Central Corridor

Passenger Rail Feasibility Study

Prepared for

Massachusetts Department of Transportation

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EXECUTIVE SUMMARY

The Central Corridor Line Passenger Rail Feasibility Study (Study) examines the implementation and operation of an intercity passenger rail service along the Central Corridor (CC). The CC Line connects the cities of Brattleboro, Vermont to New London, Connecticut via the New England Central Railroad (NECR) Palmer Division line south.

Initially, a profile of the corridor was assembled using data from partner railroads and agencies. Speed profiles and timing was developed to understand the journey length for the trip from Brattleboro to New London. Additionally, ten initial station stops were considered for analysis:

- Brattleboro, Vermont (existing Amtrak Station);
- Millers Falls, Massachusetts;
- Amherst, Massachusetts (historic station site);
- Palmer, Massachusetts (historic station site);
- Stafford Springs, Connecticut;
- Mansfield/Storrs, Connecticut;
- Willimantic, Connecticut;
- Norwich, Connecticut;
- Mohegan Sun, Connecticut, and
- New London, Connecticut (existing Amtrak Station).

Notable locations that would be served by this line include two state universities, 11 smaller colleges, the Mohegan Sun Resort and Casino, commuters between Willimantic, Norwich, and New London, and regional travelers.

Three scenarios were developed to understand the full range of potential ridership on the CC utilizing one, two, or three trainsets. One trainset would provide two round trips on the CC daily, while two trainsets would provide peak hour and off peak service, and three trainsets would provide nearly hourly service on the CC.

Ridership forecasts for the CC were estimated by developing and applying a direct demand model. The direct demand modeling approach measures rail ridership at the station level and relationship to key independent variables that are known to influence ridership, including population density, employment density, number of trains operating daily, and other level-of-service parameters. Direct demand regression models have several advantages including quick turnaround time in model outputs, the ability to test the sensitivity of independent variables, and relatively short time needed for model estimation. The direct demand model developed for the CC was also tested on the New Haven-Springfield rail corridor to determine its accuracy and produced results consistent with existing rail ridership in that corridor.

The model results indicate that the daily rail ridership in the CC in the year 2020 would be between 385 and 405 riders depending on the level of service provided. 2020 was used as the baseline year to measure ridership to provide a near term baseline year for ridership estimation. The sensitivity of ridership with respect to the number of trains running in the corridor is modest, which is typical for intercity passenger rail services in rural areas.

Total capital costs for the CC were estimated to be $376.5 million, inclusive of right-of-way upgrades, station construction and rehabilitation, and purchase of new trainsets. While the CC is an active freight line, significant rehabilitation of the right-of-way would improve speed and reliability, and provide for active passenger rail service along with the construction of stations that meet federal and industry standards. The major infrastructure components include track, grade crossings, bridges, signals, and station improvements and constructions. Capital costs for the CC were estimated based on similar costs developed for rehabilitation of the Massachusetts Department of Transportation's (MassDOT) Knowledge Corridor-Restore the Vermonter project since the rehabilitation of the CC was assumed to involve similar work. However, a detailed inspection and refinement of the cost estimate would need to occur as part of any subsequent project evaluation. Additionally, annual operating and maintenance costs are expected to be approximately $6 million, based on existing operating and maintenance costs for Amtrak services in New England and assuming utilization of a single trainset for one daily roundtrip.

According to figures developed for the Northern New England Intercity Rail Initiative (NNEIRI) project, each new trainsets would cost approximately $27 million to purchase. For this new service, six passenger cars and a locomotive would be required. For the purposes of this report, it was assumed that new rolling stock would be required and is therefore included in the capital cost.

The analysis conducted as part of the study process concluded that the anticipated ridership was limited (400 riders per day). This reflects the low population density along the corridor and minimal expected interaction between the special generators. The projected capital cost of the proposed service is approximately $376.5 million, with an annual operating and maintenance cost of $6 million. The service would only intersect in New London the Preferred Alternative of the Northeast Corridor (NEC) as identified in the Tier 1 Final EIS of the Federal Railroad Administration's (FRA) NEC Future, a comprehensive planning effort to define, evaluate, and prioritize future rail investments along the Northeast Corridor between Boston and Washington, DC. The respective state agencies and departments should continue to evaluate public support relative to furtherance of the service and include it in any statewide passenger and freight rail planning efforts in order to prioritize passenger rail service along the Central Corridor Line relative to other competing rail needs. Additionally, if any elements of passenger rail service along the Central Corridor Line should move forward, they would need to be evaluated as part of each state's capital investment planning and project selection processes in order to be scored and ranked relative to other capital rail projects.

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1. INTRODUCTION AND EXISTING CONDITIONS

The Central Corridor Line Passenger Rail Feasibility Study (Study) examines the possible implementation and operation of an intercity passenger rail service along the Central Corridor (CC). The CC connects the cities of Brattleboro, Vermont to New London, Connecticut via the New England Central Railroad (NECR) Palmer Division line south.

The Study focuses on infrastructure improvement concepts to maximize the use of an existing rail corridor between Brattleboro and New London. Figure 1.1 provides an overview of the location of the corridor and the general study area.

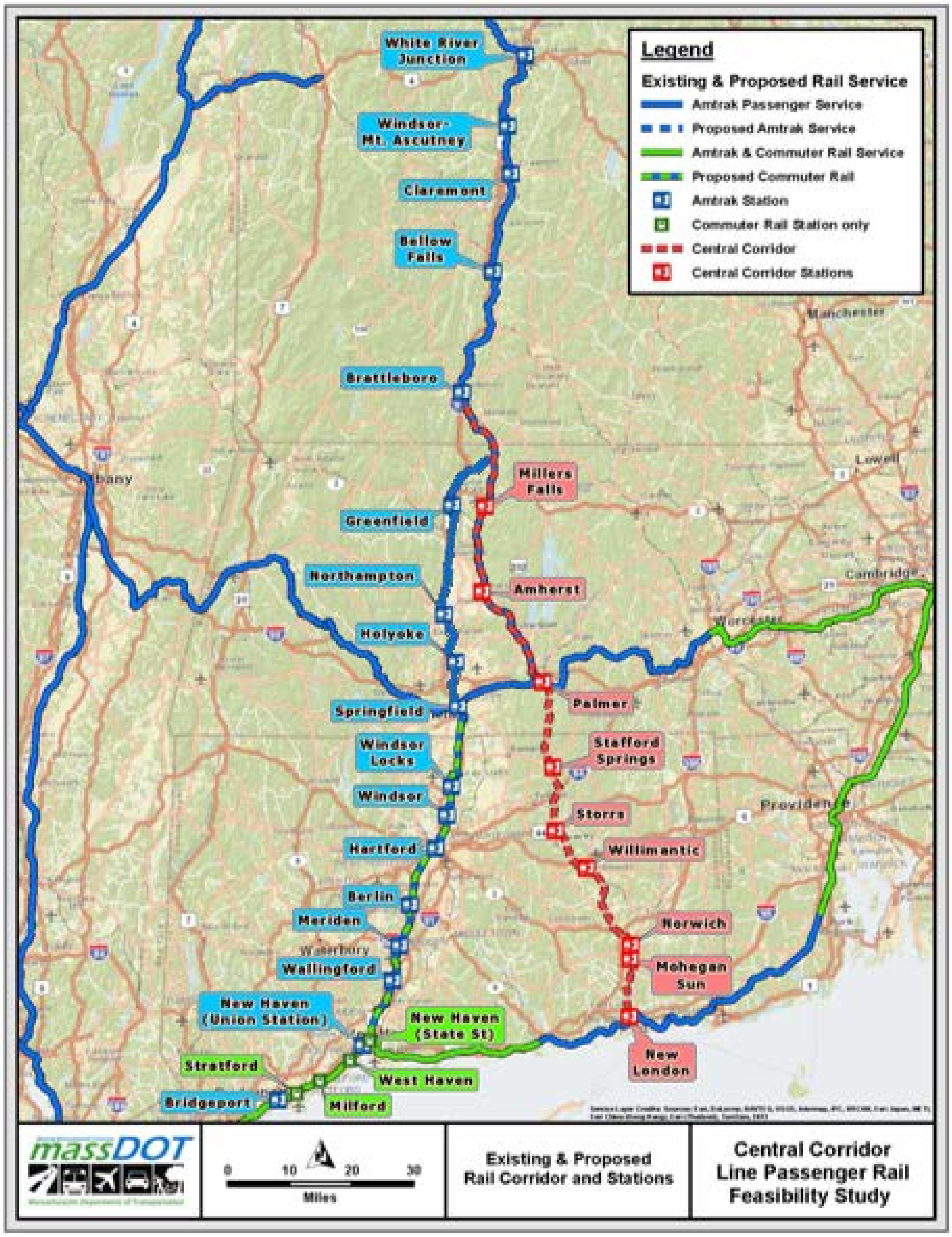

Figure 1.1 Central Corridor Study Area

The CC line is currently a freight right-of-way owned and operated by NECR, a division of Genesee & Wyoming, Inc. Currently, no passenger service operates on the CC with the exception of the segment from the Vermont/Massachusetts border to Brattleboro, VT. The Amtrak Vermonter service previously used the CC line between Palmer, MA and East Northfield, MA with a stop in Amherst, MA. However, the Vermonter was shifted to the Knowledge Corridor right-of-way in 2014 after that project was completed with Federal and state funding.

The line intersects with the Knowledge Corridor in East Northfield, Massachusetts, the CSX line (on which the daily Amtrak Lake Shore Limited operates) between Boston and Springfield in Palmer, Massachusetts, and the Amtrak Northeast Corridor (NEC) in New London, Connecticut. Passenger rail service on the CSX line, as well as service to New London on the NEC, was discussed as part of the FRA's NEC Future, a comprehensive planning effort to define, evaluate, and prioritize future rail investments along the Northeast Corridor between Boston and Washington, DC. The Preferred Alternative, selected in the Tier 1 Final EIS issued in December 2016, retains the existing Northeast Corridor route through Rhode Island and along the Connecticut shore as the primary travel corridor between Boston and New York City, with expanded service between New Haven and Springfield to serve Western Massachusetts. This Preferred Alternative does not directly impact the CC line save for connecting service in New London. Additional information on CC infrastructure and assumptions is included in Chapter 4.

The corridor passes through small and mid-size cities, towns, and rural regions in Vermont, Massachusetts, and Connecticut. Special attractions along the corridor include higher education institutions, resorts and casinos, museums, and other cultural sites. Additional information on the demographic discussion of special generators in the CC region is included in Chapter 3.

2. PROJECT ALIGNMENT AND SERVICE DEVELOPMENT

This chapter discusses the alignment and layout for the CC, as well as travel times passengers may expect to see when travelling along the line.

2.1 ALIGNMENT

The CC begins in Brattleboro, Vermont and follows the NECR Palmer Division line south to New London, Connecticut. The line is approximately 121 miles in length.

2.2 POTENTIAL STATION STOPS

The following potential station stops were considered:

- Brattleboro, Vermont (existing Amtrak Station);
- Millers Falls, Massachusetts;
- Amherst, Massachusetts (historic station site);
- Palmer, Massachusetts (historic station site);
- Stafford Springs, Connecticut;
- Mansfield/Storrs, Connecticut;
- Willimantic, Connecticut;
- Norwich, Connecticut;
- Mohegan Sun, Connecticut; and
- New London, Connecticut (existing Amtrak Station).

Station stops would require Americans with Disabilities Act (ADA) accessible station infrastructure. The stations would also need to meet American Railway Engineering and Maintenance (AREMA), Connecticut Department of Transportation (CTDOT), Massachusetts Department of Transportation (MassDOT), and Vermont Agency of Transportation (VTrans) requirements for station design.

2.3 TRAVEL TIMES

Travel times on the alignment were established using Amtrak time tables (Brattleboro to Amherst) and estimates from NECR track charts for points south. Travel times assume a two-minute dwell time at stations and one minute of recovery time. Additionally, travel times assume trains make stops at all stations and do not operate with any express or skip-stop service. Standard, non-tilt operating equipment is assumed for the purposes of travel time speeds. Travel times are profiled in Table 2.1.

Table 2.1: Travel Time from New London to Points North

City/Town	Approximate Distance from New London (Miles)	Total Run Time (H:MM)	Time from Previous Station (H:MM)
New London	0	0:00	0:00
Mohegan Sun	6	0:09	0:09
Norwich	15	0:25	0:16
Willimantic	30	0:49	0:24
Mansfield/Storrs	40	1:07	0:18
Stafford Springs	50	1:25	0:18
Palmer	64	1:50	0:25
Amherst	84	2:17	0:27
Millers Falls	99	2:38	0:21
Brattleboro	121	3:06	0:28

Travel times were derived from NECR track charts and using FRA track class regulations. Table 2.2 shows FRA track class regulations. FRA regulations establish classes of track based on maximum allowable speed. Maximum speeds in each of the options mirror FRA Track Classifications Maximum Operating Speeds for passenger rail. FRA track safety standards primarily address track geometry, infrastructure conditions, and maintenance standards.[1] NECR track charts are written in terms of FRA track class regulations.

Table 2.2: FRA Track Classifications

Over track that meets the requirements prescribed for:	The maximum allowable speed for freight trains is:	The maximum allowable speed for passenger trains is:
Class 1 Track	10 mph	15 mph
Class 2 Track	25 mph	30 mph
Class 3 Track	40 mph	60 mph
Class 4 Track	60 mph	80 mph
Class 5 Track	80 mph	90 mph

[1] FRA Track Classification standards also contain specific requirements for higher speed operation. For operation at Class 5 or higher speeds (above 80 mph), trains must be equipped with positive train control and/or cab signal systems. A positive train control system will automatically slow or stop a train if an engineer fails to respond to a signal indication. A cab signal system duplicates signal indications on a display within the locomotive cab.

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3. RIDERSHIP ANALYSIS

The purpose of this chapter is to document the methodology and results of the ridership forecasting analysis for the proposed CC rail service.

Travel times on the CC were established using existing Amtrak travel times (Brattleboro to Amherst) and estimates from NECR track charts. The estimated one-way travel time from Brattleboro to New London is approximately three hours. Fares are based on commuter rail-type distance based zone structure used by the CTDOT on the Shore Line East. Three different operating scenarios were considered for this service assuming the use of one, two, and three trainsets a day. Details of the service development assumptions and associated operating plans are presented in Appendix A.

3.1 RIDERSHIP FORECASTING METHODOLOGY

The ridership model developed for this study falls into the category of direct demand travel modeling. This direct demand approach is based on regression analysis in which the rail ridership at the station level (the dependent variable) is related to key independent variables that are known to influence ridership. These variables include population density, employment density, number of trains operating daily, and other level-of-service parameters. Direct demand regression models have several advantages including quick turnaround time in model outputs, the ability to test the sensitivity of independent variables, and relatively short time needed for model estimation. The forecasting approach produces reliable ridership projections appropriate for supporting a conceptual-level planning study such as this one.

Direct demand models provide a basis for analysis that enable accurate and substantial modeling forecasts to be created for future transportation and travel projections. The direct demand model provides better forecasting for transit models than the four-step model which is more applicable for auto-based travel. For example, direct demand models are not network based. Therefore, while the four-step regional travel demand models produce comparable ridership forecasts to direct demand models, they are not capable of capturing the impact of transit service on competing non-transit modes. Additionally, the four-step models do not provide any data to capture the air quality or highway congestion impacts that are needed in full-scale environmental studies. Therefore, for the purposes of a passenger rail study, the direct demand model was considered the most appropriate model to support feasibility planning decisions needed in consideration of this study.

The underlying assumption of direct demand modeling is that existing travel patterns in the proposed service area are an indicator of future passenger railroad demand. The strength of the direct demand methodology is that the forecasts are based on actual travel data and not assumption-based forecasts.

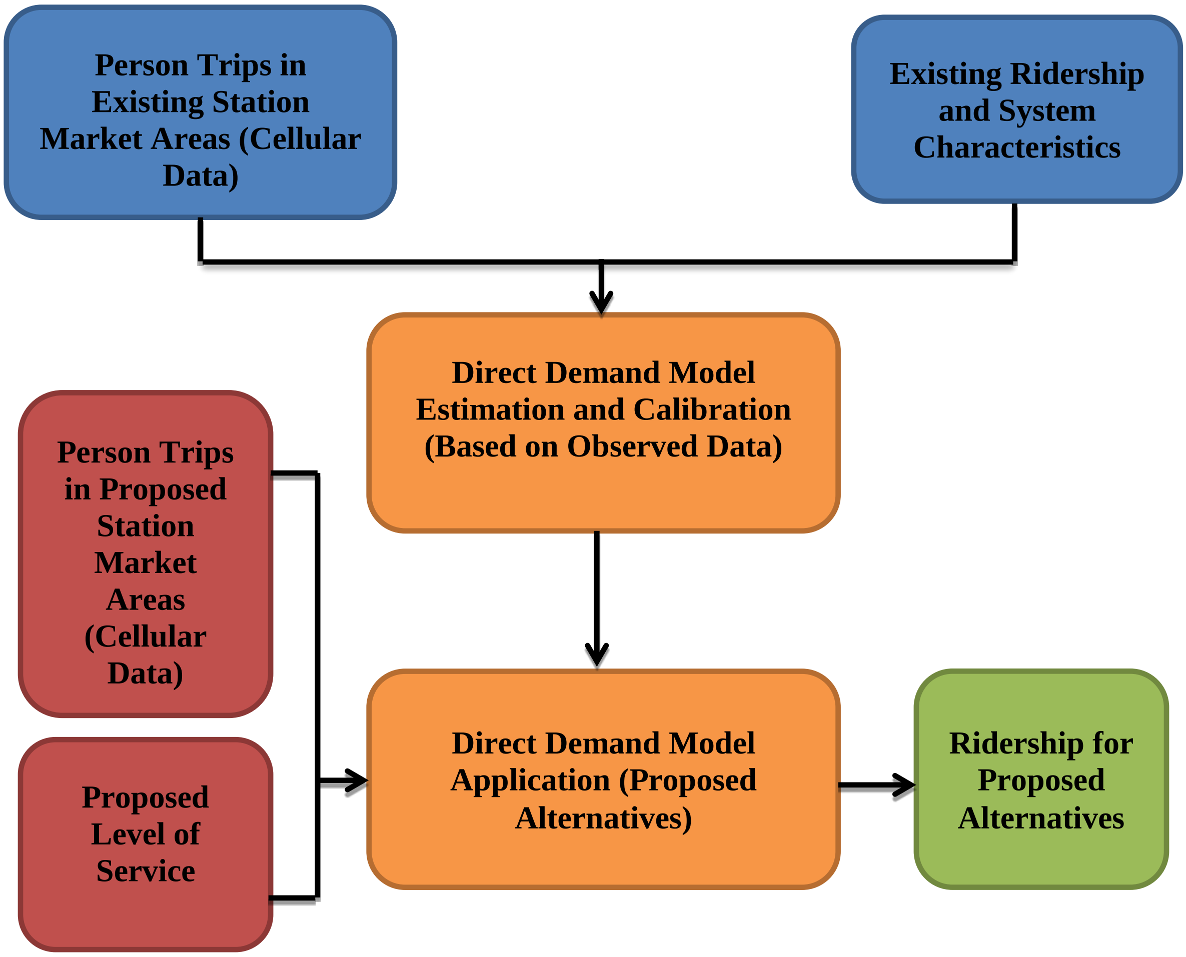
The three key steps involved in direct demand model development process include:

1. Data Assembly
2. Data Analysis
3. Model Formulation

Datasets related to person trips in the existing station market areas, existing ridership, and system characteristics were assembled and analyzed in order to establish a mathematical relationship between existing rail ridership and all modal trips in a rail corridor. The travel datasets are derived from cellular travel data (see Appendix B for further information on the use of cellular data). Use of the cellular travel datasets are referred to as direct demand model estimation and calibration. The model was subsequently applied to the proposed corridor to forecast future ridership, accounting for person trips in the proposed station market areas and level of rail service being proposed. The regression equation demonstrated acceptable calibration and correlation to existing ridership. Based on this result, the model is deemed able to produce realistic forecasts.

The modeling and process procedure and steps are illustrated in Figure 3.1. The blue boxes represent the datasets assembled from the existing rail corridors (which was used to develop the model) and the dark red boxes represent the datasets developed for the proposed corridor (which was fed to the model to develop the ridership forecasts for the proposed alternatives). The orange boxes represent the modeling process and the green box represents the results.

Figure 3.1: Modeling Approach



3.1.1 DATA ASSEMBLY

The first step in the forecasting process was to collect data on observed ridership, key demographic characteristics, and level of rail service in the existing rail corridors that are generally in the same geographic area as the proposed rail corridor.

To analyze the fundamental relationship between rail ridership and the independent variables mentioned earlier, the following data items were assembled for use in the regression model development.

- Ridership information for the existing Massachusetts, Connecticut, and Vermont Amtrak services was collected from Amtrak. This included number of daily boardings at all stations in the Vermonter and Connecticut corridors. Total boarding and alighting data by station was only available. Generally, for intercity passenger rail service, the boardings and alightings at each station were divided in half since, on a daily basis, an individual making a trip to another location will return to the origin location.
- Socio-economic data within the primary market area (15-mile buffer) of each station was desired. However, some difficulties were encountered in obtaining readily available employment data. Therefore, a decision was made to use the total number of person trips (regardless of transportation mode) made within the primary market area of each station as a proxy for population and employment.
- In addition, several special travel markets (including universities, schools, and casinos) are located within the study area. Traditional socioeconomic modeling often does not adequately capture these special travel markets. By capturing the actual origin-destination pairs, cellular phone data captures these specific special travel markets. The AirSage WiSE (Wireless Signal Extraction) platform was utilized to collect and analyze wireless network data to determine the location and movement of cell phones, which were subsequently converted to person trip origin-destination matrices. Thus, special generators such as the college population and casino patrons were more accurately represented. The cellular data collection and processing methodology is documented in Appendix B. When compared to person trips that are calculated from trip-based models, cell phone person trip data is more accurate and reliable.
- The total number of trains stopping at each station during weekdays was obtained from the CC train schedules developed for the project.
- Data on local and regional bus services and road network connections were obtained to evaluate the accessibility of each station.
- Data on fares and headways were collected from the Amtrak website.

3.1.2 DATA ANALYSIS

To verify the accuracy of AirSage cell phone data for use in the regression model, an analysis of regional travel patterns was conducted.

Figure 3.2 profiles the distribution of population densities in the existing rail corridors as well as in the CC. As demonstrated, the densities are much higher along the Knowledge Corridor (East Northfield to Springfield) and the Springfield-to-New Haven Corridor as compared to the Vermonter corridor (Vermont to Palmer) and the CC. The person trip (all modes) data extracted for each station market area from the cell phone database is generally consistent with the population densities. The data suggests that the ridership in the CC is expected to be no greater than the Vermonter and New Haven-Hartford-Springfield (NHHS) Corridors.

Figure 3.2: Population Densities in the Study Area

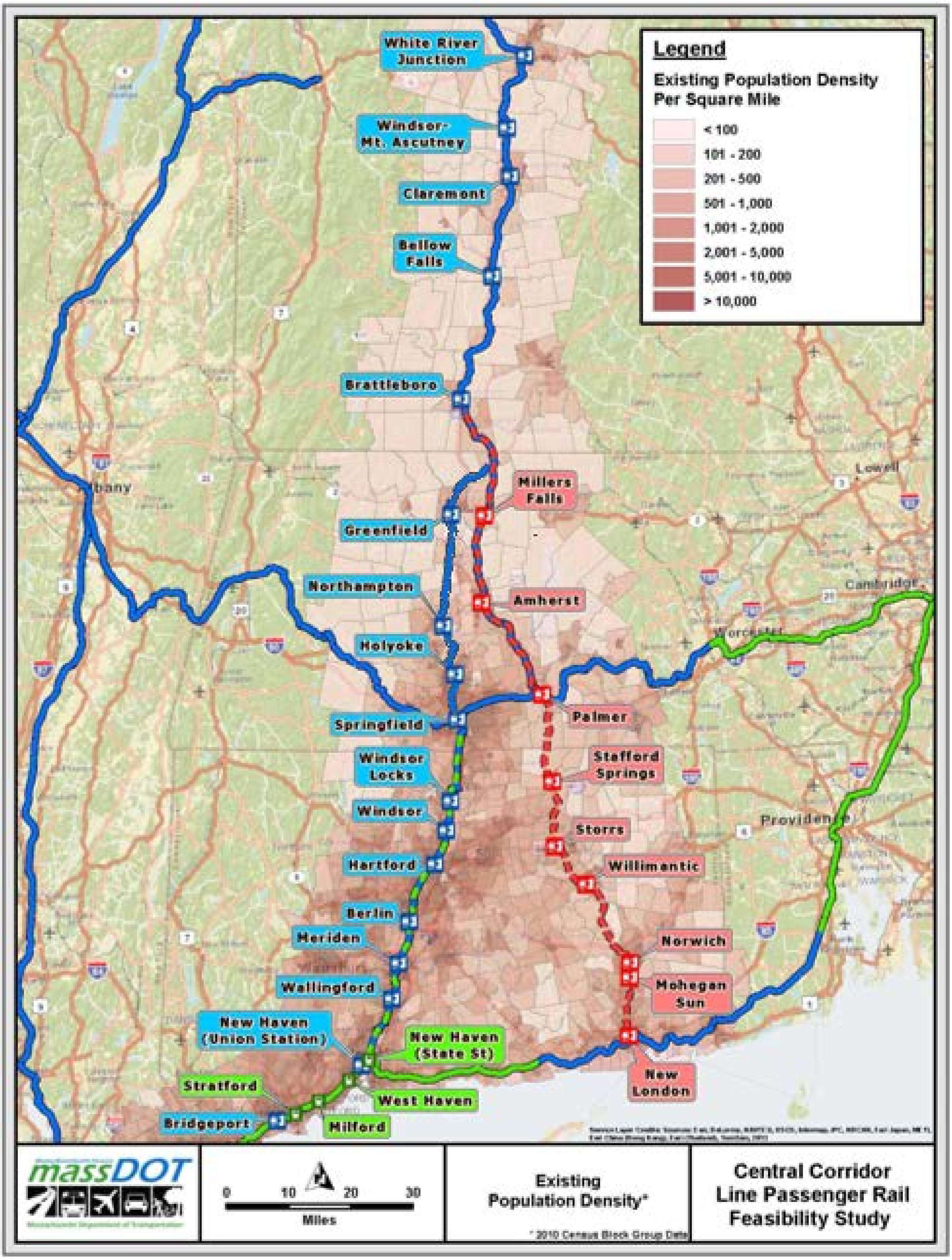


Figure 3.3 shows the person trip (all modes) data within a 15-mile buffer around each station in the existing rail corridors on a typical weekday. As seen in the figure, there are five major cities along the Vermonter Corridor in Massachusetts and Connecticut (Springfield, Hartford, Meriden, New Haven, and Bridgeport) that have some of the highest person trips (between one million and 1.5 million) within 15 miles of each station. Since the cell phone data contains origin and destination information of each trip made in the study area, it was possible to construct travel desire lines using that data. Figure 3.4 shows the trip desire lines in the existing corridor. Most trips originate or are destined to areas having high population densities, confirming the validity of the cell phone data. The person trip data and travel patterns were extracted from the cell phone data and included in Appendix C. Table 3.1 summarizes data that was used in the development of the direct demand model.

Table 3.1: Input Data Used in Model Development

Station	Number of Daily Rail Boardings	Daily Person Trips in the Corridor (All Modes)	Daily Train Stops	Hub	Accessibility
White River Junction	21	197,940	2	0	0
Windsor, VT	2	65,145	2	0	0
Claremont	3	127,874	2	0	0
Bellow Falls	7	99,620	2	0	0
Brattleboro	26	174,072	2	0	0
Springfield	194	1,453,733	14	1	0
Windsor Locks	26	746,673	12	0	0
Windsor, CT	18	805,002	10	0	0
Hartford	257	1,593,626	12	0	1
Berlin	35	1,407,792	12	0	0
Meriden	49	995,200	12	0	0
Wallingford	23	855,622	12	0	0
New Haven	NA	730,338	15	1	0
Bridgeport	110	1,340,480	15	0	0

Definition of Variables

- Station: Existing stations where characteristics of existing rail services were analyzed
- Number of Daily Boardings: Average number of people boarding the train at the existing Amtrak stations on a daily basis (derived from Amtrak data).
- Daily Person Trips: Number of daily person trips within 15-mile buffer of the existing station (derived from AirSage data).

- Daily Train Stops: Number of trains currently stopping at the station on a daily basis (derived from Vermonter and Northeast Corridor Amtrak schedule).
- Hub: A variable that captures the impact of transfer activities on ridership, otherwise unexplained by the other variables. The variable value is either 1 or 0 depending on whether or not a station involves such activities.
- Accessibility: A variable that captures impact of good accessibility to rail service on ridership, otherwise unexplained by the other variables. The variable value is either 1 or 0 depending on whether or not a station involves such activities.

Figure 3.3: Current Daily Person Trips in the Existing Rail Corridor

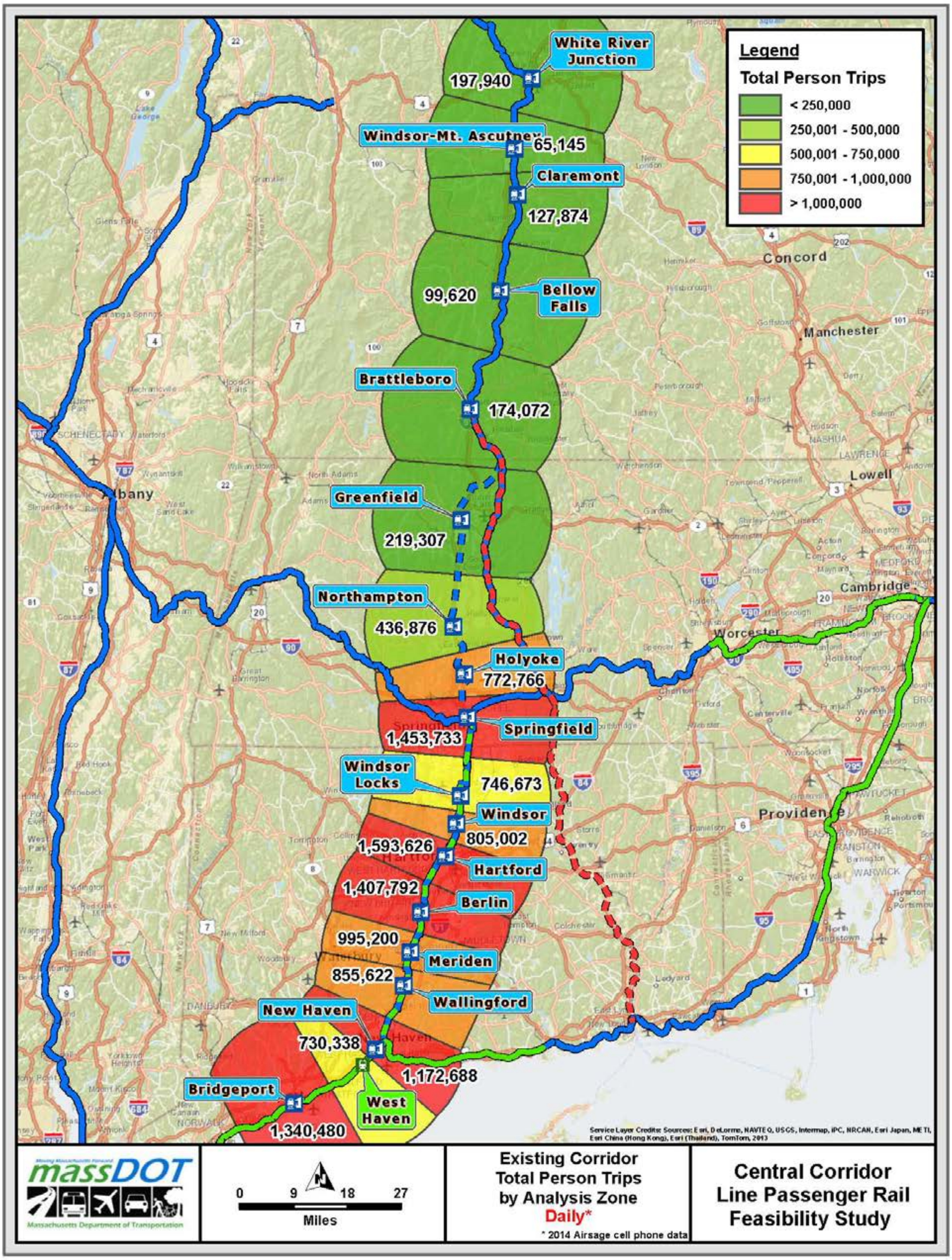
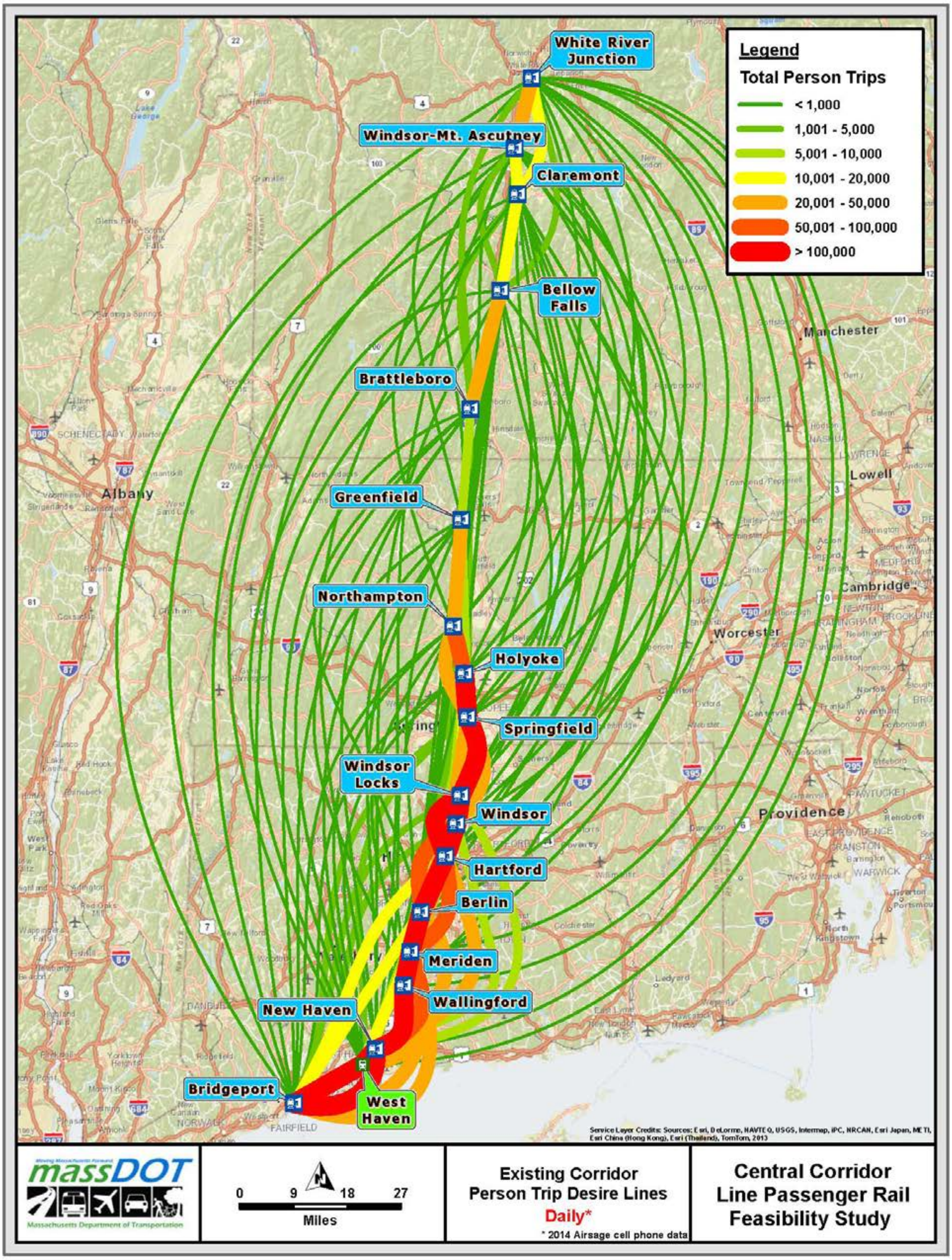


Figure 3.4: Current Travel Patterns in the Existing Rail Corridor



3.1.3 MODEL FORMULATION

During the process of model development, tests of different combinations of independent variables and data were conducted and evaluated. For example, fare payment was tested as an independent variable and found to be statistically insignificant. Therefore, the variable was dropped from further consideration in the model.

Transportation connectivity and accessibility are two important parameters that can have significant impact on ridership. The magnitude of ridership at Springfield and Hartford is much higher in comparison to other stations, as profiled in Table 3.5. To reflect the higher accessibility associated with Hartford Union Station (two interstate highways, i.e., I-84 and I-91, and the 35 bus routes that operate near the train station), an accessibility variable was used in the regression process. Similarly, since Springfield Union Station is served by local bus as well as Amtrak service and it is proximate to an intercity bus terminal, it functions like a major transportation hub. To incorporate the increased connectivity, a hub variable was introduced into the regression process.

The final regression equation that was selected for estimating the stop-level boardings is as follows:

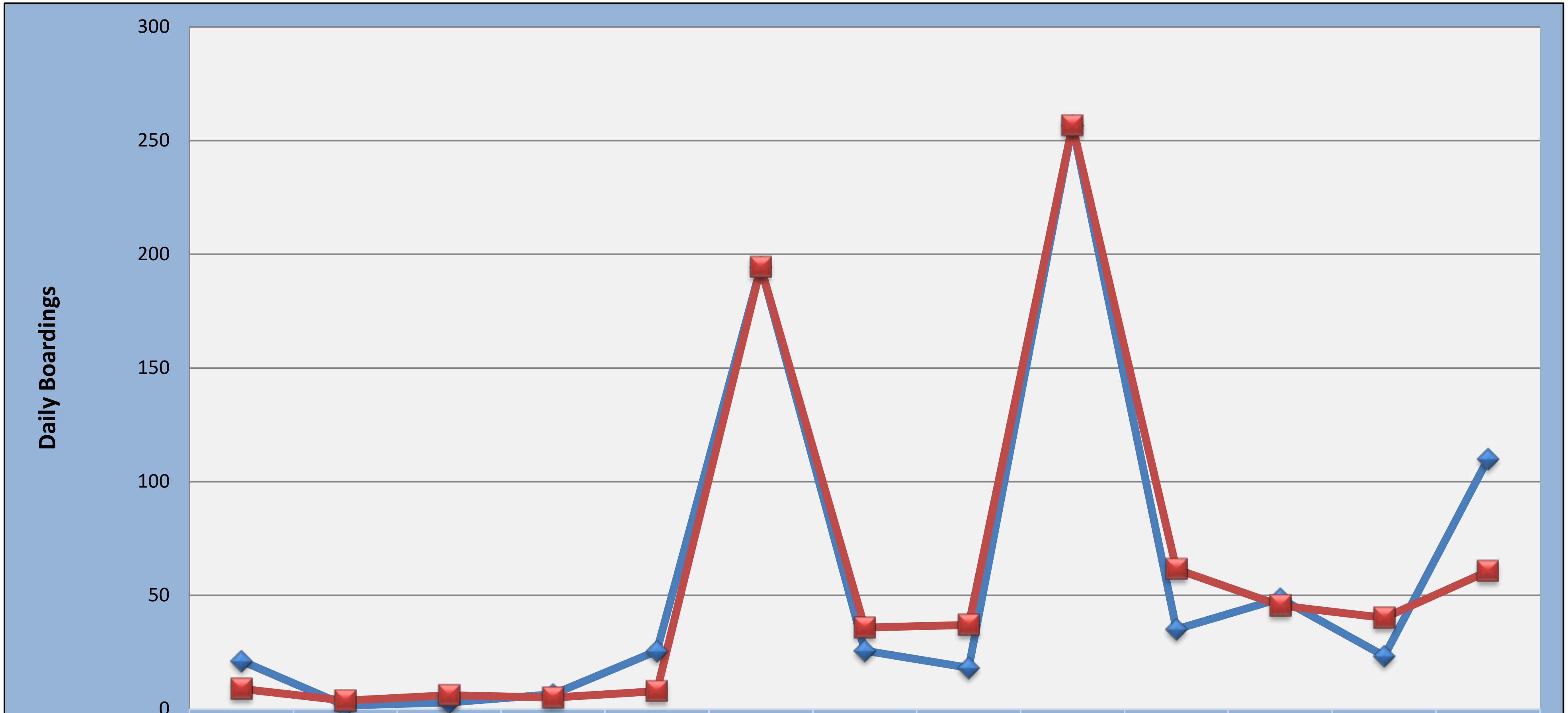
$$
\begin{aligned}
\mathit{Daily\ Boardings} &\\
&= (3.86597 \times 10^{-5} \times \mathit{Daily\ Person\ Trips}) \\
&+ (0.587245726 \times \mathit{Daily\ Train\ Stops}) + (129.9708413 \times \mathit{Hub\ Dummy}) \\
&+ (187.9974064 \times \mathit{Accessibility\ Dummy})
\end{aligned}
$$

The coefficients associated with each variable were calculated by performing a statistical analysis. They represent the magnitude of ridership change expected to result from a change in a given variable, when everything else remains the same. The coefficient signs for the dependent variables are logical.

The statistic "coefficient of determination," known as R^2, indicates the proportion of variability in the observations explained by the model. The higher the R^2 is, the better the accuracy of a model: a R^2 value of 1 would indicate that the regression line perfectly fits the data. The generally acceptable standard of R^2 is a value of 0.90; the Study's final model specification is 0.96. The F-statistic of 60.58, which is a measure of the statistical significance of the model as a whole, indicates that this model is significant at the 95% confidence level, an acceptable degree of accuracy in statistical models.

The estimated regression model was applied to simulate the current ridership in the existing corridor. Shown in Figure 3.5 is a comparison of modeled ridership versus observed ridership for several stations. As the figure details, the model simulates the current ridership with high level of accuracy, indicating that it captures the relationship between ridership and person trips, train stops, hub activity, and accessibility well.

Figure 3.5: Observed Versus Simulated Daily Boardings



	White River Junction	Windsor,VT	Claremont	Bellow Falls	Brattleboro	Springfield	Windsor Locks	Windsor,CT	Hartford	Berlin	Meriden	Wallingford	Bridgeport
Observation	21	2	3	7	26	194	26	18	257	35	49	23	110
Forecasts	9	4	6	5	8	194	36	37	257	61	46	40	61

3.2 RIDERSHIP FORECASTS

The estimated regression model was used to forecast rail ridership in the CC for three different operational scenarios as described below. An initial step in the forecast model development is to generate future year person trips (an input to the model), an annual average population growth rate was calculated from 2010 U.S. Census Bureau data and future year population projections. Regional and municipal sources were used for future growth projections. A detailed overview of future year population projections are listed in Appendix D. The annual population growth rate was then applied to base year person trips to generate the person trip input for the forecast year of 2020. Note that the projected population growth in the CC is very modest and relatively flat.

3.2.1 SCENARIOS ANALYZED

Scenario A: Rolling Stock: Single Trainset

A single trainset would be used to provide two daily round trips between Brattleboro and New London. The proposed schedule would seek to maximize connections to Amtrak NEC services in New London to and from New York. This scenario would also allow for transfer to certain NEC services to Boston and the Vermonter service.

Scenario B: Rolling Stock: Two Trainsets

Two trainsets would be used to provide four daily round trips between Brattleboro and New London. The proposed schedule would provide service throughout the day on the CC and direct connections to Amtrak NEC services toward both Boston and New York and connections to the Vermonter and Lake Shore Limited services.

Scenario C: Rolling Stock: Three Trainsets

Three trainsets would be used to provide six daily round trips between Brattleboro and New London, maximizing service on the CC and allowing for a true service throughout the day. The proposed schedule would provide service throughout the day and direct connections to Amtrak NEC services toward both Boston and New York and connections to the Vermonter and Lake Shore Limited services. It also would allow for more peak hour services than Scenarios A or B.

For all the three scenarios, the model results indicate the 2020 ridership would be similar. The ridership ranges between 385 and 405 daily boardings along the CC line. The stations carrying the most riders, as shown in Table 3.2 are Mohegan Sun and New London**.**

Table 3.2: Daily 2020 Forecasts of Central Corridor Rail Ridership by Station

Station	Scenario A	Scenario B	Scenario C
New London	77	78	78
Mohegan Sun	143	144	145
Norwich	16	18	19
Willimantic	15	16	17
Storrs	26	27	29
Stafford Springs	17	18	19
Palmer	46	47	48
Amherst	28	29	30
Millers Falls	9	11	12
Brattleboro	**7**	**8**	**9**
Total	**385**	**400**	**405**

3.3 SUMMARY

The ridership forecasts for the proposed Central Corridor line were estimated by developing and applying a simplified direct demand model. The underlying assumption in the direct demand modeling approach is that the observed railroad service usage in the existing area is an indicator of proposed and future railroad service usage. The model was built using a multivariate regression analysis technique by examining the relationship between observed rail ridership (dependent variable) and level of rail service and total trip activity (independent variables) in the existing rail corridors. The total trip activity around each rail station is an important input to the model and was extracted from cell phone data covering the study area. The person trips derived from the cell phone data served as a surrogate for population and employment in the study area.

After ensuring the model simulated current rail ridership in the existing corridors well, it was applied to estimate ridership in the CC. The CC model results indicate that daily ridership would be between 385 and 405 riders depending on the level of service provided. The sensitivity of ridership with respect to the number of trains running in the corridor is modest, which is typical for intercity passenger rail services in rural areas. For comparison purposes, note that the daily ridership of the Vermonter and Lake Shore Limited corridors were 112 and 486, respectively, in 2012 based on Amtrak data in the New England region.

4. COSTS

Costs for infrastructure, rolling stock, and annual operation and maintenance were estimated based on metrics used for similar intercity rail projects in Massachusetts, including the recently completed Knowledge Corridor restoration. Estimated cost of potential infrastructure improvements needed to support the start and continuation of passenger rail operation is an important consideration in the evaluation of the feasibility of service of the CC. The principal elements of cost estimates are definition of the service route, inventory of the existing conditions and needed infrastructure, including right-of-way and station stops, and the estimation of required infrastructure costs. Additionally, operating and maintenance costs were evaluated using existing Amtrak intercity rail operating costs. These elements are evaluated in the respective sections below.

4.1 EXISTING INFRASTRUCTURE INVENTORY

Infrastructure on the CC was assessed using existing NECR track charts, Google Maps, and Google Maps Streetview. The inventory of infrastructure includes crossings and sidings.

4.1.1 CROSSINGS

Crossings include overhead, undergrade, and grade crossings of roads, other rail lines, and natural features. Tables 4.1 to 4.3 provide a breakdown by milepost and a total number of crossings by state. The specific condition of the crossings was not evaluated as a part of this study.

Table 4.1: Bridge and Crossing Index: Connecticut

Mile Post		Overhead	Undergrade	Grade Crossing
0	5	6	6	14
5	10	2	9	6
10	15	5	5	8
15	20	3	4	9
20	25	1	2	6
25	30	2	5	6
30	35	3	3	9
35	40	0	5	11
40	45	1	2	7
45	50	3	7	5
50	55	0	7	5

55	56	0	0	1
Total Connecticut		26	55	87

Table 4.2: Bridge and Crossing Index: Massachusetts

Mile Post		Overhead	Undergrade	Grade Crossing
56	60	1	5	6
60	65	2	9	10
65	70	1	7	10
70	75	1	1	4
75	80	0	1	6
80	85	2	4	10
85	90	1	2	7
90	95	2	3	5
95	100	2	5	7
100	105	1	2	8
105	110	1	3	10
110	111	1	0	0
Total Massachusetts		15	42	83

Table 4.3: Bridge and Crossing Index: Vermont

Mile Post		Overhead	Undergrade	Grade Crossing
110	115	0	2	9
115	120	0	1	12
120	125	1	4	3
Total Vermont		1	7	24

4.1.2 **SIDINGS**

Sidings are locations where two or more tracks allow for trains to pass or be stored. As the CC is primarily a single-track line, properly operating sidings are necessary to ensure trains are able to pass efficiently. Table 4.4 profiles sidings and locations where lines intersect on the right-of-way.

Table 4.4: Sidings

State	Start Mile Post	End Mile Post
Connecticut	0.45	0.79
Connecticut	0.89	1.13
Connecticut	5.75	6.22
Connecticut	12.27	12.61
Connecticut	13.25	13.6
Connecticut	16.84	17.12
Connecticut	18.25	18.6
Connecticut	22.72	23.05
Connecticut	29.52	29.72
Connecticut	29.54	29.71
Connecticut	43.52	44
Connecticut	55	55.85
Massachusetts	64.45	64.95
Massachusetts	65.1	65.3
Massachusetts	69.12	69.42
Massachusetts	84.28	84.8
Massachusetts	85	85.82
Vermont	115.5	115.81
Vermont	120.18	121.91

4.2 ESTIMATED CAPITAL COSTS

Capital costs for the CC were estimated based on similar costs developed for rehabilitation of the MassDOT's Knowledge Corridor- Restore the Vermonter project. The Knowledge Corridor project rerouted the Amtrak Vermonter Service to a more direct route north of Springfield, saving approximately 25 minutes on the train journey, improving reliability, and increasing ridership.

The Knowledge Corridor project included crosstie replacement, rail replacement, rehabilitation of grade crossings, reactivation of passing sidings and portions of double track, upgrading of switches, improvements to signal and communications systems, surfacing and alignment of track, and improvements to bridges and station platforms.[2] The improvements to the Knowledge Corridor were designed to facilitate reliable passenger and freight rail at speeds that are competitive with road travel.

The improvements to the Knowledge Corridor project are intended to provide a level of investment that supports the initiation of service and continuation of service for a reasonable period. The major infrastructure components include track, grade crossings, bridges, and signals. The signal improvements include improvements to support train movements and upgraded warning devices at highway grade crossings. The all-inclusive average cost for the Knowledge Corridor was approximately $2.5 million per mile.

The use of the cost per mile of the Knowledge Corridor project applied to the CC was deemed to provide a reasonable order of magnitude cost for the rehabilitation of the CC. Additionally, station rehabilitation and/or addition of a station was assumed to have a cost of $8 million per station. A principal reason for this station cost is the determination that all stations on the Knowledge Corridor would be reconstructed or newly constructed as full-length high-level platforms, in accordance to standards set by the Americans with Disabilities Act and based on standards used in recently constructed MassDOT passenger rail stations. A detailed inspection and refinement of the cost estimate would occur as part of any subsequent project evaluation.

Rehabilitation of the CC was assumed to involve similar work as the Knowledge Corridor. While the CC is an active freight line, significant rehabilitation of the right-of-way is anticipated to improve speed and reliability that would provide for competitive passenger rail service. The Vermont portion of the line was recently upgraded and is assumed to be in a good state or repair; full or partial rehabilitation of 111 miles of the right-of-way in Massachusetts and Connecticut is anticipated, costing an estimated $277.5 million.

Additionally, several new stations would be required to serve the CC project. Existing stations are currently located in Brattleboro, Amherst, and New London, but new stations will be required at Mohegan Sun, Norwich, Willimantic, Mansfield/Storrs, Stafford Springs, Palmer, and Millers Falls. Based on similar and recently determined station construction costs estimated for the NNEIRI, each station would require approximately $8 million in funding. Stations would be designed and constructed with full-length, high-level platforms. In addition to new stations, it is assumed that the Brattleboro and Amherst stations will be upgraded to meet MassDOT platform standards, resulting in a full rebuilding of both sites. Therefore, an estimated total capital cost of approximately $72 million for nine new or rehabilitated stations would be necessary for CC opening day operations at all identified station sites.

Rolling stock would also be necessary for CC operations. According to figures developed recently for NNEIRI, new trainsets would cost approximately $27 million to purchase, including six passenger cars and a locomotive. However, retired or spare MBTA, Metro-North, or Shore Line East trainsets could also be used for CC operations, if at the time of opening service they are available.

[2] "Knowledge Corridor - Restore Vermonter Project: About this Project." Massachusetts Department of Transportation, http://www.massdot.state.ma.us/knowledgecorridor/, accessed November 20, 2014.

For the purposes of this report, however, it is assumed that new rolling stock would be required and is therefore included in the capital cost.

Thus, the CC capital costs, assuming full line rehabilitation, construction of seven new stations, and purchase of a single new trainset would be approximately $376.5 million. Table 4.5 describes the total capital costs. However, the cost could be less if new trainset equipment would not be necessary or fewer stations would be constructed on the Corridor. It is unadvisable to reduce funding for right-of-way improvement because of the significant penalties to speed and reliability that would result in a less significant renovation.

Table 4.5: Capital Cost Summary

Unit	Unit Cost	Unit Quantity	Total Cost
Standard Cost Per Mile for Rehabilitation (Track, Signal, Bridge)	$2.5 Million	111 Miles of Track	$277.5 Million
New Station Development	$8 Million	9 New Stations	$72 Million
Trainset	$27 Million	1 New Trainset	$27 Million
Total			$376.5 Million

The approximate cost per state is summarized in Table 4.6. The cost of the single trainset is assumed to be split among the three states evenly.

Table 4.6: Capital Cost by State

State	Track Rehabilitation	Station Development	Trainset	Total Cost Per State
Connecticut	$140 Million	$48 Million	$9.2 Million	$197 Million
Massachusetts	$138 Million	$24 Million	$9.2 Million	$171 Million
Vermont	NA	NA	$9.2 Million	$9.2 Million

4.3 ANNUAL OPERATING AND MAINTENANCE COSTS

As shown in Table 4.7, the estimated annual operating costs for service from New London to Brattleboro (utilizing Amtrak equipment) would be nearly $6 million. Due to the length of the CC, operating and maintenance costs assume the line would be operated as an intercity rail service rather than a commuter rail service. Commuter rail lines in the New England region typically operate at distances less than 60 miles from origin to destination and intercity services operate over longer lengths. Therefore, utilizing annual operating and maintenance used for state supported services in Connecticut and Massachusetts is appropriate for operations on the CC.

The estimated operating and maintenance costs are inclusive of maintenance costs associated with trains and equipment, materials and fuel, Amtrak overhead costs, and service overhead/management costs. Operating and maintenance costs are based on a formula that is determined by annual operating miles and train equipment characteristics.

Table 4.7: Central Corridor Annual Operating and Maintenance Costs

Cost/Revenue	New London-Brattleboro
Transportation (Train and Engine)	$773,564
Material/Fuel	$3,820,221
Amtrak Overhead	$1,019,848
Service Overhead/Management Costs	$350,000
Total Annual Operating Costs	$5,963,633

5. AGENCY AND STAKEHOLDER ENGAGEMENT

Stakeholder outreach was a critical component throughout the study development process. Stakeholder input was provided through direct comments and feedback at designated meetings and through letters received. The two stakeholder meetings were held in Palmer, Massachusetts in August and October 2014.

5.1 COORDINATION BETWEEN AGENCIES

MassDOT and CTDOT coordinated concepts and programming for the Study so as not to duplicate efforts. While MassDOT led the study, CTDOT provided comments, input, and data throughout the study process.

5.2 STAKEHOLDER COORDINATION

Stakeholders, including public and private organizations, were included in discussions defining the CC. Stakeholder meetings were held at the Palmer stakeholder meetings in August and October 2014. Discussions were held at each meeting to better understand the specific requirements of stakeholder groups that needed to be met. The following is a list of some of the stakeholders that were engaged during the Study:

- Amherst College
- Town of Palmer, Massachusetts
- Town of Amherst, Massachusetts
- City of Norwich, Connecticut
- New England Central Railroad
- University of Massachusetts at Amherst
- Submarine Force Library and Museum

Stakeholder and agency comments provided the project management team with valuable insight into federal, state, and corporate requirements for passenger rail operations on the CC line.

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6. SUMMARY AND RECOMMENDATIONS

This study examined the feasibility of implementing passenger service along the CC, which would follow the NECR Palmer Division line from Brattleboro, Vermont to New London, Connecticut. Notable locations that would be served by this line include two state universities, 11 smaller colleges, the Mohegan Sun Resort and Casino, commuters between Willimantic, Norwich, and New London, and regional travelers to and from the region and nearby cities. To study the feasibility of passenger rail service on the CC, the study developed potential ridership estimates for the corridor, capital costs, and annual operating and maintenance costs. Additionally, to ensure a complete understanding of the corridor, stakeholders, public agencies, and private entities that are located or function along the corridor were consulted at various public meetings.

Ridership analysis was modeled for the year 2020 using the direct demand method and utilizing travel patterns collected through Air Sage data sets. The model tracked the current Origin-Destination (O-D) pairs and to provide an understanding of the unique trips and frequencies along the corridor. From this data, a ridership model was built that included three different scenarios based on the number of daily train round trips in the CC. The model was then expanded to represent how the O-D pairs would occur under future conditions. For each of the three scenarios analyzed the ridership was projected to be around 400 daily boardings.

An analysis of existing infrastructure was conducted, including grade-crossings, sidings, and bridge. With an understanding of the existing conditions, capital costs were estimated. These costs include new stations and trains to operate along the corridor, providing an overall cost to implement the service of approximately $376.5 million, assuming infrastructure costs of full line rehabilitation, operating costs of seven new stations, and purchase of a single new train-set. Additionally, operating and maintenance costs were developed, providing an overall $6 million cost to operate and maintain the service annually.

Two meetings with stakeholders were held to describe the scope of the project, present findings, and elicit comments and feedback. The meetings occurred in August 2014 and October 2014 and included stakeholders from area railroads, institutions, government officials, and the business community. The meetings consisted of a presentation and discussion and answer session.

The analysis conducted as part of the study process concluded that the modeled ridership of 400 riders per day would be limited, primarily due to the low population density along the corridor and the minimal expected interaction between the special generators. The projected capital cost of the proposed service is approximately $376.5 million, with an annual operating and maintenance cost of $6 million.

The respective state agencies and departments should continue to evaluate public support relative to furtherance of the service and include it in any statewide passenger and freight rail planning efforts in order to prioritize passenger rail service along the Central Corridor Line relative to other competing rail needs. Additionally, if any elements of passenger rail service along the Central Corridor Line should move forward, they would need to be evaluated as part of each state's capital investment planning and project selection processes in order to be scored and ranked relative to other capital rail projects.

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APPENDIX

A. Central Corridor Project Alignment and Service Development
B. Cell Phone Data Collection and Processing Methodology
C. Person Trips and Travel Patterns Extracted from Cell Phone Data for Central Corridor
D. Population Growth Rate Analysis