NEC FUTURE
A Rail Investment Plan for the Northeast Corridor

Ridership Analysis Technical Memorandum

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Final Version

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Table of Contents

Tables

Figures

1 Introduction

1.1 PURPOSE OF THIS DOCUMENT

This technical memorandum describes the ridership forecasting process the Federal Railroad Administration (FRA) used to evaluate potential rail service and investments in the Northeast Corridor (NEC) as part of the NEC FUTURE program. This technical memorandum provides a comprehensive summary of the FRA's ridership forecasting process, including: methodology development, collection of new survey data (with full geographic coverage of the NEC), examination of travel patterns in the corridor, development of new model tools to support the ridership forecasting, modification of existing regional forecasting tools to fit the forecasting framework, and integration of interregional and regional ridership forecasts. The FRA used ridership forecasts to develop and evaluate proposed rail service alternatives by producing: rail ridership estimates at various geographic levels, ticket (fare) revenue projections, rail passenger miles traveled, travel time and cost savings, as well as information related to the non-rail modes, such as vehicle-miles traveled and trips diverted to rail from other modes.

The FRA applied the information toward a further refinement of the alternatives and in the preparation of the Tier 1 Draft Environmental Impact Statement (EIS) and the Draft Service Development Plan (SDP). The ridership data prepared for the Tier I Draft EIS are representative. The ridership estimates are based on the Service Plans created for the No Action and Action Alternatives[1], assumed future fare policies, and regional and corridor-wide estimates of growth. The Service Plans and fare policy for each alternative were developed to represent the high level goals of each alternative but not strictly optimized to capture the maximum potential ridership for each station. Therefore, estimated ridership is representational and consistent with a Tier I Draft EIS level of detail.

1.2 ORGANIZATION OF DOCUMENT

This technical memorandum addresses multiple aspects of the NEC FUTURE ridership forecasting process, including the methodology and ridership forecasts used to develop, refine, and analyze the Tier 1 EIS Alternatives.

Section 2 describes the methodology developed in the initial stages of the forecasting process, for creating a cohesive forecast for regional and interregional travel, and any modifications in the actual application of the methodology. Both of these stages (initial methodology development and modifications undertaken during application) are part of the alternatives analysis, which results in

[1] The FRA developed Service Plans for the No Action and Action Alternatives to describe the types and levels of passenger train service that could operate on the NEC in 2040. These Service Plans depict a representative train operations pattern for a typical future weekday, and include the train stops by station for both peak and non-peak periods. The Service Plans are not prescriptive in terms of the way future operations would be conducted in 2040. The Service Plans provide a basis for estimating future ridership and capital investment needs and costs, as well as to assess the environmental impacts associated with planned construction and future operations.

the identification of alternatives for review in the Draft Tier 1 EIS. For additional information regarding the integration of the ridership forecasting process and development of alternatives, see the *Tier 1 EIS Alternatives Report*.

Section 3 describes the interregional forecasting process, including development of the baseline travel market, and the total demand and mode choice models, which comprise the two steps of the Interregional Model. This section also summarizes the process for applying the new Interregional Model to the Service Plans for the No Action Alternative and Action Alternatives. Model application is the technical term for running the model, and is distinct from the model estimation stage, which is the process of creating the model.

Section 4 discusses the regional modeling process and describes the adjustment and application of the metropolitan models in the NEC. The FRA produced regional forecasts for Washington D.C., Baltimore, Philadelphia, Northern and Central New Jersey, Long Island and Mid-Hudson, New York, Southwestern Connecticut, Rhode Island, and Boston.

Sections 5 and 5.3 define the No Action Alternative and Action Alternatives that underlie the interregional and regional forecasting. These sections also describe the anticipated demographic growth in the NEC, the incorporation of non-rail modes into the modeling process, and the development of rail Service Plans for the Action Alternatives.

The final section, Section 6, summarizes the results of the ridership forecasting process, combines the regional and interregional travel forecasts, and discusses implications of the No Action Alternative and Action Alternatives.

2 Methodology

This section outlines the methodology for the analysis of travel markets and the forecast of ridership and revenue associated with passenger rail transportation alternatives for NEC FUTURE. The FRA created a Ridership Technical Working Group (TWG) to provide guidance and review NEC FUTURE ridership efforts during the development of the new Interregional Model and adjustment and application of the existing regional models. The FRA's initial work involved early service planning and alternatives development and evaluation. During this initial stage, the FRA collected data, analyzed existing and future ridership forecasts, and performed forecasting to help identify and screen initial and preliminary alternatives. The FRA based the initial forecasting on existing available market data (such as Amtrak ridership data and existing regional model data), forecasts of ridership and revenue from prior studies (such as Amtrak NEC forecasts and existing regional model forecasts of regional rail ridership), and the use of existing ridership models. The FRA used the initial work to screen alternatives and to support the development of the framework for ridership forecasting using the updated models.

2.1 FORECASTING APPROACH

The initial NEC FUTURE ridership and revenue forecasting approach included three major components to address the full scope of travel markets relevant to the NEC. These include:

- A new Interregional Model, which addressed travel between major regions in the NEC, developed primarily from a new NEC household survey
- Existing regional models, which addressed travel within major regions in the NEC (e.g., Washington, Baltimore, Philadelphia, New York, Boston, etc.)
- The FRA's own CONNECT tool, which addressed travel between the NEC FUTURE market areas and external markets such as Buffalo, New York; Pittsburgh, Pennsylvania; and Raleigh, North Carolina

2.1.1 Integration of the Interregional and Regional Forecasts

Using separate forecasting models, the FRA forecasted interregional and regional ridership for the No Action Alternative and each of the Action Alternatives. The FRA combined these forecasts to form an overall ridership forecast for the No Action Alternative and for each of the Action Alternatives. Combining the forecasts involved the identification and application of the appropriate "model of record" for each NEC rail market. Table 1 summarizes the forecasting models used to evaluate the No Action and Action Alternatives for each region pair within the Study Area. Within each of the metropolitan regions (on the diagonal of the table), the associated regional model is used. The geographic coverage of each model is shown in Section 4. The majority of region pairs are analyzed using the new Interregional Model.

In certain instances estimates of commuter rail ridership were available not only from the regional models but also from the Interregional Model. These instances primarily reflect long distance commuting activity. In order to avoid double-counting, only the regional models were used to estimate commuter rail ridership.

Table 1: Models used to Evaluate NEC FUTURE Rail Markets

From/ To	Region	Boundaries	A	B	C	D	E	F	G – L
A	Washington Metro	Northern Virginia to Pautuxent River	R1	IR	IR	IR	IR	IR	IR
B	Baltimore Metro	Susquehanna River to Pautuxent River	IR	R2	IR	IR	IR	IR	IR
C	Wilmington/ Philadelphia Metro	Susquehanna River to Trenton	IR	IR	R3	IR	IR	IR	IR
D	NY Metro, West of Hudson	Trenton to New York City	IR	IR	IR	R4	IR	IR	IR
E	NY Metro, East of Hudson	New York City, Long Island & Coastal Connecticut	IR	IR	IR	IR	R5	IR	IR
F	Providence/Boston Metro	Rhode Island to SE New Hampshire	IR	IR	IR	IR	IR	R6	IR
G	Empire Corridor	New York City to Albany	IR	IR	IR	IR	IR	IR	IR
H	Inland Connecticut, Massachusetts	New Haven to Springfield	IR	IR	IR	IR	IR	IR	IR
I	Virginia	Richmond to Washington D.C.	IR	IR	IR	IR	IR	IR	IR
J	Keystone	Philadelphia to Harrisburg	IR	IR	IR	IR	IR	IR	IR
K	Vermont	Vermont to Springfield	IR	IR	IR	IR	IR	IR	IR
L	Maine	Maine-New Hampshire	IR	IR	IR	IR	IR	IR	IR

Tools:	
IR	NEC FUTURE Interregional Model
R1	Enhanced WMATA Transit Post Processor of MWCOG Model
R2	STOPS Application for Baltimore Metropolitan Area
R3	DVRPC Regional Forecasting Model
R4	NJ TRANSIT North Jersey Travel Demand Forecasting Model
R5	MTA Regional Transit Forecasting Model
R6	STOPS Application for Boston Metro/Rhode Island Area

Source: NEC FUTURE, 2015

The FRA developed the initial interregional and regional ridership and revenue forecasting methodology in 2013, reviewed it several times with the NEC FUTURE Ridership TWG, and finalized the methodology in September 2014. Important contributions to the methodology during this time were made by staff from the Office of Management and Budget (OMB) and the FRA, using results of a pilot survey of NEC travelers to evaluate completion rates and survey duration (see Section 2.2.1). Subsequent modifications of the methodology are described in the component-relevant sections below.

2.2 INTERREGIONAL MARKETS

The travel demand modeling and forecasting approach for interregional travel consisted of the development and application of a two-stage model system. The first stage modeled total interregional travel volume by origin-destination (OD) pair. The second stage predicted the share of intercity passenger travelers expected to use each of the available intercity travel modes using a nested logit specification.

The two-stage model system was applied in reverse order (i.e., mode share before total travel demand) to allow mode share model results to be incorporated within the total demand model structure. This linkage provides the total travel model with sensitivity to changes in the level-of-service provided by all modes, allowing for the total number of trips to increase due to overall improvement in travel conditions.

2.2.1 Household Travel Survey

The development of a new comprehensive Interregional Model required new surveys of existing travel within the NEC. All of the existing available survey data was generally tied to specific existing models or forecasts focused exclusively on either intercity or certain regional sub-markets within the NEC. Although they collectively addressed all of the major NEC markets, these existing data sets and models did not provide a consistent integrated analysis and forecasting basis throughout the NEC.

To inform the Interregional Model, the FRA conducted a new extensive household survey, the NEC FUTURE Survey of Northeast Regional and Intercity Household Travel Attitudes and Behavior (Household Travel Survey). This new Household Travel Survey included a screener section to qualify and recruit respondents for the survey. Only interregional trips made between the respondent's home and eligible out-of-state locations were considered as qualifying trips. Eligible areas excluded the respondent's home state, nearby areas in adjoining states (typically less than 50 miles away from the home), and trips to locations outside of the NEC. This screening ensured that only trips meeting the definition of interregional were included in the data collection. If no qualifying trips were found, the respondent was asked questions to collect demographic information only and was not counted as a completed survey.

If a respondent took multiple qualifying trips, one was randomly selected to be the "reference trip" for the respondent. The actual mode chosen for the reference trip forms the basis for the revealed preference (RP) portion of the survey response. Respondents were then asked additional questions about this trip including:

- Type of train service used (if respondent's "reference trip" was by train).
- Mode of access used (if respondent's "reference trip" was anything other than "passenger car/truck/van").
- Mode of egress used (if respondent's "reference trip" was anything other than "passenger car/truck/van").
- Fare paid (if respondent's "reference trip" was anything other than "passenger car/truck/van").
- Estimated one-way travel time and estimated cost for tolls, parking, and fuel (if respondent's "reference trip" was anything other than "passenger car/truck/van").
- Overall purpose of the respondent's trip.

Six stated preference (SP) choice exercises represented the “core” of the survey and provided the primary basis for estimating the new mode choice model. These SP questions asked respondents to think about the context of their reference trip and then choose from among three modes of travel with characteristics specified by the survey. These characteristics varied across the questions, according to an experimental design that minimized correlations among variables.

The specific SP trade-off questions reflected an experimental design to address an appropriate cross-section of all the potential mode availability and service characteristic combinations. The detailed trip information obtained before the trade-off questions provided the context for the respondent’s travel choices and a basis for defining trip-relevant service characteristics in the trade-off questions. The responses to the survey questions provided the basis for estimating key sensitivities to changes in the service characteristics, by market segment, for the new model.

All qualifying respondents were asked demographic questions at the end of the survey.

The original design of the survey called for a two-phase approach. The recruit survey was conducted by telephone via computer-assisted telephone interviewing (CATI) using a dual frame sample with both landlines and cell phones. The follow-up survey was conducted via self-administration by respondents on the internet. Respondents without internet access were able to complete the follow-up survey by viewing a mailed packet of survey visuals and then providing answers to follow-up questions via a telephone interview. To test general operational and content issues with the survey, a pilot effort was conducted which obtained 307 completed surveys. While the pilot results showed that the survey was able to obtain the necessary information for modeling, the cumulative two-phase response rate of 4% (9% in recruitment and 49% in the follow-up) was lower than expected. As a consequence, the FRA reconsidered the data collection approach revised it as follows:

- Survey was changed from two-phases using telephone and internet or mail to one-phase conducted solely via telephone.
- Survey was shortened from an average length of 22 minutes in the pilot to an estimated 18 minutes. This required reducing the number of SP questions from 12 to 6.
- SP portion of the survey was simplified by dropping one service characteristic, reliability, because it was considered too complicated to effectively communicate to respondents via telephone.
- The amount of the incentive was increased from $5 to $10.
- The number of attempts per sampled household was increased from 5 to 10.

With these changes in place, the response rate increased to around 11%, which provided a sufficient number of completed surveys by key trip purpose and geography subsample.

To compensate for excluding reliability as a service characteristic in the mode-choice model, reliability was captured in schedule margin included in the Service Plans developed for each of the Action Alternatives.

The complete survey documentation can be found in Appendix A.

2.2.2 Total Travel Market Demand Model

In a two-stage travel demand modeling approach, total travel demand models (one for each trip purpose) are required in conjunction with the mode share models (also one for each trip purpose). Total travel demand forecasts define the total market size to which the mode shares are applied to produce ridership forecasts by mode. In general, two major factors influence total travel demand between any two geographic areas: growth in population and economic activity, and changes in the levels of service. Increases in population and economic activity contribute to organic growth, generating more travel. Improvements in levels of service generate additional trips through induced demand; more trips are taken by riders as travel between origins and destinations becomes more attractive due to better travel conditions (such as reduced travel time or cost). Measures used to represent the impacts of these changes include:

- Socio-economic data and forecasts used as the basis for estimates of organic growth:
  - population
  - employment
  - household income
- Composite modal level-of-service (LOS) was used as the basis for estimates of induced demand. The LOS is an output of the mode choice model and is the sums of the estimated utility of all modes for a particular zone pair, as shown in the following formula:

$$LOS_i = \sum_i \exp(U_i)$$

where:

LOS – Level of Service for a particular zone pair
i - mode
U_i - utility of mode i (see Section 2.2.3.1).

The total travel models have a multiplicative structure, with exponent coefficients on each of the independent variables. The models were estimated using a log-linear regression technique with total trips for each zone pair as the dependent variable. Separate models were estimated for each of the three trip purpose market segments reflected in the mode share models -- business, non-business, and commute. The models were estimated using base year data on travel by purpose between study zones (described in Section 3) using the following specification:

$$TRP(i,j) = Constant \times POP(i)^a \times POP(j)^b \times INC(i)^c \times EMP(j)^d \times LOS(i,j)^e$$

where:

TRP - trips	INC-– household income
POP - population	LOS - level-of-service
EMP - employment	B - base year

The total travel models are applied using a ratio formulation relying on data that relates total travel market growth to growth in the independent variables, computed as the ratio of the forecast year (2040) to the base year values. The application formula is as follows:

$$\frac{TRP_F(i,j)}{TRP_B(i,j)} = \left(\frac{POP_F(i)}{POP_B(i)}\right)^a x \left(\frac{POP_F(j)}{POP_B(j)}\right)^b x \left(\frac{INC_F(i)}{INC_B(i)}\right)^c x \left(\frac{INC_F(j)}{INC_B(j)}\right)^c x \left(\frac{EMP_F(i)}{EMP_B(i)}\right)^d x \left(\frac{EMP_F(j)}{EMP_B(j)}\right)^d x \left(\frac{LOS_F(i,j)}{LOS_B(i,j)}\right)^e$$

where:

TRP - trips	INC - household income
POP - population	LOS - level-of-service
EMP - employment	F - future year
	B - base year

That is, interzonal trips are projected to grow in proportion to population, adjusted for its estimated effect, *a;* in proportion to the employment changes in the attraction zone; adjusted for its estimated effect, *b*; in proportion to the income changes, adjusted for its estimated effect, *c*; and in proportion to changes in the overall level-of-service, adjusted for its estimated effect, *d*. These coefficients are interpreted as elasticities.

The results of the total travel market demand model estimation are found in Section 3.1.2.

2.2.3 Mode Choice Model

The mode share models estimate the share of total person travel by mode. The following travel modes were addressed:

- Auto (Passenger car/truck/van)
- Air
- Intercity Bus
- Train, addressing the following types of train service separately:
  - Intercity-Express (similar to Amtrak's Acela train service)
  - Intercity-Corridor (similar to Amtrak's Regional train service)
  - Regional rail (similar to the train service provided by MBTA, MNR, LIRR, NJ Transit, SEPTA, MARC, and VRE within specific regions)
  - Metropolitan rail, which would provide a new type of service to a mix of longer distance commuter and shorter distance intercity markets with amenities and pricing between existing regional commuter and Intercity-Corridor service; this service would be offered as a one-seat ride or with a required connection

The new model estimated mode share as a function of the following key independent service characteristics:

- Travel time
- Travel cost or fare, taking account of the cost implications of travel by group and individuals and also including parking charges
- Schedule of service provided by air, rail, and bus
- Alternative-specific constants reflecting the differences between modes not directly measured by other independent variables in the model (factors and traveler perceptions such as the comfort and convenience provided by each mode would be reflected here)

Three separate mode share estimates were undertaken with the following market segmentation by trip purpose:

- Business trips
- Non-business/non-work trips
- Commute (journey to work) trips

2.2.3.1 Nested Logit Model Structure

The mode choice model used a nested logit (NL) structure to reflect the differential substitution that exists between different modes of travel. The NL structure is preferable for mode choice modeling over multinomial logit (MNL) because of the Independence of Irrelevant Alternative (IIA) property inherent in the MNL model. The IIA property is problematic as any changes or additions to the alternatives results in a proportional change to the probabilities of all other alternatives. In other words, there is no differentiation among choices to account for similarities between modes and the potentially higher propensity for respondents to switch to a similar mode. The nested logit model, on the other hand, allows for grouping similar modes, so that they are more competitive within the nest versus other modes outside of the nest. The utility for each mode in the NL model can be described with this general formula:

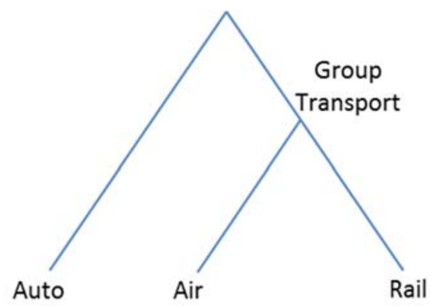
$$U_{Mode} = ASC_{Mode} + \beta_{TT} * Travel\ Time + \beta_{Cost} * Travel\ Cost + \cdots$$

where:

U_{Mode} - Utility of each mode
ASC_{Mode} - alternative-specific constant of each mode
$\beta_{TT/Cost}$ - estimated coefficient for each variable (travel time, travel cost, etc.)

The formulation of each mode’s probability is dependent on its location in the nesting structure. An example nesting structure is shown in Figure 2. The mode share probabilities for auto and rail are shown below as examples of how the probabilities are calculated for an un-nested mode and for a nested mode.

Figure 1: Example Nesting Structure



$$PR_{Auto} = \frac{\exp(U_{Auto})}{\exp(U_{Auto}) + \exp(\mu_{Group\ Transport} * \Gamma_{Group\ Transport})}$$

$$PR_{Rail} = PR_{Rail|Group\ Transport} * PR_{Group\ Transport}$$

$$PR_{Rail|Group\ Transport} = \frac{\exp\left(\frac{U_{Rail}}{\mu_{Group\ Transport}}\right)}{\exp\left(\frac{U_{Rail}}{\mu_{Group\ Transport}}\right) + \exp\left(\frac{U_{Air}}{\mu_{Group\ Transport}}\right)}$$

$$PR_{Group\ Transport} = \frac{\exp(\mu_{Group\ Transport} * \Gamma_{Group\ Transport})}{\exp(U_{Auto}) + \exp(\mu_{Group\ Transport} * \Gamma_{Group\ Transport})}$$

$$\Gamma_{Group\ Transport} = \ln\left[\exp\left(\frac{U_{Rail}}{\mu_{Group\ Transport}}\right) + \exp\left(\frac{U_{Air}}{\mu_{Group\ Transport}}\right)\right]$$

$$\mu_{Nest} = Logsum\ parameter\ for\ nest\ (estimated)$$

The estimated Logsum parameter for the nest (or nesting coefficient) indicates the degree to which the nested modes are substitutable (or similar). The values of the nesting coefficient can be interpreted as follows:

- $\mu < 0$: Not theoretically consistent with NL model and nesting structure must be rejected.
- $0 \le \mu < 1$: Implies non-zero correlation in the unobserved components (or error terms) of the nested modes and the closer μ is to zero, the more similar are the error terms of the modes with the nest.

- μ = 1: Implies zero correlation among the unobserved components (or error terms) nested modes, and mathematically collapses to a MNL model structure.
- μ > 1: Not theoretically consistent with NL model and nesting structure must be rejected.

2.2.3.2 Variable Specification and Data Segmentation

The FRA identified potential variable specifications and data segmentations as a first step of the mode choice model estimation process. Below are the descriptions of each of the options tested in the model estimation process. Not all options, however, were used in the final models.

Travel Time

Travel time is a key variable in mode choice decision-making, and was expressed in the model using two components: line-haul time and access/egress/connect time.[2] The FRA examined several different transformations of both time components, including:

- No transformation (where the travel time in minutes is used in the model directly)
- Scaled by highway distance (travel time / distance). Line-haul time and cost are often collinear which causes difficulty in RP model estimation because the model is unable to distinguish the mode choice impact for each variable independently. Scaling by distance helps to reduce this collinearity.
- Scaled by dampened highway distance (Adjusted Travel Time = Travel Time / (1.0 – k*distance). The parameter k is a specified parameter, not estimated, and is typically in the range of -0.01 to -0.1. This parameter was adjusted during model estimation to determine the value that created the best model fit. Similarly to scaling by straight distance, scaling by dampened distance reduces the collinearity between time and cost. Scaling by dampened highway distance also allows the model to exhibit lower sensitivity to time for longer trips. It is expected that a given increase in travel time, say, 15 minutes, would have a lower impact on longer trips because the 15 minutes would be smaller *percentage* of total trip time than for a shorter trip. Using the dampened distance has the additional advantage of allowing the model exhibit a differential impact for travel time changes depending on the relationship between travel time and distance. Consider two different trips that have the same travel time, but one covers a short distance and the other a longer distance. It is possible that the additional travel time would have a larger impact on a shorter distance trip, indicating that additional travel time is more onerous to the short-distance traveler.
- Log of travel time. Using the log of travel time is an additional method for handling collinearity. Similarly to dampened distance scaling, this method allowed for travelers to have a non-linear response to travel time.

Travel Cost

The FRA explored the following specifications of total travel cost in model estimation:

- No transformation. Where the travel cost in dollars is used in the model directly.

[2] Access/egress/connect time do not apply to the auto mode

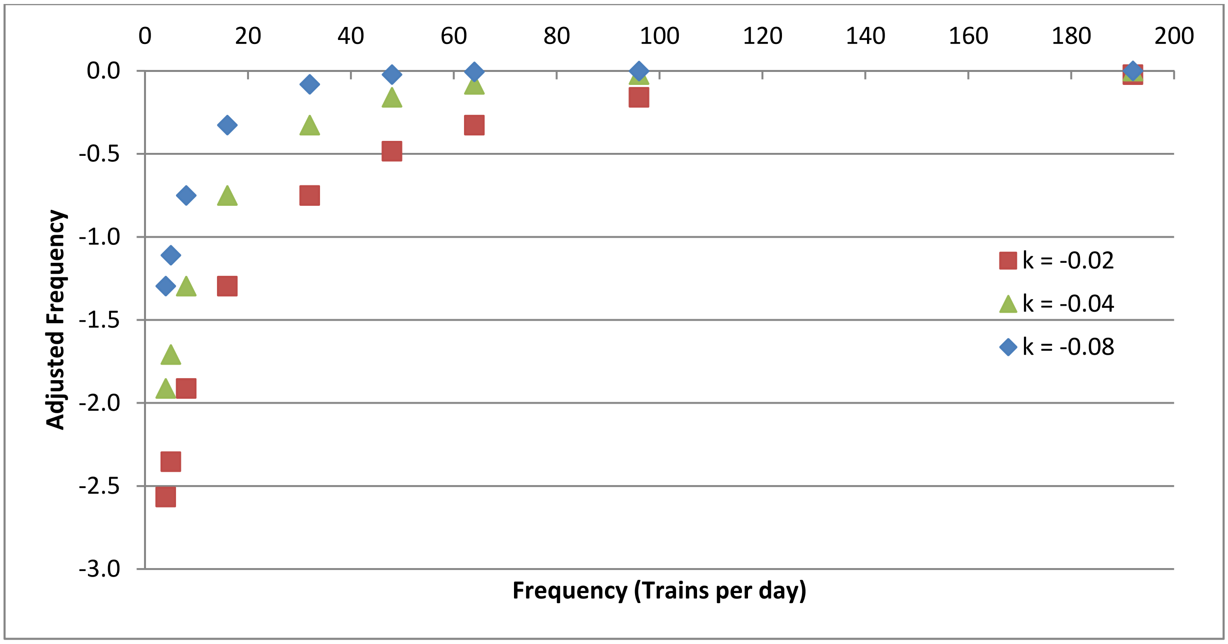
- Scaled by highway distance (travel cost / distance). Line-haul time and cost are often collinear which causes difficulty in RP model estimation because the model is unable to distinguish the mode choice impact for each variable independently. Scaling by distance helped to reduce this collinearity.
- Scaled by dampened highway distance (Adjusted Travel Cost = Travel Cost / (1.0 – k*distance, where k is a parameter). The advantages of scaling by dampened distance are explained above in the travel time discussion.
- Differentiate by mode (specify separate travel cost coefficients for each mode). Premium modes such as air and high-speed rail have very different pricing structures, and could attract customers who have a higher value of time and lower-cost sensitivity.
- Piece-wise linear. This transformation applies a different coefficient to segments of the total cost. For a potential specification of two cost segments, $1 to $99 and $100 or more, the first $99 of the total cost would have one coefficient, while the remainder of the total cost (total cost - $99) would have a second coefficient. This transformation allows for travelers to have different responses to incremental cost depending on total cost. For example, a $20 increase in fare could have a very large impact when the fare is originally $25 but only minor impact when the original fare is $300.
- Log of total cost. Similar of the other transformation, this transformation allowed differential responses to changes in cost depending on the level of the total cost.

<u>Frequency of Service</u>

Frequency of service affects all modes except for auto, and can play a large role in a traveler's decision-making process. The specifications tested are listed below.

- Total trains per day.
- Dampened trains per day (Adjusted Frequency = ln (1.0-exp(k*frequency))). This dampened specification accounts for the expectation that additional trains impact choice up until a certain saturation level, at which point travelers have enough options, and more trains will not increase the utility of the mode. The shape of this function can be adjusting using the k parameter, and some options for the level of k are shown in Figure 2.

Figure 2: Dampened Function of Frequency



Source: NEC FUTURE team, 2015

Record Weights

Combining the SP and RP datasets brings up the issue of what relative weigh to put on each source of data. Recall that each respondent provides information on one RP trip and six SP choice exercises. Judgmental approaches may use weights which can range from equal weight between each SP and RP record or equal weight between the set of SP records and each RP record. The six SP questions in the NEC Future survey were split into two groups: (1) three questions which hold values for mode 3 (out of three modes) constant, and (2) the other three questions which hold values for mode 2 (out of three modes) constant. Because the SP questions offer a more limited choice set than the RP, the SP question weights were set at 1/3 of the RP questions, as opposed to either end of the range (1 or 1/6).

The survey records are a sample of the population and may not have reflected actual traveler characteristics in the correct proportions due to sampling error or non-response issues. Incorporating record weights adjusts the sample to more accurately represent the total population. The FRA examined two different methods of weighting survey responses during the model estimation phase. The first method relied solely on the sample weights that were calculated to adjust survey records so that the demographics of the achieved sample match the general population.

The second method incorporated mode share weights. Mode share weights are used to adjust the survey records so that the mode shares by major market in the weighted sample match actual mode shares as represented in the base trip table (see Section 3.1.1.2). Using mode share weights potentially reduces the amount of validation needed after the estimation phase.

An example of the use of mode share weights is shown in Table 2 for New York to Washington. First, the number of survey records by mode for a particular market is computed. This is shown in the first row of the table, which has a total of 953 records. The next row shows the un-weighted mode share calculated directly from the survey records. In this example, there is a 54% auto mode share (510 auto records / 953 total records). The un-weighted mode share was then compared to the actual mode share from the base trip table. Because the actual mode share was calculated as 50% instead of 54% from the survey records, an additional factor was added to each auto record for that market pair that is equal to 0.94 (50% / 54%).

Table 2: Mode Share Weighting Example for New York – Washington Market

	Auto	Air	Intercity-Express Rail	Intercity-Corridor Rail	Regional Commuter Rail	Intercity Bus	Total
Number of Survey Records	510	66	55	80	0	242	953
Survey Mode Shares	54%	7%	6%	8%	0%	25%	100%
Base Trip Table Mode Shares	50%	16%	6%	12%	0%	15%	0.99
Mode Share Weight Factors = (Base Trip Table Mode Shares / Survey Mode Shares)	0.94	2.36	1.09	1.46	-	0.59	1.00

Source: NEC FUTURE team, 2015

Record Exclusion

A final method that was explored during estimation was to exclude records which were potentially erroneous or would not add value to the model estimation. The FRA tested three methods of exclusion:

- Mode exclusions. There were very few records either in the RP data or the SP data that were commuter trips taking the air mode. A possibility was to remove the air mode (and the associated records), from the commute model.
- Switching behavior restrictions. Large numbers of respondents who currently use auto did not switch to any other mode during the SP experiments, which indicated that they were auto-captive, and needed their personal vehicle either during or at either end of their trip. Because of this, they could potentially overwhelm the other responses, and cause issues in estimating the variable sensitivities. One option was to exclude these captive records from the estimation process.

Nesting Structures

Twelve nesting structures were identified for testing, which covered a large range of possibilities along the following dimensions:

- one- and two-level nest options,
- grouping the rail modes,
- grouping the premium and non-premium modes, and
- grouping common carrier modes.

These structures are shown in Figure 3. The variety of nesting structures allow for differing levels of similarity between modes, i.e., that they share certain unobservable characteristics. The impact of using nests is that it allows the model to exhibit the possibility that respondents are more likely to switch to other modes in the same nest as their chosen mode, and less likely to switch to modes in other nests. For instance, if respondents are more likely to switch to Intercity-Express from air since they are both premium modes (in price, amenities, and service characteristics) as opposed to from auto, then air and Intercity-Express should be nested together with auto in a separate nest. Some of the nesting structures contain two levels, indicating that modes share similarities in unobserved characteristics with the bottom level nest and additional (although lesser) similarities with modes in the upper level nest. Statistical tests performed on models using the same data but different nesting structures, as well as the estimated nesting coefficient values themselves informed which structure best fit the data.

Specific details on the variable specification and data segmentation testing for each model can be found in Section 3.3.1.

Figure 3: Potential Nesting Structures

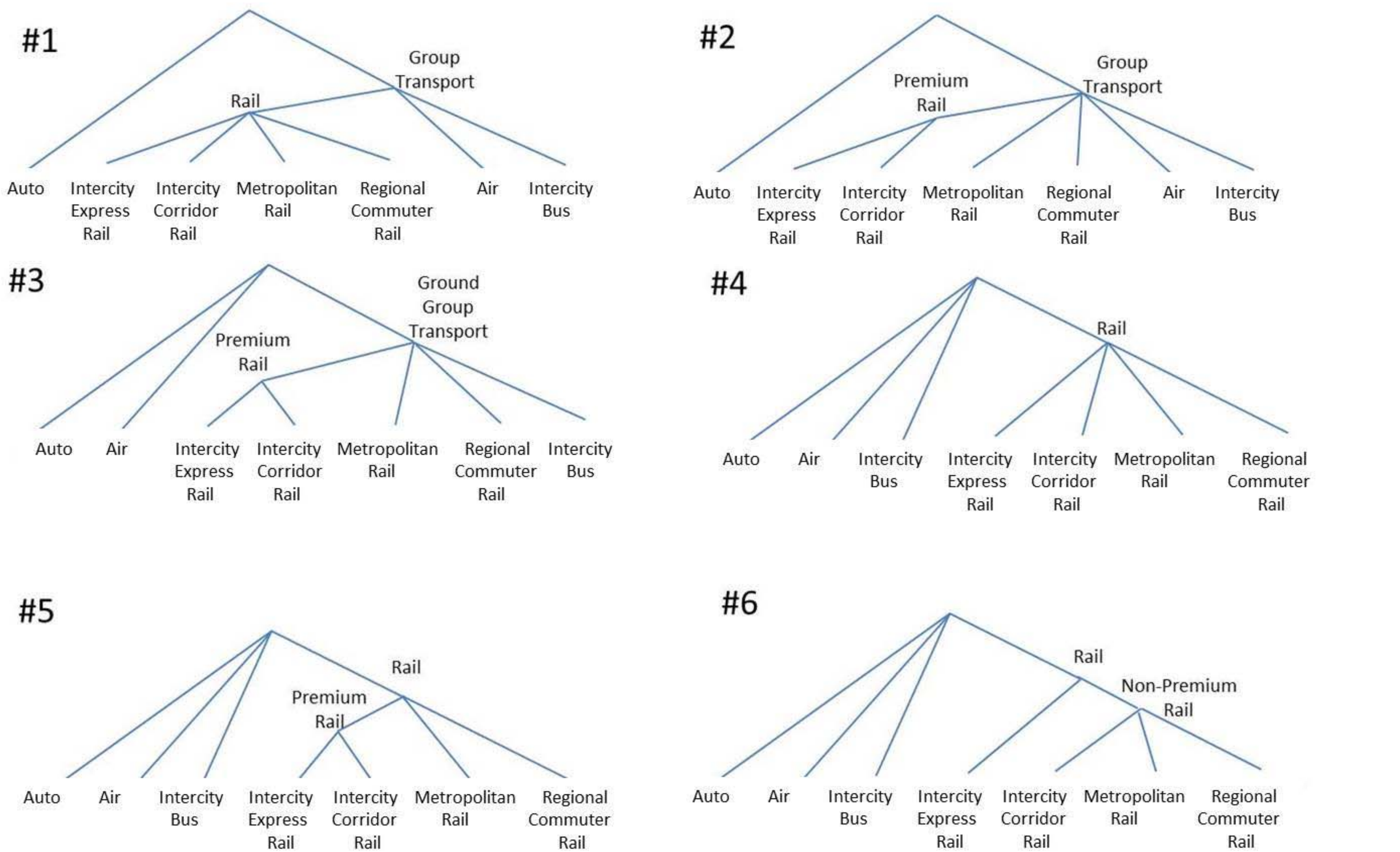
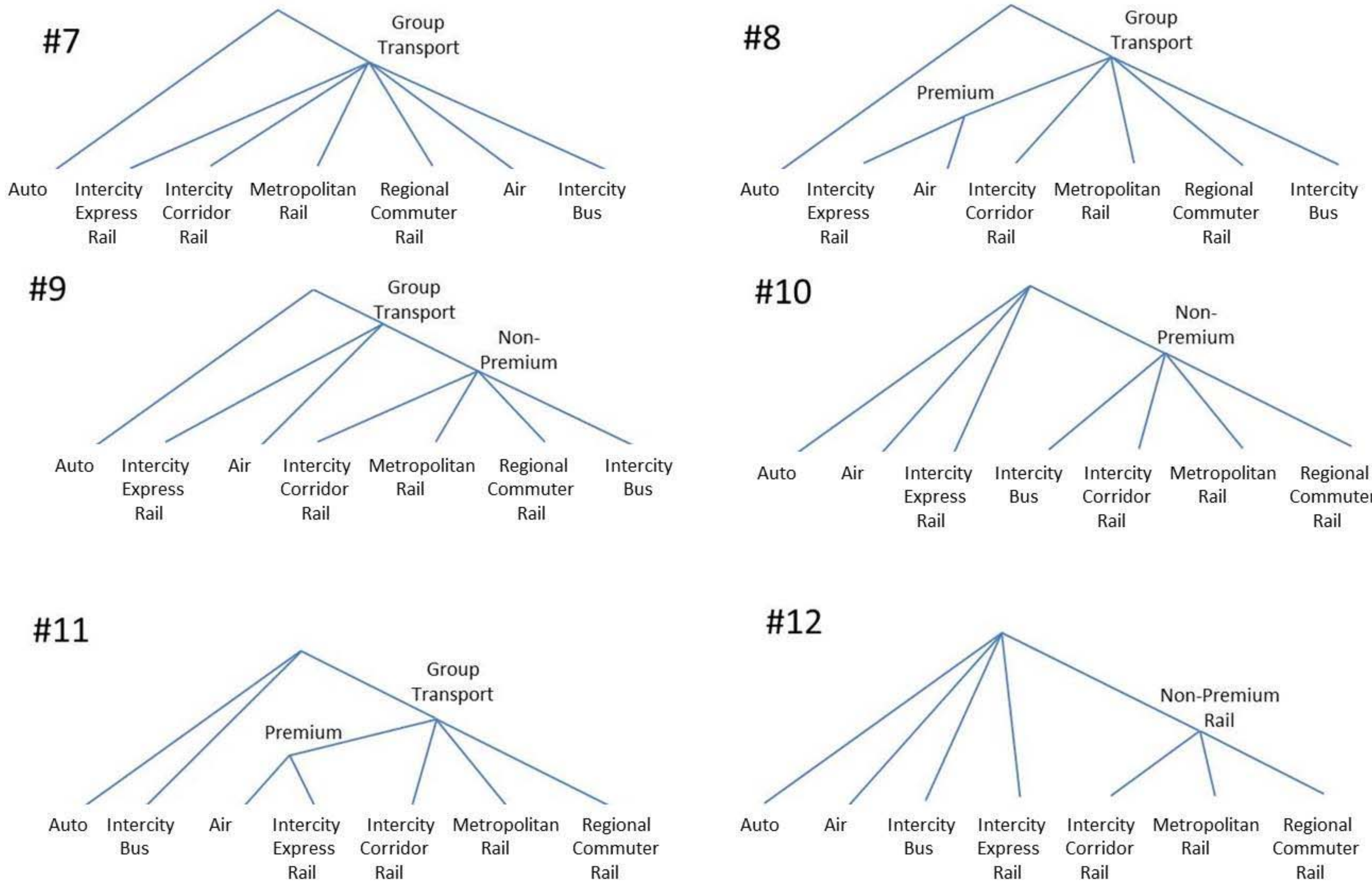


Figure 3: Potential Nesting Structures (continued)



Source: NEC FUTURE team, 2015

2.2.3.3 Survey Data Descriptive Analysis

The FRA exercised a second step in the mode choice estimation process and fully examined the completed survey responses to ensure that they would support the variable specifications and data segmentations identified in the first step of the model estimation process. Specific summaries examined in this step included:

- Number of records by trip purpose and geography to ensure that the survey responses had adequate geographic coverage for model estimation.
- Number of records by RP mode and geography to check for adequate mode coverage across different markets.
- Number of records by trip purpose and RP mode to ensure that the survey responses had adequate samples across modes.
- Number of records by SP mode to identify the number of responses who selected each mode in the SP questions, ensuring enough variation in the responses.
- Respondent switching behavior. One issue that can arise with SP surveys is not having enough variation within the service characteristics to encourage respondents to switch modes. This summary checked that there was enough switching behavior to estimate the key service variable sensitivities.

The results of the survey data descriptive analysis can be found in Section 3.2.2.

<u>Model Estimation</u>

Models of modal travel choice can be based on RP or SP data. Each type of data provides certain advantages over the other. RP data reflect actual behavior and take account of the real world conditions that respondents face. SP data takes account of a wider range of potential choices and attributes. The SP data reflect an experimental design that provides for explanatory variables that have a larger range of variability within and between alternatives and break the correlation between explanatory variables within each alternative. While models can be estimated with each type of data separately, the most robust models combine RP and SP data in order to take advantage of the unique characteristics of each type. Combining the two sets of data to estimate a single model can produce a model that retains the advantages of both RP and SP models and eliminate or dramatically reduce the disadvantages of each. The NEC FUTURE Household Travel Survey collected both types of data for use in studying travel patterns and travel behavior along the NEC.

The combined RP-SP model can be structured similarly to any NL model structure although because of the differences between the two types of data, the model structure must be slightly modified. The use of a scaling factor applied to the SP data allows for the combined estimation of the choice model, to account for a different error structure and possible biases of the SP data. This scaling factor is estimated by having a separate SP nest, as well as having an additional ASC for the SP modes. The other coefficient estimates can be constrained to be equal for both the RP and SP records.

2.2.3.4 Testing, Refinement, and Calibration

After model estimation, further testing, refinement, and calibration of the models was conducted. Model testing involved computing elasticities and conducting sensitivity analysis of key variables, such as time and cost, to ensure that the model behaves as expected and produces results that fall into reasonable ranges. Elasticity is defined as follows:

$$Elasticity\ = (\%\ Change\ in\ Probability)/(\%\ Change\ in\ Attribute)$$

For example, a sensitivity test was conducted whereby travel time by train was doubled, and the impact on both the train mode share as well as on the other mode shares was analyzed for reasonable results. Cost was also a key variable for sensitivity testing. In addition, the results of the mode estimation were explored at a market level and checked for reasonableness. Calibration factors in the form MSA-level alternative specific constants for each mode were added in order to better match observed the base year mode shares in each market.

An addition test of the estimated models was analysis of the Value of Time (VOT) implied by each model. VOT was calculated for each model by dividing the parameter on travel time by the parameter on cost. The estimated VOTs from each model were assessed for reasonableness as compared to VOT estimates from similar studies.

The SP questions in the Household Travel Survey presented four types of rail to respondents:

- High Speed Train
- Regional Train
- Commuter Train
- Metropolitan Train (a new service)

At the time the survey was developed, the FRA envisioned Metropolitan service as a rail mode that would be a service level above Regional rail services, but below Intercity-Corridor, in terms of service quality. Metropolitan would be moderately slower and cheaper than Intercity-Corridor, while not having reserved seats (so potentially some riders may need to stand), and no amenities such as restrooms or food service. When the Service Plans for the Action Alternatives became more fully developed, the Metropolitan trains ended up being very similar to the Intercity-Corridor trains in terms of frequency and stopping patterns than originally anticipated. In addition, they actually had faster travel times, due to the new equipment anticipated for use by the Metropolitan service.

To include a new mode in a logit model, the modeler must assert that the new mode is independent from the other modes included in the model so that it does violate the independence from irrelevant alternatives (IIA) property of the model. Using a nested logit lessens the stringency of the IIA requirement but does not eliminate it. Given that the more developed concept of Metropolitan service became very similar to the existing Intercity-Corridor service, the FRA decided to combine the Metropolitan mode with the Intercity-Corridor mode for ridership modeling purposes. The combined service retained the label “Intercity-Corridor.” The daily frequencies for Metropolitan and Intercity-Corridor were summed together and the travel times were averaged for each station pair to account for any differences in the service. The ASC estimated for Intercity-City rail mode was used to estimate mode share for the combined service.

As the naming convention of the rail modes differs across sections of the document, Table 3 provides a correspondence between the mode names.

Table 3: Intercity Rail Mode Naming Convention

Existing Name	Survey Name	Model Estimation Name	Application Name
Acela Rail	High Speed Train	Intercity-Express Rail	Intercity-Express Rail
Regional Rail	Regional Train	Intercity-Corridor Rail	Intercity-Corridor Rail
	Metropolitan Train	Metropolitan Rail	Intercity-Corridor Rail

Source: NEC FUTURE team, 2015

2.3 REGIONAL MARKETS

The FRA conducted the regional forecasting process with existing, off-the-shelf ridership tools to the maximum extent possible. Many of these tools have been used by Regional rail operators or other regional transit operators to plan Federal Transit Administration (FTA) New Starts investments and evaluate the implications of service and policy changes. By using the off-the-shelf tools the NEC FUTURE team maintained consistency with local existing and future planning efforts, and ridership and growth estimates.

Shorter distance, regional travel markets found within a specific major region will be addressed by the available regional models, which include:

- Washington: Metropolitan Washington Council of Governments (MWCOG)/Washington Metropolitan Area Transit Authority (WMATA) Forecasting Model
- Baltimore: Federal Transit Administration (FTA) Simplified Trips on Project Software (STOPS) implemented for the Baltimore metropolitan region.
- Philadelphia: Delaware Valley Regional Planning Commission (DVRPC) Model
- New Jersey: NJ TRANSIT North Jersey Travel Demand Forecasting Model
- New York – Metropolitan Transportation Authority (MTA)-Long Island Rail Road (LIRR)/MTA-Metro-North Railroad/Shore Line East: MTA Regional Transit Forecasting Model
- Boston: FTA STOPS implemented for Boston metropolitan region.

The FTA STOPS module was used to estimate ridership demand in locations without available local models. STOPS is the FTA's new national forecasting model, which relies on a combination of national experience and local market-based information to estimate transit project ridership. STOPS is a series of programs designed to estimate transit project ridership using a streamlined set of procedures that bypass the time-consuming process of developing and applying a regional travel demand forecasting model. STOPS is similar in structure to regional models and includes many of the same computations of transit level-of-service and market share found in model sets maintained by Metropolitan Planning Organizations and transit agencies.

A more detailed discussion of the regional forecasting tools is included in Chapter 4 of the report.

2.4 EXTERNAL MARKETS

The ridership methodology includes external markets as a third market area, comprising existing and proposed corridor services to/from Buffalo, Pittsburgh, Lynchburg, and North Carolina; and existing long-distance overnight train services, including trains to/from Florida, New Orleans, Chicago, and Montreal. The proposed methodology for analyzing these external markets made use of the FRA's own CONNECT tool, a sketch-planning tool that produces ridership forecasts based on simplified frequency and travel time assumptions and MSA-level demographics. After examining the CONNECT tool and the various Service Plans for the external corridors, the FRA determined that CONNECT was not suitable to produce accurate forecasts in these markets, given the simplified nature of the tool and its distance limitations. The CONNECT tool was not utilized and explicit ridership forecasts for these long-distance external markets were not created. Instead the focus for the Connecting Corridors was to determine that there was sufficient peak and off-peak capacity to accommodate the planned numbers of trains coming onto the NEC from connecting corridors.

3 Interregional Model

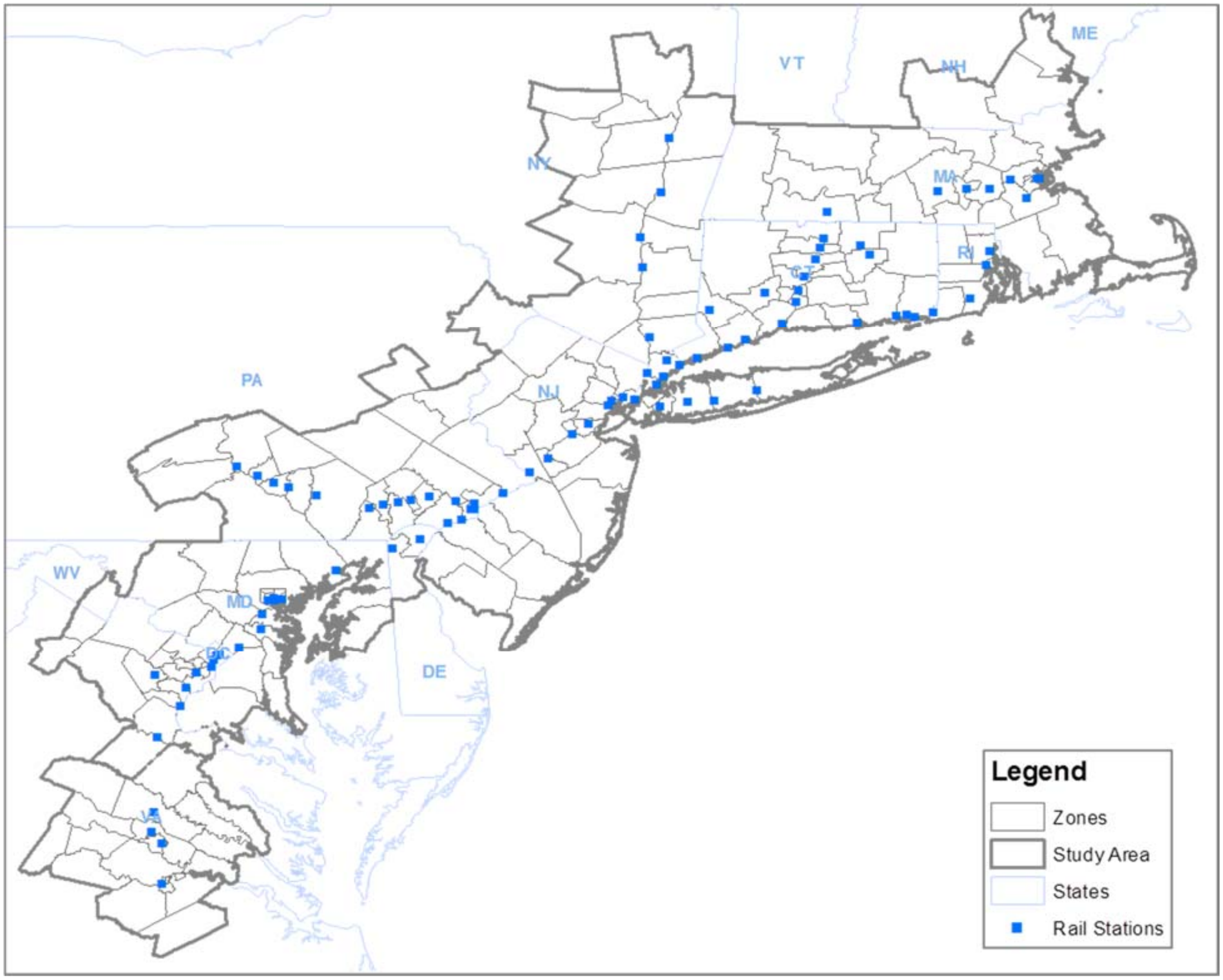
3.1 TOTAL TRAVEL MARKET DEMAND MODEL ESTIMATION

3.1.1 Baseline Travel Market Development

One of the key factors in travel demand forecasts is determining the total amount of travel occurring between origins and destinations. To forecast travel between origins and destinations it is important to develop the travel demand forecasting model at the appropriate level of analytical detail. To address this concern, the FRA developed a new zone system for the full range of alternatives. This new zone system expanded the existing interregional zone system used by Amtrak, based primarily on county boundaries. The Amtrak zone system encompasses 134 analysis zones defined to represent interregional travel in the NEC. In order to provide the geographic specificity required to represent the regional markets adequately, the FRA disaggregated the zone system to 200 zones, adding in finer zone definition in the urban areas by using Census Divisions as the basis for splitting the zones. The zone system for the model is shown in Figure 4. The zones were condensed into metropolitan areas for data summary purposes, and these areas are shown in Figure 5.

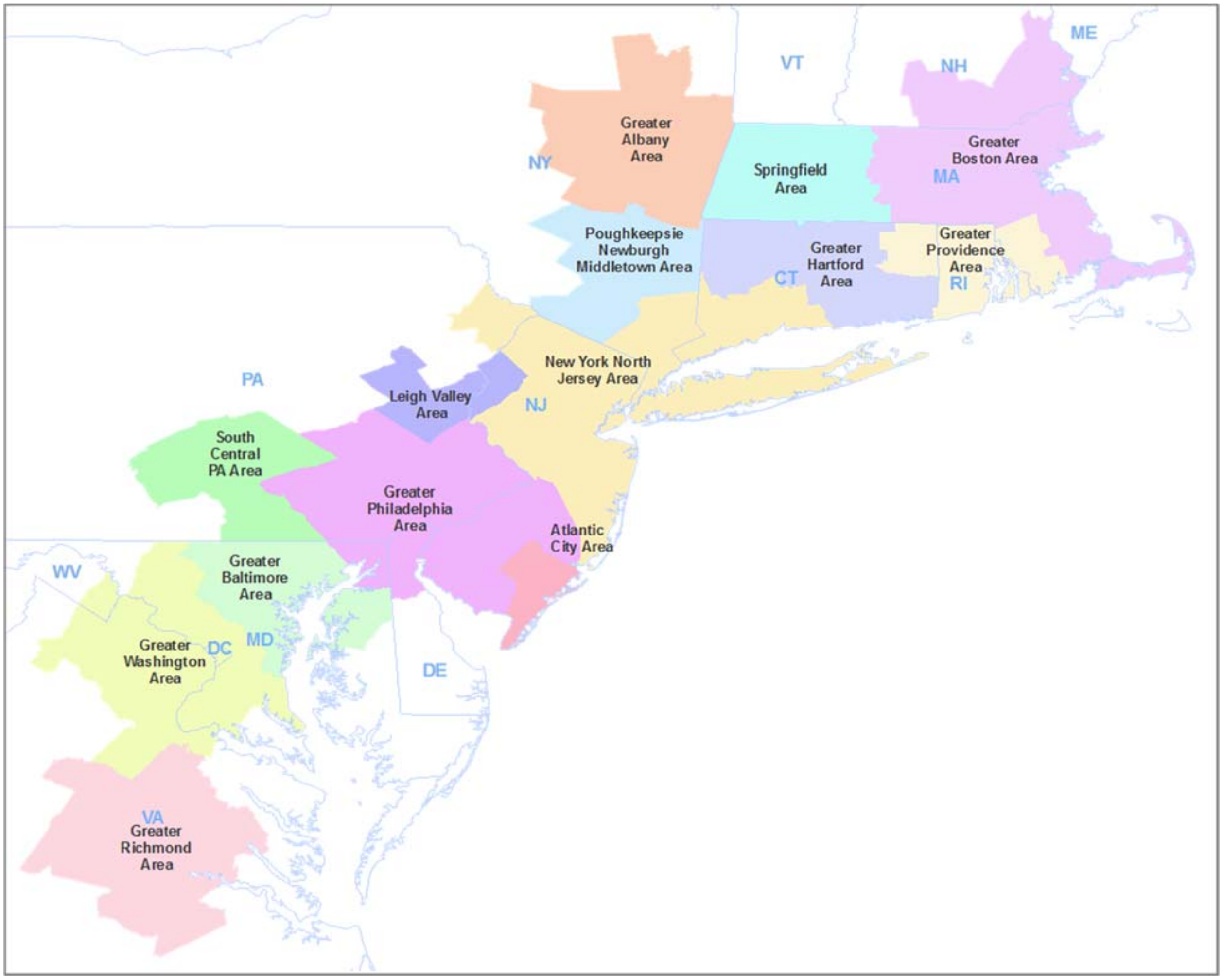
The interregional base travel market trip table consists of trips by origin and destination zone pair and intercity mode for the base modeling year of 2012. Multimodal interregional passenger market data for the Northeast were assembled from a number of different sources. This section highlights the key sources and methodology used to develop the base travel market data by intercity mode.

Figure 4: Study Area Zones



Source: NEC FUTURE team, 2015

Figure 5: Study Area Summary Metropolitan Areas



Source: NEC FUTURE team, 2015

3.1.1.1 Data Sources and Descriptions

The data sources for the base trip table vary by mode, including auto, air, rail, and bus. The sources are as follows:

- Auto market: NEC Automobile Origin-Destination (OD) Study (2014), prepared by RSG for the Northeast Corridor Commission
- Air market:
  - Air Carrier Statistics database (T-100 Domestic Market), 2012 Q3-Q4 and 2013 Q1-Q2, retrieved from http://www.transtats.bts.gov/Fields.asp?Table_ID=258
  - Airline Origin and Destination Survey (DB1B), 2012 Q3-Q4 and 2013 Q1-Q2, retrieved from http://www.transtats.bts.gov/Fields.asp?Table_ID=247
- Rail market: Amtrak Ridership and Ticket Revenue Data (FY 2013), provided by the Market Research and Analysis Department, Amtrak
- Bus market: Northeast Corridor Bus Schedule and Ridership Data (2014), prepared by RSG for the Northeast Corridor Commission
- Demographic Data: Demographic Growth Forecasts provided by Moody's Economy.com (annual for years 2010 through 2040)

The Northeast Corridor (NEC) Commission Auto Origin-Destination (OD) Study was developed using EZ-Pass data to identify travelers making longer distance auto trips in autumn 2013. Identified travelers were contacted to participate in a survey of travel patterns and trip characteristics throughout the entire NEC. The data took the form of individual survey records, geographically identified by origin and destination zip codes.

Air market data comes from two different datasets produced by the Bureau of Transportation Statistics (BTS). The first dataset is the Air Carrier Statistics database (T-100 Domestic Segment), which provides data on flight segments. This data also included the actual line-haul travel time (taken from the ramp-to-ramp time), which was averaged over all passengers for each airport pair, and the number of annual frequencies for each station pair. The Airline Origin and Destination (DB1B) dataset is a 10% sample of airline tickets which includes origin, destination, and other itinerary details, of which 12 months of data (2012 Q3-Q4 and 2013 Q1-Q2) was used to estimate the number of annual passengers between airports within the NEC. This data also included the actual fare paid by each passenger, which was averaged over all passengers for each airport pair.

Amtrak provided rail ridership data for FY 2013. This data included ridership and ticket revenue for station pairs within the NEC, split into Acela and regional trips (which correspond respectively to the Intercity-Express and Intercity-Corridor modes used in the model).

Similarly to the Auto OD Study, the Northeast Corridor Commission requested a study to quantify the bus travel market in the corridor, on which there was little data previously available. This study was completed in January 2014 and was conducted as an intercept study in addition to boarding and alighting counts in key cities. Using the count data, RSG estimated a bus trip table for the NEC.

This trip table contained the estimated number of annual trips between cities with intercity bus service.

Moody's Economy.com provided the demographic growth forecasts. These forecasts were developed from a national perspective that provides corridor-wide consistency with respect to key measures of growth, including population, income, and employment, based on detailed national and regional econometric modeling. This dataset is a custom forecast of demographic data obtained at the county level, and includes low, base, and high forecasts of total population, total non-farm employment, and total personal income. The demographic forecasts are discussed in more detail in Section 5.1.1.

The data for each mode from the sources above are either at the zip code level (auto trips) or station-to-station level. To distribute these trips to the zonal level, the trips were distributed similarly to the zonal populations. This is described in more detail in the trip table estimation process section below.

3.1.1.2 Baseline Trip Table Development Process

Using the data sources listed above, the FRA developed annual trip tables for each of the modes. The auto survey records from the OD study were not reliably distributed at the zonal level, so additional processing was required to finalize the auto trip table. The processing was completed by first assigning the auto OD survey records to the NEC FUTURE zones using zip codes. The zip code level data were then aggregated to the NEC FUTURE region-to-region level, to ensure the correct distribution of trips. The region-to-region level trips are then factored back down to the zonal level using the zonal population proportions within the regions, which was the 2012 population from Moody's Economy.com.

The other three modes (air, rail, and bus) were available at the station-to-station level, and were distributed to the zonal level in the same manner. The first step assigned the airports, rail stations, and bus boarding locations to the nearest NEC FUTURE zones. The station-to-station trips were then distributed to the zones using the same zonal population proportions as was done with the auto trips.

Table 4 summarizes the total estimated 2012 person trip volumes by mode along the corridor for travel between selected major markets, as well as for the total Study Area.

Total trips were segmented by purposes defined as follows:

- Business - includes all work related business trips
- Non-Business - includes, leisure/recreation, school, shopping, visit friends/relatives, personal business, and other trips
- Commuter - includes all commute to/from work trips

Table 4: Summary of Existing (2012) Annual Person Trips by Mode between Major Markets and Total Study Area

Origin Market	Destination Market	Auto	Air	Intercity-Express Rail	Intercity-Corridor Rail	Intercity Bus	Total
Boston	Hartford/ Springfield	3,546,047	—	—	4,522	228,832	3,779,471
Boston	New York	31,999,766	2,911,222	857,475	933,971	1,832,685	38,535,119
Boston	Philadelphia	2,990,145	1,347,578	38,670	113,532	74,393	4,564,317
Boston	Baltimore	1,019,913	1,395,068	7,114	18,588	41,772	2,482,456
Boston	Washington	813,116	2,717,932	19,155	63,864	37,234	3,651,300
Hartford/Springfield	New York	12,013,365	55,341	—	257,334	372,582	12,698,623
Hartford/Springfield	Philadelphia	1,355,415	148,549	—	17,931	6,117	1,528,012
Hartford/Springfield	Baltimore	188,360	171,871	—	4,409	3,851	368,491
Hartford/Springfield	Washington	331,218	342,613	—	14,227	5,985	694,043
Providence	New York	8,941,088	58,743	153,474	237,591	58,675	9,449,572
Providence	Philadelphia	1,167,253	136,902	10,284	28,540	5,901	1,348,879
Providence	Baltimore	1,836,285	163,063	2,135	6,754	2,345	2,010,582
Providence	Washington	135,242	326,763	4,530	17,367	3,663	487,566
New York	Philadelphia	39,149,532	828,899	522,157	1,962,317	1,698,209	44,161,114
New York	Baltimore	5,118,320	820,384	247,973	703,896	1,586,287	8,476,859
New York	Washington	8,575,252	1,996,075	1,063,569	1,794,617	1,673,015	15,102,526
Philadelphia	Baltimore	4,580,718	198,702	50,044	286,427	511,837	5,627,728
Philadelphia	Washington	4,017,246	464,782	235,193	706,775	296,762	5,720,758
Total Study Area		384,617,396	16,667,448	3,339,629	11,422,202	9,584,342	425,631,017

Source: NEC FUTURE team, 2015
Note: Trips represent total person trips in both directions

The segmentation was done using the trip purpose percentage share calculated from the NEC FUTURE Household Travel Survey, segmented by mode and trip length, for the entire Study Area. Trips by mode and purpose are shown in Table 5. The data in Table 5 shows that 70 percent of trips in the NEC market area are for non-business purpose.

Table 5: Summary of Existing (2012) Annual Person Trips by Mode and Purpose

Purpose	Auto	Air	Intercity-Express Rail	Intercity-Corridor Rail	Intercity Bus	Total
Business	63,195,087	8,716,858	1,724,564	2,698,277	1,030,920	77,365,706
Non-Business	274,271,937	7,950,590	1,423,448	7,126,202	6,990,935	297,763,112
Commute	47,150,373	0	191,617	1,597,723	1,562,491	50,502,204

Source: NEC FUTURE team, 2015

The final base trip table used in the Interregional Model was the total trips for each zone pair segmented by trip purpose.

3.1.2 Model Estimation Results

Total travel demand forecasts define the total market size to which the modal shares are applied to produce ridership forecasts by mode, as described in Section 2.2.3. This section describes the data used to estimate the new model, as well as the estimation results.

The FRA estimated the Interregional Model at the zonal level using the base year data (2013):

- Total trips by origin-destination pair from the baseline trip table
- Base year population from the Moody's demographic data
- Base year employment from the Moody's demographic data
- Base year Per Capita Income from the Moody's demographic

The FRA estimated three total demand models, one for each trip purpose, using SPSS and a linear regression form with the base year attributes. The model equation format for application is shown below, with zone I referring to the origin zone and zone j referring to the destination zone.

In the estimation process, it was necessary to constrain the relationship between population and employment because of high co-linearity. Given the size of the zones in the Interregional Model; both population and employment are correlated to the overall size of the community. A variety of ways to impose these constraints was tested in the estimation process, including the following:

- Constraining population and employment parameters to be equal,
- Using only population,
- Using only employment, and
- Changing the the dependent variable to be trips per person (effectively constraining the population parameter to be 1.0).

The FRA selected as the final model the version which provided reasonable results and good model fit statistics. The estimated coefficient values for each model are shown in Table 6, which can be interpreted as elasticities.

$$
\begin{aligned}
&Future\ Trips\ by\ Purpose \\
&\quad = Base\ Trips\ by\ Purpose \times \left(\frac{Future\ Population(i)}{Base\ Population(i)}\right)^{a} \\
&\quad \times \left(\frac{Future\ Population(j)}{Base\ Population(j)}\right)^{a} \times \left(\frac{Future\ Employment(i)}{Base\ Employment(i)}\right)^{b} \\
&\quad \times \left(\frac{Future\ Employment(j)}{Base\ Employment(j)}\right)^{b} \times \left(\frac{Future\ Per\ Capita\ Income(i)}{Base\ Per\ Capita\ Income(i)}\right)^{c} \\
&\quad \times \left(\frac{Future\ Per\ Capita\ Income(j)}{Base\ Per\ Capita\ Income(j)}\right)^{c} \times \left(\frac{Future\ LOS(i,j)}{Base\ LOS(i,j)}\right)^{d}
\end{aligned}
$$

Table 6: Total Demand Model Estimation Results

	Business Model		Non-Business Model		Commute Model	
Variable	Coeff.	**T-Stat**	**Coeff.**	**T-Stat**	**Coeff.**	**T-Stat**
Population (a)	0.7017	113.72	0.6027	117.04	0.6144	122.49
Employment (b)	0.7017	113.72	0.6027	117.04	0.6144	122.49
Per Capita Income (c)	n/a	n/a	0.3730	9.64	n/a	n/a
LOS (d)	0.1712	46.03	0.3289	85.22	0.3277	84.76
Model Characteristics						
Number of Records	19,900		19,900		19,900	
Rho-squared	0.4686		0.5795		0.5776	

Population and Employment coefficients were estimated together, so have the same value.
Source: NEC FUTURE team, 2015

3.2 MODE SHARE MODEL ESTIMATION

The FRA developed new model components using the new survey data, supplemented by network and service data as well as other relevant, available travel data. The detailed methodology used in this process is described in Section 2.3.3.

3.2.1 Data Sources

The estimation dataset comprises two types of data: mode choice data and modal service characteristics.

The NEC Household Travel Survey, described generally in Section 2.2.1 and in detail in Appendix A, is the source of information relating to respondents' mode choices. Each survey respondent provided up to seven estimation dataset records (one RP trip and six SP choice exercises). Each choice was accompanied by the trip's purpose and origin and destination zones.

For the RP records, the attributes for the respondents' chosen mode were provided by the respondents as part of the survey. The attributes of the non-chosen modes in the RP estimation dataset are based on current service characteristics. The current service characteristics also form the basis for the SP choice experiments. For each alternative mode, the experimental design combined time, cost, and frequency attributes at either the base value, +/- 15%, or +/- 30%.

The data sources and calculation processes for the modal service characteristics are provided below.

3.2.1.1 Auto Service Characteristics

The auto service characteristics include travel time, travel distance, and cost. In addition to auto line-haul service characteristics, these sources/methods apply to access/egress travel times and costs for all the other modes. Key sources include:

- Travel distance and time: Oak Ridge National Highway Network (2008), Center for Transportation Analysis, Oak Ridge National Laboratory. Retrieved from http://cta.ornl.gov/transnet/Highways.html.

- Travel cost: Standard Mileage Rates for estimating automobile operating cost (2012), Retrieved from http://www.irs.gov/Tax-Professionals/Standard-Mileage-Rates and published toll values. The mileage rate of $0.55/mile was used for the Business trip purpose and the incremental rate of $0.15/mile was used for Commute and Non-Business trips.

Auto travel time and distances were developed from an intercity highway network representing interstate, principal arterial, and other highway facilities connecting all study area zones and intercity passenger terminals. The highway network was derived from Oak Ridge National Laboratory's existing highway network database. Travel times were calculated for each link based on facility type, distance, and state speed limits.

To create zone-to-zone characteristics for auto, the FRA produced a set of network skims using an ArcGIS based application called Network Analyst. Network Analyst calculated the minimum path, based on minimizing travel time to/from each of the zones in the study area. Each minimum path calculation developed the time, distance, and toll costs associated with the trip. This process produced zone-to-zone distance and time matrices based on the minimum travel time route between each study area zone pair.

The access times and costs for all non-auto modes included the time and cost traveling from the origin zone to the bus boarding area/rail station/airport; the time and cost associated with the station, including waiting/boarding times; and the time/cost traveling from the destination bus alighting area/rail station/airport to the final destination zone. Access times and costs for travel between zones and stations/airports were developed using the same network procedure and cost per mile rates described above and used for the auto zone-to-zone travel characteristics.

3.2.1.2 Air Service Characteristics

The air service characteristics include travel time, travel cost, and frequency. These are developed using the following BTS datasets:

- Frequency and travel time: Air Carrier Statistics database (T-100 Domestic Market), 2012 Q3-Q4 and 2013 Q1-Q2, retrieved from http://www.transtats.bts.gov/Fields.asp?Table_ID=258.
- Fares: Airline Origin and Destination Survey (DB1B), 2012 Q3-Q4 and 2013 Q1-Q2, retrieved from http://www.transtats.bts.gov/Fields.asp?Table_ID=247.
- Access/egress time and cost: same sources as for auto travel time and cost for the segment of the trip which is from the origin zone to the origin airport and from the destination airport to the destination zone.

Line-haul travel time is calculated as the average ramp-to-ramp travel time from the T-100 Domestic Segment Database over one year of data. The access/egress travel time is calculated using the auto skimming process.

The calculated fare is the average fare for all passengers over a one-year time period between each pair of airports from the DB1B database. This fare is added to the mileage-based cost calculated from the auto skimming process for the access/egress portion of the trip to get the total cost for the air mode.

The frequencies were also taken from the DB1B database, which calculated the average number of daily frequencies between airports over a one year time period.

The appropriate airports were assigned to each zone based on which airport was the minimum highway distance from the centroid of the zone.

3.2.1.3 Bus Service Characteristics

The bus service characteristics include travel time, travel cost, and frequency.

- Travel Time: The intercity bus travel times were calculated using the auto travel times, multiplied by a 1.2 factor to account for slower bus speeds and intermediate stops. This factor was based on professional judgement.
- Travel Cost: Travel-time based formula based on existing fares, taken from publicly published fare data by operator.
- Access/egress time and cost: same sources as for auto travel time and cost for the segment of the trip which is from the origin zone to the boarding location and from the alighting location to the destination zone.

The intercity bus travel times were calculated using the auto travel times, multiplied by a factor of 1.2 to account for slower bus speeds and intermediate stops. This method was used to provide consistency across the modes. The use of auto travel time represents an average travel time, compared to often optimistic schedule times from the bus time tables (which do not vary by time of day). The access/egress travel time is calculated using the auto skimming process without an additional bus factor. Average daily bus frequencies were calculated from published time tables.

The intercity bus fares were taken from published fares by operator, with one or two weeks advance purchase, to represent an average fare paid. The access/egress cost calculated using the distance-based cost from the auto skimming process was added to the fare.

The appropriate bus stations were assigned to each zone based on which bus station was the minimum highway distance from the centroid of the zone.

3.2.1.4 Rail Service Characteristics

Similar to the other modes, the service characteristics for rail include travel time, cost, and frequency.

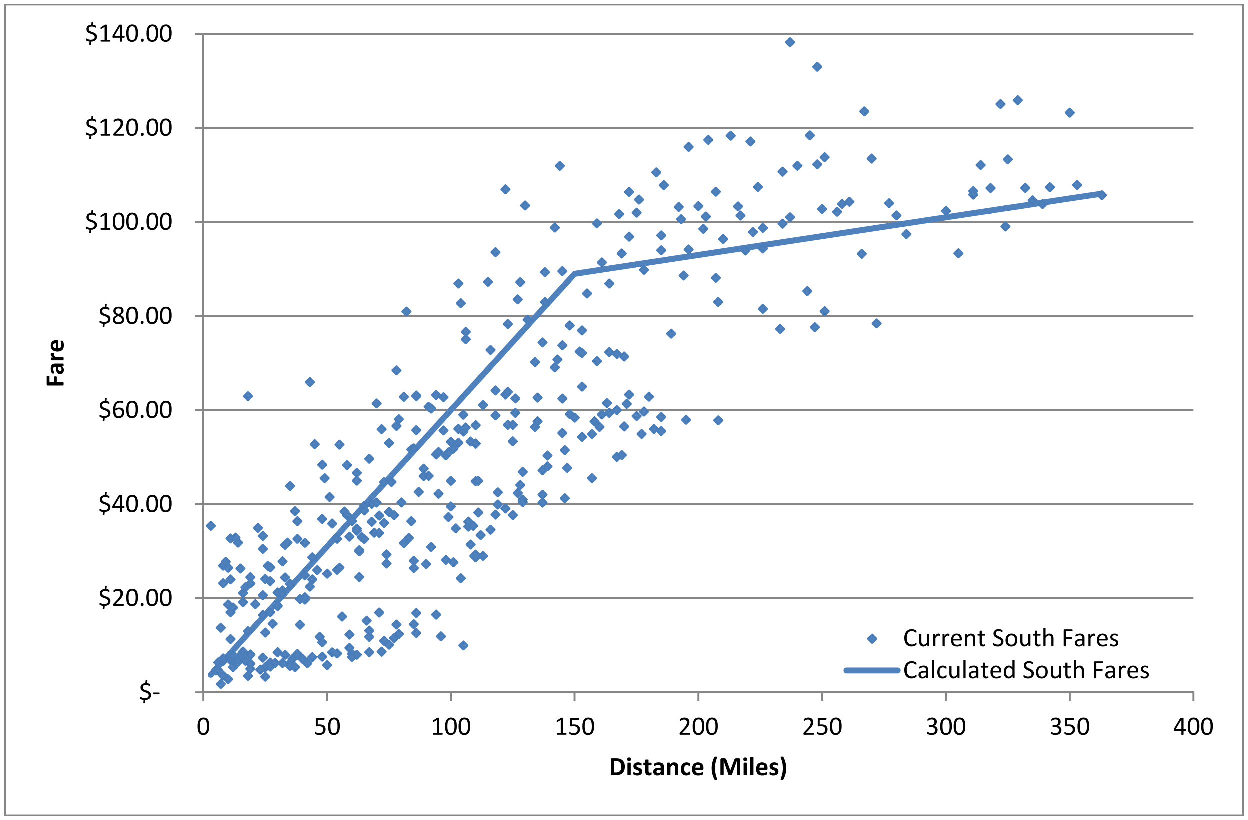
- Travel Time and Frequency:
  - For markets which currently have rail service (i.e. Acela between New York and Washington), travel time and frequency were taken from existing operator-published time tables for 2013.
  - For the new Metropolitan rail mode and markets which currently do not have rail service, travel time and frequency were based on Service Plans developed in the alternatives development process.

- Fares:
  - For markets which currently have rail service (i.e. Acela between New York and Washington), fares were the calculated average actual fares by station pair and service (from the Amtrak Ridership and Ticket Revenue data and published fares for Commuter rail).
  - For the new Metropolitan rail mode and markets which currently do not have rail service, distance-based fare formulas were calculated using existing fares.
- Access/egress time and cost: same sources as for auto travel time and cost for the segment of the trip which is from the origin zone to the boarding station and from the alighting station to the destination zone.

For the Interregional Model, the FRA assumed that rail fares would maintain the current fare structure. Distance-based fare equations were calculated based on current fares for three types of rail trips: trips entirely south of New York, trips north of New York, and trips through New York, as the current pricing structures were different in these different markets. Fares were calculated by trip geography to normalize fares for new travel markets while applying a consistent fare structure for the No Action Alternative and Action Alternatives. Figure 6 through Figure 9 show the current fares, as well as the calculated fares for each market.

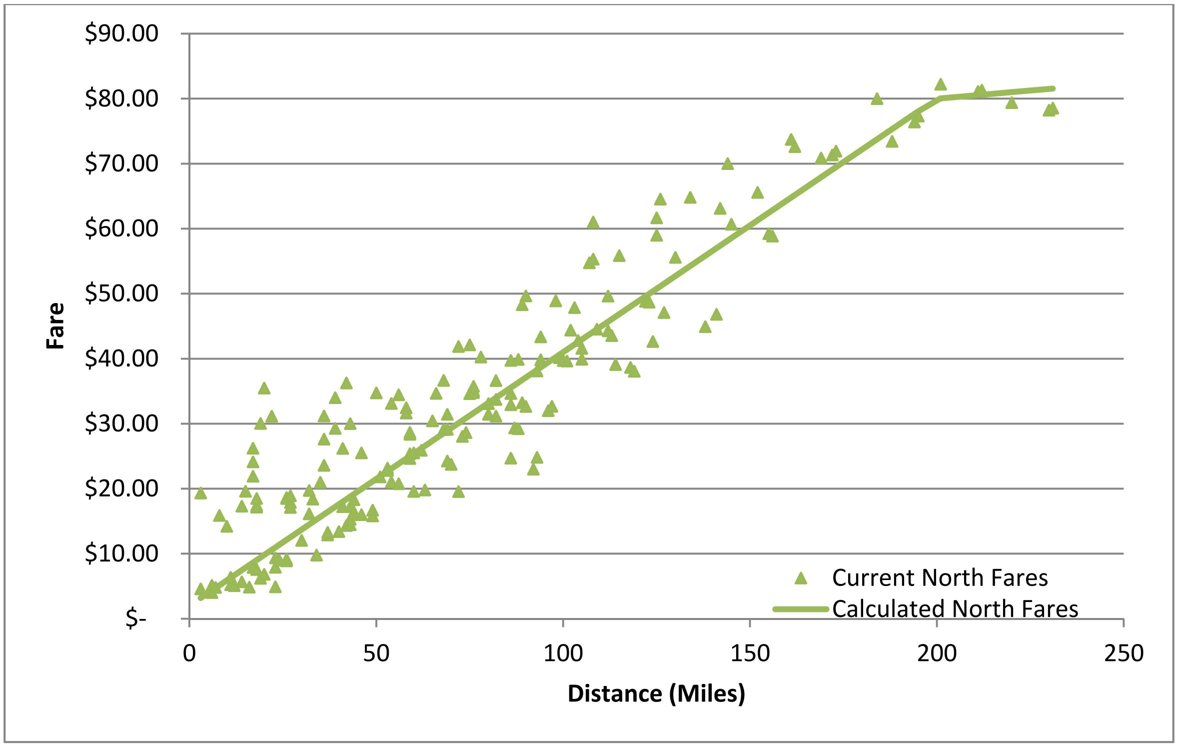
The fare equations were calculated by fitting a line to the current fare relationships and then calibrating to closely match the large key markets. The geographic equations are similar for express and non-express rail. Markets entirely south of New York show the highest rail fares, markets entirely north of New York have the lowest fares, and the through New York fares fall in the middle. This fare pricing reflects current congestion on the south end of the corridor, and is a fare policy that could potentially be adjusted in the future.

Figure 6: Non-Express Rail Distance-Based Fares for Trips South of New York



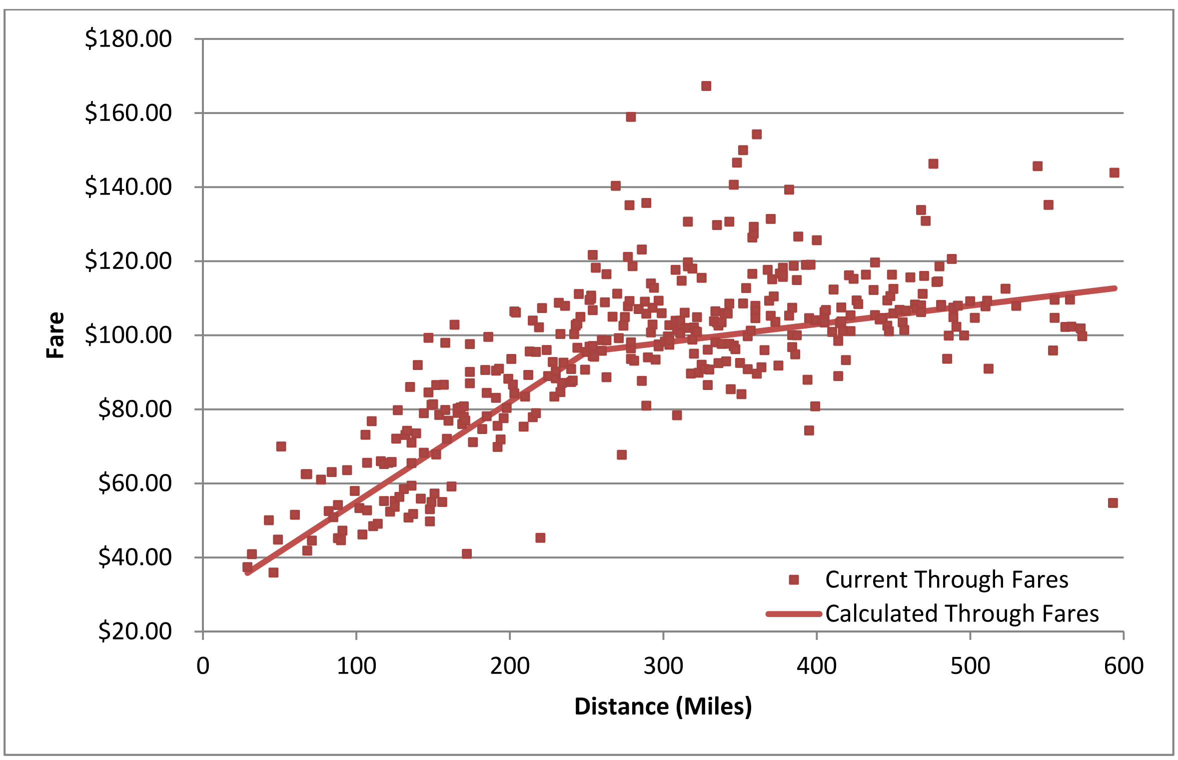
Source: NEC FUTURE team, 2015

Figure 7: Non-Express Rail Distance-Based Fares for Trips North of New York



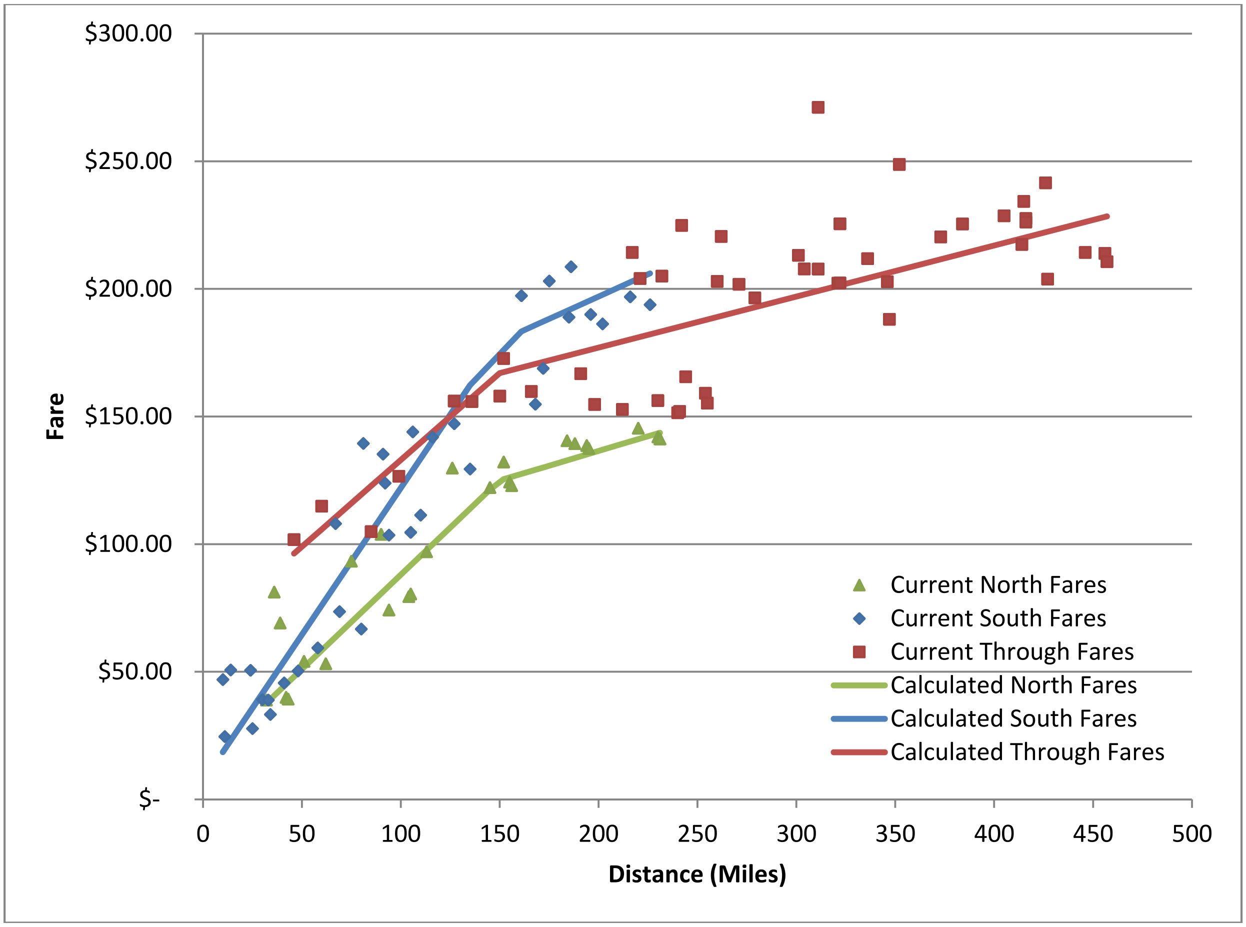
Source: NEC FUTURE team, 2015

Figure 8: Non-Express Distance-Based Fares for Trips through New York



Source: NEC FUTURE team, 2015

Figure 9: Express Distance-Based Fares



Daily train frequencies and average travel times were obtained from the Service Plans for each alternative, as described in detail in the *Service Plans and Train Equipment Options Technical Memorandum*. The FRA processed the Service Plans for input into the Interregional Model to assign an average travel time and daily frequencies for the Intercity-Express and Intercity-Corridor trains (including both Metropolitan trains and Intercity-Corridor-Other trains)[3] for each station pair. The service characteristics used for each zone pair included the service provided not only by corridor trains but also off-corridor services such as Keystone and Virginia services.

Access/egress travel time and cost were calculated for the portion of the trip from the origin zone to the boarding station and the alighting station to the destination zone in a similar manner to the other modes using the auto skimming process.

[3] For detailed definitions on service types, see the *Tier 1 EIS Alternatives Report*. Metropolitan service provides the primary Intercity rail service on the NEC. Intercity-Corridor-Other service provides connectivity and direct one-seat service between non-electrified connecting corridors and the large and mid-size markets on the NEC.

3.2.2 Survey Data Descriptive Analysis

As described in the methodology discussion, once the potential variable specifications and data segmentations were identified, the survey data was summarized and reviewed to ensure that it could support of the desired specifications. Key aspects of the survey data which support the variable specifications and data segmentations are presented in the tables below.

Table 7 details the records available for estimating each of the models by trip purpose. The survey targets were developed using the three geographies to ensure adequate coverage (North of NY, South of NY, and Through NY). Commute trips through New York did not meet the minimum number of 300 respondents required for all the other cells. However, the number of all commute trips taken as a whole exceeds the study plan minimum of 300.

Table 7: Survey Records by Trip Purpose

	Business	Non-Business	Commute	Total
North of NY	553	2,630	418	**3,601**
South of NY	987	4,437	624	**6,048**
Through NY	420	1,664	125	**2,209**
TOTAL	**1,960**	**8,731**	**1,167**	**11,858**

Source: NEC FUTURE team, 2015

Table 8 presents a summary of the actual mode taken by the respondent in the reference trip by trip purpose. The table shows that enough records were found in each of these segments to support model estimation.

Table 8: Revealed Preference (RP) Mode and Trip Purpose

Mode	Non-Business	Business	Commute	Total
Car/Truck/Van	7,036	1,189	878	9,103
Plane	232	243	17	492
Train	726	396	144	1,266
Bus	737	131	128	996
TOTAL	**8,731**	**1,959**	**1,167**	**11,857**

Source: NEC FUTURE team, 2015

Table 9 summarizes the modes that respondents selected, both in their actual reference trip (Revealed Preference Mode) and in the choice experiments presented to them (Stated Preference Modes). Because each respondent was exposed to three modes in the SP questions, the total sums to 300%.

Table 9: Revealed and Stated Preference Modes

	Revealed Preference (RP) Mode		Stated Preference (SP) Modes	
	Count	Percentage	Count	Percentage
Intercity-Express Rail	297	3%	3,247	27%
Intercity Regional Train	744	6%	10,772	91%
Regional Commuter Train	225	2%	1,133	10%
Metropolitan Train	0	0%	2,269	19%
Car/Truck/Van	9,103	77%	10,244	86%
Plane	492	4%	2,613	22%
Intercity Bus	996	8%	5,296	45%
TOTAL	**11,857**	**100%**	**35,574**	**300%**

Source: NEC FUTURE team, 2015

Stated preference surveys may not present a large enough range of service characteristics to induce respondents to switch their mode preference. The model estimation process can be problematic if the respondents are not revealing the value they place on various characteristics of travel (such as time and cost), because they do not experience through the survey the point at which their preferences could switch to another mode. This condition reduces the number of viable records for estimation. Table 10 details the number of respondents who selected the same mode for all of the stated preference questions, whether with their current revealed preference mode, or an alternate mode. Approximately 60% of respondents did not switch modes, which indicates a potential issue. To investigate the issue, Table 11 provides information related to respondents who did not switch, comparing their current RP mode versus the mode they selected in the SP questions. Of these respondents, 69% were current auto users who only selected auto. This indicates that the non-switching behavior is due likely to a large portion of the market being “auto-captive” rather than to the design of SP choice exercises.

Table 12 and Table 13 further summarize the trip records by geographic segmentation.

Table 10: Respondent Switching Behavior across Stated Preference (SP) Questions

	Count	Percent
Didn't Switch – Stayed with Current Mode	5,454	46.0%
Didn't Switch – Stayed with an Alternate Mode	1,671	14.1%
Switched Among Different Modes	4,733	39.9%
TOTAL	**11,858**	**100.0%**

Source: NEC FUTURE team, 2015

Table 11: Respondents who didn't Switch Modes – Current Mode vs. Selected Mode

		Selected Mode								Total
		Intercity-Express Train	Intercity-Corridor Train	Regional Commuter Train	Metro-politan Train	Auto	Plane	Intercity Bus	Didn't Travel	
Current Mode	Intercity-Express Train	1%	1%	0%	0%	0%	0%	0%	0%	2%
	Intercity-Corridor Train	0%	3%	0%	0%	1%	0%	0%	0%	4%
	Regional Commuter Train	0%	0%	1%	0%	0%	0%	0%	0%	2%
	Metropolitan Train	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Auto	2%	9%	1%	1%	69%	1%	0%	0%	83%
	Plane	0%	1%	0%	0%	0%	2%	0%	0%	3%
	Intercity Bus	0%	2%	0%	0%	1%	0%	2%	0%	6%
	TOTAL	**4%**	**16%**	**2%**	**2%**	**72%**	**3%**	**2%**	**0%**	**100%**

Source: NEC FUTURE team, 2015

Table 12: Records by Major Market and Trip Purpose

Market		Business	Non-Business	Commute	Total
Boston	Hartford	36	112	27	175
	New York	224	882	91	1,197
	Philadelphia	33	115	9	157
	Baltimore	16	34	1	51
	Washington	61	171	6	238
Hartford	New York	72	280	42	394
	Philadelphia	12	42	1	55
	Baltimore	1	10	-	11
	Washington	7	26	-	33
Providence	New York	36	218	18	272
	Philadelphia	6	23	1	30
	Baltimore	3	7	-	10
	Washington	9	27	1	37
New York	Philadelphia	293	1,285	209	1,787
	Baltimore	64	284	42	390
	Washington	285	880	52	1,217
Philadelphia	Baltimore	33	213	29	275
	Washington	106	582	34	722
	Total Study Area	**8,731**	**1,959**	**1,167**	**11,857**

The individual market pair records do not sum to the total study area, due to exclusion of minor markets.
Source: NEC FUTURE team, 2015

Table 13: Records by Major Market and RP Mode

Market		Auto	Plane	Train	Bus	Total
Boston	Hartford	164	2	2	7	175
	New York	846	59	166	126	1,197
	Philadelphia	107	29	14	7	157
	Baltimore	21	26	2	2	51
	Washington	100	121	12	5	238
Hartford	New York	313	—	52	28	393
	Philadelphia	46	—	3	6	55
	Baltimore	8	2	—	1	11
	Washington	17	12	2	2	33
Providence	New York	230	2	26	14	272
	Philadelphia	26	2	1	1	30
	Baltimore	4	3	3	—	10
	Washington	18	17	2	—	37
New York	Philadelphia	1,307	20	220	240	1,787
	Baltimore	270	12	53	55	390
	Washington	715	81	229	192	1,217
Philadelphia	Baltimore	240	1	10	24	275
	Washington	582	11	76	53	722
	Total Study Area	**9,103**	**492**	**1,266**	**996**	**11,857**

The individual market pair records do not sum to the total study area, due to exclusion of minor markets.
Source: NEC FUTURE team, 2015

3.2.3 General Interregional Model Estimation Process

The FRA began the model estimation process by using only the RP data to determine model segmentations and the preliminary specification of variables and nesting structures. Once it was verified that there were no unusual results from the RP only models, SP only models were estimated, and the variable sensitivities produced by the SP models were compared to the initial RP only models to ensure the SP data was functioning correctly. Many of the variable specifications and nesting structures determined in the first step of the model estimation process were tested using both sets of data (RP data only and SP data only).

After the FRA determined that RP only and SP only model estimations both produced reasonable results for multiple specifications, combined RP/SP models were estimated. The estimation process was iterative, first selecting a nested choice structure to refine the variable specifications, and then testing the alternative nesting structures from Figure 2 (to test for differential substitutability among sets of modes). The nesting coefficient values helped determine the best nesting structure, as coefficients closer to zero indicated a better fit for nesting the specified modes together. The criteria for selecting the preferred models also included looking at the fit statistics (log-likelihood and rho-squared), as well as the statistical significance of the variable coefficients.

After the new inputs and data were assembled and loaded into the model, the FRA subjected the model to extensive testing and review to confirm adequately consideration of all key market segments and that sensitivities to changes in key inputs were reasonable and within the range of expectations set by existing models and forecasts. The model estimation process for each model, including adjustments made to the variable specifications and re-estimation work is described below.

3.2.4 Business Purpose Model

3.2.4.1 Process Description

The model estimation process for the Business model followed the general procedures outlined in Section 3.2.3. Specific observations about the estimation process are:

- The RP only model had difficulty converging due to low number of records. None of the nesting structures were statistically significant, in that the nesting coefficients were outside the theoretically acceptable range of 0 to 1. Therefore the only model estimated was an un-nested multinomial logit (MNL) model.
- The SP only model produced multiple models which converged with statistically significant variables using different variable specifications and nesting structures. This provided a good basis for comparison for the variable specifications of the combined RP/SP models.
- Removing mode share weights (using sample weights only) produced more reasonable Alternative-Specific Constants (ASCs). Using the mode share weights, which were applied at the MSA-to-MSA level, the differences between the ASCs were larger than typically accepted, and were accounting for most of the mode choice utility.
- All twelve nesting structures were tested for the combined RP/SP models, and the best-performing structure was two levels, with non-premium rail modes (Intercity-Corridor, Intercity Commuter, and Metropolitan) nested under a rail nest (structure #6 in Figure 2).
- Dampened frequency performed better than trains per day, and -0.08 was the preferred parameter (values were tested between -0.1 and -0.03), as it had the best statistical fit. The value of -0.08 is a typical value used in other intercity rail models, which means that train frequency is saturated at around 50 trains per day, or that additional trains over 50 per day do not impact the mode choice decision.
- Straight time and cost produced sensitivities that were too great at the higher end of time and cost values. As discussed in the methodology section, time and cost do not necessarily have a linear relationship, as an additional 10 minutes of travel time would typically impact a 20 minute base trip time more negatively than it would for a 120 minute trip time.
- Since the straight time and cost were producing unreasonable results, the dampened versions using highway distance were tested. Dampened time and cost caused issues with nesting structures and convergence, despite trying multiple adjustment parameters, and were not possible specifications.
- The next test was done only for cost, and involved splitting cost into two variables, one applied to premium modes (Air/Intercity-Express Rail), and one for non-premium modes, to allow the VOT to vary. This was done on the basis that premium modes have a very different cost structure than the non-premium modes, and an increase in cost for those modes would have less of an impact on the respondents' choice than a similar increase in cost on the non-premium modes. Business travelers are also less likely to personally pay for travel, and are therefore less

sensitive to the price differential between the premium and non-premium modes. This produced reasonable results.

- The ASCs for the four rail modes were similar, so they were tested by holding them equal. This change increased the importance of frequency, which is a key differentiator between Intercity Commuter/Metropolitan rail and Intercity-Corridor/Intercity-Express rail. By holding the ASCs constant for all four rail modes, the frequency variable picked up more explanatory power, and it is desirable to have more of the mode choice decision based on the variables as opposed to the unseen differences picked up by the ASCs.
- The intercity bus mode is attractive, based on the ASC, primarily due to un-modeled attributes such as flexibility and ease of access.

3.2.4.2 Estimation Results

Table 14 presents the results of the model estimation, with specific descriptions of the resulting parameter estimates for each variable below:

- The ASCs represent the unobserved attributes of each mode, and indicate the order and magnitude of mode preference given all other attributes held constant. Auto is the base mode, and all other ASCs are negative, indicating Auto is the preferred mode, with Bus being highly competitive and Air being the third preference. All the Rail mode ASCs are constrained to be equal to each other and shown to be least preferred. Constraining the rail mode ASCs to be equal allows more of the mode choice decision to be based on the differences in observed attributes, such as time, cost, and frequency.
- The access/egress portion of travel time is accounted for by adding up the Total Travel time and Access/Egress/Connect Travel Time coefficients, and is therefore almost twice as onerous to the business traveler versus the line haul time, indicating a preference for ease of access. Access/egress time is determined by station location. Travelers are more likely to choose the mode with the station (rail station, airport, or bus station) closest to their trip origin, particularly for shorter trips where the access/egress time are a larger portion of the total travel time.
- Cost was split into two variables, applicable to either premium modes (Air/Intercity-Express Rail) or Non-Premium modes (Auto, Intercity Bus, Intercity-Corridor, and Commuter rail). The cost coefficient for the premium modes is approximately half of that for the non-premium modes. This segmentation was done on the basis that premium modes have a very different cost structure than the non-premium modes, and an increase in cost for those modes would have less of an impact on the respondents' choice than a similar increase in cost on the non-premium modes. Business travelers are also less likely to personally pay for travel, and are therefore less sensitive to the price differential between the premium and non-premium modes.
- The business value of time varied by mode because the cost variable is split into two variables based on mode. The VOT for the premium modes was around $92/hour and for the non-premium modes it was around $41/hour. These are typical values for business travelers, and show that they are willing to pay higher prices to save time.

- The adjusted frequency variable uses the dampened frequency formulation, which essentially allows frequency to impact mode choice up to approximately 50 trains per day, at which point the impact tapers off. The strong negative value indicates that low values of frequency have a large negative impact on business travelers taking that mode, which is intuitive because business travelers usually have tighter constraints on their travel timing, and low frequencies would require them to potentially build in extra time for their entire trip. As they have high values of time, they are more willing to shift to a mode (even if it is more expensive) if it allows them to more tightly control the timing of their trip.
- The nesting coefficients indicate a moderate substitutability among the rail modes, and a less strong substitutability among the non-premium rail modes.

Table 14: Business Model Specification

Variable	Coeff.	T-Stat
Rail ASC	-1.18	-9.9
Auto ASC	0.00	n/a
Air ASC	-0.78	-3.8
Intercity Bus ASC	-0.22	-1.4
Total Travel Time	-0.011	-10.1
Access/Egress/Connect Travel Time	-0.0087	-5.5
Total Cost - Premium Modes (Air/Intercity-Express Rail)	-0.0073	-7.2
Total Cost - Non-Premium Modes	-0.016	-8.3
Adjusted Frequency	1.45	6.8
Rail Nest	0.65	13.7
Non-Premium Rail Nest	0.97	9.2

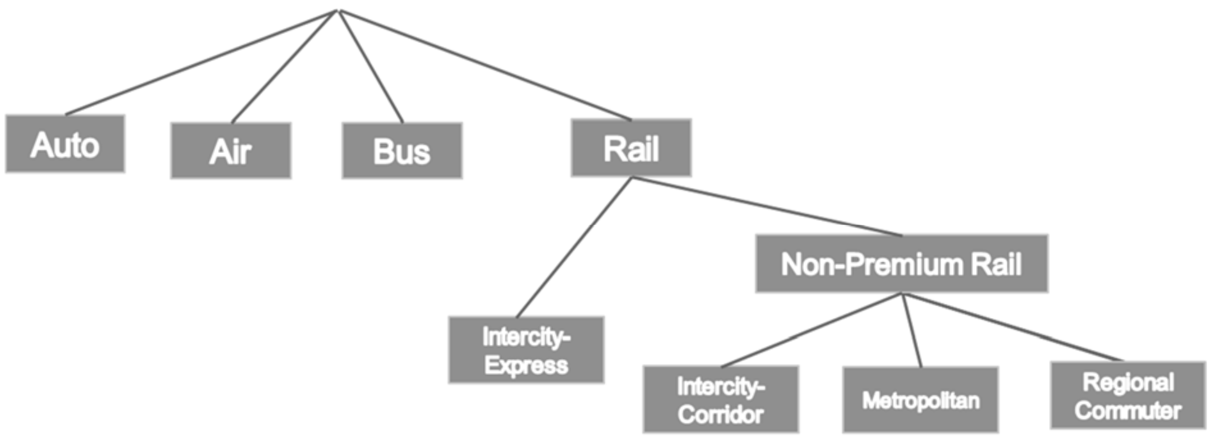
Log Likelihood		Rho-squared	
Constants Only	Final	w.r.t Zero	w.r.t. Constants
-9450.26	-8636.67	0.2016	0.0861

Estimation Records	
RP Records	1,487
SP Records	11,907
Total Records	13,394

Source: NEC FUTURE team, 2015

Figure 10 shows the final nesting structure used for the business mode choice model, selected due to best-fitting nesting coefficients and the intuitive explanation for mode of travel selection by business travelers. This nesting structure illustrates that business travelers view the premium rail service as distinct from the other rail services. Therefore the model indicates that the non-premium rail modes should be nested together.

Figure 10: Business Model Nesting Structure



Source: NEC FUTURE team, 2015

To test the reasonableness of the model results, the FRA calculated rail travel time and cost elasticities, and reviewed the results to make sure they fell in acceptable ranges. Previous experience suggests that the time and cost elasticities for intercity rail are typically within a range of -0.3 to -2. That range of -0.3 to -2 for elasticities indicates that 20% increases and decreases in the values of the service characteristics of a mode would shift that mode's share by 6% to 40%. A 40% mode share shift would indicate a large impact, and is only anticipated on the longer distance travel markets. For example, if rail currently has a 12% mode share and the calculated elasticity is -2 based on a 20% decrease in travel time, the mode share would be shifted by 40%, or would have a new mode share of 16.8%.

Table 15 shows the estimated elasticities for a 20% increase and a 20% decrease in selected rail service characteristics for key markets. Due to the structure of the logit model, the estimated elasticity depends on both the model coefficients and the relative values of modal attributes (for all modes) which vary by market.

Table 15: Business Model Service Variable Elasticities

Variable/Market	Elasticities		% Change in Mode Share	
	+20%	-20%	+20%	-20%
Intercity-Express Train Time (+20% / -20%)				
Boston - New York	-0.99	-0.79	-20%	16%
Boston – Washington	-1.81	-0.90	-36%	18%
New York – Philadelphia	-0.58	-0.57	-12%	11%
New York – Washington	-0.98	-0.80	-20%	16%
Philadelphia – Washington	-0.69	-0.66	-14%	13%
Intercity-Corridor Train Time (+20% / -20%)				
Boston - New York	-1.45	-0.92	-29%	18%
Boston – Washington	-2.41	-1.15	-48%	23%
New York – Philadelphia	-0.62	-0.67	-12%	13%
New York – Washington	-1.20	-0.83	-24%	17%
Philadelphia – Washington	-0.73	-0.66	-15%	13%
Intercity-Express Train Cost (+20% / -20%)				
Boston - New York	-1.06	-0.84	-21%	17%
Boston – Washington	-1.97	-0.94	-39%	19%
New York – Philadelphia	-0.63	-0.62	-13%	12%
New York – Washington	-1.04	-0.84	-21%	17%
Philadelphia – Washington	-0.75	-0.72	-15%	14%
Intercity-Corridor Train Cost (+20% / -20%)				
Boston - New York	-1.76	-1.04	-35%	21%
Boston – Washington	-3.41	-1.33	-68%	27%
New York – Philadelphia	-0.67	-0.74	-13%	15%
New York – Washington	-1.50	-0.90	-30%	18%
Philadelphia – Washington	-0.80	-0.71	-16%	14%

Source: NEC FUTURE team, 2015

3.2.5 Non-Business Purpose Model

3.2.5.1 Process Description

The model estimation process for the Non-Business model followed the general procedures outlined in Section 3.2.3. Specific observations about the estimation process were:

- The combined RP/SP model had time and cost parameter estimates that yielded unreasonable sensitivity estimates and the ASCs were much larger than the ASCs in the RP only and SP only models, which means a large amount of the explanatory power was shifted from the service variables to the ASCs. The RP only model and SP only model had similar parameter estimates for time and cost which appeared reasonable; however, the rank order of the ASCs differed between the RP only and SP only model. For instance, the bus mode was highly ranked in the RP model but low ranked in the SP model. One interpretation of that finding is that people say in a telephone survey that they aren't interested in taking the bus, but in actuality they do take the bus more often than one would expect given its cost and travel time. In the model that combined RP and SP data, that tension between the RP and SP data regarding the ASCs may have been the cause of difficulties in estimating appropriate parameters for the other service characteristics. Since the combined RP/SP data did not yield reasonable results and expert consensus is that RP data is preferred to SP, the RP only model was chosen as the final model. However it is important to reiterate that the elasticities from the RP only model were very similar to those from the SP only model. Because non-business was the most common trip purpose in the survey data (73.6%) there were sufficient number of records (8,731) to estimate a robust model. The number of records available for the other purposes was not sufficient to estimate an RP only model.

- Similarly to the Business model, removing mode share weights (using sample weights only) produced more reasonable ASCs. Using the mode share weights, which were applied at the MSA-to-MSA level, the differences between the ASCs were larger than typically accepted, and were accounting for most of the mode choice utility.
- After testing 12 nesting structures for the RP only model, the best-fitting structure was the rail nest (structure #4), combining all rail modes. This was determined by using the statistical fit measures of the nesting structures, as well as the statistical significance of the variables.
- Dampened frequency performed better than trains per day, and -0.08 was the preferred parameter (values were tested between -0.1 and -0.03), as it had the best statistical fit. The value of -0.08 is a typical value used in other intercity rail models, which means that train frequency is saturated at around 50 trains per day, or that additional trains over 50 per day do not impact the mode choice decision.
- Un-adjusted travel time and cost produced too-high sensitivities at the upper end of the time and cost values. As discussed in the methodology section, time and cost do not necessarily have a linear relationship, as an additional 10 minutes of travel time would typically impact a 20 minute base trip time more negatively than it would for a 120 minute trip time.
- Since the straight time and cost were producing unreasonable results, the dampened versions using highway distance were tested. The models using dampened travel time and cost did not converge.
- Using straight travel time combined with log of cost as well as a piecewise linear transformation of cost using four segments both produced reasonable sensitivities. The four segment cost variable was chosen for the final specification which allows the model the account for the finding that higher cost trips tend to be less sensitive to additional cost than less expensive trips.
- The ASCs for the four rail modes were tested by constraining some or all of them to be equal to each other. Constraining the ASCs reduced the impact of the frequency variable, which was not desirable because frequency is an important defining characteristic of the commuter rail option. Therefore the ASCs were left unconstrained.
- As mentioned above, the estimated ASC for bus shows that its un-modeled attributes (attributes other than time, cost, and frequency) make it a relatively attractive mode. These un-modeled attributes may include its usually flexible fares policies which allow a rider to choose an earlier or later departure if space is available or buying tickets last minute without paying large fare premiums.

- The Metropolitan train ASC is asserted to be the same as the Regional Commuter train based on the SP only model results (as there is no Metropolitan train mode in the RP only data).

3.2.5.2 Estimation Results

Table 16 presents the results of the model estimation, with specific descriptions of each variable below:

- The ASCs represent the unobserved attributes of each mode, and indicate the order and magnitude of mode preference given all other attributes held constant. The non-business model shares the same ASC ordering as the business model, with Auto as the base mode and all other ASCs having negative coefficients, indicating that Auto is the preferred mode, with Bus being highly competitive, Air being the third preferred, and the rail modes being the least preferred. The rail modes all have similar ASCs, but more preference is given to the faster services (like Intercity-Express).
- The access/egress portion of travel time is accounted for by adding up the Total Travel Time and Access/Egress/Connect Travel Time coefficients, and is therefore twice as onerous to the non-business traveler versus the line haul time, indicating a preference for ease of access. The relationship between the two types of time is similar to that seen in the business model, but the magnitude of the coefficients in the non-business model are approximately half of those in the business model, indicating time is less of a factor in the mode choice decision for non-business travelers as opposed to business travelers.
- Cost was included in the model as a piecewise linear transformation of cost using four segments. This specification allows the model the account for the finding that higher cost trips tend to be less sensitive to additional cost than less expensive trips.
- The non-business value of time varied by the total cost of the trip. The VOT for a trip costing less than $50 was around $6/hour, while a trip which cost $100 had a VOT of $9/hour, and a trip costing $200 had a VOT of $18/hour. These are lower values than have been seen in the corridor in the past, and indicate that price is becoming a particularly important piece of the mode choice decision, especially given that approximately 70% of travel in the study area is currently non-business. One reason for this shift in cost sensitivity could be the increased prevalence of low-cost Intercity Bus service that has occurred over the past several years, making travelers more aware of cheaper options in the interregional market.
- The adjusted frequency variable uses the dampened frequency formulation, which essentially allows frequency to impact mode choice up to approximately 50 trains per day, at which point the impact tapers off. The frequency coefficient has a much lower impact in the non-business model as opposed to the business model, as typically non-business travel is for leisure, recreation, or other purposes which have much less tight time constraints, and are more amenable to fewer options for departure time (and therefore fewer trains per day).
- The nesting coefficients indicate a moderate substitutability among the rail modes.

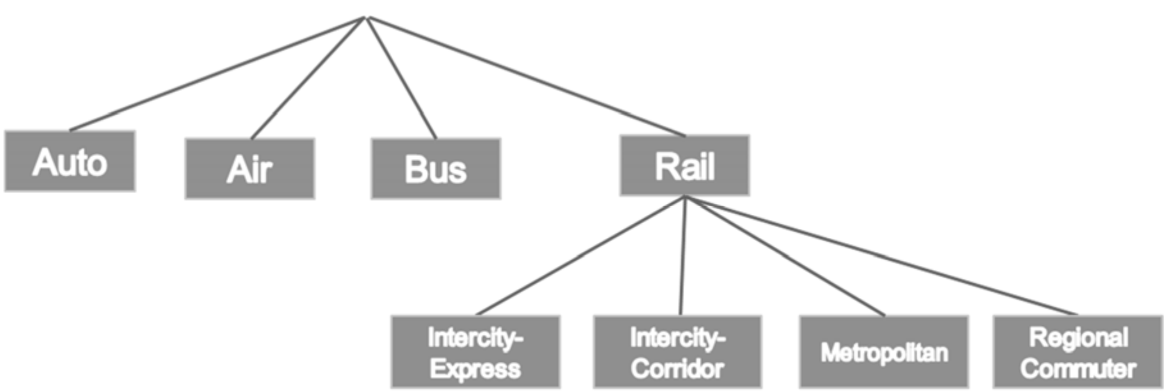
TABLE 16: NON-BUSINESS MODEL SPECIFICATION

Variable		Coeff.	T-Stat
Intercity-Express Rail ASC		-1.54	-5.7
Intercity-Corridor Rail ASC		-1.84	-7.7
Regional Commuter Rail ASC		-2.09	-9.2
Metropolitan Rail ASC		n/a	n/a
Auto ASC		0.0	n/a
Air ASC		-1.22	-4.3
Intercity Bus ASC		-1.11	-5.6
Total Travel Time		-0.0055	-8
Access/Egress/Connect Travel Time		-0.0056	-3.8
Total Cost <$50		-0.059	-9.1
Total Cost $50-$99		-0.029	-6.8
Total Cost $100-$149		-0.014	-3.3
Total Cost > $150		-0.010	-5.1
Adjusted Frequency		0.46	1.9
Rail Nest		0.7417	10.5
Log Likelihood		**Rho-squared**	
Constants Only	Final	w.r.t Zero	w.r.t. Constants
-5170.41	-4776.59	0.5698	0.0762
Estimation Records			
RP Records		8,657	
SP Records		-	
Total Records		8,657	

Source: NEC FUTURE team, 2015

Figure 11 illustrates the final nesting structure used in the non-business mode choice model, selected due to the best-fitting nesting coefficient. Non-business travelers are much more diverse, and do not exhibit strong travel patterns as a group like the other two purposes, so their nesting structure is simpler.

Figure 11: Non-Business Model Nesting Structure



Source: NEC FUTURE team, 2015

To test the reasonableness of the model results, travel time and cost elasticities, the FRA calculated and reviewed results to make sure they are in acceptable ranges, typically within a range of -0.3 to -

2. This range is discussed in more detail in Section 3.2.4. Table 17 shows the elasticities for 20% increases and decreases in the variables for key markets.

TABLE 17: SERVICE VARIABLE ELASTICITIES

Variable/Market	Elasticities		% Change in Mode Share	
	+20%	-20%	+20%	-20%
Intercity-Express Train Time (+20% / -20%)				
Boston - New York	-0.71	-1.44	-14%	29%
Boston – Washington	-1.24	-1.59	-25%	32%
New York – Philadelphia	-0.36	-1.30	-7%	26%
New York – Washington	-0.68	-1.42	-14%	28%
Philadelphia – Washington	-0.45	-1.23	-9%	25%
Intercity-Corridor Train Time (+20% / -20%)				
Boston - New York	-0.72	-1.20	-14%	24%
Boston - Washington	-1.04	-0.79	-21%	16%
New York - Philadelphia	-0.32	-1.19	-6%	24%
New York - Washington	-0.58	-1.17	-12%	23%
Philadelphia - Washington	-0.38	-1.16	-8%	23%
Intercity-Express Train Cost (+20% / -20%)				
Boston - New York	-0.80	-1.91	-16%	38%
Boston - Washington	-1.52	-2.06	-30%	41%
New York - Philadelphia	-0.39	-2.33	-8%	47%
New York - Washington	-0.77	-1.86	-15%	37%
Philadelphia - Washington	-0.49	-2.16	-10%	43%
Intercity-Corridor Train Cost (+20% / -20%)				
Boston - New York	-0.79	-1.85	-16%	37%
Boston - Washington	-1.07	-1.16	-21%	23%
New York – Philadelphia	-0.34	-1.65	-7%	33%
New York – Washington	-0.62	-1.58	-12%	32%
Philadelphia – Washington	-0.40	-1.40	-8%	28%

Source: NEC FUTURE team, 2015

3.2.6 Commute Purpose Model

3.2.6.1 Process Description

The model estimation process for the Commute model followed the general procedures outline in Section 3.2.3. Specific observations about the estimation process were:

- The RP only model had difficulty converging during initial testing. Non-switching auto records were removed to achieve convergence. These records are respondents whose RP mode was auto and they selected auto for all SP experiments, as explained in Section 3.2.2. The removed records accounted for about half of the commute records. These commuters are most likely auto-dependent and would never switch to a group transport mode.
- Unlike the other two models, the mode share weights were required to obtain convergence.
- Removing air from the choice set improved ASCs and time/cost coefficients. Since only 1.4% of respondents chose air as either their current mode or in the SP questions, air is not a logical

choice for commuting, and therefore the model was struggling to compensate for having it as a choice.

- The group transport nest structure (structure #7) produced the best model fit statistics. Most of the other nesting structures would not converge or did not have nesting coefficients which fell in the theoretically acceptable range of 0-1.
- Dampened frequency performed better than trains per day, and -0.08 was the preferred parameter (values were tested between -0.1 and -0.03), as it had the best statistical fit. The value of -0.08 is a typical value used in other intercity rail models, which means that train frequency is saturated at around 50 trains per day, or that additional trains over 50 per day do not impact the mode choice decision.
- Travel time and cost have a smaller range of values in the commute model versus the other models, and therefore an un-transformed variable for each produced reasonable time and cost sensitivities.
- One expects that the impact of an additional minute of access/egress/connect time to be higher than an additional minute of line-haul time, but ratio of the estimated parameters was much higher than could be reasonably expected. To correct for this issue, a range of constraints on the ratio of the parameters was explored: 1.0, 1.5, and 2.0 of line-haul time. Constraining the ratio to be 1.5 was determined to be the best choice for the final model.
- Multiple formulations were tested of constraining the rail ASCs to be equal, and it was determined they were best left unconstrained in the combined RP/SP model.
- Regional Commuter rail is the highly dominant mode in the commuter market as shown by the high value estimated for its ASC. The attractiveness of commuter rail in the long distance commuter market is primarily due to its high frequency, flexibility of tickets, and comfort relative to the auto mode.

3.2.6.2 Estimation Results

Table 18 presents the results of the model estimation, including specific descriptions of each variable below:

- The ASCs for the commute model exhibit a different pattern than those shown in the business and non-business models. The order of mode preference correlates strongly to the cost of the modes, with Commuter and Metropolitan rail being the most preferred, next Auto, then Intercity Bus, Intercity-Corridor, and finally Intercity-Express.
- The ratio of access/egress travel time to line haul time was constrained in the commute model, unlike the other two models. The ratio that was determined to have the best fit was approximately 2.5, making access/egress time more onerous in the commute model than in the other two models. Commute trips are typically shorter than the other interregional trips, and percentage of the total trip which is the access/egress portion is greater, making it a more important piece of the overall trip. The magnitude of the total travel coefficient is similar to that used in the non-business model.

- Cost was included as a linear variable in the commute model, which is a reasonable assumption given that the interregional commute trip is generally shorter than the other purposes, and therefore doesn't have as much variation in cost, and does not need to be scaled.
- The commute value of time is constant for all commute trips, and is approximately $28/hour. This is a slightly higher value than anticipated for the commute trip, but the ASCs account for a large portion of the utility equations, and show a strong preference toward the cheaper modes.
- Similar to the other two models, the frequency variable uses the dampened frequency formulation, and is an important piece of the commute mode choice. Similarly to business travel, commuters typically have tight time constraints, and more frequent trains allow them to manage their time effectively.
- The nesting coefficients indicate a moderate substitutability among the group transport modes, which is intuitive, as the major trade-off for commuters is driving alone or taking some form of transit.

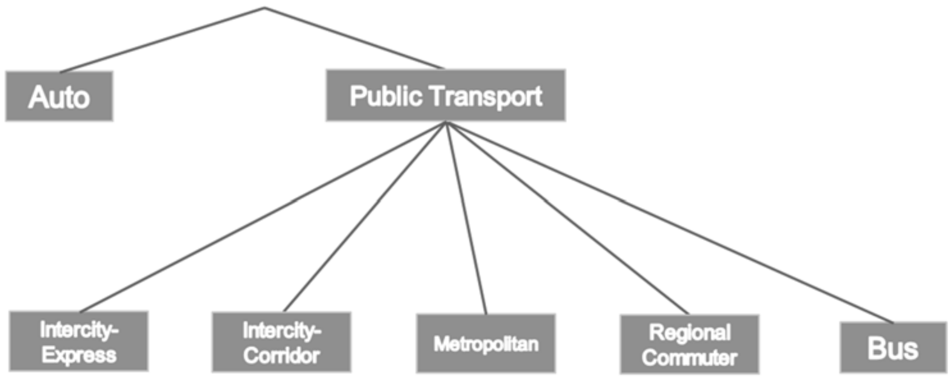
TABLE 18: COMMUTE MODEL SPECIFICATION

Variable			Coeff.	T-Stat
Intercity-Express Rail ASC			-2.20	-4
Intercity-Corridor ASC			-1.24	-6.3
Regional Commuter Rail ASC			1.59	8.5
Metropolitan Rail ASC			0.17	n/a
Auto ASC			0.00	n/a
Intercity Bus ASC			-0.19	-0.8
Total Travel Time			-0.0057	-8.8
Access/Egress/Connect Travel Time			-0.0085	n/a
Total Cost			-0.012	-6.9
Adjusted Frequency			1.22	4.3
Group Transport Nest			0.80	11.4
Log Likelihood		**Rho-squared**		
Constants Only	Final	w.r.t Zero	w.r.t. Constants	
-3495.35	-3196.12	0.2096	0.0856	
Estimation Records				
RP Records		642		
SP Records		3,619		
Excluded Air Records		129		
Excluded Auto Non-Switcher Records		3,626		
Total Records		4,261		

Source: NEC FUTURE team, 2015

Figure 12 shows the final nesting structure for the Commute model, selected due to the best-fitting nesting coefficient. The primary decision for a commuter falls between auto and some form of public transport, as shown by the nesting structure.

Figure 12: Commute Model Nesting Structure



Source: NEC FUTURE team, 2015

To test the reasonableness of the model results, travel time and cost elasticities were calculated and reviewed to make sure they are in acceptable ranges, typically within a range of -0.3 to -2, as described in detail in Section 3.2.4.2. Table 19 shows the elasticities for 20% increases and decreases in the variables for key markets.

TABLE 19: SERVICE VARIABLE SENSITIVITIES

Variable/Market	Commute		% Change in Mode Share	
	+20%	-20%	+20%	-20%
Intercity-Express Train Time (+20% / -20%)				
Boston - New York	-0.82	-1.92	-16%	38%
Boston – Washington	-1.51	-2.21	-30%	44%
New York – Philadelphia	-0.40	-1.21	-8%	24%
New York – Washington	-0.79	-1.89	-16%	38%
Philadelphia – Washington	-0.50	-1.45	-10%	29%
Intercity-Corridor Train Time (+20% / -20%)				
Boston - New York	-0.93	-0.86	-19%	17%
Boston - Washington	-1.37	-0.90	-27%	18%
New York - Philadelphia	-0.39	-0.63	-8%	13%
New York - Washington	-0.80	-0.82	-16%	16%
Philadelphia - Washington	-0.49	-0.65	-10%	13%
Intercity-Express Train Cost (+20% / -20%)				
Boston - New York	-0.97	-3.07	-19%	61%
Boston - Washington	-2.13	-3.84	-43%	77%
New York - Philadelphia	-0.43	-1.59	-9%	32%
New York - Washington	-0.94	-3.00	-19%	60%
Philadelphia - Washington	-0.56	-2.03	-11%	41%
Intercity-Corridor Train Cost (+20% / -20%)				
Boston - New York	-1.10	-1.01	-22%	20%
Boston - Washington	-1.64	-1.01	-33%	20%
New York – Philadelphia	-0.42	-0.71	-8%	14%
New York – Washington	-0.92	-0.94	-18%	19%
Philadelphia – Washington	-0.54	-0.73	-11%	15%

Source: NEC FUTURE team, 2015

3.3 INTERREGIONAL MODEL APPLICATION PROCESS

The Interregional Model application process involved multiple steps: processing the model inputs by mode; incorporating rail service schedules representing each alternative; assigning rail station pairs to each zone pair; and calculating the results of both pieces of the Interregional Model (total demand and mode choice).

The FRA used spreadsheet-based applications of both the total demand and mode choice models, and automatically computed the trips by mode once the inputs were formatted and inserted in the spreadsheet model.

3.3.1 Model Inputs by Mode

The primary inputs for the mode choice models were the service characteristics of the available modes: time (access/egress and line haul), cost, and frequency of service. For the non-rail modes (auto, air and intercity bus), the service characteristics were held constant across all alternatives and were based on existing service. The Service Plans vary by alternative and are described in detail in Section 5.3.

3.3.1.1 Auto

The FRA determined auto mode service characteristics for the base year using the process described in Section 3.2.1.1. For future year alternatives, the FRA applied additional congestion factors to the individual metropolitan areas based on information analyzed as part of the regional modeling effort. These factors ranged from 1% to 15%, with an average trip being 7-8% longer than the base year.

The regional forecasting models used forecasts of region-specific increases in automobile travel times to account for the effects of additional regional highway system congestion. Those same regional forecasts of highway travel times were used as the basis for forecasts of highway travel times for the Interregional Model. The FRA recognizes that interregional highway travelers experience urban congestion only during some portions of their journey, and that the urban congestion they experience will depend on what time of day (peak or off peak) they travel through each urban area. The approach for combining the regional forecasts for inclusion in the Interregional Model involved the following steps:

- Identified the 2040 forecasted local MPO-based estimates of travel time growth from the regional models for zonal pairs contained in the key corridors (notably I-95 and I-84). The resulting peak-period travel time changes between base year and forecast year are summarized in the first column of Table 20.
- Identified the number of people experiencing peak-period congestion. This was done by looking at New York Metropolitan Transportation Council (NYMTC) Hub-Bound estimates of Amtrak entries and exits into Manhattan over the course of an average weekday. With approximately three quarters of existing Amtrak customers beginning or ending their trip in New York City, the New York hourly counts provide a basis to identify what percentage rail riders would experience congestion on a typical weekday in each metropolitan region today. By knowing when

passengers typically arrive and depart NYC, it is possible to trace back the time of day that they hit other urban areas on their route.

- Established the average weekday peak highway travel time degradation by metropolitan area. This was done by multiplying the peak-period congestion change by the number of existing rail riders who experience congested conditions. This in effect averages the locally forecasted effects of additional highway system congestion over the course of an entire day.

TABLE 20: CURRENT YEAR TO 2040 MPO ESTIMATES OF HIGHWAY DEGRADATION APPLIED TO THE INTERCITY FORECASTING MODEL

Metropolitan Area	Time Degradation MPO	Pct of Day Congested	Peak Degradation
Washington	55%	28%	15.5%
Baltimore	8%	31%	2.3%
Philadelphia	5%	47%	2.1%
New York	20%	52%	10.4%
Rhode Island	4%	31%	1.2%
Boston	36%	29%	10.3%

Source: NEC FUTURE team, 2015

3.3.1.2 Air

Air characteristics for all alternatives (Existing Year, No Action, and all Action Alternatives) were held constant and were calculated using the procedures described in Section 3.2.1.2.

3.3.1.3 Bus

The bus service characteristics differed slightly from those used in model estimation, due to the availability of a new dataset, the Northeast Corridor Bus Schedule and Ridership Data. This dataset included frequencies and costs for most station pairs in the NEC, which were filled in as needed with frequencies from published time tables and costs calculated from a travel-time based formula estimated from the existing fares in the dataset.

The bus travel times used were still based on the auto travel times, for consistency, but future alternatives (No Action and Action) included the congestion factors described in Section 3.3.1.1, as well as an additional factor of 1.1 to account for the slower speeds of the buses, based on professional judgement and the bus travel times in the NEC bus dataset.

3.3.1.4 Rail

All of the service attributes described by mode above were static across the alternatives, and there were two processes which were alternative-specific, including processing the Service Plans and associated rail station assignment. These are described below.

Rail Station Assignment

The FRA's next step was to run the rail station assignment procedure, which ensures the best rail path is chosen for each zone pair. The Interregional Model assigns a single station pair to each zone pair to develop the appropriate rail service characteristics for each zonal pair. The FRA developed a simple utility model which examines the access/egress travel times, total travel times, daily frequencies, whether or not an integrated transit service is available, and transit factor terms (see the equations below). Two Transit Factor terms representing the two levels of transit systems present in the corridor were applied, one for the New York City zones (NYC Transit Factor) and one for the Boston, Washington, and Philadelphia zones (BosWasPhl Transit Factor). The assignment process selected the station pair with the maximum utility for each zone pair. The utility equations were calibrated iteratively until the catchment areas generally matched actual ridership patterns around major stations. The utility equations are based on the mode choice utilities estimated for the Interregional Model and are as follows:

$$Express\ Utility = -0.00546 \times Line\ Haul\ Travel\ Time + (-0.011 * 1.5) \times (Access\ Travel\ Time + Egress\ Travel\ Time) + 0.2 \times \ln\left(1 - e^{-0.08 \times Daily\ Frequency}\right) + 2.25 \times (NYC\ Transit\ Factor_O + NYC\ Transit\ Factor_D) + 2 \times (BosWasPhl\ Transit\ Factor_O + BosWasPhl\ Transit\ Factor_D)$$

$$Non - Express\ Utility = -0.00546 \times Line\ Haul\ Travel\ Time + (-0.011 * 2) \times (Access\ Travel\ Time + Egress\ Travel\ Time) + 0.2 \times \ln\left(1 - e^{-0.08 \times Daily\ Frequency}\right) + 2.25 \times (NYC\ Transit\ Factor_O + NYC\ Transit\ Factor_D) + 1 \times (BosWasPhl\ Transit\ Factor_O + BosWasPhl\ Transit\ Factor_D)$$

3.3.2 Base Year Service Characteristics by Mode

Base year service characteristics for all modes for select city pairs are shown in Table 21 through Table 23. These tables illustrate the trade-offs in service characteristics among modes. For the Tier I EIS Alternatives, the FRA held the air service characteristics constant at their current levels, while auto and bus experience travel time congestion (longer travel times). The rail service characteristics vary by alternative based on the Service Plans. The future year service characteristics are described in more detail in Section 5.

The auto travel costs in Table 22 are shown for full cost (used in the Business model) and for incremental cost (used in the Non-Business and Commute models). All other modes use a single cost for all models.

Table 21: Line-Haul Travel Time for Select City Pairs (for Current Service)

Origin Market	Dest. Market	Distance (miles)	Auto	Air	Bus	Intercity-Express	Intercity-Corridor
Boston	Hartford	111	1:55	0:58	1:55	NA	5:01
Boston	New York	229	5:29	2:37	5:50	3:31	4:13
Boston	Philadelphia	322	7:01	2:10	7:31	4:53	6:00
Boston	Baltimore	416	8:53	2:11	9:42	5:57	7:16
Boston	Washington	456	9:50	2:26	10:33	6:33	8:02
Hartford	New York	120	3:50	2:31	4:13	NA	2:43
Hartford	Philadelphia	214	5:22	2:03	5:54	NA	4:24
Hartford	Baltimore	307	7:14	1:56	8:05	NA	5:37
Hartford	Washington	348	8:11	2:36	8:56	NA	6:20
Providence	New York	184	5:40	2:12	6:14	2:55	3:30
Providence	Philadelphia	278	7:13	2:35	7:56	4:17	5:17
Providence	Baltimore	372	9:05	1:40	10:07	5:21	6:33
Providence	Washington	412	10:02	2:20	10:58	5:57	7:19
New York	Philadelphia	95	2:14	1:24	2:28	1:07	1:23
New York	Baltimore	189	4:06	2:07	4:38	2:11	2:39
New York	Washington	229	5:04	3:18	5:30	2:47	3:23
Philadelphia	Baltimore	101	2:13	2:13	2:34	1:01	1:11
Philadelphia	Washington	141	3:11	2:38	3:26	1:37	1:55

Source: NEC FUTURE team, 2015

Table 22: Travel Line-Haul Cost for Select City Pairs (For Current Service)

Origin Market	Dest. Market	Auto		Air	Bus	Intercity-Express	Intercity-Corridor
		Full ($0.55/mi)	Incremental ($0.15/mi)				
Boston	Hartford	$61	$17	$270	$29	NA	NA
Boston	New York	$126	$34	$170	$29	$141	$79
Boston	Philadelphia	$177	$48	$228	$52	$202	$101
Boston	Baltimore	$229	$62	$109	$46	$228	$108
Boston	Washington	$251	$68	$144	$43	$211	$101
Hartford	New York	$66	$18	$326	$30	NA	$44
Hartford	Philadelphia	$117	$32	$198	$30	NA	$84
Hartford	Baltimore	$169	$46	$130	$39	NA	$98
Hartford	Washington	$191	$52	$227	$43	NA	$98
Providence	New York	$101	$28	$390	$29	$139	$73
Providence	Philadelphia	$153	$42	$241	$39	$197	$98
Providence	Baltimore	$204	$56	$220	$48	$220	$104
Providence	Washington	$227	$62	$160	$51	$218	$99
New York	Philadelphia	$52	$14	$54	$31	$135	$61
New York	Baltimore	$104	$28	$133	$24	$189	$94
New York	Washington	$126	$34	$272	$25	$194	$94
Philadelphia	Baltimore	$55	$15	$122	$17	$104	$51
Philadelphia	Washington	$78	$21	$219	$14	$129	$63

Source: NEC FUTURE team, 2015

TABLE 23: DAILY FREQUENCIES FOR SELECT CITY PAIRS (FOR CURRENT SERVICE)

Origin Market	Dest. Market	Air	Bus	Intercity-Express	Intercity-Corridor
Boston	Hartford	4	11	NA	NA
Boston	New York	16	69	10	9
Boston	Philadelphia	20	3	10	8
Boston	Baltimore	15	2	10	8
Boston	Washington	22	2	10	8
Hartford	New York	4	26	NA	6
Hartford	Philadelphia	8	2	NA	5
Hartford	Baltimore	7	1	NA	5
Hartford	Washington	5	2	NA	5
Providence	New York	4	14	10	9
Providence	Philadelphia	7	2	10	8
Providence	Baltimore	16	1	10	8
Providence	Washington	16	1	10	8
New York	Philadelphia	7	83	16	32
New York	Baltimore	6	69	16	22
New York	Washington	7	93	16	22
Philadelphia	Baltimore	8	17	16	22
Philadelphia	Washington	9	17	16	22

Source: NEC FUTURE team, 2015

3.3.3 Model Calibration

As mentioned in Section 2.2.3.4, MSA-level calibration factors were required to match the base year mode shares at more detailed geographic level. To match current mode shares, the mode choice model was calibrated both at the MSA level and for select stations, by adding calibration factors to the ASCs for each zone pair. The MSA-level factors ranged from -14.58 to 10.00 with an average value of -1.33, and were applied to trips that had either end in the particular MSA.

The station-level calibration was done to account for the integrated transit systems that are present in Boston, New York City, Philadelphia, and Washington. This additional factor was only applied to station and zone combinations that are within the transit system areas. These station-level factors ranged from -4.00 to 3.80 with an average factor of 0.51, and worked to shift rail trips within the MSA to the more urban zones from a more uniform distribution across the entire MSA (negative factors were applied to suburban stations and positive factors were applied to urban stations). Because the local transit systems (and other access/egress modes) were not modeled explicitly in the mode choice models, this factor helped shift the modeled rail travel towards zones that were more transit accessible.

The final calibrated ASCs for each MSA pair were calculated using the following formula:

Calibrated ASC_{ij} = Estimated ASC + MSA_i factor + MSA_j factor + $Station_i$ factor + $Station_j$ factor

In general, in the MSA pairs which did not include the station-level calibration, the calibrated ASCs contributed to approximately half of the total utility of each mode. Thus unspecified factors such as individual perceptions of the mode, schedule preferences, auto ownership, and regional factors account for approximately half of the mode choice. Given the geographic extent of the Study Area, large differences in the performance of modes are anticipated across different regions, and the ASCs are used to adjust the mode preference accordingly.

3.3.4 Summarize Model Outputs

The primary output of the model was trips by mode for each zonal pair, which can be described in various ways to support alternatives evaluation. The FRA chose to use the following model outputs for NEC Future.

- Annual trips by mode for two levels of geographic aggregation:
  - MSA areas (collectively do not cover entire Study Area)
  - Greater metropolitan area (collectively covers the entire Study Area), which are shown in Figure 5.
- Annual rail passenger miles
- Annual and average weekday passengers at two levels:
  - Station boardings
  - Station-to-station ridership

4 Regional Models

The FRA applied six separate regional forecasting models during the evaluation of the NEC FUTURE alternatives. From these the key alternative attributes that will drive the magnitude of the forecasting results are:

- Rail travel time
- Access travel time
- Egress travel times
- Number of transfers required to make the trip
- Rail service frequency
- Attributes of competing modes including automobile and other transit modes (depending on the region - subway, bus, ferry and light rail transit [LRT])
- Total costs of travel (fares, park-and-ride costs and connecting transit service costs, if required)

While leveraging existing, off-the-shelf tools to the maximum extent possible, the FRA performed additional model development where targeted model improvements were required to prepare high-quality Regional rail forecasts. A discussion of each of the tools employed and their application is provided below by metropolitan region.

4.1 WASHINGTON, D.C., – WMATA TRANSIT POST-PROCESSOR OF THE MWCOG REGIONAL FORECASTING MODEL

The WMATA transit post-processor of the MWCOG regional forecasting model was used as the basis for the NEC FUTURE Regional rail forecasting in the Washington, D.C., metropolitan area. The model includes a complete representation of:

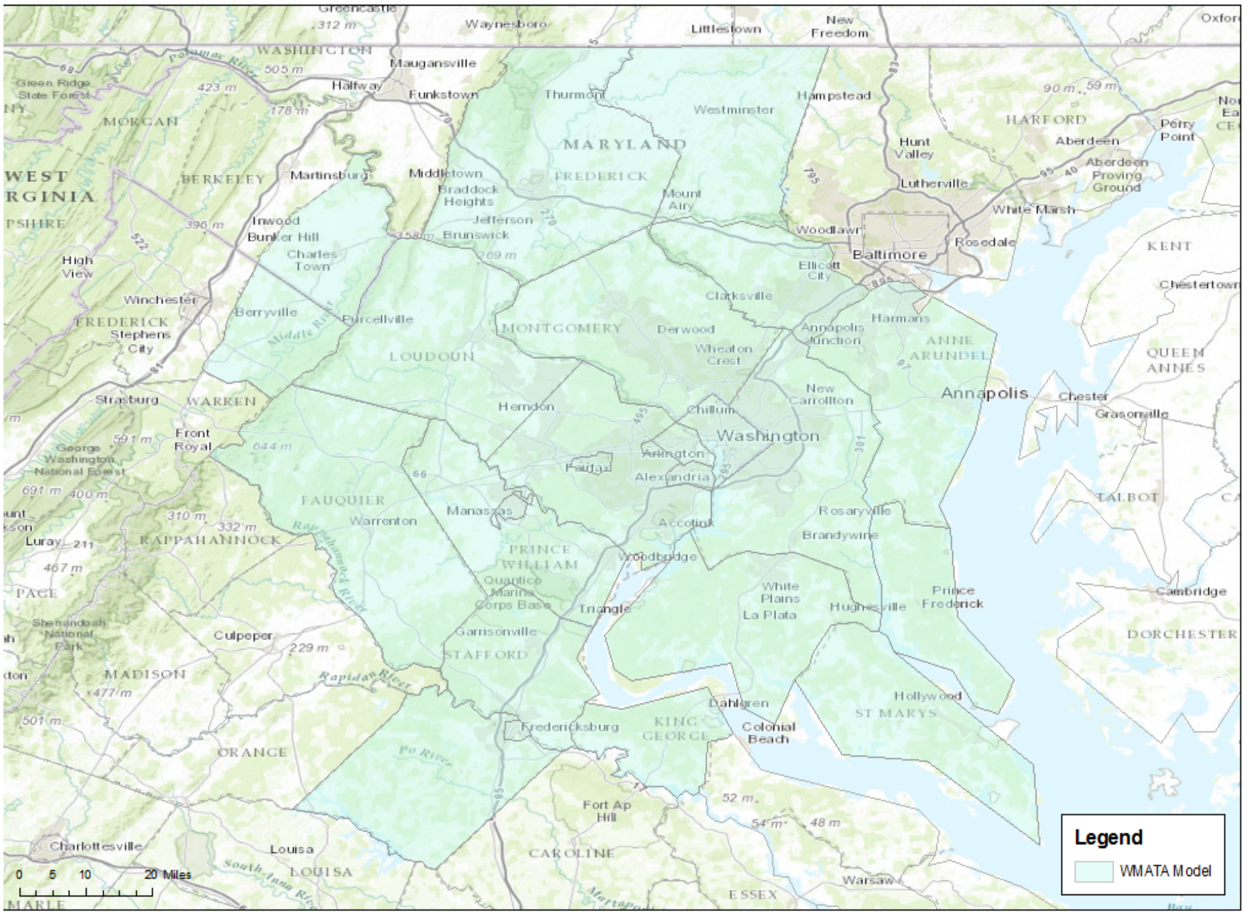
- Virginia Railway Express (VRE) service
- Maryland Area Regional Commuter (MARC) Brunswick service
- MARC Penn Line (Baltimore-Washington International [BWI] Airport to Union Station)
- MARC Camden Line (Dorsey to Union Station)
- WMATA Metrorail
- All regional bus service (WMATA Metrobus, DASH, ART, Ride On, Fairfax Connector, PRTC, TheBus and MTA Commuter Bus)

The counties included in the WMATA/MWCOG forecasting model include:

- **Maryland:**
  - Carroll County
  - Howard County
  - Anne Arundel County
  - Calvert County
  - St. Mary's County
  - Charles County
  - Prince Georges County
  - Montgomery County
  - Frederick County
- **District of Columbia**
- **Virginia:**
  - Arlington County
  - City of Alexandria
  - Fairfax County, including cities of Fairfax, Falls Church, Vienna
  - Prince William County, including City of Manassas and Manassas Park
  - Loudon County
  - Stafford County
  - Fauquier County
  - Spotsylvania County
  - Clarke County
- **West Virginia**
  - Jefferson County

Figure 13 provides a map of the WMATA/MWCOG modeling region.

Figure 13: WMATA/MWCOG Modeling Region



Source: NEC FUTURE team, 2015

The WMATA transit post-processor adds several improvements to enhance forecasting capabilities for transit. These improvements include:

- More detailed representation of Metrorail Stations and their access options. Inclusion of a "pedestrian environment variable", which uses census blocks per square mile as a measure of walk-ability within the metropolitan Washington, D.C. area. This measure was successful in explaining why some geographic areas have high transit market shares and other areas have lower transit market shares.
- Substitution of a mode choice model in place of geographically based, transit sub-mode specific constants. This approach more closely follows FTA New Starts guidance on ridership forecasting.
- Enhanced calibration and validation of the WMATA's Metrorail system.

The FRA determined during the model review process that further enhancements to the MWCOG/WMATA model were needed to support the NEC FUTURE alternatives evaluation. The section below discusses the necessary modifications.

4.1.1 Washington, D.C., Regional Rail Survey Data

The 2012 VRE and 2011 MARC on-board surveys facilitated the best available understanding of current commuter rail ridership patterns. These survey-based ridership patterns were used to calibrate and validate the NEC FUTURE regional models in Washington, D.C.

The model development approach, consistent with FTA best practices, started with the construction of a trip table for both the MARC and VRE customers based on survey data. The first step in the model calibration and validation process involved iteratively assigning this survey-based trip table to the regional model transit networks. The observed trip table was fed to the model for the purpose of determining if the networks, path-building, and assignment routines could replicate the surveyed travel patterns. These tests revealed that several model enhancements were required.

4.1.2 Washington, D.C., Regional Rail Network Improvements

Inspection of the WMATA networks indicated that the representation of key commuter rail stations and terminals required refinement to accurately represent the customer experience in access/egress and transfers at major urban stations. The existing model used generic two-minute access/entry and transfer times for all commuter rail stations. While those generic times are generally good enough for suburban stations, they understate the impedance associated with using the urban core stations, where the connections are more complicated, involve several complex transfers, and often include changes in elevations and grade (elevated to surface or elevated to underground). Most importantly, the models did not represent the difference in accessibility at Union Station between MARC (upstairs, often using high-level platforms) and VRE (downstairs with low-level platforms). The revised model provides an update to the egress and transfer times at the following stations:

- Union Station (VRE) – 6 min to Metro, 6 min to street
- Union Station (MARC) – 3 min to Metro, 3 min to street
- L'Enfant Plaza - – 4 min to Metro, 3 min to street
- Crystal City – 5 min to Metro, 5 min to street
- Alexandria – 6 min to Metro, 4 min to street

4.1.3 Washington, D.C., Regional Rail Path-Builder Refinements

The early survey assignments revealed that a large number of commuter rail trips were not assigned to the commuter rail networks from areas near the Metrorail system. That is, the model outputs for commuter rail could not replicate observed ridership on commuter rail. To better calibrate the model to match observed results, the following changes were made:

- Changed the weight on waiting time for commuter rail from 2.5 to 0.5.
- Adjusted the drive access weights upward from 1.5 to 2.5
- Implemented a 20% discount for commuter rail in-vehicle travel time.

- Reworked the path-building parameter that represents service frequency or "combined headways" for commuter rail.

The first adjustment was required because the commuter rail path-building procedures that identify the minimum path between all origins and destinations in the region used a very high weight for waiting time for commuter rail—2.5 times in-vehicle travel time (IVTT). In the Washington, D.C. area, Metrorail offers significantly more frequency than either MARC or VRE. While that waiting time relationship is likely accurate for higher frequency Metrorail and Metrobus service, it was set too high for the relatively infrequent commuter rail services offered currently. Customers who use commuter rail use the schedules and time tables to determine what time they need to arrive at the station so the heavy weight on waiting time for commuter rail needed to be adjusted downward.

The second adjustment was required because the original model output showed too many trips on the MARC Penn Line and too few trips on the MARC Camden Line. In addition to the high weight on waiting time (discussed above), the model had a relatively low weight on automobile access time 1.5 times IVTT. This combination of the high waiting time weight and the low drive-access weights meant the path-builder and the assignment routine routed more customers to Penn Line services and kept customers away from the Camden Line.

The 20% discount for commuter rail travel time is consistent with other models on the NEC (MTA and NJ TRANSIT) and provides additional favoring for the commuter rail to account for the fact that customers get a high-quality service, with guaranteed seats as compared to other regional transit modes.

The final adjustment involved tuning how the path-builder combines local and express train service for the purpose of calculating the waiting time (a surrogate for service frequency). The original model was set such that there was no tolerance for non-optimal trains, meaning only the fastest (express) trains were considered to be part of the minimum path and ignored the local trains from the selection of best path. The parameter was reset so that the path-builder would evaluate the composite travel time of waiting time and in-vehicle travel time. Doing so shifted the criteria, the path-builder uses so it would now accept a local train if the improved waiting time exceeded the extra travel time associated with choosing the local train. This adjustment significantly improved the station-level assignments by ensuring that local and express service were both evaluated by the path-builder.

With these adjustments, observed travel patterns were replicated for both MARC and VRE customers with the networks.

4.1.4 Washington, D.C., Regional Rail Mode Choice Calibration

Following the tuning of the transit path-building and assignment routines, the 2012 VRE and 2011 MARC on-board surveys were used to establish trip targets by trip purpose and geography, for the purpose of mode choice calibration. Several iterations were performed where: 1) the mode choice model was calibrated, 2) the resulting commuter rail trips were assigned to the refined networks and 3) the resulting output was reviewed and compared to observed ridership counts. The early attempts at mode choice calibration showed that while the overall total number of Regional rail trips was accurate the assignment of trips to individual stations was significantly different from the survey data.

The FRA compared the WMATA home-based-work trip table to the 2006-2010 American Community Survey (ACS) journey-to-work data. From this analysis, significant differences were found between the WMATA model (derived from the MWCOG gravity model) versus ACS data. Gravity models, often applied in urban forecasting models, frequently perform poorly for trip distribution. This is typically due to the fact that gravity models generally use only transportation performance as the basis for aligning where people live and work. In the real world, the drivers of residential choice include other factors such as housing stock, price of housing, and quality of schools.

To correct this issue, the home-based work trip table was rebuilt using an iterative proportional fitting (IPF or matrix balancing technique) such that:

- The total number of home-to-work flows originating and terminating in each Traffic Analysis Zone (TAZ) matches the MWCOG trip tables.
- The flow trips between TAZs matches the patterns observed in the Home-to-Work flows from the ACS.

The advantage of this approach was that it maintained consistency with the local regional trip making at the TAZ level and was consistent with local estimates of population and employment from trip generation, which is a significant portion of the model while replacing the weakest part of the forecasting process (trip distribution) with actual data. This change supplied the refined NEC FUTURE model with a total home-to-work person trip table that was more representative of measured behavior.

With the refinement to the total person trip table, the performance of the refined model greatly improved. However one imbalance remained that needed to be addressed. While the resulting forecasts showed the correct total number of commuter rail trips, the split between MARC and VRE was incorrect:

- MARC had 10% too few trips; while
- VRE had 10% too many trips

When attempting to identify the cause of the imbalance, it was found that the WMATA & MWCOG Models used values of time that are far in excess of typical urban forecasting models. Typically an urban model uses a value of time of between $5/hour to $18/hour (most are in the $8-$12/hour range). The WMATA and MWCOG mode choice models use values of times between $31 and $40/hour. These higher values of time mean that models are less sensitive to fares. The MWCOG model documentation cites the high percentage of federal workers in Washington who receive transit subsides as the rationale for the high values of time. A value of time of $35 per hour (the average value used in the WMATA model) suggests that people are willing to pay $2 in order to save 3.5 minutes of travel time. In contrast a value of time of $10 per hour (a typical value from other urban models) suggests that people are willing to pay $2 only if they save 12 minutes of travel time.

The pricing structure of MARC and VRE are very different. Table 24 shows that in general, VRE is approximately $2 more expensive per trip than MARC, for travel of similar distances.

TABLE 24: COMPARISON OF MARC AND VRE PRICING STRUCTURES

VRE	Monthly	Per Trip	Distance (mi)	Cost Per Mile
Fredericksburg	$305.90	$7.65	55	$0.14
Leland Road	$287.40	$7.19	51	$0.14
Brooke	$287.40	$7.19	46	$0.16
Quantico	$250.80	$6.27	35	$0.18
Rippon	$232.40	$5.81	28	$0.21
Woodbridge	$232.40	$5.81	24	$0.24
Lorton	$214.10	$5.35	19	$0.28
Franconia-Springfield	$195.70	$4.89	14	$0.35
Alexandria	$177.30	$4.43	9	$0.49
Crystal City	$177.30	$4.43	5	$0.89
L'Enfant	$158.80	$3.97	2	$1.99

MARC	Monthly	Per Trip	Distance (mi)	Cost Per Mile
Perryville	$275.00	$6.88	75	$0.09
Aberdeen	$250.00	$6.25	69	$0.09
Edgewood	$225.00	$5.63	59	$0.10
Martin State Airport	$200.00	$5.00	50	$0.10
Baltimore Penn	$175.00	$4.38	38	$0.12
West Baltimore	$175.00	$4.38	35	$0.13
Halethorpe	$150.00	$3.75	31	$0.12
BWI Airport	$150.00	$3.75	28	$0.13
Odenton	$125.00	$3.13	21	$0.15
Bowie State	$125.00	$3.13	15	$0.21
Seabrook	$100.00	$2.50	10	$0.25
New Carrollton	$100.00	$2.50	8	$0.31

Source: NEC FUTURE team, 2015

A travel time penalty, or "shadow price" of 8.5 minutes of equivalent in-vehicle travel time was applied to VRE services to represent the application of a more typical urban model value of time. This adjustment immediately addressed the imbalance of commuter rail trips between MARC and VRE. Rather than adjusting the model value of time, which would require complete and wholesale recalibration of the model, these shadow prices were used in model calibration and application. This finding has been provided to both VRE and MWCOG to assist in their future model development efforts.

4.1.5 Washington, D.C., Regional Rail Model Validation

With the adjustments to Washington, D.C., Regional rail model discussed above, the refined forecasting model reproduced existing conditions. Key validation measures are:

- For MARC:
  - Total daily MARC boardings are replicated within 3%.
  - Total daily MARC boardings at Union Station (terminal) are replicated within 5%.
  - Total daily MARC Penn Line boardings (NEC) are replicated within 4%.
  - Total daily MARC Camden Line boardings are replicated within 2%.
- For VRE:
  - Total daily VRE boardings are replicated within 3%.
  - Total daily VRE boardings at Urban Core Stations (Alexandria, Crystal City, L'Enfant and Union Station) are replicated within 9%l
  - Total daily VRE Fredericksburg Line boardings (NEC) are replicated within 10%l
  - Total daily VRE Manassas Line boardings are replicated within 5%l

The detailed station validation is shown at the Station Level in Appendix C for MARC and VRE.

4.2 BALTIMORE MARYLAND REGIONAL RAIL MARKET, FTA SIMPLIFIED TRIPS ON PROJECT SYSTEM

The Baltimore regional market is unique among other major regions analyzed in the NEC FUTURE forecasting process. The MARC OD survey reveals that the bulk of rail trips produced and attracted from the Baltimore region represent travel between the Baltimore and Washington regions. Since the bulk of travel is interregional travel it can be analyzed using the interregional forecasting process.

However, for the small portion of Regional rail activity that exists, a regional forecasting tool is required. Baltimore Metropolitan Council (BMC) maintains a regional forecasting model; however, it does not have the capabilities required for use in the NEC FUTURE context. Specifically, it contains only a partial representation of Washington, D.C., market, contains only a limited representation of Virginia areas, and it has a coarse representation of intra-Baltimore Regional rail trips.

Therefore, an FTA Simplified Trips on Project System (STOPS) based application was developed for the Baltimore regional market. FTA STOPS module is the FTA's new national forecasting model, which relies on a combination of national experience and local market-based information to estimate transit project ridership. STOPS is a series of programs designed to estimate transit project ridership using a streamlined set of procedures that bypass the process of developing and applying a regional travel demand forecasting model. STOPS is quite similar in structure to regional models and includes many of the same computations of transit level-of-service and market share found in model sets maintained by Metropolitan Planning Organizations and transit agencies.

The STOPS application includes all relevant transit services to commuter rail in the Baltimore area including:

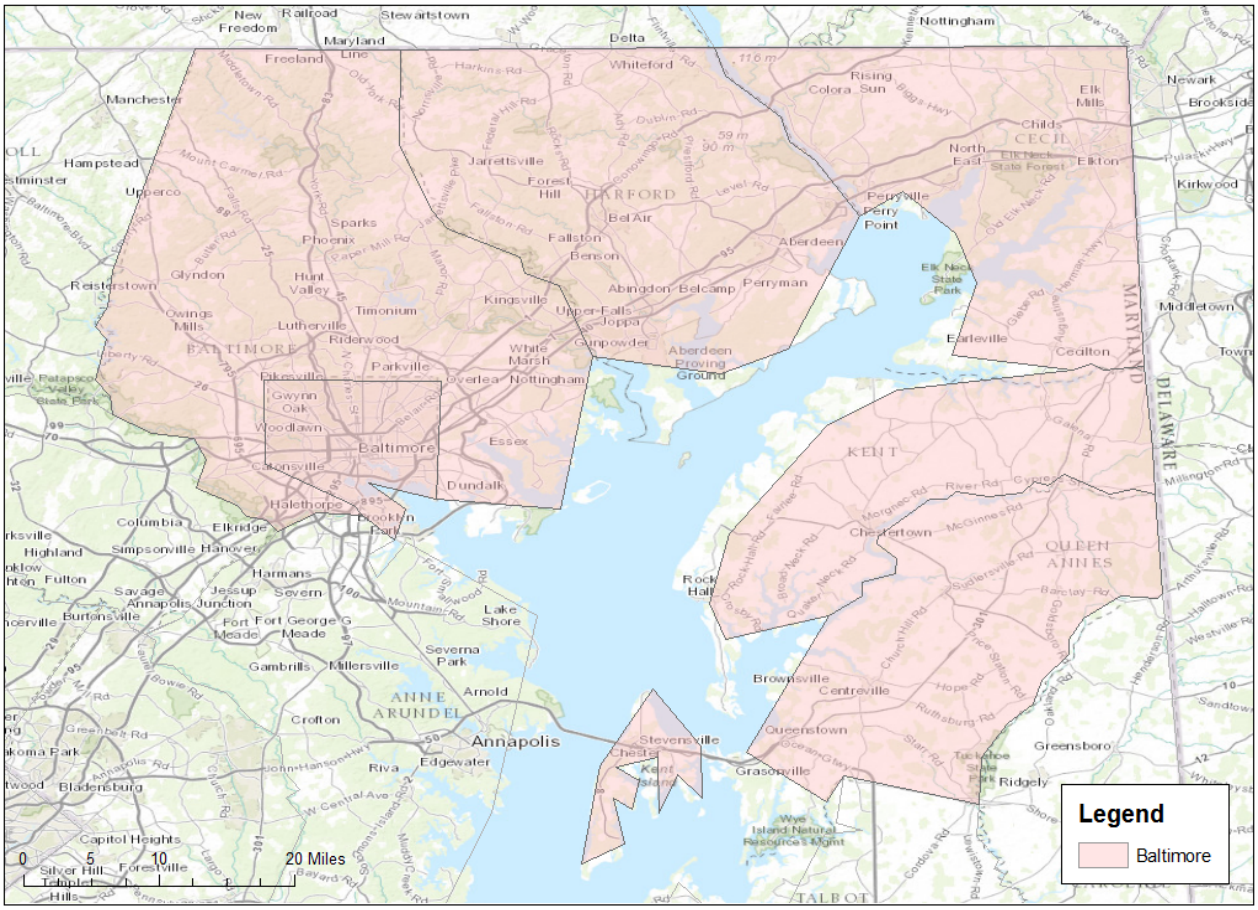
- MARC (BWI Airport to Perryville)
- Baltimore Light Rail
- Baltimore Subway
- MTA Buses

The Baltimore area STOPS model representation includes the following counties:

- Cecil County, Maryland
- Harford County, Maryland
- Baltimore County, Maryland
- Baltimore City, Maryland
- Kent County, Maryland
- Queen Anne's County, Maryland

A map of the Baltimore metropolitan area is included in Figure 14.

Figure 14: Baltimore STOPS Application Area



Source: NEC FUTURE team, 2015

4.2.1 Baltimore STOPS-based Data Assembly

The data assembled to implement a STOPS-based forecast for the Baltimore regional travel markets include:

- U.S. Census Bureau Transportation Planning Package (CTPP) of home-to-work flows in the BMC model region.
- MARC General Transit Feed Specification Data (GTFS) to represent commuter rail service within Baltimore.
- Maryland MTA General Transit Feed Specification Data to represent regional transit services in the Baltimore metropolitan region.
- MARC rail ridership data. Identification of MARC trips that occur wholly within the Baltimore metropolitan area shows that out of 30,000 MARC average weekday linked trips per day, only 700 trips (2 percent) are wholly within the Baltimore area.
- Station boarding counts for the intra-Baltimore region. The 2012 MARC OD survey was used to identify the number of Regional rail trips occurring within the Baltimore market.

- Table of BMC automobile travel times for current conditions and 2040.

4.2.2 Baltimore STOPS Calibration

The Baltimore STOPS application reproduced existing conditions to a high degree of fidelity. Key validation measures are:

- Total daily MARC Baltimore market boardings are perfectly replicated.
- Total daily MARC Baltimore boardings at Penn Station are replicated within 4 trips.
- Total daily MARC Penn Line boardings (NEC) are perfectly replicated.

The detailed station validation is shown at the Station Level in Appendix D for Baltimore market MARC trips.

4.3 PHILADELPHIA REGIONAL RAIL MARKET, DELAWARE VALLEY REGIONAL PLANNING COMMISSION MODEL

In Philadelphia, FRA used the current version of the Delaware Valley Regional Planning Commission (DVRPC) Forecasting Model. This model is the regional metropolitan planning organization (MPO) forecasting model, which covers the entire Philadelphia region and represents all regional transit services including:

- SEPTA Regional Rail
- NJ TRANSIT Atlantic City Line
- SEPTA Subway
- DRPA PATCO
- Regional bus routes (SEPTA, NJ TRANSIT, others)

The geographic area for the DVRPC model encompasses the entire metropolitan area and includes the following counties:

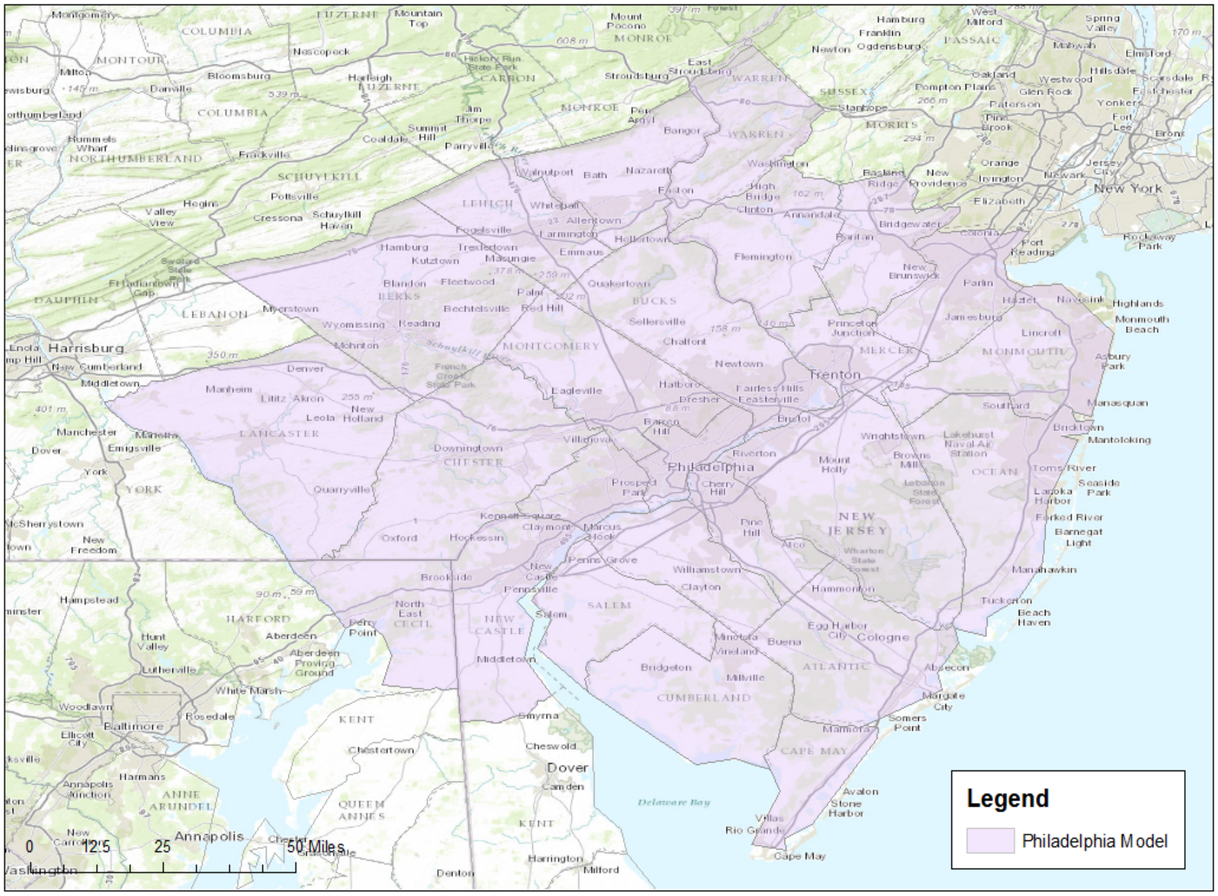
- **Maryland:**
  - Cecil County
- **Delaware:**
  - New Castle County
- **Pennsylvania:**
  - Chester County
  - Delaware County
  - Lancaster County

- Berks County
- Lehigh County
- Northampton County
- Montgomery County
- Bucks County
- Philadelphia

- **New Jersey:**
  - Salem County
  - Cumberland County
  - Cape May County
  - Atlantic County
  - Gloucester County
  - Camden County
  - Burlington County
  - Mercer County
  - Warren County
  - Hunterdon County
  - Somerset County
  - Middlesex County
  - Monmouth County
  - Ocean County
  - Atlantic County

A map of the DVRPC forecasting area is included in Figure 15.

Figure 15: DVRPC Modeling Area



Source: NEC FUTURE team, 2015

The DVRPC forecasting model was calibrated to represent base year 2012 conditions and was validated to commuter rail ridership using DVRPC's 2011 comprehensive regional transit survey. The summary of the DVRPC regional validation is provided in Appendix E.

For the purpose of the NEC FUTURE, DVRPC staff utilized its model to produce ridership forecasts for each alternative. The results from the DVRPC model were used to evaluate NEC FUTURE alternatives service between Newark, Delaware and Trenton, New Jersey.

4.4 NORTHERN AND CENTRAL NEW JERSEY REGIONAL RAIL MARKET, NJ TRANSIT NORTH JERSEY TRAVEL DEMAND FORECASTING MODEL

In northern New Jersey, the current version of NJ TRANSIT's North Jersey Travel Demand Forecasting Model (NJTDFM) was used for ridership forecasting. This model is NJ TRANSIT's regional forecasting model which simulates all transit travel in Central and Northern New Jersey. The NJTDFM forecasting model was calibrated to represent base year 2010 conditions and was validated to commuter rail ridership using NJ TRANSIT's Year 2005 comprehensive rail surveys.

The NJTDFM includes a representation of all Northern New Jersey based transit services including:

- NJ TRANSIT commuter rail system, except the Atlantic City Rail Line
- NJ TRANSIT Light Rail Services, including Hudson-Bergen LRT, River Line LRT and Newark LRT
- Port Authority of New York and New Jersey Port Authority Trans-Hudson (PATH) service.
- Regional bus services (NJ TRANSIT and private operators)
- Trans-Hudson Express Bus Lane (XBL) and supporting infrastructure that provides bus priority treatments into the Port Authority Bus Terminal during the AM peak period
- Regional Ferry services offered crossing the Hudson River and from Monmouth County
- Ferry buses that provide service between ferry terminals and locations within Manhattan
- NYC Subway System for distribution of Trans-Hudson transit customers to their ultimate destination
- SEPTA's Northeast Corridor Line between Cornwall Heights and Trenton
- Metro-North Port Jervis and Pascack Valley Lines from Orange and Rockland Counties
- PANYNJ AirTrain connection to the Northeast Corridor at Newark Liberty International Airport (EWR)
- Metro-North Hudson Line service from Beacon and Tarrytown, to capture Orange and Rockland County customers who cross the Hudson River to access Hudson Line service

The geographic area for the NJTDFM model encompasses all of Northern New Jersey and surrounding area and included New York City:

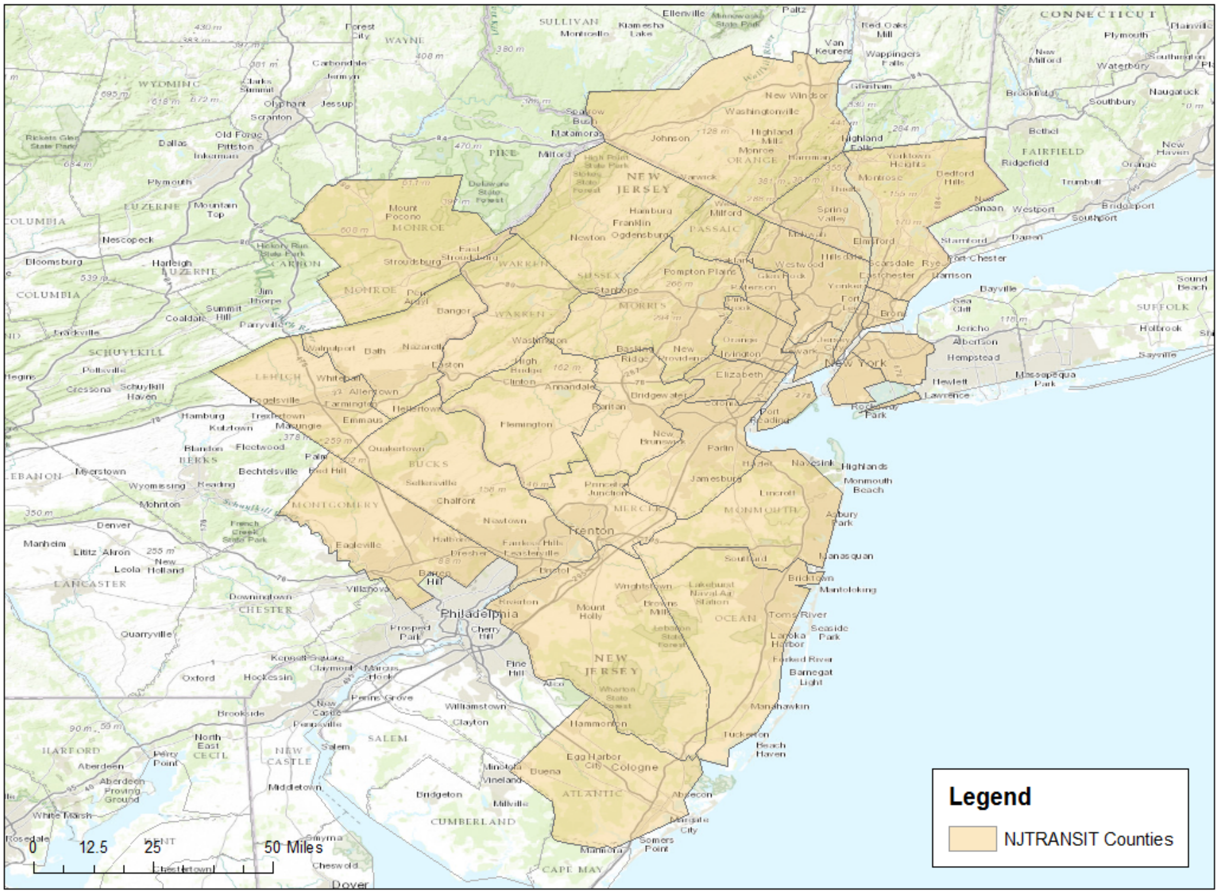
- **Pennsylvania:**
  - Lehigh County
  - Northampton County
  - Montgomery County
  - Monroe County
  - Bucks County
- **New Jersey:**
  - Atlantic County
  - Burlington County
  - Mercer County
  - Warren County
  - Hunterdon County
  - Somerset County

- Middlesex County
- Monmouth County
- Ocean County
- Essex County
- Bergen County
- Morris County
- Sussex County
- Passaic County
- Union County
- Hudson County

- **New York:**
  - Orange County
  - Rockland County
  - New York County
  - Queens County
  - Bronx County
  - Richmond County
  - Kings County
  - Westchester County

A map of the NJTDFM forecasting area is included in Figure 16.

Figure 16: NJTDFM Modeling Area



Source: NEC FUTURE team, 2015

One of the most important elements about the NJTDFM is its Trans-Hudson capacity analysis post-processing tool used to justify the Access the Region's Core (ARC) project. The ARC project was justified in large part as a mechanism to relieve current and forecasted Trans-Hudson capacity limitations. A procedure was developed and accepted by FTA in the evaluation of the ARC project where:

- Unconstrained NJTDFM assignments are compared to the available capacity by mode to cross the Hudson River.
- Time penalties are iteratively applied to constrain the total transit demand across the Hudson River to available capacity.
- The final results balance the assigned volumes with the available capacity.

For the purpose of the NEC FUTURE, NJTDFM forecasts were used to identify the impacts associated with the No Action and Action alternatives. The results from the NJTDFM model were used to evaluate market response to service offerings from points north of Trenton, New Jersey and New York City.

The NJTDFM was also used to forecast West of Hudson market impacts from Metro-North territory (Orange and Rockland Counties). Orange and Rockland Counties, New York are included in the NJTDFM and the MTA's Regional Transit Forecasting Model (RTFM). Because these rail markets overlap, these markets were simulated using the NJTDFM and removed these markets from the MTA RTFM to avoid double-counting. This was done because the bulk of these trips enter Manhattan with all of the other Trans-Hudson services.

The NJTDFM is validated to a high degree of fidelity. Key validation measures are:

- Total daily NJ TRANSIT boardings are replicated within 1%.
- Total daily NJ TRANSIT boardings at Penn Station (terminal) are replicated within 1%.
- All NJ TRANSIT lines are replicated within 10%.
- Total daily NJ TRANSIT boardings on the NEC and New Jersey Coast Line are replicated within 7%.

The detailed station validation is shown at the station level in Appendix F for NJ TRANSIT and Metro-North's Pascack Valley and Port Jervis Lines.

4.5 LONG ISLAND, MID-HUDSON AND SOUTHWESTERN CONNECTICUT REGIONAL RAIL MARKET, MTA REGIONAL TRANSIT FORECASTING MODEL

For the East-of-Hudson portion of the New York City Regional rail market, the NEC FUTURE forecasting process used the MTA RTFM. The MTA's model simulates all transit travel within New York City, Long Island, Mid-Hudson (Westchester, Putnam and Dutchess Counties) and coastal Connecticut. The RTFM forecasting model was calibrated to represent base year 2010 conditions and was validated to commuter rail ridership using Long Island Rail Road 2006 origin-destination survey and Metro-North's Year 2007 origin-destination survey. The RTFM includes a representation of all regional commuter rail operators including:

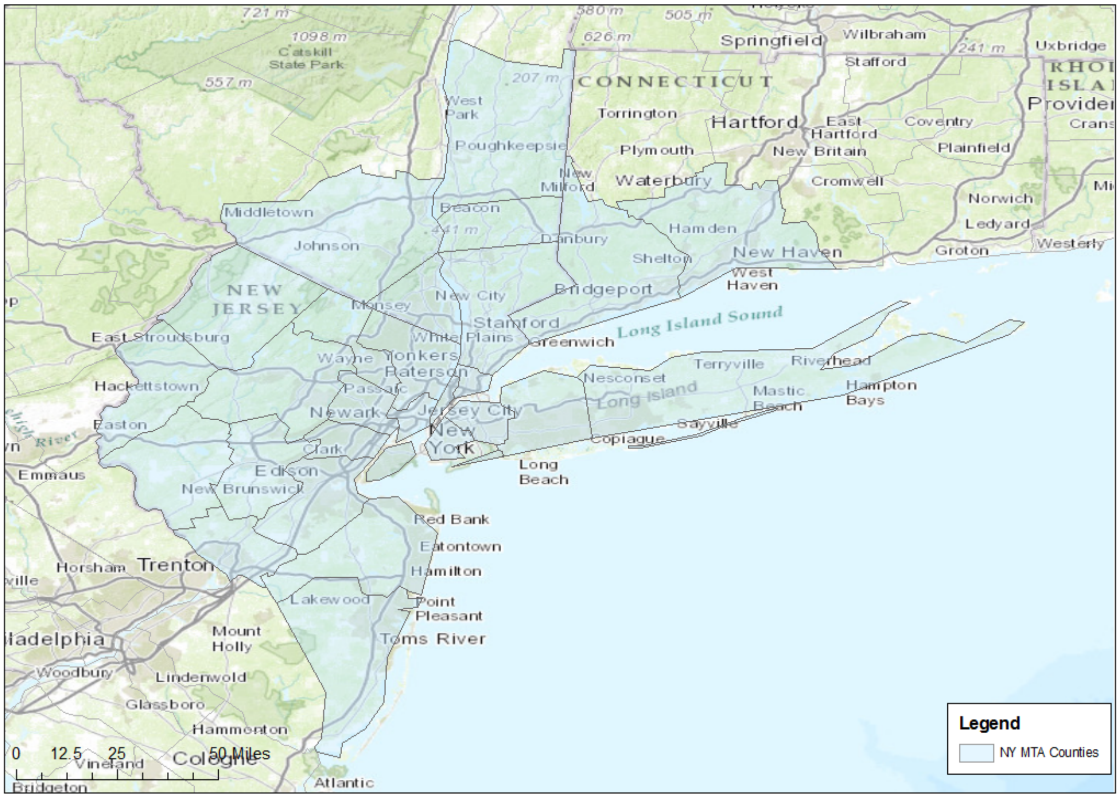
- MTA-Long Island Railroad
- MTA-Metro-North Railroad
- Shore Line East (New Haven State Street to Stamford)
- NJ TRANSIT commuter rail
- New York City Transit (NYCT) Subway
- PANYNJ AirTrain Connections to Newark Liberty International Airport (EWR) and John F. Kennedy International Airport (JFK)
- PANYNJ PATH
- Regional ferry service
- Regional bus services (NYCT, MTA bus, NICE, BeeLine, Suffolk Transit, CT Transit, etc.)

The geographic area for the RTFM model encompasses all of New York Metropolitan area including**:**

- **New Jersey**
  - Mercer County
  - Warren County
  - Hunterdon County
  - Somerset County
  - Middlesex County
  - Monmouth County
  - Ocean County
  - Essex County
  - Bergen County
  - Morris County
  - Sussex County
  - Passaic County
  - Union County
  - Hudson County
- **New York**
  - Orange County (trips taken out, to avoid double-counting with NJTDFM)
  - Rockland County (trips taken out, to avoid double-counting with NJTDFM)
  - New York County
  - Queens County
  - Bronx County
  - Richmond County
  - Kings County
  - Westchester County
  - Putnam County
  - Dutchess County
- **Connecticut:**
  - Fairfield County
  - New Haven County
  - Litchfield County

A map of the RTFM forecasting area is included in Figure 17.

Figure 17: RTFM Modeling Area



Source: NEC FUTURE team, 2015

The current version of the RTFM that was employed for NEC FUTURE was used to develop the Metro-North Penn Station Access Environmental Assessment forecasts in 2013. The calibration of this version of the model included an effort to accurately represent growth in non-traditional, emerging markets. Two markets of considerable emphasis include reverse-peak commutation from Manhattan to Bronx and the significant growth (two-ways) in Metro-North utilization to Connecticut activity centers, especially Stamford.

The RTFM is validated to a high degree of fidelity. Key validation measures are:

- Total AM peak-period LIRR and MNR boardings are replicated within 2%.
- Total AM peak-period LIRR terminal arrivals at Penn Station are replicated within 2%.
- Total AM peak-period MNR terminal arrivals at Penn Station are replicated within 1%.
- Total AM peak-period boardings by LIRR and MNR lines are replicated within 10%, with most achieving a 5% difference.

The detailed station validation is shown at the station level in Appendix G for LIRR and Metro-North East of Hudson Lines.

4.6 RHODE ISLAND/BOSTON REGIONAL RAIL MARKET, FTA SIMPLIFIED TRIPS ON PROJECT SYSTEM

The original forecasting approach for Rhode Island and Boston metropolitan market was to request that the Central Transportation Planning Staff (CTPS) of the Boston MPO to run demand forecasts for the Boston area (similar to the approach employed for the Philadelphia market). Unfortunately, CTPS reported that they could not meet the NEC FUTURE schedule. In response, an FTA STOPS-based forecasting methodology was developed for the Boston metropolitan region.

4.6.1 Boston Area STOPS-based Data Assembly

The data required to implement a STOPS-based forecast were assembled for the Boston regional travel markets. Because Massachusetts Bay Transportation Authority (MBTA) service extends into Rhode Island, the Boston STOPS application was developed to include all of Rhode Island and Eastern Massachusetts. The services embedded into the Boston STOPS application include:

- MBTA commuter rail service
- MBTA subway service
- Regional bus service
- MBTA Ferry Service

The geographic area for the Boston STOPS application encompasses all of New York Metropolitan area including**:**

- **Rhode Island**
  - Providence
  - Bristol
  - Kent
  - Washington
  - Newport
- **Massachusetts:**
  - Essex
  - Middlesex
  - Norfolk
  - Suffolk
  - Bristol
  - Plymouth
  - Worcester

A map of the Boston STOPS forecasting area is included in Figure 18.

Figure 18: Boston STOPS Modeling Area

Source: NEC FUTURE team, 2015

Below describes the data that was assembled for the STOPS application:

- U.S. Census Transportation Planning Package (CTPP) of home-to-work flows for Rhode Island and Massachusetts.
- MBTA General Transit Feed Specification Data (GTFS) to represent all MBTA commuter rail services operating in Rhode Island, Eastern Massachusetts and Southeast New Hampshire.
- GTFS data to represent regional transit services in the Boston metropolitan region.
- Regional Rail count data by station that was obtained from CTPS. The count data by station were fed into the STOPS process to facilitate the auto-calibration routines.
- MBTA subway station-level count data. This count data by station were fed into the STOPS model to facilitate the automatic calibration for STOPS to mimic overall subway activity.
- Total MBTA region-wide unlinked trips from the National Transit Database. This parameter is used by STOPS to calibrate itself to the total number of regional unlinked trips.
- Current and 2040 estimates of highway travel times from Rhode Island Department of Transportation (RIDOT) obtained from the Rhode Island Statewide model.

- Current and 2040 estimates of highway travel time within the Boston metropolitan region from CTPS.

Because the Boston area STOPS methodology overlaps two adjoining areas (CTPS and Rhode Island), a data assembly step was performed to successfully combine both modeling areas for STOPS. This activity involved:

- Developing a combined RIDOT statewide model and CTPS TAZ system. The approach started by used the CTPS model definitions and then added Rhode Island DOT TAZs to complete the region.
- Combining the two regional model's highway travel times (CTPS and RIDOT) into one set of comprehensive automobile travel times for current conditions and 2040 conditions.

4.6.2 Boston STOPS Application Adjustments to 2040 Highway Travel Times

The final application of the STOPS model deviated in one respect from the FTA's documentation. The deviation was required to generate coherent Year 2040 No Action Alternative STOPS-based forecasts in the Boston metropolitan area. The issue involved the magnitude of the growth in the underlying highway travel times supplied by RIDOT and CTPS.

This deviation was required because the initial applications of STOPS revealed a much larger change in MBTA rail ridership between NEC FUTURE's base year calibration and 2040, as compared to the underlying demographic growth. The results of the STOPS Forecast of MBTA commuter rail unlinked trips, using the FTA methodology, implied that MBTA commuter rail trips would double by 2040 in the No Action Alternative. As a basis of comparison, the Boston central business district (CBD) employment growth is projected to grow by only 15%.

The more than doubling of the Boston commuter rail trips was deemed unrealistic. Further investigation showed that highway travel time degradation was the driver of the high level of commuter rail ridership growth in 2040.

For most of the zones to the Boston CBD, the CTPS and RIDOT supplied highway travel times degrade by 30-50% in 2040. In Boston, where there are sprawling commute patterns for MBTA commuter rail service, this generally translates to an increase in total highway travel time on the order of 10-35 minutes between base and 2040.

This finding was reported to FTA, which revealed a previously undocumented element of STOPS. STOPS weights automobile travel time in excess of 45 minutes as two times the weight of automobile travel time under 45 minutes. This weighting effectively doubles the effect of the highway degradation for long automobile trips. This feature is included in an effort to calibrate STOPs to reflection national New Starts project experience.

To address the issue of unrealistically high commuter rail forecasts the STOPS process was adjusted to remove the weighting of highway travel times in excess of 45 minutes and also to place an upper limit on the forecasted degradation of highway travel times to just 20 percent. FTA concurred with the approach used to establish the 2040 No Action Alternative forecasts and the plausibility of the forecast.

4.6.3 Boston STOPS Calibration

The Boston STOPS-based regional forecasting process reproduced existing conditions very well with:

- Total daily MBTA boardings replicated within 5%.
- Total daily MBTA boardings at North Station and South Station replicated within 3%.
- Total daily MBTA boardings by line replicated within 10%.

The detailed station validation is shown at the station level in Appendix H for MBTA services.

5 Alternatives Description

5.1 YEAR 2040 CONTEXT

For analysis purposes, all alternatives tested used a forecast year of 2040. Travel demand forecasts are driven by demographics and service levels. This section describes the background data used across the 2040 No Action and Action Alternatives, which lead to the forecasts described Section 6.

5.1.1 Year 2040 Demographic Forecasts

The fundamental driver of growth in total trip making in the NEC FUTURE Study Area comes from forecasted growth in population, employment, and income. Forecasts used as the basis for growth were extracted from Moody's Analytics June 2013 "base" demographic forecasts. These forecasts were obtained on a county-level basis for the NEC FUTURE Study Area. The detailed county-level demographic forecasts are summarized in Appendix B.

Table 25 and Table 26 present the population and employment projections, and percentage change for the major NEC metropolitan areas as contained in Moody's Analytics June 2013 forecasts. Three forecasts were supplied by Moody's. They include "low", "base" and "high" conditions. All of the forecasted results use the "base" (or most likely) condition. Table 25 shows that population in the major metropolitan markets is projected to grow between 6.2% (Hartford) to 29% (Washington D.C.). The low-high bounds are also fairly tightly bound to the "base" condition, generally plus or minus 5% points of the base forecast.

While the "base" forecasts shows employment growing slightly faster than population, the low-high bounds are much wider for employment than population. This is an important element of the demographic forecasts, as Moody's forecast suggests larger uncertainty associated with future NEC employment. Their "low" scenario includes a contraction of the overall job market (as compared to today), while their "high" scenario includes a full boom in economic activity with large scale growth in employment. This suggests that one of the significant risks to the forecasts is the strength of the regional employment market, as Moody's has placed a wide band on these forecasts.

TABLE 25: NEC POPULATION FORECASTS

Market	Population				Percentage Change vs 2013		
	2013	2040 (Low)	2040 (Base)	2040 (High)	2040 (Low)	2040 (Base)	2040 (High)
Boston	6,450,199	6,601,973	6,887,907	7,187,507	2.5%	6.8%	11.3%
Hartford/Springfield	1,793,652	1,876,120	1,905,128	1,934,799	4.7%	6.2%	7.8%
Providence	970,100	981,930	1,036,320	1,093,830	1.4%	6.8%	12.5%
New York	22,210,216	23,276,389	24,306,295	25,392,888	5.0%	9.4%	14.2%
Philadelphia	6,600,373	6,874,020	7,108,418	7,352,289	4.3%	7.7%	11.3%
Baltimore	2,773,720	3,000,040	3,144,720	3,298,650	8.3%	13.4%	18.7%
Washington	5,930,470	7,126,550	7,654,620	8,237,550	20.5%	29.1%	38.6%

Source: NEC FUTURE team, 2015

TABLE 26: NEC EMPLOYMENT FORECASTS

Market	Employment				Percentage Change vs 2013		
	2013	2040 (Low)	2040 (Base)	2040 (High)	2040 (Low)	2040 (Base)	2040 (High)
Washington	3,104,290	2,780,660	3,857,570	4,800,890	(2.8%)	24.3%	61.8%
Baltimore	1,363,290	1,279,250	1,678,610	2,022,560	1.7%	23.1%	55.4%
Philadelphia	3,007,064	2,680,470	3,575,796	4,322,700	(4.0%)	18.9%	49.8%
New York	10,076,605	8,809,933	11,826,539	14,660,218	(6.0%)	17.4%	51.2%
Providence	426,410	351,670	475,500	559,910	(9.6%)	11.5%	39.3%
Hartford/Springfield	872,692	729,401	963,242	1,145,307	(9.7%)	10.4%	37.4%
Boston	3,275,290	2,755,633	3,736,399	4,599,365	(8.5%)	14.1%	47.6%

Source: NEC FUTURE team, 2015

While the Moody's Analytics demographic forecasts serve as the overall county-level control totals for growth, the forecasting process required demographic data at the sub-county level, for both the Regional Models and the Interregional Model.

5.1.1.1 Regional Demographic Data Process

For the purpose of developing the sub-county level demographic process for the regional models, a methodology was employed where:

- Local MPO adopted forecasts of population, households and employment were used as the starting point
- County-level adjustment factors were derived to scale the MPO total population, households and employment to the Moody's control totals.

This approach used a process where the growth on the NEC came from one consistent NEC wide source (Moody's) and used the local MPO forecasts as the basis for where growth occurs at the sub-county level. This means that localized development and redevelopment initiatives are reflected in the NEC FUTURE forecasts.

5.1.1.2 Interregional Demographic Data Process

The Interregional Model process required that the demographic data be at the zonal level, which was smaller or larger than the county-level, depending on the particular zone. This process was completed by first splitting the county-level forecasts to the Census Division level, which is a much smaller geographic area. The population and income were split using the ratios of population at the Census Division versus the county from 2010 Census data, and employment was split using the ratios of employment from 2010 Census Data. Once the demographic forecasts were split, they were summed to equal the zonal level demographics.

5.1.2 Service Level Forecasts - Non-Rail Modes

For all 2040 alternatives (No Action and Action Alternatives), the non-rail modes were held constant across alternatives in terms of frequency, travel time, and cost for both the Regional and Interregional Model. The future year service characteristics for the non-rail modes in the

Interregional Model are discussed in Section 3.3.1. The future year service characteristics for the non-rail modes in the Regional models are unchanged from the source models.

5.2 NO ACTION ALTERNATIVE DESCRIPTION

The No Action Alternative represents the Year 2040 condition where an NEC FUTURE alternative is not implemented and serves as the basis of comparison to evaluate impacts of the Action Alternatives. This section discusses the elements used to establish the Year 2040 NEC FUTURE No Action Alternative forecasts.

5.2.1 Year 2040 No Action Alternative Railroad Service Plan

For both Interregional Model and regional models, the basis for the 2040 No Action Alternative Service Plan are today's level-of-service. The infrastructure improvements included in the No Action Alternative are described in the *No Action Alternative Report*. No Action Alternative infrastructure improvements include those projects that are funded or in approved funding plans, represent safety or other mandates, or are necessary to keep the railroad operating. With one exception (described below), the No Action Alternative represents no significant change in capacity or service from today.

The only service change that is included between today's service and the 2040 No Action Alternative is the completion of the LIRR East Side Access (ESA) project. The analysis assumes implementation of the LIRR ESA Operating Plan version 3.0 for the LIRR East Side Access. Otherwise, the No Action Alternative Service Plan for all other rail operators, including VRE, MARC, SEPTA, NJ TRANSIT, Metro-North, Shore Line East and MBTA are identical to today's service. Intercity service does not change from existing conditions to the No Action Alternative. A more thorough discussion concerning the contents of the No Action Alternative is described in the *Service Plans and Train Equipment Train Options Technical Memorandum* and the *No Action Alternative Report*.

5.2.2 Rail Pricing

For the No Action Alternative, Regional rail pricing was held constant through the analysis in real dollars, meaning Regional rail fares are assumed to grow with inflation.

For the Interregional Model, the rail fares were assumed to maintain the current fare structure for the No Action Alternative, as described in Section 3.2.1.4.

5.3 ACTION ALTERNATIVES DESCRIPTION

This section documents the Action Alternatives (focusing on the Service Plans) that were evaluated with the NEC FUTURE forecasting process.

5.3.1 Action Alternative Service Plans

- **Alternative 1 maintains the role of rail** as it is today, keeping pace with the level of rail service required to support proportional growth in population and employment, building off Service Plans developed by the NEC service operators to meet the projected organic increase in travel demand. To keep pace, Alternative 1 would include new rail services and investment to expand capacity, add tracks, and relieve key chokepoints, particularly through northern New Jersey, New York, and Connecticut.

- **Alternative 2 grows the role of rail**, expanding rail service at a faster pace than the proportional growth in regional population and employment. South of New Haven, CT, service and infrastructure improvements would be focused generally within or adjacent to the existing NEC; however, north of New Haven, a new supplemental route would be added between New Haven, Hartford, and Providence to increase resiliency, serve new markets, and address capacity constraints. The existing NEC generally would expand to four tracks, with six tracks through portions of New Jersey and southwestern Connecticut. Alternative 2 would include new direct service to Philadelphia International Airport, and some Regional rail run-through service in New York City and Washington, D.C., to increase terminal throughput.
- **Alternative 3 transforms the role of rail**, positioning rail as a dominant mode for interregional and regional travelers and commuters. Service and infrastructure improvements would include upgrades on the NEC and the addition of a two-track second spine that would operate adjacent to the NEC south of New York and expand to new markets north of New York. This new spine would support high-performance rail services between major markets and would provide additional capacity for Intercity and Regional rail services on both the existing NEC and new spine. Alternative 3 would support a wide variety of new Intercity and Regional rail services, tailored to the needs of specific markets, including non-stop express trains, high-speed zone-express trains serving the long-distance commute market, and new service to markets off the existing NEC.

  Alternative 3 also includes four sub-options with different high-speed route options on the North End. These new route options are:
- Alternative 3.1 - New York to Boston via Central Connecticut and Providence
- Alternative 3.2 - New York to Boston via Long Island and Providence
- Alternative 3.3 - New York to Boston via Long Island and Worchester
- Alternative 3.4- New York to Boston via Central Connecticut and Worchester

The Intercity peak-hour Service Plan summary is shown in Table 27. The service approximately doubles in Alternative 1 compared to the No Action Alternative, quadruples versus the No Action Alternative in Alternative 2, and has more than four times the service versus the No Action in select locations (primarily north of New York) in Alternative 3, as described in the Alternative summaries above. The reasons for this are discussed in the *Service Plans and Train Equipment Options Technical Memorandum*. A summary of travel times and daily service frequencies for the major city pairs are provided in Table 28 and Table 29. The Regional rail Service Plans are summarized in Table 30.

TABLE 27: INTERCITY SERVICE IN STANDARD PEAK HOUR

	Existing	No-Action	Alt 1	Alt 2	Alt 3
South End					
Intercity Express	1	1	2	4	6
Intercity Corridor					
Washington-Philadelphia	1	1	2	2	2
Philadelphia-New York	2	2	2	2	2
Metropolitan					
Washington-Philadelphia	0	0	2	4	4
Philadelphia-New York	0	0	3	4	8
North End					
Intercity Express	<1	<1	2	4	6
Intercity Corridor					
New York-New Haven	<1	<1	2	2	2
New York-Boston	<1	<1	1	0	0
New York-Springfield	0	0	1	2	2
Metropolitan					
New York-New Haven	0	0	2	4	4
New York-Boston (OSB-KEN Bypass)	0	0	2	0	0
New York-Boston	0	0	0	0	0
New York-Springfield	0	0	0	1	2
New Route	0	0	0	4	4
Connecting Corridors					
Virginia	<1	<1	2	2	4
Empire	1	1	2	2	2
Keystone	1	1	1	2	2
Springfield	<1	<1	1	2	2
Knowledge Corridor	1 tpd	1 tpd	<1	1	1
Inland Route	0	0	<1	1	1
Other	0	0	0	0	2

Intercity-Corridor includes the new Metropolitan service as well as the base Intercity-Corridor service.
Source: NEC FUTURE team, 2015

TABLE 28: SELECTED STATION PAIRS INTERCITY SERVICE PLAN SUMMARY – NO ACTION, ALTERNATIVE 1 AND ALTERNATIVE 2

Intercity-Express	Existing/No Action		Alternative 1		Alternative 2	
Trip Pair	FREQ	TT	FREQ	TT	FREQ	TT
Boston-New York	10	212	19	174	42	153
Boston-Philadelphia	10	293	16	246	27	216
Boston-Washington	10	394	16	345	27	307
New York – Philadelphia	16	68	24	64	41	55
New York – Washington	16	167	24	163	41	146
Philadelphia – Washington	16	97	24	97	41	89
Intercity-Corridor	**Existing/No Action**		**Alternative 1**		**Alternative 2**	
Trip Pair	**FREQ**	**TT**	**FREQ**	**TT**	**FREQ**	**TT**
Boston-New York	9	253	28	215	50	219
Boston-Philadelphia*	8	361	26	302	45	301
Boston-Washington	8	482	24	417	30	423
New York - Philadelphia*	32	84	62	79	77	72
New York – Washington	22	204	45	188	54	181
Philadelphia* - Washington	22	116	46	110	69	128

Source: NEC FUTURE team, 2015
Note: Intercity-Corridor Travel Time Weighted Averages (based on Travel Times to Market East and 30th Street Station)

TABLE 29: SELECTED STATION PAIRS INTERCITY SERVICE PLAN SUMMARY – ALTERNATIVE 3 OPTIONS

Intercity-Express	Alternative 3.1		Alternative 3.2		Alternative 3.3		Alternative 3.4	
Trip Pair	FREQ	TT	FREQ	TT	FREQ	TT	FREQ	TT
Boston-New York	75	117	75	118	75	128	76	124
Boston-Philadelphia	59	168	59	169	60	178	62	176
Boston-Washington	59	233	59	234	60	243	62	242
New York – Philadelphia	73	43	73	43	73	43	75	44
New York – Washington	73	108	73	108	73	108	75	108
Philadelphia – Washington	73	65	73	65	73	65	75	65
Intercity-Corridor	**Alternative 3.1**		**Alternative 3.2**		**Alternative 3.3**		**Alternative 3.4**	
Trip Pair	**FREQ**	**TT**	**FREQ**	**TT**	**FREQ**	**TT**	**FREQ**	**TT**
Boston-New York	72	180	70	187	72	184	72	179
Boston-Philadelphia*	49	266	51	285	48	272	52	264
Boston-Washington	45	371	45	380	45	375	46	371
New York - Philadelphia*	108	71	113	71	108	71	110	71
New York – Washington	75	172	77	172	75	172	76	172
Philadelphia* - Washington	79	118	81	118	79	118	80	118

Source: NEC FUTURE team, 2015
Note: Intercity-Corridor Travel Time Weighted Averages (based on Travel Times to Market East and 30th Street Station)

TABLE 30: AVERAGE WEEKDAY REGIONAL RAIL SERVICE PLAN SUMMARY (TRAINS/HOUR)

	Existing/No-Action				Alt 1				Alt 2				Alt 3			
	PK	SHD	REV	OPK	PK	SHD	REV	OPK	PK	SHD	REV	OPK	PK	SHD	REV	OPK
Washington Region																
MD Regional Rail	3	2.5	1.5	1.3	6	5	3	2	10	6	5	3	12	8	6	3
VA Regional Rail	5.5	1	0.2	0.1	6	4	2	0.4	8	6	4	4	8	6	4	4
Philadelphia Region																
North Side Regional Rail	7	4	4	2.3	8	5	5	3	12	6	5	4	12	7	6	4
South Side Regional Rail	5	4	3.5	3	6	6	6	3	14	10	12	7	20	14	16	11
New York Region																
NJ-NEC/NJCL Trans-Hudson	15	8	7	3	20	10	7	3	22	14	10	4	24	14	10	4
NJ-Other Regional Rail	6	3	3	2	0	0	0	0	0	0	0	0	0	0	0	0
NJ-Inner Branch	0	0	0	0	10	8	6	6	20	14	10	8	30	24	20	12
CT-Nhaven Line (PS&GCT)	22	16	12	3	26	20	16	8	32	19	15	6	36	19	15	6
Boston Region																
NEC Regional Rail	9	4	4	2.6	12	10	10	4	14	10	10	5	20	14	12	9
Other Regional Rail	3	2	1	0.5	4	3	1	1	4	3	1	1	8	4	2	2

PK - Peak Period, Peak Direction
SHD -Shoulder of Peaks
REV - Reverse Peak
OPK- Off-Peak

Source: NEC FUTURE team, 2015

Table 30 above shows the levels of service progressing across each of the Action Alternatives in the regional models. In all of the regional rail markets, the Action Alternatives offer increased service and capacity throughout the day, which utilize the available capacity and responds to the overarching vision for each alternative. Also included in the Action Alternatives for the regional rail markets is the new Metropolitan service. The approach taken was to represent the portions of Metropolitan trains operating within each region. These trains were simulated as additional service frequencies opportunities for travel within regions. Fares for Metropolitan were assumed to be consistent with commuter rail fares for travel within regions. Alternative 1 essentially has approximately 1.5 times greater service over the No Action Alternative, Alternative 2 about doubles service over the No Action Alternative, and Alternative 3 has approximately 2.5 times the service over the No Action Alternative.

5.3.2 Rail Pricing

For the Action Alternatives, Regional rail pricing was held constant through the analysis in real dollars, meaning Regional rail fares are assumed to grow with inflation.

For the interregional alternatives, changes in Action Alternative pricing were considered for the following reasons:

- Strong customer demand coupled with the inability to add service during peak hours has allowed Amtrak to significantly raise fares on the NEC during the past decade.

- These capacity constraints coupled with higher demand on the South End has led to significantly higher pricing on a per mile basis on the South End as compared the North End.
- The NEC FUTURE household survey revealed NEC travelers who are non-business generally have very low values of time. This means these customers are generally more sensitive to fare than they are to travel time. Because the NEC FUTURE program is attempting to identify the rail capacity necessary to serve existing and growing markets along and off the NEC, understanding the impact of pricing in essential to identifying potential infrastructure needs.

While the analysis started with the assumption that current Amtrak pricing structures would be in place, the impact of lower fares on resulting rail demand was evaluated. The purpose of these tests was to establish the model's sensitivity to pricing and understand the impacts associated with lowering fares on the Intercity-Corridor service. It was found that operating and maintenance costs associated with Action Alternatives were lower than the associated passenger fare revenues, so there appears to be flexibility to discount fares and the system would still be able to cover operating expenses.

Multiple fare discounts were tested for the non-express service and a 30 percent discount off of current fares on non-express services was identified as fare policy that would attract additional riders while at the same time still covering operating expenses. This fare policy was used to establish the Action Alternative forecasts. This fare policy was not intended as a fare-maximizing or ridership-maximizing analysis.

6 Ridership Forecasts and Findings

This section describes the ridership forecasts for the No Action and Action Alternatives resulting from the methodology described above. The ridership forecasts provide the basis for estimating the magnitude and incidence of benefits to users of rail services associated with the alternatives. The ridership forecasts are also the basis for estimating ancillary benefits to other travelers indirectly impacted by rail service changes in the corridor. The benefit measures associated with the alternatives largely stem from predicted changes in travel behavior in response to new services and reduced and/or more reliable travel times provided by the alternatives for certain markets.

This section discusses the key alternative evaluation measures associated with:

- Annual total rail linked (trips from ultimate origin to ultimate destination, ignoring transfers) trips
- Impacts to rail passenger miles
- Impacts to non-rail linked trips
- Impacts to automobile vehicle-miles of travel
- Peak-hour forecasted impacts at key screenline locations with an analysis of forecasted demand versus seat supply

It is important to note that the year 2040 ridership forecasts presented below were constrained to the available seated capacity for each alternative when forecasted demand exceeded available seats. Instead of simply removing rail trips in excess of available capacity, the process used in this analysis involved iteratively running the forecasting model (for both Interregional Model and regional models) to identify the appropriate shadow prices or "time penalties" required to divert trips from rail to other non-rail modes. In essence, this approach applies additional travel time to divert trips from rail to other non-rail modes and to balance forecasted rail demand to seated capacity. This approach identifies the modes that would be used in the event of a capacity constrained rail system, which is important for estimating other evaluation measures such as auto vehicle miles traveled. However, this analysis did not apply capacity constraints to other modes. Capacity constraints for rail were most evident in the No Action Alternative, where the most significant constraint was identified at the Hudson River screenline, where all three types of rail service – Intercity-Express, Intercity-Corridor and Regional rail, were shown to have peak ridership demand significantly above available seating capacity in the average weekday peak hour. Capacity constraints were applied to the following services, by alternative:

- **No Action Alternative:** Intercity-Express, Intercity-Corridor and New Jersey Regional rail crossing the Trans-Hudson screenline
- **Alternative 1:** NJ Regional rail crossing the Trans-Hudson screenline

Alternatives 2 and 3 did not require adjustments for capacity constraints.

As a result of applying the capacity constraints to the Hudson River screenline, Alternative 1 was shown to operate with ridership at levels very close to the seating capacity provided on Regional rail trains during peak hours. Alternative 2 also operates at ridership levels close to seating capacity but no adjustments for capacity constraints are required. By contrast, Alternative 3 provided significant residual capacity, available to accommodate future growth in ridership beyond what was estimated in the regional models for 2040.

The Service Plans developed for the alternatives were intended to be demonstrative of possible future service and were not optimized for ridership or revenue potential. In addition, the mix of service (Intercity-Express versus Intercity-Corridor) was not held constant across alternatives, which impacts the share of riders choosing each rail mode.

The remainder of this section provides discussion and findings related to the ridership forecasts for each alternative. Region-to-region summaries of ridership trip tables by mode are provided in Appendix I (Intercity rail) and Appendix J (Regional rail) of this report.

6.1 IMPACTS TO RAIL LINKED TRIPS

The number of rail-linked trips that each alternative attracts is an indicator of the value of proposed NEC FUTURE improvements. Linked trips by mode represent the region-wide total travel from each origin to each destination traveling by rail. The linked trip tables are a direct output from the both the Interregional Model and regional models. Each linked trip is counted once, no matter how many transfers are made or how many rail vehicles are boarded. Accordingly, this measure is directly related to the total travel occurring by rail and provides a basis for comparing alternatives that force many transfers to alternatives that force few transfers.

Table 31 provides the forecasted annual estimate of rail linked trips. Table 32 summarizes the annual rail linked trips by mode for the Alternative 3 route options. The key findings shown in Table 31 include:

- The vast majority of existing and forecasted rail linked trips are on regional rail services.
- Appendix J shows that approximately 75% of the forecasted Regional rail trips are concentrated in the Northern New Jersey, New York and Southwestern Connecticut (the New York City metropolitan area).
- While making up a relatively small share of the total rail travel, Intercity rail service linked trips are forecasted to grow more rapidly than the Regional rail linked trips.
- Appendix I shows that for Intercity rail travel more than 80% of linked trips have at least one trip end in Northern New Jersey, New York and Southwestern Connecticut (the New York City area).

The growth in the No Action Alternative ridership compared to existing ridership (shown in Table 31) reflects organic growth due to demographic changes in the Study Area. However, recall that the ridership estimates for the No Action Alternative had to be reduced to meet capacity constraints (for both Intercity and Regional rail). Based on regional estimates, growth of Regional rail exceeds growth of Intercity rail in terms of absolute number of trips, due to the overall size of the regional market. Intercity-Express ridership grows at a much higher rate than the Intercity-Corridor because Intercity-Corridor existing demand is already close to capacity in contrast to Intercity-Express, which has more available seats. Since the No Action Alternative essentially maintains the service currently offered, the amount of organic growth from the No Action Alternative compared to existing ridership demonstrates the need to facilitate future rail ridership, which will be at a significantly higher level in 2040 than is currently observed.

TABLE 31: ANNUAL INTERREGIONAL AND REGIONAL LINKED RAIL TRIPS (IN 1,000S OF ONE-WAY TRIPS)

Passenger Rail Trips	Existing	2040 No Action	2040 Alternative 1	2040 Alternative 2	2040 Alternative 3 (average)
Intercity-Express	3,300	5,700	5,100	6,500	7,600
Intercity-Corridor	11,400	13,600	28,600	30,600	31,400
Subtotal Interregional	14,700	19,300	33,600	37,100	39,000
Subtotal Regional	324,500	419,800	474,500	495,400	545,500
Total Rail Trips	339,200	439,100	508,100	532,400	579,900
Regional as a percentage of total trips	95.7%	95.6%	93.4%	93.1%	94.1%

Source: NEC FUTURE team, 2015

TABLE 32: YEAR 2040 ALTERNATIVE 3 ROUTE OPTIONS, INTERREGIONAL AND REGIONAL RAIL TRIPS (IN 1,000S OF ONE-WAY TRIPS)

Alternative 3 Route Options	Central Connecticut/ Providence (3.1)	Long Island/ Providence (3.2)	Long Island/ Worcester(3.3)	Central Connecticut/ Worcester (3.4)
Intercity-Express	7,900	7,800	7,600	7,100
Intercity-Corridor	31,000	30,900	32,200	31,500
Subtotal-Interregional	38,900	38,700	39,800	38,600
Subtotal Regional	545,500	545,500	545,500	545,500
Total Rail Trips	**584,500**	**584,200**	**585,300**	**584,100**

Source: NEC FUTURE team, 2015

Intercity-Express trips decrease in Alternative 1 compared to the No Action Alternative. This occurs for multiple reasons. First, the analysis includes a 30 percent discount in fares for Intercity-Corridor service over the fares in the No Action Alternative because the new equipment envisioned for the Action Alternatives has lower operating costs than the current equipment (see *Operations and Maintenance Costs Technical Memorandum* for more details on operating costs). In addition, Intercity-Corridor service (which includes Metropolitan service) provides improved speeds, which are more comparable to the Intercity-Express service in the No Action Alternative. As a result, Intercity-Corridor service (including Metropolitan service) attracts some riders that would have chosen Intercity-Express service in the No Action Alternative, as it has significant cost savings for a similar travel time. Finally, Intercity-Corridor service has a much larger increase in service compared to the Intercity-Express service, as seen in Table 28. Increases in ridership are also the result of the changes in service associated with the Action Alternatives. These Service Plans are not prescriptive, and do not necessarily reflect the operating plans of any of the NEC operators.

The Intercity-Corridor ridership approximately doubles compared to the No Action Alternative, while the Intercity-Express ridership decreases by approximately 11%. Overall, interregional ridership grows by 75%, and the Regional rail ridership grows by 13% over the No Action Alternative.

The Alternative 2 forecast shows growth relative to the No Action Alternative in both Intercity-Express and Intercity-Corridor ridership, with 14% and 125% increases, respectively. These increases in ridership are the result of service changes associated with the Action Alternatives. These Service Plans are not prescriptive, and do not necessarily reflect the operating plans of any of the NEC operators. The higher growth in the Intercity-Corridor ridership is primarily due to the proposed reduced fare structure and suggested improvements in service (for both frequency and travel time) for the Intercity-Corridor service. As described in the mode choice model description sections (Sections 3.2.4, 3.2.5, and 3.2.6), the dampened function of frequency used in the Interregional Model mean the impact of frequency flattens out at approximately 50 trains per day, and further increases in frequency have minimal to no impact. As shown in Table 28, for most key markets in Alternative 2 in the Intercity-Corridor service reaches the 50 trains per day level and there are approximately 40 trains per day in most of the Intercity-Express markets. This means that frequency is approaching optimal levels of frequency based on the model sensitivities in Alternative 2. Travel times in Alternative 2 are also greatly improved over the No Action Alternative, with the Intercity-Corridor travel times approaching the same travel times as Intercity-Express. This means that travelers, approximately 70% of whom are non-business travelers who are primarily sensitive to cost as opposed to time (as described in Section 3.2.5.2), are able to travel with express-like speeds at the reduced fare of the Intercity-Corridor service. The Regional rail ridership has a more modest increase over the No Action Alternative, with an 18% increase.

The Alternative 3 variations, on average, have an increase of 33% in Intercity-Express forecasted ridership and 131% increase in Intercity-Corridor forecasted ridership over the No Action Alternative. Ridership increases are the result of Service Plans developed by the FRA, which do not necessarily reflect operating plans from any of the operating railroads within the corridor The addition of the second spine on the north end contributes (along with the addition of new markets and increased speeds) to the forecasted increase in Intercity-Express ridership. The frequencies of both types of Intercity services for all key markets are at or well above the 50 trains per day level (see Table 29), at which point additional trains do not attract new riders according the Interregional Model specifications. The major benefit of the Alternative 3 options over the No Action Alternative is highly increased speeds, but the Interregional Model for non-business travelers (the largest traveler segment) shows that non-business travelers are much more sensitive to cost than travel time. As a result, there is not as significant of an impact to total ridership for Alternative 3 as some may have expected. The Intercity-Express mode exhibits the biggest travel time improvement, and the fare structure remains the same as in the No Action Alternative while the Intercity-Corridor mode has a 30% decrease in fare over the No Action Alternative’s fare. Business travelers are the most likely to take Intercity-Express rail, due to their higher values of time described in Section 3.2.4.2; although, they comprise only 18% of all travelers. The low prevalence of riders willing to pay for increased travel times contributes to the difficulty in gaining large increases in the Intercity-Express ridership. The Regional rail ridership has an increase of 30% in overall ridership, due to the large increases in frequency over the No Action Alternative, which include relief from all the capacity constraints that are present in the No Action Alternative.

The Alternative 3 variations resulted in similar forecasted ridership totals, with the small differences in forecasted intercity ridership due to the different markets served. One of the findings from examining the differences between the Alternative 3 variations was that, in the No Action Alternative, there were riders traveling long distances from these “new” markets to take a train on the NEC. By adding in Alternative 3 stations in these new areas, it increased the accessibility and reduced the travel time, but in some cases the total cost increased, as riders were spending a larger portion of their trip on the train, which has a higher per mile cost as opposed to driving to access a train station further away. The high cost sensitivity in the non-business model combined with the higher cost of longer rail vs. access trips also contributed to the smaller than expected ridership in the transformative Alternative 3 variations. The major impact of adding in new stations is that existing riders shifted to stations that are closer to their origin and/or destination resulting in short access/egress trips.

In addition to absolute trip numbers, the distribution of trip-making patterns also plays a key role in the assessment of the alternatives. As mentioned above, both the regional and interregional trips are heavily focused on the New York metropolitan region. To further examine the geography of the trips, Table 33 looks at the break-down of the total interregional trips by three segments:

- Trips from a major metropolitan region (Boston, New York, Philadelphia, or Washington, D.C., as shown in Figure 5 and in Appendix I) to another major metropolitan region,
- Trips from a major metropolitan region to a non-major region (all other regions in the study area, and
- Trips from one non-major region to another non-major region.

One of the goals of introducing the new Metropolitan service (included in the Intercity-Corridor service for modeling purposes) was to provide access to formerly unserved or under-served markets, typically the non-major markets. While rail services in these non-major markets double their mode shares in Alternatives 2 and 3 relative to the No Action Alternative, ridership in these markets are still a very small amount of trips relative to ridership for markets with at least one end or both ends in one of the four major metropolitan areas in the corridor.

For Alternative 1 compared to the No Action Alternative, the impact of the new Metropolitan markets can start to be seen in the mode share for the major to/from non-major region market, in which the Intercity-Corridor mode share more than doubles from 3.1% to 7.4%. For all of the market segments, the mode share increases for Alternative 1 over the No Action Alternative are seen in the Intercity-Corridor ridership, instead of the Intercity-Express ridership due to the introduction of the reduced fares for that service. The Intercity-Express mode shares remain relatively constant. The majority of rail trips are in the major to major region segment, but the highest increases in mode share are seen in the major to non-major region segment. This is primarily due to high rail mode share saturation in the existing major to major segment, whereas the major to non-major region market has additional opportunities for growth and more room for improvement in the services offered.

Alternative 2 compared to the No Action Alternative also sees large increases in the Intercity-Corridor mode share focused on the major to non-major region segment due to the increased service, new markets served and fare structure.

Alternative 3 compared to the No Action Alternative exhibits similar patterns to the other Alternatives, with slightly higher increases in mode share. The Intercity-Express mode share increases by 50% over the No Action Alternative for trips in the major to major region segment, as these are heavily business travelers benefiting from the time savings and high frequencies offered in Alternative 3.

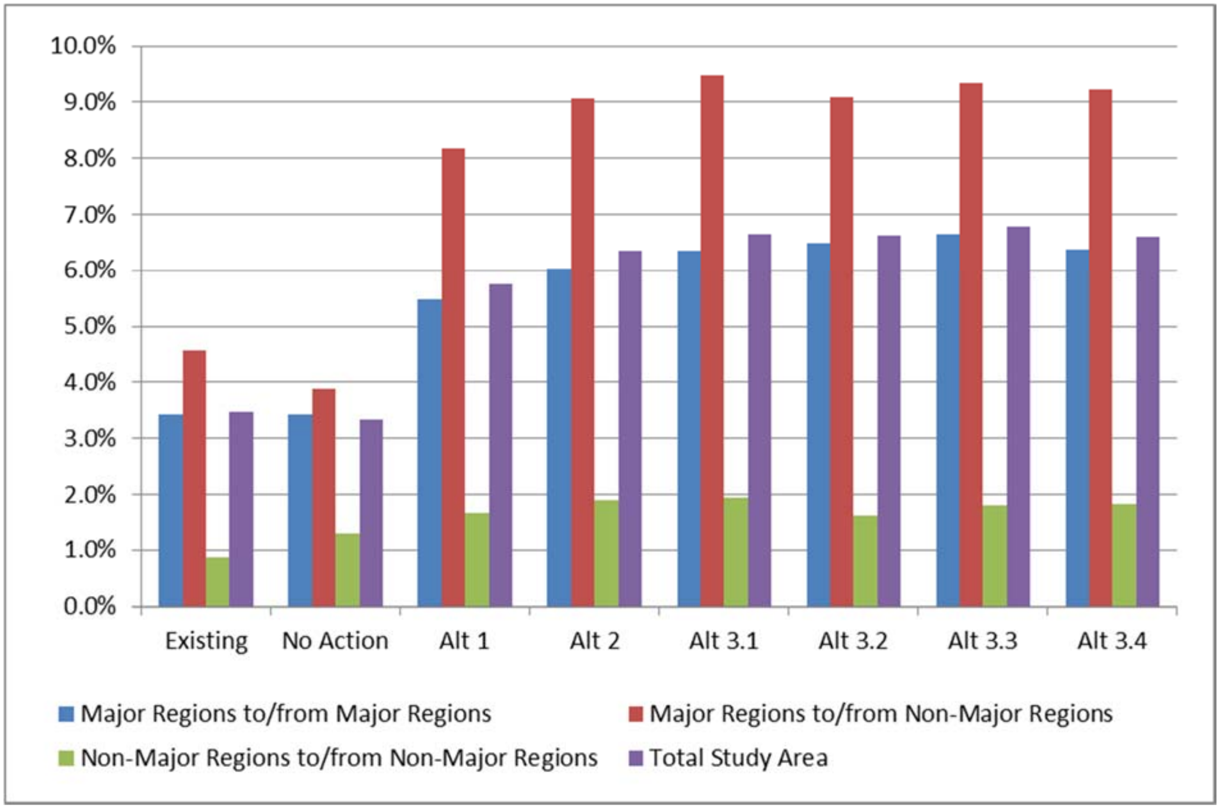
TABLE 33: INTERREGIONAL TRIPS (IN 1,000S OF ONE-WAY TRIPS) AND MODE SHARE BY GEOGRAPHIC SEGMENT

		Intercity Express Trips	Intercity-Corridor Trips	Total Intercity Rail Trips	Total Interregional Trips	Intercity Express Mode Share	Intercity-Corridor Mode Share	Intercity Rail Mode Share
Existing 2013	Major – Major	2,600	6,600	9,200	268,300	1.0%	2.4%	3.4%
	Major – Non-Major	700	4,500	5,200	113,500	0.6%	4.0%	4.6%
	Non-Major – Non-Major	20	350	370	43,200	0.0%	0.8%	0.9%
	Total Study Area	3,300	11,400	14,700	425,000	0.8%	2.7%	3.5%
No Action	Major – Major	4,600	8,000	12,600	368,100	1.2%	2.2%	3.4%
	Major – Non-Major	1,100	4,800	6,000	153,900	0.7%	3.1%	3.9%
	Non-Major – Non-Major	40	710	750	57,500	0.1%	1.2%	1.3%
	Total Study Area	5,700	13,600	19,300	579,500	1.0%	2.3%	3.3%
Alt 1	Major – Major	3,900	16,500	20,400	370,800	1.0%	4.4%	5.5%
	Major – Non-Major	1,100	11,100	12,200	149,500	0.8%	7.4%	8.2%
	Non-Major – Non-Major	-	1,000	1,100	63,800	0.1%	1.6%	1.7%
	Total Study Area	5,100	28,600	33,600	584,100	0.9%	4.9%	5.8%
Alt 2	Major – Major	4,800	17,600	22,400	371,500	1.3%	4.7%	6.0%
	Major – Non-Major	1,600	11,900	13,500	148,600	1.1%	8.0%	9.1%
	Non-Major – Non-Major	100	1,200	1,200	65,000	0.1%	1.8%	1.9%
	Total Study Area	6,500	30,600	37,100	585,200	1.1%	5.2%	6.3%
Average Alt 3	Major – Major	5,800	18,300	24,100	372,100	1.6%	4.9%	6.5%
	Major – Non-Major	1,700	12,100	13,800	148,400	1.1%	8.2%	9.3%
	Non-Major – Non-Major	100	1,100	1,200	65,300	0.2%	1.7%	1.8%
	Total Study Area	7,600	31,500	39,100	585,800	1.3%	5.4%	6.7%

Figure 19 takes a closer look at the changes in Intercity rail mode shares across the alternatives. Due to the capacity constraints, the No Action Alternative reduces the mode share in all geographic segments except for the non-major regions to non-major regions segment.

In all alternatives, the largest increases in mode share are in the major regions to/from non-major regions segment. The non-major to/from non-major region segment has the most modest increases in mode share and also has the smallest number of trips.

Figure 19: Intercity Rail Mode Share (Intercity-Express + Intercity-Corridor)



6.2 IMPACTS TO RAIL PASSENGER MILES

Total passenger miles are calculated as a function of the total rail passengers for each station pair multiplied by the rail distance between the station pairs and then summed by service type. Generally, rail passenger miles will exhibit the same patterns as seen for passenger trips. While the trips using intercity rail services make up a small percentage of total trips, they are typically much longer than trips made on regional services, so they account for much larger percentage of total passenger miles.

As shown in Table 34, Intercity-Express passenger miles decrease in Alternative 1 compared to the No Action Alternative, which is a similar to the result for passenger trips which was discussed in Section 6.1. The intercity passenger miles share increases from 22% in the No Action Alternative to 31% in Alternative 1, accounting for almost one-third of all passenger miles in the study area. In contrast, the Intercity passenger trips share increases from 4% to 7% in Alternative 1. Alternative 1 has a quarter more total passenger rail miles compared to the No Action Alternative.

Alternatives 2 and 3 have a similar split for Intercity passenger miles versus regional passenger miles, with 32% and 31% of total passenger rail miles being Intercity rail. Alternative 2 has approximately one-third more passenger rail miles compared to the No Action Alternative, and

Alternative 3 on average has approximately 1.5 times the passenger rail miles compared to the No Action Alternative.

TABLE 34: TOTAL ANNUAL INTERCITY AND REGIONAL RAIL PASSENGER MILES (IN 1,000S)

Service Type	No Action	Alternative 1	Alternative 2	Alternative 3 (average)
Intercity-Express	1,076,300	944,400	1,211,000	1,459,900
Intercity-Corridor	2,026,700	4,665,800	5,021,400	5,105,600
Regional	11,264,356	12,547,148	13,455,849	14,713,860
Total Passenger Miles	14,367,356	18,157,348	19,688,249	21,279,360
Regional as a percentage of total passenger miles	78.4%	69.1%	68.3%	69.1%
Percent increase compared to No Action		26%	37%	48%

Source: NEC FUTURE team, 2015

The Alternative 3 routing options between New York and Boston result in growth in passenger miles as shown in Table 35. Similar to the passenger rail trips, there are only small differences between the routing options, with the Long Island/Worcester option having the greatest number of passenger rail miles.

TABLE 35: ALTERNATIVE 3 ROUTE OPTIONS – TOTAL ANNUAL INTERCITY PASSENGER MILES (IN 1,000S)

Service Type	Central CT/ Providence (3.1)	Long Island/ Providence (3.2)	Long Island/ Worcester (3.3)	Central CT/ Worcester (3.4)
Intercity-Express	1,536,900	1,511,800	1,433,200	1,357,700
Intercity-Corridor	5,121,600	4,857,100	5,255,000	5,188,700
Total Passenger Miles	6,658,500	6,368,900	6,688,200	6,546,400

Source: NEC FUTURE team, 2015

6.3 IMPACTS TO NON-RAIL LINKED TRIPS AND AUTOMOBILE VEHICLE-MILES OF TRAVEL

Using the No Action Alternative as a baseline, additional impacts of each of the Action Alternatives can be measured by trips diverted from other modes.

Table 36 summarizes the total forecasted Intercity rail trips and those diverted from auto, air, or intercity bus (as compared to the No Action Alternative). Intercity rail trips also include those trips diverted from other rail services (for example, from Intercity-Express to Intercity-Corridor). Compared to the No Action Alternative, 36 percent of the total Intercity rail trips estimated for Alternative 1 are diverted from other modes; of those diversions, the majority of diversions are auto diversions. Alternatives 2 and 3 divert 44 percent and 46 percent of the total Intercity rail trips respectively. Table 37 presents the trips diverted from other modes for the Alternative 3 route options, each of which have similar diversions.

Another source of new rail ridership was induced demand, or new trips due to improving the overall transportation system. These trips are generated in the Total Travel Market Demand Model, and generated an additional 0.7% (for Alt 1) to 1.1% (for Alt 3.3) total trips over the No Action Alternative.

TABLE 36: TOTAL INTERCITY ANNUAL PASSENGER RAIL TRIPS DIVERTED FROM OTHER MODES AS OPPOSED TO THE NO ACTION ALTERNATIVE (1,000S OF TRIPS)

Mode	Alternative 1	Alternative 2	Alternative 3 (average)
Auto Diversions	9,500	12,700	13,800
Air Diversions	1,300	1,800	2,200
Intercity Bus Diversions	1,400	1,700	1,900
Induced Rail Trips	200	400	400
Total Rail Trips	33,600	37,100	39,000
% Trips Diverted from Other Modes	36%	44%	46%

Source: NEC FUTURE team, 2015

TABLE 37: ALTERNATIVE 3 OPTIONS - TOTAL INTERCITY ANNUAL PASSENGER RAIL TRIPS DIVERTED FROM OTHER MODES AS OPPOSED TO THE NO ACTION ALTERNATIVE (1,000S OF TRIPS)

Mode	Central Connecticut/ Providence (3.1)	Long Island/ Providence (3.2)	Long Island/ Worcester (3.3)	Central Connecticut/ Worcester (3.4)
Auto Diversions	13,700	14,200	13,500	13,600
Air Diversions	2,200	2,300	2,200	2,200
Intercity Bus Diversions	1,900	2,000	1,900	1,900
Induced Rail Trips	400	400	400	400
Total Rail Trips	39,000	39,800	38,600	38,700
% Trips Diverted to Rail	46%	47%	46%	46%

Source: NEC FUTURE team, 2015

Table 38 below presents the Regional rail annual passenger trips diverted from other modes. Each of the regional forecasting tools applied follows FTA's New Starts requirements for a fixed total person trip table for 2040. Because the fixed trip table is not allowed to increase, unlike the forecasts from the Interregional Model, there are no "induced" trips. The percentage of Total Rail Trips Diverted from Other Modes is calculated by dividing the Total Diverted Rail Trips from the Action Alternative by the Total Rail Trips of the No Action Alternative (420,000).

TABLE 38: TOTAL ESTIMATED REGIONAL ANNUAL RAIL TRIPS DIVERTED FROM OTHER MODES AS OPPOSED TO THE NO ACTION ALTERNATIVE (1,000S OF TRIPS)

Mode	Alternative 1	Alternative 2	Alternative 3
Auto Diversions	36,200	42,100	73,700
Other Transit Diversions (bus, subway, LRT)	18,500	33,500	47,400
Total Diverted Rail Trips	54,700	75,600	121,100
Total Rail Trips	474,500	495,400	545,500
% of Total Rail Trips Diverted from Other Modes	13%	18%	29%

Source: NEC FUTURE team, 2015

The effectiveness of the Action Alternatives in diverting trips from auto is also reflected in the annual reduction in automobile mode vehicle-miles traveled (VMT) versus the No Action Alternative, as shown in Table 39. This is a benefit to all travelers, as it helps reduce congestion on the highway network. Increases in both Intercity and Regional rail ridership result in reduced VMT; the largest reductions are achieved in Alternative 3. Table 40 provides details for each of the Alternative 3 route options. In this metric, VMT reduced due to trips diverted to Intercity rail are approximately double that of the VMT reduction associated with Regional rail for Alternatives 1 and 2, and approximately 1.5 times that of Regional rail in Alternative 3.

TABLE 39: ANNUAL REDUCTION IN AUTOMOBILE VEHICLE-MILES TRAVELED COMPARED TO NO ACTION ALTERNATIVE (IN 1,000S OF MILES)

Market/Service Type	Alternative 1	Alternative 2	Alternative 3 (average)
Intercity Rail Market Automobile VMT Reduction	(1,280.7)	(1,733.2)	**(1,890.6)**
Regional Rail Market Automobile VMT Reduction	(684.0)	(850.1)	(1,223.5)
Total VMT Reduction	**(1,964.6)**	**(2,583.3)**	**(3,114.2)**

Source: NEC FUTURE team, 2015

TABLE 40: ANNUAL REDUCTION IN AUTOMOBILE VEHICLE-MILES TRAVELED COMPARED TO NO ACTION ALTERNATIVE – ALTERNATIVE 3 ROUTE OPTIONS (IN 1,000S OF MILES)

Market/Service Type	Central Connecticut/ Providence (3.1)	Long Island/ Providence (3.2)	Long Island/ Worcester (3.3)	Central Connecticut/ Worcester (3.4)
Intercity Rail VMT Reduction	(1,913.1)	(1,805.7)	(1,977.0)	(1,866.7)
Regional Rail VMT Reduction	(1,223.5)	(1,223.5)	(1,223.5)	(1,223.5)
Total VMT Reduction	**(3,136.6)**	**(3,029.2)**	**(3,200.5)**	**(3,090.2)**

Source: NEC FUTURE Travel Demand Model outputs, April 2015

6.4 PEAK-HOUR, PEAK-DIRECTION IMPACTS AT KEY SCREENLINES

For each of the Action Alternatives, FRA compared available railroad capacity and the extent to which that capacity was utilized at key screenlines during the average weekday peak hour in 2040. A significant shortcoming of the No Action Alternative is the existence of capacity constraints, such that the system cannot serve the amount of passengers who want to travel by rail, pushing them onto other modes (primarily auto). The four key screenline locations that were analyzed include:

- North of Washington Union Station
- Hudson River, between New Jersey and Manhattan
- East River, between Manhattan and Queens
- South of Boston South Station

Table 41 summarizes the 2040 forecasted peak-hour capacity constrained ridership volumes and available seat capacity at key locations for peak-hour trains for each alternative (including both Intercity and Regional ridership), as well the unserved ridership, the number of riders which are turned away (estimated as the difference between the constrained and unconstrained demand). The location with the largest number of riders who are not accommodated due to the fact that demand exceeds capacity for the No-Action Alternative is the Hudson River screenline, with approximately 6,600 unserved riders per hour. The small amount forecasted unserved demand at the Washington, D.C., East River, and Boston screenlines is a result of the Intercity service being over-subscribed in the No Action Alternative.

Alternative 1 remains capacity constrained at the Hudson River screenline, although the amount of unserved ridership is reduced. While there are only modest capacity constraints in the No Action Alternative for the other screenlines, the capacity increases that result from Alternative 1 attract a significant amount of new riders. Chapter 9 of the Tier 1 Draft EIS contains additional information on the capacity of Alternative 1.

Alternatives 2 and 3 address the capacity constraints that are present in the No Action Alternative, and meet all the forecasted demand. Chapter 9 of the Tier 1 Draft EIS contains additional information on the capacity of Alternatives 2 and 3.

Table 41: Weekday AM Peak-Hour, Peak-Direction Volume/Capacity at Key Locations

Screenline	No Action Alternative	Alternative 1	Alternative 2	Alternative 3 (average)	Alternative 3 (range)
Washington, D.C., (north of Union Station)					
Total Practical Capacity (Slots/Hour)	12	16	20	32	32
Total Trains per Hour	6	12	20	24	24
Total-Practical Seats per hour (Intercity and Regional rail)	6,400	11,750	17,435	20,927	20,927
Total Constrained Ridership (passengers per hour)	5,809	9,615	11,173	12,403	12,328-12,514
Volume/Capacity Ratio	0.91	0.82	0.64	0.59	0.59-0.60
Total Ridership Unserved (passengers turned away per hour)	44	0	0	0	0
Hudson River					
Total Practical Capacity (Slots/Hour)	24	44	52	76	76
Total Trains per Hour	24	37	52	70	70
Total-Practical Seats per hour (Intercity and Regional rail)	28,850	44,835	63,035	78,905	78,905
Total Constrained Ridership (passengers per hour)	30,374	44,993	61,280	71,111	71,029-71,257
Volume/Capacity Ratio	1.05	1.00	0.97	0.90	0.90
Total Ridership Unserved (passengers turned away per hour)	6,601	2,889	0	0	0

East River					
Total Practical Capacity (Slots/Hour)	40	48	70	74	74
Total Trains per Hour	38	48	60	73	72-74
Total-Practical Seats per hour (Intercity and Regional rail)	38,260	45,352	56,338	68,261	67,277-69,244
Total Constrained Ridership (passengers per hour)	32,795	42,450	49,289	52,430	52,239-52,630
Volume/Capacity Ratio	0.86	0.94	0.87	0.77	0.76-0.78
Total Ridership Unserved (passengers turned away per hour)	340	0	0	0	0
Boston South					
Total Practical Capacity (Slots/Hour)	24	24	24	32	24-40
Total Trains per Hour	11	17	22	28	24-32
Total-Practical Seats per hour (Intercity and Regional rail)	10,000	16,128	20,870	23,420	20,260-26,580
Total Constrained Ridership (passengers per hour)	9,562	13,528	14,682	18,480	18,213-18,731
Volume/Capacity Ratio	0.96	0.84	0.70	0.79	0.70-0.90
Total Ridership Unserved (passengers turned away per hour)	75	0	0	0	0

Source: NEC FUTURE team, 2015
Note: Ridership Values are both Intercity and Regional rail services, in the standard peak hour, year 2040.

6.5 KEY FINDINGS

The FRA selected a number of key results and findings from the ridership forecasting process and has summarized them below.

6.5.1 Trip Characteristics of Rail and Total Travel Markets

The FRA has identified two general findings describing the behavior of travelers in the NEC:

- In the No Action Alternative and Action Alternatives the majority of passenger rail ridership, as well as overall travel in the corridor, is focused on the New York metropolitan area. Approximately 75% of Regional rail ridership trips and 80% of Intercity rail ridership trips have at least one trip end in the New York metropolitan area.
- The majority of total travel (by all modes) in the interregional markets is for non-business purposes, making up approximately 70% of interregional travel. The rest of the total interregional market is made up of 18% business travel and 12% commuter travel

6.5.2 Market Responses to Action Alternatives

The FRA has identified two general findings regarding the market response to the service improvements in the Action Alternatives.

- Rail trips in the Study Area are predominantly Regional rail trips, which comprise 96% of all trips in the No Action Alternative, 96% in Alternative 1, 93% in Alternative 2 and 94% in Alternative 3. Alternative 1 demonstrated an overall increase in total rail trips over the No Action Alternative of 16%. Alternative 2 demonstrated a 21% increase, and Alternative 3 a 32% increase over the No Action Alternative.
- The mode split between Intercity and Regional rail shifts more in favor of Intercity if measured with passenger miles instead of trips because Intercity rail trips are typically much longer than Regional rail trips. In Alternative 1, Intercity passenger miles comprise 31% of the total miles as compared to 22% in the No Action Alternative. Alternatives 2 and 3 have a similar split, with 32% and 31% of total passenger rail miles being Intercity rail. The overall increase in passenger miles over the No Action Alternative was 26% for Alternative 1, 37% for Alternative 2, and 48% for Alternative 3. In all of the Action Alternatives, the number of passenger miles grew at a greater rate than the number of overall trips, indicating that the distances that travelers are covering by rail are longer overall than in the No Action Alternative.

6.5.3 Service Variable Sensitivities

The FRA has identified five major findings associated with ridership demand sensitivity to service characteristics relating to mode choice selection. The need to determine the amount and type of service that would accommodate future corridor demand drove the interactive process of developing Service Plans for each alternative. This process utilized feedback from the travel demand analysis and engineering and capital costing analyses. The Interregional Model development process provided insights into the potential responses of current residents of the study area toward the three different levels of rail service. The representative Service Plans the FRA developed for each of the alternatives allow for anticipated future growth and provide a basis for the FRA to assess the environmental impacts of the alternatives at a programmatic level. The critical service variables in the mode choice model include travel time, travel cost, and frequency of service.

The five key findings related to ridership demand sensitivity to service characteristics in the NEC are:

- Travel time and travel cost typically have an inverse relationship, and can be used to calculate the Value of Time (VOT), or the amount respondents are willing to pay to save additional travel time. The new business and commuter Interregional Models had VOTs that were similar to others seen in the corridor or for similar prior models. However, the non-business model demonstrated much lower values of time, ranging from around $6 to around $20 (allowed to vary by total cost of the trip). These are lower values than represented in the corridor in the past, and indicate that price is becoming a particularly important piece of the mode choice decision, especially given that approximately 70% of interregional travel in the study area is currently non-business. One indication of this shift in cost sensitivity may be the increased prevalence of low-cost Intercity Bus service that has occurred over the past several years, making travelers more aware of cheaper options in the interregional market. The market for Intercity Express rail service continues to appeal to business travelers who place a higher value on time and are willing to pay for the service/time savings; but this is only 18% of total travelers.

- In all three mode choice models of the Interregional Model (business, non-business, and commute), the FRA utilized a dampened function of frequency. This specification accounts for the expectation that additional departure options impact choice up until a certain saturation level, at which point travelers have enough options, and more frequency will not increase the utility of the mode. This saturation point in the models is around 50 trains per day, which indicates that once the trains are less than 30 minutes apart, the importance of frequency drops off. Alternative 1 comes close to hitting this saturation point with respect to service frequency, with both Intercity- Express and Intercity-Corridor service operated at 30 minute intervals. The frequency dampening factor becomes apparent in Alternatives 2 and 3, which provide Intercity-Express and Intercity-Corridor/Metropolitan train service at time intervals of 15 minutes or less. Despite this increase in frequency, there is a lower incremental increase in ridership demand. This is particularly clear with Alternative 3, which despite addition of a second spine, generates only 1.9 million additional Intercity rail trips.
- Investment in major improvements in Intercity rail service – travel time reductions, frequency increases, and price reductions – will impact rail mode share, but may not significantly change the rail volumes for travel between metro areas that have only a small overall demand (e.g., Danbury-Springfield). Thus, increases in rail volume are most dependent on share changes for travel between the large markets in the area (such as New York, Boston, Philadelphia, and Washington), but these already have a large rail share. Where rail is the dominant mode of travel (Philadelphia-New York, and to a slightly lesser extent Washington-New York), capturing additional rail share by further improving rail service is relatively difficult. In markets where there are multiple competing modes (such as New York-Boston), significant improvements in rail service tend to result in a higher modal shift in favor of rail.
- There is corresponding growth in Regional rail trips across each of the alternatives. Regional rail trips are forecast to increase by 13% for Alternative 1, 18% for Alternative 2, and 30% for Alternative 3 compared to the No Action Alternative. The conditions that influence Regional rail ridership demand –the opportunities for growth that are provided by the Action Alternatives, and the levels of growth – vary region-by-region; however, in all cases the models forecast a strong response of Regional rail ridership. In Alternative 1, ridership grows at a rate commensurate with the anticipated growth in population and employment, which was the expected result.
- The FRA has identified that the most significant finding to emerge from the analysis with respect to Regional rail ridership is the potential to grow Regional rail travel beyond keeping pace with demographic growth. This would be achieved by investing in rail system capacity and operating additional Regional rail service. The Regional rail ridership growth rates estimated for Alternatives 2 and 3 (18% and 30% respectively) demonstrate the potential for increasing rail’s share of regional travel markets, and thereby growing the role of rail in regional travel.

7 Risk and Forecast Uncertainty

The FRA recognizes that the travel forecasts supporting planning investments must be able to address the uncertainty about a range of future assumptions that serve as inputs to the travel models. The behavioral responses of travelers to changes or new features in the transportation system must also be considered. The forecasting process should disclose the risk and uncertainty associated with any long term planning effort, including potential outcomes associated with any of the Tier I Draft EIS Alternatives. Many sources of uncertainty about inputs to the forecasting methods can be addressed through sensitivity testing or other methods; however even the use of these methods will not eliminate all elements of risk and uncertainty. Also, increases in ridership are the result of the NEC FUTURE Service Plans, which are not prescriptive and do not necessarily reflect the future operating plans of any of the railroads within the corridor.

7.1 DATA INPUTS

The first type of uncertainty surrounding the travel forecasts are related to data inputs. These sources of uncertainty include:

- Demographics
  - Population, employment, income levels
  - Location/magnitude of changes in demographics
- Rail Project Implementation
  - Physical scope: service extensions, station locations, inter-modal connections, and access
  - Service plan: travel times, fares, other
- Transportation System: Levels of service and costs
  - Highway: congestion, parking prices, gasoline prices
  - Other transit: background transit service levels and fares
  - Other intercity modes – air and bus
  - Investments in connecting corridors that could result in increased demand on the study area corridor

A primary driver of the total travel forecasts are the demographic forecasts. This analysis has relied on the “base” forecast to represent a moderate and reasonable picture of what is expected to happen in terms of population, employment and income in the future. However, there is uncertainty in the “base” forecast. The actual demographics in 2040 may vary in both size and distribution. For example, differences between various sources and locations of growth in employment and population may occur in the New York City metropolitan area, greatly impact travel patterns in the largest trip generator in the corridor. The demographic forecasts do not incorporate effects on future spatial development patterns or economic activity that might result from major improvements in the quantity, quality and extent of the rail transportation network, such as might occur in the Action Alternatives.

The second category of the data inputs that can provide uncertainty are the rail services being modeled. The FRA examined a large Study Area currently served by multiple rail operators. Thus, the actual implementation of the Service Plans modeled may differ from the planned implementation, and specific details which were assumed or simplified for analysis (such as station location and access characteristics) could impact the forecasted rail ridership.

Another key component of risk is the condition of the transportation system in the Study Area overall, and the levels of service and costs associated with the non-rail modes. In the modeled alternatives, the FRA made assumptions about the capacity and attractiveness of the non-rail modes, variations of which could impact mode choice in the study area significantly. In general, the non-rail modes were held constant to current service levels, with the exception that a level of future congestion was added to highway travel time (impacting access/egress time, auto travel time, and bus travel time). There is uncertainty in how these non-rail modes will respond in the future, to both changes in the rail mode (more competitive service) and other factors, such as fuel price changes or changes in trip-making. With overall growth in study area population and employment for the period through 2040, the travel demand models generally show an increase in travel by other modes as well as rail, in all of the Action Alternatives. To the extent that other modes may be constrained in their physical or operational capacity to accommodate growth, FRA had no basis within the scope of NEC FUTURE to estimate the magnitude of such constraints, and the non-rail modes therefore were not capacity constrained in the Interregional Model and regional models.

7.2 MODEL

There are inherent uncertainties surrounding the model itself, which include:

- Coefficient estimates
- Survey results
  - Stated preference questions are based on theoretical experiments, not actual experience
  - Based on current attitudes, and do not account for unseen attributes changing, such as overall mode preferences or other attributes such as multi-modal stations allowing ease for transfer, future growth around stations, future rates of car ownership, etc.

Each coefficient estimate specified in Section 3.2 has a standard error associated with it (which can be calculated using the t-stat shown in the model estimation results tables) which implies a range around the estimate. While the model produces a point estimate for the forecast, there is an error bar associated with each variable coefficient around that estimate and as a result the model forecasts also have probabilistic ranges associated with them.

In addition to the coefficients, there is uncertainty produced by the survey results used to estimate the model, in multiple dimensions. The first dimension is that the decisions made by the respondent in the stated choice questions which make up the basis for the mode choice model are made with all available information in front of them, and are assumed to make a rational decision for the mode which creates the most utility for the respondent. This may not be the actual decision the respondent would make if faced with this decision in their daily life, and may be biased by their current perception of each mode. For example, intercity bus was seen as less desirable in the SP experiments, but was actually a preferred mode using the RP data only.

The second dimension of uncertainty related to the survey results are the limitation of basing the model on current attitudes. This can limit the ability of the model to forecast results in areas where modes may change dramatically, such as in Alternative 3, where the service is in intended to be transformative – with trains running at headways more typical of transit services than intercity railroads, the convenience of not having to rely on a timetable or advance reservations for basic intercity travel, the ability to make intercity rail trips to other places within the NEC in timeframes previously only possible for trips within a region, the increase in the geographic reach of the NEC rail network, the ability to get to rail stations in a greater variety of ways, and a dramatic improvement in the overall convenience of traveling by rail. Respondents base their answers on their current perception of how travel operates, but a more reliable service could potentially shift the general attitude towards rail over time. In the mode choice model, this is represented by the alternative specific constant (which captures all unseen attributes), but it does not vary across alternatives. Another example of how the current attitudes may be limiting the model is in how the rail system is connected to the overall transportation network. One of the ideas behind transforming the transportation network would be increased connectivity, including such things as multi-modal stations, rental car facilities, and other ways that would allow travelers to more easily use the rail system. Respondents currently familiar with more limited options at rail stations today might not fully realize the advantages of this connectivity and allow it to influence their response.

Appendix A – Household Travel Survey Technical Memorandum

A Rail Investment Plan for the Northeast Corridor

Household Travel Survey Technical Memorandum

March 15, 2015
Final Version

Table of Contents

Tables

Figures

Appendix A: NEC Questionnaire
Appendix B: Report on Survey Non-Response

1. Overview

1.1 STUDY OBJECTIVES

The Survey of Northeast Regional and Intercity Household Travel Attitudes and Behavior (NEC Survey) was commissioned by the Federal Railroad Administration (FRA) to collect information on intercity and regional travel behavior and preferences of Northeast residents, and inform the modeling efforts as part of the NEC FUTURE Program.

The goal of the NEC survey is to help the NEC FUTURE program in preparing a Passenger Rail Corridor Investment Plan (PRCIP) for the Northeast region. The PRCIP, when completed, will improve the capacity and reliability of passenger rail travel in the Northeast.

The results of the survey will be used to develop a new model for forecasting future travel behavior in response to future services provided by different modes of travel in the Northeast. The primary use of the model will be to analyze the ridership impacts of alternative rail investment plans for the Northeast Corridor (NEC) as part of the aforementioned PRCIP for the Northeast region. In addition, the new NEC model and the data underlying the model will be available to the FRA for use in future projects involving the NEC.

The information collected included frequency of trips, origin and destination, modes of travel, trip purpose, party size, trip costs, and other trip characteristics. The survey also obtained stated travel preferences under alternative choice scenarios that included different and new travel modes, travel times, costs, schedules, and other service characteristics.[1]

1.2 RESPONDENT UNIVERSE

The respondent universe consisted of all persons aged 18 to 74 residing in households with a working telephone located within the Northeast Corridor of the United States[2]. The surveys were conducted among those who spoke English[3].

1.3 STUDY AREA

The study area spans the Northeast Corridor, including counties within the following States: Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Virginia, and Washington DC/District of Columbia. For purposes of defining and analyzing transportation alternatives for NEC FUTURE, the Study Area encompasses

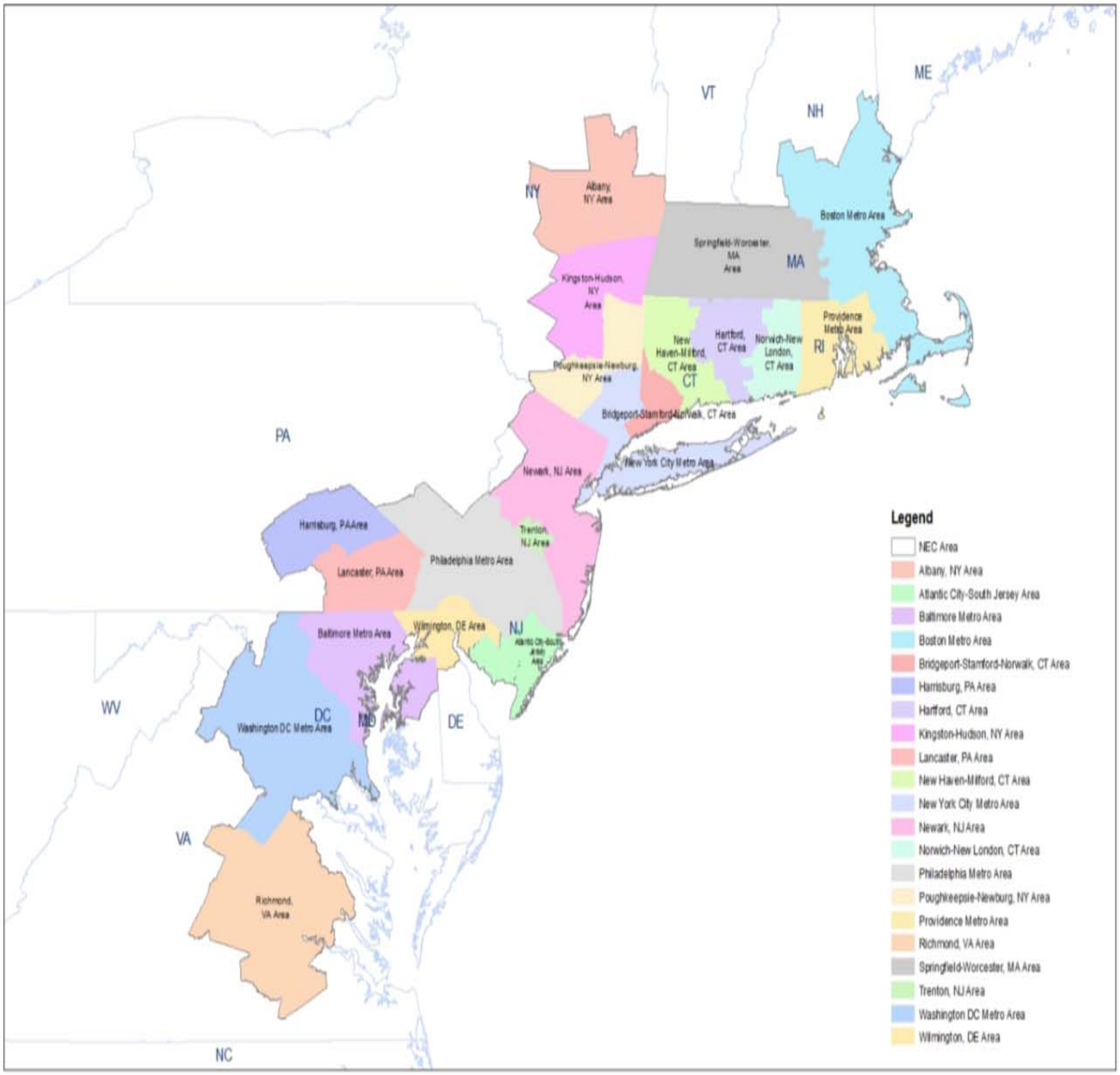
[1] OMB Control Number for the Survey is 2130-0600.

[2] Using a telephone household sample does not cause coverage bias as telephone service for many household is intermittent and thus will include households that were recently part of the non-telephone population.

[3] Limiting to English speaking respondents has minimal impact, based on the prevalence of the use of English in the United States and especially among target respondents, who are long distance travelers.

the region served by the NEC, plus those areas that can be reached directly by train or via a transfer to connecting rail corridors from the NEC. It is defined graphically in Figure 1.

Figure 1: Northeast Corridor Geography



2. Sampling and Survey Design

2.1 DUAL FRAME SAMPLING

The NEC Survey sample design employed a partially overlapping dual frame design containing probability samples drawn from independent sampling frames for landline phones and for cell phones.

2.1.1 Random Digit Dialing (RDD) of Landline and Cell Samples

List-assisted landline RDD sampling provides only a small coverage error for landline telephone households within landline banks, yet the restriction of the sampling frame to only landline banks would have introduced a much more serious coverage error. The increasing percentage of households that have abandoned their landline telephones for cell phones has significantly eroded the population coverage provided by landline-based surveys. The key group that is missing from landline RDD samples is the cell phone-only group. There is also potential bias in landline samples from under-coverage of young people who tend to rely on their cell phones more than their landline phones. Therefore, the cell phone sample for this survey was designed to be composed of both cell phone-only and cell phone users with a landline in their household.

Due to the higher cost of cell phone interviews compared to landline interviews, dual frame surveys are not usually designed with proportional allocation of sample between the landline and cell phone strata. The most recent data published from the National Health Interview Survey[4] shows 27.1% of adults residing in cell phone-only households in the Northeast region of the United States during the first half of 2013.

The sample allocation consisted of a two-stratum design (landline and cell phone) with 22% of the total sample being obtained from the cell phone frame.

2.1.2 Generation of Landline Sample

The landline sample was drawn from telephone banks randomly selected from an enumeration of the Working Residential Hundred Blocks within the active telephone exchanges. The Working Hundreds Blocks are defined as each block of 100 potential telephone numbers within an exchange that includes one or more residential listings (i.e., this will be a list-assisted sample). A two-digit number was then randomly generated for each selected Working Residential Hundred Block to complete the phone number to be called. By randomly generating these numbers, a process known as random digit dialing (RDD), every number in the sampling frame of Hundreds Blocks had an equal probability of selection regardless of whether it is listed or unlisted. The RDD sample of telephone numbers was dialed to determine which are currently working residential household telephone numbers. The systematic dialing of those numbers to obtain a residential contact was done to yield a probability sample of landline telephone numbers.

[4] Blumberg, Stephen J. and Julian V. Luke. Wireless Substitution: Early Release of Estimates From the National Health Interview Survey, January-June 2013. U.S. Department Of Health And Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics. Released 12/2013.

2.1.3 Generation of Cell Sample

The cell phone sample was randomly selected from 1,000 banks used exclusively for cell phones, using RDD. Stratification by area code was not performed since area code is not a great predictor of geography for cell phone sample. Procedures for sample selection were similar to those used in selecting the landline sample, except that the cell sample was not list-assisted. In addition, the cell phone was treated as a single user device. Therefore the cell phone sample did not require the same recruit procedures used within the landline sample to select a single participant from multiple eligible household members.

2.2 SURVEY SAMPLE CHARACTERISTICS

2.2.1 Survey Sample Requirements

The key dimension driving survey sample size requirements is trip purpose. Prior survey research and model estimation analysis, including most other intercity and regional surveys/models nationwide, have consistently shown trip purpose to be a significant determinant of travel behavior with respect to key sensitivities to service characteristics. For example, travelers on business trips typically show a higher value of time than travelers on non-business trips. For the purposes of this NEC research, trips were divided into the following three strata:

- Commute Trips, including only the daily commute to or from the usual place of work
- Business Trips, which include all non-commute trips associated with a business purpose such as company meetings, sales trips, etc.
- Non-Business Trips, which includes all other non-commute and non-business trips

Another important dimension is geography. The survey sample needed to address a cross-section of trips in different markets representative of the NEC. In the NEC FUTURE study, initial analysis of available market data and conceptual future rail alternatives has identified and confirmed the importance of the following key geographic stratification of the NEC:

- Travel North of New York
- Travel South of New York
- Travel through the New York Area (between points north of and south of New York)

The above stratification is particularly important with respect to business and non-business intercity trips, where there are important differences in the characteristics and availability of different modes of travel. The specific type of longer commute trip between regions addressed within the new NEC model is in itself a unique market. However, it is a much smaller market that does not lend itself to similar geographic stratification.

The new NEC model will be stratified into business, non-business and commute trips. Therefore, it is important to ensure the overall survey sample provides sufficient numbers of completed surveys within each of these segments. It is a given that larger samples will provide more precision, but there is a diminishing return on this relationship and requirements must be properly balanced with the need to efficiently and effectively use available resources.

2.2.2 Survey Sample Development

As with any sampling plan, there is always some uncertainty as to whether the data will actually reflect the universe of travelers until the survey itself is completed. However, existing data sets were used to derive NEC sample expectations. In the survey sample development stage, two key sources were examined to assess the expected distribution of the NEC sample: (1) the 2006 Amtrak NEC Traveler Surveys, which used a similar survey approach, and (2) the 2006 to 2008 3-year ACS CTPP Journey to Work (JTW) flow data, which provided a basis for estimating the incidence of longer commuter trips between NEC regions. Table 1 below provides the estimated size of the key trip purpose and geography subsamples for a total target sample of 12,500 completed surveys.

Table 1: Target Survey Sample by Trip Purpose and Geography

	Business	Non-Business	Commute	Total
North of NY	517	2,462	*	
South of NY	1,242	5,816	*	
Through NY	371	1,367	*	
Total	**2,130**	**9,645**	**725**	**12,500**

** Stratification of commuter travel by these markets was not examined independently.*

2.2.3 Obtained Survey Sample

In total, 11,858 completed surveys were obtained. Table 2 provides the breakdown by trip purpose and geography. Taking into account weighting, the margin of error at 95% confidence level for an estimated population percentage of 50% based on the total sample size is plus or minus 1.4 percentage points.

Table 2: Obtained Survey Sample by Trip Purpose and Geography

	Business	Non-Business	Commute	Total
North of NY	553	2,630	418*	
South of NY	987	4,437	624*	
Through NY	420	1,664	125*	
Total	**1,960**	**8,731**	**1,167**	**11,858**

* *Stratification of commuter travel by these markets was not examined independently.*

2.3 SURVEY CONTENT AND STRUCTURE

The information collected in the survey included frequency of trips, origin and destination, modes of travel (and class of service if applicable), trip purpose, party size, trip costs, and other trip characteristics. The NEC Survey was also designed to elicit travel preferences under alternative choice scenarios that included different and new modes, costs, schedules and other service characteristics. The background variables and stated preference module are described below.

2.3.1 Travel and Background Data Collected

The NEC Survey included questions about current longer distance trips and Stated Preference (SP) questions about alternative choices in response to different mode availability and modal service characteristics. For the purposes of this survey longer distance trips are defined as those made from the home area to other eligible areas. Eligible areas excluded the respondent's home State, nearby areas in adjoining States (typically less than 50 miles away from the home), and areas where the trip would have been entirely outside of the NEC. The survey collections information related to longer distance trips that were taken by the respondent during the 12 months prior to the interview date. The long distance trips tend to be less frequent and are likely more memorable. In order to minimize respondent burden, the survey collected information on a single qualifying origin and destination

The travel and background variables collected included:

- Trip data
  - Origin & destination
  - Frequency of trips in the last 12 months for that origin & destination
  - Purpose of each trip: Commute, Business, Non-business
  - Travel modes for a randomly selected trip purpose
  - Fare, duration, trip party, and information on access & egress for the most recent trip for the randomly selected travel mode for the randomly selected trip purpose (the reference trip)
- Demographic data
  - Age, gender, household size, vehicles owned, education, employment, income, race and Hispanic/Latino ethnicity, landline/cell phone ownership

2.3.2 Stated Preference Module

Six SP trade-off questions relating to the reference trip were presented to the respondent. The specific SP trade-off questions reflected an experimental design that addressed a cross section of all of the potential mode availability and service characteristic combinations so that each respondent was not asked to address too complex a choice task or was unnecessarily burdened by a longer interview. Specifically, each respondent was presented with choice questions addressing three of the following seven modes of travel within the NEC:

- High Speed Train
- Regional Train
- Commuter Train

- Metropolitan Train (a new service type)
- Passenger Car/Truck/Van
- Plane
- Bus

For a specific respondent, the selected modes used in the stated preference questions included the respondent's first choice mode, (i.e., the mode they actually used for the reference trip) and two randomly selected modes. Thus, each respondent will be asked to choose from among three modes of travel. The number of respondents that was exposed to each of the NEC modes is as follows:

- High Speed Train: 3,247 respondents
- Regional Train: 10,772 respondents
- Commuter Train: 1,133 respondents
- Metropolitan Train: 2,269 respondents
- Passenger Car/Truck/Van: 10,244 respondents
- Plane: 2,613 respondents
- Bus: 5,296 respondents

Note that the above total to 35,574, or three times the obtained sample size, because each respondent was exposed to three modes.

The detailed trip information obtained before the stated preference trade-off questions provided the context for the respondent's travel choices and a basis for defining trip-relevant service characteristics in the trade-off questions. The stated preference questions varied the values of a randomly selected subset of service characteristics for each mode using an experimental design that minimized the correlation among independent variables. Respondents were randomly assigned to one of three subgroups that saw changes in these variables[5]:

- Group 1: travel time and cost (schedule fixed)
- Group 2: travel time and schedule (cost fixed)
- Group 3: cost and schedule (travel time fixed)

This survey design limited the number of changing variables that any one respondent needed to react to and thus made the task more manageable. Respondents were presented with a total of six SP questions that addressed three choices of mode of travel with varying characteristics within one of the three pairs of variables listed above.

Base values of all variables were pre-determined for each mode for each possible origin and destination in the market area. This was done for each mode using the following sources:

[5] An earlier version of the survey also explored reliability as a service characteristic, but as a result of changes stemming from the results of the pilot study (see Section 2.4), it was not possible to retain reliability as a service characteristic of the modes in the final study.

- High Speed Train: Based on current Amtrak Acela average travel times and fares
- Regional Train: Based on current Amtrak Regional average travel times and fares
- Commuter Train: Based on current commuter rail average travel times and fares from different commuter rail operators including MBTA, MNR, NJT, LIRR, SEPTA, MARC and VRE.
- Metropolitan Train: Based on current commuter rail travel times and Amtrak Regional average travel times and fares. The process involved averaging the two sources to create values that were in-between Regional and commuter services, to reflect the proposed service.
- Passenger Car/Truck/Van: Based on highway travel time skims using the NHPN road network and mileage based costs
- Plane: Based on FAA BTS air data average travel times and fares.
- Bus: Based on current bus average travel times and fares from published schedule for all bus service operators
- Access/Egress for all modes (except auto): Based on highway travel time skims using the NHPN road network

The service characteristics for all the modes for a particular respondent were determined by the origin and destination of the respondent's reference trip. In addition, the respondent's self-reported fare information for the mode the respondent actually took is used for that mode in the SP questions. If the respondent did not remember the fare paid, the base values for that mode and origin and destination were used.

In the pilot survey phase, most self-reported rail, air and bus fares by respondents were reasonable when compared to published fares. The project team developed transportation network models of all modes which produced the relevant base values for travel times and costs, which also scale with trip length and geography. To allow the SP questions to explore a wide variety for potential service offerings across all modes, high and low values for the service characteristics were computed as follows:

- Total Travel Time High: randomize among +15%, +30% over base values
- Total Travel Time Low: randomize among -15%, -30% under base values
- Total Cost High: randomize among +15%, +30% over base values
- Total Cost Low: randomize among -15%, -30% under base values
- Schedule High: randomize among next two higher amounts over base (e.g., "Every Two Hours", "Every Three Hours")
- Schedule Low: randomize among next three lower amounts under base (e.g., "Every 30 minutes", "Every 20 minutes", "Every 15 minutes")

The responses to the SP survey questions will be used to provide the basis for estimating key sensitivities to changes in the service characteristics in the new model. Considerable care has been taken in the design of the NEC FUTURE survey to avoid presenting or showing any bias for/against any specific mode to respondents. First and foremost, the survey is household-based and mode neutral in recruiting respondents and identifying specific trips they have taken. Key elements of this effort included:

- Identification of the survey as USDOT-sponsored, not FRA, when speaking with respondents
- Randomized order of presenting candidate markets to select a specific market where the respondent made a trip
- Random selection of specific mode and trip purpose taken in this market
- Use of this randomly selected mode as one of the available modes shown in the stated preference questions
- Randomly selecting from remaining available modes to complete the list of modes shown to each respondent in the stated preference questions
- Randomizing the order that these modes were shown to respondents
- Using similar language throughout the survey where mode-specific information was presented to respondents

2.4 PILOT STUDY

Prior to moving forward with the full scale study, a pilot study was conducted to consider the effectiveness of the stated preference exercises, test the strength of the model, and assess response rates.

2.4.1 Scope and Timeline

The pilot consisted of 626 recruits, which resulted in 307 follow-up completes. The fielding period encompassed August 28, 2013 through November 4, 2013.

The pilot was a two-phase process: the recruitment survey and the follow-up survey. The recruitment survey was conducted by telephone. Recruitment respondents who qualified (being an adult and having taken a qualifying longer distance trip in the Northeast) and agreed to the second part of the study were offered two options for completing the follow-up survey.

Those with Internet access were sent a unique link via email to their individualized Internet follow-up survey. Those without Internet access were first mailed a packet of customized stated preference choice exercises. They were then able to view the travel scenarios when they were called for the phone version of the follow-up survey. For respondents without internet access, the recruitment survey also collected the necessary information from the respondent to develop SP choice questons that were customized to the particulars of the respondent's reference trip.

The two phase format was first chosen so that respondents could be exposed to the SP choice questions using a visual format (either through the internet or printed materials). The visual representation was considered essential due to the complex nature of the SP choice questions which for the pilot study had four service characteristics that could vary with among three modes, and 12 SP questions for each respondent.

2.4.2 Results

- The geographic distribution of the survey population reflected the relative population of the areas within the Northeast Corridor, with the areas near the largest cities being the most commonly reported home areas.
- The majority of respondents' trips were for leisure or non-business purposes (79.2%) with business (15.6%) and commuting (5.2%) distant second and third reasons for travel.
- The majority chose internet (86.3%) as their follow-up mode.
- The recruitment response rate was 9%[6] which is calculated as the number of complete interviews divided by the number of complete interviews plus the number of non-interviews (e.g.,screened/refusals/breakoffs) plus an estimate of the number of cases of unknown eligibility (e.g., no answer/busy/answering machine/un-screened refusals/callbacks) that are likely to be actually eligible. The factor for estimating the rate of eligibility among the unknown eligibility cases is determined as: (screened contacts and complete interviews minus screen-outs) divided by (screened contacts and complete interviews). Un-useable numbers are excluded from the calculation altogether.
  - Achieving a robust response rate was challenging because to be considered a "complete" response a respondent had to have traveled to a qualifying area and agree to participate in the follow-up survey. This represented a double hurdle for meeting the recruitment completion criteria.
  - Roughly one-quarter (22%) of respondents we spoke with screened out because they had not traveled to a qualifying area.
  - Of those who took a qualifying trip and met the other qualifying criteria of being an adult and living in the study area about half agreed to participate in the follow-up survey.
- The follow-up response rate was 49% overall (50% for Internet follow-up and 41% for mail/phone follow-up). This rate was calculated as the percentage of respondents who completed the follow-up survey divided by those who both qualified for the survey and agreed to the follow-up in the recruitment phase.
- The cumulative response rate across both parts of the pilot survey (recruitment and follow-up) was 4%.
- A preliminary look at non-response bias (which compared key demographic measures to the distribution in the general population) showed some differences—particularly, the follow-up survey respondents skewed higher in terms of household income and age and were less likely to be Hispanic compared to the general population in the study areas. However, the demographics of the general population in the Northeast Corridor is likely different from

[6] 12% calculated from landline sample. Cell sample recruit response rate was 4%.

long distance travelers in this region, who may indeed have higher incomes, and generally be older and less Hispanic than non long distance travelers.

- The average recruitment survey length was 7 minutes. The follow-up survey ran 15 minutes for the phone portion of the mail/phone version and 18 minutes for the Internet version.
- Pilot survey responses were preliminarily tested for general operational and content issues with the survey as well as respondent fatigue in the stated preference questions. One issue with stated preference questions is respondent fatigue, whereby increasing the number of experiments, alternatives and attributes can result in survey drop-offs. The questionnaire was designed to include 12 experiments with 3 alternatives, each with 2 attributes that vary and 2 that are fixed.
  - One approach that was used to assess fatigue in the pilot phase was to count the number of experiments declined (no response provided). Very few respondents declined to answer any of the SP questions.
  - Additionally, an analysis of the time spent answering each SP question was conducted, and it did not indicate that respondents were getting tired and taking longer to answer the latter questions in the series. On average, respondents took the longest to understand and answer the first question in the series.
- Variation in mode switching behavior was also analyzed to ensure the level of the variation in the stated preference variables was adequate for model estimation. Each respondent was assigned three modes for the series (their existing mode of travel, their second choice mode, and a randomly assigned mode that is available for their origin-destination pair). 48% of respondents did not switch modes at all, indicating that the variation may not be great enough between the variables. Of the non-switching mode respondents, 78% used Auto, which tends to be the hardest mode to switch to a shared ride mode. This did not indicate a problem with the questionnaire design but rather that the non-auto modes were not competitive enough to attract travelers to make the switch.
- Additionally, the mode switching behavior was analyzed for illogical responses (switching modes to a less desirable circumstance) and most appeared to be making logical switches.
- Test models were run in order to estimate whether key variables such as time and cost were providing meaningful coefficients. Simple multinomial logit (MNL) mode choice models were tested for all of the respondents and for business and non-business trip purposes, and in all cases the coefficients behaved as expected.
- The pilot results indicated Passenger car/truck/van as the primary chosen mode, reflecting the results of similar studies in the northeast.

2.4.3 Recommendations to the Main Study

The following recommendations were implemented based on the pilot study results:

- The SP variable values were adjusted to increase the relative attractiveness of non-auto modes, by reducing rail travel times and increasing auto travel times that were presented to respondents using Auto. Since the pilot results showed that many Auto respondents continued to choose auto across all SP questions, making the non-auto modes more attractive should create more variable responses.

- To improve response rates:
- The survey design was simplified from a two-phase methodology to a one-phase CATI telephone survey. As a result of this change, the SP questions could no longer be presented visually. In an effort to simplify the SP questions for ease of understanding when asked verbally via the telephone interview, the reliability was dropped from the service characteristics used to describe the alternative modes. In addition, the schedule of the alternative modes was changed from being a deviation (in minutes) from the respondent's preferred arrival or departure time, to being described as the number of minutes between departures.
- The total survey length was shortened from the pilot (7 minutes for the recruit and 15-18 minutes for the follow-up) to 18 minutes for the revised one-phase survey.
- The incentive was increased from $5 to $10.
- The maximum number of attempts per phone number dialed was increased from 5 to 10.

3. Field Implementation

3.1 ONE-PHASE CATI SURVEY

The original design of data collection efforts called for a two-phase survey approach. The recruit survey would be conducted by telephone via computer-assisted telephone interviewing (CATI) using a dual frame sample with both landlines and cell phones. The follow-up survey was to be conducted mostly via self-administration by respondents on the Internet. Respondents without Internet access would complete the follow-up survey by viewing a mailed packet of survey visuals and then providing answers to follow-up questions via a telephone interview.

Based on the findings from the pilot study, including a relatively low overall response rate across both phases, the original proposed data collection approach was reconsidered and revised. A one-phase dual frame CATI methodology was used for the main study. This methodology provided adequate sample population coverage and response rates at a reasonable schedule and cost.

3.1.1 Scope, Timeline and Survey Length

The NEC FUTURE survey was administered via CATI to a randomly selected sample of 11,858 respondents age 18 to 74 years old residing in the Northeast Corridor who have made longer distance trips in the Northeast Corridor within the past 12 months. 9,216 interviews were conducted with the landline sample, and 2,642 interviews conducted with the cell phone sample. The survey was fielded from April 23, 2014 through July 31, 2014. The average survey length was 16 minutes.

3.1.2 Recruitment and Eligibility

In the survey’s introduction, respondents were informed that participation is voluntary, and their answers will be kept private and will be used only for statistical purposes. Name and address was collected for the purpose of mailing incentive checks. Name and address, along with phone number were removed from the final data file.

Questionnaire Outline

An outline of the questionnaire screener is as follows:

- Safety (Cell phone sample only). Respondents were first asked if they were in a safe place to talk (e.g., not driving).
- Household Members (Landline sample only). To identify a random member of the household to participate in the survey, respondent was asked to provide number of people in household.
- Age. Respondents were asked to confirm age as one aspect of eligibility.
- Home location (Cell phone sample only). Those in the cell phone sample were asked to confirm their home location (this is already known for land lines).

- Regular/Daily Commute Trips. The respondent was asked if his/her regular commute trip is to an eligible out-of-state location and, if so, how many times in a typical week they make the trip, by mode. Eligible areas excluded the respondent's home State, nearby areas in adjoining States (typically less than 50 miles away from the home), and areas where the trip would have been entirely outside of the NEC.
- Other Qualifying Non-Commute Trips. If no qualifying commute trip was given based on responses to the preceding section on commute trips, the respondent was then asked about non-commute trips to out-of-state locations. This line of questioning included those pertaining to frequency in the past 12 months, mode and trip purpose. Eligible areas excluded the respondent's home State, nearby areas in adjoining States (typically less than 50 miles away from the home), and areas where the trip would have been entirely outside of the NEC.
- Selection of Reference Trip. The screener concluded with the random selection of a specific mode and trip purpose from those identified above. For reference trip assignment purposes, the respondent was also asked whether a round trip was taken.
- Demographics. If no qualifying trip was found in either the Commute or Non-Commute series of questions, the survey skipped to collect demographic information. In these cases, the interview was not counted as a completed survey. Demographic data collected included: age, gender, household size, vehicles owned, education, employment status, income, race and Hispanic/Latino ethnicity, and landline/cell phone ownership.

Upon completing the questionnaire screener, eligible participants were then taken through the main questionnaire. An outline of the main questionnaire is as follows:

- Reference Trip Details. In the first series of questions in the main questionnaire, the respondent was asked specifics about the reference trip assigned upon completion of the screener. As applicable for the reference trip, these questions included the specific type of rail service used, access and egress mode of travel, fare for common carrier modes, cost for auto mode, station/terminal waiting time, party size, trip purpose, specific origin and destination airport/station, and whether a connection was involved and the duration of reference trip. Trip data obtained in this section provided revealed preferences for the respondent's travel choices and may have helped to form the basis for defining trip-relevant service characteristics in subsequent trade-off questions (e.g., self-reported fare for train trips was generally used as the base fare in the stated preference module7).
- Main Mode Choice Trade-Off Questions. The trade-off questions included choice exercises that provided information used for estimating the new mode choice model. Specifically, six trade-off questions relating to the reference trip and three trip characteristics (i.e., travel cost, travel time and schedule) were presented to the respondent. The specific trade-off questions reflected an experimental design that addressed a cross section of all of the potential mode availability and the three trip characteristic combinations.

[7] Respondents who did not remember their fare, or gave unreasonable estimates, were provided default value in the trade-offs section based on published fares for travel between their place of origin and destination.

- To lessen respondent burden, each individual respondent was presented with three mode scenarios: Mode A representing the actual mode the respondent used for the reference trip and two randomly selected alternatives (Mode B and Mode C). Mode alternatives were described by the (one-way) total travel time, total cost, and schedule.
- The first choice exercise asked respondents to choose a mode based on the "base" characteristics of the three alternative modes. The next five choice exercises modified the characteristics of the available alternatives using percent changes over or under the base values.
- For an individual respondent, only two of the three characteristics changed from the base trip values. One group of respondents (Version 1) saw travel cost and travel time vary, but schedule remained the same. In Version 2, travel time varied but travel time and schedule did not vary. Other respondents were shown scenarios in which schedule was varied but travel cost and travel time were fixed (Version 3).
- Additionally, subversions of the survey varied the order of characteristics presented. For example, Version 1a listed time first followed by cost while Version 1b listed cost first, then time.

- Demographics. Respondents completing the entire survey, as well as those ineligible for the main survey based on their non-qualifying trip behavior, were asked to answer a set of demographic questions prior to ending the interview. These questions included age, gender, household size, vehicles owned, education, employment status, income, race and Hispanic/Latino ethnicity, and landline/cell phone ownership.

3.1.3 Incentive Structure

Respondents received a $10 check for their participation in the survey. The $10 check was mentioned during the introduction and awarded after the respondent completed the survey. The $10 served as a token of appreciation for the respondents' effort and was used to help maximize response rate.

The pilot phase study offered a $5 incentive for a two-phase survey effort. Given that the survey was reduced in total length to 18 minutes or shorter and revised to a one-phase design, the $10 amount was deemed a sufficient incentive to encourage participation.

3.2 CONTACT STRATEGY

Interviewing was conducted according to a schedule designed to facilitate successful contact with sampled households and complete interviews with the designated respondent within those households. Initial telephone contact was attempted during the hours of the day and days of the week that have the greatest probability of respondent contact based on the call history of previous surveys conducted at Abt SRBI. Based on these contact goals, interviewing was conducted generally between 5:30 p.m. and 9:30 p.m. on weekdays; between 9:00 a.m. and 9:30 p.m. on Saturdays; and between 12:00 noon and 9:30 p.m. on Sundays. The NEC FUTURE survey also included some limited weekday daytime calling within its calling algorithm.

The NEC FUTURE survey employed a 10 call strategy for landline and cell phone numbers where up to 10 call attempts were made to unanswered numbers before the number was classified as a permanent no answer. This change from the pilot protocol of 5 call attempts was enacted to help improve the survey response rate. Callbacks to unanswered numbers were made on different days over a number of weeks according to a standard callback strategy. If contact was made but the interview could not be conducted at that time, the interviewer rescheduled the interview at a time convenient to the respondent.

3.2.1 Initiating Contact

When a household was reached in the landline sample in the screener, the interviewer first screened for age eligibility. If only one household member was age eligible, then the interviewer will seek to interview that individual. If there was more than one eligible household member, then the interviewer randomly selected one respondent from among them using the last birthday method. That person was targeted for interview. Appointments were set up with respondents if it was inconvenient for them to be interviewed at the time of contact. If the randomly selected respondent was not available at the time of contact, then the interviewer obtained a good time to call back to reach that person.

For cell phone sample records, the interviewer immediately asked questions to determine whether the person on the phone was in a situation that could pose a safety risk to that individual (e.g., driving at the time of the call). If the contacted individual was found to be in a situation that could pose a risk, the interviewer terminated the call and scheduled a call back. If it was safe for the contacted individual to proceed with the call, then the interviewer proceeded with the screening questions. The interviewer first screened for age eligibility. If the cell phone user was eligible to participate, then the interviewer proceeded with the interview. If it was an inconvenient time for the respondent, then the interviewer scheduled an appointment for a better interview time.

When contact was made with an answering machine or voice mail, a message was left according to a set protocol. For landline numbers, a message was left on the 3rd attempt. The message explained that the household had been selected as part of a national USDOT study, asked that they call our toll-free number to schedule an interview, and included reference to the FRA web site which included information about the survey so that prospective respondents could verify the survey’s legitimacy.

3.2.2 Refusal Tracking

Higher response rates can be achieved through procedures built on careful documentation of refusal cases. The Project Director reviewed the information about refusals and terminations on the CATI system on an ongoing basis to identify any problems with the contact script, questionnaire or interviewing procedures that might have contributed to non-participation. In addition to relying on the CATI data records, the Project Director also consulted with the interviewing Shift Supervisor, who monitored the interviewing and debriefed the interviewers.

3.2.3 FRA Website

FRA placed on its web site information that prospective respondents were able to access to verify the survey's legitimacy. The interviewers provided concerned respondents with the web address to FRA's home page. There was a link on the home page that directed respondents to information on the source of the survey and why participation is important. A toll-free number to reach Abt SRBI, the survey contractor, was also provided for scheduling of interviews.

3.3 INTERVIEWER PROTOCOLS

3.3.1 Training

Abt SRBI phone interviewers received training for both the pilot and the main study. During training, interviewers were given general background information on the purpose of the research and provided an overview of the study and data collection. Included in the training was a thorough review of the questionnaire. In general, training objectives included:

- Briefing on study purpose
- Familiarization of questionnaire in the CATI structure
- Imparting an understanding of each question and valid response options
- Testing of various paths through mock interviews
- Rehearsing of interview procedures
- Distribution of study related materials and resources

3.3.2 Monitoring

Each interviewer was monitored throughout the course of the project. The monitor evaluated the interviewer on his or her performance and discussed any problems that an interviewer was having with the shift supervisor. Before the end of the interview shift, the monitor and/or shift supervisor discussed the evaluation with the interviewer. If the interviewer was not able to meet study standards, he or she was removed from the project.

All interviewers on the project underwent two types of monitoring, in-script entry visual review and audio monitoring. For in-script entry visual review, the study monitor sat at a computer allowing access to view what interviewers are recording real-time. Also, the audio from the interview was monitored. The audio-monitoring allowed the supervisor to determine the quality of the interviewer's performance in terms of:

- Initial contact and recruitment procedures;
- Reading the questions, fully and completely, as written;
- Reading response categories, fully and completely, (or not reading them) according to study specifications;
- Whether or not ambiguous or confused responses are clarified;

- How well questions from the respondent are handled without alienating the respondent;
- Avoiding bias by either comments or vocal inflection;
- Ability to persuade wavering, disinterested or hostile respondents to continue the interview; and,
- General professional conduct throughout the interview.
- The combined real-time visual and audio monitoring allowed monitoring of interviewer accuracy for code punches and verbatim responses.

3.4 RESPONSE RATES

3.4.1 Definition

The NEC FUTURE survey response rate was calculated as the number of complete interviews divided by the number of complete interviews plus the number of non-interviews (e.g.,screened/refusals/breakoffs) plus an estimate of the number of cases of unknown eligibility (e.g., no answer/busy/answering machine/un-screened refusals/callbacks) that are likely to be actually eligible.

The factor for estimating the rate of eligibility among the unknown eligibility cases is determined as: (screened contacts and complete interviews minus screen-outs) divided by (screened contacts and complete interviews). Un-useable numbers are excluded from the calculation altogether.

3.4.2 Summary

The NEC FUTURE survey response rate was a cumulative 11% across both landline and cell phone samples. It was 12% for the landline sample and 7% for the cell phone sample. The response rate calculation summaries (for landline+cell, landline only and cell only) are shown in Table 3, Table 4, and Table 5.

Table 3: Survey Response Rate (Landline + Cell)

		Original Count	Estimated Qualified Household*	Estimated Response Eligible^
T1	**TOTAL**	**761,150**		
A	**NON-Usable Numbers**	**449,394**		
A1	NIS/DIS/Change#/Intercepts	379,667		
A2	Non-residential #	35,958		
A3	Computer/Fax tone	22,992		
A4	Line problem	10,777		
T2	**Total Usable Numbers**	**311,756**		
B	**UNKNOWN ELIGIBLE HOUSEHOLD*^**	**157,147**	**64,365**	**31,850**
B1	Probable unassigned number	46,306		
B2	No answer/Busy	30,399		
B3	Answering machine	80,442		
C	**NOT ELIGIBLE RESPONDENT^**	**7,321**	**7,321**	**3,623**
C1	Language barrier	3,716		
C2	Health/Deaf	2,910		
C3	Respondent away for duration	695		
D	**UNKNOWN ELIGIBLE RESPONDENT^**	**113,057**		**55,944**
D1	Callback	76,581		
D2	Spanish Callback not screened	0		
D3	Refusals not screened	36,476		
E	**CONTACTS SCREENED**	**22,004**		
E1	Qualified callback	2,910		2,910
E2	Refusals – Qualified	1,988		1,988
E3	Terminates	0		0
E4	Screen-outs	17,106		
F	**COMPLETE**	**11,858**		**11,858**
A'	**ESTIMATED ELIGIBLE HH RATE =T2/T1**	**40.96%**		
B'	**ELIGIBLE RESPONSE RATE = E+F-E4/(E+F)**	**49.48%**		
C'	**SUM RESPONSE ELIGIBLE COUNT**			**108,173**
D'	**RESPONSE RATE = F/C'**	**10.96%**		

*Estimated Qualified HH=Original Count * A'

^Response Eligible = Qualified Household Count * B'

Table 4: Survey Response Rate (Landline Only)

		Original Count	Estimated Qualified Household*	Estimated Response Eligible^
T1	**TOTAL**	**661,384**		
A	**NON-Usable Numbers**	**434,288**		
A1	NIS/DIS/Change#/Intercepts	368,810		
A2	Non-residential #	32,860		
A3	Computer/Fax tone	22,867		
A4	Line problem	9,751		
T2	**Total Usable Numbers**	**227,096**		
B	**UNKNOWN ELIGIBLE HOUSEHOLD*^**	**117,366**	**40,299**	**20,491**
B1	Probable unassigned number	46,262		
B2	No answer/Busy	25,683		
B3	Answering machine	45,421		
C	**NOT ELIGIBLE RESPONDENT^**	**5,039**	**5,039**	**2,562**
C1	Language barrier	2,037		
C2	Health/Deaf	2,561		
C3	Respondent away for duration	441		
D	**UNKNOWN ELIGIBLE RESPONDENT^**	**78,640**		**39,986**
D1	Callback	50,400		
D2	Spanish Callback not screened	0		
D3	Refusals not screened	28,240		
E	**CONTACTS SCREENED**	**16,481**		
E1	Qualified callback	2,320		2,320
E2	Refusals – Qualified	1,530		1,530
E3	Terminates	0		0
E4	Screen-outs	12,631		
F	**COMPLETE**	**9,216**		**9,216**
A'	**ESTIMATED ELIGIBLE HH RATE =T2/T1**	**34.34%**		
B'	**ELIGIBLE RESPONSE RATE = E+F-E4/(E+F)**	**50.85%**		
C'	**SUM RESPONSE ELIGIBLE COUNT**			**76,105**
D'	**RESPONSE RATE = F/C'**	**12.11%**		

*Estimated Qualified HH=Original Count * A'

^Response Eligible = Qualified Household Count * B'

Table 5: Survey Response Rate (Cell Only)

		Original Count	Estimated Qualified Household*	Estimated Response Eligible^
T1	**TOTAL**	**99,766**		
A	**NON-Usable Numbers**	**15,106**		
A1	NIS/DIS/Change#/Intercepts	10,857		
A2	Non-residential #	3,098		
A3	Computer/Fax tone	125		
A4	Line problem	1,026		
T2	**Total Usable Numbers**	**84,660**		
B	**UNKNOWN ELIGIBLE HOUSEHOLD*^**	**39,781**	**33,758**	**15,256**
B1	Probable unassigned number	44		
B2	No answer/Busy	4,716		
B3	Answering machine	35,021		
C	**NOT ELIGIBLE RESPONDENT^**	**2,282**	**2,282**	**1,031**
C1	Language barrier	1,679		
C2	Health/Deaf	349		
C3	Respondent away for duration	254		
D	**UNKNOWN ELIGIBLE RESPONDENT^**	**34,417**		**15,554**
D1	Callback	26,181		
D2	Spanish Callback not screened	0		
D3	Refusals not screened	8,236		
E	**CONTACTS SCREENED**	**5,523**		
E1	Qualified callback	590		590
E2	Refusals – Qualified	458		458
E3	Terminates	0		0
E4	Screen-outs	4,475		
F	**COMPLETE**	**2,642**		**2,642**
A'	**ESTIMATED ELIGIBLE HH RATE =T2/T1**	**84.86%**		
B'	**ELIGIBLE RESPONSE RATE = E+F-E4/(E+F)**	**45.19%**		
C'	**SUM RESPONSE ELIGIBLE COUNT**			**35,531**
D'	**RESPONSE RATE = F/C'**	**7.44%**		

*Estimated Qualified HH=Original Count * A'
^Response Eligible = Qualified Household Count * B'

4. Quality Assurance and Quality Control

4.1 CHECKS FOR CONSISTENCY AND COMPLETENESS

Abt SRBI implemented a comprehensive quality assurance and quality control system to ensure the delivery of a clean database with a maximum degree of consistency, completeness and accuracy. The process began with the software Abt SRBI uses for telephone surveys. Abt SRBI's CATI system is able to program loops, rotations, randomization and extremely complex skip patterns. The system includes automatic range checks for data entry. It can be programmed to conduct complicated calculations. Abt SRBI's CATI system can also carry forward earlier responses, which can be integrated into later questions. All these functions ensured the quality of the data collected and were customized to the unique study specifications of the NEC FUTURE survey.

In addition to programming capabilities within the Abt SRBI CATI system, ad-hoc manual inspections of collected data were conducted as further checks. This primarily included doing common sense checks on the frequencies of questions, and examining the distribution of key survey variables (e.g., chosen mode, trip purpose, etc.).

4.1.1 CATI Software

The data were collected electronically through the use of CATI. The CATI system allows a computer to perform a number of functions prone to error when done manually by interviewers, including:

- Providing correct question sequence;
- Automatically executing skip patterns based on prior answers to questions (which decreases overall interview time and consequently the burden on respondents);
- Recalling answers to prior questions and displaying the information in the text of later questions;
- Providing random rotation of specified questions or response categories (to avoid bias);
- Ensuring that questions cannot be skipped; and
- Rejecting invalid responses or data entries (e.g., out of range).

The CATI system lists questions and corresponding response categories automatically on the screen, eliminating the need for interviewers to track skip patterns and flip pages. This ability within CATI to customize and check responses "in-the-moment" makes the survey methodology more efficient to administer and helps to achieve high-quality data with a lower respondent burden due to this efficiency. Moreover, the data entered by interviewers get directly stored in SRBI servers.

CATI systems typically include safeguards to reduce interviewer error in direct key entry of survey responses. CATI also allows the computer to perform a number of critical assurance routines that are monitored by survey supervisors, including tracking average interview length, refusal rate, and termination rate by interviewer; and performing consistency checks for inappropriate combination of answers.

4.1.2 Survey Tool Program Testing

The project team tested the CATI program thoroughly in test mode – running the interviewing program through multiple loops. The analytical staff tested all possible response categories for each question and numerous origin/destination & travel mode combinations in order to identify embedded logic errors, as well as obvious skip problems. Several analysts tested the program simultaneously to identify problems quickly, and to double check the comprehensiveness of the testing protocols.

After initial testing and corrections, the questionnaire program was also run through our autopilot program. This program tests the interview program by initiating the CATI interview and then by generating a dummy database of random responses as the questions appear. This database permitted us to track the response pattern compared to the hard copy questionnaire in order to further identify skip or other programming errors.

5. Weighting the Data

5.1 LANDLINE SAMPLE BASE WEIGHTS

For producing population-based estimates and for all statistical analyses, each respondent was assigned a sampling weight. To properly compute the weights for survey respondents (n=11,858), information required for weighting was also collected from adults who reported living inside the study area but were screened out because their travel patterns made them ineligible for the survey (n=13,094). Base weights and post-stratification weights were computed for both respondents and screen-outs as outlined in the steps below. The final weight variable, labeled WEIGHT, contains valid weight values for respondents only. The final weight assigned to each respondent consists of a base sampling weight and a post-stratification adjustment of this weight.

For the landline sample, the base weights were computed in two stages. The first stage base weight is calculated as the inverse of the probability of selecting the respondent. Since households are selected through the selection of landlines, the probability of selecting the household is the same as the probability of selecting the telephone number of the household. Specifically, the weight is the ratio of (1) the number of telephone numbers in the 1+ working banks (groups of 100 consecutive numbers that contain at least one directory-listed residential number) and (2) the number of telephone numbers drawn from those banks and actually released for data collection. The probability of selecting each landline telephone number is computed separately for each study area county, resulting in 140 sampling strata. The probability of selecting telephone numbers in the landline sample is computed as

$$\frac{N_h}{n_h}$$

where N_h is the count of landline numbers in each sampling stratum *h*, and n_h is the count of landline numbers from each sampling stratum *h* in the released sample replicates.

The second stage base weights adjust for the fact that only one adult in the household was selected to complete the interview. When landline numbers were dialed, interviewers asked to speak with "the member of this household age 18 or older who has had the most recent birthday." The probability that that individual was selected among all of the eligible (ages 18+) household members is the reciprocal of the number of adults in the household. We denote the number of adults, *A*, in household *i* as A_i. For cases from the landline sample, the sampling weight for within-household selection is simply A_i.

The final base weights for the landline sample are the product of the first stage and the second stage base weights described above.

5.2 CELL SAMPLE BASE WEIGHTS

There is only one stage of base weighting for cases selected from the cell sample. This base weight accounts for the probability of selecting the cell phone number from the cell sample in each study area county. The probability of selecting telephone numbers in the cell phone sample is computed as

$$\frac{N_h}{n_h}$$

where N_h is the count of cell phone numbers in each sampling stratum *h*, and n_h is the count of cell phone numbers from each sampling stratum *h* in the released sample replicates.

5.3 COMBINED SAMPLE BASE WEIGHTS

The final base weights for the landline and cell sample were then integrated into a combined sample base weight using composite estimation (Hartley 1962). The combined sample base weights adjust for the overlap between the landline RDD frame and the cellular RDD frame. Respondents who reported living in households with both a landline telephone and a cell phone were integrated into the sample using a compositing factor set to equal to 0.5. Cell phone only and landline-only respondents received a compositing factor set equal to 1.

5.4 POST-STRATIFICATION ADJUSTMENT OF COMBINED SAMPLE BASE WEIGHTS

The post-stratification adjustment of the final combined base weights was done through a process known as raking. Raking is a post-stratification procedure that can be used when post-strata are formed using more than one variable but only the marginal population totals are known. The raking procedure adjusts the combined sample base weights such that the sum of the weights agrees with population totals by age, gender, race/ethnicity etc. Prior to raking the weights, missing values in the survey variables used for weighting were imputed using the modal response in the survey data. These imputed values were used only for the purposes of weighting and were not included in the final survey dataset. Raking is used to reduce biases from non-response and non-coverage in sample surveys. The raking procedure aligned survey respondents and screen-outs to known population benchmarks[8] for the study's geographic area on the following dimensions:

- Age By Gender
- Education Level By Gender
- Race/Ethnicity
- State of Residence
- Household Telephone Service By State (cell phone only, landline only, or dual service)

All of the population benchmarks (control totals), with the exception of telephone service, were obtained from the 2012 American Community Survey 5 year Estimates, filtered on adults aged 18 and older living in households in the 140 counties in the study area. The telephone service population estimates were constructed from the model-based estimates released by the National

[8] The raking procedure did not include income because the non-response rate for income questions are generally high (18% for this study) and there are also general concerns that respondents often don't accurately report their income category. For these reasons, income was not used a population benchmark dimension.

Center for Health Statistics for the year 2012[9]. These state-level estimates were then re-based on adults, ages 18 and older, living in households with a telephone, and updated to reflect national increases in the cell phone only population since 2012.

The final weight variable, labeled WEIGHT, contains valid weight values for only respondents who completed the entire survey (n=11,858). A summary of the weights is shown in Table 6.

Table 6: Summary of Weights

Weight Variable	Number of cases (n)	Minimum weight	Maximum weight	Standard Deviation	Design effect	Effective n
WEIGHT	11,858	0.035	12.106	1.090	2.44	4,869

5.5 DESIGN EFFECT AND VARIANCE ESTIMATION

Weighting and survey design features that depart from simple random sampling tend to result in an increase in the variance of survey estimates. This increase, known as the design effect or deff, should be incorporated into the margin of error, standard errors, and tests of statistical significance. The design effect is the ratio of the variance derived from a survey sample design to the variance that would be obtained from a simple random sample, assuming the same sample size. We estimate the design effect based on the study sample weights as the ratio of the average of the squared weights to the average of the weights. The formula for that estimation is:

$$\frac{n\sum_i w_i^2}{(\sum_i w_i)^2} = 1 + cv^2(w_i)$$

where *n* equals the sample size. Weighting has a statistical impact on the resulting sample size in that the weighted sample, in effect, is reduced. In statistical tests where weighted data are used, those tests need to use what is called the effective sample size for variance calculations[10]. The effective sample size (or effective base) is calculated as *n* divided by the design effect. Thus, the sample size of 11,858 has a statistical effective sample size of 4,869 (i.e., 11,858/2.44). The use of these weights in statistical analyses ensures that the demographic characteristics of survey respondents closely approximate the demographic characteristics of the population in the study area. As such, they produce estimates that are generalizable to the study population.

[9] Blumberg SJ, Ganesh N, Luke JV, Gonzales G. Wireless substitution: State-level estimates from the National Health Interview Survey, 2012. National health statistics reports; no 70. Hyattsville, MD: National Center for Health Statistics. 2013.

[10] For generalized and approximate values of the standard error (se) for a given proportion (p) that incorporate the Deff, the following formula can be used:

$$\text{se}(p) = z[\text{Deff}(\text{pq/n})]^{1/2}$$

where z = the normalized confidence level (e.g., for 2-tailed 95% confidence, z. 975 = 1.96), p is your study proportion of interest, q = (1 - p), and n is the sample size. However, variance calculations that take into account complex sample designs may also be used with available statistical packages such as SAS, SPSS or STATA.

Appendix A: NEC Questionnaire

Survey of Northeast Regional and Intercity Household Travel Attitudes and Behavior

Screener

INTRO. Hello. My name is _____________ from Abt SRBI, calling on behalf of the U.S. Department of Transportation. We are conducting an important survey that will help plan transportation in your area. This survey is completely voluntary and any answers you give are kept strictly private to the extent permitted by law. This survey should take approximately 18 minutes of your time. We will send you a $10 incentive as a token of appreciation for your participation after the completion of the survey.
[IF REQUESTED BY RESPONDENT, Privacy Statement and Paperwork Reduction Act Burden Statement:
Privacy Statement:

Your name may be requested for interview scheduling or mailing your token of appreciation. When analysis of the questionnaire is completed, all name and address files will be destroyed. Thus permanent data will be anonymous. The U.S. Department of Transportation privacy information can be found at http://www.dot.gov/privacy]

Paperwork Reduction Act Burden Statement
The US Department of Transportation, Federal Railroad Administration is conducting this survey to collect data on travel patterns along the Northeast Corridor. This information will be used to estimate a forecasting model of travel mode choice in the Northeast Corridor. The information obtained will be used to provide guidance to future service planning. 49 USC 103 (j)(5) (6) authorizes collection of this information. A federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirements of the Paperwork Reduction Act unless that collection of information displays a currently valid OMB Control Number. The OMB Control Number for this information collection is 2130-0600. Public reporting for this collection of information is estimated to be approximately 18 minutes per response. All responses to this collection of information are voluntary. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to: Information Collection Clearance Officer, Federal Railroad Administration, 1200 New Jersey Avenue, SE, Washington, D.C. 20590.

ASK C1 IF CELL SAMPLE, THEN SKIP TO S1b. IF LANDLINE, SKIP TO S1.

C1 Are you currently driving, or someplace else where it is NOT safe to talk?

1 Yes/Call Me Later **Ask for Name and Schedule Callback**
2 No **Skip to S.1b & ask for age 18+ verification**
3 Refused **Thank and Terminate**

S1 So that we interview a random cross-section of the population, may I please ask how many persons 18 or older live in your household?

(1-10, 10 = "10 or more)
98 No one in household 18-74 **Thank and Terminate**
99 Refused **Thank and Terminate**

ASK S1A IF S1>1. OTHERWISE, SKIP TO S1B.

S1A May I please speak to the member of this household age 18 or older who has had the most recent birthday?

1 Speaking with respondent **Skip to S1C**
2 Respondent comes to phone **Skip to S1B**
3 Not Available **Ask for Name and Schedule Callback**
6 Refused **Thank and Terminate**

Speaking With Respondent:

S1B Hello. My name is _____________ from Abt SRBI, calling on behalf of the U.S. Department of Transportation. We are conducting an important survey that will help plan transportation in your area. This survey is completely voluntary and any answers you give are kept strictly private to the extent permitted by law. This survey should take approximately 18 minutes of your time. We will send you $10 as a thank-you for your participation after the completion of the survey. [If coming from C.1 or if S1=1, skip to here and ask:] Are you 18 years of age or older?
[IF REQUESTED BY RESPONDENT, Privacy Statement and Paperwork Reduction Act Burden Statement], provide info from first page:

1 Yes **Continue**
2 No **Thank and Terminate**
3 Refused **Thank and Terminate**

ASK S1C FOR ALL SAMPLE (LANDLINE OR CELL).

S1C First, I'd like to confirm your home state. Do you live in **(Read name of state from sample.)**?

1 Yes	**Skip to Instructions before S1E**
2 No	**Continue to S1D**
3 Refused	**Go to End Interview Routine**

S1D Then what state do you live in?

PROGRAMMER: DO NOT INCLUDE STATE ASKED IN S1C IN ANSWER LIST

1. Connecticut
2. Delaware
3. Maryland
4. Massachusetts
5. New Hampshire
6. New Jersey
7. New York
8. Pennsylvania
9. Rhode island
10. Virginia
11. Washington DC/District of Columbia
12. All other States, specify -> **Go to End Interview Routine**
99. Refused -> **Go to End Interview Routine**

IF S1C OR S1D = 11 (WASHINGTON, DC), SKIP S1E AND GO DIRECTLY TO S2A.

S1E. And what city or town in (State from S1C/S1D) do you live in?

PROGRAMMER: SHOW LIST OF CITIES IN (STATE FROM S1C/S1D). PROVIDE "CITY/TOWN NOT FOUND" AND "DON'T KNOW/REFUSED" AS RESPONSES FOR EACH STATE LIST.

Interviewer: Confirm spelling of city with respondent. As you type, a list of cities matching what you typed so far will be presented. The list will become more focused and fewer cities will be presented as you type in more letters of the city. Choose appropriate response.

PROGRAMMER: CONSULT LIST OF QUALIFYING CITIES FOR EACH STATE. IF CITY MENTIONED IS A QUALIFYING CITY, CONTINUE WITH S2A. OTHERWISE GO TO END INTERVIEW ROUTINE.
SET *[HOME CITY]* = (Home City from S1E/Washington, DC from S1C/S1D)

The following questions ask whether the respondent's usual commute to work trip qualifies as an interregional trip and would therefore be relevant for our model. If the respondent has an interregional commute, that commute trip will be the reference trip for the SP choice exercises. We will collect data on commuter trips by all modes to this location and then randomly select a mode to use as the reference trip.

S2A. Now I'd like you to think about trips for the purpose of daily commuting. Did you commute in the **past 12 months** to a state outside of (Home State from S1C/S1D)?

1 Yes	**Continue**
2 No	**Skip to S3A**
3 Don't know/Refused	**Skip to S3A**

S2B To which state did you commute to in the **past 12 months**? (Do Not Read List)
PROGRAMMER: DO NOT INCLUDE RESPONDENT'S HOME STATE FROM S1C/S1D

1. Connecticut
2. Delaware
3. Maryland
4. Massachusetts
5. New Hampshire
6. New Jersey
7. New York
8. Pennsylvania
9. Rhode island
10. Virginia
11. Washington DC/District of Columbia
12. All other state mentions, specify -> **Go to S3A**

99. Refused -> **Go to S3A**

IF S2B = 11 (WASHINGTON, DC), SKIP S2C AND GO DIRECTLY TO S2D.

S2C. What city or town did you commute to in (State from S2B)?

PROGRAMMER: SHOW LIST OF CITIES IN (STATE FROM S2B). PROVIDE "CITY/TOWN NOT FOUND" AND "DON'T KNOW/REFUSED" AS RESPONSES FOR EACH STATE LIST.

Interviewer: Confirm spelling of city with respondent. As you type, a list of cities matching what you typed so far will be presented. The list will become more focused and fewer cities will be presented as you type in more letters of the city. Choose appropriate response.

PROGRAMMER: CONSULT LIST OF QUALIFYING CITIES FOR EACH STATE, AND CHECK THAT ORIGIN AND DESTINATION CITY PAIR MEETS LONG DISTANCE TRAVEL CRITERIA. IF CITY MENTIONED MEETS BOTH QUALIFICATIONS, CONTINUE WITH S2D. OTHERWISE SKIP TO S3A.
SET *[Commute City]* = (Commute City from S2C/Washington, DC from S2B)

S2D. How many days in a typical week did you commute to (Commute City from S2C/Washington, DC from S2B)? (1-7, 8=Don't Know, 9=Refused)

PROGRAMMER: IF RESPONDENT HAS INDICATED AT LEAST ONE COMMUTE TRIP TO AREA IN S2D (1-7), ASK S2E. OTHERWISE, SKIP TO S3A.

S2E. Of the (Number from S2D) times in a typical week you commuted, how many times did you travel by (**ROTATE AND READ MODES**)? (0-7; 9=DK/Ref) **(RECONCILE RESPONSES TO NUMBER FROM S.2D)**

S2E # By Mode of Transportation			
1. Passenger Car/Truck/Van	2. Plane	3. Train	4. Bus

PROGRAMMER: IF RESPONDENT ANSWERED S2E, SKIP ALL QUESTIONS IN S3 SERIES AND GO TO INSTRUCTIONS AFTER S3F.

The following questions will determine if the respondent took any qualifying interregional non-commute trip. The list of states comprising the region of interest for this study will be randomized so as to not bias the respondent into thinking about the most recent trip or the most frequently visited place. The first such trip that is identified will be used as the location of the reference trip. We will collect data on trips by all modes and purposes to this location and then randomly select a mode-purpose combination to use as the reference trip. In addition to providing this basis of the reference trip, the data on number of traips by mode and purpose will also provide information on overall shares by mode and purpose within markets, supplementing other available aggregate data.

S3A1. Now I'm going to ask you about trips which you may have taken in the **past 12 months** to states beyond the state you live in for **any reason other than daily commuting**. This may include business trips or leisure which include vacation trips, or family occasions or other non-business reasons. Have you taken any business or leisure trips in the past 12 months?

1. Yes **CONTINUE**
2. No **SKIP TO TEXT BEFORE D-1**

S3A2. I'm going to read a list of states. As I read each one, please tell me if you have taken **any non-commute** trips from your home to that state in the **past 12 months**.

Have you traveled to (State) in the past 12 months for reasons other than daily commuting? Have you traveled to (Next state)?

PROGRAMMER: RANDOMIZE ORDER OF STATES PRESENTED. DO NOT INCLUDE RESPONDENT'S HOME STATE FROM S1C/S1D.

IF "NO" OR "DK/REF" TO ANY STATE, KEEP ASKING THE NEXT RANDOMIZED STATE. IF NO OTHER STATES LEFT TO ASK ABOUT, SKIP TO TEXT BEFORE D-1.

IF "YES" TO A STATE IN S3A, ASK S3B FOR THAT STATE. HOWEVER, IF S3A = 11 (WASHINGTON, DC), NO NEED TO ASK S3B. JUST CHECK THAT ORIGIN AND DESTINATION CITY PAIR MEETS LONG DISTANCE TRAVEL CRITERIA. IF YES, SKIP TO INSTRUCTIONS BEFORE S3D. IF NO, ASK THE NEXT RANDOMIZED STATE IN LIST. IF NO OTHER STATES LEFT TO ASK ABOUT, SKIP TO TEXT BEFORE D-1.

	S3A		
	1. Yes	2. No	DO NOT READ 9. Don't know/ Refused
1. Connecticut			
2. Delaware			
3. Maryland			
4. Massachusetts			
5. New Hampshire			
6. New Jersey			
7. New York State			
8. Pennsylvania			
9. Rhode Island			
10. Virginia			
11. Washington DC			

S3B. What city or town did you travel to in (State from S3A)?
Interviewer: if more than one city/town, say: Please tell me the city or town for which you made the most trips to in the past 12 months.

PROGRAMMER: SHOW LIST OF CITIES IN (STATE FROM S3A). PROVIDE "CITY/TOWN NOT FOUND" AND "DON'T KNOW/REFUSED" AS RESPONSES FOR EACH STATE LIST.

Interviewer: Confirm spelling of city with respondent. As you type, a list of cities matching what you typed so far will be presented. The list will become more focused and fewer cities will be presented as you type in more letters of the city. Choose appropriate response.

PROGRAMMER: CONSULT LIST OF QUALIFYING CITIES FOR EACH STATE, AND CHECK THAT ORIGIN AND DESTINATION CITY PAIR MEETS LONG DISTANCE

TRAVEL CRITERIA. IF CITY MENTIONED MEETS BOTH QUALIFICATIONS, SKIP TO INSTRUCTIONS BEFORE S3D.
IF CITY DOES NOT MEET BOTH QUALIFICATIONS, ASK:

S3C1. Have you been to any other cities or towns in (State from S3A just asked) in the past 12 months, for reasons other than daily commuting? Please think of any cities or towns in (State from S3A just asked) that are at least 25 miles away from the one you just told me about.

1	Yes	**CONTINUE WITH S3C2.**
2	No, none, at least 25 miles away	**RETURN TO S3A AND ASK ABOUT NEXT RANDOMIZED STATE IN LIST. IF NO OTHER STATES LEFT TO ASK ABOUT, SKIP TO TEXT BEFORE D-1.**
3	Don't know/Refused	**RETURN TO S3A AND ASK ABOUT NEXT RANDOMIZED STATE IN LIST. IF NO OTHER STATES LEFT TO ASK ABOUT, SKIP TO TEXT BEFORE D-1.**

S3C2. What other city or town did you travel to in (State from S3A just asked)?
PROGRAMMER: SHOW LIST OF CITIES IN (STATE FROM S3A). PROVIDE "CITY/TOWN NOT FOUND" AND "DON'T KNOW/REFUSED" AS RESPONSES FOR EACH STATE LIST.

Interviewer: Confirm spelling of city with respondent. As you type, a list of cities matching what you typed so far will be presented. The list will become more focused and fewer cities will be presented as you type in more letters of the city. Choose appropriate response.

PROGRAMMER: CONSULT LIST OF QUALIFYING CITIES FOR EACH STATE, AND CHECK THAT ORIGIN AND DESTINATION CITY PAIR MEETS LONG DISTANCE TRAVEL CRITERIA.
IF CITY MENTIONED MEETS BOTH QUALIFICATIONS, CONTINUE TO S3D. IF CITY DOES NOT MEET BOTH QUALIFICATIONS, THEN ASK ABOUT NEXT RANDOMIZED STATE IN LIST. IF NO OTHER STATES LEFT TO ASK ABOUT, SKIP TO TEXT BEFORE D-1.

SET *[NON-COMMUTE CITY]* = (Non-Commute City from S3B/S3C2/Washington, DC from S3A)

S3D. How many trips did you make from your home to (***[Non-Commute City]*** in the past 12 months? (**IF NECESSARY**: Your best estimate is fine.) (1-999; 998=998 or more; 999=DK/Ref) **IF DK/REF, SKIP TO TEXT BEFORE D-1.**

S3E. Of these ***([Total Trips] from S3D)*** trips, how many were for (**ROTATE BUSINESS, AND LEISURE or NON-BUSINESS**): <Business>|<Leisure or Non-Business>)?

(RECONCILE RESPONSES TO TOTAL TRIPS FROM S3D) (**IF NECESSARY**: Your best estimate is fine.) (0-999; 998=998 or more; 999=DK/Ref) **(MUST HAVE AT LEAST ONE RESPONSE IN S3E SERIES THAT IS 1-998 TRIPS)**

S3F. Now, I'd like to get more information on the modes of travel you used between ***[Home City]*** and ***[Non-Commute City]***. For the (**ROTATE AND READ TOTALS FROM S3E IF 1-998**) trips you made for (**ROTATE AND READ IN PURPOSE:** <Business>|<Leisure or Non-Business>), how many were by (**ROTATE AND READ MODES**)? If you used different modes for the departing and return trips, please count them as half trips. (**IF NECESSARY**: Your best estimate is fine.)
Please remember that I'm focusing on trips between ***[Home City]*** and ***[Non-Commute City]***), excluding daily commuting (**REPEAT FOR EACH MODE**) (**REPEAT ENTIRE PROCESS FOR EACH PURPOSE ≥1 IN S3E; IF S3E=0/DK/ REF, THEN SKIP THAT PURPOSE**) (0-999; 998=998 or more; 999=DK/Ref) **(RECONCILE RESPONSES TO TOTAL FOR EACH PURPOSE) (MUST HAVE AT LEAST ONE RESPONSE OF 1-998 TRIPS IN S3F SERIES FOR EACH PURPOSE ASKED)**

	S3E	S3F # By Mode of Transportation			
	TOTAL	1. Passenger Car/Truck/Van	2. Plane	3. Train	4. Bus
A. Business					
B. Leisure or Non-Business					

PROGRAMMER:
SET [TRIP CITY] = [COMMUTE CITY]/[NON-COMMUTE CITY] (NOTE THAT BASED ON QUESTIONNAIRE, THERE CAN ONLY BE ONE OF EITHER COMMUTE CITY OR NON-COMMUTE CITY BUT NOT BOTH]

SELECT A MODE AND TRIP PURPOSE COMBINATION.
IF S2E=1-7 FOR ANY OF THE 4 MODES (GAVE AT LEAST ONE COMMUTING MODE), SET *[Actual Mode]* = MODE IN S2E WITH HIGHEST NUMBER OF TIMES COMMUTED AND SET *[Trip Purpose]* = COMMUTING.
OTHERWISE, RANDOMLY SELECT A MODE AND TRIP PURPOSE COMBINATION WHERE TRIPS≥1 (1-998 TRIPS) IN S3E & S3F. SET *[Actual Mode]* = RANDOMLY SELECTED MODE AND *[Trip Purpose]* =RANDOMLY SELECTED TRIP PURPOSE. AVOID PLANE IF *[AirAvailable]* = 0, OR BUS IF *[BusAvailable]* = 0 UNLESS THESE ARE THE ONLY AVAILABLE MODES BASED ON RESEPONDENT'S ANSWERS. SEE

REFERENCE EXCEL FILE. [IF NECESSARY, WE MAY ALSO NEED TO OVER-SAMPLE CERTAIN COMBINATIONS.]

S4. Now I'd like you to think about your most recent ***[Actual Mode]*** trip from ***[Home City]*** to ***[Trip City]*** for ***[Trip Purpose]***. Did you immediately return home after visiting ***[Trip City]***, or did you travel to another city after visiting ***[Trip City]***?

1 Immediately returned home (Round trip) **Continue**
2 Traveled to a third city (One-way trip) **Continue**
9 No such trip/Don't know/Refused **Skip to Text before D-1**

SET RANDOMLY:
IF S4=1 (Round Trip):
[Origin City] = [Home City]
AND *[Destination City] = [Trip City]*
OR
[Origin City] = [Trip City]
AND
[Destination City] =[Home City]

IF S4=2 (One-way Trip):
[Origin City] = [Home City]
AND *[Destination City] = [Trip City]*

Set [Origin Zone] (used for lookup table for Q14A and tradeoff questions) to be based on [Origin City]
&
Set [Destination Zone] (used for lookup table for Q14A and tradeoff questions) to be based on [Destination City]

If S3F2 Plane Total Trips >0 or S2e2=1-7 set ***[AirAvailable]***=1)
If S3F4 Bus Total Trips >0 or S2e4=1-7 set ***[BusAvailable]***=1)

MAIN QUESTIONNAIRE

The following questions ask specifics about the reference trip, including specific type of rail service if rail was the actual mode taken, access and egress mode of travel, fare for common carrier modes, cost for auto mode, station/terminal waiting time, party size, trip purpose, specific origin and destination airport/station, whether a connection was involved and length of trip. The questions cycle through each potential mode that the respondent may have used, but each respondent is asked questions about only one mode,the actual mode the used for the reference trip.

Specific One-Way Trip & Mode

Now, please think about your most recent **one-way** ***[Actual Mode]*** trip from ***[Origin City]*** to ***[Destination City]*** for ***[Trip Purpose]***.

Programmer: Insert the following text if the *[Destination City]* selected is *[Home City]:*
Please note that we are now asking about the return trip from ***[Origin City]*** to ***[Destination City]***

Ask Q1 only if ***[Actual Mode]*** = “Train” AND (***[AcelaAvailable]***=1 OR ***[CRAvailable]***=1)
If ***[Actual Mode]*** = “Train” AND (***[AcelaAvailable]***=0 AND ***[CRAvailable]***=0), set Q1=2 and skip to instructions after Q1
(See reference Excel file; note that regular “non-Acela” Amtrak service is available in all markets to be surveyed)

1. What was the primary type of train service you used to travel between ***[Origin City]*** and ***[Destination City]***? (Read List)
   (If necessary: read appropriate text descriptions of available train services) (See reference Excel file for *[Amtrak Train Name]*)

   1 An Amtrak Acela train (list only if ***[AcelaAvailable]***=1)
   2 An Amtrak ***[AmtrakTrainName]*** train (not Acela)
   3 A ***[CROperator]*** train (list only if ***[CRAvailable]***=1)

   Do Not Read

   8 Don’t Know
   9 Refused

THERE ARE NO Q2-Q3

Skip to instructions before Q9A if ***[Actual Mode]*** = “Passenger Car/Truck/Van”

Ask Q4A, Q5A & Q6A if ***[Actual Mode]***="Train" (Then skip to instructions before Q9A)

4A. At which station did you board the train (replace "train" with Q1 answer, if available) on your one-way trip from ***[Origin City]*** to ***[Destination City]***? (Read List of Stations for ***[Origin City]*** if necessary) **(See reference Excel file) (999=DK) (Provide an Other Specify option in case respondent gives response not in reference file)** (Accept Only ONE Answer and set ***[Origin Station]***) (If DK, set ***[Origin Station]*** as "your origin station")

5A. Which ONE of the following best describes the MAIN form of transportation you used to get to ***[Origin Station]*** to board the train? Did you get to the train by … (Read List)? (Accept Only ONE Answer)

(Do Not Rotate)
2 Local Bus
3 Commuter rail
4 Subway
5 Private car - parked at station
6 Private car - dropped off at station
7 Taxi
8 Rental car
9 Walk
10 Or some other way (Specify:)____________
Do Not Read
99 Don't know/Not sure

6A. Approximately how much time did you spend at the station from the time you arrived at ***[Origin Station]*** to the time your train departed (Read List If Necessary)?

1 10 minutes or less
2 11-20 minutes
3 21-30 minutes
4 31-40 minutes
5 41-50 minutes
6 51-60 minutes (0:51-1:00)
7 61-75 minutes (1:01-1:15)
8 76-90 minutes (1:16-1:30)
9 91-105 minutes (1:31-1:45)
10 106-120 minutes (1:46-2:00)
11 over 2 hours
Do Not Read
99 Don't know/Not sure

Ask Q4B, Q5B & Q6B if ***[Actual Mode]***=”Plane” (Then skip to skip to instructions before Q9A)

4B. At which airport did you board the plane on your one-way trip from ***[Origin City]*** to ***[Destination City]***? (Read List of Airports for ***[Origin City]*** if necessary) **(999=DK) (Provide an Other Specify option in case respondent gives response not in reference file) (See reference Excel file)** (Accept Only ONE Answer and set ***[Origin Airport]***) (If DK, set ***[Origin Airport]*** as “your origin airport”)

5B. Which ONE of the following best describes the MAIN form of transportation you used to get to ***[Origin Airport]*** to board the plane? Did you get to the airport by … (Read List)? (Accept Only ONE Answer)

(Do Not Rotate)
1 Amtrak train (only display for ***[Origin Airport]***=”Newark” OR “BWI”)
2 Local Bus
3 Commuter rail
4 Subway
5 Private car - parked at airport
6 Private car - dropped off at airport
7 Taxi
8 Rental car
9 Walk
10 Or some other way (Specify:)____________
Do Not Read
99 Don’t know/Not sure

6B. Approximately how much time did you spend at the airport from the time you arrived at ***[Origin Airport]*** to the time your plane departed (Read List If Necessary)? NOTE: This includes the time it took to pass through security.

1 10 minutes or less
2 11-20 minutes
3 21-30 minutes
4 31-40 minutes
5 41-50 minutes
6 51-60 minutes (0:51-1:00)
7 61-75 minutes (1:01-1:15)
8 76-90 minutes (1:16-1:30)
9 91-105 minutes (1:31-1:45)
10 106-120 minutes (1:46-2:00)
11 over 2 hours
Do Not Read
99 Don’t know/Not sure

Ask Q5C if ***[Actual Mode]***="Bus"

5C. Which ONE of the following best describes the MAIN form of transportation you used to get to the bus terminal or stop serving ***[Origin City]*** to board the bus on your one-way trip from ***[Origin City]*** to ***[Destination City]***? Did you get to the terminal or stop by … (Read List)? (Accept Only ONE Answer)

(Do Not Rotate)
2 Local Bus
3 Commuter rail
4 Subway
5 Private car - parked at terminal/stop
6 Private car - dropped off at terminal/stop
7 Taxi
8 Rental car
9 Walk
10 Or some other way (Specify:)____________
Do Not Read
99 Don't know/Not sure

THERE ARE NO Q7-Q8

Ask Q9A, Q10A, Q11A, Q12A, Q13A if ***[Actual Mode]***="Train" (Then skip to instructions before Q15)

9A. At which station did you get off the train (replace "train" with Q1 answer, if available) on your one-way trip from ***[Origin City]*** to ***[Destination City]***? (Read List of Stations for ***[Destination City]*** if necessary) **(See reference Excel file) (999=DK)** (**Provide an Other Specify option in case respondent gives response not in reference file)** (Accept Only ONE Answer and set ***[Destination Station]***) (If DK, set ***[Destination Station]*** as "your destination station")

10A. Which ONE of the following best describes the MAIN form of transportation you used to get from ***[Destination Station]*** to your final destination in ***[Destination City]***? Was it … (Read List)? (Accept Only ONE Answer)

(Do Not Rotate)
2 Local Bus
3 Commuter rail
4 Subway
5 Private car - parked at station
6 Private car - picked up at station
7 Taxi
8 Rental car
9 Walk
10 Or some other way (Specify:)____________
Do Not Read
99 Don't know/Not sure

11A. Did your one-way trip from ***[Origin Station]*** to ***[Destination Station]*** require that you connect from one train to another train at another station to complete the trip? (Do Not Read List)

1 Yes
2 No
99 Don't know/Not sure

12A. What total fare did you pay for your trip by train from ([**Q4A answer**] *in text*) to ([**Q9A answer**] *in text*)? If you traveled with other people, please just provide the amount for your individual fare.

$__ __ __ __ (0 – 999; 998="$998 or more;" 999=DK)
Total Fare

Ask Q13A if Q12A = 1-998
13A. Was the $**(Amount in Q12A)** a one-way or round trip fare?

1 One-way fare
2 Round trip fare
Do Not Read
3 Don't know/Not sure

Do the following if Q13A is asked. If Q13A=2, Set ***[Rail Fare]*** = Q12A / 2; otherwise if Q13A=1 or 3 set ***[Rail Fare]*** = Q12A

Ask Q9B, Q10B, Q11B, Q12B, Q13B if ***[Actual Mode]***="Plane" (Then skip to instructions before Q15)

9B. At which airport did you get off the plane on your one-way trip from ***[Origin City]*** to ***[Destination City]***? (Read List of Airports for ***[Destination City]*** if necessary) **(See reference Excel file) (999=DK) (Provide an Other Specify option in case respondent gives response not in reference file)** (Accept Only ONE Answer and set ***[Destination Airport]***) (If DK, set ***[Destination Airport]*** as "your destination airport")

10B. Which ONE of the following best describes the MAIN form of transportation you used to get from ***[Destination Airport]*** to your final destination in ***[Destination City]***? Was it … (Read List)? (Accept Only ONE Answer)

(Do Not Rotate)
1 Amtrak train (only display for ***[Destination Airport]***="Newark" OR "BWI")
2 Bus
3 Commuter rail
4 Subway
5 Private car - parked at airport
6 Private car – picked up at airport
7 Taxi
8 Rental car
9 Walk
10 Or some other way (Specify:)____________
Do Not Read
99 Don't know/Not sure

11B. Did your one-way trip from ***[Origin Airport]*** to ***[Destination Airport]*** require that you connect from one plane to another plane at another airport to complete the trip? (Do Not Read List)

1 Yes
2 No
3 Don't know/Not sure

12B. What total fare did you pay for your trip by plane from ([**Q4B answer**] *in text*) to ([**Q9B answer**] *in text*)? If you traveled with other people, please just provide the amount for your individual fare.

$__ __ __ __ (0 – 999; 998="$998 or more;" 999=DK)
Total Fare

Ask Q13B if Q12B = 1-998
13B. Was the $**(Amount in Q12B)** a one-way or round trip fare?

1 One-way fare
2 Round trip fare
Do Not Read
3 Don't know/Not sure

Do the following if Q13B is asked. If Q13B=2, Set ***[Air Fare]*** = Q12B / 2; otherwise if Q13B=1 or 3 set ***[Air Fare]*** = Q12B

Ask Q10C, Q11C, Q12C if ***[Actual Mode]***=”Bus” (Then Skip to instructions before Q15)

10C. Which ONE of the following best describes the MAIN form of transportation you used after you got off the bus to get from the bus terminal or stop to your final destination in ***[Destination City]***? Was it … (Read List)? (Accept Only ONE Answer)

(Do Not Rotate)
2 Local Bus
3 Commuter rail
4 Subway
5 Private car - parked at terminal/stop
6 Private car - picked up at terminal/stop
7 Taxi
8 Rental car
9 Walk
10 Or some other way (Specify:)____________
Do Not Read
99 Don’t know/Not sure

11C. Did your one-way trip from ***[Origin City]*** to ***[Destination City]*** require that you transfer from one bus to another bus in route to complete the trip? (Do Not Read List)

1 Yes
2 No
3 Don’t know/Not sure

12C. What one-wayfare did you pay for your trip by bus from ***[Origin City]*** to ***[Destination City]***? If you traveled with other people, please just provide the amount for your individual fare.

$__ __ __ __ (0 – 999; 998=”$998 or more;” 999=DK)
Total Fare

If Q12C = 1-998, set ***[Bus Fare]*** = Q12C

Ask Q14A, Q14B, Q14C & Q14D if ***[Actual Mode]*** = "Passenger Car/Truck/Van"

Lookup default auto times [Auto_Travel_Time_1], [Auto_Travel_Time_2], [Auto_Travel_Time_3] based on [Origin Zone] and [Destination Zone] in reference Excel file. [Origin Zone] and [Destination Zone] will be based on [Origin City] and [Destination City] respectively.

14A. What do you estimate was your <u>one-way</u> travel time by passenger car/truck/van from ***[Origin City]*** to ***[Destination City]***? Was it closest to **(Read List. Accept Only One Answer)?**

Rotate
1 ***[Auto_Travel_Time_1]***
2 ***[Auto_Travel_Time_2]***
3 ***[Auto_Travel_Time_3]***
Do Not Read
4 Don't know/Not sure

If **[Q14A]**=1 set ***[Auto_Travel_Time]*** = ***[Auto_Travel_Time_1]***
If **[Q14A]**=2 or 4 set ***[Auto_Travel_Time]*** = ***[Auto_Travel_Time_2]***
If **[Q14A]**=3 set ***[Auto_Travel_Time]*** = ***[Auto_Travel_Time_3]***

14B. What do you estimate was the cost of your <u>one-way</u> trip by passenger car/truck/van from ***[Origin City]*** to ***[Destination City]*** …?

For Tolls $__ __ __ (000 – 997; 998="$998 or more;" 999=DK)
Tolls

14C. For Parking $__ __ __ (000 – 997; 998="$998 or more;" 999=DK)
Parking

14D. For Fuel $__ __ __ (001 – 997; 998="$998 or more;" 999=DK)
Fuel

If none of Q14B, Q14C or Q14D = 999, set ***[Car Fare]*** = Q14B+Q14C+Q14D

Ask All.

15. Which ONE of the following best describes the main purpose of your ***[Actual Mode]*** trip from ***[Origin City]*** to ***[Destination City]***? Was it …? **(Read List. Accept Only One Answer.)**

    1 Daily commute to or from work
    2 Business travel
    3 Travel to or from school
    4 Visit family or friends
    5 Vacation where you're away for about a week or more
    6 Leisure/recreation such as dining, sporting events, theater or long weekend getaways
    7 Personal or family business such as a wedding, funeral or medical trip
    8 Shopping
    9 Other (Specify)_______
    Do Not Read
    99 Don't know/Not sure

16. Did you travel alone or in a group on this ***[Actual Mode]*** trip? "Group" means two or more people who planned to travel together on the same trip.

1 Alone	Skip to instructions before Q24A
2 In a group	Ask Q17
Do Not Read	
3 Don't know/Not sure	Skip to instructions before Q24A

17. Which ONE of the following best describes the other people in your group? **(Read List. Accept Only One Answer) Interviewer:** If respondent's travel group included family along with friends/business associates, please select "Family"

    1 Family
    2 Friends
    3 Business associates
    Do Not Show
    4 Don't know/Not sure

18. Including yourself, how many adults 18 or older were in the group?

    # adults: __ __ [1-20; 20 = "20 or more"; 99=DK]

19. And, how many were children… **(Read List)**?

Under 6 years of age: __ __ [0-20; 20 = “20 or more”; 99=DK]
6-12 years: __ __ [0-20; 20 = “20 or more”; 99=DK]
13-17 years: __ __ [0-20; 20 = “20 or more”; 99=DK]

THERE ARE NO Q20-Q23

Ask Q24A if S4 = 1 (Round Trip) and ***[Trip Purpose]*** = business or leisure or non-business. Otherwise, skip to Main Mode Choice Trade-Offs Section.
24A. About how many nights were you away from home on your round trip?

__ [0-7; 8 = ”8 or more;” 9=DK]
Nights

If Q24A = 0, ask Q24B. Otherwise skip to Main Mode Choice Trade-Offs Section

24B. Approximately how many hours did you spend at **[Trip City]**, excluding travel time?

__ [0-24; 99=DK]
Number of Hours

Main Mode Choice Trade-Off Questions

In the following section, respondents are asked 6 Stated Preference choice exercises that relate to one way reference trip for that respondent. The actual mode the respondent used for the reference trip is always ModeA. Two other modes are randomly selected by the program to be available as alternatives.

The alternatives are described by the (one-way) total travel time, total cost, and schedule. Total travel time is the sum of access time, station waiting time, line haul time, transfer time (if relevant) and egress time.

Total cost is the sum of the (one-way) access costs, fare, and egress costs. For the passenger Car/Truck/Van option, cost is the sum of gas costs, tolls, and parking fees.

Schedule is described as departures every “X minutes” or “X hours.” Schedule is not described for the passenger Car/Truck/Van option.

Estimates of the current average values for these descriptors for each mode and origin zone/destination pair are derived from transportation network models of all the modes. These values, called “base” values are contained in a lookup database that is referenced by the CATI program.

If the respondent provided values of fares are within a reasonable range of the values found in the lookup database, the program will adapt the base values to include the respondent provided information. In addition, the program will use the actual reported cost and travel time from respondents who used auto, regardless of database estimate.

The first choice exercise asks respondents to choose a mode based on the “base” characteristics of the three alternative modes. The next five choice exercises modify the characteristics of the available alternatives using percent changes over or under the base values.

For an individual respondent, only two of the three characteristics will change from the base values. One group of respondents (those receiving version 1) will see travel cost and travel time vary, but schedule will remain unchanged from the base values. Version 2 will vary travel time and schedule and keep travel cost fixed. Version 3 will vary schedule and travel cost and keep travel time fixed.

There are also subversions of the survey whereby the order of the two characteristics is reversed. For instance, version 1a lists time first followed by cost while version 1b lists cost first followed by time.

Available modes include:

- ***"High Speed Train" (Where Database file is Not #N/A)***
- ***"Regional Train"***
- ***"Commuter Train" (Where Database file is Not #N/A)***
- ***"Metropolitan Train" (Where Database file is Not #N/A, randomized with or without a transfer)***
- ***"Passenger Car/Truck/Van"***
- ***"Plane" (Where Database file is Not #N/A) (Note: Same as if [Air_Available]=1)***
- ***"Bus" (Where Database file is Not #N/A) (Note: Same as if [Bus_Available]=1)***

Select three modes for trade-off questions as follows:

If [Actual Mode] = "Passenger Car/Truck/Van" OR "Plane" OR "Bus", Set [MODEA] = [Actual Mode]
If [Q1] = 1, [MODEA] = "High Speed Train"
If [Q1] = 2, 8 OR 9, [MODEA] = "Regional Train"
If [Q1] = 3, [MODEA] = "Commuter Train"

Set [MODEB] = RANDOMIZE AMONG AVAILABLE MODES ≠ [MODEA]
Set [MODEC] = RANDOMIZE AMONG AVAILABLE MODES ≠ [MODEA] ≠ [MODEB]

If in setting [MODEA], [MODEB] or [MODEC], the particular mode selected is not available because Database file values for that mode are #N/A, then please select from remaining modes that are still available (not #N/A in Database file and not already selected as [MODEA], [MODEB] or [MODEC]).

For MODEB and MODEC selection, prioritize to select "Regional Train," "Metropolitan Train," or both if not already selected as MODE and Database file values for the mode(s) are not #N/A.

Set base values for characteristics of each of the three modes. Variables to be assigned include: [TimeA], [CostA], and [SchedA] associated with [MODEA]; [TimeB], [CostB], and [SchedB] associated with [MODEB]; and [TimeC], [CostC], and [SchedC] associated with [MODEC]. These values will be set based on [Origin Zone] and [Destination Zone] from lookup database. Use modifications where respondent-provided data is available and reasonable. These characteristics include:

- ***High Speed Train***
  - ***Total Time***
  - ***Total Cost***
  - ***Schedule***
- ***Regional Train***
  - ***Total Time***
  - ***Total Cost***
  - ***Schedule***
- ***Commuter Train***
  - ***Total Time***
  - ***Total Cost***
  - ***Schedule***
- ***Metropolitan Train***
  - ***Total Time***
  - ***Total Cost***
  - ***Schedule***
- ***Plane***
  - ***Total Time***
  - ***Total Cost***
  - ***Schedule***
- ***Bus***
  - ***Total Time***
  - ***Total Cost***
  - ***Schedule***
- ***Car***
  - ***Total Time***
  - ***Total Cost***

Where actual mode is rail/air/bus, use respondent-provided fares if within a reasonable range of database values. For chosen car mode, use respondent-provided total cost when provided; otherwise use database values.

For Example (repeat formula for all non Auto modes)
If [MODEA] = "High Speed Train," check if respondent provided [Rail Fare] is within acceptable database value range (Within 'Acela Lo' and 'Acela Hi') for rail fare based on [Origin Zone] to [Destination Zone]. If it is, [Fare Diff] = [Rail Fare] – [Acela Fare] from Benchmark reference file, then apply that difference (as an addition if positive; as a subtraction if negative) to [Total Cost] for High Speed Train in database ([Total Cost] = [Total Cost] + [Fare Diff]); otherwise use database value for that zone pair.

If [MODEA] (essentially [Actual Mode])="Passenger Car/Truck/Van," [Total Cost] = [Car Fare] if available (that is, none in Q14B-D=999); otherwise use SP database value for that zone pair.

Also if [MODEA]="Passenger Car/Truck/Van," use [Auto_Travel_Time] set from Q14A for Total Travel Time.

Randomly assign respondent to one of three sub-groups which will see variations in 2 trip characteristics (Note: these will be [Var1] and [Var2], [Var3] and [Var4], [Var5] and [Var6] referenced in the appropriate grid):
(1) travel time and travel cost (use Version 1 questions)
(2) travel time and schedule (use Version 2 questions)
(3) travel cost and schedule (use Version 3 questions)

Schedule will take one of the following values for each mode:

- ***"Every 5 minutes"***
- ***"Every 10 minutes"***
- ***"Every 15 minutes"***
- ***"Every 20 minutes"***
- ***"Every 30 minutes"***
- ***"Every Hour"***
- ***"Every Two Hours"***
- ***"Every Three Hours"***
- ***"Every Four Hours"***

Use base values for other variables that will not change across trade-off questions.
Set high and low values for variables that change as follows:

- ***TimeHi: randomize among +15%, +30% over base values***
- ***TimeLo: randomize among -15%, -30% under base values***
- ***CostHi: randomize among +15%, +30% over base values***
- ***CostLo: randomize among -15%, -30% under base values***
- ***SchedHi = randomize among next two higher values (e.g., if Schedule = "Every Hour" then randomize among "Every Two Hours", Every Three Hours")***
- ***SchedLo = randomize among next three lower values (e.g., if Schedule = "Every Hour" then randomize among "Every 30 minutes", "Every 20 minutes", "Every 15 minutes")***

Instructions to respondent:

In the next series of questions, I ask you to make a choice about which travel mode you would prefer for that trip from ***[Origin City]*** to ***[Destination City]*** that you just told me about. For these next questions, I would like you to consider a choice between

- ***[MODEA];***
- ***[MODEB]; and***
- ***[MODEC]***.

Provide description of MODEA, MODEB and MODEC if they are rail.
If MODEA, MODEB or MODEC = "Commuter Train":
Read description of commuter rail: The commuter train is similar to the existing services provided by ***[CROperator]*** (name of commuter rail operator in respondent's home area). It provides passengers with shared bench seating – not individual seats. Seating is not guaranteed so some passengers might have to stand during the busiest times. Service is provided by a single train, so no transfer is required.

If MODEA, MODEB and MODEC = "High Speed Train":
Read description of High Speed Train: The high-speed train is very similar to Amtrak's Acela service. It provides passengers with individual seats, as opposed to the shared bench seating on commuter trains. Seating is guaranteed so passengers do not have to stand even during the busiest times. Service is provided by a single train, so no transfer is required.

If MODEA, MODEB and MODEC = "Regional Train":
Read description of Regional Train: The regional train is similar to Amtrak's Regional, Empire, and Keystone service. It provides passengers with individual seats, as opposed to the shared bench seating on commuter trains. Seating is guaranteed so passengers do not have to stand even during the busiest times. Service is provided by a single train, so no transfer is required.

If MODEA, MODEB and MODEC = "Metropolitan Train":
Read description of Metropolitan Train: The metropolitan train is a proposed new service. It provides passengers with individual seats, as opposed to the shared bench seating on commuter trains. However, like commuter trains, seating is not guaranteed so some passengers might have to stand during the busiest times. (***RANDOMIZE***: "This service will be provided by a single train, so no transfer is required.", "This service will be provided by two trains, requiring a transfer, but schedules are coordinated to minimize transfer time and riders purchase just one ticket.").

Note that, if the trip is made by train, plane or bus, the total travel time information I describe includes all time including getting to and from the airport or station and time waiting at the airport or station. The total cost includes the fare as well as the cost of getting to and from the airport or station.

The SP questions rely on an experimental design that provides for variations in five (5) different variables across three (3) modes. Although the experimental design could have also accommodated a sixth variable, we believe this would make the task too difficult for respondents. Furthermore, the sixth variable is not required when one of the modes is car and one of the variables is schedule, which is not relevant for car. A full orthogonal design generates eight (8) total combinations in the five (5) variables at two levels each, from which six are randomly selected to use in the six SP questions for a given respondent. The tables shown below reflect this same experimental design, with differences between them only reflecting the specific variables that are being used.

Note that the variable levels used for the first mode, which is the current mode used by the respondent, reflect base and high (worse) values and the variable levels used for the other two modes reflect base and low (better) values. This has been done to present alternative choices that are more attractive than the current mode, since little is learned about preferences by presenting non-chosen modes that get even worse.

Version 1 (vary travel time and travel cost and keep schedule fixed)

Please assume that the schedules for ***[MODEA]***, ***[MODEB]***, and ***[MODEC]*** are always the same in every case, with …

- ***[MODEA]*** providing service departing ***[SchedA]***;
- ***[MODEB]*** providing service departing ***[SchedB]***; and
- ***[MODEC]*** providing service departing ***[SchedC]***

(where [MODEA], [MODEB], or [MODEC] ="Passenger Car/Truck/Van", schedule variable does not exist so skip over appropriate MODE and Sched text)

Randomize among Versions 1a and 1b (time-cost or cost-time order)

Version 1a (Q25A-Q30A)

25A. First, please consider the situation where the ***[MODEA]*** **Total Travel Time** is ***[TimeA]*** and one-way **Total Cost** is ***[CostA]***; the ***[MODEB]*** **Total Travel Time** is ***[TimeB]*** and one-way **Total Cost** is ***[CostB]***; and the ***[MODEC]*** **Total Travel Time** is ***[TimeC]*** and one-way **Total Cost** is ***[CostC]***. Under these conditions, and assuming these were the only choices available, what would you choose for your trip from ***[Origin_City]*** to ***[Destination_City]***? Would you …

1 Travel by ***[MODEA]***;
2 Travel by ***[MODEB]***;
3 Travel by ***[MODEC]***;
4 Not make the trip at all

Do Not Read

8 Don't know/Not sure

For Q26A-Q27A, randomly select 2 rows of values from A1, A2, and A3 in table
For Q28A-Q30A, randomly select 3 rows of values from B1, B2, B3, and B4 in table

26A-30A. Next, please consider the situation where the ***[MODEA]*** **Total Travel Time** is ***[var1]*** and one-way **Total Cost** is ***[var2]***; the ***[MODEB]*** **Total Travel Time** is ***[var3]*** and one-way **Total Cost** is ***[var4]***; and the ***[MODEC]*** **Total Travel Time** is ***[var5]*** and one-way **Total Cost** is ***[var6]***. What would you choose for your trip from ***[Origin_City]*** to ***[Destination_City]***? Would you…

1 Travel by ***[MODEA]***;
2 Travel by ***[MODEB]***;
3 Travel by ***[MODEC]***;
4 Not make the trip at all

Do Not Read

8 Don't know/Not sure

	MODEA		MODEB		MODEC	
	Travel Time [var1]	Total Cost [var2]	Travel Time [var3]	Total Cost [var4]	Travel Time [var5]	Total Cost [var6]
Q25A	[TimeA]	[CostA]	[TimeB]	[CostB]	[TimeC]	[CostC]
A1	[TimeHiA]	[CostHiA]	[TimeLoB]	[CostB]	[TimeC]	[CostC]
A2	[TimeA]	[CostHiA]	[TimeLoB]	[CostLoB]	[TimeC]	[CostC]
A3	[TimeHiA]	[CostA]	[TimeB]	[CostLoB]	[TimeC]	[CostC]
B1	[TimeA]	[CostHiA]	[TimeB]	[CostLoB]	[TimeLoC]	[CostC]
B2	[TimeHiA]	[CostA]	[TimeLoB]	[CostLoB]	[TimeLoC]	[CostC]
B3	[TimeA]	[CostA]	[TimeLoB]	[CostB]	[TimeLoC]	[CostC]
B4	[TimeHiA]	[CostHiA]	[TimeB]	[CostB]	[TimeLoC]	[CostC]

NEC FUTURE

<u>Version 1b (Q25B-Q30B)</u>

25B. First, please consider the situation where the ***[MODEA]*** one-way **Total Cost** is ***[CostA]*** and **Total Travel Time** is ***[TimeA]***; the ***[MODEB]*** one-way **Total Cost** is ***[CostB]*** and **Total Travel Time** is ***[TimeB]***; and the ***[MODEC]*** one-way **Total Cost** is ***[CostC]*** and **Total Travel Time** is ***[TimeC]***. Under these conditions, and assuming these were the only choices available, what would you choose for your trip from ***[Origin_City]*** to ***[Destination_City]***? Would you…

1 Travel by ***[MODEA]***;
2 Travel by ***[MODEB]***;
3 Travel by ***[MODEC]***;
4 Not make the trip at all

Do Not Read

8 Don't know/Not sure

For Q26B-Q27B, randomly select 2 rows of values from A1, A2, and A3 in table
For Q28B-Q30B, randomly select 3 rows of values from B1, B2, B3, and B4 in table

26B-30B. Next, please consider the where the ***[MODEA]*** one-way **Total Cost** is ***[var1]*** and **Total Travel Time** is ***[var2]***; the ***[MODEB]*** one-way **Total Cost** is ***[var3]*** and **Total Travel Time** is ***[var4]***; and the ***[MODEC]*** one-way **Total Cost** is ***[var5]*** and **Total Travel Time** is ***[var6]***. What would you choose for your trip from ***[Origin_City]*** to ***[Destination_City]***? Would you…

1 Travel by ***[MODEA]***;
2 Travel by ***[MODEB]***;
3 Travel by ***[MODEC]***;
4 Not make the trip at all

Do Not Read

8 Don't know/Not sure

This table matches the prior table, only the order of the columns (cost and time) have been switched)

	MODEA		MODEB		MODEC	
	Total Cost [var1]	Travel Time [var2]	Total Cost [var3]	Travel Time [var4]	Total Cost [var5]	Travel Time [var6]
Q25B	[CostA]	[TimeA]	[CostB]	[TimeB]	[CostC]	[TimeC]
A1	[CostHiA]	[TimeHiA]	[CostLoB]	[TimeB]	[CostC]	[TimeC]
A2	[CostA]	[TimeHiA]	[CostLoB]	[TimeLoB]	[CostC]	[TimeC]
A3	[CostHiA]	[TimeA]	[CostB]	[TimeLoB]	[CostC]	[TimeC]
B1	[CostA]	[TimeHiA]	[CostB]	[TimeLoB]	[CostLoC]	[TimeC]
B2	[CostHiA]	[TimeA]	[CostLoB]	[TimeLoB]	[CostLoC]	[TimeC]
B3	[CostA]	[TimeA]	[CostLoB]	[TimeB]	[CostLoC]	[TimeC]
B4	[CostHiA]	[TimeHiA]	[CostB]	[TimeB]	[CostLoC]	[TimeC]

<u>Version 2 (vary travel time and schedule and keep travel cost fixed)</u>

Please assume that the one-way total costs for ***[MODEA]***, ***[MODEB]***, and ***[MODEC]*** are always the same in every case, with …

- ***[MODEA]*** one-way **Total Cost** at ***[CostA]***;
- ***[MODEB]*** one-way **Total Cost** at ***[CostB]***; and
- ***[MODEC]*** one-way **Total Cost** at ***[CostC]***

<u>Version 2 (Q25C-Q30C)</u>

(where [MODEA], [MODEB], or [MODEC] =”Passenger Car/Truck/Van”, schedule variable does not exist so skip over appropriate MODE and Sched text in questions)

25C. First, please consider the situation where the ***[MODEA]*** **Total Travel Time** is ***[TimeA]*** providing service departing ***[SchedA]***; the ***[MODEB]*** **Total Travel Time** is ***[TimeB]*** providing service departing ***[SchedB]***; and the ***[MODEC]*** **Total Travel Time** is ***[TimeC]*** providing service departing ***[SchedC]***. Under these conditions, and assuming these were the only choices available, what would you choose for your trip from ***[Origin_City]*** to ***[Destination_City]***? Would you…

1 Travel by ***[MODEA]***;
2 Travel by ***[MODEB]***;
3 Travel by ***[MODEC]***;
4 Not make the trip at all

Do Not Read

8 Don’t know/Not sure

Since schedule is not relevant for the car mode, there are 3 different designs depending on which mode is car.

For Q26C-Q27C, randomly select 2 rows of values from A1, A2, and A3 in table
For Q28C-Q30C, randomly select 3 rows of values from B1, B2, B3, and B4 in table
Use appropriate table depending upon which mode is ”Passenger Car/Truck/Van”

26C-30C. Next, please consider the situation where the ***[MODEA]*** **Total Travel Time** is ***[var1]*** providing service departing ***[var2]***; the ***[MODEB]*** **Total Travel Time** is ***[var3]*** providing service departing ***[var4]***; and the ***[MODEC]*** **Total Travel Time** is ***[var5]*** providing service departing ***[var6]***. What would you choose for your trip from ***[Origin_City]*** to ***[Destination_City]***? Would you…

1 Travel by ***[MODEA]***;
2 Travel by ***[MODEB]***;
3 Travel by ***[MODEC]***;
4 Not make the trip at all

Do Not Read

8 Don’t know/Not sure

	MODEA (Car)		MODEB (not Car)		MODEC (not Car)	
	Travel Time [var1]	N/A	Travel Time [var3]	Schedule [var4]	Travel Time [var5]	Schedule [var6]
Q25C	[TimeA]		[TimeB]	[SchedB]	[TimeC]	[SchedC]
A1	[TimeHiA]		[TimeLoB]	[SchedHiB]	[TimeC]	[SchedC]
A2	[TimeA]		[TimeLoB]	[SchedHiB]	[TimeC]	[SchedLoC]
A3	[TimeHiA]		[TimeB]	[SchedB]	[TimeC]	[SchedLoC]
B1	[TimeA]		[TimeB]	[SchedHiB]	[TimeLoC]	[SchedLoC]
B2	[TimeHiA]		[TimeLoB]	[SchedB]	[TimeLoC]	[SchedLoC]
B3	[TimeA]		[TimeLoB]	[SchedB]	[TimeLoC]	[SchedC]
B4	[TimeHiA]		[TimeB]	[SchedHiB]	[TimeLoC]	[SchedC]

	MODEA (not Car)		MODEB (Car)		MODEC (not Car)	
	Travel Time [var1]	Schedule [var2]	Travel Time [var3]	N/A	Travel Time [var5]	Schedule [var6]
Q25C	[TimeA]	[SchedA]	[TimeB]		[TimeC]	[SchedC]
A1	[TimeHiA]	[SchedHiA]	[TimeLoB]		[TimeC]	[SchedC]
A2	[TimeA]	[SchedHiA]	[TimeLoB]		[TimeC]	[SchedLoC]
A3	[TimeHiA]	[SchedA]	[TimeB]		[TimeC]	[SchedLoC]
B1	[TimeA]	[SchedHiA]	[TimeB]		[TimeLoC]	[SchedLoC]
B2	[TimeHiA]	[SchedA]	[TimeLoB]		[TimeLoC]	[SchedLoC]
B3	[TimeA]	[SchedA]	[TimeLoB]		[TimeLoC]	[SchedC]
B4	[TimeHiA]	[SchedHiA]	[TimeB]		[TimeLoC]	[SchedC]

	MODEA (not Car)		MODEB (not Car)		MODEC (Can be Car)	
	Travel Time [var1]	Schedule [var2]	Travel Time [var3]	Schedule [var4]	Travel Time [var5]	N/A(car) or Schedule [var6]
Q25C	[TimeA]	[SchedA]	[TimeB]	[SchedB]	[TimeC]	[SchedC]
A1	[TimeHiA]	[SchedHiA]	[TimeLoB]	[SchedB]	[TimeC]	[SchedC]
A2	[TimeA]	[SchedHiA]	[TimeLoB]	[SchedLoB]	[TimeC]	[SchedC]
A3	[TimeHiA]	[SchedA]	[TimeB]	[SchedLoB]	[TimeC]	[SchedC]
B1	[TimeA]	[SchedHiA]	[TimeB]	[SchedLoB]	[TimeLoC]	[SchedC]
B2	[TimeHiA]	[SchedA]	[TimeLoB]	[SchedLoB]	[TimeLoC]	[SchedC]
B3	[TimeA]	[SchedA]	[TimeLoB]	[SchedB]	[TimeLoC]	[SchedC]
B4	[TimeHiA]	[SchedHiA]	[TimeB]	[SchedB]	[TimeLoC]	[SchedC]

<u>Version 3 (vary travel cost and schedule and keep travel time fixed)</u>

Please assume that the total travel time for ***[MODEA]***, ***[MODEB]***, and ***[MODEC]*** are always the same in every case, with …

- ***[MODEA]*** **Total Travel Time** at ***[TimeA]***;
- ***[MODEB]*** **Total Travel Time** at ***[TimeB]***; and
- ***[MODEC]*** **Total Travel Time** at ***[TimeC]***

<u>Version 3 (Q25D-Q30D)</u>

(where [MODEA], [MODEB], or [MODEC] =”Passenger Car/Truck/Van”, schedule variable does not exist so skip over appropriate MODE and Sched text in questions)

25D. First, please consider the situation where the ***[MODEA]*** one-way **Total Cost** is ***[CostA]*** providing service departing ***[SchedA]***; the ***[MODEB]*** one-way **Total Cost** is ***[CostB]*** providing service departing ***[SchedB]***; and the ***[MODEC]*** one-way **Total Cost** is ***[CostC]*** providing service departing ***[SchedC]***. Under these conditions, and assuming these were the only choices available, what would you choose for your trip from ***[Origin_City]*** to ***[Destination_City]***? Would you…

1 Travel by ***[MODEA]***;
2 Travel by ***[MODEB]***;
3 Travel by ***[MODEC]***;
4 Not make the trip at all

Do Not Read

8 Don’t know/Not sure

For Q26D-Q27D, randomly select 2 rows of values from A1, A2, and A3 in table
For Q28D-Q30D, randomly select 3 rows of values from B1, B2, B3, and B4 in table
Use appropriate table depending upon which mode is ”Passenger Car/Truck/Van”

26D-30D. Next, please consider the situation where the ***[MODEA]*** one-way **Total Cost** is ***[var1]*** providing service departing ***[var2]***; the ***[MODEB]*** one-way **Total Cost** is ***[var3]*** providing service departing ***[var4]***; and the ***[MODEC]*** one-way **Total Cost** is ***[var5]*** providing service departing ***[var6]***. What would you choose for your trip from ***[Origin_City]*** to ***[Destination_City]***? Would you…

1 Travel by ***[MODEA]***;
2 Travel by ***[MODEB]***;
3 Travel by ***[MODEC]***;
4 Not make the trip at all

Do Not Read

8 Don’t know/Not sure

	MODEA (Car)		MODEB (not Car)		MODEC (not Car)	
	Total Cost [var1]	N/A	Total Cost [var3]	Schedule [var4]	Total Cost [var5]	Schedule [var6]
Q25D	[CostA]		[CostB]	[SchedB]	[CostC]	[SchedC]
A1	[CostHiA]		[CostLoB]	[SchedHiB]	[CostC]	[SchedC]
A2	[CostA]		[CostLoB]	[SchedHiB]	[CostC]	[SchedLoC]
A3	[CostHiA]		[CostB]	[SchedB]	[CostC]	[SchedLoC]
B1	[CostA]		[CostB]	[SchedHiB]	[CostLoC]	[SchedLoC]
B2	[CostHiA]		[CostLoB]	[SchedB]	[CostLoC]	[SchedLoC]
B3	[CostA]		[CostLoB]	[SchedB]	[CostLoC]	[SchedC]
B4	[CostHiA]		[CostB]	[SchedHiB]	[CostLoC]	[SchedC]

	MODEA (not Car)		MODEB (Car)		MODEC (not Car)	
	Total Cost [var1]	Schedule [var2]	Total Cost [var3]	N/A	Total Cost [var5]	Schedule [var6]
Q25D	[CostA]	[SchedA]	[CostB]		[CostC]	[SchedC]
A1	[CostHiA]	[SchedHiA]	[CostLoB]		[CostC]	[SchedC]
A2	[CostA]	[SchedHiA]	[CostLoB]		[CostC]	[SchedLoC]
A3	[CostHiA]	[SchedA]	[CostB]		[CostC]	[SchedLoC]
B1	[CostA]	[SchedHiA]	[CostB]		[CostLoC]	[SchedLoC]
B2	[CostHiA]	[SchedA]	[CostLoB]		[CostLoC]	[SchedLoC]
B3	[CostA]	[SchedA]	[CostLoB]		[CostLoC]	[SchedC]
B4	[CostHiA]	[SchedHiA]	[CostB]		[CostLoC]	[SchedC]

	MODEA (not Car)		MODEB (not Car)		MODEC (can be Car)	
	Total Cost [var1]	Schedule [var2]	Total Cost [var3]	Schedule [var4]	Total Cost [var5]	N/A(car) or Schedule [var6]
Q25D	[CostA]	[SchedA]	[CostB]	[SchedB]	[CostC]	[SchedC]
A1	[CostHiA]	[SchedHiA]	[CostLoB]	[SchedB]	[CostC]	[SchedC]
A2	[CostA]	[SchedHiA]	[CostLoB]	[SchedLoB]	[CostC]	[SchedC]
A3	[CostHiA]	[SchedA]	[CostB]	[SchedLoB]	[CostC]	[SchedC]
B1	[CostA]	[SchedHiA]	[CostB]	[SchedLoB]	[CostLoC]	[SchedC]
B2	[CostHiA]	[SchedA]	[CostLoB]	[SchedLoB]	[CostLoC]	[SchedC]
B3	[CostA]	[SchedA]	[CostLoB]	[SchedB]	[CostLoC]	[SchedC]
B4	[CostHiA]	[SchedHiA]	[CostB]	[SchedB]	[CostLoC]	[SchedC]

Demographics

Ask All
The last few questions are for classification purposes only.

D-1. Into which of the following categories does your age fall? (Read List)
1 18-24
2 25-34
3 35-44
4 45-54
5 55-64
6 65 or older
Do Not Read
8 Don't know/Not sure

D-2. Record Gender:

1 Male
2 Female

D-3. How many people, including yourself, live in your household?

__ __ __ __ __ (1-10; 10=="10 or more;" 99=DK)

D-4. How many motor vehicles are owned, leased, or available for regular use by the people who currently live in your household?

__ __ __ __ __ (0-10; 10=="10 or more;" 99=DK)

D-5. What is your 5-digit home zip code? (DK=99999)

__ __ __ __ __

D-6. What is the last grade of school you completed?
1 Grade school or less
2 Some high school
3 High school graduate
4 Technical/training beyond high school
5 Some college
6 College graduate
7 Graduate school
Do Not Read
8 Don't know/Not sure

D-7. What is your current employment status?
1 Employed full-time
2 Employed part-time
3 A student
4 Retired
5 A homemaker, or
6 Not employed
7 Other (Specify)____
Do Not Read
8 Don’t know/Not sure

D-8. What is the total annual income of your household, before taxes?
1 Less than $25,000
2 $25,000 - $49,999
3 $50,000 - $74,999
4 $75,000 - $99,999
5 $100,000 - $149,999
6 $150,000 - $199,999
7 $200,000 - $249,999
8 $250,000 or over
Do Not Read
9 Don’t know/Not sure

D-9. Are you Hispanic or Latino? (Do Not Read List)
1 Yes
2 No
3 Don’t know/Not sure

D-10. What is your race? Please select one or more. Would you say...? **(Note:** Select all that apply**)** (Read List)
1 White
2 Black or African American
3 Asian
4 Native Hawaiian or Other Pacific Islander, or
5 American Indian or Alaska native
Do Not Read
8 Don’t know/Not sure

ASK D11 FOR LANDLINE SAMPLE
D-11. Now thinking about your telephone use, do you have a working cell phone? [INTERVIEWER: THIS INCLUDES SHARED CELL PHONES.] (Do Not Read List)
1 Yes
2 No
3 Don’t know/Not sure

ASK D12 FOR CELL SAMPLE

D-12. Now thinking about your telephone use, in addition to the cell phone, do you also have a regular phone that you use to make and receive calls where you currently live? [IF NEEDED: A regular telephone is sometimes called a landline or phone that is wired to a jack in the wall.] (Do Not Read List)

1 Yes
2 No
3 Don't know/Not sure

END INTERVIEW ROUTINE

Thank you! Let me take down your name and mailing address to make sure we send the ten dollar "thank-you" check to the right address. Again, all information you give are kept strictly private.

May I please have your **(Record):**

Name:
Street Address:
City:
State:
Zip code:

Interviewer Note: Confirm spelling of name and mailing information with respondent.

[Interviewer Note: (If Needed): The U.S. Department of Transportation privacy information can be found at http://www.dot.gov/privacy]

PROGRAMMER: PROVIDE OPTION FOR RESPONDENT TO DECLINE INCENTIVE IF WANTED

Thank you very much for your time!

Appendix B: Report on Survey Non-Response

New York, NY
Silver Spring, MD
Cambridge, MA
Chicago, IL
Durham, NC
Fort Meyers, FL
Hadley, MA
Huntington, WV
Scottsdale, AZ
West Long Branch, NJ

Survey of Northeast Regional and Intercity Household Travel Attitudes and Behavior (NEC FUTURE Study)

Report on Survey Non-Response

November 12, 2014

Prepared for
Federal Railroad Administration

Submitted by
PB-AECOM a Joint Venture

Prepared by
Abt SRBI Inc.

Table of Contents

1. Introduction

Non-response, the failure to obtain survey measures on all sampled individuals, can undermine the rationale for inference in probability-based samples. There are two main potential consequences from non-response: (1) non-response bias and (2) underestimation of the standard errors. While a low response rate doesn't necessarily imply non-response bias, a low response rate becomes an issue when non-respondents differ significantly from respondents demographically or on a characteristic related to the variables the study aims to measure. A non-response bias analysis provides insight into the degree to which non-response introduces bias or affects the estimation of standard errors.

The NEC FUTURE Study is a stated-preference study designed to specifically support the development of a new travel demand forecasting model for the NEC. The target population consisted of residents of the Northeast Corridor who travelled to an area outside of their immediate vicinity. For purposes of making a non-response adjustment during the weighting of the data, non-eligible respondents (i.e., those who did not travel to a qualifying area in the past 12 months) were still asked basic demographic questions. The study was conducted by telephone from April 2014 through July 2014. The sample weights include a non-response adjustment based solely on the comparison to population estimates of the northeast residents. However, the non-response bias analysis for the NEC FUTURE study consisted of three parts:

1. **ACS Comparison.** The demographic composition of the respondents was compared to the general adult population residing in the Northeast Corridor based on 2012 American Community Survey (ACS) 5-year estimate data. The NEC FUTURE respondents used in this comparison (n=24,952) contained all qualifying completes and non-qualifying screen outs who did not qualify but provided their demographic info.
2. **Auxiliary Data Comparison.** Additional sample data associated with each telephone number was purchased from the sampling vendor, SSI. This data is known as auxiliary data and contains information gathered through credit bureau reports associated with specific phone number and the geographic location of the household. For example, the auxiliary data contains information on the percentage of various racial groups in the vicinity of the household, household income, and whether the household is in an urban, suburban or rural area. The qualifying completed cases were compared to non-qualifying screen outs using this data, as well as to non-respondents.
3. **Non-Response Follow-up Study.** A non-response follow-up (NRFU) survey was conducted among 590 households who had a final disposition of soft refusal or non contact when the main field collection ended. The NRFU was conducted approximately 2 months after data collection was completed. NRFU respondents completed a brief (7 minutes) survey that collected screener and demographic data. The NEC FUTURE Survey respondents (including both qualifying and non-qualifying) were compared to the NRFU respondents on key demographic and behavioral variables.

2. Comparison to American Community Survey (ACS) Data

NEC FUTURE respondents were compared on key demographic measures to the general population residing within the Northeast Corridor (based on 2012 ACS 5-year estimate data).

The NEC respondent sample was drawn from all persons aged 18 to 74 residing in English speaking households with a working telephone located within the Northeast Corridor. In order to qualify for the main study, respondents needed to have taken a long distance interstate trip between two qualifying regions within the past 12 months. The interstate trip could have either been for leisure, business or commuting.

The n=24,952 NEC FUTURE respondents which were compared to population demographics from the 2012 ACS (5-year estimate) include both completes who qualified for the study and screen outs who did not qualify but provided their demographic info. Because the demographics of long distance travelers between specific areas within the Northeast Corridor may differ from the general Northeast Corridor population, both qualifying and non-qualifying respondents were included in the NEC respondent base to ensure its comparability to the general population.

The analysis examined age, gender, race/ethnicity, income, education, household size, employment status, and geographic distribution within the Northeast Corridor.

Survey weights were computed to align survey respondents (qualified completes and non-qualifying screen outs) to ACS benchmarks. The alignment process, called “raking,” was applied to a subset of the demographic dimensions collected in the survey: age, gender, education level, race/ethnicity, state of residence and telephone service. Other demographic information was not used in the raking; including more dimensions would likely increase the variance of the weights and reduce precision. See Section 5.0: “Weighting the Data” in the main technical memorandum for detailed description of the weighting procedure.

(Note on reporting: Throughout the report, percentages have been rounded to the nearest whole number. Occasionally this will cause the sum of percentages to equal slightly more or less than 100. Don’t know/Refused answers were not shown in the tables.)

Table 2.1: Demographic Comparison to ACS (Age, Gender)

		ACS Benchmark (n=40,248,754)	Respondents (Qualified and Not Qualified) (n=24,952)	Diff vs. Population
AGE	18-24	13%	6%	-7%
	25-34	17%	9%	-8%
	35-44	18%	13%	-5%
	45-54	20%	20%	0%
	55-64	15%	22%	7%
	65+	17%	30%	13%
GENDER				
	Male	48%	41%	-7%
	Female	52%	59%	7%

The study population was older than the general population by a significant margin. Seniors were almost twice as likely to be found in the study sample compared to their proportion in the population. As result, younger respondents, especially those 18-34, were underrepresented in the sample. Gender was also skewed with females being overrepresented in the sample by 7 points.

Table 2.2: Demographic Comparison to ACS (Race and Ethnicity)

		ACS Benchmark (n=40,248,754)	Respondents (Qualified and Not Qualified) (n=24,952)	Diff vs. Population
RACE/ETHNICITY	White Non-Hispanic	63%	69%	6%
	Black/African American Non-Hispanic	15%	18%	3%
	Hispanic	13%	8%	-5%
	Multi-race/other race Non-Hispanic[1]	9%	5%	-4%

Only half of Hispanics were represented in the sample. There were also smaller differences for other race/ethnicity categories when compared to ACS general population information.

[1] The difference in the other race/multi-race category may be attributed to the fact that the NEC survey did not include an “other race” option, while the ACS does. 8% of respondents did not answer the race questions; some of them could have potentially selected the other race category if it were an option.

Table 2.3: Demographic Comparison to ACS (Income and Household Size)

		ACS Benchmark (n=19,371,076)[2]	Respondents (Qualified and Not Qualified) (n=24,952)	Diff vs. Population
HOUSEHOLD INCOME	<$25k	19%	19%	0%
	$25-49.9k	19%	21%	2%
	$50-74.9k	17%	17%	0%
	$75-99.9k	13%	14%	1%
	$100-149.9k	16%	14%	-2%
	$150-199.9k	8%	7%	-1%
	$200-249.9k	4%	3%	-1%
	$250k or over	5%	5%	0%
HOUSEEHOLD SIZE	1 person	28%	24%	-5%
	2 people	31%	33%	2%
	3 people	16%	16%	0%
	4 people	14%	15%	1%
	5 people	6%	7%	1%
	6+ people	4%	5%	2%

In regards to income, the study sample matched the general population quite well. Likewise, there was very little difference with regards to household size, although single person households were slightly underrepresented.

Table 2.4: Demographic Comparison to ACS (Education, Employment)

		ACS Benchmark (n=40,248,754)	Respondents (Qualified and Not Qualified) (n=24,952)	Diff vs. Population
EDUCATION	Less than High School	13%	6%	-7%
	High School Graduate	27%	25%	-2%
	Some College	26%	20%	-6%
	College Graduate	20%	29%	9%
	Graduate School	14%	21%	7%
EMPLOYMENT STATUS				
	Employed	63%	54%	-9%
	Unemployed	6%	8%	2%
	Not in Labor Force	32%	38%	6%

Those with at least a college degree were much more likely to be in the study when compared to the population (50% vs 34%). In terms of employment status, those who are not in the labor force were overrepresented in the sample as one would typically expect with a telephone survey.

[2] Based on ACS households.

Table 2.5: Geographic Comparison to ACS

		ACS Benchmark (n=40,248,754)	Respondents (Qualified and Not Qualified) (n=24,952)	Diff vs. Population
STATE DISTRIBUTION	Connecticut	7%	7%	0%
	Delaware	1%	1%	0%
	Maryland	10%	10%	0%
	Massachusetts	13%	13%	0%
	New Hampshire	2%	1%	-1%
	New Jersey	17%	16%	-1%
	New York	28%	26%	-1%
	Pennsylvania	13%	14%	1%
	Rhode Island	2%	2%	0%
	Virginia	7%	8%	0%
	Washington DC	1%	2%	1%

The geographic distribution of the study sample within the Northeast Corridor reflected the Northeast Corridor population distribution across the inclusive states.

3. Auxiliary Sample Data Comparison

Auxiliary data refers to additional data which can be appended to sample purchased from Survey Sampling Inc (SSI). Most of this data comes from credit bureaus via various applications the household has completed and is associated with their phone number. While the auxiliary data are only available for some households, a comparison of respondents to non-respondents is still a worthwhile exercise because if strong systematic bias is present in the sample it will likely be obvious when such a comparison is made. The auxiliary data represent the most recent information on demographic characteristics including household income, race of those living in the respondent's neighborhood, and type of area the household is located in. The quality of this information varies since most of this is gathered though credit bureaus and applications for services. The younger and more mobile/itinerant populations are not as likely to be represented in the auxiliary data. Neither are minorities or lower income individuals. This data does, however, give us a more robust analysis of who completed and who did not at the case level, rather than at the aggregate level.

In total, just under twelve thousand (n=11,858) individuals qualified and completed the NEC survey. As shown in Table 3.1, around nine thousand (n=9,216) of these qualifying respondents were derived from the landline sample with the remaining 2,642 completes coming from cell sample. See Section 3.0: "Field Implementation" in the main technical memorandum for a summary of survey results.

Table 3.1: Respondent Status by Sample Type

	Non-Qualifying Respondents (n=13,094)	**Qualifying Respondents (n=11,858)**	**Total (n=24,952)**
Sample Type			
Landline	**10,188**	**9,216**	**19,404**
Cell phone	2,906	2,642	5,548

Non-qualifying respondents included participants deemed ineligible due to reporting of no travel to a qualifying area, no commute/business/leisure trips taken, and other criteria assessed during the screening interview. For the purposes of this analysis, only landline qualifying respondents (n=9,216) and landline non-qualifying respondents (n=10,188) were compared.

In total, 850,000 landline phone numbers were loaded and available as sample for dialing on the NEC survey. The non-respondent landline sample that did not include qualifying and non-qualifying respondents encompassed 209,769 phone numbers. The majority of landline numbers loaded into the Sample Management System was bad numbers (e.g., business phones, disconnected, etc.) and was excluded from the analysis.

Note: The base sizes shown in Tables 3.2 through 3.5 are slightly less than the base sizes shown in Table 3.1 due to exclusion of cases without auxiliary data available.

Respondents to the NEC survey were largely classified as suburban (Table 3.2). Qualifying respondents were slightly more likely to be classified as suburban (73.2%) than non-qualifying respondents (67%) and non-respondents (69%).

Table 3.2: Geographic Classification by Respondent Type

	Qualifying Respondents (n=9,208)	Non-Qualifying Respondents (n=10,178)	Non-Respondents (n=209,769)
Geographic Classification			
Urban	25.3%	31.9%	29.8%
Suburban	73.2%	67.0%	69.0%
Rural	1.5%	1.1%	1.2%
Data are unweighted. Based to landline sample.			

The geographic distribution by state of qualifying respondents was roughly the same as non-respondents. The distributions were also generally similar between qualifying and non-qualifying respondents, with exception of Connecticut and New York: a slightly larger group of non-qualifying respondents to the NEC survey were from New York in comparison to qualifying respondents. In Connecticut, the opposite was true: a greater proportion of qualifying respondents resided in Connecticut in comparison to non-qualifying respondents (Table 3.3).

Table 3.3: Geographic Distribution (State) by Respondent Type

	Qualifying Respondents (n=9,208)	Non-Qualifying Respondents (n=10,178)	Non-Respondents (n=209,769)
Geographic Distribution			
Connecticut	8.9%	5.4%	6.5%
Delaware	1.3%	1.2%	1.0%
Maryland	10.7%	9.1%	9.0%
Massachusetts	12.3%	12.7%	13.0%
New Hampshire	1.4%	1.6%	1.7%
New Jersey	16.8%	16.3%	18.5%
New York	23.3%	29.0%	28.1%
Pennsylvania	13.2%	13.9%	12.2%
Rhode Island	2.7%	2.2%	1.8%
Virginia	7.8%	7.1%	6.9%
Washington DC	1.7%	1.5%	1.2%
Data are unweighted. Based to landline sample.			

Auxiliary income data suggested non-qualifying respondents had a substantially lower average household income in comparison to their qualifying respondent counterparts (Table 3.4). A difference of 33% separated the median incomes of qualifying respondents and non-qualifying respondents ($95,523 vs. $68,000, respectively). Non-respondents had both a mean and median income which was closer to qualifying respondents than non-qualifying respondents.

Table 3.4: Annual Household Income by Respondent Type

	Qualifying Respondents (n=9,208)	Non-Qualifying Respondents (n=10,178)	Non-Respondents (n=209,769)
Household Income			
Mean	$114,613	$80,709	$98,224
Median	$95,523	$68,000	$85,122

Data are unweighted.
Based to land line sample.

According to auxiliary data obtained regarding the overall racial composition of participant neighborhoods, qualifying respondents were more likely to reside in predominately white areas than non-qualifying respondents (Table 3.5). Non-respondents fell between qualifying and non-qualifying respondents in terms of the percentage residing in predominantly white areas.

Table 3.5: Neighborhood Racial Distribution (Average Percent) by Respondent Type

	Qualifying Respondents (n=9,208)		Non-Qualifying Respondents (n=10,178)		Non-Respondents (n=209,769)	
Racial Distribution of Neighborhood						
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
White	77.2%	86.0%	70.5%	81.0%	74.1%	83.0%
Black/African-American	12.8%	4.0%	18.1%	6.0%	14.0%	5.0%
Hispanic	7.7%	4.0%	10.4%	5.0%	9.9%	5.0%
Asian, Native Hawaiian or Other Pacific Islander	5.2%	3.0%	4.8%	3.0%	5.8%	3.0%
American Indian or Alaska Native	0.1%	0.0%	0.2%	0.0%	0.2%	0.0%

Data are unweighted.
Based to records containing race data. Based to landline sample.

4. Non-Response Follow-up Study Results

The purpose of the Non-Response Follow-Up Study (NRFU) is to ascertain travel behavior and demographic characteristics of those who did not respond to the original survey and to contrast the characteristics of this population to those that did participate. For the purposes of this analysis, NRFU respondents were compared to respondents to the main survey (including completes and screen-outs). If main survey respondents and NRFU respondents are substantively different, survey estimates are biased.

The NRFU survey instrument consisted of screening, travel and demographic questions from the main study questionnaire, and used a methodology similar to that employed for the original survey. The NRFU survey was conducted from September 25, 2014 to September 28, 2014, approximately 2 months after the main data collection closed at the end of July, 2014. The NRFU was conducted via telephone with randomly selected respondents that had previously not participated in the main survey. Overall 590 interviews were completed.

Sample for the NRFU was drawn from the remaining sample from the main survey. Records with a final disposition of soft refusal or non-contact were eligible to be included in the NRFU. However, due to the large amount of calling that was done for the main survey, not all cases with these dispositions were included in the NRFU sample.

The NRFU questionnaire contained questions that covered general screening and demographics. Additionally, NRFU respondents were asked if they remembered receiving a call regarding the initial Department of Transportation information request, and, if so, why they had refused to participate. The average interview length for the NRFU was 7 minutes. Respondents who completed the NRFU survey received a $25 check incentive for completing the survey. Respondents were informed of the incentive during the introduction to the survey.

The results of the NRFU and main survey were compared to evaluate the differences between NRFU respondents and main survey respondents (main survey completes and screen-outs). This analysis examined age, gender, race/ethnicity, income, education, employment status, and geographic distribution. Data are unweighted, and 'Don't know/Refused answers are not shown in the table.

Table 4.1: Comparison of NEC FUTURE Study Respondents with Non-Respondents by Age and Gender

	Respondents (NRFU) (n=590)	Respondents (Main Survey) (n=24,592)	Difference NRFU vs. Main Survey (% point)
Age			
18-24	5%	6%	-1%
25-34	6%	9%	-3%
35-44	13%	13%	0%
45-54	22%	20%	2%
55-64	21%	22%	-1%
65+	33%	30%	3%
Gender			
Male	40%	41%	-1%
Female	60%	59%	1%

Table 4.1 compared main survey respondents and NRFU respondents by age and gender. Comparisons between the main survey respondents and NRFU respondents were very similar in terms of age and gender. The NRFU respondents tended to be slightly older than the main survey respondents with 76% of the respondents being 45 or older. This was slightly higher than the 72% of respondents 45 or older in the main survey.

Table 4.2: NRFU Comparison (Race and Ethnicity)

	Respondents (NRFU) (n=590)	Respondents (Main Survey) (n=24,592)	Difference NRFU vs. Main Survey (% point)
Race			
White	72%	75%	-3%
Black/African American	21%	20%	1%
Asian	5%	4%	1%
Native Hawaiian or Other Pacific Islander	<1%	1%	-<1%
American Indian or Alaska Native	2%	1%	1%
Hispanic Ethnicity			
Yes	6%	7%	-1%
No	91%	93%	-2%

The race profile of main survey respondents and NRFU respondents as shown in Table 4.2 was fairly similar in all race categories except for white. The percentage of white respondents in the NRFU sample is 3 percentage points lower than the main survey. Both the main survey and the NRFU reached a similar proportion of Hispanic respondents.

Table 4.3: NRFU Comparison (Household Income and Education)

	Respondents (NRFU) (n=590)	Respondents (Main Survey) (n=24,592)	Difference NRFU vs. Main Survey (% point)
Household Income			
Less than $25,000	19%	19%	0%
$25,000 - $49,999	22%	21%	1%
$50,000 - $74,999	18%	17%	1%
$75,000 - $99,999	13%	14%	-1%
$100,000 - $149,999	15%	14%	1%
$150,000 - $199,999	6%	7%	-1%
$200,000 - $249,999	2%	3%	-1%
$250,000 or over	5%	5%	0%
Education			
Grade school or less	1%	1%	0%
Some high school	6%	4%	2%
High school graduate	25%	25%	0%
Technical/ training beyond high school	2%	3%	-1%
Some college	17%	17%	0%
College graduate	29%	28%	1%
Graduate School	20%	20%	0%

Table 4.3 shows the distributions for income and education in each sample. Income and education were both comparable in the NRFU and main survey.

Table 4.4: NRFU Comparison (Employment Status)

	Respondents (NRFU) (n=590)	Respondents (Main Survey) (n=24,592)	Difference NRFU vs. Main Survey (% point)
Employment Status			
Employed-full time	43%	42%	1%
Employed part time	8%	10%	-2%
Student	2%	3%	-1%
Retired	33%	29%	4%
Homemaker	4%	4%	0%
Not employed	6%	7%	-1%
Other	4%	4%	0%

The employment status of respondents (Table 4.4) who participated in the NRFU was similar to the profile of those who responded to the main survey. A somewhat higher percentage of NRFU respondents reported that they were retired.

Table 4.5: NRFU Comparison Geographic Distribution

	Respondents (NRFU) (n=590)	Respondents (Main Survey) (n=24,592)	Difference NRFU vs. Main Survey (% point)
Geographic Distribution			
Connecticut	6%	7%	-1%
Delaware	2%	1%	1%
Maryland	11%	10%	1%
Massachusetts	14%	13%	1%
New Hampshire	2%	1%	1%
New Jersey	12%	16%	-4%
New York	28%	26%	2%
Pennsylvania	13%	14%	-1%
Rhode Island	2%	2%	0%
Virginia	9%	8%	1%
Washington DC	1%	2%	-1%

The state of residence of main survey respondents and NRFU respondents was fairly similar, with only New Jersey being slightly higher for main survey respondents.

Finally, only 12% of NRFU respondents recalled receiving a call regarding this Department of Transportation information request previously. Among the few (12%) who remembered the survey request, the vast majority (63%) cited being too busy as the reason for non-response. No other reason given totaled more than 6% of those who recalled the initial survey request.

5. Conclusion

Overall, the results of the non-response bias analysis were encouraging. Both the auxiliary data and the NRFU results showed very little differences between respondents (total qualifying and non-qualifying) and non-respondents. However, both auxiliary data comparisons and NRFU studies are limited in what they can tell us about the representativeness of the sample. The auxiliary data, while an excellent source of additional data on a case by case basis, has large holes in the dataset which cannot be assumed to be random. That is, a certain segment of the population is more likely to have information about their income, racial composition and age of household members due to credit applications they have completed or subscriptions they have purchased. The bias contained in the auxiliary data cannot be measured on a case by case basis with much certainty so we are forced to view the results with this caveat in mind.

The NRFU study presents another issue, in that we are completing an abbreviated survey with folks who did not originally respond (although most NRFU respondents do not recall the original request for an interview). However, these NRFU respondents are not necessarily a good representation of all non-respondents from the main survey. Most likely the NRFU respondents represent those who are more likely to respond to surveys but did not have a chance or the time to do so during the main study. As a result, most of the comparisons between respondents (total qualifying and non-qualifying) and NRFU respondents do not show much of a difference. Both the auxiliary data and the NRFU study should be viewed as high level tests of non-response bias. If either one of these showed significant differences, then this would be a red flag and would likely indicate that non-ignorable non-response bias is present in the study. However, if the comparisons do not show much of a difference it is important that one does not draw the conclusion that there is no non-response bias associated with the study.

The demographic comparison to ACS data, the final component of the non-response bias analysis, is the gold standard in terms of identifying issues with non-response. Although the analysis is conducted at the aggregate level, the ACS represents the best estimate of who lives in the Northeast Corridor. When conducting the comparison, we found a few variables which were biased enough to be of concern, namely, age, gender, Hispanic ethnicity, and education. These four variables were different enough from the population characteristics and the non-response adjustment which was made during the weighting process took this into account. So, although we found non-ignorable non-response when comparing demographic characteristics from the study respondents to the general population, we were able to mitigate the bias through a weighting process that adjusted the demographics from the study sample to match the population.

Appendix B – Moody's Demographic Forecasts of Population and Employment

	Base Population			Base Employment		
	2012	2040	% Growth	2012	2040	% Growth
NEW HAMPSHIRE						
Hillsborough County	403,240	424,710	5%	199,390	223,140	12%
Rockingham County	298,530	342,300	15%	144,330	181,090	25%
Strafford County	124,440	148,990	20%	47,720	62,480	31%
Subtotal	**826,210**	**916,000**	**11%**	**391,440**	**466,710**	**19%**
MASSACHUSETTS						
Barnstable County	215,760	239,870	11%	93,600	105,270	12%
Berkshire County	130,080	128,630	-1%	63,180	65,950	4%
Bristol County	552,010	636,570	15%	217,120	266,060	23%
Dukes County	17,120	22,190	30%	11,030	18,520	68%
Essex County	757,220	795,390	5%	312,620	360,140	15%
Franklin County	71,510	71,740	0%	26,740	27,980	5%
Hampden County	466,200	492,780	6%	202,960	223,770	10%
Hampshire County	160,000	177,190	11%	61,980	71,600	16%
Middlesex County	1,541,010	1,621,720	5%	849,730	984,460	16%
Nantucket County	10,360	12,790	23%	8,120	13,000	60%
Norfolk County	683,230	699,870	2%	329,920	360,280	9%
Plymouth County	500,230	480,360	-4%	177,800	181,990	2%
Suffolk County	747,330	868,480	16%	615,460	762,510	24%
Worcester County	807,500	864,160	7%	325,930	349,880	7%
Subtotal	**6,659,560**	**7,111,740**	**7%**	**3,296,190**	**3,791,410**	**15%**
RHODE ISLAND						
Bristol County	49,110	51,470	5%	14,260	15,660	10%
Kent County	164,730	171,130	4%	76,080	82,790	9%
Newport County	82,070	85,080	4%	40,380	43,860	9%
Providence County	628,750	681,830	8%	282,560	320,930	14%
Washington County	125,950	131,890	5%	51,180	56,120	10%
Subtotal	**1,050,610**	**1,121,400**	**7%**	**464,460**	**519,360**	**12%**
NEW YORK						
Bronx County	1,412,300	1,546,200	9%	249,740	313,910	26%
Dutchess County	297,310	314,260	6%	115,250	124,610	8%
Kings County	2,572,620	2,929,300	14%	540,030	705,960	31%
Nassau County	1,349,900	1,441,720	7%	623,410	734,360	18%
New York County	1,622,080	1,693,690	4%	2,472,840	2,964,140	20%
Orange County	374,910	418,510	12%	136,510	155,920	14%
Putnam County	99,550	91,030	-9%	25,990	27,260	5%
Queens County	2,277,530	2,508,940	10%	533,260	674,370	26%
Richmond County	471,130	476,810	1%	96,360	111,860	16%
Rockland County	318,650	366,450	15%	122,210	161,310	32%
Suffolk County	1,499,210	1,573,540	5%	645,430	747,040	16%
Westchester County	963,150	1,011,060	5%	431,840	520,330	20%
Subtotal	**13,258,340**	**14,371,510**	**8%**	**5,992,870**	**7,241,070**	**21%**

Source: NEC FUTURE team, 2015

	Base Population			Base Employment		
	2012	2040	% Growth	2012	2040	% Growth
CONNECTICUT						
Fairfield County	935,040	1,003,210	7%	421,190	478,010	13%
Hartford County	897,290	960,590	7%	512,840	572,760	12%
Litchfield County	187,460	192,660	3%	62,110	51,610	-17%
Middlesex County	165,400	172,050	4%	67,430	73,140	8%
New Haven County	863,230	916,260	6%	365,880	398,240	9%
New London County	274,320	290,400	6%	131,630	150,050	14%
Tolland County	151,410	156,800	4%	41,990	45,350	8%
Windham County	117,680	132,860	13%	39,440	36,010	-9%
Subtotal	**3,591,830**	**3,824,830**	**6%**	**1,642,510**	**1,805,170**	**10%**
NEW JERSEY						
Atlantic County	275,730	305,480	11%	135,300	156,660	16%
Bergen County	920,650	972,940	6%	456,200	500,900	10%
Burlington County	451,730	513,150	14%	202,180	241,480	19%
Camden County	513,840	558,480	9%	203,400	232,450	14%
Cape May County	96,340	102,100	6%	40,540	45,440	12%
Cumberland County	158,110	185,180	17%	56,850	65,010	14%
Essex County	788,000	836,320	6%	358,370	408,960	14%
Gloucester County	290,260	355,200	22%	102,090	131,330	29%
Hudson County	654,440	775,470	18%	248,810	306,260	23%
Hunterdon County	126,960	121,750	-4%	49,280	50,810	3%
Mercer County	368,870	420,200	14%	245,110	289,000	18%
Middlesex County	825,670	1,062,850	29%	409,390	525,910	28%
Monmouth County	629,800	685,840	9%	259,800	282,290	9%
Morris County	498,780	562,140	13%	287,700	348,620	21%
Ocean County	581,970	714,570	23%	158,580	194,290	23%
Passaic County	503,260	499,500	-1%	181,350	187,000	3%
Salem County	65,710	68,590	4%	22,930	24,840	8%
Somerset County	328,670	416,900	27%	182,790	231,440	27%
Sussex County	147,240	137,060	-7%	38,360	38,380	0%
Union County	545,320	647,930	19%	234,480	299,590	28%
Warren County	107,470	103,630	-4%	37,300	40,050	7%
Subtotal	**878,820**	**10,045,280**	**13%**	**3,910,810**	**4,600,710**	**18%**
DELAWARE						
New Castle County	547,200	670,490	23%	282,520	369,050	31%
Subtotal	**547,200**	**670,490**	**23%**	**282,520**	**369,050**	**31%**
WEST VIRGINIA						
Jefferson County	54,700	66,880	22%	16,270	19,630	21%
Subtotal	**54,700**	**66,880**	**22%**	**16,270**	**19,630**	**21%**
WASHINGTON, DC						
District of Columbia (DC)	636,710	806,400	27%	732,990	851,370	16%
Subtotal	**636,710**	**806,400**	**27%**	**732,990**	**851,370**	**16%**

Source: NEC FUTURE team, 2015

	Base Population			Base Employment		
	2012	2040	% Growth	2012	2040	% Growth
PENNSYLVANIA						
Bucks County	627,100	597,200	-5%	262,800	287,700	9%
Carbon County	65,020	71,590	10%	17,790	22,680	27%
Chester County	507,940	568,710	12%	251,880	324,200	29%
Delaware County	561,430	538,690	-4%	218,870	241,530	10%
Lehigh County	355,930	448,370	26%	186,080	271,520	46%
Montgomery County	809,500	843,890	4%	489,510	586,730	20%
Northampton County	299,640	346,190	16%	106,070	142,000	34%
Philadelphia County	1,549,930	1,655,370	7%	670,410	823,260	23%
Pike County	56,880	60,090	6%	10,670	12,590	18%
Subtotal	**4,833,370**	**5,130,100**	**6%**	**2,214,080**	**2,712,210**	**22%**
MARYLAND						
Anne Arundel County	552,420	689,580	25%	251,670	348,270	38%
Baltimore City	621,580	608,340	-2%	355,860	386,160	9%
Baltimore County	819,030	916,360	12%	391,080	484,870	24%
Calvert County	89,780	93,130	4%	23,290	24,540	5%
Carroll County	167,270	164,340	-2%	59,130	64,410	9%
Cecil County	101,840	121,020	19%	29,940	39,390	32%
Charles County	151,130	180,360	19%	44,720	54,200	21%
Frederick County	240,390	282,210	17%	95,960	116,170	21%
Harford County	249,280	281,750	13%	90,880	113,920	25%
Howard County	301,240	424,970	41%	167,140	261,460	56%
Kent County	20,190	22,330	11%	6,950	10,470	51%
Montgomery County	1,008,740	1,255,200	24%	476,490	611,750	28%
Prince George's County	882,760	954,360	8%	329,340	361,680	10%
Queen Anne's County	48,730	59,380	22%	14,460	19,520	35%
Subtotal	**5,254,380**	**6,053,330**	**15%**	**2,336,910**	**2,896,810**	**24%**
VIRGINIA						
Alexandria City	147,090	210,480	43%	104,660	140,520	34%
Arlington County	222,670	345,140	55%	187,870	273,450	46%
Clarke County	14,350	15,120	5%	4,140	4,100	-1%
Fairfax County	1,160,410	1,499,760	29%	620,310	757,130	22%
Fauquier County	66,710	73,820	11%	22,710	23,610	4%
King George County	24,650	41,370	68%	11,590	28,280	144%
LoudounCounty	341,070	601,550	76%	155,690	257,930	66%
Prince Wiliam County	491,150	801,620	63%	125,430	192,310	53%
Spotsylvania	153,870	200,040	30%	61,190	74,680	22%
Stafford County	135,190	184,800	37%	41,250	52,990	28%
Warren County	38,210	42,380	11%	12,700	13,230	4%
Subtotal	**2,795,370**	**4,016,080**	**44%**	**1,347,540**	**1,818,230**	**35%**
TOTAL	**48,387,100**	**54,134,040**	**12%**	**22,628,590**	**27,091,730**	**20%**

Source: NEC FUTURE team, 2015

Appendix C – Detailed Validation for Washington, D.C. Regional Rail Services

Table C-1: Year 2012 Average Weekday MARC Passenger Boardings by Station (Counts vs. Modeled)

		Year 2012 Counts			Year 2012 Model		
Line	**Station**	**Peak**	**Off-Peak**	**Total**	**Peak**	**Off-Peak**	**Total**
Camden MARC	Dorsey	568	47	615	885	-	885
	Jessup	-	-	-	-	-	-
	Savage	413	35	448	515	-	515
	Laurel Park	7	-	7	-	-	-
	Laurel	551	43	594	468	19	486
	Muirkirk	312	23	335	214	7	221
	Greenbelt	64	3	67	77	14	91
	College Park	126	26	152	26	6	32
	Riverdale	29	3	32	62	18	80
	Subtotal	**2,070**	**180**	**2,250**	**2,244**	**64**	**2,308**
Penn MARC	New Carrollton	258	182	440	347	167	514
	Seabrook	257	21	278	124	144	268
	Bowie	452	99	551	470	253	723
	Odenton	1,771	236	2,007	1,625	231	1,856
	BWI	1,439	321	1,760	1,151	244	1,395
	Subtotal	**4,177**	**859**	**5,036**	**3,716**	**1,039**	**4,755**
Brunswick MARC	Brunswick	656	44	700	344	11	355
	Point of Rocks	465	40	505	335	5	339
	Dickerson	14	5	19	11	1	11
	Barnesville	69	5	74	3	1	4
	Boyds	14	2	16	2	-	2
	Germantown	728	39	767	631	-	631
	Metropolitan Grove	219	27	246	354	2	356
	Gaithersburg	438	35	473	255	5	260
	Washington Grove	27	8	35	63	3	66
	Shady Grove	-	-	-	-	-	-
	Rockville	538	39	577	492	3	495
	Garrett Park	25	7	32	23	4	27
	Kensington	225	14	239	520	3	523
	Silver Spring	723	21	744	627	11	637
	Duffields	164	6	170	42	-	42
	Harpers Ferry	74	3	77	302	-	302
	Frederick	142	-	142	-	-	-
	Monocacy/I-270	262	-	262	46	-	46
	Subtotal	**4,783**	**295**	**5,078**	**4,048**	**45**	**4,093**
MARC	Union Station	7,430	1,024	8,454	7,857	1,086	8,942
	Total MARC	**18,460**	**2,358**	**20,818**	**17,864**	**2,233**	**20,097**

Source: NEC FUTURE team, 2015

Table C-2: Year 2012 Average Weekday VRE Passenger Boardings by Station (Counts vs. Modeled)

Line	Station	Year 2012 Counts			Year 2012 Model		
		Peak	Off-Peak	Total	Peak	Off-Peak	Total
VRE	Union Station	1,941	-	1,941	2,712	27	2,738
	L'Enf ant	3,870	-	3,870	3,739	-	3,739
	Crystal City	2,052	-	2,052	2,068	2	2,070
	Alexandria	957	-	957	1,077	19	1,095
	Backlick Road	260	-	260	175	2	177
	Rolling Road	503	-	503	355	6	361
	Burke Centre	1,047	-	1,047	1,233	34	1,267
	Manassas Park	828	-	828	618	9	627
	Manassas	944	-	944	1,147	22	1,168
	Broad Run/Airport	1,141	-	1,141	1,400	20	1,419
	Franconia/Springfield	259	-	259	214	3	217
	Lorton	618	-	618	547	5	552
	Woodbridge	664	-	664	841	8	849
	Rippon	614	-	614	1,253	10	1,263
	Potomac Shores	-	-	-	-	-	-
	Quantico	518	-	518	43	2	45
	Brooke	552	-	552	441	-	441
	Leeland Road	884	-	884	222	1	223
	Fredericksburg	1,432	-	1,432	1,337	7	1,344
	Spotsylvania	-	-	-	-	-	-
	Sudley Manor	-	-	-	-	-	-
	Gainesville	-	-	-	-	-	-
	Haymarket	-	-	-	-	-	-
	Total VRE	**19,084**	**-**	**19,084**	**19,419**	**173**	**19,591**

Source: NEC FUTURE team, 2015

Appendix D – Detailed Validation for Baltimore Regional Rail Services

Table D-1: Year 2013 Average Weekday Baltimore Regional MARC Passenger Boardings by Station (Counts vs. Modeled)

Station Name	2013 Counts	2013 Model
Perryville	-	58
Aberdeen	61	82
Edgewood	57	58
Martin State Airport	38	52
Penn Station	256	252
West Baltimore	182	130
Halethorpe	130	93
Camden Yards	-	-
St. Denis	-	-
Total	**724**	**724**

Source: NEC FUTURE team, 2015

Appendix E – Detailed Validation for Philadelphia Regional Rail Services

Table E-1: Year 2010 Average Weekday SEPTA Regional Rail Passenger Boardings by Station (Counts vs. Modeled)

Line	DAILY COUNT	VISUM	Diff	%Diff
Trunk Lines	59,596	52,454	(7,142)	-12%
R1 - Airport	2,445	2,203	(242)	-10%
R2 - Wilmington	4,429	4,895	466	11%
R2 - Warminster	2,437	2,699	262	11%
R3 - Elwyn	4,997	5,779	782	16%
R3 - West Trenton	5,453	5,796	343	6%
R5 - Thorndale	12,209	14,125	1,916	16%
R5 - Doylestown	6,266	6,545	279	4%
R6 - Norristown	5,339	5,875	536	10%
R6 - Cynwyd	296	302	6	2%
R7 - Trenton	5,837	5,795	(42)	-1%
R7 - Chestnut Hill East	2,637	2,408	(229)	-9%
R8 - Fox Chase	2,269	2,183	(86)	-4%
R8 - Chestnut Hill West	2,767	2,306	(461)	-17%
TOTAL	**116,977**	**113,366**	**(3,611)**	**-3%**

Source: NEC FUTURE team, 2015

Table E-2: Year 2010 Average Weekday SEPTA Regional Rail Passenger Boardings by Station (Counts vs. Modeled)

Station	Counts					Model				
	AM	MD	PM	NT	Daily	AM	MD	PM	NT	Daily
Trunk Lines										
Glenside	686	115	96	177	1,074	1,065	243	277	103	1,688
Jenkintown	1,085	258	229	204	1,776	1,096	272	378	114	1,861
Elkins Park	427	61	33	44	565	645	122	69	28	862
Melrose Park	325	48	18	52	443	227	42	88	29	384
Fern Rock	290	102	167	199	758	332	182	391	105	1,010
Wayne Junction	271	121	85	151	628	376	164	284	108	932
North Philadelphia R8	2	1	6	2	11	44	51	98	12	205
North Philadelphia R7	48	22	40	28	138	96	73	166	29	364
North Broad	85	37	16	38	176	181	90	66	25	363
Temple	177	882	1,428	635	3,122	735	613	1,115	295	2,758
Market East	1,512	2,073	8,849	1,380	13,814	760	1,502	9,487	1,375	13,124
Suburban	1,351	2,384	17,856	2,938	24,529	833	1,721	16,066	2,120	20,741
30th Street	1,691	1,780	5,454	1,356	10,281	1,349	1,216	3,898	599	7,063
University City	60	329	1,689	203	2,281	162	134	628	176	1,099
Subtotal	**8,010**	**8,213**	**35,966**	**7,407**	**59,596**	**7,901**	**6,426**	**33,011**	**5,116**	**52,454**
R1 - Airport										
Easmrick	145	45	82	50	322	77	79	128	63	347
Terminal A	49	140	154	192	535	280	520	480	431	1,691
Terminal B	87	92	113	132	424	7	5	11	1	24
Terminal C & D	100	253	170	240	763	-	-	-	-	-
Terminal E & F	55	95	111	140	401	11	28	84	18	140
Subtotal	**436**	**625**	**630**	**754**	**2,445**	**376**	**631**	**683**	**513**	**2,203**
R2 - Wilmington										
Darby	63	12	13	5	93	105	18	29	17	169
Curtis Park	60	11	27	2	100	110	18	48	20	196
Sharon Hill	98	10	7	4	119	118	26	11	9	163
Folcroft	117	20	26	11	174	121	20	40	20	202
Glenolden	191	25	20	12	248	191	28	31	15	266
Norwood	149	29	12	5	195	142	19	12	8	181
Prospect Park	173	25	16	7	221	182	31	45	22	280
Ridley Park	192	34	19	3	248	151	28	56	22	256
Crum Lynne	70	6	11	5	92	47	12	22	8	89
Eddystone	35	3	13	7	58	50	17	58	8	132
Chester	128	53	92	29	302	127	40	195	44	407
Highland Avenue	50	9	14	10	83	51	15	51	13	131
Marcus Hook	383	32	40	11	466	284	64	89	21	458
Claymont	508	20	20	7	555	380	24	40	7	451
Wilmington	368	69	342	69	848	383	44	334	23	784
Churchmans Crossing	279	-	16	-	295	236	-	74	-	309
Newark. DE	308	-	21	3	332	205	-	218	-	423
Subtotal	**3,172**	**358**	**709**	**190**	**4,429**	**2,882**	**404**	**1,353**	**256**	**4,895**
R2 - Warminster										
Warminster	734	119	78	100	1,031	794	118	45	13	970
Hatboro	346	29	53	45	473	263	59	44	22	387
Willow Grove	340	43	54	54	491	477	73	126	38	713
Crestmcnt	47	5	6	12	70	60	15	23	12	110
Roslyn	178	15	19	25	237	99	20	35	13	166
Ardsley	106	14	5	10	135	269	35	27	20	351
Subtotal	**1,751**	**225**	**215**	**246**	**2,437**	**1,961**	**319**	**300**	**119**	**2,699**

Source: NEC FUTURE team, 2015

Station	Counts					Model				
	AM	MD	PM	NT	Daily	AM	MD	PM	NT	Daily
R3 - Elwyn										
Elwyn	406	30	48	20	504	457	95	2	1	554
Media	373	57	58	41	529	292	58	159	45	554
Moylan-Rose Valley	201	17	19	11	248	76	13	10	4	104
Wallingford	241	30	10	17	298	204	37	36	14	292
Swathmore	598	92	72	24	786	247	96	157	49	549
Morton-Rutledge	459	45	19	46	569	848	-	80	26	954
Secane	440	45	15	22	522	259	8	31	16	314
Primos	273	39	17	35	364	272	16	93	41	422
Clifton-Aldan	290	16	10	23	339	139	24	67	35	265
Gladstone	188	15	11	7	221	247	30	31	20	330
Landsdowne	323	50	16	22	411	414	71	86	32	603
Femwood-Yeadon	76	21	12	10	119	105	40	96	27	268
Angora	12	11	4	2	29	73	23	51	21	168
49th Street	30	9	8	11	58	100	42	208	53	403
Subtotal	**3,910**	**477**	**319**	**291**	**4,997**	**3,733**	**554**	**1,106**	**386**	**5,779**
R3 - West Trenton										
West Trenton. NJ	177	18	51	18	264	83	12	35	2	131
Yardley	288	41	33	43	405	402	30	22	8	462
Woodboume	388	38	42	46	514	548	43	59	13	663
Langhorne	485	65	44	82	676	825	111	65	18	1,019
Neshaminy Falls	208	32	7	27	274	39	7	19	6	71
Trevose	185	16	38	36	275	333	42	96	24	494
Somerton	678	32	35	122	867	628	78	145	31	882
Forest Hills	335	22	18	45	420	80	15	69	9	173
Philmont	518	56	28	51	653	549	93	51	11	704
Bethayres	528	32	24	52	636	283	45	72	12	413
Meadowbrook	86	17	7	20	130	275	35	19	8	337
Rydal	57	18	22	10	107	67	29	61	18	176
Nobel	145	24	41	22	232	143	31	76	20	270
Subtotal	**4,078**	**411**	**390**	**574**	**5,453**	**4,255**	**571**	**790**	**180**	**5,796**
R5 - Thorndale										
Overbrook	501	115	91	65	772	404	150	150	75	779
Merlon	197	30	14	12	253	98	25	30	12	185
Narberth	624	99	95	48	866	605	138	90	30	863
Wynnewood	488	62	65	62	677	136	26	26	12	200
Ardmore	517	126	106	92	841	702	165	179	53	1,099
Haverford	236	56	63	20	375	371	140	203	70	784
Bryn Mawr	416	128	218	69	831	248	155	273	69	745
Rosemont	241	41	59	19	360	232	69	71	23	394
Villanova	209	80	188	94	571	241	54	27	4	325
Radnor	246	44	173	24	487	96	34	21	1	152
St. Davids	175	33	39	11	258	154	96	167	34	451
Wayne	383	92	119	71	665	189	86	128	30	433
Strafford	542	71	109	41	763	669	167	121	39	996
Devon	399	32	55	20	506	288	57	39	9	394
Berwyn	170	27	50	14	261	400	112	145	38	695
Daylesford	149	20	21	16	206	225	51	61	20	357
Paoli	549	111	482	98	1,240	732	185	402	57	1,375
Malvern	406	41	56	34	537	313	197	254	69	833
Exton	516	21	36	13	586	1,118	217	41	5	1,382
Whitford	292	19	9	3	323	367	79	20	9	475
Downingtown	304	28	16	10	358	389	57	72	28	547
Thomdale	382	44	28	19	473	613	56	7	6	682
Subtotal	**7,942**	**1,320**	**2,092**	**855**	**12,209**	**8,590**	**2,317**	**2,524**	**694**	**14,125**

Source: NEC FUTURE team, 2015

Station	Counts AM	Counts MD	Counts PM	Counts NT	Counts Daily	Model AM	Model MD	Model PM	Model NT	Model Daily
R5 - Doylestown										
Doylestown	186	54	31	25	298	163	54	77	23	317
Del Val College	22	16	17	7	62	58	40	33	14	144
New Britain	25	14	5	10	54	19	8	10	7	44
Chalfont	67	7	14	17	105	111	23	8	6	148
Link Bek	15	2	24	6	47	31	14	20	6	70
Colmar	216	22	12	27	277	227	47	8	4	287
Fortuna	41	8	17	9	75	37	15	24	13	89
Lansdale	862	248	151	130	1,391	838	154	142	45	1,177
Pennbrook	244	69	78	23	414	148	51	57	13	267
Noah Wales	548	82	107	96	833	475	111	132	30	748
Gwynedd Valley	167	16	41	27	251	222	70	42	12	347
Penllyn	93	23	15	20	151	83	27	40	13	163
Ambler	633	120	102	90	945	562	135	147	37	881
Fort Washington	565	78	185	69	897	490	120	68	13	691
Oreland	168	25	40	24	257	334	71	53	19	477
North Hills	147	27	18	19	211	370	161	110	56	697
Subtotal	**3,999**	**811**	**857**	**599**	**6,266**	**4,164**	**1,100**	**969**	**312**	**6,545**
R6 - Norristown										
Elm Street	282	27	56	42	407	643	111	44	23	821
Main Street	126	33	21	47	227	126	21	29	17	192
Norristown T.C.	559	90	145	69	863	288	115	181	43	627
Conshohocken	382	29	183	65	659	339	98	301	75	813
Spring Mill	173	24	135	31	363	210	58	125	29	422
Miquon	251	12	123	45	431	539	104	25	4	671
Ivy Ridge	510	31	18	27	584	293	53	56	34	435
Manayunk	362	62	52	50	526	104	34	63	23	223
Wissahickon	417	44	28	25	514	127	70	354	97	649
East Falls	481	120	53	33	687	402	108	146	69	726
Allegheny	33	19	13	13	78	89	82	97	26	295
Subtotal	**3,576**	**491**	**825**	**447**	**5,339**	**3,159**	**856**	**1,421**	**438**	**5,875**
R6 - Cynwyd										
Wynnefield Avenue	87	1	2	-	90	83	3	9	-	75
Bala	66	3	9	-	78	19	3	47	-	69
Cynwyd	118	4	5	1	128	111	10	38	-	158
Subtotal	**271**	**8**	**16**	**1**	**296**	**193**	**16**	**92**	**-**	**302**
R7 - Trenton										
Bridesburg	51	33	34	36	154	76	59	106	19	260
Tacony	116	36	17	25	194	61	13	22	12	108
Holmesburg Jct.	417	83	39	74	613	115	28	78	35	255
Torresdale	776	72	41	107	996	692	100	147	52	991
Comwells Heights	1,125	88	46	67	1,326	1,086	164	27	8	1,285
Eddington	6	6	14	3	29	30	14	38	9	91
Croydon	204	33	36	38	311	343	42	34	21	440
Bristol	157	62	63	40	322	429	54	95	41	618
Levittown	374	49	43	60	526	589	65	62	12	728
Trenton	286	290	521	269	1,366	353	127	486	52	1,018
Subtotal	**3,512**	**752**	**854**	**719**	**5,837**	**3,774**	**666**	**1,095**	**260**	**5,795**

Source: NEC FUTURE team, 2015

Station	Counts					Model				
	AM	MD	PM	NT	Daily	AM	MD	PM	NT	Daily
R3 - Elwyn										
Chestnut Hill East	180	28	58	30	296	75	19	50	16	160
Gravers	121	11	11	4	147	77	26	32	18	153
Wyndmoor	575	67	40	44	728	365	81	98	56	600
Mount Airy	244	32	16	14	306	152	38	76	33	299
Sedgwick	220	31	12	15	278	136	21	33	23	213
Stenton	366	59	23	36	484	190	31	47	26	293
Washington Lane	143	29	18	16	204	109	11	31	20	170
Germantown	67	28	22	14	131	100	17	72	19	208
Wister	44	11	7	3	65	178	34	65	36	312
Subtotal	**1,960**	**296**	**205**	**176**	**2,637**	**1,381**	**277**	**503**	**247**	**2,408**
Fox Chase	1,036	98	65	61	1,260	572	104	34	14	724
Ryers	273	32	24	18	347	274	52	38	24	387
Cheltenham	232	29	4	19	284	235	41	46	30	352
Lawndale	166	34	15	15	230	222	34	41	25	322
Olney	112	14	10	12	148	255	52	59	32	398
Subtotal	**1,819**	**207**	**118**	**125**	**2,269**	**1,559**	**283**	**217**	**124**	**2,183**
R3 - Elwyn										
Queen Lane	318	54	97	13	482	296	72	77	46	492
Chelten Avenue	271	54	48	9	380	161	39	81	28	310
Tulpehocken	105	32	18	5	158	115	28	34	19	196
Upsal	283	56	33	16	388	95	20	27	20	162
Carpenter	272	44	31	8	355	266	66	52	31	415
Allen Lane	201	46	27	5	279	99	23	37	23	182
St. Martins	162	30	30	1	223	62	24	29	14	128
Highland	53	3	4	-	60	4	2	8	1	16
Chestnut Hill West	220	73	107	42	442	205	60	102	38	405
Subtotal	**1,885**	**392**	**391**	**99**	**2,767**	**1,304**	**334**	**448**	**220**	**2,306**
Total	**46,321**	**14,586**	**43,587**	**12,483**	**116,977**	**45,233**	**14,756**	**44,512**	**8,865**	**113,366**

Source: NEC FUTURE team, 2015

Appendix F – Detailed Validation for New Jersey Regional Rail Services

Table F-1: Year 2010 Average Weekday NJ TRANSIT Passenger Trips by Station (Counts vs. Modeled), Main, Bergen, Port Jervis Lines

MAIN/BERGEN/PORT JERVIS	2010 Counts Total Daily	2010 Model Productions	2010 Model Attactions	2010 Model Total
Portiere's	338	306	-	306
Otisville	123	48	-	48
Middletown	951	849	1	850
Campbell Hall	327	522	-	522
Salisbury Mills	997	620	-	620
Harriman	1,505	1,894	-	1,894
Tuxedo	339	353	-	353
Sloatsburg	143	1	-	1
Subtotal	**4,724**	**4,593**	**1**	**4,594**
Suffern	1,860	2,087	-	2,087
Mahwah	484	36	-	36
Route 17	1,510	1,715	13	1,728
Ramsey	1,404	818	117	935
Allendale	832	859	49	908
Waldwick	970	578	27	605
Ho-Ho- Kus	882	965	33	998
Ridgewood	2,800	2,242	197	2,439
Glen Rock (Main)	540	562	28	590
Glen Rock (Bergen)	1,374	1,030	17	1,047
Subtotal	**12,656**	**10,892**	**481**	**11,373**
Hawthorne	930	963	197	1,160
Paterson	1,282	1,027	286	1,313
Clifton	1,514	1,151	122	1,273
Passaic	1,130	881	94	975
Delawanna	1,146	909	164	1,073
Lyndhurst	1,494	1,157	60	1,217
Kingsland	834	985	89	1,074
Subtotal	**8,330**	**7,073**	**1,012**	**8,085**
Radbum	2,810	1,931	64	1,995
Broadway	542	843	118	961
Plauderville	726	382	69	451
Garfield	466	451	42	493
Wesmont	-	-	-	-
Rutherford	2,012	1,341	117	1,458
Subtotal	**6,556**	**4,948**	**410**	**5,358**
TOTAL	**32,266**	**27,506**	**1,904**	**29,410**

Source: NEC FUTURE team, 2015

Table F-2: Year 2010 Average Weekday NJ TRANSIT Passenger Trips by Station (Counts vs. Modeled), Pascack Valley Line

PASCACK VALLEY LINE	2010 Counts Total Daily	2010 Model Productions	2010 Model Attractions	2010 Model Total
Spring Valley	308	364	3	367
Nanuet	958	1,511	1	1,512
Pearl River	702	630	23	653
Montvale	348	578	4	582
Park Ridge	352	422	9	431
Woodcliff Lake	214	402	5	407
Hillsdale	704	500	8	508
Westwood	740	711	21	732
Emerson	424	473	6	479
Oradell	624	552	17	569
River Edge	968	666	41	707
Subtotal	**6,342**	**6,809**	**138**	**6,947**
N. Hackensack	882	534	23	557
Hackensack-Anderson St	628	386	97	483
Hackensack-Essex	578	646	165	811
Teterboro/VVilliams Ave	184	272	44	316
Wood-ridge	568	448	35	483
Subtotal	**2,840**	**2,286**	**364**	**2,650**
Sports Complex	-	-	-	-
TOTAL	**9,182**	**9,095**	**5,021**	**9,597**

Source: NEC FUTURE team, 2015

Table F-3: Year 2010 Average Weekday NJ TRANSIT Passenger Trips by Station (Counts vs. Modeled), Boonton Line

	2010 Counts	2010 Model		
BOONTON LINE	**Total Daily**	**Productions**	**Attractions**	**Total**
Hackettstown	308	341	16	357
Mount Olive	74	-	-	-
Netcong (Both Lines)	410	309	2	311
Lake Hopatcong (Both Lines)	238	267	-	267
Mount Arlington	248	8	13	21
Dover	2,872	2,638	74	2,712
Denville (Both Lines)	1,126	1,405	104	1,509
Subtotal	**5,276**	**4,968**	**209**	**5,177**
Mountain Lakes	78	122	47	169
Boonton	170	143	20	163
Towa co	238	134	-	134
Lincoln Park	280	231	17	248
Mountain View	412	257	83	340
Wayne Rt 23 Transit Ctr	180	87	4	91
Subtotal	**1,358**	**974**	**171**	**1,145**
Little Falls	382	454	66	520
Great Notch	48	-	-	-
Montclair St. University	1,066	441	17	458
Montclair Heights	650	741	7	748
Mountain Ave	242	594	19	613
Upper Monclair	1,018	398	-	398
Watchung Ave	1,418	1,263	18	1,281
Walnut St	1,852	1,464	9	1,473
Subtotal	**6,676**	**5,355**	**136**	**5,491**
Montclair-Bay St	1,964	1,517	56	1,573
Glen Ridge	2,008	1,859	3	1,862
Bloomfield	1,900	1,643	27	1,670
Watsessing Ave	384	767	8	775
Subtotal	**6,256**	**5,786**	**94**	**5,880**
TOTAL	**19,566**	**17,083**	**610**	**17,693**

Source: NEC FUTURE team, 2015

Table F-4: Year 2010 Average Weekday NJ TRANSIT Passenger Trips by Station (Counts vs. Modeled), Morris and Essex Lines

	2010 Counts	2010 Model		
MORRIS/ESSEX LINES	**Total Daily**	**Productions**	**Attractions**	**Total**
Mount Tabor	82	305	65	370
Morris Plains	1,360	2,021	145	2,166
Morristown	3,782	3,398	435	3,833
Convent Station	2,460	1,368	54	1,422
Madison	2,888	2,226	226	2,452
Chatham	3,000	2,754	136	2,890
Subtotal	**13,572**	**12,072**	**1,061**	**13,133**
Gladstone	346	470	5	475
Peapack	88	167	-	167
Far Hills	318	32	-	32
Bernardsville	374	510	2	512
Basking Ridge	206	401	104	505
Lyons	900	515	6	521
Millington	342	274	8	282
Stirling	174	339	-	339
Gilette	280	385	28	413
Berkeley Heights	996	549	107	656
Murray Hill	1,114	542	160	702
New Providence	1,070	837	190	1,027
Subtotal	**6,208**	**5,021**	**610**	**5,631**
Summit	7,122	6,266	584	6,850
Short Hills	2,856	1,749	295	2,044
Millburn	3,384	2,862	174	3,036
Maplewood	6,068	4,772	431	5,203
South Orange	7,212	5,583	567	6,150
Mountain Station	616	411	161	572
Highland Avenue	484	300	241	541
Orange	2,268	1,567	502	2,069
Brick Church	3,092	3,213	389	3,602
East Orange	606	159	36	195
Subtotal	**33,708**	**26,882**	**3,380**	**30,262**
NEWARK BROAD ST	**4,962**	**692**	**2,930**	**3,622**
TOTAL	**58,450**	**44,667**	**7,981**	**52,648**

Source: NEC FUTURE team, 2015

NEC FUTURE

Table F-5: Year 2010 Average Weekday NJ TRANSIT Passenger Trips by Station (Counts vs. Modeled), Raritan Valley Line

RARITAN VALLEY LINE	2010 Counts Total Daily	2010 Model Productions	Attractions	Total
Bloomsbury	-	-	-	-
Hampton	-	-	-	-
High Bridge	152	611	1	612
Annandale	234	297	-	297
Lebanon	60	394	-	394
White House	242	282	7	289
North Branch	200	407	-	407
Raritan	1,344	1,264	54	1,318
Somerville	1,260	990	51	1,041
Bridgewater	688	1,303	37	1,340
Subtotal	**4,180**	**5,548**	**150**	**5,698**
Bound Brook	1,362	1,060	46	1,106
Dunellen	2,002	1,660	61	1,721
Plainfield	1,936	1,967	142	2,109
Netherwood	1,118	996	144	1,140
Fanwood	1,826	1,760	88	1,848
Westfield	4,572	3,848	112	3,960
Garwood	180	142	25	167
Cranford	2,350	2,049	106	2,155
Roselle Park	1,730	1,216	38	1,254
Union Township	2,392	929	129	1,058
Subtotal	**19,468**	**15,627**	**891**	**16,518**
West Trenton	-	-	-	-
1-95	-	-	-	-
Hopewell	-	-	-	-
Belle Mead	-	-	-	-
Hillsborough	-	-	-	-
Subtotal	**-**	**-**	**-**	**-**
TOTAL	**23,648**	**21,175**	**1,041**	**22,216**

Source: NEC FUTURE team, 2015

Table F-6: Year 2010 Average Weekday NJ TRANSIT Passenger Trips by Station (Counts vs. Modeled), Northeast Corridor/North Jersey Coast Lines

NORTHJERSEY COASTLINE/ NORTHEAST CORRIDOR	2010 Counts Total Daily	2010 Model Productions	Attractions	Total
Bay Head	462	108	2	110
Pt Pleasant Beach	634	688	20	708
Manasquan	436	581	11	592
Spring Lake	426	602	15	617
Belmar	618	333	17	350
Bradley Beach	546	691	37	728
Asbury Park	1,152	360	63	423
Allenhurst	326	229	8	237
Elberon	396	421	75	496
NJ CL Bay Head-Elberon	**4,996**	**4,013**	**248**	**4,261**
Long Branch	2,482	2,397	200	2,597
Little Silver	1,850	2,252	131	2,383
Red Bank	2,872	2,509	294	2,803
Middletown	3,614	4,051	123	4,174
Hazlet	1,972	3,404	8	3,412
Matawan	5,744	5,205	122	5,327
South Amboy	2,306	1,335	31	1,366
Perth Amboy	1,964	836	121	957
Woodbridge	3,546	2,071	245	2,316
Avenal	332	494	119	613
NJ CL Long Branch-Avenal	**26,682**	**24,554**	**1,394**	**25,948**
Subtotal - NJCL	**31,678**	**28,567**	**1,642**	**30,209**
Trenton	9,860	9,904	866	10,770
Hamiton	9,916	7,080	49	7,129
Princeton Junction	14,528	15,010	545	15,555
Jersey Ave	3,620	2,986	217	3,203
North Brunswick		-	-	-
New Brunswick	10,956	9,365	1,071	10,436
Edison	6,468	6,309	546	6,855
Metuchen	7,848	6,465	192	6,657
Metro park	15,012	12,375	717	13,092
NEC Trenton-Metropark	**78,208**	**69,494**	**4,203**	**73,697**
Rahway	6,428	4,978	709	5,687
Linden	4,262	2,669	529	3,198
Elizabeth	7,856	5,006	958	5,964
North Elizabeth	1,006	792	319	1,111
Newark International Airport	5,734	-	4,317	4,317
NEC Rahway-Newark Airport	**25,286**	**13,445**	**6,832**	**20,277**
Subtotal NEC	**103,494**	**82,939**	**11,035**	**93,974**
Total	**135,172**	**111,506**	**12,677**	**124,183**

Source: NEC FUTURE team, 2015

Table F-7: Year 2010 Average Weekday NJ TRANSIT Passenger Trips by Station (Counts vs. Modeled), Trans-Hudson and Urban Core Facilities

NJ URBAN CORE AND MANHATTAN FACILITIES	2010 Counts Total Daily	2010 Model Productions	Attractions	Total
Newark Penn Station (NJT)				
NEC/NJCL		28,251	28,844	57,095
Raritan Valley Line		140	20,281	20,421
Subtotal	**52,898**	**28,391**	**49,125**	**77,516**
Hoboken (NJT)				
NJCL		-	429	429
Main Line		197	5,040	5,237
Port Jervis/Bergen Line		64	14,679	14,743
Pascack Valley Line		28	6,054	6,082
Montclair-Boonton Line		-	3,503	3,503
Morristown Line		-	2,542	2,542
Gladstone Line		174	4,091	4,265
Subtotal	**32,116**	**463**	**36,338**	**36,801**
Existing NY Penn Station (NJT)	159,782	2,864	156,897	159,761
South Ferry Terminal		1,372	46,195	47,567
World Financial Center		128	5,966	6,094
Midtown Ferry Terminal		671	27,889	28,560
Lower Manhattan Ferry Terminal		16	7,651	7,667
Lincoln Tunnel				
PABT		6,449	159,996	166,445
Non- PABT		6,756	3,533	10,289
Subtotal	**175,000**	**13,205**	**163,529**	**176,734**
George Washington Bridge Bus Term	11,500	3,085	9,723	12,808
Holland Tunnel Buses	10,500	-	10,274	10,274
Total		**50,195**	**513,587**	**563,782**

Source: NEC FUTURE team, 2015
Note: NY Penn Station is highlighted for being the most significant terminal in Manhattan for NJTRANSIT.

Appendix G – Detailed Validation for New York Regional Rail Services

Table G-1: Year 2010 AM Peak-Period (6-10 AM) Boarding and Alighting Passengers by Metro-North Station (Counts vs. Modeled), Hudson Line

	2007 Metro-North OD Survey Counts by Station						2010 FRA NEC FUTURE Base Model					
	Inbound			Outbound			Inbound			Outbound		
	Ons	Offs	Total	Ons	Offs	Total	ONS	OFFS	TOTAL	ONS	OFFS	TOTAL
METRO NORTH HUDSON LINE												
Poughkeepsie	969	-	969	-	130	130	785	-	785	-	432	432
New Hamburg	840	-	840	-	8	8	736	47	783	67	47	114
Beacon	1,855	10	1,865	16	42	59	1,146	34	1,179	95	37	132
Cold Spring	347	-	347	-	26	26	396	1	397	3	1	4
Garrison	267	-	267	-	8	8	251	2	253	2	3	5
Peekskill	947	28	975	-	31	31	1,145	37	1,182	7	173	181
Cortiandt	763	12	775	-	7	7	197	25	222	11	27	39
Croton-Harmon	2,676	327	3,003	-	54	54	2,047	62	2,109	13	41	55
Ossining	958	15	973	-	52	52	1,240	23	1,262	20	112	132
Scarborough	725	4	729	2	4	6	661	14	675	8	25	32
Philipse Manor	270	-	270	3	-	3	195	5	201	1	16	17
Tarrytown	1,730	73	1,803	28	224	252	1,613	107	1,720	91	331	421
Irvington	635	14	649	-	111	111	500	18	518	9	49	59
Ardsley-on-Hudson	187	12	199	-	41	41	2	-	2	-	2	2
Dobbs Ferry	754	22	776	-	80	80	832	56	888	20	132	152
Hastings-on-Hudson	800	24	824	-	45	45	694	23	717	18	162	180
Greystone	355	12	367	-	22	22	956	17	973	39	152	191
Glenwood	235	-	235	11	13	24	343	5	348	3	6	9
Yonkers	650	108	758	75	71	146	837	123	960	146	330	476
Ludlow	164	16	180	-	-	-	920	36	955	40	43	83
RIerdale	591	15	606	-	7	7	823	122	945	134	23	157
Spuyten Duyvil	895	6	901	14	-	14	866	93	959	125	4	129
Marble Hill	155	235	390	183	-	183	-	240	240	255	2	257
University Hts.	61	30	91	89	-	89	11	64	75	37	1	37
Morris Hts.	-	22	22	57	-	57	82	208	289	98	-	98
Yankee Stadium	-	-	-	-	-	-	-	-	-	-	-	-
Total	**17,831**	**985**	**18,816**	**477**	**977**	**1,454**	**17,278**	**1,360**	**18,638**	**1,242**	**2,151**	**3,393**

Source: NEC FUTURE team, 2015

Table G-2: Year 2010 AM Peak-Period (6-10 AM) Boarding and Alighting Passengers by Metro-North Station (Counts vs. Modeled), Harlem Line

	2007 Metro-North OD Survey Counts by Station						2010 FRA NEC FUTURE Base Model					
	Inbound			Outbound			Inbound			Outbound		
	Ons	Offs	Total	Ons	Offs	Total	ONS	OFFS	TOTAL	ONS	OFFS	TOTAL
METRO NORTH HARLEM LINE												
Wassaic	65	-	65	-	13	13	71	-	71	-	1	1
Tenmile River	11	-	11	-	2	2	-	-	-	-	-	-
Dover Plains	80	-	80	-	4	4	46	-	46	-	-	-
Harlem Valley-	100	-	100	-	7	7	208	-	208	-	1	1
Pawling	198	-	198	-	-	-	-	-	-	-	-	-
Patterson	104	-	104	-	-	-	-	-	-	-	-	-
Southeast	966	34	1,000	-	11	11	564	35	599	1	47	48
Brewster	744	12	756	-	26	26	1,193	13	1,206	22	96	117
Croton Falls	451	-	451	-	48	48	431	3	434	3	3	6
Purdy's	404	-	404	-	6	6	300	1	301	1	3	5
Goldens Bridge	987	16	1,003	-	27	27	855	2	856	2	2	4
Katonah	723	-	723	-	72	72	779	1	780	1	2	3
Bedford Hills	421	34	455	9	106	115	704	3	707	2	14	15
Mount Kisco	723	110	833	-	156	156	1,306	46	1,352	6	75	81
Chappaqua	1,443	69	1,512	-	86	86	837	9	847	7	12	18
Pleasantville	611	13	624	-	72	72	617	37	654	16	103	119
Hawthorne	511	14	525	7	109	116	386	66	452	17	115	132
Valhalla	260	5	265	-	45	45	108	26	134	11	73	84
North White Plains	1,437	36	1,473	-	328	328	2,415	67	2,482	26	201	226
White Plains	3,608	425	4,033	208	2,530	2,737	2,585	420	3,005	48	2,462	2,510
East White Plains	-	-	-	-	-	-	-	-	-	-	-	-
Hartsdale	2,130	8	2,138	-	99	99	1,305	15	1,320	39	73	112
Scarsdale	2,915	30	2,945	20	231	251	3,848	41	3,889	83	184	266
Crestwood	1,372	70	1,442	17	38	55	1,232	8	1,240	11	147	158
Tuckahoe	928	12	940	48	26	74	1,611	39	1,650	92	188	280
Bronxville	1,984	29	2,013	57	125	182	1,817	67	1,884	108	247	354
Fleetwood	1,647	11	1,658	157	6	163	2,275	88	2,363	131	370	501
Mt. Vernon West	788	2	790	160	31	191	662	50	711	115	132	247
Wakefield	320	16	336	137	8	145	919	108	1,027	196	98	294
Woodlawn	720	33	753	215	28	243	322	180	502	403	17	419
Williams Bridge	114	51	165	251	11	262	183	132	315	357	7	364
Botanical Garden	146	201	347	41	47	88	170	153	323	158	5	163
Tremont	-	26	26	-	-	-	76	255	330	180	6	186
Melrose	-	25	25	10	-	10	50	362	412	237	3	240
Total	**26,914**	**1,282**	**28,196**	**1,337**	**4,298**	**5,635**	**27,872**	**2,226**	**30,099**	**2,271**	**4,687**	**6,958**

Source: NEC FUTURE team, 2015

Table G-3: Year 2010 AM Peak-Period (6-10 AM) Boarding and Alighting Passengers by Metro-North Station (Counts vs. Modeled), New Haven Line

	2007 Metro-North OD Survey Counts by Station						2010 FRA NEC FUTURE Base Model					
	Inbound			Outbound			Inbound			Outbound		
	Ons	Offs	Total	Ons	Offs	Total	ONS	OFFS	TOTAL	ONS	OFFS	TOTAL
METRO NORTH												
NEW HAVEN LINE												
Danbury	204	-	204	-	11	11	324	-	324	-	31	31
Bethel	253	-	253	-	-	-	92	22	114	4	6	9
Redding	55	-	55	-	-	-	-	-	-	-	-	-
Branchville	140	-	140	-	-	-	338	1	339	2	-	2
Cannondale	150	-	150	-	-	-	405	1	406	1	1	2
Wilton	168	4	172	-	-	-	124	6	130	1	3	4
Merrit-7	122	112	234	-	-	-	98	36	134	4	5	9
New Canaan	779	3	782	-	16	16	1,047	-	1,047	-	28	28
Talmadge Hill	324	-	324	-	-	-	133	6	139	1	14	14
Springdale	346	2	348	-	5	5	413	12	425	5	58	64
Glenbrook	243	-	243	-	-	-	296	20	316	10	92	102
NH State Street	6	-	6	-	154	154	127	-	127	-	214	214
New Haven	1,692	-	1,692	-	319	319	1,231	1	1,232	11	330	341
West Haven	-	-	-	-	-	-	-	-	-	-	-	-
Milford	1,239	19	1,258	17	96	113	1,066	88	1,154	81	176	256
Startford	1,128	29	1,157	15	18	33	921	174	1,095	116	162	277
East Bridgeport	-	-	-	-	-	-	-	-	-	-	-	-
Bridgeport	1,916	270	2,186	118	124	242	1,735	406	2,141	152	513	665
Fairfield Metro	-	-	-	-	-	-	-	-	-	-	-	-
Fairfield	2,152	107	2,259	61	189	250	2,266	90	2,356	31	106	137
Southport	242	8	250	4	10	14	254	36	289	16	28	43
Green's Farms	511	8	519	10	6	16	843	50	892	9	49	58
Westport	1,559	132	1,692	33	89	122	1,554	111	1,666	41	88	128
East Norwalk	460	73	533	22	24	47	275	112	387	32	171	203
South Norwalk	1,299	518	1,817	35	300	336	1,650	490	2,140	152	191	342
Rowayton	401	13	414	21	23	44	280	18	298	5	49	54
Darien	927	84	1,011	21	96	117	988	31	1,020	25	60	85
Noroton Heights	1,020	19	1,039	15	-	15	651	95	746	43	59	102
Stamford	3,468	2,604	6,072	273	1,595	1,869	4,170	2,263	6,433	375	1,915	2,290
Old Greenwich	609	43	652	-	56	56	539	68	606	34	79	113
Riverside	494	20	514	-	4	4	586	14	601	34	43	77
Cos Cob	578	24	602	-	24	24	703	24	727	24	58	82
Greenwich	1,458	622	2,081	82	834	916	1,697	613	2,310	80	888	968
Port Chester	1,261	68	1,329	88	309	397	1,333	58	1,391	113	522	634
Cross Westchester	-	-	-	-	-	-	-	-	-	-	-	-
Rye	1,303	59	1,362	22	346	368	1,347	93	1,440	81	235	316
Harrison	1,469	78	1,548	102	216	318	1,980	693	2,674	78	282	361
Mamaroneck	1,206	31	1,237	51	188	238	1,577	52	1,629	105	314	419
Larchmont	2,332	28	2,360	51	138	189	2,001	67	2,069	91	331	422
New Rochelle	2,192	116	2,308	268	412	680	1,941	170	2,111	242	705	947
Pelham	1,577	24	1,601	78	36	114	1,576	71	1,647	122	254	375
Mount Vernon East	923	122	1,045	505	109	614	1,047	60	1,107	175	182	357
Fordham (both lines)	174	751	925	1,927	88	2,014	75	695	769	2,600	66	2,666
Total	**36,385**	**5,992**	**42,377**	**3,818**	**5,836**	**9,654**	**37,684**	**6,747**	**44,431**	**4,893**	**8,307**	**13,200**

Source: NEC FUTURE team, 2015

Appendix H – Detailed Validation for Boston Regional Rail Services

Table H-1: Year 2012 Average Weekday MBTA Boarding Passengers by Station (Counts vs. Modeled), Rockport/Newburyport Lines

Branch/Station	2012 Counts	2012 Model
Rockport/Newburyport		
Rockport	174	178
Gloucester	354	97
West Gloucester	53	61
Manchester	203	73
Beverley Depot	124	3
Prides Crossing	13	23
Montserrat	216	49
Newburyport	538	444
Rowley	78	37
Ipswich	393	123
Hamilton/Wenham	248	128
North Beverley	223	283
Beverley Depot	1,432	1,687
Salem	2,104	2,291
Swampscott	719	856
Lynn	551	835
River Works Commrail	66	81
Chelsea	182	621
Subtotal	**7,671**	**7,870**

Source: NEC FUTURE team, 2015

Table H-2: Year 2012 Average Weekday MBTA Boarding Passengers by Station, Haverhill/Lowell Lines

Branch/Station	2012 Counts	2012 Model
Haverhill		
Haverhill	386	120
Bradford	209	455
Lawrence	562	833
Andover	369	571
Ballardvale	152	391
North Wilmington	69	132
Reading	813	235
Wakefield	496	401
Greenwood	128	90
Melrose Highlands	181	282
Melrose/Cedar Park	141	32
Wyoming Hill	66	185
Malden Center Commra	102	410
Subtotal	**3,674**	**4,137**
Lowell		
Lowell	1590	1341
North Billerica	792	1022
Wilmington	497	1134
Anderson/Woburn	895	1397
Mishawum	29	14
Winchester Center	474	434
Wedgemere	286	223
West Medford	559	757
Subtotal	**5,122**	**6,322**

Source: NEC FUTURE team, 2015

Table H-3: Year 2012 Average Weekday MBTA Boarding Passengers by Station (Counts vs. Modeled), Fitchburg/Worcester Lines

Branch/Station	2012 Counts	2012 Model
Fitchburg		
Fitchburg	287	158
North Leominster	213	326
Shirley	167	141
Ayer	284	188
Littleton/Route 495	214	256
South Acton	689	949
West Concord	346	9
Concord	390	264
Lincoln	185	169
Silver Hill	7	0
Hastings	27	56
Kendal Green	104	0
Brandeis/Roberts	459	292
Waltham	448	483
Waverley	101	211
Belmont	105	179
Porter Square Commra	1,616	1,491
Subtotal	**5,642**	**5,172**
Worcester		
Worcester	915	815
Grafton	364	498
Westborough	473	499
Southborough	423	121
Ashland	449	276
Framingham	950	2,023
West Natick	816	733
Natick	578	563
Wellesley Square	512	486
Wellesley Hills	250	389
Wellesley Farms	269	89
Riverside/I-95	0	0
Auburndale	183	115
West Newton	173	178
Newtonville	289	273
Yawkey	362	598
Subtotal	**7,006**	**7,656**

Source: NEC FUTURE team, 2015

Table H-4: Year 2012 Average Weekday MBTA Passenger Trips by Station (Counts vs. Modeled), Needham Heights, Franklin and Fairmont Lines

Branch/Station	2012 Counts	2012 Model
Needham Heights		
Needham Heights	254	279
Needham Center	181	13
Needham Junction	386	187
Hersey	515	311
West Roxbury	361	148
Highland	292	559
Bellevue	248	190
Roslindale Village	373	799
Forest Hills Commrail	97	119
Subtotal	**2,707**	**2,605**
Franklin		
Forge Park/Route 495	674	328
Franklin	526	809
Norfolk	619	520
Walpole	639	861
Plimptonville	9	12
Windsor Gardens	276	309
Norwood Central	940	802
Norwood Depot	311	214
Islington	107	246
Dedham Corporate	382	145
Endicott	252	361
Subtotal	**4,735**	**4,607**
Fairmount		
Readville	344	938
Fairmount	125	205
Morton Street	68	94
Talbot Ave Commrail	0	137
Four Corners/Geneva	0	176
Uphams Corner	52	60
Newmarket Commrail	0	26
Subtotal	**589**	**1,636**

Source: NEC FUTURE team, 2015

Table H-5: Year 2012 Average Weekday MBTA Boarding Trips by Station and Direction (Counts vs. Modeled), Providence, Middleborough/Lakeville and Kingston/Plymouth

Branch/Station	2012 Counts	2012 Model
Providence		
Westerly	0	0
Kingston Ri	0	0
Wickford Junction Co	159	183
TF Green Commrail	157	264
Providence	1,383	1,483
Providence Station H	0	0
Pawtucket	0	0
South Attleboro	923	1,249
Attleboro	1,394	1,094
Mansfield	1,823	2,088
Sharon	1,149	773
Stoughton	776	227
Canton Center	389	419
Canton Junction	1,137	2,614
Route 128	1,349	650
Subtotal	**10,639**	**11,044**
Middleborough/Lakeville		
Middleborough/Lakeville	616	323
Bridgewater	555	377
Campello	300	595
Brockton	318	767
Montello	330	507
Holbrook/Randolph	380	174
Subtotal	**2,499**	**2,743**
Kingston/Plymouth		
Kingston/Route 3	630	691
Plymouth	21	96
Halifax	293	412
Hanson	384	422
Whitman	417	374
Abington	579	530
South Wheymouth	421	887
Subtotal	**2,745**	**3,412**

Source: NEC FUTURE team, 2015

Table H-6: Year 2012 Average Weekday MBTA Passenger Boarding by Station and Direction (Counts vs. Modeled), Urban Core Facilities

Branch/Station	2012 Counts	2012 Model
Greenbush		
Greenbush Commrail	405	523
N Scituate Commrail	339	239
Cohasset Commrail	254	311
Nantasket Junction	168	196
West Hingham	215	160
East Weymouth	466	474
Weymouth Landing	326	281
Subtotal	**2,173**	**2,184**
Hyde Park, Ruggles, & Back Bay		
Hyde Park	575	1,701
Ruggles Commrail	1,690	939
Back Bay Commrail	7,995	7,387
Subtotal	**10,260**	**10,027**
Braintree, Quincy, & JFK		
Braintree Commrail	235	226
Quincy Center Commrail	217	206
JFK/UMASS Commrail	421	764
Subtotal	**873**	**1,196**
South Station		
South Station Commrail	21,772	21,811
North Station		
North Station Commrail	16,436	16,915

Source: NEC FUTURE team, 2015

Appendix I – MSA-to-MSA Level Interregional Trips by Mode for each Alternative

Table I-1: Trip Tables by Mode and MSA pair: Existing (2013)

Annual Auto Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	181,683	1,220,032	274,954	331,129	30,063	770,297	235,446	22,545	33,451	85,832	41,191	14,375	55,127	3,182	3,299,306
Greater Washington Area	1,220,032	32,479,558	1,936,209	2,542,653	234,572	4,106,873	1,358,767	159,063	184,429	121,289	235,735	113,665	381,308	68,630	45,142,783
Greater Baltimore Area	274,954	1,936,209	11,823,819	2,296,706	181,262	2,458,625	598,813	96,256	142,810	229,972	156,208	1,086,280	368,085	31,220	21,681,219
Greater Philadelphia Area	331,129	2,542,653	2,296,706	3,415,507	532,594	18,459,926	1,946,907	140,800	195,843	130,946	759,731	866,188	1,491,606	221,382	33,331,919
Leigh Valley Area	30,063	234,572	181,262	532,594	97,729	5,136,317	239,961	23,211	50,421	20,823	151,118	194,690	472,793	51,220	7,416,774
New York - North Jersey Area	770,297	4,106,873	2,458,625	18,459,926	5,136,317	122,439,296	795,798	2,131,898	3,128,391	2,293,999	8,336,620	6,472,649	15,086,836	2,059,157	193,676,683
South Central PA Area	235,446	1,358,767	598,813	1,946,907	239,961	795,798	697,210	80,687	108,552	107,991	165,133	69,413	107,111	54,514	6,566,304
Atlantic City Area	22,545	159,063	96,256	140,800	23,211	2,131,898	80,687	55,051	39,245	40,474	130,361	21,941	30,926	28,890	3,001,348
Poughkeepsie-Newburgh-Middletown Area	33,451	184,429	142,810	195,843	50,421	3,128,391	108,552	39,245	211,943	264,377	289,097	178,860	534,281	156,361	5,518,061
Greater Albany Area	85,832	121,289	229,972	130,946	20,823	2,293,999	107,991	40,474	264,377	751,454	431,501	273,628	871,516	312,180	5,935,983
Greater Hartford Area	41,191	235,735	156,208	759,731	151,118	8,336,620	165,133	130,361	289,097	431,501	3,283,341	1,099,810	2,315,638	172,480	17,567,964
Greater Providence Area	14,375	113,665	1,086,280	866,188	194,690	6,472,649	69,413	21,941	178,860	273,628	1,099,810	2,114,476	411,346	42,297	12,959,620
Greater Boston Area	55,127	381,308	368,085	1,491,606	472,793	15,086,836	107,111	30,926	534,281	871,516	2,315,638	411,346	743,940	391,092	23,261,603
Springfield Area	3,182	68,630	31,220	221,382	51,220	2,059,157	54,514	28,890	156,361	312,180	172,480	42,297	391,092	2,099	3,594,704
Total Trips	3,299,306	45,142,783	21,681,219	33,331,919	7,416,774	193,676,683	6,566,304	3,001,348	5,518,061	5,935,983	17,567,964	12,959,620	23,261,603	3,594,704	382,954,271

Annual Air Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	22,830	13,006	103,752	344	96,657	342	-	2,131	3,993	2,030	1,716	75,883	20	322,704
Greater Washington Area	22,830	-	-	287,729	58,197	981,295	71,872	-	18,220	97,845	194,399	248,759	1,322,144	83,331	3,386,622
Greater Baltimore Area	13,006	-	-	88,273	2,799	385,930	4,408	-	10,339	114,319	104,409	238,500	545,114	35,454	1,542,551
Greater Philadelphia Area	103,752	287,729	88,273	-	3,187	431,241	132,729	-	2,600	39,373	126,014	105,485	647,521	-	1,967,904
Leigh Valley Area	344	58,197	2,799	3,187	1	9,792	199	-	4	20	115	351	19,887	22	94,918
New York - North Jersey Area	96,657	981,295	385,930	431,241	9,792	-	9,290	-	-	28,906	17,692	46,504	1,430,566	9,937	3,447,809
South Central PA Area	342	71,872	4,408	132,729	199	9,290	-	-	172	113	710	1,120	3,496	-	224,451
Atlantic City Area	-	-	-	-	-	-	-	-	-	-	-	-	11,805	-	11,805
Poughkeepsie-Newburgh-Middletown Area	2,131	18,220	10,339	2,600	4	-	172	-	-	-	48	166	6,754	-	40,435
Greater Albany Area	3,993	97,845	114,319	39,373	20	28,906	113	-	-	-	105	479	7,519	-	292,672
Greater Hartford Area	2,030	194,399	104,409	126,014	115	17,692	710	-	48	105	-	-	342	-	445,864
Greater Providence Area	1,716	248,759	238,500	105,485	351	46,504	1,120	-	166	479	-	-	-	-	643,080
Greater Boston Area	75,883	1,322,144	545,114	647,521	19,887	1,430,566	3,496	11,805	6,754	7,519	342	-	-	-	4,071,032
Springfield Area	20	83,331	35,454	-	22	9,937	-	-	-	-	-	-	-	-	128,764
Total Trips	322,704	3,386,622	1,542,551	1,967,904	94,918	3,447,809	224,451	11,805	40,435	292,672	445,864	643,080	4,071,032	128,764	16,620,611

Annual Bus Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	264	15,161	3,725	423	59,768	1,082	200	552	-	2,853	107	1,370	-	85,504
Greater Washington Area	264	282	74,362	44,972	4,178	695,755	10,893	1,940	5,157	-	3,126	1,474	1,132	-	843,535
Greater Baltimore Area	15,161	74,362	214	49,062	9,419	235,739	20,397	794	1,200	-	3,588	1,245	860	-	412,042
Greater Philadelphia Area	3,725	44,972	49,062	39,096	4,354	785,078	30,744	330	1,033	-	3,203	3,462	14,486	-	979,547
Leigh Valley Area	423	4,178	9,419	4,354	1,281	225,192	1,341	80	142	285	3,325	915	10,184	292	261,410
New York - North Jersey Area	59,768	695,755	235,739	785,078	225,192	1,657,307	38,143	36,741	26,005	181,690	386,372	158,355	879,577	71,232	5,436,952
South Central PA Area	1,082	10,893	20,397	30,744	1,341	38,143	-	901	408	-	-	-	-	-	103,909
Atlantic City Area	200	1,940	794	330	80	36,741	901	-	100	-	240	93	278	-	41,696
Poughkeepsie-Newburgh-Middletown Area	552	5,157	1,200	1,033	142	26,005	408	100	306	983	710	293	7,460	1,606	45,957
Greater Albany Area	-	-	-	-	285	181,690	-	-	983	-	-	-	25,357	15,371	223,686
Greater Hartford Area	2,853	3,126	3,588	3,203	3,325	386,372	-	240	710	-	-	-	130,255	44,219	577,890
Greater Providence Area	107	1,474	1,245	3,462	915	158,355	-	93	293	-	-	-	64,167	6,095	236,204
Greater Boston Area	1,370	1,132	860	14,486	10,184	879,577	-	278	7,460	25,357	130,255	64,167	74,519	24,779	1,234,422
Springfield Area	-	-	-	-	292	71,232	-	-	1,606	15,371	44,219	6,095	24,779	-	163,593
Total Trips	85,504	843,535	412,042	979,547	261,410	5,436,952	103,909	41,696	45,957	223,686	577,890	236,204	1,234,422	163,593	10,646,348

Annual Intercity-Express Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Washington Area	-	9,036	17,595	98,837	1,205	539,693	-	7,284	8,076	-	5,247	2,327	9,609	753	699,660
Greater Baltimore Area	-	17,595	2,130	22,243	195	121,011	-	920	1,667	-	1,763	1,527	3,742	163	172,955
Greater Philadelphia Area	-	98,837	22,243	6,654	445	227,885	-	499	628	-	4,474	4,078	17,187	1,082	384,012
Leigh Valley Area	-	1,205	195	445	-	296	-	35	0	-	60	262	3,312	17	5,826
New York - North Jersey Area	-	539,693	121,011	227,885	296	22,031	-	14,002	201	-	31,082	65,398	409,217	3,150	1,433,966
South Central PA Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic City Area	-	7,284	920	499	35	14,002	-	123	73	-	463	101	184	81	23,765
Poughkeepsie-Newburgh-Middletown Area	-	8,076	1,667	628	0	201	-	73	0	-	121	207	2,559	18	13,549
Greater Albany Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Hartford Area	-	5,247	1,763	4,474	60	31,082	-	463	121	-	536	1,053	4,727	42	49,569
Greater Providence Area	-	2,327	1,527	4,078	262	65,398	-	101	207	-	1,053	687	7,858	39	83,537
Greater Boston Area	-	9,609	3,742	17,187	3,312	409,217	-	184	2,559	-	4,727	7,858	5,021	532	463,948
Springfield Area	-	753	163	1,082	17	3,150	-	81	18	-	42	39	532	1	5,877
Total Trips	-	699,660	172,955	384,012	5,826	1,433,966	-	23,765	13,549	-	49,569	83,537	463,948	5,877	3,336,664

Annual Intercity-Corridor Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	995	39,829	3,831	15,217	2,392	106,982	5,715	458	3,249	12,833	5,395	1,616	7,778	282	206,571
Greater Washington Area	39,829	164,463	172,151	324,981	7,848	926,559	55,509	8,862	15,932	12,519	27,874	13,455	32,734	4,110	1,806,827
Greater Baltimore Area	3,831	172,151	10,025	106,378	3,040	302,709	10,362	1,179	4,667	9,385	11,054	6,085	6,547	1,259	648,672
Greater Philadelphia Area	15,217	324,981	106,378	428,040	9,097	873,146	170,162	2,414	3,363	6,730	32,408	23,055	53,757	9,693	2,058,441
Leigh Valley Area	2,392	7,848	3,040	9,097	65	61,551	6,078	34	44	104	1,744	2,241	9,881	310	104,430
New York - North Jersey Area	106,982	926,559	302,709	873,146	61,551	509,870	48,698	10,826	53,731	195,370	314,920	205,999	484,053	66,130	4,160,544
South Central PA Area	5,715	55,509	10,362	170,162	6,078	48,698	26,335	1,232	848	3,740	3,813	1,987	1,997	534	337,011
Atlantic City Area	458	8,862	1,179	2,414	34	10,826	1,232	167	81	475	744	173	301	129	27,076
Poughkeepsie-Newburgh-Middletown Area	3,249	15,932	4,667	3,363	44	53,731	848	81	937	4,502	973	556	2,325	686	91,894
Greater Albany Area	12,833	12,519	9,385	6,730	104	195,370	3,740	475	4,502	12,306	3,162	1,881	7,257	2,038	272,300
Greater Hartford Area	5,395	27,874	11,054	32,408	1,744	314,920	3,813	744	973	3,162	17,693	10,682	31,337	1,992	463,792
Greater Providence Area	1,616	13,455	6,085	23,055	2,241	205,999	1,987	173	556	1,881	10,682	15,921	78,805	392	362,848
Greater Boston Area	7,778	32,734	6,547	53,757	9,881	484,053	1,997	301	2,325	7,257	31,337	78,805	58,166	4,338	779,275
Springfield Area	282	4,110	1,259	9,693	310	66,130	534	129	686	2,038	1,992	392	4,338	6	91,900
Total Trips	206,571	1,806,827	648,672	2,058,441	104,430	4,160,544	337,011	27,076	91,894	272,300	463,792	362,848	779,275	91,900	11,411,581

Source: NEC FUTURE team, 2015

Table I-2: Trip Tables by Mode and MSA pair: No Action Alternative

Annual Auto Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	243,600	1,756,617	336,754	450,659	37,674	867,514	325,620	26,996	32,748	61,191	49,961	19,245	68,977	4,394	4,281,951
Greater Washington Area	1,756,617	48,867,568	2,890,046	3,786,489	351,341	5,886,465	1,984,323	224,403	239,672	155,350	326,992	154,292	527,940	95,995	67,247,492
Greater Baltimore Area	336,754	2,890,046	15,987,960	3,219,835	246,380	3,406,623	849,320	130,279	190,198	311,657	208,813	1,503,185	506,238	42,362	29,829,650
Greater Philadelphia Area	450,659	3,786,489	3,219,835	5,033,982	707,218	24,644,822	2,784,699	192,119	262,842	169,766	1,021,709	1,164,014	2,039,123	296,061	45,773,338
Leigh Valley Area	37,674	351,341	246,380	707,218	126,956	6,480,643	346,418	28,735	64,798	27,079	198,838	263,300	625,929	68,198	9,573,509
New York - North Jersey Area	867,514	5,886,465	3,406,623	24,644,822	6,480,643	161,917,513	1,101,396	2,741,211	4,139,304	3,103,747	10,796,170	8,530,229	19,942,550	2,735,872	256,294,060
South Central PA Area	325,620	1,984,323	849,320	2,784,699	346,418	1,101,396	969,316	106,583	147,735	139,251	225,268	95,391	150,534	74,173	9,300,029
Atlantic City Area	26,996	224,403	130,279	192,119	28,735	2,741,211	106,583	71,331	52,113	55,079	172,039	28,834	40,621	38,585	3,908,927
Poughkeepsie-Newburgh-Middletown Area	32,748	239,672	190,198	262,842	64,798	4,139,304	147,735	52,113	277,660	357,599	372,137	234,775	704,216	202,940	7,278,738
Greater Albany Area	61,191	155,350	311,657	169,766	27,079	3,103,747	139,251	55,079	357,599	1,049,054	558,482	362,393	1,149,623	419,313	7,919,585
Greater Hartford Area	49,961	326,992	208,813	1,021,709	198,838	10,796,170	225,268	172,039	372,137	558,482	4,144,333	1,382,644	3,022,515	231,386	22,711,286
Greater Providence Area	19,245	154,292	1,503,185	1,164,014	263,300	8,530,229	95,391	28,834	234,775	362,393	1,382,644	2,700,332	533,431	54,562	17,026,628
Greater Boston Area	68,977	527,940	506,238	2,039,123	625,929	19,942,550	150,534	40,621	704,216	1,149,623	3,022,515	533,431	969,506	523,259	30,804,462
Springfield Area	4,394	95,995	42,362	296,061	68,198	2,735,872	74,173	38,585	202,940	419,313	231,386	54,562	523,259	2,689	4,789,789
Total Trips	4,281,951	67,247,492	29,829,650	45,773,338	9,573,509	256,294,060	9,300,029	3,908,927	7,278,738	7,919,585	22,711,286	17,026,628	30,804,462	4,789,789	516,739,442

Annual Air Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	33,918	10,822	138,819	281	80,908	502	-	1,582	1,892	2,875	2,908	104,188	31	378,727
Greater Washington Area	33,918	-	-	428,877	84,684	1,345,211	105,709	-	18,988	133,511	272,593	359,250	1,915,227	115,049	4,813,018
Greater Baltimore Area	10,822	-	-	119,400	3,143	520,230	5,537	-	11,717	151,746	138,186	364,934	750,999	46,214	2,122,928
Greater Philadelphia Area	138,819	428,877	119,400	-	3,448	551,305	185,276	-	3,090	51,091	168,260	150,914	883,018	-	2,683,499
Leigh Valley Area	281	84,684	3,143	3,448	2	10,882	293	-	5	22	171	538	23,682	26	127,179
New York - North Jersey Area	80,908	1,345,211	520,230	551,305	10,882	-	13,303	-	-	42,390	26,084	72,422	1,969,995	15,017	4,647,747
South Central PA Area	502	105,709	5,537	185,276	293	13,303	-	-	205	136	1,094	1,784	5,414	-	319,253
Atlantic City Area	-	-	-	-	-	-	-	-	-	-	-	-	15,890	-	15,890
Poughkeepsie-Newburgh-Middletown Area	1,582	18,988	11,717	3,090	5	-	205	-	-	-	57	204	8,315	-	44,165
Greater Albany Area	1,892	133,511	151,746	51,091	22	42,390	136	-	-	-	138	681	9,942	-	391,550
Greater Hartford Area	2,875	272,593	138,186	168,260	171	26,084	1,094	-	57	138	-	-	448	-	609,906
Greater Providence Area	2,908	359,250	364,934	150,914	538	72,422	1,784	-	204	681	-	-	-	-	953,636
Greater Boston Area	104,188	1,915,227	750,999	883,018	23,682	1,969,995	5,414	15,890	8,315	9,942	448	-	-	-	5,687,118
Springfield Area	31	115,049	46,214	-	26	15,017	-	-	-	-	-	-	-	-	176,338
Total Trips	378,727	4,813,018	2,122,928	2,683,499	127,179	4,647,747	319,253	15,890	44,165	391,550	609,906	953,636	5,687,118	176,338	22,970,953

Annual Bus Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	3,746	79,568	21,316	7,531	357,263	7,477	3,816	3,855	-	9,684	455	6,778	-	501,489
Greater Washington Area	3,746	599	100,336	68,628	13,399	1,342,505	14,485	9,126	6,732	-	3,887	2,048	2,321	-	1,567,812
Greater Baltimore Area	79,568	100,336	256	59,064	29,198	365,565	23,755	2,821	1,546	-	3,649	1,458	1,570	-	668,786
Greater Philadelphia Area	21,316	68,628	59,064	67,196	9,973	1,268,354	38,107	1,630	1,429	-	3,455	3,957	20,560	-	1,563,672
Leigh Valley Area	7,531	13,399	29,198	9,973	5,872	791,569	4,299	567	420	630	7,908	2,182	28,236	448	902,231
New York - North Jersey Area	357,263	1,342,505	365,565	1,268,354	791,569	3,809,442	62,375	170,694	49,646	323,240	542,894	246,189	1,660,882	86,054	11,076,670
South Central PA Area	7,477	14,485	23,755	38,107	4,299	62,375	-	3,346	554	-	-	-	-	-	154,397
Atlantic City Area	3,816	9,126	2,821	1,630	567	170,694	3,346	-	445	-	681	269	766	-	194,162
Poughkeepsie-Newburgh-Middletown Area	3,855	6,732	1,546	1,429	420	49,646	554	445	468	1,465	837	378	10,860	1,636	80,272
Greater Albany Area	-	-	-	-	630	323,240	-	-	1,465	-	-	-	33,328	15,468	374,131
Greater Hartford Area	9,684	3,887	3,649	3,455	7,908	542,894	-	681	837	-	-	-	152,367	41,406	766,767
Greater Providence Area	455	2,048	1,458	3,957	2,182	246,189	-	269	378	-	-	-	83,515	5,769	346,219
Greater Boston Area	6,778	2,321	1,570	20,560	28,236	1,660,882	-	766	10,860	33,328	152,367	83,515	105,162	23,933	2,130,277
Springfield Area	-	-	-	-	448	86,054	-	-	1,636	15,468	41,406	5,769	23,933	-	174,714
Total Trips	501,489	1,567,812	668,786	1,563,672	902,231	11,076,670	154,397	194,162	80,272	374,131	766,767	346,219	2,130,277	174,714	20,501,601

Annual Intercity-Express Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Washington Area	-	11,200	26,177	130,630	4,705	933,654	-	8,995	17,367	-	5,752	2,383	8,205	787	1,149,857
Greater Baltimore Area	-	26,177	3,287	25,593	868	191,792	-	956	3,656	-	1,840	1,649	3,582	170	259,567
Greater Philadelphia Area	-	130,630	25,593	7,870	1,500	360,017	-	510	1,187	-	3,917	3,977	16,262	927	552,391
Leigh Valley Area	-	4,705	868	1,500	-	1,218	-	89	1	-	936	2,468	21,768	117	33,671
New York - North Jersey Area	-	933,654	191,792	360,017	1,218	96,374	-	19,033	758	-	75,921	120,384	771,960	6,752	2,577,863
South Central PA Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic City Area	-	8,995	956	510	89	19,033	-	126	142	-	382	86	139	66	30,522
Poughkeepsie-Newburgh-Middletown Area	-	17,367	3,656	1,187	1	758	-	142	1	-	211	232	2,800	31	26,386
Greater Albany Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Hartford Area	-	5,752	1,840	3,917	936	75,921	-	382	211	-	648	1,157	6,649	49	97,462
Greater Providence Area	-	2,383	1,649	3,977	2,468	120,384	-	86	232	-	1,157	743	9,084	42	142,204
Greater Boston Area	-	8,205	3,582	16,262	21,768	771,960	-	139	2,800	-	6,649	9,084	7,287	909	848,646
Springfield Area	-	787	170	927	117	6,752	-	66	31	-	49	42	909	1	9,851
Total Trips	-	1,149,857	259,567	552,391	33,671	2,577,863	-	30,522	26,386	-	97,462	142,204	848,646	9,851	5,728,421

Annual Intercity-Corridor Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	955	29,741	2,454	14,147	1,385	98,113	5,482	355	16,264	85,075	5,670	1,670	7,497	401	269,210
Greater Washington Area	29,741	368,273	219,960	369,431	6,266	1,055,525	64,788	9,158	45,314	40,257	28,633	12,016	33,914	6,608	2,289,886
Greater Baltimore Area	2,454	219,960	16,318	132,262	3,056	381,762	13,916	1,359	15,776	43,024	11,151	6,289	7,623	2,111	857,064
Greater Philadelphia Area	14,147	369,431	132,262	386,475	9,058	1,281,581	121,127	2,889	8,158	24,631	33,298	22,619	65,194	12,101	2,482,970
Leigh Valley Area	1,385	6,266	3,056	9,058	50	79,130	3,815	29	63	200	1,476	1,820	9,864	273	116,484
New York - North Jersey Area	98,113	1,055,525	381,762	1,281,581	79,130	666,264	41,141	15,640	36,520	158,067	314,928	180,508	455,066	47,478	4,811,724
South Central PA Area	5,482	64,788	13,916	121,127	3,815	41,141	26,416	867	2,678	19,306	3,622	1,926	2,542	1,840	309,467
Atlantic City Area	355	9,158	1,359	2,889	29	15,640	867	215	186	1,450	673	141	225	175	33,362
Poughkeepsie-Newburgh-Middletown Area	16,264	45,314	15,776	8,158	63	36,520	2,678	186	455	2,132	2,545	2,003	12,249	605	144,948
Greater Albany Area	85,075	40,257	43,024	24,631	200	158,067	19,306	1,450	2,132	6,770	13,163	11,202	52,898	3,610	461,787
Greater Hartford Area	5,670	28,633	11,151	33,298	1,476	314,928	3,622	673	2,545	13,163	21,839	13,423	35,822	2,248	488,492
Greater Providence Area	1,670	12,016	6,289	22,619	1,820	180,508	1,926	141	2,003	11,202	13,423	22,862	92,455	458	369,392
Greater Boston Area	7,497	33,914	7,623	65,194	9,864	455,066	2,542	225	12,249	52,898	35,822	92,455	77,188	4,275	856,812
Springfield Area	401	6,608	2,111	12,101	273	47,478	1,840	175	605	3,610	2,248	458	4,275	7	82,190
Total Trips	269,210	2,289,886	857,064	2,482,970	116,484	4,811,724	309,467	33,362	144,948	461,787	488,492	369,392	856,812	82,190	13,573,789

Source: NEC FUTURE team, 2015

Table I-3: Trip Tables by Mode and MSA pair: Alternative 1

Annual Auto Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	242,819	1,739,238	334,791	439,652	36,679	795,669	318,140	26,702	39,811	102,663	41,509	16,748	63,535	3,841	4,201,798
Greater Washington Area	1,739,238	48,772,092	2,817,292	3,686,720	349,408	5,547,694	1,966,551	220,332	247,834	164,368	297,651	144,352	513,120	93,749	66,560,400
Greater Baltimore Area	334,791	2,817,292	15,980,818	3,172,912	245,187	3,218,634	847,941	129,597	192,477	319,864	190,473	1,488,507	495,100	41,380	29,474,974
Greater Philadelphia Area	439,652	3,686,720	3,172,912	4,934,947	703,362	24,264,065	2,763,718	191,332	262,722	175,027	969,337	1,118,943	1,954,861	284,706	44,922,302
Leigh Valley Area	36,679	349,408	245,187	703,362	126,917	6,463,764	345,679	28,729	64,776	27,036	195,543	259,008	617,809	67,761	9,531,658
New York - North Jersey Area	795,669	5,547,694	3,218,634	24,264,065	6,463,764	161,224,276	1,078,771	2,733,292	4,097,316	2,964,026	10,273,515	8,199,851	19,417,084	2,667,307	252,945,264
South Central PA Area	318,140	1,966,551	847,941	2,763,718	345,679	1,078,771	965,835	106,366	148,676	147,583	214,737	90,446	143,000	74,216	9,211,658
Atlantic City Area	26,702	220,332	129,597	191,332	28,729	2,733,292	106,366	71,287	52,092	54,873	169,583	28,346	40,288	38,308	3,891,128
Poughkeepsie-Newburgh-Middletown Area	39,811	247,834	192,477	262,722	64,776	4,097,316	148,676	52,092	276,446	352,247	371,455	234,301	704,541	202,204	7,246,898
Greater Albany Area	102,663	164,368	319,864	175,027	27,036	2,964,026	147,583	54,873	352,247	1,033,472	561,606	366,390	1,172,726	418,653	7,860,533
Greater Hartford Area	41,509	297,651	190,473	969,337	195,543	10,273,515	214,737	169,583	371,455	561,606	4,139,512	1,372,949	2,995,923	230,621	22,024,415
Greater Providence Area	16,748	144,352	1,488,507	1,118,943	259,008	8,199,851	90,446	28,346	234,301	366,390	1,372,949	2,689,598	505,933	54,372	16,569,742
Greater Boston Area	63,535	513,120	495,100	1,954,861	617,809	19,417,084	143,000	40,288	704,541	1,172,726	2,995,923	505,933	955,129	519,823	30,098,871
Springfield Area	3,841	93,749	41,380	284,706	67,761	2,667,307	74,216	38,308	202,204	418,653	230,621	54,372	519,823	2,686	4,699,627
Total Trips	4,201,798	66,560,400	29,474,974	44,922,302	9,531,658	252,945,264	9,211,658	3,891,128	7,246,898	7,860,533	22,024,415	16,569,742	30,098,871	4,699,627	509,239,269

Annual Air Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	33,415	10,778	135,417	268	69,108	479	-	1,678	3,733	1,995	2,338	93,467	23	352,700
Greater Washington Area	33,415	-	-	406,088	83,769	1,258,585	104,585	-	20,050	134,847	258,008	342,461	1,862,520	111,156	4,615,485
Greater Baltimore Area	10,778	-	-	114,034	3,146	480,860	5,536	-	11,915	153,406	134,194	360,951	741,645	45,297	2,061,761
Greater Philadelphia Area	135,417	406,088	114,034	-	3,410	531,887	183,103	-	3,057	51,055	162,453	142,132	855,298	-	2,587,935
Leigh Valley Area	268	83,769	3,146	3,410	2	10,765	292	-	5	22	167	500	23,941	26	126,314
New York - North Jersey Area	69,108	1,258,585	480,860	531,887	10,765	-	12,448	-	-	37,133	24,131	61,230	1,794,888	13,481	4,294,516
South Central PA Area	479	104,585	5,536	183,103	292	12,448	-	-	208	146	1,041	1,486	4,383	-	313,709
Atlantic City Area	-	-	-	-	-	-	-	-	-	-	-	-	15,871	-	15,871
Poughkeepsie-Newburgh-Middletown Area	1,678	20,050	11,915	3,057	5	-	208	-	-	-	57	203	8,135	-	45,308
Greater Albany Area	3,733	134,847	153,406	51,055	22	37,133	146	-	-	-	138	690	10,493	-	391,665
Greater Hartford Area	1,995	258,008	134,194	162,453	167	24,131	1,041	-	57	138	-	-	439	-	582,623
Greater Providence Area	2,338	342,461	360,951	142,132	500	61,230	1,486	-	203	690	-	-	-	-	911,992
Greater Boston Area	93,467	1,862,520	741,645	855,298	23,941	1,794,888	4,383	15,871	8,135	10,493	439	-	-	-	5,411,081
Springfield Area	23	111,156	45,297	-	26	13,481	-	-	-	-	-	-	-	-	169,983
Total Trips	352,700	4,615,485	2,061,761	2,587,935	126,314	4,294,516	313,709	15,871	45,308	391,665	582,623	911,992	5,411,081	169,983	21,880,943

Annual Bus Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	3,733	78,838	20,200	7,101	325,292	7,139	3,758	3,492	-	8,928	363	6,190	-	465,034
Greater Washington Area	3,733	589	94,005	63,240	13,039	1,228,828	14,157	8,826	6,823	-	3,178	1,550	1,430	-	1,439,397
Greater Baltimore Area	78,838	94,005	252	57,118	28,921	339,548	23,688	2,786	1,548	-	3,127	1,188	1,132	-	632,151
Greater Philadelphia Area	20,200	63,240	57,118	64,128	9,838	1,223,429	37,248	1,624	1,411	-	2,882	3,318	18,369	-	1,502,805
Leigh Valley Area	7,101	13,039	28,921	9,838	5,866	785,206	4,271	566	418	622	7,837	2,106	27,721	444	893,956
New York - North Jersey Area	325,292	1,228,828	339,548	1,223,429	785,206	3,757,106	60,737	169,626	45,193	287,486	461,891	216,249	1,536,573	80,250	10,517,411
South Central PA Area	7,139	14,157	23,688	37,248	4,271	60,737	-	3,329	547	-	-	-	-	-	151,117
Atlantic City Area	3,758	8,826	2,786	1,624	566	169,626	3,329	-	445	-	640	227	610	-	192,435
Poughkeepsie-Newburgh-Middletown Area	3,492	6,823	1,548	1,411	418	45,193	547	445	448	1,390	799	364	10,782	1,620	75,280
Greater Albany Area	-	-	-	-	622	287,486	-	-	1,390	-	-	-	34,692	15,513	339,703
Greater Hartford Area	8,928	3,178	3,127	2,882	7,837	461,891	-	640	799	-	-	-	148,869	41,355	679,505
Greater Providence Area	363	1,550	1,188	3,318	2,106	216,249	-	227	364	-	-	-	76,067	5,758	307,189
Greater Boston Area	6,190	1,430	1,132	18,369	27,721	1,536,573	-	610	10,782	34,692	148,869	76,067	102,662	23,518	1,988,615
Springfield Area	-	-	-	-	444	80,250	-	-	1,620	15,513	41,355	5,758	23,518	-	168,458
Total Trips	465,034	1,439,397	632,151	1,502,805	893,956	10,517,411	151,117	192,435	75,280	339,703	679,505	307,189	1,988,615	168,458	19,353,055

Annual Intercity-Express Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Washington Area	-	14,374	26,779	113,003	1,236	700,495	-	8,556	10,109	-	11,483	4,915	15,938	1,174	908,062
Greater Baltimore Area	-	26,779	4,328	27,475	259	170,059	-	1,179	2,586	-	3,896	3,280	6,576	294	246,711
Greater Philadelphia Area	-	113,003	27,475	7,012	796	356,714	-	511	951	-	8,348	8,113	30,940	1,808	555,669
Leigh Valley Area	-	1,236	259	796	-	844	-	45	0	-	124	419	4,349	20	8,093
New York - North Jersey Area	-	700,495	170,059	356,714	844	67,219	-	20,933	606	-	100,927	126,000	674,150	6,464	2,224,412
South Central PA Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic City Area	-	8,556	1,179	511	45	20,933	-	138	113	-	1,003	193	282	150	33,103
Poughkeepsie-Newburgh-Middletown Area	-	10,109	2,586	951	0	606	-	113	0	-	339	305	3,736	32	18,779
Greater Albany Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Hartford Area	-	11,483	3,896	8,348	124	100,927	-	1,003	339	-	766	1,626	7,758	67	136,337
Greater Providence Area	-	4,915	3,280	8,113	419	126,000	-	193	305	-	1,626	1,721	8,990	47	155,609
Greater Boston Area	-	15,938	6,576	30,940	4,349	674,150	-	282	3,736	-	7,758	8,990	8,512	947	762,178
Springfield Area	-	1,174	294	1,808	20	6,464	-	150	32	-	67	47	947	1	11,005
Total Trips	-	908,062	246,711	555,669	8,093	2,224,412	-	33,103	18,779	-	136,337	155,609	762,178	11,005	5,059,957

Annual Intercity-Corridor Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	2,055	55,375	6,306	35,652	3,389	273,586	16,129	828	12,490	56,263	21,059	6,220	30,345	1,305	521,001
Greater Washington Area	55,375	493,591	337,423	595,283	14,595	2,183,496	92,495	16,133	48,351	35,360	84,730	45,943	117,687	15,528	4,135,991
Greater Baltimore Area	6,306	337,423	25,464	211,909	5,816	788,958	16,065	2,137	16,522	41,078	40,114	29,639	32,337	4,868	1,558,634
Greater Philadelphia Area	35,652	595,283	211,909	552,345	17,275	2,047,371	156,917	4,120	9,748	22,967	110,750	91,099	206,154	27,307	4,088,897
Leigh Valley Area	3,389	14,595	5,816	17,275	132	117,447	4,913	86	100	296	6,669	9,470	39,094	951	220,233
New York - North Jersey Area	273,586	2,183,496	788,958	2,047,371	117,447	1,688,224	77,637	30,228	92,761	388,695	1,128,372	668,114	1,667,589	144,023	11,296,500
South Central PA Area	16,129	92,495	16,065	156,917	4,913	77,637	31,557	1,192	2,060	13,056	18,138	8,926	14,670	2,184	455,939
Atlantic City Area	828	16,133	2,137	4,120	86	30,228	1,192	263	262	1,953	3,152	704	780	445	62,284
Poughkeepsie-Newburgh-Middletown Area	12,490	48,351	16,522	9,748	100	92,761	2,060	262	1,790	8,180	3,892	3,055	14,449	1,531	215,190
Greater Albany Area	56,263	35,360	41,078	22,967	296	388,695	13,056	1,953	8,180	23,845	12,433	9,022	36,195	4,753	654,095
Greater Hartford Area	21,059	84,730	40,114	110,750	6,669	1,128,372	18,138	3,152	3,892	12,433	28,616	26,935	77,972	3,377	1,566,206
Greater Providence Area	6,220	45,943	29,639	91,099	9,470	668,114	8,926	704	3,055	9,022	26,935	48,443	147,475	736	1,095,780
Greater Boston Area	30,345	117,687	32,337	206,154	39,094	1,667,589	14,670	780	14,449	36,195	77,972	147,475	101,493	9,784	2,496,024
Springfield Area	1,305	15,528	4,868	27,307	951	144,023	2,184	445	1,531	4,753	3,377	736	9,784	12	216,801
Total Trips	521,001	4,135,991	1,558,634	4,088,897	220,233	11,296,500	455,939	62,284	215,190	654,095	1,566,206	1,095,780	2,496,024	216,801	28,583,575

Source: NEC FUTURE team, 2015

Table I-4: Trip Tables by Mode and MSA pair: Alternative 2

Annual Auto Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	242,800	1,739,201	334,777	443,265	37,235	794,073	319,447	26,694	39,384	100,775	41,247	17,217	64,133	3,776	4,204,025
Greater Washington Area	1,739,201	48,718,937	2,808,385	3,675,716	349,148	5,488,161	1,957,986	219,538	246,067	163,569	294,557	141,456	507,798	92,789	66,403,308
Greater Baltimore Area	334,777	2,808,385	15,978,968	3,167,000	244,925	3,185,582	843,774	129,426	191,809	319,043	188,937	1,484,595	491,293	40,637	29,409,151
Greater Philadelphia Area	443,265	3,675,716	3,167,000	4,896,535	701,957	24,154,359	2,749,504	191,003	262,022	171,818	959,126	1,104,810	1,926,058	278,989	44,682,163
Leigh Valley Area	37,235	349,148	244,925	701,957	126,909	6,459,447	345,104	28,712	64,774	27,028	195,085	257,767	611,792	67,560	9,517,445
New York - North Jersey Area	794,073	5,488,161	3,185,582	24,154,359	6,459,447	161,097,895	1,061,385	2,730,076	4,096,792	2,961,990	10,231,378	8,119,960	19,248,036	2,631,878	252,261,011
South Central PA Area	319,447	1,957,986	843,774	2,749,504	345,104	1,061,385	962,583	106,280	148,265	144,338	209,500	88,524	138,349	73,124	9,148,163
Atlantic City Area	26,694	219,538	129,426	191,003	28,712	2,730,076	106,280	71,266	52,070	54,836	168,747	28,095	40,120	38,022	3,884,885
Poughkeepsie-Newburgh-Middletown Area	39,384	246,067	191,809	262,022	64,774	4,096,792	148,265	52,070	276,446	352,247	371,138	234,011	702,204	202,010	7,239,240
Greater Albany Area	100,775	163,569	319,043	171,818	27,028	2,961,990	144,338	54,836	352,247	1,033,472	560,888	365,783	1,172,017	417,887	7,845,691
Greater Hartford Area	41,247	294,557	188,937	959,126	195,085	10,231,378	209,500	168,747	371,138	560,888	4,130,626	1,356,447	2,957,371	230,448	21,895,493
Greater Providence Area	17,217	141,456	1,484,595	1,104,810	257,767	8,119,960	88,524	28,095	234,011	365,783	1,356,447	2,689,012	506,945	54,205	16,448,827
Greater Boston Area	64,133	507,798	491,293	1,926,058	611,792	19,248,036	138,349	40,120	702,204	1,172,017	2,957,371	506,945	937,873	518,900	29,822,887
Springfield Area	3,776	92,789	40,637	278,989	67,560	2,631,878	73,124	38,022	202,010	417,887	230,448	54,205	518,900	2,685	4,652,909
Total Trips	4,204,025	66,403,308	29,409,151	44,682,163	9,517,445	252,261,011	9,148,163	3,884,885	7,239,240	7,845,691	21,895,493	16,448,827	29,822,887	4,652,909	507,415,197

Annual Air Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	33,415	10,778	137,362	271	68,548	485	-	1,646	3,600	1,913	2,420	94,874	22	355,334
Greater Washington Area	33,415	-	-	405,293	83,837	1,224,448	103,994	-	19,377	134,738	248,738	338,063	1,842,883	108,824	4,543,608
Greater Baltimore Area	10,778	-	-	113,826	3,137	470,075	5,524	-	11,727	153,231	131,586	359,892	737,939	44,782	2,042,497
Greater Philadelphia Area	137,362	405,293	113,826	-	3,403	525,965	181,673	-	3,042	51,020	159,243	140,101	848,803	-	2,569,730
Leigh Valley Area	271	83,837	3,137	3,403	2	10,717	292	-	5	22	165	491	23,227	26	125,595
New York - North Jersey Area	68,548	1,224,448	470,075	525,965	10,717	-	11,782	-	-	37,125	22,879	59,625	1,744,129	12,563	4,187,856
South Central PA Area	485	103,994	5,524	181,673	292	11,782	-	-	207	142	1,003	1,392	3,897	-	310,390
Atlantic City Area	-	-	-	-	-	-	-	-	-	-	-	-	15,864	-	15,864
Poughkeepsie-Newburgh-Middletown Area	1,646	19,377	11,727	3,042	5	-	207	-	-	-	57	203	8,039	-	44,302
Greater Albany Area	3,600	134,738	153,231	51,020	22	37,125	142	-	-	-	138	690	10,499	-	391,205
Greater Hartford Area	1,913	248,738	131,586	159,243	165	22,879	1,003	-	57	138	-	-	431	-	566,152
Greater Providence Area	2,420	338,063	359,892	140,101	491	59,625	1,392	-	203	690	-	-	-	-	902,876
Greater Boston Area	94,874	1,842,883	737,939	848,803	23,227	1,744,129	3,897	15,864	8,039	10,499	431	-	-	-	5,330,585
Springfield Area	22	108,824	44,782	-	26	12,563	-	-	-	-	-	-	-	-	166,217
Total Trips	355,334	4,543,608	2,042,497	2,569,730	125,595	4,187,856	310,390	15,864	44,302	391,205	566,152	902,876	5,330,585	166,217	21,552,211

Annual Bus Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	3,732	78,826	20,811	7,377	323,524	7,222	3,755	3,476	-	8,855	373	6,255	-	464,205
Greater Washington Area	3,732	587	93,320	63,213	12,959	1,208,313	13,938	8,746	6,733	-	3,015	1,435	1,096	-	1,417,089
Greater Baltimore Area	78,826	93,320	250	56,924	28,878	334,521	23,382	2,774	1,540	-	3,061	1,134	1,054	-	625,664
Greater Philadelphia Area	20,811	63,213	56,924	63,037	9,792	1,212,534	36,572	1,612	1,407	-	2,793	3,214	17,932	-	1,489,839
Leigh Valley Area	7,377	12,959	28,878	9,792	5,865	783,272	4,233	565	417	622	7,818	2,075	27,223	442	891,538
New York - North Jersey Area	323,524	1,208,313	334,521	1,212,534	783,272	3,745,178	59,595	169,168	45,184	287,451	459,085	204,048	1,502,823	77,696	10,412,391
South Central PA Area	7,222	13,938	23,382	36,572	4,233	59,595	-	3,320	544	-	-	-	-	-	148,806
Atlantic City Area	3,755	8,746	2,774	1,612	565	169,168	3,320	-	445	-	615	215	563	-	191,779
Poughkeepsie-Newburgh-Middletown Area	3,476	6,733	1,540	1,407	417	45,184	544	445	448	1,390	792	359	10,664	1,614	75,013
Greater Albany Area	-	-	-	-	622	287,451	-	-	1,390	-	-	-	34,659	15,462	339,585
Greater Hartford Area	8,855	3,015	3,061	2,793	7,818	459,085	-	615	792	-	-	-	144,915	41,341	672,290
Greater Providence Area	373	1,435	1,134	3,214	2,075	204,048	-	215	359	-	-	-	76,360	5,749	294,961
Greater Boston Area	6,255	1,096	1,054	17,932	27,223	1,502,823	-	563	10,664	34,659	144,915	76,360	100,920	23,415	1,947,878
Springfield Area	-	-	-	-	442	77,696	-	-	1,614	15,462	41,341	5,749	23,415	-	165,718
Total Trips	464,205	1,417,089	625,664	1,489,839	891,538	10,412,391	148,806	191,779	75,013	339,585	672,290	294,961	1,947,878	165,718	19,136,756

Annual Intercity-Express Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Washington Area	-	15,410	29,170	132,308	1,551	845,795	-	9,558	13,242	-	25,031	7,147	22,397	4,617	1,106,227
Greater Baltimore Area	-	29,170	4,737	31,584	339	204,469	-	1,333	3,474	-	9,086	4,830	9,108	1,264	299,395
Greater Philadelphia Area	-	132,308	31,584	7,242	1,393	418,600	-	569	1,198	-	18,076	11,417	41,070	6,624	670,082
Leigh Valley Area	-	1,551	339	1,393	-	980	-	68	1	-	250	597	5,829	67	11,074
New York - North Jersey Area	-	845,795	204,469	418,600	980	68,241	-	25,500	735	-	155,148	175,892	892,659	18,930	2,806,947
South Central PA Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic City Area	-	9,558	1,333	569	68	25,500	-	157	139	-	2,314	300	425	460	40,823
Poughkeepsie-Newburgh-Middletown Area	-	13,242	3,474	1,198	1	735	-	139	0	-	463	439	4,998	75	24,764
Greater Albany Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Hartford Area	-	25,031	9,086	18,076	250	155,148	-	2,314	463	-	9,912	5,206	11,702	219	237,407
Greater Providence Area	-	7,147	4,830	11,417	597	175,892	-	300	439	-	5,206	2,250	11,933	84	220,096
Greater Boston Area	-	22,397	9,108	41,070	5,829	892,659	-	425	4,998	-	11,702	11,933	8,178	633	1,008,933
Springfield Area	-	4,617	1,264	6,624	67	18,930	-	460	75	-	219	84	633	1	32,975
Total Trips	-	1,106,227	299,395	670,082	11,074	2,806,947	-	40,823	24,764	-	237,407	220,096	1,008,933	32,975	6,458,723

Annual Intercity-Corridor Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	2,081	55,427	6,340	26,752	2,207	279,698	14,214	843	13,293	59,938	21,764	5,375	27,322	1,427	516,681
Greater Washington Area	55,427	568,935	349,216	589,479	14,680	2,220,282	106,611	16,331	48,721	36,663	87,486	54,921	147,233	16,663	4,312,648
Greater Baltimore Area	6,340	349,216	27,606	216,671	6,175	830,522	22,673	2,224	16,788	42,540	40,440	35,442	40,367	5,630	1,642,635
Greater Philadelphia Area	26,752	589,479	216,671	613,125	19,014	2,177,751	180,400	4,566	10,454	27,692	119,431	112,169	248,544	30,636	4,376,684
Leigh Valley Area	2,207	14,680	6,175	19,014	146	126,215	5,752	87	104	306	7,141	11,031	47,839	1,172	241,868
New York - North Jersey Area	279,698	2,220,282	830,522	2,177,751	126,215	1,887,218	105,063	31,900	93,385	391,641	1,129,831	757,384	1,813,688	187,518	12,032,097
South Central PA Area	14,214	106,611	22,673	180,400	5,752	105,063	36,225	1,319	2,616	17,613	26,057	11,947	22,480	3,717	556,687
Atlantic City Area	843	16,331	2,224	4,566	87	31,900	1,319	272	265	2,001	2,941	950	971	505	65,174
Poughkeepsie-Newburgh-Middletown Area	13,293	48,721	16,788	10,454	104	93,385	2,616	265	1,790	8,180	4,202	3,318	16,664	1,764	221,545
Greater Albany Area	59,938	36,663	42,540	27,692	306	391,641	17,613	2,001	8,180	23,845	13,511	9,909	37,225	5,931	676,993
Greater Hartford Area	21,764	87,486	40,440	119,431	7,141	1,129,831	26,057	2,941	4,202	13,511	31,241	46,386	132,043	3,470	1,665,944
Greater Providence Area	5,375	54,921	35,442	112,169	11,031	757,384	11,947	950	3,318	9,909	46,386	48,363	141,836	939	1,239,969
Greater Boston Area	27,322	147,233	40,367	248,544	47,839	1,813,688	22,480	971	16,664	37,225	132,043	141,836	129,924	11,384	2,817,519
Springfield Area	1,427	16,663	5,630	30,636	1,172	187,518	3,717	505	1,764	5,931	3,470	939	11,384	14	270,770
Total Trips	516,681	4,312,648	1,642,635	4,376,684	241,868	12,032,097	556,687	65,174	221,545	676,993	1,665,944	1,239,969	2,817,519	270,770	30,637,213

Source: NEC FUTURE team, 2015

Table I-5: Trip Tables by Mode and MSA pair: Alternative 3.1

Annual Auto Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	242,819	1,740,041	335,773	444,604	37,493	803,523	321,813	26,870	39,960	102,202	41,760	17,665	64,805	3,834	4,223,161
Greater Washington Area	1,740,041	48,716,793	2,812,356	3,671,314	349,025	5,438,556	1,968,703	220,502	231,083	163,067	287,594	138,299	502,940	92,436	66,332,710
Greater Baltimore Area	335,773	2,812,356	15,980,314	3,171,742	245,080	3,169,689	848,252	129,609	186,118	318,114	185,158	1,479,711	487,926	40,434	29,390,276
Greater Philadelphia Area	444,604	3,671,314	3,171,742	4,901,946	702,289	24,146,987	2,751,230	191,234	260,825	172,143	958,353	1,105,805	1,919,293	276,722	44,674,488
Leigh Valley Area	37,493	349,025	245,080	702,289	126,912	6,461,628	345,204	28,723	64,761	27,031	194,691	256,421	608,145	67,386	9,514,790
New York - North Jersey Area	803,523	5,438,556	3,169,689	24,146,987	6,461,628	161,046,351	1,067,908	2,731,030	4,093,527	2,959,586	10,174,398	8,063,485	19,117,650	2,625,607	251,899,925
South Central PA Area	321,813	1,968,703	848,252	2,751,230	345,204	1,067,908	963,101	106,370	148,170	145,072	210,519	88,828	141,731	72,051	9,178,953
Atlantic City Area	26,870	220,502	129,609	191,234	28,723	2,731,030	106,370	71,282	51,950	54,887	168,421	27,926	40,024	37,968	3,886,796
Poughkeepsie-Newburgh-Middletown Area	39,960	231,083	186,118	260,825	64,761	4,093,527	148,170	51,950	276,446	352,247	369,443	232,006	689,314	201,676	7,197,526
Greater Albany Area	102,202	163,067	318,114	172,143	27,031	2,959,586	145,072	54,887	352,247	1,033,472	558,770	364,636	1,168,024	417,905	7,837,155
Greater Hartford Area	41,760	287,594	185,158	958,353	194,691	10,174,398	210,519	168,421	369,443	558,770	4,126,306	1,358,134	2,958,600	229,911	21,822,058
Greater Providence Area	17,665	138,299	1,479,711	1,105,805	256,421	8,063,485	88,828	27,926	232,006	364,636	1,358,134	2,688,774	505,496	54,198	16,381,385
Greater Boston Area	64,805	502,940	487,926	1,919,293	608,145	19,117,650	141,731	40,024	689,314	1,168,024	2,958,600	505,496	937,287	519,606	29,660,841
Springfield Area	3,834	92,436	40,434	276,722	67,386	2,625,607	72,051	37,968	201,676	417,905	229,911	54,198	519,606	2,686	4,642,419
Total Trips	4,223,161	66,332,710	29,390,276	44,674,488	9,514,790	251,899,925	9,178,953	3,886,796	7,197,526	7,837,155	21,822,058	16,381,385	29,660,841	4,642,419	506,642,483

Annual Air Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	33,434	10,805	137,892	276	69,973	491	-	1,739	3,702	1,984	2,620	97,326	22	360,265
Greater Washington Area	33,434	-	-	403,514	83,880	1,175,914	105,027	-	12,726	134,614	239,648	330,640	1,815,079	107,721	4,442,197
Greater Baltimore Area	10,805	-	-	114,270	3,131	463,567	5,526	-	9,728	153,019	129,250	358,029	732,475	44,484	2,024,284
Greater Philadelphia Area	137,892	403,514	114,270	-	3,406	524,378	181,861	-	2,943	51,026	158,874	141,426	850,043	-	2,569,632
Leigh Valley Area	276	83,880	3,131	3,406	2	10,735	292	-	5	22	163	480	22,518	26	124,937
New York - North Jersey Area	69,973	1,175,914	463,567	524,378	10,735	-	11,978	-	-	37,126	22,467	57,677	1,683,720	12,460	4,069,994
South Central PA Area	491	105,027	5,526	181,861	292	11,978	-	-	205	143	978	1,450	4,190	-	312,141
Atlantic City Area	-	-	-	-	-	-	-	-	-	-	-	-	15,856	-	15,856
Poughkeepsie-Newburgh-Middletown Area	1,739	12,726	9,728	2,943	5	-	205	-	-	-	57	198	7,487	-	35,088
Greater Albany Area	3,702	134,614	153,019	51,026	22	37,126	143	-	-	-	138	687	10,414	-	390,891
Greater Hartford Area	1,984	239,648	129,250	158,874	163	22,467	978	-	57	138	-	-	431	-	553,990
Greater Providence Area	2,620	330,640	358,029	141,426	480	57,677	1,450	-	198	687	-	-	-	-	893,207
Greater Boston Area	97,326	1,815,079	732,475	850,043	22,518	1,683,720	4,190	15,856	7,487	10,414	431	-	-	-	5,239,537
Springfield Area	22	107,721	44,484	-	26	12,460	-	-	-	-	-	-	-	-	164,712
Total Trips	360,265	4,442,197	2,024,284	2,569,632	124,937	4,069,994	312,141	15,856	35,088	390,891	553,990	893,207	5,239,537	164,712	21,196,732

Annual Bus Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	3,745	79,235	20,862	7,467	327,838	7,284	3,793	3,626	-	8,926	390	6,331	-	469,497
Greater Washington Area	3,745	587	93,689	63,119	12,883	1,187,920	14,253	8,820	5,898	-	2,889	1,364	970	-	1,396,137
Greater Baltimore Area	79,235	93,689	251	57,115	28,913	332,064	23,595	2,782	1,474	-	2,977	1,087	993	-	624,175
Greater Philadelphia Area	20,862	63,119	57,115	63,217	9,806	1,212,195	36,684	1,614	1,404	-	2,781	3,248	18,059	-	1,490,105
Leigh Valley Area	7,467	12,883	28,913	9,806	5,866	784,140	4,239	565	418	622	7,796	2,046	26,760	440	891,962
New York - North Jersey Area	327,838	1,187,920	332,064	1,212,195	784,140	3,744,735	59,989	169,150	45,137	287,453	452,518	197,717	1,478,984	77,377	10,357,217
South Central PA Area	7,284	14,253	23,595	36,684	4,239	59,989	-	3,322	545	-	-	-	-	-	149,912
Atlantic City Area	3,793	8,820	2,782	1,614	565	169,150	3,322	-	444	-	610	207	533	-	191,839
Poughkeepsie-Newburgh-Middletown Area	3,626	5,898	1,474	1,404	418	45,137	545	444	448	1,390	776	349	10,278	1,609	73,794
Greater Albany Area	-	-	-	-	622	287,453	-	-	1,390	-	-	-	34,348	15,464	339,277
Greater Hartford Area	8,926	2,889	2,977	2,781	7,796	452,518	-	610	776	-	-	-	144,996	41,309	665,579
Greater Providence Area	390	1,364	1,087	3,248	2,046	197,717	-	207	349	-	-	-	76,023	5,747	288,177
Greater Boston Area	6,331	970	993	18,059	26,760	1,478,984	-	533	10,278	34,348	144,996	76,023	100,813	23,480	1,922,569
Springfield Area	-	-	-	-	440	77,377	-	-	1,609	15,464	41,309	5,747	23,480	-	165,425
Total Trips	469,497	1,396,137	624,175	1,490,105	891,962	10,357,217	149,912	191,839	73,794	339,277	665,579	288,177	1,922,569	165,425	19,025,664

Annual Intercity-Express Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Washington Area	-	16,438	31,136	152,241	1,771	1,121,093	-	9,528	43,262	-	35,210	10,118	36,290	6,901	1,463,988
Greater Baltimore Area	-	31,136	4,731	30,312	341	242,677	-	1,196	11,170	-	11,785	6,453	11,781	1,725	353,307
Greater Philadelphia Area	-	152,241	30,312	6,560	1,013	495,550	-	508	3,014	-	21,427	14,915	50,793	7,073	783,408
Leigh Valley Area	-	1,771	341	1,013	-	1,032	-	57	2	-	321	759	7,374	83	12,752
New York - North Jersey Area	-	1,121,093	242,677	495,550	1,032	85,917	-	27,979	1,992	-	166,820	190,785	1,069,635	21,532	3,425,012
South Central PA Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic City Area	-	9,528	1,196	508	57	27,979	-	139	285	-	2,619	325	482	533	43,651
Poughkeepsie-Newburgh-Middletown Area	-	43,262	11,170	3,014	2	1,992	-	285	1	-	579	788	11,497	89	72,681
Greater Albany Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Hartford Area	-	35,210	11,785	21,427	321	166,820	-	2,619	579	-	7,960	5,765	12,764	188	265,437
Greater Providence Area	-	10,118	6,453	14,915	759	190,785	-	325	788	-	5,765	2,275	12,314	91	244,589
Greater Boston Area	-	36,290	11,781	50,793	7,374	1,069,635	-	482	11,497	-	12,764	12,314	8,327	678	1,221,936
Springfield Area	-	6,901	1,725	7,073	83	21,532	-	533	89	-	188	91	678	1	38,894
Total Trips	-	1,463,988	353,307	783,408	12,752	3,425,012	-	43,651	72,681	-	265,437	244,589	1,221,936	38,894	7,925,656

Annual Intercity-Corridor Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	2,055	54,172	4,305	24,032	1,706	256,874	10,822	550	12,052	57,155	20,636	4,350	22,898	1,323	472,929
Greater Washington Area	54,172	570,761	340,750	576,613	14,694	2,133,494	88,078	14,749	52,903	37,686	101,587	68,025	179,489	16,356	4,249,357
Greater Baltimore Area	4,305	340,750	25,659	209,703	5,897	832,461	15,628	2,094	19,884	44,228	47,042	43,692	50,151	5,864	1,647,358
Greater Philadelphia Area	24,032	576,613	209,703	603,675	18,752	2,114,605	177,398	4,255	10,313	27,166	117,273	104,595	245,835	33,733	4,267,950
Leigh Valley Area	1,706	14,694	5,897	18,752	141	121,805	5,607	83	119	302	7,616	12,792	53,501	1,388	244,402
New York - North Jersey Area	256,874	2,133,494	832,461	2,114,605	121,805	1,941,903	94,848	27,570	96,779	395,192	1,217,409	842,329	1,956,339	194,186	12,225,794
South Central PA Area	10,822	88,078	15,628	177,398	5,607	94,848	35,481	1,188	2,741	16,568	23,973	11,614	16,936	5,164	506,045
Atlantic City Area	550	14,749	2,094	4,255	83	27,570	1,188	269	272	1,933	3,067	1,173	1,128	500	58,831
Poughkeepsie-Newburgh-Middletown Area	12,052	52,903	19,884	10,313	119	96,779	2,741	272	1,790	8,180	6,451	5,724	29,128	2,212	248,548
Greater Albany Area	57,155	37,686	44,228	27,166	302	395,192	16,568	1,933	8,180	23,845	16,581	11,567	43,607	5,905	689,914
Greater Hartford Area	20,636	101,587	47,042	117,273	7,616	1,217,409	23,973	3,067	6,451	16,581	39,555	43,359	129,394	4,284	1,778,226
Greater Providence Area	4,350	68,025	43,692	104,595	12,792	842,329	11,614	1,173	5,724	11,567	43,359	48,840	144,269	940	1,343,271
Greater Boston Area	22,898	179,489	50,151	245,835	53,501	1,956,339	16,936	1,128	29,128	43,607	129,394	144,269	130,837	10,180	3,013,691
Springfield Area	1,323	16,356	5,864	33,733	1,388	194,186	5,164	500	2,212	5,905	4,284	940	10,180	12	282,046
Total Trips	472,929	4,249,357	1,647,358	4,267,950	244,402	12,225,794	506,045	58,831	248,548	689,914	1,778,226	1,343,271	3,013,691	282,046	31,028,362

Source: NEC FUTURE team, 2015

Table I-6: Trip Tables by Mode and MSA pair: Alternative 3.2

Annual Auto Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	244,229	1,768,156	337,437	454,489	38,196	889,965	327,408	27,153	46,054	128,425	50,500	19,356	69,177	4,551	4,405,097
Greater Washington Area	1,768,156	48,717,004	2,810,666	3,668,343	348,990	5,413,667	1,968,402	220,515	244,848	163,254	287,532	138,917	504,284	92,605	66,347,183
Greater Baltimore Area	337,437	2,810,666	15,980,253	3,171,211	245,074	3,158,165	848,099	129,609	191,263	318,116	184,985	1,480,959	488,861	40,541	29,385,239
Greater Philadelphia Area	454,489	3,668,343	3,171,211	4,894,607	702,044	24,051,198	2,748,113	191,202	262,046	171,777	958,566	1,109,598	1,926,544	275,747	44,585,485
Leigh Valley Area	38,196	348,990	245,074	702,044	126,911	6,456,870	345,070	28,723	64,774	27,030	194,644	256,879	609,576	67,359	9,512,140
New York - North Jersey Area	889,965	5,413,667	3,158,165	24,051,198	6,456,870	161,033,301	1,064,512	2,729,360	4,096,721	2,959,734	10,153,933	8,066,608	19,116,884	2,617,755	251,808,672
South Central PA Area	327,408	1,968,402	848,099	2,748,113	345,070	1,064,512	962,356	106,347	148,297	144,539	211,248	89,077	142,283	71,513	9,177,264
Atlantic City Area	27,153	220,515	129,609	191,202	28,723	2,729,360	106,347	71,282	52,080	54,886	168,303	27,972	40,045	37,924	3,885,401
Poughkeepsie-Newburgh-Middletown Area	46,054	244,848	191,263	262,046	64,774	4,096,721	148,297	52,080	276,446	352,247	370,883	234,170	703,624	201,904	7,245,357
Greater Albany Area	128,425	163,254	318,116	171,777	27,030	2,959,734	144,539	54,886	352,247	1,033,472	558,727	364,866	1,168,890	417,813	7,863,779
Greater Hartford Area	50,500	287,532	184,985	958,566	194,644	10,153,933	211,248	168,303	370,883	558,727	4,124,834	1,357,220	2,956,329	230,021	21,807,724
Greater Providence Area	19,356	138,917	1,480,959	1,109,598	256,879	8,066,608	89,077	27,972	234,170	364,866	1,357,220	2,689,095	505,860	54,195	16,394,774
Greater Boston Area	69,177	504,284	488,861	1,926,544	609,576	19,116,884	142,283	40,045	703,624	1,168,890	2,956,329	505,860	942,781	519,178	29,694,316
Springfield Area	4,551	92,605	40,541	275,747	67,359	2,617,755	71,513	37,924	201,904	417,813	230,021	54,195	519,178	2,686	4,633,793
Total Trips	4,405,097	66,347,183	29,385,239	44,585,485	9,512,140	251,808,672	9,177,264	3,885,401	7,245,357	7,863,779	21,807,724	16,394,774	29,694,316	4,633,793	506,746,223

Annual Air Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	34,310	10,839	140,577	284	84,505	507	-	2,052	7,071	2,912	2,927	102,889	31	388,903
Greater Washington Area	34,310	-	-	402,758	83,876	1,156,124	105,017	-	19,129	134,618	240,011	332,102	1,819,940	107,887	4,435,773
Greater Baltimore Area	10,839	-	-	114,176	3,131	455,930	5,525	-	11,652	153,016	129,450	358,532	733,767	44,573	2,020,592
Greater Philadelphia Area	140,577	402,758	114,176	-	3,406	521,293	181,537	-	3,046	51,024	158,571	141,635	851,043	-	2,569,066
Leigh Valley Area	284	83,876	3,131	3,406	2	10,705	292	-	5	22	163	484	22,727	26	125,123
New York - North Jersey Area	84,505	1,156,124	455,930	521,293	10,705	-	11,799	-	-	37,075	22,412	58,069	1,685,659	12,304	4,055,876
South Central PA Area	507	105,017	5,525	181,537	292	11,799	-	-	207	142	976	1,480	4,563	-	312,045
Atlantic City Area	-	-	-	-	-	-	-	-	-	-	-	-	15,858	-	15,858
Poughkeepsie-Newburgh-Middletown Area	2,052	19,129	11,652	3,046	5	-	207	-	-	-	57	204	8,104	-	44,456
Greater Albany Area	7,071	134,618	153,016	51,024	22	37,075	142	-	-	-	138	688	10,430	-	394,223
Greater Hartford Area	2,912	240,011	129,450	158,571	163	22,412	976	-	57	138	-	-	431	-	555,121
Greater Providence Area	2,927	332,102	358,532	141,635	484	58,069	1,480	-	204	688	-	-	-	-	896,122
Greater Boston Area	102,889	1,819,940	733,767	851,043	22,727	1,685,659	4,563	15,858	8,104	10,430	431	-	-	-	5,255,411
Springfield Area	31	107,887	44,573	-	26	12,304	-	-	-	-	-	-	-	-	164,821
Total Trips	388,903	4,435,773	2,020,592	2,569,066	125,123	4,055,876	312,045	15,858	44,456	394,223	555,121	896,122	5,255,411	164,821	21,233,389

Annual Bus Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	3,757	79,776	21,790	7,673	374,420	7,538	3,839	3,835	-	9,738	476	6,810	-	519,651
Greater Washington Area	3,757	587	93,601	62,932	12,870	1,173,378	14,245	8,818	6,536	-	2,894	1,376	998	-	1,381,993
Greater Baltimore Area	79,776	93,601	251	57,089	28,911	329,306	23,582	2,782	1,525	-	2,975	1,098	1,011	-	621,908
Greater Philadelphia Area	21,790	62,932	57,089	62,979	9,799	1,199,923	36,535	1,611	1,407	-	2,771	3,257	18,153	-	1,478,246
Leigh Valley Area	7,673	12,870	28,911	9,799	5,866	782,509	4,231	565	417	622	7,796	2,056	26,902	441	890,657
New York - North Jersey Area	374,420	1,173,378	329,306	1,199,923	782,509	3,735,555	59,717	168,965	45,155	287,136	449,334	198,404	1,474,847	76,820	10,355,470
South Central PA Area	7,538	14,245	23,582	36,535	4,231	59,717	-	3,318	544	-	-	-	-	-	149,711
Atlantic City Area	3,839	8,818	2,782	1,611	565	168,965	3,318	-	445	-	610	210	542	-	191,705
Poughkeepsie-Newburgh-Middletown Area	3,835	6,536	1,525	1,407	417	45,155	544	445	448	1,390	789	361	10,733	1,611	75,196
Greater Albany Area	-	-	-	-	622	287,136	-	-	1,390	-	-	-	34,409	15,458	339,015
Greater Hartford Area	9,738	2,894	2,975	2,771	7,796	449,334	-	610	789	-	-	-	144,701	41,313	662,921
Greater Providence Area	476	1,376	1,098	3,257	2,056	198,404	-	210	361	-	-	-	76,063	5,747	289,045
Greater Boston Area	6,810	998	1,011	18,153	26,902	1,474,847	-	542	10,733	34,409	144,701	76,063	101,295	23,455	1,919,918
Springfield Area	-	-	-	-	441	76,820	-	-	1,611	15,458	41,313	5,747	23,455	-	164,844
Total Trips	519,651	1,381,993	621,908	1,478,246	890,657	10,355,470	149,711	191,705	75,196	339,015	662,921	289,045	1,919,918	164,844	19,040,280

Annual Intercity-Express Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Washington Area	-	16,509	30,774	150,427	1,747	1,106,614	-	9,505	14,313	-	34,813	10,238	36,818	6,872	1,418,630
Greater Baltimore Area	-	30,774	4,725	30,149	340	235,521	-	1,194	3,405	-	11,738	6,603	12,266	1,743	338,459
Greater Philadelphia Area	-	150,427	30,149	6,450	1,012	530,789	-	506	1,151	-	22,340	15,206	55,577	7,212	820,819
Leigh Valley Area	-	1,747	340	1,012	-	1,036	-	57	1	-	310	766	7,470	83	12,822
New York - North Jersey Area	-	1,106,614	235,521	530,789	1,036	66,101	-	28,835	704	-	166,666	195,694	1,057,717	20,698	3,410,375
South Central PA Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic City Area	-	9,505	1,194	506	57	28,835	-	139	140	-	2,719	353	512	547	44,506
Poughkeepsie-Newburgh-Middletown Area	-	14,313	3,405	1,151	1	704	-	140	0	-	409	439	5,291	63	25,916
Greater Albany Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Hartford Area	-	34,813	11,738	22,340	310	166,666	-	2,719	409	-	10,481	5,601	12,517	219	267,814
Greater Providence Area	-	10,238	6,603	15,206	766	195,694	-	353	439	-	5,601	2,282	12,366	90	249,637
Greater Boston Area	-	36,818	12,266	55,577	7,470	1,057,717	-	512	5,291	-	12,517	12,366	9,037	683	1,210,254
Springfield Area	-	6,872	1,743	7,212	83	20,698	-	547	63	-	219	90	683	1	38,210
Total Trips	-	1,418,630	338,459	820,819	12,822	3,410,375	-	44,506	25,916	-	267,814	249,637	1,210,254	38,210	7,837,442

Annual Intercity-Corridor Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	24	11,882	1,089	5,141	390	35,829	2,794	94	1,782	9,535	3,592	1,106	7,704	149	81,111
Greater Washington Area	11,882	570,370	343,594	584,527	14,791	2,240,240	88,539	14,750	50,237	37,402	101,719	64,678	169,898	15,877	4,308,505
Greater Baltimore Area	1,089	343,594	25,751	210,857	5,908	872,205	15,871	2,096	17,755	44,230	47,147	40,951	46,483	5,554	1,679,491
Greater Philadelphia Area	5,141	584,527	210,857	615,442	19,122	2,243,958	182,581	4,305	10,464	27,718	116,514	98,980	228,463	35,125	4,383,195
Leigh Valley Area	390	14,791	5,908	19,122	143	130,884	5,802	82	103	303	7,716	12,127	50,772	1,424	249,565
New York - North Jersey Area	35,829	2,240,240	872,205	2,243,958	130,884	1,997,063	100,393	30,269	93,528	395,253	1,252,918	829,029	1,970,186	207,479	12,399,234
South Central PA Area	2,794	88,539	15,871	182,581	5,802	100,393	36,551	1,224	2,573	17,326	22,810	11,248	15,483	5,918	509,113
Atlantic City Area	94	14,750	2,096	4,305	82	30,269	1,224	269	252	1,933	3,122	1,076	1,045	544	61,062
Poughkeepsie-Newburgh-Middletown Area	1,782	50,237	17,755	10,464	103	93,528	2,573	252	1,790	8,180	4,619	3,119	14,246	1,926	210,574
Greater Albany Area	9,535	37,402	44,230	27,718	303	395,253	17,326	1,933	8,180	23,845	16,639	11,243	42,243	6,044	641,894
Greater Hartford Area	3,592	101,719	47,147	116,514	7,716	1,252,918	22,810	3,122	4,619	16,639	38,828	44,805	133,040	4,085	1,797,553
Greater Providence Area	1,106	64,678	40,951	98,980	12,127	829,029	11,248	1,076	3,119	11,243	44,805	48,356	143,629	945	1,311,292
Greater Boston Area	7,704	169,898	46,483	228,463	50,772	1,970,186	15,483	1,045	14,246	42,243	133,040	143,629	121,374	10,778	2,955,343
Springfield Area	149	15,877	5,554	35,125	1,424	207,479	5,918	544	1,926	6,044	4,085	945	10,778	12	295,861
Total Trips	81,111	4,308,505	1,679,491	4,383,195	249,565	12,399,234	509,113	61,062	210,574	641,894	1,797,553	1,311,292	2,955,343	295,861	30,883,792

Source: NEC FUTURE team, 2015

Table I-7: Trip Tables by Mode and MSA pair: Alternative 3.3

Annual Auto Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	242,776	1,739,131	335,638	443,835	37,444	800,641	321,359	26,851	39,622	100,775	41,692	17,737	64,718	3,829	4,216,048
Greater Washington Area	1,739,131	48,716,878	2,812,543	3,671,250	349,027	5,400,201	1,968,660	220,518	244,534	162,938	287,225	140,187	496,887	92,378	66,302,356
Greater Baltimore Area	335,638	2,812,543	15,980,313	3,171,802	245,080	3,156,817	848,252	129,612	191,259	318,114	184,855	1,486,714	486,997	40,523	29,388,519
Greater Philadelphia Area	443,835	3,671,250	3,171,802	4,901,946	702,281	24,047,267	2,751,233	191,233	262,062	172,143	956,454	1,114,789	1,914,706	275,873	44,576,872
Leigh Valley Area	37,444	349,027	245,080	702,281	126,912	6,457,146	345,204	28,723	64,774	27,031	194,582	259,491	607,503	67,350	9,512,549
New York - North Jersey Area	800,641	5,400,201	3,156,817	24,047,267	6,457,146	161,031,674	1,066,566	2,729,275	4,096,707	2,959,628	10,145,132	8,155,755	19,011,199	2,616,542	251,674,550
South Central PA Area	321,359	1,968,660	848,252	2,751,233	345,204	1,066,566	963,101	106,370	148,310	145,072	209,765	90,000	141,411	71,688	9,176,991
Atlantic City Area	26,851	220,518	129,612	191,233	28,723	2,729,275	106,370	71,282	52,080	54,887	168,509	28,123	39,820	37,979	3,885,261
Poughkeepsie-Newburgh-Middletown Area	39,622	244,534	191,259	262,062	64,774	4,096,707	148,310	52,080	276,446	352,247	370,953	234,268	703,696	201,920	7,238,878
Greater Albany Area	100,775	162,938	318,114	172,143	27,031	2,959,628	145,072	54,887	352,247	1,033,472	558,643	365,221	1,165,821	417,818	7,833,810
Greater Hartford Area	41,692	287,225	184,855	956,454	194,582	10,145,132	209,765	168,509	370,953	558,643	4,127,482	1,368,931	2,952,467	229,979	21,796,670
Greater Providence Area	17,737	140,187	1,486,714	1,114,789	259,491	8,155,755	90,000	28,123	234,268	365,221	1,368,931	2,690,182	507,050	54,245	16,512,693
Greater Boston Area	64,718	496,887	486,997	1,914,706	607,503	19,011,199	141,411	39,820	703,696	1,165,821	2,952,467	507,050	907,821	515,181	29,515,276
Springfield Area	3,829	92,378	40,523	275,873	67,350	2,616,542	71,688	37,979	201,920	417,818	229,979	54,245	515,181	2,685	4,627,990
Total Trips	4,216,048	66,302,356	29,388,519	44,576,872	9,512,549	251,674,550	9,176,991	3,885,261	7,238,878	7,833,810	21,796,670	16,512,693	29,515,276	4,627,990	506,258,461

Annual Air Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	33,406	10,802	137,667	275	69,466	490	-	1,710	3,600	1,976	2,660	97,090	22	359,165
Greater Washington Area	33,406	-	-	403,517	83,881	1,153,180	105,026	-	19,117	134,605	239,201	341,131	1,812,794	107,610	4,433,467
Greater Baltimore Area	10,802	-	-	114,283	3,131	455,589	5,526	-	11,652	153,019	129,160	361,135	733,803	44,530	2,022,631
Greater Philadelphia Area	137,667	403,517	114,283	-	3,406	521,216	181,861	-	3,047	51,026	158,497	143,186	851,187	-	2,568,894
Leigh Valley Area	275	83,881	3,131	3,406	2	10,708	292	-	5	22	163	509	22,564	26	124,984
New York - North Jersey Area	69,466	1,153,180	455,589	521,216	10,708	-	11,873	-	-	37,074	22,283	61,956	1,676,524	12,275	4,032,145
South Central PA Area	490	105,026	5,526	181,861	292	11,873	-	-	207	143	973	1,564	4,187	-	312,143
Atlantic City Area	-	-	-	-	-	-	-	-	-	-	-	-	15,856	-	15,856
Poughkeepsie-Newburgh-Middletown Area	1,710	19,117	11,652	3,047	5	-	207	-	-	-	57	203	8,139	-	44,137
Greater Albany Area	3,600	134,605	153,019	51,026	22	37,074	143	-	-	-	138	691	10,416	-	390,733
Greater Hartford Area	1,976	239,201	129,160	158,497	163	22,283	973	-	57	138	-	-	431	-	552,879
Greater Providence Area	2,660	341,131	361,135	143,186	509	61,956	1,564	-	203	691	-	-	-	-	913,036
Greater Boston Area	97,090	1,812,794	733,803	851,187	22,564	1,676,524	4,187	15,856	8,139	10,416	431	-	-	-	5,232,992
Springfield Area	22	107,610	44,530	-	26	12,275	-	-	-	-	-	-	-	-	164,463
Total Trips	359,165	4,433,467	2,022,631	2,568,894	124,984	4,032,145	312,143	15,856	44,137	390,733	552,879	913,036	5,232,992	164,463	21,167,523

Annual Bus Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	3,743	79,177	20,775	7,443	325,969	7,260	3,788	3,607	-	8,919	392	6,323	-	467,396
Greater Washington Area	3,743	587	93,694	63,117	12,883	1,169,605	14,251	8,821	6,575	-	2,890	1,454	875	-	1,378,496
Greater Baltimore Area	79,177	93,694	251	57,117	28,913	329,237	23,595	2,782	1,525	-	2,970	1,124	979	-	621,364
Greater Philadelphia Area	20,775	63,117	57,117	63,217	9,806	1,199,092	36,684	1,614	1,407	-	2,773	3,305	18,041	-	1,476,948
Leigh Valley Area	7,443	12,883	28,913	9,806	5,866	782,663	4,239	565	417	622	7,794	2,102	26,813	441	890,567
New York - North Jersey Area	325,969	1,169,605	329,237	1,199,092	782,663	3,735,562	59,903	168,957	45,154	287,128	448,450	202,537	1,459,643	76,779	10,290,677
South Central PA Area	7,260	14,251	23,595	36,684	4,239	59,903	-	3,322	545	-	-	-	-	-	149,801
Atlantic City Area	3,788	8,821	2,782	1,614	565	168,957	3,322	-	445	-	610	232	523	-	191,660
Poughkeepsie-Newburgh-Middletown Area	3,607	6,575	1,525	1,407	417	45,154	545	445	448	1,390	791	362	10,689	1,611	74,965
Greater Albany Area	-	-	-	-	622	287,128	-	-	1,390	-	-	-	34,222	15,458	338,821
Greater Hartford Area	8,919	2,890	2,970	2,773	7,794	448,450	-	610	791	-	-	-	144,305	41,307	660,807
Greater Providence Area	392	1,454	1,124	3,305	2,102	202,537	-	232	362	-	-	-	76,553	5,747	293,806
Greater Boston Area	6,323	875	979	18,041	26,813	1,459,643	-	523	10,689	34,222	144,305	76,553	98,782	22,973	1,900,719
Springfield Area	-	-	-	-	441	76,779	-	-	1,611	15,458	41,307	5,747	22,973	-	164,315
Total Trips	467,396	1,378,496	621,364	1,476,948	890,567	10,290,677	149,801	191,660	74,965	338,821	660,807	293,806	1,900,719	164,315	18,900,342

Annual Intercity-Express Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Washington Area	-	16,572	31,291	151,697	1,770	1,103,809	-	9,495	14,358	-	36,732	6,059	33,961	7,047	1,412,791
Greater Baltimore Area	-	31,291	4,732	30,164	341	235,542	-	1,191	3,405	-	12,281	3,901	11,266	1,736	335,848
Greater Philadelphia Area	-	151,697	30,164	6,560	1,017	531,000	-	508	1,154	-	22,023	8,988	48,165	7,059	808,336
Leigh Valley Area	-	1,770	341	1,017	-	1,037	-	57	1	-	322	442	7,023	80	12,088
New York - North Jersey Area	-	1,103,809	235,542	531,000	1,037	66,050	-	28,936	699	-	180,476	131,486	1,002,275	19,653	3,300,962
South Central PA Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic City Area	-	9,495	1,191	508	57	28,936	-	139	140	-	2,421	239	513	458	44,098
Poughkeepsie-Newburgh-Middletown Area	-	14,358	3,405	1,154	1	699	-	140	0	-	252	273	3,526	26	23,833
Greater Albany Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Hartford Area	-	36,732	12,281	22,023	322	180,476	-	2,421	252	-	9,842	2,290	11,393	271	278,303
Greater Providence Area	-	6,059	3,901	8,988	442	131,486	-	239	273	-	2,290	1,150	10,436	83	165,347
Greater Boston Area	-	33,961	11,266	48,165	7,023	1,002,275	-	513	3,526	-	11,393	10,436	5,759	530	1,134,846
Springfield Area	-	7,047	1,736	7,059	80	19,653	-	458	26	-	271	83	530	3	36,945
Total Trips	-	1,412,791	335,848	808,336	12,088	3,300,962	-	44,098	23,833	-	278,303	165,347	1,134,846	36,945	7,553,395

Annual Intercity-Corridor Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	2,115	55,541	4,583	25,525	1,809	264,826	11,464	583	12,694	59,938	20,777	4,163	23,353	1,333	488,705
Greater Washington Area	55,541	570,493	340,319	577,273	14,693	2,277,282	88,143	14,757	50,613	37,875	101,274	54,183	195,760	16,454	4,394,660
Greater Baltimore Area	4,583	340,319	25,659	209,753	5,897	875,261	15,628	2,095	17,761	44,228	47,199	32,134	50,239	5,652	1,676,409
Greater Philadelphia Area	25,525	577,273	209,753	603,693	18,765	2,252,494	177,394	4,256	10,439	27,166	119,958	95,750	252,738	35,110	4,410,314
Leigh Valley Area	1,809	14,693	5,897	18,765	140	130,275	5,607	82	103	302	7,776	8,843	54,373	1,437	250,103
New York - North Jersey Area	264,826	2,277,282	875,261	2,252,494	130,275	1,999,426	97,108	30,333	93,553	395,414	1,254,502	750,847	2,214,295	210,219	12,845,835
South Central PA Area	11,464	88,143	15,628	177,394	5,607	97,108	35,481	1,188	2,556	16,568	25,104	9,699	17,335	5,672	508,946
Atlantic City Area	583	14,757	2,095	4,256	82	30,333	1,188	269	251	1,933	3,157	950	1,384	564	61,802
Poughkeepsie-Newburgh-Middletown Area	12,694	50,613	17,761	10,439	103	93,553	2,556	251	1,790	8,180	4,680	3,143	15,945	1,941	223,649
Greater Albany Area	59,938	37,875	44,228	27,166	302	395,414	16,568	1,933	8,180	23,845	16,761	10,752	46,976	6,036	695,972
Greater Hartford Area	20,777	101,274	47,199	119,958	7,776	1,254,502	25,104	3,157	4,680	16,761	35,676	31,652	140,120	4,091	1,812,726
Greater Providence Area	4,163	54,183	32,134	95,750	8,843	750,847	9,699	950	3,143	10,752	31,652	47,734	142,794	885	1,193,528
Greater Boston Area	23,353	195,760	50,239	252,738	54,373	2,214,295	17,335	1,384	15,945	46,976	140,120	142,794	180,758	17,575	3,353,642
Springfield Area	1,333	16,454	5,652	35,110	1,437	210,219	5,672	564	1,941	6,036	4,091	885	17,575	12	306,982
Total Trips	488,705	4,394,660	1,676,409	4,410,314	250,103	12,845,835	508,946	61,802	223,649	695,972	1,812,726	1,193,528	3,353,642	306,982	32,223,274

Source: NEC FUTURE team, 2015

Table I-8: Trip Tables by Mode and MSA pair: Alternative 3.4

Annual Auto Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	242,776	1,739,131	335,638	443,835	37,444	800,557	321,359	26,851	39,622	100,775	41,692	17,734	64,701	3,829	4,215,944
Greater Washington Area	1,739,131	48,716,817	2,812,399	3,670,295	349,031	5,485,099	1,968,591	220,456	244,074	162,946	286,576	139,905	495,966	92,294	66,383,580
Greater Baltimore Area	335,638	2,812,399	15,980,251	3,171,174	245,078	3,181,174	848,225	129,599	189,795	318,120	184,722	1,486,276	486,310	40,411	29,409,174
Greater Philadelphia Area	443,835	3,670,295	3,171,174	4,901,755	702,259	24,158,193	2,751,224	191,218	262,257	172,146	956,089	1,113,863	1,909,210	276,227	44,679,745
Leigh Valley Area	37,444	349,031	245,078	702,259	126,912	6,461,619	345,204	28,723	64,762	27,031	194,566	259,338	606,317	67,359	9,515,642
New York - North Jersey Area	800,557	5,485,099	3,181,174	24,158,193	6,461,619	161,064,778	1,067,908	2,731,292	4,094,586	2,959,630	10,158,800	8,157,600	19,061,824	2,623,026	252,006,086
South Central PA Area	321,359	1,968,591	848,225	2,751,224	345,204	1,067,908	963,101	106,370	148,172	145,072	210,559	90,055	141,060	72,064	9,178,964
Atlantic City Area	26,851	220,456	129,599	191,218	28,723	2,731,292	106,370	71,279	52,108	54,886	168,391	28,091	39,778	37,981	3,887,022
Poughkeepsie-Newburgh-Middletown Area	39,622	244,074	189,795	262,257	64,762	4,094,586	148,172	52,108	276,446	352,247	369,706	233,912	693,462	201,716	7,222,867
Greater Albany Area	100,775	162,946	318,120	172,146	27,031	2,959,630	145,072	54,886	352,247	1,033,472	558,668	365,153	1,165,094	417,907	7,833,148
Greater Hartford Area	41,692	286,576	184,722	956,089	194,566	10,158,800	210,559	168,391	369,706	558,668	4,129,418	1,368,615	2,954,604	229,838	21,812,245
Greater Providence Area	17,734	139,905	1,486,276	1,113,863	259,338	8,157,600	90,055	28,091	233,912	365,153	1,368,615	2,690,160	506,960	54,247	16,511,911
Greater Boston Area	64,701	495,966	486,310	1,909,210	606,317	19,061,824	141,060	39,778	693,462	1,165,094	2,954,604	506,960	907,678	515,294	29,548,256
Springfield Area	3,829	92,294	40,411	276,227	67,359	2,623,026	72,064	37,981	201,716	417,907	229,838	54,247	515,294	2,685	4,634,876
Total Trips	4,215,944	66,383,580	29,409,174	44,679,745	9,515,642	252,006,086	9,178,964	3,887,022	7,222,867	7,833,148	21,812,245	16,511,911	29,548,256	4,634,876	506,839,459

Annual Air Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	33,406	10,802	137,667	275	69,483	490	-	1,710	3,600	1,976	2,660	97,046	22	359,138
Greater Washington Area	33,406	-	-	403,274	83,881	1,197,498	105,023	-	18,348	134,606	238,402	340,567	1,808,459	107,350	4,470,815
Greater Baltimore Area	10,802	-	-	114,199	3,131	467,297	5,526	-	11,236	153,017	128,919	361,006	732,893	44,390	2,032,415
Greater Philadelphia Area	137,667	403,274	114,199	-	3,406	524,855	181,861	-	3,073	51,026	158,306	142,917	849,662	-	2,570,244
Leigh Valley Area	275	83,881	3,131	3,406	2	10,735	292	-	5	22	163	508	22,414	26	124,859
New York - North Jersey Area	69,483	1,197,498	467,297	524,855	10,735	-	11,978	-	-	37,126	22,267	61,912	1,678,822	12,383	4,094,354
South Central PA Area	490	105,023	5,526	181,861	292	11,978	-	-	205	143	980	1,560	4,164	-	312,220
Atlantic City Area	-	-	-	-	-	-	-	-	-	-	-	-	15,855	-	15,855
Poughkeepsie-Newburgh-Middletown Area	1,710	18,348	11,236	3,073	5	-	205	-	-	-	57	203	7,755	-	42,593
Greater Albany Area	3,600	134,606	153,017	51,026	22	37,126	143	-	-	-	138	691	10,404	-	390,773
Greater Hartford Area	1,976	238,402	128,919	158,306	163	22,267	980	-	57	138	-	-	431	-	551,638
Greater Providence Area	2,660	340,567	361,006	142,917	508	61,912	1,560	-	203	691	-	-	-	-	912,022
Greater Boston Area	97,046	1,808,459	732,893	849,662	22,414	1,678,822	4,164	15,855	7,755	10,404	431	-	-	-	5,227,904
Springfield Area	22	107,350	44,390	-	26	12,383	-	-	-	-	-	-	-	-	164,171
Total Trips	359,138	4,470,815	2,032,415	2,570,244	124,859	4,094,354	312,220	15,855	42,593	390,773	551,638	912,022	5,227,904	164,171	21,269,000

Annual Bus Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	3,743	79,177	20,775	7,443	326,039	7,260	3,788	3,607	-	8,919	392	6,321	-	467,465
Greater Washington Area	3,743	587	93,681	63,072	12,884	1,199,347	14,250	8,821	6,824	-	2,878	1,445	864	-	1,408,395
Greater Baltimore Area	79,177	93,681	251	57,093	28,912	332,980	23,593	2,781	1,545	-	2,971	1,117	971	-	625,072
Greater Philadelphia Area	20,775	63,072	57,093	63,217	9,805	1,212,653	36,684	1,614	1,416	-	2,767	3,300	17,965	-	1,490,362
Leigh Valley Area	7,443	12,884	28,912	9,805	5,866	784,128	4,239	565	418	622	7,791	2,098	26,702	440	891,914
New York - North Jersey Area	326,039	1,199,347	332,980	1,212,653	784,128	3,746,375	59,989	169,187	45,151	287,453	450,817	202,458	1,469,871	77,279	10,363,725
South Central PA Area	7,260	14,250	23,593	36,684	4,239	59,989	-	3,322	545	-	-	-	-	-	149,883
Atlantic City Area	3,788	8,821	2,781	1,614	565	169,187	3,322	-	447	-	608	230	516	-	191,879
Poughkeepsie-Newburgh-Middletown Area	3,607	6,824	1,545	1,416	418	45,151	545	447	448	1,390	780	356	10,314	1,609	74,848
Greater Albany Area	-	-	-	-	622	287,453	-	-	1,390	-	-	-	34,175	15,463	339,104
Greater Hartford Area	8,919	2,878	2,971	2,767	7,791	450,817	-	608	780	-	-	-	144,580	41,299	663,410
Greater Providence Area	392	1,445	1,117	3,300	2,098	202,458	-	230	356	-	-	-	76,538	5,747	293,680
Greater Boston Area	6,321	864	971	17,965	26,702	1,469,871	-	516	10,314	34,175	144,580	76,538	98,770	22,987	1,910,573
Springfield Area	-	-	-	-	440	77,279	-	-	1,609	15,463	41,299	5,747	22,987	-	164,823
Total Trips	467,465	1,408,395	625,072	1,490,362	891,914	10,363,725	149,883	191,879	74,848	339,104	663,410	293,680	1,910,573	164,823	19,035,133

Annual Intercity-Express Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Washington Area	-	16,527	31,225	152,762	1,762	996,668	-	9,606	-	-	39,567	6,465	36,329	7,579	1,298,492
Greater Baltimore Area	-	31,225	4,737	30,567	341	216,821	-	1,210	55	-	13,356	4,199	12,099	1,869	316,480
Greater Philadelphia Area	-	152,762	30,567	6,789	1,016	464,664	-	526	245	-	23,956	9,692	50,423	7,835	748,475
Leigh Valley Area	-	1,762	341	1,016	-	1,010	-	57	-	-	361	474	7,434	88	12,542
New York - North Jersey Area	-	996,668	216,821	464,664	1,010	51,498	-	27,563	17	-	188,396	133,489	975,559	21,797	3,077,483
South Central PA Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic City Area	-	9,606	1,210	526	57	27,563	-	144	41	-	2,613	255	541	497	43,053
Poughkeepsie-Newburgh-Middletown Area	-	-	55	245	-	17	-	41	-	-	-	137	-	-	496
Greater Albany Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greater Hartford Area	-	39,567	13,356	23,956	361	188,396	-	2,613	-	-	6,336	2,317	11,571	270	288,743
Greater Providence Area	-	6,465	4,199	9,692	474	133,489	-	255	137	-	2,317	1,186	10,702	84	169,001
Greater Boston Area	-	36,329	12,099	50,423	7,434	975,559	-	541	-	-	11,571	10,702	5,765	533	1,110,957
Springfield Area	-	7,579	1,869	7,835	88	21,797	-	497	-	-	270	84	533	3	40,555
Total Trips	-	1,298,492	316,480	748,475	12,542	3,077,483	-	43,053	496	-	288,743	169,001	1,110,957	40,555	7,106,276

Annual Intercity-Corridor Rail Trips	Greater Richmond Area	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	Leigh Valley Area	New York - North Jersey Area	South Central PA Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Richmond Area	2,115	55,541	4,583	25,525	1,809	264,869	11,464	583	12,694	59,938	20,778	4,168	23,450	1,333	488,851
Greater Washington Area	55,541	570,626	340,628	578,111	14,695	2,146,533	88,253	14,730	67,973	37,858	100,617	55,098	200,831	16,392	4,287,887
Greater Baltimore Area	4,583	340,628	25,741	210,405	5,902	836,347	15,671	2,092	23,814	44,223	46,632	32,685	51,641	5,879	1,646,242
Greater Philadelphia Area	25,525	578,111	210,405	603,778	18,801	2,129,548	177,407	4,259	11,034	27,163	118,862	96,605	260,994	33,641	4,296,133
Leigh Valley Area	1,809	14,695	5,902	18,801	141	121,856	5,607	83	120	302	7,755	9,027	56,084	1,417	243,599
New York - North Jersey Area	264,869	2,146,533	836,347	2,129,548	121,856	1,947,681	94,844	27,577	97,272	395,128	1,223,118	747,632	2,160,718	197,712	12,390,835
South Central PA Area	11,464	88,253	15,671	177,407	5,607	94,844	35,481	1,188	2,738	16,568	23,950	9,614	17,945	5,145	505,875
Atlantic City Area	583	14,730	2,092	4,259	83	27,577	1,188	268	311	1,933	3,118	980	1,436	522	59,082
Poughkeepsie-Newburgh-Middletown Area	12,694	67,973	23,814	11,034	120	97,272	2,738	311	1,790	8,180	6,682	3,772	34,853	2,249	273,481
Greater Albany Area	59,938	37,858	44,223	27,163	302	395,128	16,568	1,933	8,180	23,845	16,732	10,851	48,111	5,901	696,733
Greater Hartford Area	20,778	100,617	46,632	118,862	7,755	1,223,118	23,950	3,118	6,682	16,732	36,721	32,084	136,700	4,306	1,778,056
Greater Providence Area	4,168	55,098	32,685	96,605	9,027	747,632	9,614	980	3,772	10,851	32,084	47,729	142,681	881	1,193,805
Greater Boston Area	23,450	200,831	51,641	260,994	56,084	2,160,718	17,945	1,436	34,853	48,111	136,700	142,681	181,000	17,397	3,333,840
Springfield Area	1,333	16,392	5,879	33,641	1,417	197,712	5,145	522	2,249	5,901	4,306	881	17,397	12	292,787
Total Trips	488,851	4,287,887	1,646,242	4,296,133	243,599	12,390,835	505,875	59,082	273,481	696,733	1,778,056	1,193,805	3,333,840	292,787	31,487,206

Source: NEC FUTURE team, 2015

Appendix J – MSA-to-MSA Level Regional Rail Trips for each Alternative

Table J-1: Regional Rail Linked Trips by MSA pair: Year 2040 No Action Alternative, Origin-Destination Format

Annual Intercity-Corridor Rail Trips	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	South Central PA Area	Leigh Valley Area	New York - North Jersey Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Washington Area	13,649,394	4,309,919	39,312	0	0	0	0	0	0	0	0	0		17,998,625
Greater Baltimore Area	4,309,919	263,633	0	0	0	0	0	0	0	0	0	0	0	4,573,553
Greater Philadelphia Area	39,312	0	31,963,840	0	0	786,472	4,144	0	0	0	0	0	0	32,793,768
South Central PA Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leigh Valley Area	0	0	0	0	0	181,892	0	0	0	0	0	0	0	181,892
New York - North Jersey Area	0	0	786,472	0	181,892	314,804,584	0	3,103,116	0	0	0	0	0	318,876,064
Atlantic City Area	0	0	4,144	0	0	0	0	0	0	0	0	0	0	4,144
Poughkeepsie-Newburgh-Middletown Area	0	0	0	0	0	3,103,116	0	177,896	0	0	0	0	0	3,281,012
Greater Albany Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Hartford Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Providence Area	0	0	0	0	0	0	0	0	0	0	706,230	2,384,633	0	3,090,863
Greater Boston Area	0	0	0	0	0	0	0	0	0	0	2,384,633	36,637,525	0	39,022,158
Springfield Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	17,998,625	4,573,553	32,793,768	0	181,892	318,876,064	4,144	3,281,012	0	0	3,090,863	39,022,158	0	419,822,078

Source: NEC FUTURE team, 2015

Table J-2: Regional Rail Linked Trips by MSA pair: Year 2040 Alternative 1, Origin-Destination Format

Annual Intercity-Corridor Rail Trips	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	South Central PA Area	Leigh Valley Area	New York - North Jersey Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Washington Area	23,377,514	5,886,307	62,517	0	0	0	0	0	0	0	0	0		29,326,338
Greater Baltimore Area	5,886,307	426,647	0	0	0	0	0	0	0	0	0	0	0	6,312,954
Greater Philadelphia Area	62,517	0	35,215,712	0	0	1,027,120	12,580	0	0	0	0	0	0	36,317,929
South Central PA Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leigh Valley Area	0	0	0	0	0	206,016	0	0	0	0	0	0	0	206,016
New York - North Jersey Area	0	0	1,027,120	0	206,016	339,779,880	0	3,251,856	0	0	0	0	0	344,264,872
Atlantic City Area	0	0	12,580	0	0	0	0	0	0	0	0	0	0	12,580
Poughkeepsie-Newburgh-Middletown Area	0	0	0	0	0	3,251,856	0	172,272	0	0	0	0	0	3,424,128
Greater Albany Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Hartford Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Providence Area	0	0	0	0	0	0	0	0	0	0	3,976,895	4,066,870	0	8,043,765
Greater Boston Area	0	0	0	0	0	0	0	0	0	0	4,066,870	42,492,685	0	46,559,555
Springfield Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	29,326,338	6,312,954	36,317,929	0	206,016	344,264,872	12,580	3,424,128	0	0	8,043,765	46,559,555	0	474,468,138

Source: NEC FUTURE team, 2015

Table J-3: Regional Rail Linked Trips by MSA pair: Year 2040 Alternative 2, Origin-Destination Format

Annual Intercity-Corridor Rail Trips	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	South Central PA Area	Leigh Valley Area	New York - North Jersey Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Washington Area	29,992,651	6,716,964	62,927	0	0	0	0	0	0	0	0	0		36,772,542
Greater Baltimore Area	6,716,964	454,706	0	0	0	0	0	0	0	0	0	0	0	7,171,670
Greater Philadelphia Area	62,927	0	36,386,392	0	0	1,264,216	12,580	0	0	0	0	0	0	37,726,115
South Central PA Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leigh Valley Area	0	0	0	0	0	208,088	0	0	0	0	0	0	0	208,088
New York - North Jersey Area	0	0	1,264,216	0	208,088	349,257,504	0	3,152,696	0	0	0	0	0	353,882,504
Atlantic City Area	0	0	12,580	0	0	0	0	0	0	0	0	0	0	12,580
Poughkeepsie-Newburgh-Middletown Area	0	0	0	0	0	3,152,696	0	171,976	0	0	0	0	0	3,324,672
Greater Albany Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Hartford Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Providence Area	0	0	0	0	0	0	0	0	0	0	3,624,370	4,141,210	0	7,765,580
Greater Boston Area	0	0	0	0	0	0	0	0	0	0	4,141,210	44,346,465	0	48,487,675
Springfield Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	36,772,542	7,171,670	37,726,115	0	208,088	353,882,504	12,580	3,324,672	0	0	7,765,580	48,487,675	0	495,351,426

Source: NEC FUTURE team, 2015

Table J-4: Regional Rail Linked Trips by MSA pair: Year 2040 Alternative 3, Origin-Destination Format

Annual Intercity-Corridor Rail Trips	Greater Washington Area	Greater Baltimore Area	Greater Philadelphia Area	South Central PA Area	Leigh Valley Area	New York - North Jersey Area	Atlantic City Area	Poughkeepsie-Newburgh-Middletown Area	Greater Albany Area	Greater Hartford Area	Greater Providence Area	Greater Boston Area	Springfield Area	Total Trips
Greater Washington Area	37,063,509	7,482,062	99,645	0	0	0	0	0	0	0	0	0		44,645,216
Greater Baltimore Area	7,482,062	481,676	0	0	0	0	0	0	0	0	0	0	0	7,963,738
Greater Philadelphia Area	99,645	0	37,925,888	0	0	1,490,804	12,580	0	0	0	0	0	0	39,528,917
South Central PA Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leigh Valley Area	0	0	0	0	0	249,972	0	0	0	0	0	0	0	249,972
New York - North Jersey Area	0	0	1,490,804	0	249,972	374,433,488	0	3,449,436	0	0	0	0	0	379,623,700
Atlantic City Area	0	0	12,580	0	0	0	0	0	0	0	0	0	0	12,580
Poughkeepsie-Newburgh-Middletown Area	0	0	0	0	0	3,449,436	0	172,272	0	0	0	0	0	3,621,708
Greater Albany Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Hartford Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Providence Area	0	0	0	0	0	0	0	0	0	0	4,218,795	4,665,130	0	8,883,925
Greater Boston Area	0	0	0	0	0	0	0	0	0	0	4,665,130	56,309,010	0	60,974,140
Springfield Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	44,645,216	7,963,738	39,528,917	0	249,972	379,623,700	12,580	3,621,708	0	0	8,883,925	60,974,140	0	545,503,896

Source: NEC FUTURE team, 2015