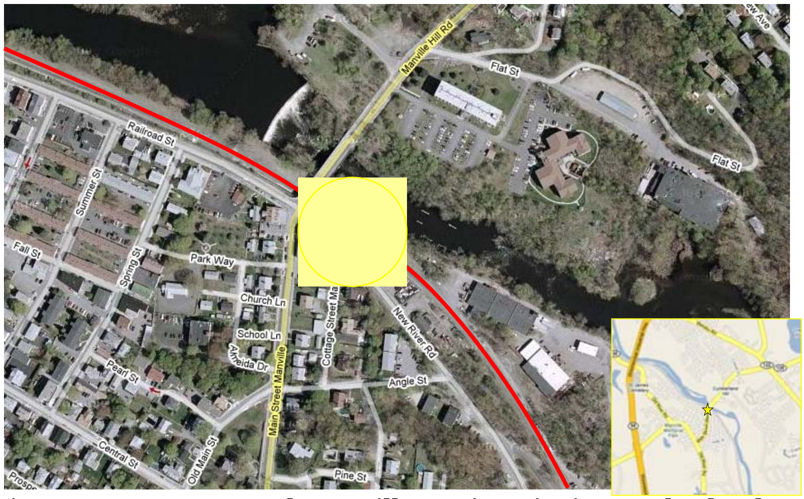


Figure III.10: Proposed Manville Station Site in Cumberland, RI

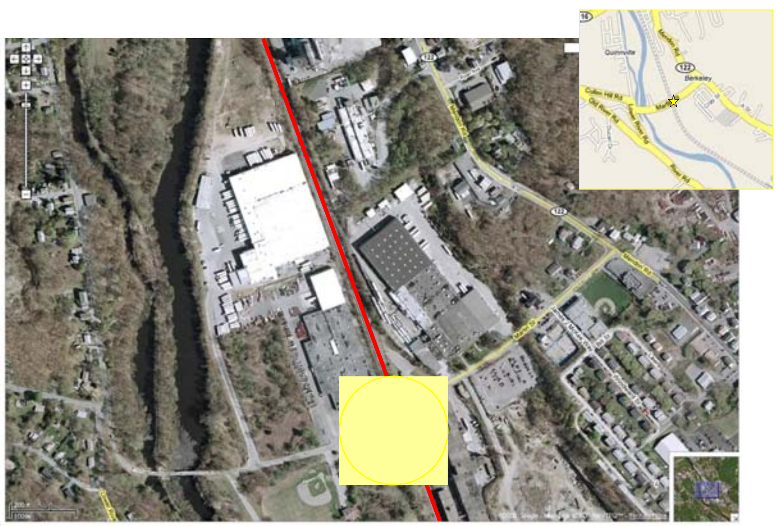


Figure III.11: Proposed Berkeley Station Site in Cumberland, RI

Other Facilities - While it was assumed that the newly constructed MBTA Pawtucket yard could be utilized for midday layovers[30], a new yard and maintenance facility for the passenger equipment would be required in the vicinity of Woonsocket.

Institutional

[30] Since Woonsocket trains would only use the Pawtucket yard during the midday period no expansion of capacity at this yard would be required. No specialized equipment would be necessary for DMUs to layover at midday in Pawtucket Yard.

Operation of this route will require cooperation with the P&W, Amtrak, and the MBTA. The highest level of cooperation would be required with the P&W which shares the longest sections of right-of-way with the proposed passenger service. Given the frequent intercity and commuter trains already calling at Providence station, cooperation with Amtrak and the MBTA would be critical to coordinate the operation of trains into Providence station via the shared Amtrak NEC Track 1. It is anticipated that the new passenger trains could be operated by P&W under contract to RIDOT or RIPTA.

An important opportunity offered by the route to Providence is the ability to connect to MBTA Boston services at a restored Pawtucket Station[31]. This service operated by the MBTA would provide access to South Station in Boston. Service to Providence could be scheduled to allow for timed transfers at Pawtucket station to trains to or from Boston, providing a convenient transit option for commuters from Woonsocket and Cumberland to Boston.

PART II: EVALUATION

Evaluation of potential services is an important step towards making the most effective use of limited resources. The study team evaluated the potential routes through estimation of the infrastructure costs associated with restoration of passenger rail service on each route. For the most attractive route, vehicle and operating costs as well as expected revenues were developed and evaluated. In order to estimate the operating costs for the most attractive alternative, sketch operating plans were designed.

Infrastructure Costs

To understand the feasibility of the services identified, especially given the extraordinary infrastructure investments required for routes to Boston, the cost of infrastructure construction required for passenger service restoration was estimated for each alternative routing. JEK used a simple three-step process to estimate capital infrastructure costs.

Step 1.) Estimated Quantities

The study team established current conditions through site visits, inspection of track charts, and review of aerial photography. Rough specifications for extraordinary infrastructure items, such as sections of embankment across Harris Pond and the Blackstone River Bridge, were developed from these sources. The length of right-of-way and existing track determined the extent of track construction or upgrade and signaling required. Potential station sites were selected through the use of aerial photographs, travel demand analysis and traffic routing tools[32]. The number of grade crossings requiring signal upgrades was derived from track charts. The numbers of new stations

[31] Consultation with the consultant team managing the Pawtucket station restoration project indicates that a cross platform transfer between Woonsocket trains and MBTA trains to/from Boston is possible given current plans.

[32] Google maps

and private parcels within the right-of-way determined the amount of land that would be acquired for each alternative.[33]

Step 2.) Unit Costs

Unit costs for land were estimated based on an internet survey of property for sale in each town. [34]

The unit costs used to estimate the capital construction costs of each scheme were gathered from a variety of sources. The majority of cost estimates were achieved through consultation with JEK's rail and structural engineers, however, some information gathered through the planning team's survey efforts was also employed. The unit cost estimates assembled and their sources are listed in Table III.2.

Table III.2: Infrastructure Cost Components

Category	Cost Item(s)	Unit	Unit $	Source for Unit Costs
Track and Signal	New Track Construction	Track Feet	$250	Jacobs Edwards & Kelcey
	Existing Track Upgrade	Track Feet	$25	Jacobs Edwards & Kelcey
	Turnout (No. 20) Construction	Each	$175,000	Jacobs Edwards & Kelcey
	Grade Crossing Signal Upgrade	Each	$250,000	Jacobs Edwards & Kelcey
	New Signal System (CTC)	Track Feet	$190	Jacobs Edwards & Kelcey
Stations	High Level Platform	Each	$300,000	Jacobs Edwards & Kelcey
	Parking Lot (100 spaces)	Each	$100,000	Jacobs Edwards & Kelcey
	Site Development	Each	$500,000	Jacobs Edwards & Kelcey
	Ticket Vending	Each	$87,000	NJ TRANSIT
	Closed-Circuit TV	Station	$350,000	Jacobs Edwards & Kelcey
Other Infrastructure	Maintenance Facility[1]	Vehicle	$538,000	KKO and Associates survey
	R.O.W. Embankment	Linear Foot	$6,000	Jacobs Edwards & Kelcey
	Blackstone River Bridge	Linear Foot	$15,000	Jacobs Edwards & Kelcey
	Amtrak Crossover (Existing Interlocking)	Each	$2,000,000	Jacobs Edwards & Kelcey

[1] It is assumed that some locomotive maintenance would be performed at the P&W's shop in Worcester. A much larger fraction of DMU maintenance would be performed in Woonsocket.

Step 3.) Contingency and Support Costs

A 30% contingency factor was applied to estimates of property acquisition to reflect the variability in land value and uncertainty relating to litigation and other acquisition costs. Contingency costs were also added to the directly estimated infrastructure and

[33] It was assumed that (1) each new station site would require two acres of land (2) a 60 foot wide railroad easement would be acquired through privately owned parcels that interrupt the rail alignments (3) services to Boston would be operated under coordination with the Massachusetts DCR, so that the DCR would retain ownership of their rail trail between Blackstone and Franklin (4) for alternatives 1 and 2, the historic B&P alignment between River Street and Harris Pond would be purchased from the P&W (5) for alternative 3, passenger service would operate under contract with the P&W so that the P&W would retain ownership of their Mainline.

[34] Retrieved May 21, 2007 from www.loopnet.com, www.homesalesri.com, www.windhillrealty.com

construction cost items to account for unforeseen circumstances. A 15% contingency factor was applied to the relatively predictable costs for track and signal upgrades or new track construction. A 30% contingency factor was applied to other infrastructure or construction costs, which are more difficult to estimate accurately at this stage of planning. In addition to the contingency, various engineering and support costs were added to the estimate as listed in Table III.3.

Table III.3: Support Costs

Cost Item	**Budgeted Amount**
Engineering and construction management	15% of construction cost
Administration	4% of construction cost
Insurance and permitting	3% of construction cost

Assuming the operational and infrastructure needs described in the Identification section and specified under Step 1 of the cost estimation process, the study team was able to calculate the expected capital costs for infrastructure construction. The findings of the three step estimation method are presented in Table III.4.

Table III.4: Estimated Infrastructure Costs by Alternative

	Alternatives 1 and 2 Boston via B&P and B&W	**Alternative 3** Boston via P&W and B&W	**Alternative 4** Providence via P&W and Boston via Pawtucket
Right-of-way Acquisition			
Land	$6,207,000	$3,459,000	$1,415,000
Contingency (30%)	$1,862,000	$1,038,000	$425,000
Infrastructure			
Track and signal	$18,586,000	$18,757,000	$28,140,000
Stations	$1,424,000	$1,424,000	$8,519,000
Embankment	$9,000,000	$9,000,000	$0
Bridges	$0	$5,250,000	$0
Maintenance facility	$3,230,000	$3,230,000	$3,230,000
Contingency (% varies)	$6,884,000	$8,485,000	$7,746,000
Support			
Engineering & CM (15%)	$5,868,000	$6,922,000	$7,145,000
Insurance and Permitting (3%)	$1,174,000	$1,384,000	$1,429,000
Administration (4%)	$1,565,000	$1,846,000	$1,905,000
Total	**$55,800,000**	**$60,795,000**	**$59,954,000**

The estimated infrastructure costs for Boston service, Alternatives 1 through 3, range between $56 million and $60 million while the estimated infrastructure cost for Providence service, Alternative 4, is $59 million.

Since the Providence route is approximately double the length of proposed Boston route extensions, the estimates translate to infrastructure costs per route mile of $3.7 million for service to Providence, as compared to approximately $7 million per route mile for service to Boston (see Table III.5). One reason the Boston schemes are associated with higher route mile costs of infrastructure restoration is that Boston routes would require complete replacement of the majority of track, as opposed to an upgrade of existing track in the Providence case. Additionally, each Boston route would require extraordinary infrastructure projects that are not required for restoration of passenger service to Providence.

Comparing forecast ridership with projected capital costs for track, signals, and structures, Alternative 4: service to Providence with connections to Boston at Pawtucket is clearly the most attractive transit investment in terms of cost effectiveness. With estimated infrastructure costs and ridership forecasts, the infrastructure cost per rider can be evaluated for each alternative. The expected infrastructure cost per rider for the route to Providence is $57,000 as compared to costs per rider for Boston services which range from $181,000 to $226,000.

Table III.5: Infrastructure Cost per Route Mile

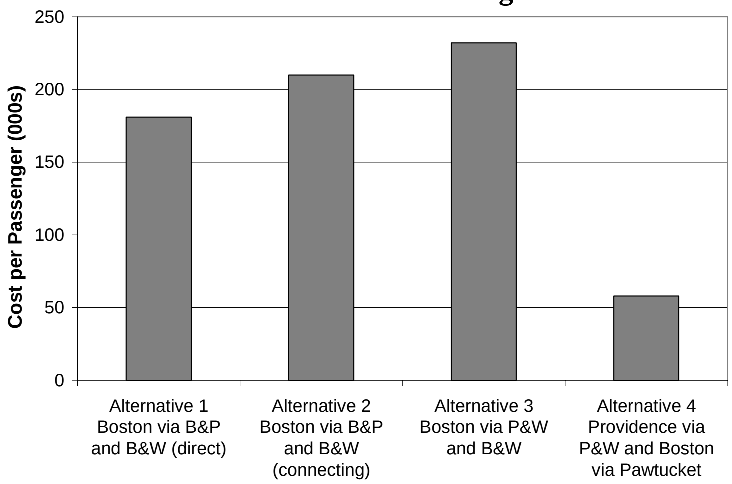
	Alternative 1 &2 **Boston via B&P and B&W**	**Alternative 3** **Boston via P&W and B&W**	**Alternative 4** **Providence via P&W and Boston via Pawtucket**
Route Miles	8	9	16
Infrastructure cost per route mile	$6,975,000	$6,755,000	$3,747,000

Table III.6: Infrastructure Costs per Forecast Inbound Boarding

	Alternative 1 **Boston via B&P and B&W (direct)**	**Alternative 2** **Boston via B&P and B&W (connecting)**	**Alternative 3** **Boston via P&W and B&W**	**Alternative 4** **Providence via P&W and Boston via Pawtucket**
Forecast Inbound Boardings	308	266	262	1,034
Infrastructure cost per rider	$181,000	$210,000	$232,000	$58,000

As evidenced by the performance metrics in Table III.6 and illustrated in Figure III.12, all Boston services require a relatively large infrastructure investment for moderate forecast ridership. Providence services require one-third to one-fourth of the investment per passenger while maintaining a convenient transit connection to downtown Boston via a transfer at Pawtucket station.

Figure III.12: Infrastructure Costs per Forecast Inbound Boarding



Because service between Woonsocket and Providence, offering a connection to Boston at Pawtucket, is expected to provide the greatest benefit at the lowest cost per passenger and route mile, the study team recognizes this route as the most viable. Routes to Boston appear to be impractical due to the substantial obstacles facing rail service restoration on long abandoned routes and the high cost of implementation per forecast passenger. Further evaluation of passenger rail service including estimation of operating cost and fare revenue focused solely on the route between Woonsocket and Providence.

Sketch Operating Plan

To estimate the operating cost associated with service to Providence, preliminary operating plans were developed. The primary objective of the planned service to Providence was to provide a convenient alternative for travel between Woonsocket and downtown Providence and Boston. Since over 80% of the expected riders would use the service to access employment locations in downtown Providence or Boston, trains were scheduled with a focus on serving commuters to downtown locations during the morning peak period and to residential areas during the afternoon peak period. In order to allow for competitive service to Boston (via a transfer to MBTA trains at Pawtucket) trains from Woonsocket were scheduled to provide timed transfers to MBTA trains at Pawtucket. Where possible, transfer times were scheduled at five minutes. Schedules were created to maximize the number of connections to Boston services.

Service Design Assumptions

The assumptions made in order to complete the service design were:

- Each station stop requires a minimum dwell time of 20 seconds plus 0.5 seconds for each boarding or alighting passenger. At least one minute of additional dwell time is allowed to enable inbound and outbound train meets to occur, when necessary, without disrupting schedules.

- Turn time of at least ten minutes is required at each terminal before starting on the return trip.
- Acceleration and braking characteristics are of a standard push-pull locomotive hauled train (Use of self-powered rail cars, also known as DMU's, might be considered as an economic alternative to push-pull equipment).
- The track is Class 3 with a maximum allowable speed of 60mph except where otherwise restricted by curves in the alignment.
- Amtrak and MBTA services into Pawtucket and Providence are equivalent to those planned by RIDOT's South County Commuter Rail project.

Woonsocket to Providence Service

Service between Woonsocket and Providence would be operated on existing freight track[35] to 0.5 miles north of Providence Station where trains would crossover to Amtrak's Northeast Corridor (NEC) Main Line. Woonsocket services would share the right-of-way with P&W freight traffic on the freight track and with MBTA and Amtrak trains on the NEC Mainline. Three peak trips in each direction could be operated through the use of two peak train sets. The scheduled services allow for connections with three peak trips to Boston in the morning as well as three peak trips from Boston in the afternoon. Between Woonsocket and Providence, stations in the communities of Manville, Berkeley, and Pawtucket/Central Falls would also be served.

Schedule

The preliminary schedule offers a total of 28 daily trips with 14 trips in each direction.[36] Three am peak trips would arrive in Providence between 7:00 am and 9:00 am, and three pm peak trips would depart Providence between 5:00 pm and 7:00 pm. Service would begin at approximately 5:00 am and run until approximately 10:30 pm. Rail travel time between Woonsocket and Providence would be under 30 minutes. Full schedules, including information on met MBTA trains, are presented in Figure III.13.

This schedule would provide timed connections to 17 MBTA commuter trains, with three of these trains arriving in Boston between 7:00 am and 9:00 am, and three departing Boston between 4:00 pm and 7:00 pm. Rail travel time between Woonsocket and Boston, including transfer time at Pawtucket would be approximately 1 hour and 30 minutes. All but three connections to MBTA service would allow for five minutes of transfer time in order to minimize wait time while allowing for slight deviations from schedules. The three exceptions result in two six minute scheduled transfers and one eight minute transfer. It should also be noted that connections with MBTA trains 814 and 809 would require adjustments of approximately five minutes to Amtrak trains 2159,

[35] Freight track is the Providence and Worcester (P&W) Railroad's Mainline which continues as Amtrak's Track 7 south of the "Boston Switch" location in Pawtucket.

[36] The 28 trip per day service provides a modicum of peak service to both Boston and Providence with midday and some evening service. Operating costs could be reduced somewhat by cutting the numbers of scheduled off peak and shoulder peak trips.

currently arriving in Providence from Boston at 9:51 am, and 809, arriving in Providence from Boston at 2:20 pm.

Equipment
Two peak consists with two cars each would be required to operate the schedule and provide seats for all forecast passengers. Only one of these consists would be required during off-peak periods. One spare consist would be recommended in case of a failure on either of the required train sets.

The study team did not determine if additional MBTA coaches would be required to accommodate the additional 196 weekday passengers that would travel to Boston. No capital cost for these coaches was estimated.

Crew
The daily schedule could be operated with three crews working one split shift and two straight shifts. More specifically, the shifts could be:

Crew 1: 5:30 am to 12:00 pm
Crew 2: 1:00 pm to 10:30 pm
Crew 3: 5:00 am to 9:00 am and 5:00 pm to 8:00 pm

It is anticipated that the split shift crew and their train would layover at the MBTA's new yard in Pawtucket during the midday break in service.

Figure III.13: Preliminary Schedules – Woonsocket to Providence Service

Inbound Service

STATION	MP	2	4	6	8	10	12	14	16	18	20	22	24	26	28
Cycle	MP	*y*	*x*	*y*	*x*	*y*	*x*	*x*	*x*	*x*	*x*	*x*	*y*	*x*	*x*
Woonsocket	16.2	5:06	5:48	6:52	7:18	8:09	9:25	10:44	13:12	14:56	16:17	17:39	18:25	19:17	21:24
Manville	14.2	5:09	5:51	6:55	7:21	8:13	9:29	10:48	13:16	15:00	16:21	17:43	18:29	19:21	21:28
Berkeley	8.8	5:18	6:00	7:04	7:30	8:21	9:37	10:56	13:24	15:08	16:29	17:53	18:37	19:29	21:36
Pawtucket	4.5	5:26	6:08	7:12	7:38	8:28	9:44	11:03	13:31	15:15	16:36	18:01	18:46	19:36	21:43
Providence	0.0	5:34	6:16	7:20	7:46	8:35	9:51	11:10	13:38	15:22	16:43	18:08	18:53	19:43	21:50
South Station (Boston)	43.5	6:40	7:19	8:16	8:49		10:55		14:38		17:40	19:03			10:55
Previous Train		**YD**	**YD**	**1**	**3**	**5**	**7**	**9**	**11**	**13**	**15**	**17**	**19**	**21**	**25**
Time In				6:26	7:06	7:58	8:46	10:27	11:46	14:46	15:59	17:28	18:05	19:02	20:36
Next Train		**1**	**3**	**5**	**7**	**10X**	**9**	**11**	**13**	**15**	**17**	**21**	**23**	**25**	**27**
Time Out		5:58	6:38	7:30	8:20	8:45	10:01	11:20	14:20	15:32	17:00	18:34	19:03	20:10	22:02
Connecting Train Number		802	804	808	810		814		818		New2	824			828

Outbound Service

STATION	MP	1	3	5	7	9	11	13	15	17	19	21	23	25	27
Cycle	MP	*y*	*x*	*y*	*x*	*x*	*x*	*x*	*x*	*x*	*y*	*x*	*y*	*x*	*x*
South Station (Boston)	43.5						10:25	13:25	14:37		16:35	17:40	18:10	19:10	21:05
Providence	0.0	5:58	6:38	7:30	8:20	10:01	11:20	14:20	15:32	17:00	17:37	18:34	19:03	20:10	22:02
Pawtucket	4.5	6:04	6:44	7:36	8:26	10:07	11:26	14:26	15:39	17:07	17:44	18:41	19:10	20:16	22:08
Berkeley	8.8	6:13	6:51	7:45	8:33	10:14	11:33	14:33	15:46	17:15	17:52	18:49	19:18	20:23	22:15
Manville	14.2	6:22	7:02	7:54	8:42	10:23	11:42	14:42	15:54	17:23	18:00	18:57	19:26	20:32	22:24
Woonsocket	16.2	6:26	7:06	7:58	8:46	10:27	11:46	14:46	15:59	17:28	18:05	19:02	19:31	20:36	22:28
Previous Train		**2**	**4**	**6**	**8**	**12**	**14**	**16**	**18**	**20**	**21X**	**22**	**26**	**26**	**28**
Time In		5:34	6:16	7:20	7:46	9:51	11:10	13:38	15:22	16:43	17:15	18:08	18:53	19:43	21:50
Next Train		**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**YD**	**28**	**YD**
Time Out		6:52	7:18	8:09	9:25	10:44	13:12	14:56	16:17	17:39	18:25	19:17		21:24	
Connecting Train Number							805	809	New1		813	817	819	821	825

YD = To/From Yard

Service Regimes

A variety of operating regimes were considered to better understand the potential for passenger services. Costs were estimated for four service regimes.

Table III.7: Service Regimes Evaluated (Woonsocket to Providence)

Regime	Powered Car	Number of Coaches	Crew Size
DMU	Diesel Multiple Unit (DMU)	1	2
DMU-OPTO	Diesel Multiple Unit (DMU)	1	1
Locomotive	Locomotive	2	2
Locomotive-OPTO	Locomotive	2	1

OPTO

One person train operations (OPTO) employs a single person on each train as opposed to a more typical crew size of two or more people. Every commuter railroad in North America operates with a single engineer in the control cab. The engineer controls the movement of the train, responds to traffic control signals and stops short of obstructions. In addition to the engineer at the throttle, most systems operate with a conductor and one or more assistant conductors in the passenger compartments. The primary responsibilities of these staff are to verify/collect passenger revenue, operate doors to enter and exit the train, supervise boarding and alighting passengers, maintain decorum in the passenger cabins and respond to passenger emergencies.

The practical factors that have been keeping large train crews on North American commuter trains are revenue collection and passenger boarding. The typical US commuter rail fare collection relies on 100% revenue verification and allows passengers to purchase tickets from the conductors on each train. Passenger movements between low-level platforms and high floor cars are supervised by the train crew. Because these factors can be dealt with through automated fare collection and high-level platforms, it is increasingly possible to employ OPTO in order to gain substantial reductions in the cost of operations. Cost estimates were developed for service regimes involving OPTO to evaluate the feasibility of lower crew cost options.

Compliant DMU Vehicles

A Diesel Multiple Unit (DMU) is a passenger rail car with a self-contained, on-board source of motive power, making reliance on a locomotive or electric power distribution system unnecessary. Historically, nearly all DMUs have used on-board diesel engines for propulsion power and have been capable of operation as a single train with multiple cars. While motive power may be a diesel internal combustion engine or an alternative self-contained, on-board source, all DMUs in common use rely on diesel propulsion.

Colorado Railcar Aero DMU: The single level Aero DMU seats 92 and is capable of pulling one or two commuter rail coaches. Colorado Railcar also offers a bi-level DMU that seats 188, and unpowered “dummy” coaches that seat 92 and 218 for the single level and bi-level versions. The Aero has been purchased for use on Florida’s low density Tri-Rail service as part of the FRA DMU Demonstration Project along with a bi-level DMU and a bi-level coach. In addition, five

DMUs have been ordered for use on the Washington County Commuter Rail line in Portland, Oregon. Construction is underway and operations are due to commence in the fall of 2008.

United Transit Systems DMU: United Transit Systems (a consortium of Tokyo-based Sojitz Corp. and Seoul-based Rotem Co.) was chosen to build 28 Category 1 DMUs for North Carolina. The North Carolina cars were expected to be fully compliant with all FRA regulations with 2x2 seating for 80 passengers and capacity for up to 200. Rotem has several decades of DMU and EMU experience worldwide in the United Kingdom, Ireland and Korea.

Figure III.14: Colorado Railcar DMU

Table III.8A: Characteristics of DMUs in North America

	Colorado Railcar Aero DMU	United Transit Systems DMU
First Year of Service	2005	2008
Fleet Size	1	28
Seating Capacity	92	80
Standees[37]	148	120
Total Passenger Capacity	240	200
Approx. Capital Cost (millions)	$3.5	$3.5[38]
Total Horsepower	1,200	950
Engines	2	2
Drive Train	Diesel - mechanical	Diesel - mechanical
Weight (tons)	74	65
Length (feet)	85	85
Height (feet)	15.1	14.5
Tons/Seat	0.8	0.8

Figure III.15: United Transit Systems DMU

Any of the vehicles described above would be adequate for the DMU services in Woonsocket. For the purposes of this plan it is assumed that each DMU train would consist of a powered DMU with an unpowered trailer coach.

[37] Standee capacity figures are based on vendor reports which may vary in the perception of acceptable levels of passenger crowding

[38] Rotem offered a range of capital costs ($3.5 to $7.0 depending on quantity ordered). The study team assumed that the bid would be competitive with the cost for a Colorado Railcar DMU.

Push-Pull Locomotives and Coaches

Locomotive-hauled diesel push-pull operations characterize most of the commuter railroads in North America. In this configuration, a diesel electric locomotive is employed to provide propulsion, lighting and HVAC power for the train. The diesel engine drives an electric generator that supplies power to electric motors on the locomotive's drive-wheels. A separate diesel engine and generator typically provides electric power to heat, cool and light the passenger coaches. The typical minimum length for a push-pull train is a locomotive and three coaches. Trains with two cars are occasionally deployed, but are not favored. It is assumed that a two-car train could be deployed for Woonsocket service. The typical diesel locomotive is 60 to 70 feet long and weighs 125 tons. The maximum practical train length for a single passenger locomotive is typically 8 or 9 cars.

The locomotive hauls the train in pull configuration. When the consist reaches the end of its trip and turns to head back toward its origin, the engineman shifts the locomotive into push mode and changes his seating position from the locomotive to a work station at the far end of the last car in the consist. This work station provides a throttle, brakes, and other controls that allow him to operate the locomotive and the train in the push configuration.

The passenger coaches are unpowered trailers. Coaches can be either single-level or bi-level. Regardless of height, the typical coach is 85 feet long. A single-level car generally weighs about 50 tons. A bi-level weighs approximately 60 tons. The Massachusetts Bay Transportation Authority (MBTA) in Boston operates a mix of single-level and bi-level equipment. Metro-North and ConnDOT only operate single level coaches at this time.

For shorter commuter type trips each single-level coach typically seats 100 to 125 passengers. Higher seating capacities are achieved by narrowing the center aisle of the car and providing five seats in every row - two seats on one side of the aisle and three on seats on the other (3-2 seating). Structurally, the typical single-level coach rests on a center sill above the wheelsets ("trucks") at either end of the car. Passenger entry and egress from the car requires either a high-level platform designed to match the height of the car floor or uses short three step stairways (called "traps") located at each corner of the car.

Table III.8B:
Characteristics of Push Pull Option

Typical New Two-Car Push-Pull Trainset (Single-level)	
Seating Capacity	210
Capital Cost (Millions)	$5.1
Horsepower	3000
Engines	1
Drive Train	Diesel-Electric
Weight (Tons)	225
Length (Feet)	235
Tons/Seat	1.1

Figure III.16: Push-pull train

Vehicle Costs

The cost of rolling stock for the Woonsocket to Providence service was estimated using JEK's vehicle procurement figures. Table III.9 lists the assumed cost per vehicle and the source.

Table III.9: Vehicle Procurement Cost

Vehicle Type	Vehicle Cost	Source
DMU	$3,500,000	Colorado Rail Car Corporation
Push-pull locomotive	$2,500,000	MotivePower Inc.
Coach	$1,300,000	JEK calculated industry average

Since it was previously determined that the service would require three consists, two for peak service and one spare (see Sketch Operating Plans), expected vehicle costs can be calculated with the unit costs from Table III.5. The total cost of vehicles for DMU service would be $14.4 million and the total cost of vehicles for push-pull service would be $15.3 million.

Estimating Operating Costs

For the service to Providence, five categories of operating cost were estimated, those being: rail transportation, mechanical maintenance, maintenance of way, trackage fees and administration.

To estimate operating costs, it was assumed that the Providence and Worcester (P&W) freight railroad, which owns the majority of the right-of-way, would operate the passenger service under contract to the State of Rhode Island. It is expected that the P&W would continue to dispatch the line and charge the state a fee for the increase in dispatching capacity required.

<u>Estimating Transportation Expense</u>

Transportation costs include the direct costs for service provision including train crews, supervisors and dispatchers, propulsion energy and train supplies. Although only weekday schedules were developed, the costs for weekend services were estimated based on a 10 hour service day each Saturday, Sunday and holiday. The following was assumed for transportation cost estimation:

- Operators and conductors would cost the fully loaded rate of $42.96/staff hour, a figure based on the operator rate for a Midwestern regional carrier adjusted to reflect the Woonsocket area cost of living. Overtime is charged at 1.5 times the hourly wage, or $28.50/staff hour. Absentee coverage is charged at two times the hourly wage, or $38.00/staff hour.

- Four full-time field supervisors (one chief supervisor and three assistant supervisors) would be responsible for all aspects of the commuter rail operations providing full coverage for the 10-17 hour daily operation, seven days a week, at a fully-loaded hourly rate of $51.55 for the supervisor and $42.96 for each assistant supervisor.
- Dispatching would be provided by the P&W, owner of the line, for an annual fee of $100,000.

- Under the One Person Train Operation (OPTO) scenarios, it is recommended that fare collection be achieved by a proof of payment system. In North America, Proof of Payment (POP) is used on a variety of rail systems including the light rail system in Buffalo, the commuter rail systems in South Florida and San Francisco, and the new DMU operation in Ottawa.[39] One staff member is allocated, full time, to the servicing of ticket vending machines and administration of POP issues.
- Diesel fuel costs are based on the MBTA's 2007 contract price for diesel fuel ($1.92).
- Diesel vehicle fuel efficiency is assumed to be 1.02 mpg for a DMU hauling a trailer, and 0.57 mpg for a push-pull, locomotive hauled consist with two coaches.

Estimating Mechanical Expense (MOE)

The mechanical costs include labor and materials for vehicle maintenance. It is assumed that the private operator would maintain the selected vehicles at costs approximating productivity observed elsewhere in the United States.

Table III.10: Maintenance of Equipment Costs

Cost Element	Vehicle Type	Annual Cost
Labor Cost	DMU	$ 73,099[40]
	Push-pull locomotive	$112,813[41]
	Coach	$ 28,203[42]
Supplies Cost	DMU	$ 57,635[43]
	Push-pull locomotive	$ 60,938[44]
	Coach	$ 15,235[45]

Using these figures, the estimated annual DMU maintenance cost is $174,172 for a two unit DMU consist (DMU and 1 coach), as compared to a cost of $260,627 for a two coach push-pull consist.

[39] Proof of payment is commonly used by overseas transit operations to provide a higher level of service within available operating funds. Under a proof of payment system, on board train staff would not verify that every passenger has a valid ticket and would not sell tickets on board the train. All patrons would need to have purchased a valid time-stamped ticket from a vending machine on the station platform prior to boarding the train. Supervisors would randomly ride trains inspecting tickets. Passengers discovered without a valid ticket would be subject to a substantial fine. A local ordinance (or state law) would be necessary to empower the transit fare inspector to enforce the fare evasion fine. The fare evasion fine is typically administered like a traffic ticket.

[40] NJ TRANSIT commuter rail maintenance labor rates in 2002 calculated from NTD 2002 figures for vehicle maintenance labor costs and hours. Result was inflated to 2007 dollars by 5% annually and then adjusted by the urban cost of living difference between Newark, NJ and Providence, RI.

[41] Based on MBTA locomotive maintenance labor costs estimated in 2000 and inflated to 2007 dollars, and then adjusted by urban cost of living difference between Boston, MA and Providence, RI.

[42] Based on MBTA locomotive maintenance labor costs estimated in 2000 and inflated to 2007 dollars, factored by Metro-North's ratio of coach to locomotive maintenance costs and then adjusted by urban cost of living difference between Boston, MA and Providence, RI.

[43] Based on 1995 KKO survey of SPRC manufacturers inflated to 2007 dollars

[44] Based on MBTA locomotive maintenance costs estimated in 2000 and inflated to 2007 dollars.

[45] Based on MBTA locomotive maintenance costs estimated in 2000 and inflated to 2007 dollars and factored by Metro-North's ratio of coach to locomotive maintenance costs.

Rolling Stock Renewal
Consistent with recommended practice it is assumed that all rolling stock would have a useful life of 30 years and require a midlife overhaul at approximately 15 years.[46] The cost of a midlife overhaul is approximately one-third of the purchase price of a new vehicle. Under these assumptions, the annual cost of rolling stock renewal for DMU service would be $638,400 or $678,300 for Push-pull service.

Estimating Maintenance of Way (MOW) Expense
MOW costs include the everyday direct costs for inspection and maintenance of the infrastructure, including labor and materials. They also include long term costs for rail and tie renewal, bridge maintenance, etc. JEK estimates and reports these long-term asset renewal costs necessary to achieve a steady state financial plan separately from routine maintenance and inspection services.

- Two supervisor/Chief engineer, two signal maintainers and four track, bridge and station maintainers are assumed. The supervisor would earn a fully-loaded hourly rate of $51.55 while other personnel earn $42.96/hour[47].
- It is assumed that the MOW materials cost would mirror typical commuter rail agency experiences as reported to the National Transit Database. The average materials cost per MOW labor hour, escalated to reflect costs in 2007, was estimated at $11.85.

Infrastructure Asset Renewal
Costs for renewal of ties, rail, bridges, grade crossings, station platforms and parking, and turnouts were allocated on a per year basis assuming the costs and the life span exhibited in Table III.11. It is likely that these costs would not be incurred during the early years of service when infrastructure has been recently restored.

Table III.11: Asset Renewal Costs

Asset	Renewal Cost	Life Span (years)
Ties & Ballast	$250 per tie	30
Rail	$1 million per track-mile	50
Bridges	$2 million per bridge	75
Grade Crossings	$400,000 per grade crossing	30
Station Platforms	$275,000 per platform	50
Station Parking	$500 per space	30
Turnouts	$400,000 per turnout	25

The long-term cost for infrastructure asset renewal was estimated at $1,124,600 per year.

[46] This estimate may overstate the costs that may actually be incurred. Most public transit agencies fall considerably short of recommended practice due to financial constraints and other considerations. For instance, Conn Dot is presently giving a second midlife overhaul to its 30 year old rolling stock expecting to get 45 years of service from each vehicle. MBTA is just starting midlife overhauls on its 20 year old coaches.
[47] Assuming P&W maintenance, rates were derived from reported hourly rates for shortline force account work elsewhere in the United States adjusted to reflect 2007 conditions in the area of Woonsocket, RI.

Estimating Trackage Fees

Because there is a private owner of the P&W mainline, it was assumed that the state of Rhode Island would pay the owner trackage fees for the use of all track. The trackage fees were assumed to be $0.392 per car-mile based on trackage fees charged elsewhere to operate passenger trains on privately owned freight routes in New England.

Rhode Island Department of Transportation (RIDOT) is presently negotiating with Amtrak concerning trackage fees for passenger service south of Providence. When these negotiations are completed, estimates of Amtrak trackage fees for the five miles between Boston Switch and Providence should be updated.

Estimating Administrative Expense

Administrative costs include revenue collection and accounting, marketing, personnel, training and safety. These costs are estimated at 15% of the Transportation, MOE and MOW costs.

Findings

With estimates of unit cost and a draft operating plan, the annual cost of providing each alternative service regime could be approximated. Annual service statistics, that describe the quantity of service provided under each alternative, are presented in Table III.12.

Table III.12: Quantities Provided by Rolling Stock Type

Annual Quantities	**DMU**	**Push-Pull**
Route Miles	16.2	16.2
Track Miles	19.2	19.2
Total Trips per Year	8,380	8,380
Revenue Train Miles	135,756	135,756
Operating Crew Hours	9,040	9,040
Ops Crew Overtime Hours	1,835	1,835
Ops Crew Absentee Coverage Hours	1,472	1,472
Operations Support/Supervisor Hours	8,320	8,320
Locomotives	0	3
DMUs	3	0
Coaches	3	6
Maintenance Supervisor Hours	4,160	4,160
Maintenance Crew Hours	14,560	12,480
Bridges	1	1
Grade Crossings	13	13
Platforms	4	4
Parking Spaces	300	300
Turnouts	11	11

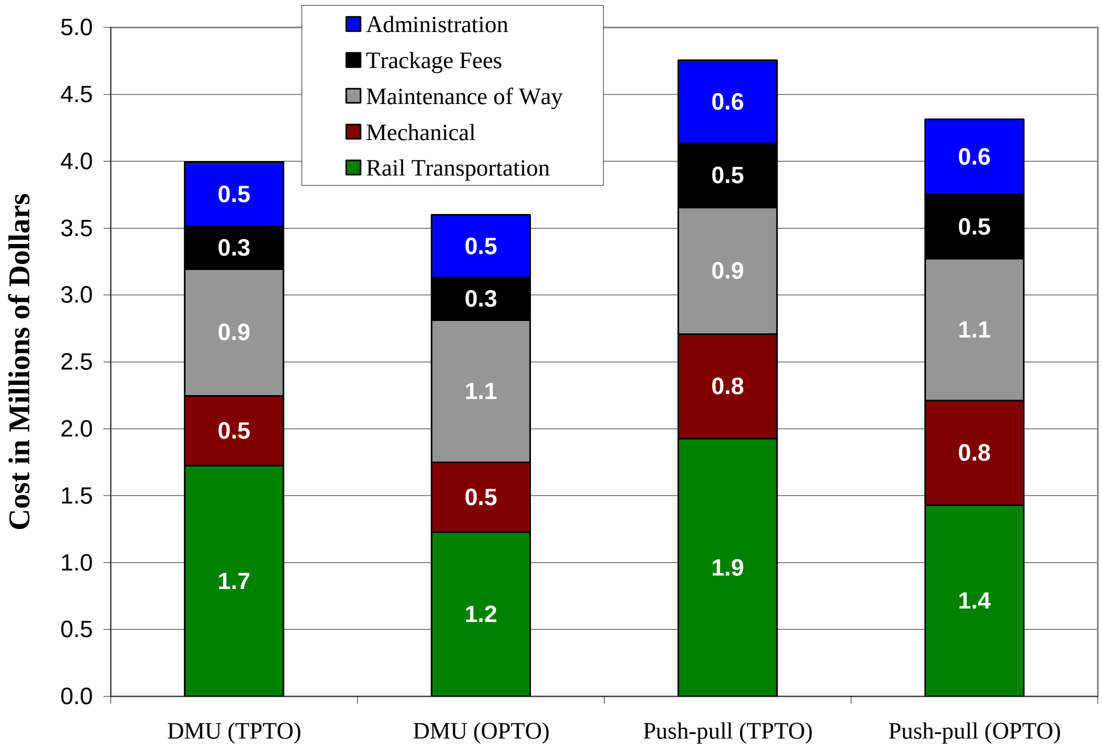
Table III.13 summarizes the forecast operating expense for the four alternative service packages illustrated in Figure III.17. Operating costs range from a low of $3.6 million for DMU service with one person train operation to a high of $4.8 million for push-pull service with two person train operations.[48]

Table III.13: Summary of Routine Operating Costs for Woonsocket to Providence Service Regimes

	DMU Service		Push-Pull Service	
	TPTO[49]	**OPTO[50]**	**TPTO**	**OPTO**
Rail Transportation				
Train Crews	$993,225	$496,612	$993,225	$496,612
Supervision	$375,318	$375,318	$375,318	$375,318
Dispatching	$100,000	$100,000	$100,000	$100,000
Fuel	$255,541	$255,541	$457,283	$457,283
Mechanical				
Labor	$303,905	$303,905	$507,656	$507,656
Materials	$218,609	$218,609	$274,223	$274,223
Maintenance of Way				
Labor	$750,637	$839,998	$750,637	$839,998
Materials	$197,105	$221,743	$197,105	$221,743
Trackage Fees				
	$319,125	$319,125	$478,687	$478,687
Administration				
15%	$495,455	$468,832	$649,296	$574,804
Total	**$3,992615**	**$3,600,479**	**$4,754,255**	**$4,314,250**

[48] Long term costs for vehicle and infrastructure asset renewal are not included in the summaries of routine operating cost. Please refer to the *Rolling Stock Renewal* and *Infrastructure Asset Renewal* sections for estimates of these costs.
[49] TPTO – Two Person Train Operation
[50] OPTO – One Person Train Operation

Figure III.17: Routine Operating Costs for Woonsocket to Providence Service Regimes



Estimating Revenue

The expected revenues were estimated using ridership forecasts and the current MBTA zonal fare structure. For trips to Boston, Pawtucket station is associated with Zone 8 fares.[51] The average fare from Zone 8 to Boston, accounting for passengers traveling with discounted passes, is estimated at $5.83.[52] For trips within Rhode Island, the distance between stations was used to assign each origin and destination pair a fare based on the MBTA's zonal regime for single-trip tickets. Fares to Pawtucket and Providence are displayed in Table III.14.

Table III.14: One-way Fares to Providence and Pawtucket, Annual Inbound Boardings and Revenue

Station	Zone to Providence	Fare to Providence	Zone to Pawtucket	Fare to Pawtucket	Annual Inbound Boardings to Provid.	Annual Inbound Boardings to Boston	Annual RI Revenue	Annual MBTA Revenue
Woonsocket	3	$5.25	2	$4.75	28,874	39,128	$674,895	$456,235
Manville	2	$4.75	1	$4.25	7,826	7,286	$136,274	$84,954
Berkeley	1	$4.25	1A	$1.70	78,526	6,476	$689,494	$75,515
Pawtucket	1A	$1.70	-	-	110,908	0	$377,088	$0
Total					**226,134**	**52,891**	**$1,877,751**	**$616,704**

[51] KKO and Associates, LLC (Sep 2003). Pawtucket/Central Falls Rail Station, Draft, Stage 2: Ridership Forecasts. Prepared for Pawtucket Foundation: Pawtucket, RI.
[52] MBTA Railroad Operations (FY2007). Average Fare Calculation. MBTA: Boston, MA.

Based on these fares, Rhode Island's estimated annual fare revenue is $1.9 million. Because the service would offer a connection to MBTA service to Boston, the MBTA would derive $0.6 million in annual revenue for new trips on MBTA services, where the entire fare between Pawtucket and Boston is retained by the MBTA. Passengers destined for Boston make up nearly 25% of the total forecast passengers. Total combined passenger revenue for RIDOT and MBTA would be approximately $2.5 million.[53]

It should be noted, however, that the fares assumed for intra-Rhode Island service (shown in Table III.14) may be somewhat higher than fares that would be actually charged. The assumed fares amount to a roundtrip fare of $10.50 between Woonsocket and Providence, and $21.16, on average, between Woonsocket and Boston. In order to make the service more accessible to potential passengers, it is likely that Rhode Island would offer lower fares along the corridor between Woonsocket and Providence. Lowering intra-state fares would decrease the revenue collected from each passenger, but would likely increase the number of passengers served.

Only Rhode Island revenue for travel along the line between Woonsocket and Providence is considered in the calculation of performance indicators below.

Performance Statistics

This portion of the report integrates information from the passenger and revenue forecasts with estimates of operating and capital costs to provide four key measures to rank and evaluate the alternative service regimes.

- Capital cost per weekday inbound passenger
- Operating cost per annual passenger trip
- Farebox recovery ratio
- Required annual operating support

Results are summarized in Table III.15 and Figures III.18 through III.21.

Table III.15: Performance Statistics for Woonsocket to Providence Service Regimes

	DMU Service		Push-Pull Service	
	TPTO	OPTO	TPTO	OPTO
Capital cost per weekday inbound passenger	$70,881	$70,881	$71,739	$71,739
Operating cost per annual passenger trip	$7.15	$6.45	$8.52	$7.73
Fare recovery ratio	47%	52%	39%	44%
Required annual operating support	$2,114,864	$1,722,728	$2,876,503	$2,436,499

<u>Capital Cost per Weekday Inbound Passenger</u>

It is assumed that virtually all of the forecast riders on the proposed services would be new transit riders. The forecast capital cost to divert these travelers from the highway to the transit

[53] Parking revenue and costs are not reflected in performance measures.

network would range between $70,881 and $71,739 per rider. This range of capital costs per passenger lies above the range of projected performance for similar planned projects that are currently participating in the FTA New Starts Program as shown in Table III.16.

Figure III.18: Capital Cost per Forecast Weekday Inbound Passenger

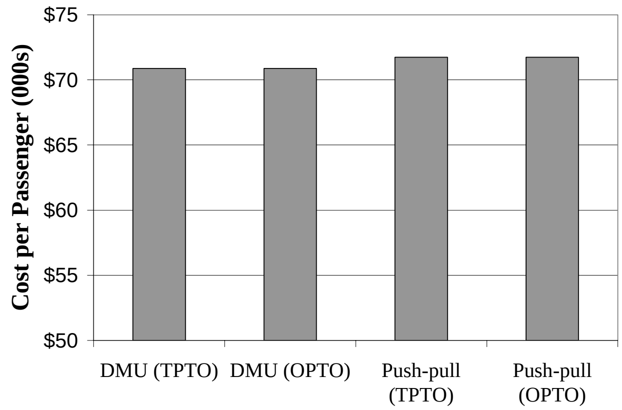


Table III.16: Projected Capital Costs and Ridership for Comparable Projects in FTA New Starts Program

State	Project	Projected Capital Cost (Millions)	Estimated Daily Ridership	Capital Cost Per Daily Boarding	Status
CA	Oceanside Escondido Rail Corridor	$351.5	19,000	$18,501	Fully Funded
NC	Raleigh Durham Regional Rail	$809.9	13,800	$58,688	Final Design
OR	Wilsonville/Beaverton Commuter Rail	$117.3	3,000	$39,100	Final Design
PA	Schuylkill Valley Metro	$2,588.9	41,200	$62,837	Preliminary Engineering
UT	Weber County to Salt Lake Com. Rail	$611.7	11,800	$51,839	Final Design

Source: FTA Annual Report on New Starts 2005: Appendix A updated with data from the FTA Annual Report on New Starts 2007: Appendix A

It should be noted that not all projects currently participating in the FTA program are expected to receive federal funding to complete construction. The Oceanside Escondido project with its relatively favorable cost economics has an FTA Funding Grant Agreement, while the Raleigh-Durham project is having difficulties reaching approval for full funding.

<u>Operating Cost per Passenger Trip</u>

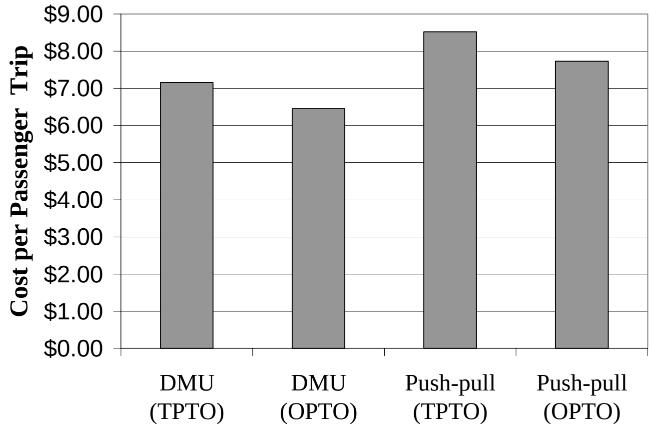
The forecast operating cost per passenger trip for all service packages ranges between $6.00 and $9.00 per boarding.

This range is favorable when compared to the per passenger operating costs reported for the eight smallest US commuter railroads[54]. Among the eight smallest commuter railroads the

[54] San Jose ACE, San Diego Coaster, Miami Tri-Rail, New Haven Shore Line East, Dallas Trinity Railway Express (TRE), Chicago NICTD, Seattle Sounder, Washington Virginia Railway Express (VRE).

average operating cost per passenger boarding in 2003 was $12.51, with a maximum of $19.37 (ACE) and a minimum of $8.18 (NICTD).

Figure III.19: Operating Cost per Forecast Passenger Trip

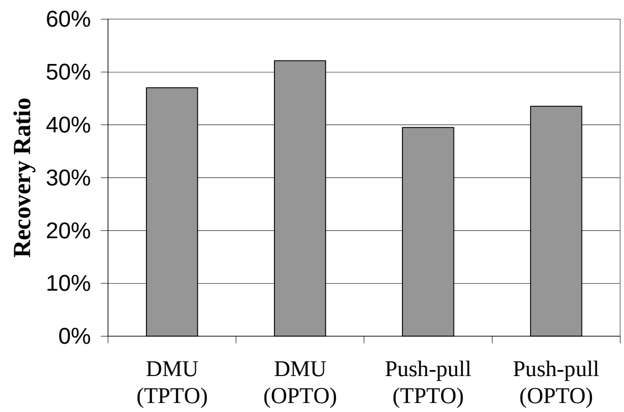


Farebox Recovery Ratio

The fraction of operating costs covered by passenger fare revenue would range between approximately 39% and 52%. However, it is likely that fares lower than those assumed would be charged, which may cause farebox recovery ratios to decrease.

This range compares very favorably with typical farebox recovery ratios achieved by comparable services, based on figures reported by the eight smallest US commuter railroads. Among the eight smallest commuter railroads the average farebox recovery ratio in 2003 was 29%, with a maximum of 55% (VRE) and a minimum of 6% (TRE).

Figure III.20: Fare Recovery Ratio

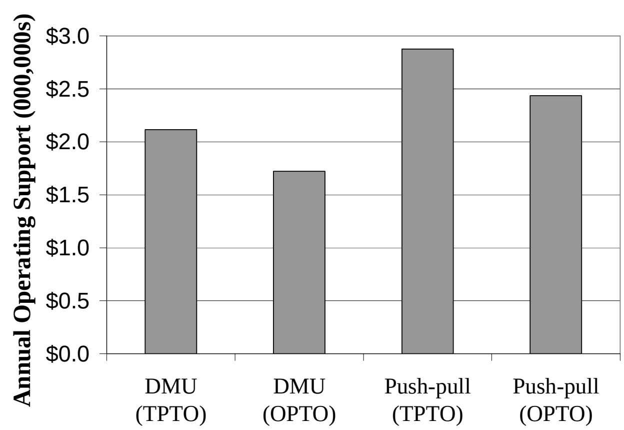


Required Annual Operating Support

All of the service packages would require a substantial level of annual support from sources other than passenger revenues to fund operations. The required operating support estimated by the study team ranges from $1.7 to $2.9 million.

Compared with the eight smallest operating US commuter railroads, the required annual operating support required for the Woonsocket service packages is quite low. Among the eight comparable systems the average annual level of required operating support was $13 million, with a maximum of $25.4 (TRE) and a minimum of $5.4

Figure III.21: Annual Operating Support



(Shore Line East), in 2003. None of the eight operating systems require less annual operating support than would be projected for the Woonsocket to Providence service regimes.

Conclusions

Ridership forecasts do not vary with the type of equipment used, or train crew size. Therefore, DMU, OPTO service, which is associated with the lowest operating cost, achieves the most favorable fare recovery ratio (60%), and the lowest level of required operating support ($1.5 million).